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| 1.1. COVER PAGE | |
| Name and designation of project part: | E - STUDY ON THE RESULTS OF GEOTECHNICAL AND GEOPHYSICAL INVESTIGATIONS |
| The Orderer: | SAFEGE DOO BEOGRAD Beogradska ulica 27 11000 Belgrade Serbia |
| Structure: | NOVI SAD REGIONAL WASTE MANAGEMENT CENTER |
| Type of technical documentation: | PD – Preliminary design |
| For construction/execution of works: | New construction |
| Seal and signature: | Designer: Civil Engineering Institute Central Road Laboratory LLC Veternik Živorada Petrovića 13, Veternik, Novi Sad Dr. Radomir Jakovljević, PhD Civil Eng. General director |
| Signature: | Responsible designer: Nikola Dakić, M.Sc.Geol.Eng. 391 R032 18 |
| Number of project part: | GEL-001-419.1-22 |
| Place and date: | Veternik, Novi Sad, October 2022 |

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1.3. DECISION ON APPOINTING THE RESPONSIBLE DESIGNER

Pursuant to the Law on Mining and Geological Research (Official Gazette of the RS No. 101/15, 95/18 and 40/21), the Law on Planning and Construction ("Official Gazette of the RS", No. 72/2009, 81/2009 - corrected, 64/2010 - decision of CC, 24/2011, 121/2012, 42/2013 - decision of CC, 50/2013 - decision of CC, 98/2013 - decision of CC, 132/2014, 145/2014, 83/ 2018, 31/2019, 37/2019 - other law, 9/2020 and 52/2021) and other Legal acts, regulations and standards related to this area such as:

RESPONSIBLE DESIGNER

for the making of the "STUDY ON THE RESULTS OF THE GEOTECHNICAL AND GEOPHYSICAL INVESTIGATIONS FOR THE NOVI SAD REGIONAL WASTE MANAGEMENT CENTER", the following is appointed:

Nikola Dakić, M.Sc.Geol.Eng.391 R032 18

Designer:

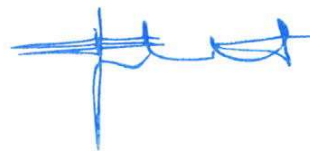
Civil Engineering Institute Central
Road Laboratory LLC Veternik,
13 Živorada Petrovića
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Responsible
person /
Representative:

Dr. Radomir Jakovljević, PhD Civil
Eng.
General director

Seal:

Signature:



Number of
technical
documentation:

GEL-001-419.1-22

Place and date:

Veternik, Novi Sad, October 2022

1.4. STATEMENT OF THE AUTHORIZED PERSON FOR THE STUDY ON GEOTECHNICAL INVESTIGATION

As an authorized person who prepared the "**STUDY ON THE RESULTS OF THE
GEOTECHNICAL AND GEOPHYSICAL INVESTIGATIONS FOR THE NOVI SAD
REGIONAL WASTE MANAGEMENT CENTER** "

Nikola Dakić, M.Sc.Geol.Eng.

I H E R E B Y D E C L A R E

1. that the Study is made in all respects in accordance with the Law on Planning and Construction, regulations, standards and norms in the field of geotechnics and rules of the profession;
2. that during the preparation of the study all prescribed and determined measures and recommendations for the fulfillment of the basic requirements for the facility were respected, and that the Study was prepared in accordance with the measures and recommendations proving the fulfillment of the basic requirements.

Responsible designer:

Nikola Dakić, M.Sc.Geol.Eng.

Licence no.:

391 R032 18

Signature:



Number of technical
documentation:

GEL-001-419.1-22

Place and date:

Veternik, Novi Sad, October 2022

1.5. TEXT DOCUMENTATION

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1. INTRODUCTION

On the basis of the agreement between "CIVIL ENGINEERING INSTITUTE CENTRAL ROAD LABORATORY" LLC VETERNIK, from Novi Sad, as the Contractor, and "SAFEGE" DOO BELGRADE (VRAČAR), from Belgrade, as Client, terrain investigation works and laboratory tests were carried out and a "Study on the results of geotechnical and geophysical investigations for the Novi Sad Regional Waste Management Center".

For the purpose of preparing this study, archival documentation was used and investigation works were carried out, which consisted of terrain and laboratory investigations and tests. Terrain investigations were carried out by the Contractor, and included investigation drilling, penetration tests and excavation of trial pits. Laboratory tests of soil samples were performed at the Contractor's headquarters, i.e. at an accredited laboratory for geomechanics and foundation engineering. The results of investigations and testing are analyzed and presented in special chapters of the study.

Terrain investigation works and laboratory tests were carried out in the period from August to October 2022.

The report was prepared in all respects according to the "Law on Planning and Construction of Facilities" (Official Gazette of the RS No. 72/09, 81/09-corrected, 64/10 - CC decision, 24/11, 121/12, 42/13 - CC decision, 50/13 - CC decision, 98/13 - CC decision, 132/14, 145/14, 83/18, 31/19, 37/19 - other law, 9/20 and 52/21), "The Law on Mining and Geological Research" (Official Gazette of the RS No. 101/15, 95/18 and 40/21), "Regulations on the Content of the Geological Research Project and Research Results" (Official Gazette of the RS No. 44/95 and 51/96), "Regulations on the content, method and procedure of preparation and the method of control of technical documentation according to the class and purpose of the facilities" (Official Gazette of the RS No. 73/19), as well as other valid regulations and standards for the preparation this type of technical documentation.

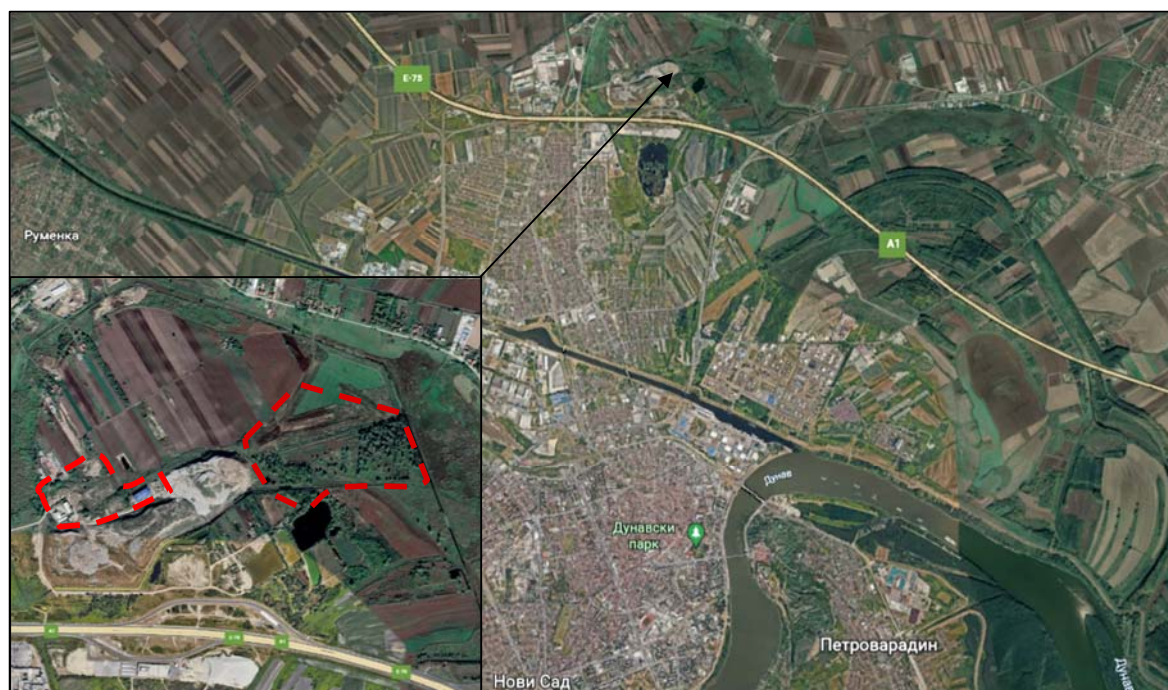
2. GENERAL

The construction of the Novi Sad Regional Waste Management Center is planned next to the existing unsanitary city landfill. The existing city landfill in Novi Sad is located north of the city center of Novi Sad, at a distance of about 150 meters from the IA state road A1 (highway E75) Subotica - Novi Sad - Belgrade and about 400 meters from the state IIA road no. 100 Subotica - Novi Sad - Belgrade. Access to the location also takes place via IIA state road no. 100. The location of the landfill is about 700 meters from the outskirts of the city and about 6 km from the center of Novi Sad.

The absolute elevations of the terrain in the zones of the facilities in question have been significantly altered by planned and unplanned dumping of municipal and construction waste, and range from 73.00 - 80.00 m above sea level. The investigation terrain in question covers an area of ~ 50 ha.

The location of the investigation site in question is shown on the terrain layout with the location of the investigation works, within the **Attachment 1.6.1**.

Photo 1 shows a wider and narrower view of the geographical position of the investigation area.




 - locations covered by newly designed investigation works

Photo 1 - Geographical position of the investigation area (<https://earth.google.com>)

3. TYPES AND SCOPE OF CONDUCTED INVESTIGATIONS AND TESTS

Investigation works included terrain and laboratory tests and investigations. Terrain investigations collected data on the spatial position of the soil layers, their thickness, the depth of the ground water level, appropriate terrain tests were performed, while in the laboratory, laboratory tests were performed to examine the physical and mechanical characteristics of the soil.

The scope and content of the investigation works is appropriate in accordance with the size, importance and purpose of the facilities as well as the phase of the project.

3.1. ANALYSIS OF EXISTING DOCUMENTATION

In order to determine the degree of investigation of the terrain that is the subject of the study, an analysis of the results of the investigations carried out in its immediate and wider surroundings was carried out. An overview of the documentation used for the preparation of this study is given in **Table 1**.

Table 1 - Archival documentation used

| Serial number | Documentation name | The Contractor | Year of publication |
|---------------|--|--|---------------------|
| 1. | Basic geological map and explanatory text for the Novi Sad sheet, L 34-100 | "Federal geological institute", Belgrade | 1977 |
| 2. | Geotechnical study of the performed investigation works for the proposed regional landfill in Novi Sad | "Hidrozavod DTD" JSC, Novi Sad | 2016 |
| 3. | Geotechnical study on the stabilization conditions of the untreated municipal waste landfill in Novi Sad | "Tehnohidrosfera" LLC, Beočin | 2020 |
| 4. | Study on geotechnical investigations, which is part of the Preliminary Design for the construction of a Regional Sanitary Landfill with accompanying facilities for waste management for the City of Novi Sad and the municipalities of Bačka Palanka, Bački Petrovac, Beočin, Žabalj, Srbobran, Temerin and Vrbas, with the aim of establishing a regional waste management system, on cp. no. Phase 1: 106/1, 106/3, 107, 109/3, 113/1, 113/3, 113/6, 113/8, 114/5, 119/1, 119/11, 119/12, 119/13, 119/14, 119/15, 120/2, 120/3, 135/1, 135/2, 136/2, 136/3, 138, 141, 3175/1, 3177/2, 3177/5, C.P. Novi Sad III Phase 2: part 115, part 117, part 118/1, 119/11, 120/2, 120/3, part 123/3, part 124, part 125, part 126, part 127, part 128/1, part 128/2, part 129, part 130, part 131, part 132, 135/1, 135/2, 136/2, 136/3, 138, 141, 3175/1, 3177/2, 3177/5 C.P. Novi Sad III | "Hidrozavod DTD" JSC, Novi Sad | 2021 |
| 5. | Seismic hazard map of the Republic of Serbia Return period 475 years | "Seismological Survey of Serbia", Belgrade | 2018 |
| 6. | Landfill design, which is part of the Preliminary Design for the construction of a Regional Sanitary Landfill with accompanying facilities for waste management for the City of Novi Sad and the municipalities of Bačka Palanka, Bački Petrovac, Beočin, Žabalj, Srbobran, Temerin and Vrbas, with the aim of establishing a regional waste management system, on cp. no. Phase I: 106/1, 106/3, 107, 109/3, 113/1, 113/3, 113/6, 113/8, 114/5, 119/1, 119/11, 119/12, 119/13, 119/14, 119/15, 120/2, 120/3, 135/1, 135/2, 136/2, 136/3, 138, 141, 3175/1, 3177/2, 3177/5, C.P. Novi Sad III Phase II: part 115, part 117, part 118/1, 119/11, 120/2, 120/3, part 123/3, part 124, part 125, part 126, part 127, part 128/1, part 128/2, part 129, part 130, part 131, part 132, 135/1, 135/2, 136/2, 136/3, 138, 141, 3175/1, 3177/2, 3177/5 C.P. Novi Sad III | "Hidrozavod DTD" JSC, Novi Sad | 2021 |
| 7. | Structure design, which is part of the Preliminary Design for the construction of a Regional Sanitary Landfill with accompanying facilities for waste management for the City of Novi Sad and the municipalities of Bačka Palanka, Bački Petrovac, Beočin, Žabalj, Srbobran, Temerin and Vrbas, with the aim of establishing a regional waste management system, on cp. no. Phase 1: 106/1, 106/3, 107, 109/3, 113/1, 113/3, 113/6, 113/8, 114/5, 119/1, 119/11, 119/12, 119/13, 119/14, 119/15, 120/2, 120/3, 135/1, 135/2, 136/2, 136/3, 138, 141, 3175/1, 3177/2, 3177/5, C.P. Novi Sad III | "Hidrozavod DTD" JSC, Novi Sad | 2021 |

| Serial number | Documentation name | The Contractor | Year of publication |
|---------------|---|------------------------------------|---------------------|
| | Phase II: part 115, part 117, part 118/1, 119/11, 120/2, 120/3, part 123/3, part 124, part 125, part 126, part 127, part 128/1, part 128/2, part 129, part 130, part 131, part 132, 135/1, 135/2, 136/2, 136/3, 138, 141, 3175/1, 3177/2, 3177/5 C.P. Novi Sad III | | |
| 8. | <p>Road design, which is part of the Preliminary Design for the construction of a Regional Sanitary Landfill with accompanying facilities for waste management for the City of Novi Sad and the municipalities of Bačka Palanka, Bački Petrovac, Beočin, Žabalj, Srbobran, Temerin and Vrbas, with the aim of establishing a regional waste management system, on cp. no.</p> <p>Phase 1: 106/1, 106/3, 107, 109/3, 113/1, 113/3, 113/6, 113/8, 114/5, 119/1, 119/11, 119/12, 119/13, 119/14, 119/15, 120/2, 120/3, 135/1, 135/2, 136/2, 136/3, 138, 141, 3175/1, 3177/2, 3177/5, C.P. Novi Sad III</p> <p>Phase II: part 115, part 117, part 118/1, 119/11, 120/2, 120/3, part 123/3, part 124, part 125, part 126, part 127, part 128/1, part 128/2, part 129, part 130, part 131, part 132, 135/1, 135/2, 136/2, 136/3, 138, 141, 3175/1, 3177/2, 3177/5 C.P. Novi Sad III</p> | "Hidrozagradnja DTD" JSC, Novi Sad | 2021 |

The analysis of the results of the existing investigations determined that the given location was the subject of investigations for the purposes of the preparation of basic geological documentation and the preliminary design level.

The aforementioned documentation under number 1 served as a review of regional investigations and provides only basic data on the geological structure, age and tectonics of the examined terrain, as well as its wider surroundings.

On the basis of the mentioned existing documents under numbers 2, 3 and 4, it can be concluded that the investigations was sufficient for observing the hydrogeological, general geological and seismic characteristics of the terrain, however, not sufficient for defining the engineering geological and geotechnical characteristics of the terrain, which play a crucial role in analysis of construction conditions and calculation of the interaction of facilities and soil. Therefore, in 2022, additional geotechnical investigations and tests were carried out.

Documentation under number 5 was used to define the seismicity of the terrain and determine the acceleration of soil oscillation at the given location.

Documentation under numbers 6, 7 and 8 served as the basis for performing geotechnical calculations and defining the conditions and recommendations for the construction of the designed facilities within the investigation area.

On the basis of the above, the methods and scope of the investigations necessary to determine all the relevant parameters that define this terrain as a geotechnical environment for the purposes of preparing the study were defined.

3.2. TERRAIN INVESTIGATIONS

Terrain investigations were carried out with the aim of collecting data on the lithological structure of the terrain, the spatial position of the soil layers, their thickness, the depth to the groundwater level, active geodynamic processes and phenomena, all with the aim of supplementing existing geotechnical documentation.

The terrain investigation works carried out at the location in question consisted of:

- Reconnaissance and engineering geological mapping of the terrain (~ 50 ha);
- Investigation drilling with engineering geological mapping of the core of investigation boreholes and taking samples for laboratory tests (42 investigation boreholes);
- Excavation of trial pits with engineering geological mapping of trial pits and taking samples for laboratory tests (11 trial pits);

- Performance of standard penetration tests - SPT (49 tests);
- Performance of cone penetration tests - CPTu (9 tests);
- Performance of dynamic penetration tests - DPSH-A (3 tests).

The spatial layout of the terrain investigation works in the subject investigation area is shown on the terrain layout with the location of the investigation works, which is given in the **Attachment 1.6**.

3.2.1. Reconnaissance and engineering geological mapping of the terrain

Based on the provided geodetic layout of the terrain, the analysis of archival documentation and the site inspection, a detailed engineering geological mapping of the terrain was carried out within the limits of the investigation area of the facility, an area of about 50 ha.

Reconnaissance and engineering-geological mapping of the terrain was carried out within the boundaries of the investigation area that is the subject of the investigations. On that occasion, the lithological units present in the surface part of the terrain were determined, as well as all engineering geological and hydrogeological processes and phenomena that could have an impact on the construction and exploitation of the facility in question.

3.2.2. Investigation drilling

Investigation drilling was performed with a Fraste ML hydraulic machine drilling rig, a rotary process with continuous coring, with an initial and final drilling diameter of Ø 131 mm. In this way, the reliable separation of characteristic lithological environments and their spatial representation, sampling, determination of the occurrence and level of ground water, etc. are ensured.

In the subject area, forty-two (42) investigation boreholes were drilled with the designations B-1 to B-42, with a total drilling length of 470.20 m' (individual depths from 10.00 m to 25.00 m), the data of which are attached in **Table 2**.

Table 2 - Overview of the technical characteristics of the performed investigation borehole

| Designation | Coordinates | | | Depth (m) | GWL (m) | The Contractor, date |
|-------------|-------------|-----------|-------|-----------|---------|----------------------|
| | X | Y | Z | | | |
| B-1 | 5 019 239 | 7 409 214 | 79.04 | 10.00 | 3.60 | GI CPL, 03-09-2022 |
| B-2 | 5 019 253 | 7 409 238 | 79.30 | 10.00 | 3.50 | GI CPL, 03-09-2022 |
| B-3 | 5 019 277 | 7 409 208 | 78.18 | 10.00 | 3.70 | GI CPL, 03-09-2022 |
| B-4 | 5 019 301 | 7 409 223 | 78.36 | 10.00 | 3.80 | GI CPL, 05-09-2022 |
| B-5 | 5 019 282 | 7 409 219 | 78.13 | 10.00 | 3.80 | GI CPL, 12-09-2022 |
| B-6 | 5 019 191 | 7 409 326 | 78.92 | 10.00 | 4.00 | GI CPL, 25-08-2022 |
| B-7 | 5 019 182 | 7 409 330 | 79.11 | 10.00 | 3.60 | GI CPL, 27-08-2022 |
| B-8 | 5 019 153 | 7 409 270 | 79.56 | 10.00 | 4.00 | GI CPL, 30-08-2022 |
| B-9 | 5 019 156 | 7 409 289 | 79.40 | 10.00 | 4.60 | GI CPL, 31-08-2022 |
| B-10 | 5 019 140 | 7 409 239 | 79.63 | 10.00 | 4.30 | GI CPL, 30-08-2022 |
| B-11 | 5 019 132 | 7 409 244 | 80.14 | 10.00 | 4.50 | GI CPL, 30-08-2022 |
| B-12 | 5 019 138 | 7 409 314 | 79.19 | 10.00 | - | GI CPL, 25-08-2022 |
| B-13 | 5 019 173 | 7 409 353 | 78.86 | 20,00 | 3.70 | GI CPL, 31-08-2022 |
| B-14 | 5 019 144 | 7 409 381 | 78.73 | 12.00 | 1.80 | GI CPL, 31-08-2022 |
| B-15 | 5 019 197 | 7 409 438 | 79.12 | 20,00 | - | GI CPL, 27-08-2022 |
| B-16 | 5 019 240 | 7 409 483 | 79.19 | 12.00 | 3.50 | GI CPL, 06-09-2022 |
| B-17 | 5 019 222 | 7 409 500 | 79.24 | 12.00 | 3.50 | GI CPL, 25-08-2022 |
| B-18/P-2 | 5 019 184 | 7 409 509 | 78.29 | 11.00 | 3.84 | GI CPL, 06-09-2022 |
| B-19 | 5 019 229 | 7 409 460 | 79.29 | 10.00 | 3.40 | GI CPL, 06-09-2022 |
| B-20 | 5 019 389 | 7 409 397 | 79.67 | 10.00 | 5.80 | GI CPL, 01-09-2022 |
| B-21 | 5 019 358 | 7 409 378 | 79.40 | 10.00 | 5.00 | GI CPL, 01-09-2022 |

| Designation | Coordinates | | | Depth (m) | GWL (m) | The Contractor, date |
|-------------|-------------|-----------|-------|-----------|---------|----------------------|
| | X | Y | Z | | | |
| B-22/P-1 | 5 019 349 | 7 409 314 | 79.27 | 10.00 | 4.74 | GI CPL, 08-09-2022 |
| B-23 | 5 019 330 | 7 409 305 | 79.21 | 10.00 | 5.00 | GI CPL, 05-09-2022 |
| B-24 | 5 019 345 | 7 409 300 | 79.11 | 10.00 | 5.00 | GI CPL, 05-09-2022 |
| B-25 | 5 019 322 | 7 409 288 | 78.90 | 10.00 | 5.20 | GI CPL, 01-09-2022 |
| B-26 | 5 019 225 | 7 409 588 | 79.56 | 10.00 | 4.00 | GI CPL, 08-09-2022 |
| B-27 | 5 019 274 | 7 409 586 | 79.74 | 10.00 | 4.00 | GI CPL, 02-09-2022 |
| B-28 | 5 019 246 | 7 409 614 | 79.59 | 10.00 | 4.00 | GI CPL, 08-09-2022 |
| B-29 | 5 019 279 | 7 409 661 | 79.71 | 10.00 | 4.00 | GI CPL, 02-09-2022 |
| B-30 | 5 019 304 | 7 409 646 | 79.71 | 10.20 | 4.00 | GI CPL, 29-08-2022 |
| B-31 | 5 019 325 | 7 409 672 | 79.72 | 10.00 | 4.00 | GI CPL, 29-08-2022 |
| B-32 | 5 019 307 | 7 409 683 | 80.11 | 10.00 | 4.00 | GI CPL, 29-08-2022 |
| B-33 | 5 019 226 | 7 410 390 | 76.90 | 10.00 | 1.90 | GI CPL, 26-08-2022 |
| B-34 | 5 019 247 | 7 410 397 | 76.70 | 10.00 | 2.00 | GI CPL, 26-08-2022 |
| B-35 | 5 019 250 | 7 409 370 | 76.68 | 10.00 | 1.50 | GI CPL, 26-08-2022 |
| B-36/P-3 | 5 019 224 | 7 410 302 | 76.90 | 25.00 | 1.17 | GI CPL, 07-09-2022 |
| B-37 | 5 019 249 | 7 410 326 | 76.68 | 10.00 | 1.50 | GI CPL, 09-09-2022 |
| B-38 | 5 019 237 | 7 410 278 | 76.75 | 10.00 | 1.50 | GI CPL, 09-09-2022 |
| B-39 | 5 019 240 | 7 410 258 | 76.65 | 10.00 | 1.50 | GI CPL, 09-09-2022 |
| B-40 | 5 019 504 | 7 410 806 | 74.14 | 14.00 | 1.10 | GI CPL, 12-09-2022 |
| B-41 | 5 019 439 | 7 410 449 | 73.86 | 12.00 | 2.10 | GI CPL, 13-09-2022 |
| B-42 | 5 019 545 | 7 410 145 | 74.85 | 12.00 | 1.40 | GI CPL, 13-09-2022 |

At the time of performing the investigation boreholes, the level of ground water in the boreholes was registered at depths of 1.10 m to 5.80 m from the terrain surface.

The location of the investigation boreholes is shown on the terrain layout with the location of the investigation works given within the **Attachment 1.6.1**.

3.2.3. Engineering geological mapping of the core of investigation boreholes and taking samples for laboratory tests

Along with the performance of investigation boreholes, detailed engineering geological mapping of the core was performed and representative soil samples were taken. After each drilling interval, the core was removed from the sampler and cleaned, and then a detailed engineering geological mapping of the same was performed. During the mapping, lithological soil types, humidity, consistency, color, etc. were determined. After completing the mapping, the core was placed in boxes, labeled with the investigation work designation and photographed.

After mapping the core of the investigation boreholes, representative soil samples were selected for laboratory tests. The samples were properly labeled, packed and transported to the accredited laboratory for geomechanical testing. A total of 470.20 m' of core was mapped in detail.

After the completion of investigation drilling and sampling, as well as engineering geological mapping of the core, the investigation boreholes were backfilled, with compaction, whereby the terrain was brought to approximately the same condition as before drilling.

The results of engineering geological mapping of investigation boreholes are documented in the form of profiles of investigation boreholes and presented in the Documentation book within the **Attachment 1.5.1.1-41**.

3.2.4. Excavation of trial pits

Immediately after the drilling of investigation boreholes, trial pits were also drilled, as their supporting element, with the aim of taking samples to obtain the data needed for determining compaction parameters and the California bearing ratio.

For the purposes of determining the condition and composition of the subsurface soil, as well as obtaining the results of terrain and laboratory tests that are carried out in trial pits or on samples from trial pits, and within the framework of the construction of the Waste Management Regional Center in Novi Sad, by the "Civil Engineering Institute Central Road Laboratory", in 2022, a total of 11 (eleven) investigation boreholes were drilled. The trial pits are marked with labels from TP-1 to TP-11, and the total depth is 18.90 m (individual depths from 1.40 to 2.10 m), the basic data of which are attached in **Table 3**. Excavation of trial pits was carried out with a JCB 3XC combined operating machine.

Table 3 - Overview of the basic identification data of the excavated trial pits

| Designation | Coordinates | | | Depth (m) | GWL (m) | The Contractor, date |
|-------------|-------------|-----------|-------|-----------|---------|----------------------|
| | X | Y | Z | | | |
| TP-1 | 5 019 243 | 7 409 193 | 78.70 | 2.10 | - | GI CPL, 02-09-2022 |
| TP-2 | 5 019 255 | 7 409 263 | 80.50 | 1.90 | - | GI CPL, 02-09-2022 |
| TP-3 | 5 019 337 | 7 409 433 | 79.50 | 2.00 | - | GI CPL, 02-09-2022 |
| TP-4 | 5 019 369 | 7 409 626 | 76.80 | 1.50 | 1.50 | GI CPL, 02-09-2022 |
| TP-5 | 5 019 281 | 7 409 600 | 79.60 | 1.50 | - | GI CPL, 02-09-2022 |
| TP-6 | 5 019 452 | 7 409 945 | 75.20 | 1.40 | - | GI CPL, 02-09-2022 |
| TP-7 | 5 019 296 | 7 409 438 | 80.50 | 1.40 | - | GI CPL, 02-09-2022 |
| TP-8 | 5 019 213 | 7 410 332 | 80.50 | 2.00 | - | GI CPL, 02-09-2022 |
| TP-9 | 5 019 310 | 7 410 656 | 76.40 | 1.40 | - | GI CPL, 02-09-2022 |
| TP-10 | 5 019 608 | 7 410 616 | 78.20 | 1.70 | 1.70 | GI CPL, 02-09-2022 |
| TP-11 | 5 019 682 | 7 410 358 | 76.60 | 2.00 | 2.00 | GI CPL, 05-09-2022 |

At the time of the excavation of the trial pits, the groundwater level was registered in trial pits TP-4 (at the bottom of the pit, at a depth of 1.50 m from the terrain surface), TP-10 (at the bottom of the pit, at a depth of 1.70 m from the terrain surface) and TP -11 (at the bottom of the pit, at a depth of 2.00 m from the terrain surface).

The location of the trial pits is shown on the terrain layout with the location of the investigation works given within the **Attachment 1.6.1**.

3.2.5. Engineering geological mapping of the trial pits and taking samples for laboratory tests

After the excavation, engineering geological mapping of the trial pits was carried out and they were marked with basic identification data.

During mapping, special attention is paid to determining the lithological type of soil, humidity, consistency and color. During the mapping, representative samples were taken for laboratory tests and the trial pits were photographed. The samples were properly labeled, packed and carefully transported to the Accredited laboratory. A total of ~ 37.80m³ was mapped.

Also, in the trial pits, the testing of the terrain value of the California bearing ratio CBR (using a dynamic cone penetrometer) and the dynamic modulus of deformations (using a circular plate load) was performed.

The results of engineering geological mapping of trial pits are documented in the form of profiles of trial pits and presented in the Documentation book within the **Attachment 1.5.2.1-11**.

3.2.6. Standard Penetration Test - SPT test

Standard penetration tests were carried out in accordance with the "EN ISO 22476-3" standard. The beating of the cylinder with the blade, i.e. the cone, it was performed with the blows of a hammer weighing 63.5 kg, which fell freely from a height of 0.76 m.

Standard penetration testing was performed in investigation boreholes labeled B-2, B-3, B-8, B-12, B-18/P-2, B-20, B-25, B-26, B-27, B-28, B-32, B-35, B-36/P-3, B-38, B-40, B-41 and B-42, and a total of forty-nine (49) tests were performed. On that occasion, the number of hammer blows required for three successive indentations of 15 cm each was recorded, so the first measurement is not taken into account, so the final result N represents the sum of the second and third counts for a total penetration of 30 cm. After removing the accessories, the material in the two-part sampler is removed and soil identification is performed on the disturbed sample.

The main goal of the standard penetration tests was to define the homogeneity or heterogeneity of the soil, to estimate the parameters of strength and deformability of unbound environments based on literature correlations, to establish direct correlations with the results of laboratory tests, to take soil samples from a split-spoon sampler to define identification and classification indicators, to directly determine the bearing capacity and subsidence of shallow and deep foundations (depending on the need).

The depth of the measuring point and the number of blows N are documented and shown in the profile of the investigation boreholes in the Documentation book in the **Attachment 1.5.1.1-41** and the **Attachment 1.7.2**, while the analyzes of the results of standard penetration tests will be presented in the following chapters of this study.

3.2.7. Cone penetration test - CPTu test

The cone penetration tests were performed in accordance with the "SRPS EN ISO 22476-1" standard, using a Pagani TG-63 penetrometer with a capacity of 200 kN. By static penetration with the use of a piezocone, the penetration resistance of the cone q_c (MPa), the friction along the rod casing f_s (kPa) and the pore pressure U_2 (kPa) were measured.

The main goal of scone penetration tests is to determine the resistant properties of unbound and water-saturated coarse-grained environments, from which it is difficult to obtain suitable samples for laboratory geomechanical tests, soil homogeneity or heterogeneity, soil identification, compaction evaluation, assessment of bearing capacity and subsidence. Therefore, these tests, combined with investigation drilling and laboratory tests, give a complete picture of the terrain. The cone penetration test was performed at nine (9) investigation locations, with a total length of 192.57 m'.

The technical characteristics of the performed cone penetration tests are shown in **Table 4**.

Table 4 - Overview of the technical characteristics of the performed CPTu tests

| Designation | Coordinates | | | Depth (m) | The Contractor, date |
|-------------|-------------|-----------|-------|-----------|----------------------|
| | X | Y | Z | | |
| CPTu-1 | 5 019 286 | 7 409 214 | 78.84 | 21.08 | GI CPL, 07-09-2022 |
| CPTu-2 | 5 019 334 | 7 409 280 | 79.10 | 24.74 | GI CPL, 09-09-2022 |
| CPTu-3 | 5 019 376 | 7 409 367 | 79.40 | 22.62 | GI CPL, 13-09-2022 |
| CPTu-4 | 5 019 192 | 7 409 323 | 79.00 | 25.81 | GI CPL, 14-09-2022 |
| CPTu-5 | 5 019 243 | 7 409 218 | 79.50 | 21.93 | GI CPL, 19-09-2022 |
| CPTu-6 | 5 019 223 | 7 409 591 | 79.35 | 19.93 | GI CPL, 12-09-2022 |
| CPTu-7 | 5 019 249 | 7 410 332 | 76.68 | 18.35 | GI CPL, 22-09-2022 |
| CPTu-8 | 5 019 237 | 7 410 383 | 76.80 | 20.09 | GI CPL, 15-09-2022 |
| CPTu-9 | 5 019 250 | 7 410 263 | 76.65 | 18.02 | GI CPL, 15-09-2022 |

The results of the CPTu test are shown in the form of a diagram in the Documentation book in the **Attachment 1.7.1**, while the analysis of the test results is shown in the following chapters of this study.

3.2.8. Dynamic penetration test - DPSH-A test

The dynamic penetration test was performed with a Pagani TG-63 hydraulic penetrometer. The dynamic penetration test was performed according to the "SRPS EN ISO 22476-2" standard. The spike and the equipment for the DPSH-A test were used for the testing. The test was carried out with blows of a hammer weighing 63.5 kg, which fell freely from a height of 0.76 m. The test was carried out by continuously driving the cone into the ground under the blows of a hammer, with the number of blows recorded for every 10 cm of penetration of the cone, which resulted in the N_{10} number of blows. In total, three (3) dynamic penetration tests were performed, at depths from 2.40 to 20.00 m.

Technical data on performed dynamic penetrations are given in **Table 5**.

Table 5 - Technical data of performed DPSH tests

| Serial number | Designation | Coordinates | | | Depth (m) |
|---------------|-------------|-------------|-----------|-------|-----------|
| | | X | Y | Z | |
| 1. | DPSH-1 | 5 019 334 | 7 409 280 | 79.10 | 15.00 |
| 2. | DPSH-2 | 5 019 312 | 7 409 667 | 80.00 | 20.00 |
| 3. | DPSH-3 | 5 019 288 | 7 409 639 | 79.80 | 2.40 |

The main goal of the dynamic penetration tests was to define the homogeneity or heterogeneity of the soil in locations where it was not possible to perform the CPTu test, to estimate the parameters of strength and deformability of unbound environments based on literature correlations, to establish direct correlations with the results of laboratory tests, to directly determine the bearing capacity and subsidence of shallow and deep foundations (depending on the need). The results of the DPSH-A tests are shown in the Documentation book in the **Attachment 1.57.3**, while the analysis of the results of the dynamic penetration test is shown in the following chapters of this study.

3.3. LABORATORY TESTS

Laboratory tests were performed on disturbed and undisturbed samples from investigation boreholes and pits in order to determine the physical and mechanical properties of isolated lithological environments. The laboratory tests were performed in accordance with the applicable regulations and standards for the appropriate type of test in the Laboratory for Geomechanics and Foundation engineering of the "Civil Engineering Institute Central Road Laboratory", based in Veternik, Novi Sad.

The laboratory tests included ninety-four (94) samples from investigation boreholes, labeled from B-1 to B-42, and twenty-three (23) samples from trial pits, labeled from TP-1 to TP-11, and a total of one hundred seventeen (117) disturbed and undisturbed soil samples. **Table 6** shows the number and type of performed laboratory tests.

Table 6 - Overview of laboratory tests

| Laboratory tests on samples | Number of tested |
|--|------------------|
| Determination of the granulometric composition of the soil | 115 pcs. |
| Determination of bulk density of soil | 45 pcs. |
| Determination of bulk density of solid particles | 94 pcs. |
| Determination of natural moisture content of the soil | 115 pcs. |
| Determination of soil consistency | 29 pcs. |
| Determination of compressibility and consolidation of the soil in an oedometer | 18 pcs. |
| Determination of soil resistance by direct shear test | 27 pcs. |
| Determination of soil organic matter content | 8 pcs. |
| Determining the humidity and dry bulk density ratio - Proctor's test | 19 pcs. |
| Determination of the California bearing ratio - CBR test | 17 pcs. |
| Determination of the water permeability coefficient of the soil | 2 pcs. |

The results of the performed tests are presented in a table, in the form of diagrams and individual minutes, in the Documentation Book as part of the **Attachment 1.6**

4. OVERVIEW OF INVESTIGATION RESULTS

Based on the analysis of archival documentation, the results of terrain investigations and laboratory tests, in this chapter, the properties of the investigation area are given through the following sub-chapters:

- Geomorphological characteristics of the terrain;
- Geological structure of the terrain;
- Hydrogeological characteristics of the terrain;
- Analysis of the results of reconnaissance and engineering geological mapping of the terrain;
- Analysis of the results of standard penetration - SPT test;
- Analysis of the results of cone penetration - CPTu test;
- Analysis of the results of dynamic penetration - DPSH-A test;
- Engineering geological characteristics of lithological layers;
- Seismicity of the terrain.

4.1. GEOMORPHOLOGICAL CHARACTERISTICS OF THE TERRAIN

The basic geomorphological feature of the wider investigation area is the lowland morphology of the South Bačka basin, which is part of the Pannonian plain.

The wider investigation area covers the southern parts of the Novi Sad sheet, i.e. the extreme northern parts of the Fruška Gora mountain, and the northern parts of the Novi Sad sheet, i.e. the vast plain of South Bačka. The lowland terrain is characterized by a large width of river valleys, with strong lateral and weak vertical erosion, which form extensive alluvial plains on the left bank of the Danube - river terraces and loess plateaus. Therefore, morphologically, in the wider investigation area, the southern Bačka loess terrace, with an average height of 86 m, the alluvial terrace of the Danube, with a height of about 80 m, and the alluvial plain of the Danube stand out. The most significant natural stream is the Danube River, and in addition to natural flows, there are also a large number of artificial ones, of which the Small Canal, or the Danube - Tisa - Danube Canal, is in the immediate vicinity. The drainage network belongs to the Danube basin.

The narrower investigation area in the landfill area belongs to the alluvial plain of the Danube, i.e. it is built by alluvial sediments, while the relief of the terrain is flat, without significant hypsometric differences, and to the north and northeast of the investigation area rises the first river terrace of the Danube (south-Bačka loess plateau). The elevations of the terrain surface within the location in question vary in the range of ~ 74-80 m above sea level. In addition to the mentioned relief, there is also anthropogenic relief, which is the result of human activity. It is represented by forms of anthropogenic origin in the form of filled and deposited material, i.e. landfill and waste. The absolute elevation of the terrain in the zone of filled and deposited material ranges up to ~ 103 m above sea level.

4.2. GEOLOGICAL STRUCTURE OF THE TERRAIN

Based on the analysis of archival documentation, terrain reconnaissance, as well as engineering geological mapping of the terrain, the geological structure of the wider investigation site up to the depth of the investigation works was defined. It was concluded that the geological structure in the immediate vicinity or wider surroundings of the landfill in question is composed of Quaternary, Holocene and Pleistocene sediments, which is primarily a consequence of complex sedimentation conditions.

On the basis of archival documentation under number 1, a description of the mapped units is given and the geological structure of the terrain is shown with the location of the investigation area mapped (**Photo 2**).

In the wider investigation area, the sediments of the Pleistocene and Holocene are represented by the *first river terrace* (*t₁*), characterized by yellowish sandy aleurites and aleuritic sands, with partly aleuritic habitus, and by *alluvium*, i.e. the *abandoned watercourse facies* (*am*), characterized by organogenic-marsh clays and sands, and *bed and flood facies* (*alp*), characterized by sands, clay soils and gravels.

In the narrower investigation area, Holocene sediments are present in the form of *the abandoned watercourse facies* (*am*) and *the bed and flood facies* (*alp*). *The abandoned watercourse facies* is represented by brown-yellow organogenic-marsh clays, brown-gray ground water sands, silts locally clayed

and clay with a loess-like appearance. *The flood facies* is represented by silty-sandy sediments in the shallower (younger) parts, and by brown to gray fine-grained sands in the deeper (older) parts. The sediments of the *bed facies* lie at the bottom of the flood facies or stagnant tributary facies, and are represented by grayish fine-grained to medium-grained clean sands (in the upper parts), which become coarser-grained with depth, and then turn into gray sandy gravels.

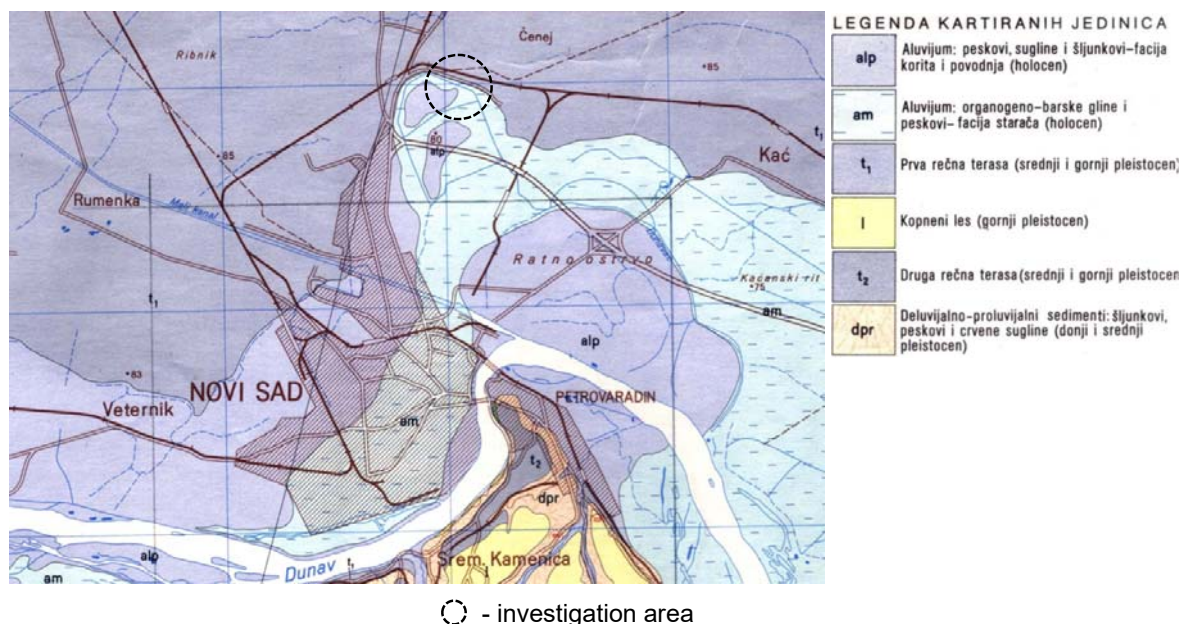


Photo 2 - Geological structure of the wider investigation area with the legend of the mapped units (excerpt from BGM 1:100 000, Novi Sad sheet, L34 - 100)

4.3. HYDROGEOLOGICAL CHARACTERISTICS OF THE TERRAIN

The analysis of archival documentation under numbers 2, 3 and 4 found that the hydrogeological characteristics of the terrain are defined in detail, and the general characteristics of the represented lithological environments will be given in the chapter.

The main hydrological feature of the wider investigation area is represented by the Danube River and the Small Canal, as constant flows, and several smaller canals as occasional flows. The extremely heterogeneous lithological composition of the terrain also conditions complex hydrogeological conditions.

Based on the analysis of archival documentation and the performed tests, it can be established that the *sediments of the abandoned watercourse facies* are quite heterogeneous and diverse in terms of composition. Therefore, the sediments of the abandoned watercourse facies, i.e. *brown-yellow organogenic-marsh clays* and *ground water clays with a loess-like appearance*, are characterized by lower water permeability. In such materials, occasional aquifers of small yield are formed, at a shallow depth from the surface of the terrain, and the nature of the material and the hydrogeological conditions that prevail in the terrain are such that they do not provide conditions for the formation of "real" aquifer, but rather water that is "trapped" in a layer with intergranular porosity. The material's filtration coefficient is about $k_f = 10^{-5} - 10^{-8}$ cm/s. Sediments of the abandoned watercourse facies, which are represented by *brown-gray ground water sands*, are characterized by intergranular porosity, while within them compacted aquifers with a free level are formed. Locally, they can also be under low pressure, due to roof poorly water-permeable organogenic-bog clays or ground water clays with a loess-like appearance. The material's filtration coefficient is about $k_f = 10^{-2} - 10^{-6}$ cm/s.

The flood facies sediments, in the upper parts of the facies represented by *ground water-sandy sediments*, are characterized by intergranular porosity, while the material filtration coefficient is $k_f = 10^{-4} - 10^{-6}$ cm/s. In their floor there are *brown to gray fine-grained sands*, which are characterized by higher primary intergranular porosity and water permeability, while their value of the filtration coefficient is around $k_f = 10^{-3}$ cm/s.

The *bed facies sediments*, present at the floor of the previously mentioned facies and represented by *grayish fine-grained to medium-grained clean sands* in the upper parts, are characterized by increased primary intergranular porosity and increased water permeability, and their value of the filtration coefficient is around $k_f = 10^{-2} - 10^{-3}$ cm/s. With depth, they become coarser-grained and turn into *gray-colored sandy gravels*, characterized by high primary intergranular porosity, high water permeability and easy drainability, with the function of a hydrogeological reservoir, while their filtration coefficient values are $k_f = 10^{-2}$ cm/s.

The groundwater level measured in investigation boreholes, in the period from the end of August to mid-September 2022, was 1.10 - 5.80 m from the terrain surface, while the groundwater level measured in trial pits, at the beginning of September, was 1.50 - 2.00 m from the terrain surface.

After measuring the groundwater level in newly constructed investigation boreholes and trial pits, three (3) piezometer structures were installed in three (3) investigation boreholes, labeled with B-18/P-2, B-22/P-1 and B-36/P-3. By observing the water level in the installed piezometers, on 20-09-2022, the groundwater level was registered at a level of 74.53 m above sea level.

Finally, by comparing previously measured groundwater levels from archival documentation and the newly obtained values of the groundwater level, the elevation of the terrain with the maximum groundwater level was adopted, which is 75.89 m above sea level.

Physical-chemical testing of the water sample determined the affiliation to class A1, which characterizes the tested water sample as non-aggressive to concrete and reinforced concrete.

4.4. ANALYSIS OF THE RESULTS OF RECONNAISSANCE AND ENGINEERING GEOLOGICAL MAPPING OF THE TERRAIN

Through the analysis of archival documentation, as well as the reconnaissance of the terrain, it was found out that on the terrain in the area of the newly designed facilities 1, 2, 3, 4, 5, 6, 7, 8, 8a, 8b, 18 and 19, construction debris (mainly composed of blocks, bricks, concrete) is being filled in a planned manner, which is not adequately spread over the surface of the terrain and is not compacted. The height of the embankment is ~ 1-4 m. **Photos 3-6** show the current condition of the terrain, while **Photo 7** shows the zone of the unplanned construction debris landfill.



Photo 3



Photo 4



Photo 5



Photo 6



Photo 7

In the zone of the newly designed facilities 9, 10, 12, 13 and 14, the planned filling of the terrain was carried out, while at the future location of the facility 11, unplanned filling of construction debris was carried out, which was not adequately spread over the terrain surface and was not compacted. The embankment is ~ 3 m high. There are no deformations on the existing facilities, based on which it can be concluded that the terrain is conditionally stable in its current state. On **Photo 8**, the boundaries of the terrain filling are framed, of which the zone of planned filled terrain is marked in green, while the zone of unplanned terrain filling is marked in red.



Photo 8

In the area of the newly designed facilities 15, 15a, 15b, 15c, 15d, 15e, 16, 20, 21, 22, 23 and 23a, municipal waste was deposited over which coherent materials (clay ground water) were placed, and, in some parts, a broken stone. **Photo 9** shows the zone of municipal waste disposal and filling.



Photo 9

At facility 20 (Hall for Sorting Delivered Garbage), uneven subsidence of the facility was registered by geodetic measurement of reference points, while damage to the facility's pillars, cracks in the floor slab and deformation of the floor slab at the junction of the slab and the facility's pillars can be seen on the facility itself. **Photos 10-11** show deformations on the facility.



Photo 10



Photo 11

In the area of newly designed facilities 24 - 37, the terrain is stable. The engineering geological reconnaissance of the terrain did not register processes and phenomena that would directly or indirectly indicate the instability of the terrain, and that could have a harmful effect on future facilities. However, it should be noted that the GWL in this zone is very high during reconnaissance in certain places and at the surface of the terrain. In **Photo 12**, the area of the stable part of the terrain is framed.



Photo 12

4.5. ANALYSIS OF THE RESULTS OF PERFORMED SPT TESTS

The obtained data of the number of N blows were corrected to N_{60} and $(N_1)_{60}$ using the forms given in the standard "EN ISO 22476-3:2005".

The correction of the obtained number of N blows to 60% energy efficiency is calculated using the formula:

$$N_{60} = \frac{E_r \cdot N}{60\%}$$

where:

- N - number of blows;
- N_{60} - corrected number of blows at 60% energy efficiency;
- E_r - energy efficiency of the equipment (81%).

The correction of the corrected number N_{60} by the correction factors for accessories and overlay load is calculated using the formula:

$$(N_1)_{60} = \lambda \cdot C_n \cdot N_{60}$$

where:

- N_{60} - corrected number of blows at 60% energy efficiency;
- $(N_1)_{60}$ - corrected number of blows N_{60} with the factor of the length of the accessory and the overlay load;
- λ - correction factor for energy loss due to the length of the rods;
- C_n - correction factor that depends on the overlay load.

Correction factor that depends on the overlay load (C_n) is obtained by the following relation:

$$C_n = \sqrt{98/\sigma'_v}$$

where:

- C_n - correction factor that depends on the overlay load.
- σ'_v - Normal stress at the depth of the performed test.

Table 7 - The correction factor that depends on the length of the rods (λ) is obtained from the following relation:

| Rod length | Correction value |
|------------|------------------|
| 3 - 4 m | 0.75 |
| 4 - 6 m | 0.85 |
| 6 - 10 m | 0.95 |
| > 10 m | 1,00 |

In the case of fine-grained sand or silt below the groundwater level, an additional correction for the groundwater level is recommended, which refers to the correction of the number of blows $(N_1)_{60}$ when the values of the number of blows are large (especially over 15), due to the dilatation effect. In such cases, the following formula was used (Terzaghi & Peck, 1948):

$$(N_1)_{60 \text{ (CORR)}} = 15 + 0.5 \cdot [(N_1)_{60} - 15]$$

where:

- $(N_1)_{60}$ - corrected number of blows N_{60} with the factor of the length of the accessory and the overlay load;
- $(N_1)_{60 \text{ (CORR)}}$ - corrected number of blows $(N_1)_{60}$ for groundwater level.

Table 8 - Relative compaction (D_r), i.e. compaction index (I_D), is determined based on the value of the corrected number of blows $(N_1)_{60}$:

| Compaction | $(N_1)_{60}$ | I_D (%) |
|----------------|--------------|-----------|
| very loose | 0 - 3 | 0 - 15 |
| loose | 3 - 8 | 15 - 35 |
| medium compact | 8 - 25 | 35 - 65 |
| compact | 25 - 42 | 65 - 85 |
| very compact | 42 - 58 | 85 - 100 |

Based on the I_D parameter, the degree of R_c compaction was calculated using the following correlation (Lee & Singh, 1971):

$$R_c = 80 + 0.2 \cdot I_D$$

where:

- I_D - compaction index;
 R_c - compaction degree.

Table 9 - The angle of internal friction (φ) is determined based on the value of relative compaction and the participation of sand particles:

| D_r (%) | Fine-grained | | Medium-grained | | Coarse-grained | |
|-----------|--------------|-----------|----------------|-----------|----------------|-----------|
| | uniform | graduated | uniform | graduated | uniform | graduated |
| 40 | 34° | 36° | 36° | 38° | 38° | 41° |
| 60 | 36° | 38° | 38° | 41° | 41° | 43° |
| 80 | 39° | 41° | 41° | 43° | 43° | 44° |
| 100 | 42° | 43° | 43° | 44° | 44° | 46° |

Typical values of the angle of internal friction (φ), shown in the previous table, are determined based on European standards. In addition, the values according to Peck et al. (1953) were also obtained, in order to compare the results and possibly obtain lower values. With that, the following correlation was used to obtain the angle of internal friction (φ) (Peck et al., 1953):

$$\varphi = 27 + 0.3 \cdot (N_1)_{60}$$

where:

- φ - angle of internal friction;
 $(N_1)_{60}$ - corrected number of N_{60} blows for the effect of accessory length and overlay load.

As the European standard does not define the correlations between the obtained number of blows and the resistant-deformable properties of the soil for coherent materials, the following correlation was used to obtain the undrained shear strength of the soil (Stroud, 1974):

$$c_u = (4-5) \cdot N_{60} \quad \text{za } 20 < I_P < 30$$

where:

- c_u - undrained cohesion;
 N_{60} - corrected number of blows at 60% energy efficiency of the hammer;

To obtain the bulk density of **coherent soil**, based on standard penetration tests, the following correlation was used (Peck et al., 1974):

$$\gamma = 16.8 + 0.15 \cdot N_{60}$$

where:

- γ - bulk density.

To obtain the bulk density of **loose soil**, based on standard penetration tests, the following correlation was used (Bowles, 1977):

$$\gamma = 16.0 + 0.1 \cdot N_{60}$$

where:

- γ - bulk density.

To obtain orientational values of the compressibility modulus of **coherent soil**, the following correlation was used (Stojadinović, 1974):

$$M_v = 3 \cdot N_{60} \text{ (kPa/cm}^2\text{)} = 3 \cdot N_{60} \cdot 98.87 \text{ (kPa)}$$

where:

- M_v - compressibility modulus;
 N_{60} - corrected number of blows at 60% energy efficiency of the hammer;

To obtain orientational values of the compressibility modulus of **loose soil**, the following correlation was used (Stojadinović, 1974):

$$M_v = c_1 + c_2 \cdot (N_1)_{60} \text{ (kPa/cm}^2\text{)} = c_1 + c_2 \cdot (N_1)_{60} \cdot 98.87 \text{ (kPa)}$$

where:

- M_v - compressibility modulus;
 $(N_1)_{60}$ - corrected number of blows N_{60} with the factor of the length of the accessory and the overlay load;
 c_1, c_2 - coefficients obtained from the following table.

Table 10 - Values of coefficients c_1 and c_2 used to obtain orientational values of compressibility modulus of loose soil:

| soil type | gravel with sand and sand with gravel | sand | fine sand | | ground water sand |
|-----------|---------------------------------------|------|-----------|-----------|-------------------|
| | | | above GWL | below GWL | |
| c_1 | - | 40 | - | - | 20 |
| c_2 | 8 | 4 | 3 | 8 | 5 |

Table 11 shows the results of the corrected number of N blows on N_{60} and $(N_1)_{60}$, as well as the calculated parameters of the angle of internal friction, undrained shear strength and compressibility modulus.

Table 11 - Results of SPT tests performed in investigation boreholes

| Investigation borehole | Layer designation | Layer lower limit (m) | The depth of the test (m) | GWL | N | Er (%) | N_{60} | γ (kN/m ³) | σ' (kPa) | C_N | λ | $(N_1)_{60}$ | $(N_1)_{60}$ (CORR) | I_D (%) | R_c (%) | Φ [EC7] (°) | Φ [Peck et al.] (°) | C_u (kPa) | M_v (kPa) |
|------------------------|-------------------|-----------------------|---------------------------|------|----|--------|----------|-------------------------------|-----------------|-------|-----------|--------------|---------------------|-----------|-----------|------------------|--------------------------|-------------|-------------|
| B-2 | SaP | 10.00 | 3.00 | 5.50 | 6 | 81 | 8 | 18.0 | 48.0 | 1.43 | 0.85 | 10 | - | 39 | 87.8 | 34 | 30 | - | 6841 |
| | | | 6.00 | | 5 | | 7 | 16.7 | 99.5 | 0.99 | 0.95 | 6 | - | 28 | 85.6 | 32 | 29 | - | 5035 |
| | | | 9.20 | | 8 | | 11 | 17.1 | 131.5 | 0.86 | 0.95 | 9 | - | 37 | 87.4 | 33 | 30 | - | 7006 |
| B-3 | SaP | 10.00 | 2.00 | 5.50 | 7 | 81 | 9 | 16.9 | 34.9 | 1.68 | 0.75 | 12 | - | 44 | 88.8 | 34 | 31 | - | 3523 |
| | | | 5.50 | | 7 | | 9 | 16.9 | 94.1 | 1.02 | 0.95 | 9 | - | 37 | 87.4 | 33 | 30 | - | 7246 |
| | | | 8.00 | | 9 | | 12 | 17.2 | 119.1 | 0.91 | 0.95 | 10 | - | 39 | 87.8 | 34 | 30 | - | 8282 |
| B-8 | SaP | 10.00 | 2.00 | 5.00 | 7 | 81 | 7 | 16.7 | 36 | 1.65 | 0.75 | 8 | - | 35 | 87 | 33 | 30 | - | 6107 |
| | | | 5.00 | | 15 | | 15 | 17.5 | 88.5 | 1.05 | 0.95 | 15 | - | 51 | 90.2 | 35 | 31 | - | 11742 |
| | | | 7.50 | | 16 | | 16 | 17.6 | 113.5 | 0.93 | 0.95 | 14 | - | 48 | 89.6 | 35 | 31 | - | 11311 |
| B-12 | siSa | 4.50 | 2.70 | 5.00 | 5 | 81 | 5 | 16.5 | 44.5 | 1.48 | 0.85 | 7 | - | 32 | 86.4 | 32 | 29 | - | 5345 |
| | SaP | 10.00 | 6.50 | | 20 | | 20 | 18.0 | 103.2 | 0.97 | 0.95 | 19 | 17 | 54 | 90.8 | 35 | 33 | - | 13346 |
| | | | 10.00 | | 18 | | 18 | 17.8 | 138.2 | 0.84 | 0.95 | 14 | - | 43 | 88.6 | 34 | 31 | - | 11105 |
| B-18 | nt | 5.60 | 2.20 | 1.40 | 4 | 81 | 4 | 17.4 | - | - | - | - | - | - | - | - | - | 20 | 1201 |
| | CIM | 8.00 | 5.50 | | 5 | | 5 | 17.6 | - | - | - | - | - | - | - | - | - | 27 | 1602 |
| | SaP | 10.00 | 9.00 | | 9 | | 9 | 16.9 | 100.4 | 0.99 | 1 | 9 | - | 37 | 87.4 | 33 | 30 | - | 7385 |
| B-20 | SaM | 8.00 | 2.80 | 6.00 | 9 | 81 | 9 | 16.9 | 50 | 1.40 | 0.75 | 10 | - | 39 | 87.8 | 34 | 30 | - | 2942 |
| | | | 5.50 | | 14 | | 14 | 17.4 | 97 | 1.01 | 0.95 | 13 | - | 46 | 89.2 | 34 | 31 | - | 3823 |
| | siSa | 10.00 | 8.50 | | 9 | | 9 | 16.9 | 127 | 0.88 | 0.92 | 8 | - | 35 | 87 | 33 | 29 | - | 5753 |
| B-25 | SaP | 10.00 | 2.80 | 6.20 | 18 | 81 | 18 | 17.8 | 49.8 | 1.40 | 0.75 | 18 | 17 | 54 | 90.8 | 36 | 33 | - | 4963 |
| | | | 5.50 | | 20 | | 20 | 18.0 | 97.9 | 1.00 | 0.95 | 19 | 17 | 56 | 91.2 | 35 | 33 | - | 5079 |
| | | | 8.50 | | 9 | | 9 | 16.9 | 133.4 | 0.86 | 0.95 | 8 | - | 35 | 87 | 33 | 29 | - | 6086 |
| B-26 | nt-CIM | 6.60 | 2.50 | 4.00 | 5 | 81 | 5 | 17.6 | - | - | - | - | - | - | - | - | - | 27 | 1602 |
| | | | 4.20 | | 3 | | 3 | 17.2 | - | - | - | - | - | - | - | - | - | 14 | 801 |
| | CIM | 10.00 | 8.10 | | 7 | | 7 | 17.8 | - | - | - | - | - | - | - | - | - | 34 | 2002 |
| B-27 | nt-siSa | 4.70 | 2.00 | 4.00 | 5 | 81 | 5 | 94.0 | - | - | - | - | - | - | - | - | - | 27 | 1602 |
| | | | 4.00 | | 5 | | 5 | 17.6 | - | - | - | - | - | - | - | - | - | 27 | 1602 |
| | siSa | 10.00 | 7.50 | | 15 | | 15 | 17.5 | 101 | 0.99 | 0.95 | 14 | - | 48 | 89.6 | 35 | 31 | - | 8847 |
| B-28 | nt | 6.60 | 1.00 | 4.00 | 7 | 81 | 7 | 17.8 | - | - | - | - | - | - | - | - | - | 34 | 2002 |
| | | | 3.90 | | 5 | | 5 | 17.6 | - | - | - | - | - | - | - | - | - | 27 | 1602 |
| | | | 6.30 | | 4 | | 4 | 17.4 | - | - | - | - | - | - | - | - | - | 20 | 1201 |
| B-32 | nt | 8.40 | 3.40 | 5.00 | 4 | 81 | 4 | 17.4 | - | - | - | - | - | - | - | - | - | 20 | 1201 |
| | | | 6.20 | | 5 | | 5 | 17.6 | - | - | - | - | - | - | - | - | - | 27 | 1602 |
| | SaP | 10.00 | 10.00 | | 18 | | 18 | 17.8 | 132 | 0.86 | 1 | 15 | - | 51 | 90.2 | 35 | 32 | - | 11961 |
| B-35 | SaP | 10.00 | 3.30 | 2.50 | 9 | 81 | 9 | 16.9 | 50.3 | 1.40 | 0.85 | 11 | - | 43 | 88.6 | 34 | 30 | - | 8868 |
| | | | 6.00 | | 11 | | 11 | 17.1 | 69.3 | 1.19 | 0.95 | 12 | - | 44 | 88.8 | 34 | 31 | - | 9650 |
| | | | 9.00 | | 18 | | 18 | 17.8 | 99.3 | 0.99 | 1 | 17 | 16 | 53 | 90.6 | 35 | 32 | - | 13790 |
| B-36 | SaU-SaP | 24.10 | 5.00 | 1.20 | 9 | 81 | 9 | 16.9 | 58.3 | 1.30 | 0.85 | 10 | - | 39 | 87 | 34 | 30 | - | 8237 |

| Investigation borehole | Layer designation | Layer lower limit (m) | The depth of the test (m) | GWL | N | Er (%) | N ₆₀ | γ (kN/m ³) | σ' (kPa) | C _N | λ | (N ₁) ₆₀ | (N ₁) ₆₀ (CORR) | I _D (%) | R _c (%) | φ [EC7] (°) | φ [Peck et al.] (°) | C _u (kPa) | M _v (kPa) |
|------------------------|-------------------|-----------------------|---------------------------|------|----|--------|-----------------|------------------------|----------|----------------|------|---------------------------------|--|--------------------|--------------------|-------------|---------------------|----------------------|----------------------|
| | | | 8.00 | | 11 | | 11 | 17.1 | 88.3 | 1.05 | 0.95 | 11 | - | 40 | 87 | 34 | 30 | - | 8549 |
| B-38 | SaP | 10.00 | 2.00 | | 5 | | 5 | 16.5 | 29.7 | 1.82 | 0.85 | 8 | - | 35 | 87 | 33 | 30 | - | 6595 |
| | | | 5.00 | 1.50 | 9 | 81 | 9 | 16.9 | 59.7 | 1.28 | 0.85 | 10 | - | 39 | 87.8 | 34 | 30 | - | 8140 |
| | | | 9.00 | | 9 | | 9 | 16.9 | 99.7 | 0.99 | 1 | 9 | - | 37 | 87.4 | 33 | 30 | - | 7411 |
| | | | 3.00 | | 8 | | 8 | 16.8 | 37.5 | 1.62 | 0.85 | 11 | - | 40 | 88 | 34 | 30 | - | 8804 |
| B-40 | SaP | 14.00 | 6.00 | 1.10 | 7 | 81 | 7 | 16.7 | 67.5 | 1.20 | 0.95 | 8 | - | 35 | 87 | 33 | 29 | - | 6111 |
| | | | 9.20 | | 11 | | 11 | 17.1 | 99.5 | 0.99 | 1 | 11 | - | 40 | 88 | 34 | 30 | - | 8478 |
| | | | 2.00 | 2.30 | 8 | 81 | 8 | 18.0 | - | - | - | - | - | - | - | - | - | 41 | 2403 |
| B-41 | saSi | 2.70 | 3.00 | | 7 | | 7 | 16.7 | 39.4 | 1.58 | 0.85 | 9 | - | 37 | 87.4 | 33 | 30 | - | 7157 |
| B-42 | SaU | 12.00 | 6.40 | 1.40 | 12 | 81 | 12 | 17.2 | 73.4 | 1.16 | 0.95 | 13 | - | 44 | 88.8 | 34 | 31 | - | 10549 |
| | | | 10.00 | | 12 | | 12 | 17.2 | 109.4 | 0.95 | 1 | 11 | - | 40 | 88 | 34 | 30 | - | 9096 |

4.6. ANALYSIS OF THE RESULTS OF PERFORMED CPT TESTS

The processing of the obtained results as well as obtaining the parameters of deformability and strength was done on the basis of the "SRPS EN 1997-2" standard, using the following formulas:

The following correlation was used to obtain the compressibility modulus:

$$M_v = \alpha \cdot q_c$$

where:

- M_v - compressibility modulus;
- α - coefficient (Sanglerat, 1972);
- q_c - cone penetration resistance;

The following relation was used to obtain the angle of internal friction of the soil:

$$\varphi = 13.5 \cdot \log q_c + 23$$

where:

- φ - angle of internal friction;
- q_c - cone penetration resistance;

The values of the coefficient "α" are determined based on the type of soil and the resistance of the soil during the penetration of the cone "q_c" and are given in **Table 12**.

Table 12 - Values of coefficient α - "SRPS EN 1997-2"

| Soil type | Cone resistance q _c (MN/m ²) | Coefficient α |
|------------------------------------|---|---------------|
| CIL - low-plastic clay | q _c ≤ 0.7 | 3 < α < 8 |
| | 0.7 < q _c < 2 | 2 < α < 5 |
| | q _c ≥ 2 | 1 < α < 2.5 |
| SiL - low-plastic silt | q _c < 2 | 3 < α < 6 |
| | q _c ≥ 2 | 1 < α < 2 |
| CIH - high-plastic clay | q _c < 2 | 2 < α < 6 |
| SiH - high-plastic silt | q _c ≥ 2 | 1 < α < 2 |
| OL - high-organic silt | q _c < 1.2 | 2 < α < 8 |
| Pt-OH - peat and high-organic clay | q _c < 0.7 | 1.5 < α < 4 |
| | 50 < ω ≤ 100% | 1 < α < 1.5 |
| | 100 < ω ≤ 200% | 0.4 < α < 1.0 |
| | ω > 200% | |
| Chalk - soft carbonate rock | 2 < q _c ≤ 3 | 2 < α < 4 |
| | q _c > 3 | 1.5 < α < 3 |
| Sand | q _c < 5 | α = 2 |
| | q _c > 10 | α = 1.5 |

Tables 13-21 give an interpretation of the results of the CPTu tests, as well as the obtained values of the strength and deformability parameters.

Table 13 - Display of the processing of the results of the Cpt-1 tests

| Layer designation | Layer lower limit (m) | q_c (kN/m ²) | f_s (kN/m ²) | R_f (%) | α | M_v (kN/m ²) | φ (°) | C_u (kN/m ²) |
|-------------------|-----------------------|----------------------------|----------------------------|-----------|----------|----------------------------|---------------|----------------------------|
| saSi | 2.00 | 4960 | 51.79 | 1.04 | 1,00 | 4960 | 32 | - |
| SaP | 3.00 | 11380 | 95.24 | 0.84 | 1,00 | 11380 | 37 | - |
| | 7.90 | 7530 | 55.57 | 0.74 | 1.25 | 9412.5 | 35 | - |
| | 8.60 | 5220 | 39.02 | 0.75 | 1.50 | 7830 | 33 | - |
| | 15.80 | 11180 | 83.36 | 0.75 | 1,00 | 11180 | 37 | - |
| | 16.20 | 4110 | 51.00 | 1.24 | 1.50 | 6165 | 31 | - |
| | 18.70 | 11610 | 70.48 | 0.61 | 1,00 | 11610 | 37 | - |
| | 21.10 | 17810 | 109.64 | 0.62 | 1,00 | 17810 | 40 | - |

Table 14 - Display of the processing of the results of the Cpt-2 tests

| Layer designation | Layer lower limit (m) | q_c (kN/m ²) | f_s (kN/m ²) | R_f (%) | α | M_v (kN/m ²) | φ (°) | C_u (kN/m ²) |
|-------------------|-----------------------|----------------------------|----------------------------|-----------|----------|----------------------------|---------------|----------------------------|
| saSi | 1.20 | 6100 | 57.14 | 0.94 | 1,00 | 6100 | 34 | - |
| SaP | 7.80 | 10250 | 87.98 | 0.86 | 1,00 | 10250 | 37 | - |
| | 8.50 | 6210 | 50.70 | 0.82 | 1.25 | 7763 | 34 | - |
| | 15.70 | 11140 | 85.39 | 0.77 | 1,00 | 11140 | 37 | - |
| CIM | 16.60 | 2690 | 64.78 | 2.41 | 1,00 | 2690 | - | 131.00 |
| SaP | 21.70 | 14690 | 93.30 | 0.64 | 1.50 | 22035 | 39 | - |
| | 22.40 | 20740 | 117.71 | 0.57 | 1.50 | 31110 | 41 | - |
| | 24.70 | 18520 | 115.80 | 0.63 | 1.50 | 27780 | 40 | - |

Table 15 - Display of the processing of the results of the Cpt-3 tests

| Layer designation | Layer lower limit (m) | q_c (kN/m ²) | f_s (kN/m ²) | R_f (%) | α | M_v (kN/m ²) | φ (°) | C_u (kN/m ²) |
|-------------------|-----------------------|----------------------------|----------------------------|-----------|----------|----------------------------|---------------|----------------------------|
| nt | 0.40 | 7040 | 109.77 | 1.56 | 1.25 | 8800 | 34 | - |
| | 1.70 | 2950 | 10.82 | 0.37 | 1.50 | 4425 | 29 | - |
| | 5.60 | 10430 | 64.53 | 0.62 | 1,00 | 10430 | 37 | - |
| SaU | 8.90 | 7400 | 46.92 | 0.63 | 1.25 | 9250 | 35 | - |
| | 12.90 | 10270 | 65.81 | 0.64 | 1,00 | 10270 | 37 | - |
| | 18.20 | 13320 | 84.49 | 0.63 | 1,00 | 13320 | 38 | - |
| | 18.70 | 6660 | 76.85 | 1.15 | 1.25 | 8325 | 34 | - |
| | 20.60 | 11040 | 51.47 | 0.47 | 1,00 | 11040 | 37 | - |
| | 22.60 | 13800 | 94.48 | 0.68 | 1,00 | 13800 | 38 | - |

Table 16 - Display of the processing of the results of the Cpt-4 tests

| Layer designation | Layer lower limit (m) | q_c (kN/m ²) | f_s (kN/m ²) | R_f (%) | α | M_v (kN/m ²) | φ (°) | C_u (kN/m ²) |
|-------------------|-----------------------|----------------------------|----------------------------|-----------|----------|----------------------------|---------------|----------------------------|
| saSi | 1.20 | 2550 | 14.83 | 0.58 | 1,00 | 2550 | 28 | - |
| SaP-SaU | 8.40 | 8730 | 53.54 | 0.61 | 1.25 | 10913 | 36 | - |
| CIM | 9.10 | 1800 | 20.03 | 1.11 | 2.00 | 3600 | - | 89.89 |
| SaP-SaU | 9.90 | 5220 | 28.02 | 0.54 | 1.25 | 6525 | 33 | - |
| | 17.20 | 11400 | 65.01 | 0.57 | 1,00 | 11400 | 37 | - |
| | 18.30 | 30420 | 162.16 | 0.53 | 1,00 | 30420 | 43 | - |
| | 21.00 | 14380 | 80.61 | 0.56 | 1,00 | 14380 | 39 | - |
| | 21.80 | 20900 | 118.61 | 0.57 | 1,00 | 20900 | 41 | - |
| | 22.40 | 9980 | 74.56 | 0.75 | 1.25 | 12475 | 36 | - |
| | 25.80 | 16450 | 104.73 | 0.64 | 1,00 | 16450 | 39 | - |

Table 17 - Display of the processing of the results of the Cpt-5 tests

| Layer designation | Layer lower limit (m) | q_c (kN/m ²) | f_s (kN/m ²) | R_f (%) | α | M_v (kN/m ²) | φ (°) | C_u (kN/m ²) |
|-------------------|-----------------------|----------------------------|----------------------------|-----------|----------|----------------------------|---------------|----------------------------|
| nt | 0.90 | 4510 | 48.79 | 1.08 | 1.50 | 6765 | 32 | - |
| | 2.10 | 2330 | 6.50 | 0.28 | 1.50 | 3495 | 28 | - |
| SaP-SaM | 5.60 | 8560 | 51.39 | 0.60 | 1.25 | 10700 | 36 | - |
| | 15.00 | 10580 | 60.47 | 0.57 | 1.00 | 10580 | 37 | - |
| | 16.20 | 17060 | 87.55 | 0.51 | 1.00 | 17060 | 40 | - |
| | 16.80 | 3870 | 44.14 | 1.14 | 1.50 | 5805 | 31 | - |
| | 21.90 | 11050 | 52.24 | 0.47 | 1.25 | 13813 | 37 | - |
| | | | | | | | | |

Table 18 - Display of the processing of the results of the Cpt-6 tests

| Layer designation | Layer lower limit (m) | q_c (kN/m ²) | f_s (kN/m ²) | R_f (%) | α | M_v (kN/m ²) | φ (°) | C_u (kN/m ²) |
|-------------------|-----------------------|----------------------------|----------------------------|-----------|----------|----------------------------|---------------|----------------------------|
| nt | 1.20 | 10890 | 86.2 | 0.79 | 1.00 | 10890 | - | - |
| | 4.70 | 3780 | 62.62 | 1.66 | 1.00 | 3780 | - | - |
| | 6.00 | 1290 | 20.34 | 1.58 | 2.00 | 2580 | - | 65.00 |
| | 6.90 | 520 | 31.84 | 6.12 | 1.50 | 780 | - | 23.14 |
| CIM | 7.80 | 650 | 21.97 | 3.38 | 2.00 | 1300 | - | 27.44 |
| | 11.20 | 540 | 8.26 | 1.53 | 2.00 | 1080 | - | 17.56 |
| SaP | 13.20 | 6670 | 45.66 | 0.68 | 1.25 | 8338 | 34 | - |
| | 16.80 | 14370 | 98.79 | 0.69 | 1.00 | 14370 | 39 | - |
| | 18.90 | 12180 | 75.03 | 0.62 | 1.00 | 12180 | 38 | - |
| | 19.30 | 5310 | 32.36 | 0.61 | 1.25 | 6638 | 33 | - |
| | 19.90 | 10170 | 63.97 | 0.63 | 1.00 | 10170 | 37 | - |

Table 19 - Display of the processing of the results of the Cpt-7 tests

| Layer designation | Layer lower limit (m) | q_c (kN/m ²) | f_s (kN/m ²) | R_f (%) | α | M_v (kN/m ²) | φ (°) | C_u (kN/m ²) |
|-------------------|-----------------------|----------------------------|----------------------------|-----------|----------|----------------------------|---------------|----------------------------|
| saSi | 0.30 | 1010 | 10.21 | 1.01 | 2.00 | 2020 | 23 | - |
| SaP | 2.80 | 4060 | 13.68 | 0.34 | 1.50 | 6090 | 31 | - |
| | 6.70 | 6600 | 22.81 | 0.35 | 1.25 | 8250 | 34 | - |
| | 13.60 | 8970 | 35.98 | 0.40 | 1.25 | 11213 | 36 | - |
| | 14.00 | 5630 | 28.90 | 0.51 | 1.25 | 7038 | 33 | - |
| | 15.40 | 16110 | 57.25 | 0.36 | 1.00 | 16110 | 39 | - |
| | 16.80 | 10690 | 44.15 | 0.41 | 1.00 | 10690 | 37 | - |
| | 18.30 | 16510 | 65.57 | 0.40 | 1.00 | 16510 | 39 | - |

Table 20 - Display of the processing of the results of the Cpt-8 tests

| Layer designation | Layer lower limit (m) | q_c (kN/m ²) | f_s (kN/m ²) | R_f (%) | α | M_v (kN/m ²) | φ (°) | C_u (kN/m ²) |
|-------------------|-----------------------|----------------------------|----------------------------|-----------|----------|----------------------------|---------------|----------------------------|
| siSa | 1.50 | 3630 | 19.38 | 0.53 | 1.50 | 5445 | 31 | - |
| SaP | 2.50 | 2270 | 5.30 | 0.23 | 1.50 | 3405 | 28 | - |
| | 5.70 | 5030 | 22.56 | 0.45 | 1.50 | 7545 | 32 | - |
| | 8.50 | 8420 | 46.44 | 0.55 | 1.25 | 10525 | 35 | - |
| | 12.60 | 11510 | 67.77 | 0.59 | 1.00 | 11510 | 37 | - |
| | 13.10 | 5570 | 37.89 | 0.68 | 1.25 | 6963 | 33 | - |
| | 16.50 | 8890 | 52.17 | 0.59 | 1.25 | 11113 | 36 | - |
| | 20.10 | 14790 | 86.77 | 0.59 | 1.00 | 14790 | 39 | - |
| | | | | | | | | |

Table 21 - Display of the processing of the results of the Cpt-9 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | R _f (%) | α | M _v (kN/m ²) | φ (°) | C _u (kN/m ²) |
|-------------------|-----------------------|-------------------------------------|-------------------------------------|--------------------|------|-------------------------------------|-------|-------------------------------------|
| nt | 0.40 | 2680 | 53.94 | 2.01 | 1,00 | 2680 | - | 148.44 |
| SaU-SaP | 2.90 | 3480 | 15.03 | 0.43 | 1.50 | 5220 | 30 | - |
| | 8.10 | 6660 | 34.29 | 0.51 | 1.25 | 8325 | 34 | - |
| | 10.60 | 8270 | 47.03 | 0.57 | 1.25 | 10338 | 35 | - |
| | 14.10 | 10250 | 57.40 | 0.53 | 1,00 | 10250 | 37 | - |
| CIL | 14.50 | 1770 | 23.91 | 1.35 | 2.00 | 3540 | - | 82.22 |
| SaU-SaP | 18.00 | 14420 | 83.95 | 0.58 | 1,00 | 14420 | 39 | - |

The results of the CPTu tests are given in the Documentation Book as part of the **Attachment 1.7.1**.

The following correlation was used to determine the value of shear wave propagation speed using the liner resistance f_s(Tun 2003):

$$V_s = 18.55 + 118.80 \cdot \log(f_s)$$

where:

V_s - propagation speed of shear waves;

f_s - friction on the cone liner;

The following correlation (Mayne 2006) was used to determine the shear wave propagation speed using the cone resistance q_c:

$$V_s = 109.29 + 52.674 \cdot \ln(q_c)$$

where:

V_s - propagation speed of shear waves;

q_c - cone penetration resistance;

Tables 22-30 provide an interpretation of the shear wave velocity results.

Table 22 - Display of the interpretation of the Vs results from the CPTu-1 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | Mayne(2006.) Vs (m/s) | Tun (2003.) Vs (m/s) |
|-------------------|-----------------------|-------------------------------------|-------------------------------------|-----------------------|----------------------|
| saSi | 2.00 | 4960 | 51.79 | 193.64 | 222.20 |
| SaP | 3.00 | 11380 | 95.24 | 237.39 | 253.63 |
| | 7.90 | 7530 | 55.57 | 215.63 | 225.84 |
| | 8.60 | 5220 | 39.02 | 196.33 | 207.59 |
| | 15.80 | 11180 | 83.36 | 236.45 | 246.76 |
| | 16.20 | 4110 | 51.00 | 183.74 | 221.41 |
| | 18.70 | 11610 | 70.48 | 238.44 | 238.10 |
| | 21.10 | 17810 | 109.64 | 260.98 | 260.90 |

Table 23 - Display of the interpretation of the Vs results from the CPTu-2 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | Mayne(2006.) Vs (m/s) | Tun (2003.) Vs (m/s) |
|-------------------|-----------------------|-------------------------------------|-------------------------------------|-----------------------|----------------------|
| saSi | 1.20 | 6100 | 57.14 | 204.54 | 227.27 |
| SaP | 7.80 | 10250 | 87.98 | 231.88 | 249.54 |
| | 8.50 | 6210 | 50.70 | 205.48 | 221.10 |
| | 15.70 | 11140 | 85.39 | 236.26 | 248.00 |
| CIM | 16.60 | 2690 | 64.78 | 161.41 | 233.75 |
| SaP | 21.70 | 14690 | 93.30 | 250.83 | 252.57 |
| | 22.40 | 20740 | 117.71 | 269.00 | 264.56 |
| | 24.70 | 18520 | 115.80 | 263.04 | 263.72 |

Table 24 - Display of the interpretation of the Vs results from the CPTu-3 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | Mayne(2006.) Vs (m/s) | Tun (2003.) Vs (m/s) |
|-------------------|--------------------------|--|--|-----------------------------|----------------------------|
| nt | 0.40 | 7040 | 109.77 | 212.09 | 260.96 |
| | 1.70 | 2950 | 10.82 | 166.27 | 141.42 |
| | 5.60 | 10430 | 64.53 | 232.79 | 233.55 |
| SaU | 8.90 | 7400 | 46.92 | 214.72 | 217.11 |
| | 12.90 | 10270 | 65.81 | 231.98 | 234.56 |
| | 18.20 | 13320 | 84.49 | 245.68 | 247.45 |
| | 18.70 | 6660 | 76.85 | 209.17 | 242.56 |
| | 20.60 | 11040 | 51.47 | 235.79 | 221.88 |
| | 22.60 | 13800 | 94.48 | 247.54 | 253.22 |

Table 25 - Display of the interpretation of the Vs results from the CPTu-4 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | Mayne(2006.) Vs (m/s) | Tun (2003.) Vs (m/s) |
|-------------------|--------------------------|--|--|-----------------------------|----------------------------|
| saSi | 1.20 | 2550 | 14.83 | 158.60 | 157.68 |
| SaP-SaU | 8.40 | 8730 | 53.54 | 223.42 | 223.92 |
| CIM | 9.10 | 1800 | 20.03 | 140.25 | 173.19 |
| SaP-SaU | 9.90 | 5220 | 28.02 | 196.33 | 190.51 |
| | 17.20 | 11400 | 65.01 | 237.48 | 233.93 |
| | 18.30 | 30420 | 162.16 | 289.18 | 281.09 |
| | 21.00 | 14380 | 80.61 | 249.71 | 245.03 |
| | 21.80 | 20900 | 118.61 | 269.41 | 264.96 |
| | 22.40 | 9980 | 74.56 | 230.47 | 241.00 |
| | 25.80 | 16450 | 104.73 | 256.79 | 258.53 |

Table 26 - Display of the interpretation of the Vs results from the CPTu-5 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | Mayne(2006.) Vs (m/s) | Tun (2003.) Vs (m/s) |
|-------------------|--------------------------|--|--|-----------------------------|----------------------------|
| nt | 0.90 | 4510 | 48.79 | 188.63 | 219.12 |
| | 2.10 | 2330 | 6.50 | 153.85 | 115.12 |
| SaP-SaM | 5.60 | 8560 | 51.39 | 222.39 | 221.80 |
| | 15.00 | 10580 | 60.47 | 233.55 | 230.20 |
| | 16.20 | 17060 | 87.55 | 258.71 | 249.29 |
| | 16.80 | 3870 | 44.14 | 180.57 | 213.96 |
| | 21.90 | 11050 | 52.24 | 235.84 | 222.65 |

Table 27 - Display of the interpretation of the Vs results from the CPTu-6 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | Mayne(2006.) Vs (m/s) | Tun (2003.) Vs (m/s) |
|-------------------|--------------------------|--|--|-----------------------------|----------------------------|
| nt | 1.20 | 10890 | 86.2 | 235.07 | 248.49 |
| | 4.70 | 3780 | 62.62 | 179.33 | 232.00 |
| | 6.00 | 1290 | 20.34 | 122.70 | 173.98 |
| | 6.90 | 520 | 31.84 | 74.85 | 197.10 |
| CIM | 7.80 | 650 | 21.97 | 86.60 | 177.96 |
| | 11.20 | 540 | 8.26 | 76.83 | 127.49 |
| SaP | 13.20 | 6670 | 45.66 | 209.25 | 215.70 |
| | 16.80 | 14370 | 98.79 | 249.67 | 255.52 |
| | 18.90 | 12180 | 75.03 | 240.96 | 241.33 |
| | 19.30 | 5310 | 32.36 | 197.23 | 197.94 |
| | 19.90 | 10170 | 63.97 | 231.46 | 233.10 |

Table 28 - Display of the interpretation of the Vs results from the CPTu-7 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | Mayne(2006.) Vs (m/s) | Tun (2003.) Vs (m/s) |
|-------------------|--------------------------|--|--|-----------------------------|----------------------------|
| saSi | 0.30 | 1010 | 10.21 | 109.81 | 138.42 |
| SaP | 2.80 | 4060 | 13.68 | 183.10 | 153.52 |
| | 6.70 | 6600 | 22.81 | 208.69 | 179.90 |
| | 13.60 | 8970 | 35.98 | 224.85 | 203.41 |
| | 14.00 | 5630 | 28.90 | 200.32 | 192.10 |
| | 15.40 | 16110 | 57.25 | 255.69 | 227.37 |
| | 16.80 | 10690 | 44.15 | 234.09 | 213.97 |
| | 18.30 | 16510 | 65.57 | 256.99 | 234.37 |

Table 29 - Display of the interpretation of the Vs results from the CPTu-8 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | Mayne(2006.) Vs (m/s) | Tun (2003.) Vs (m/s) |
|-------------------|--------------------------|--|--|-----------------------------|----------------------------|
| siSa | 1.50 | 3630 | 19.38 | 177.20 | 171.49 |
| SaP | 2.50 | 2270 | 5.30 | 152.47 | 104.59 |
| | 5.70 | 5030 | 22.56 | 194.38 | 179.33 |
| | 8.50 | 8420 | 46.44 | 221.52 | 216.58 |
| | 12.60 | 11510 | 67.77 | 237.98 | 236.08 |
| | 13.10 | 5570 | 37.89 | 199.75 | 206.08 |
| | 16.50 | 8890 | 52.17 | 224.38 | 222.58 |
| | 20.10 | 14790 | 86.77 | 251.19 | 248.83 |

Table 30 - Display of the interpretation of the Vs results from the CPTu-9 tests

| Layer designation | Layer lower limit (m) | q _c (kN/m ²) | f _s (kN/m ²) | Mayne(2006.) Vs (m/s) | Tun (2003.) Vs (m/s) |
|-------------------|--------------------------|--|--|-----------------------------|----------------------------|
| nt | 0.40 | 2680 | 53.94 | 161.22 | 224.30 |
| SaU-SaP | 2.90 | 3480 | 15.03 | 174.98 | 158.37 |
| | 8.10 | 6660 | 34.29 | 209.17 | 200.93 |
| | 10.60 | 8270 | 47.03 | 220.57 | 217.23 |
| | 14.10 | 10250 | 57.40 | 231.88 | 224.74 |
| CIL | 14.50 | 1770 | 23.91 | 139.37 | 182.33 |
| SaU-SaP | 18.00 | 14420 | 83.95 | 249.86 | 247.12 |

4.7. ANALYSIS OF THE RESULTS OF PERFORMED DPSH-A TESTS

Data processing of the performed DPSH tests was carried out according to "SRPS EN ISO 22476-2", on the basis of which the resistance of the cone r_d and the dynamic resistance of the cone q_d were determined. After that, a correlation was established between the dynamic resistance of the cone q_d and the standard penetration test (SPT), where the numbers of blows for N_{30SB} were adopted, on the basis of which the value of SPT N was obtained. Based on the value of SPT N , the values of SPT N_{60} and SPT $(N_1)_{60}$ were further calculated. Finally, the values of the compaction index I_d (D_r) and the angle of internal friction ϕ for loose soils were obtained. Data processing and obtained values of physical and mechanical soil parameters are defined in the framework of "SRPS EN 1997-2".

The results of the DPSH test are given in the Documentation Book, in the **Attachment 1.7.3**, while the data processing and correlations with the physical and mechanical parameters of the soil are shown in **Table 31**.

Table 31 - Data obtained by processing the results of DPSH tests

| Test designation | Layer designation | Layer lower limit (m) | Layer thickness (m) | q_d (MPa) | Compaction index | φ' (°) | α | Mv (MPa) |
|------------------|-------------------|-----------------------|---------------------|-------------|------------------|----------------|----------|----------|
| DPSH-1 | saSi | 0.8 | 0.8 | 4.224 | - | - | 2.0 | 8.448 |
| | SaP | 7.0 | 6.2 | 4.590 | Loose | 32 | 2.0 | 9.180 |
| | | 8.2 | 1.2 | 2.174 | Loose | 32 | 2.0 | 4.348 |
| | | 15.0 | 6.8 | 4.003 | Loose | 32 | 2.0 | 8.006 |
| DPSH-2 | nt | 1.0 | 1 | 7.063 | - | - | 0.5 | 3.532 |
| | | 4.2 | 3.2 | 2.715 | - | - | 0.5 | 1.358 |
| | | 13.5 | 9.3 | 1.852 | - | - | 0.5 | 0.926 |
| | SaP | 20.0 | 6.5 | 4.820 | - | - | 2.0 | 9.640 |
| DPSH-3 | nt | 1.3 | 1.3 | 7.343 | - | - | 0.5 | 3.672 |
| | | 2.4 | 1.1 | 6.604 | - | - | 0.5 | 3.302 |

4.8. GEOMECHANICAL CHARACTERISTICS OF LITHOLOGICAL LAYERS

Based on the adopted archival documentation and the processing of the results of terrain investigations and laboratory tests, the engineering and geological characteristics of the isolated lithological environments with the values of physical and mechanical parameters were defined. The terrain, starting from its surface, is built by the following sediments:

Filled soil (af) - characterized by typically heterogeneous and anisotropic properties in terms of material composition and compaction. Depending on local conditions, it can be built from construction waste (**nt_{st}**) or municipal waste (**nt_{org}**).

In the composition of construction waste (**af_{con}**), clays, silts and sands mixed with the remains of construction waste (brick, gravel, concrete, PVC bags...) can be determined. Black to black-brown color. The thickness of the layer registered in the boreholes is from 0.60 to 3.50 m.

In the composition of municipal waste - Landfill (**af_{org}**), clay, silt and sand mixed with organic matter of different origins, packaging residues... can be determined. Black to black-brown color. The thickness of the layer is from 5.00 to 9.80 m.

Sandy silts (saSi - saSiL - saCIL) - fixed on the surface of the terrain or locally in the floor of the embankments and the roof of the sands. The determined thickness of the layer in the investigation boreholes is from 0.60 to 1.40 m. Depending on the local conditions and content of the clay fraction, it can be non-plastic to highly plastic. Light brown color.

In accordance with the ESCS classification, the layer is defined as: saSi - silt with > 15% sand particles; saSiL – low-plastic silt with > 15% sand particles; saCIL – low-plastic clay with > 15% sand particles; saSiM – medium-plastic silt with > 15% sand particles; saSiH – high-plastic silt with > 15% sand particles.

The values of physical and mechanical soil parameters obtained by laboratory geomechanical testing of samples from the borehole are shown in **Table 32**.

Table 32 - Overview of the results of laboratory tests

| Percentage of fractions in the granulometric composition | |
|--|---------------|
| Clay (%) | 12 - 22 |
| Silt (%) | 34 - 57 |
| Sand (%) | 25 - 49 |
| Gravel (%) | 0 - 6 |
| Bulk density, humidity, consistency limits | |
| γ (kN/m ³) | 14.30 – 19.50 |
| γ_d (kN/m ³) | 14.30 - 15.60 |
| W (%) | 18.50 – 52.72 |

| | |
|--|---------------|
| W _L (%) | 29.43 – 58.92 |
| W _P (%) | 20.31 – 39.21 |
| I _P | 8.90 – 19.71 |
| I _c | 0.30 – 1.40 |
| Shear resistance - direct shear | |
| φ (°) | 17 – 24 |
| c (kN/m ²) | 6 – 14 |
| Compressibility module - oedometer | |
| M _{v 0-12.50} (kN/m ²) | 301 – 1106 |
| M _{v 12.50-25} (kN/m ²) | 393 – 1596 |
| M _{v 25-50} (kN/m ²) | 498 – 1655 |
| M _{v 50-100} (kN/m ²) | 671 – 1965 |
| M _{v 100-200} (kN/m ²) | 1646 – 2905 |
| M _{v 200-400} (kN/m ²) | 4033 – 5195 |
| M _{v 400-800} (kN/m ²) | 8163 – 10324 |

Based on the processing of the results of the standard penetration tests (IB-41), correlations were made on the basis of which the resistant-deformable characteristics were obtained, and the values were determined:

| | |
|--|------|
| Undrained shear strength c _u (kN/m ²) | 41 |
| Compressibility modulus M _v (kN/m ²) | 2403 |

Based on the processing of the results of the cone penetration tests, correlations were made on the basis of which the resistant-deformable characteristics were obtained, and the values were determined:

| | |
|--|-------------|
| Undrained shear strength c _u (kN/m ²) | 55.78 |
| Compressibility modulus M _v (kN/m ²) | 2550 - 6100 |

Clay to ground water clay (CIM - SIM) – light gray clays to ground water clays, with uneven participation of sand. Medium plastic, soft to firm consistency.

In accordance with the ESCS classification, the layer is defined as: CIM - medium plasticity clay; CIH – high plasticity clay; SIM – medium plasticity silt.

The results obtained by laboratory geomechanical testing of samples from the borehole are shown in **Table 33**.

Table 33 - Overview of the results of laboratory tests

| Percentage of fractions in the granulometric composition | |
|---|---------------|
| Clay (%) | 14 – 35 |
| Silt (%) | 63 – 71 |
| Sand (%) | 1 – 15 |
| Gravel (%) | – |
| Bulk density. humidity. consistency limits | |
| γ (kN/m ³) | 18.10 – 20.20 |
| γ _d (kN/m ³) | 12.70 – 16.20 |
| W (%) | 24.43 – 47.25 |
| W _L (%) | 36.72 – 51.61 |
| W _P (%) | 20.54 – 27.97 |
| I _P | 15.40 – 25.32 |
| I _c | 0.00 0.76 |

| Shear resistance - direct shear | |
|--|--------------|
| φ (°) | 7 – 17 |
| c (kN/m ²) | 11 – 16 |
| Compressibility module - oedometer | |
| M _v 0-12.50 (kN/m ²) | 288 – 1211 |
| M _v 12.50-25 (kN/m ²) | 653 – 1844 |
| M _v 25-50 (kN/m ²) | 800 – 1966 |
| M _v 50-100 (kN/m ²) | 1323 – 3326 |
| M _v 100-200 (kN/m ²) | 2355 – 5525 |
| M _v 200-400 (kN/m ²) | 4533 – 9975 |
| M _v 400-800 (kN/m ²) | 9029 – 17105 |

Based on the performed standard penetration tests, the N number of blows was obtained, which was corrected, and on the basis of which the values of the physical and mechanical characteristics of the soil were calculated:

| | |
|---|-----------|
| Undrained shear strength c_u (kN/m ²) | 27-34 |
| Compressibility modulus M_v (kN/m ²) | 1602-2002 |

Sand to ground water sand (siSa - SaP) – light brown to dark gray channel facies sediments represented by sand to ground water sand. The sand is fine-grained to coarse-grained, medium to uniformly graded, loose to medium compact, water saturated. Favorable geotechnical characteristics.

In accordance with the ESCS classification, the layer is defined as: siSa - ground water sand with > 15% smaller particles; SaP – poorly graded sand with the participation of smaller fractions <5%; SaU – uniformly graded sand with the participation of smaller fractions <5%; SaM – medium-graded sand with the participation of smaller fractions < 5%.

The determined thickness of the layer is conditioned by the depth of investigation of the investigation boreholes and is from 3.00 to 23.10 m.

Intercalations of low plastic to medium plastic clay were registered within the layer.

The values of physical and mechanical soil parameters obtained by laboratory geomechanical testing of samples from the borehole are shown in **Table 34**.

Table 34 - Overview of the results of laboratory tests

| Percentage of fractions in the granulometric composition | |
|--|----------------|
| Clay (%) | 1.30 – 12.70 |
| Silt (%) | 1.00 – 41.60 |
| Sand (%) | 42.80 – 100.00 |
| Gravel (%) | 0.00 – 11.20 |
| Bulk density. humidity. consistency limits | |
| γ (kN/m ³) | 19.90 |
| γ_d (kN/m ³) | 16.70 |
| W (%) | 1.09 – 31.52 |
| W _L (%) | - |
| W _P (%) | - |
| I _P | - |
| I _c | - |
| Shear resistance - direct shear | |
| φ (°) | 29 – 38 |
| c (kN/m ²) | 0 – 8 |
| Compressibility module - oedometer | |

| | |
|-------------------------------------|---------------|
| M_v 0-12.50 (kN/m ²) | 485 – 3289 |
| M_v 12.50-25 (kN/m ²) | 349 – 4624 |
| M_v 25-50 (kN/m ²) | 993 – 4656 |
| M_v 50-100 (kN/m ²) | 1489 – 5604 |
| M_v 100-200 (kN/m ²) | 3492 – 10454 |
| M_v 200-400 (kN/m ²) | 6768 – 21284 |
| M_v 400-800 (kN/m ²) | 12992 – 40688 |

Based on the processing of the results of the standard penetration tests, correlations were made on the basis of which the resistant-deformable characteristics were obtained, and the values were determined:

Angle of internal friction ϕ (°) 29 - 36

Compressibility modulus M_v 2942 - 13790
(kN/m²)

Based on the processing of the results of the cone penetration tests, correlations were made on the basis of which the resistant-deformable characteristics were obtained, and the values were determined:

Angle of internal friction ϕ (°) 28 - 43

Compressibility modulus M_v 3405 - 31110
(kN/m²)

Marly clays (CIM) – light gray deposits with a low content of sand and gravel and a significant amount of silt. Medium plasticity and hard consistency.

In accordance with the ESCS classification, the layer is defined as: CIM - medium plasticity clay.

The determined thickness of the layer in the investigation borehole B-36 is determined by the depth of the investigation and is 0.90 m.

The results obtained by laboratory geomechanical testing of samples from the borehole are shown in **Table 35**.

Table 35 - Overview of the results of laboratory tests

| Percentage of fractions in the granulometric composition | |
|--|-------|
| Clay (%) | 22 |
| Silt (%) | 73 |
| Sand (%) | 3 |
| Gravel (%) | 2 |
| Bulk density, humidity, consistency limits | |
| γ (kN/m ³) | 19.50 |
| γ_d (kN/m ³) | 15.40 |
| W (%) | 26.80 |
| W_L (%) | 37.50 |
| W_P (%) | 24.60 |
| I_P | 12.90 |
| I_c | 0.80 |
| Shear resistance - direct shear | |
| ϕ (°) | 26 |
| c (kN/m ²) | 24 |
| Compressibility module - oedometer | |
| M_v 0-12.50 (kN/m ²) | 1349 |
| M_v 12.50-25 (kN/m ²) | 1311 |

| | |
|---------------------------------------|-------|
| $M_{v\ 25-50}$ (kN/m ²) | 1641 |
| $M_{v\ 50-100}$ (kN/m ²) | 2623 |
| $M_{v\ 100-200}$ (kN/m ²) | 4451 |
| $M_{v\ 200-400}$ (kN/m ²) | 7290 |
| $M_{v\ 400-800}$ (kN/m ²) | 12786 |

For a more complete overview of the geological structure and engineering and geological properties of the terrain in the investigation area, as well as for the purpose of taking soil samples for terrain identification, classification of materials and determining the suitability of the terrain for the construction of access roads of the Waste Management Regional Center, the excavation of trial pits was carried out, the basic data of which are previously attached in **Table 3**.

Table 36 shows a spreadsheet of laboratory tests of soil samples from trial pits.

Table 36 - Overview of the results of laboratory tests

| Pit designation | Sampling depth (m) | Granulometric composition | | | | Dry bulk density $\rho_{d\ max}$ | Optimum humidity W_{opt} [%] | Laboratory CBR [%] | Laboratory classification |
|-----------------|--------------------|---------------------------|------|-------|--------|----------------------------------|--------------------------------|--------------------|---------------------------|
| | | clay | silt | sand | gravel | | | | |
| IJ-1 | 0.50 | 7.7 | 34.4 | 57.9 | 0.0 | 1.75 | 15.9 | 12.0 | clsiSa |
| | 0.90 | - | 0.1 | 99.6 | 0.3 | 1.56 | 20.0 | 12.0 | SaP |
| IJ-2 | 0.55 | 6.5 | 28.8 | 64.7 | 0.0 | 1.73 | 16.5 | 9.0 | siSa |
| | 1.10 | - | 0.8 | 98.0 | 1.2 | 1.58 | 19.7 | 10.0 | SaP |
| IJ-3 | 0.20 | 12.3 | 36.9 | 50.8 | 0.0 | 1.79 | 15.0 | 14.0 | clSa |
| | 0.50 | 4.8 | 24.9 | 70.2 | 0.1 | 1.73 | 19.8 | - | siSa |
| | 1.10 | - | 4.1 | 95.9 | 0.0 | 1.57 | 19.2 | 12.0 | SaP |
| IJ-4 | 0.20 | 10.4 | 43.8 | 45.8 | 0.0 | 1.75 | 15.9 | 9.5 | saCIL |
| | 0.50 | - | 0.0 | 100.0 | 0.0 | 1.57 | 15.7 | - | SaU |
| IJ-5 | 0.00 | 18.1 | 61.0 | 17.2 | 3.7 | - | - | - | saCIL |
| | 0.50 | 20.1 | 59.8 | 16.9 | 3.3 | 1.83 | 16.6 | 7.5 | saCIL |
| IJ-6 | 0.30 | 17.6 | 31.8 | 50.6 | 0.0 | 1.78 | 15.6 | 8.0 | clSa |
| | 0.60 | - | 7.0 | 93.0 | 0.0 | 1.60 | 19.6 | 15.0 | siSaU |
| IJ-7 | 0.40 | 17.8 | 29.8 | 52.4 | 0.0 | 1.61 | 20.1 | 4.0 | clSa |
| | 0.80 | 3.6 | 34.8 | 61.6 | 0.0 | 1.77 | 16.4 | 11.0 | siSa |
| | 1.10 | 13.4 | 83.6 | 3.0 | 0.0 | 1.66 | 21.8 | 3.0 | SiL |
| IJ-8 | 0.30 | - | 2.3 | 97.7 | 0.0 | 1.73 | 15.6 | 16.0 | SaP |
| | 0.60 | - | - | - | - | - | - | - | - |
| IJ-9 | 0.50 | - | - | - | - | - | - | - | - |
| | 1.20 | 21.7 | 57.2 | 21.1 | 0.0 | - | - | - | saSiM |
| IJ-10 | 0.00 | 19.5 | 36.7 | 43.7 | 0.0 | 1.51 | 23.8 | 4.0 | saSiM |
| | 0.70 | 0.9 | 11.5 | 87.5 | 0.0 | 1.51 | 21.1 | 9.0 | siSaP |
| IJ-11 | 0.00 | - | 5.7 | 94.3 | 0.0 | 1.56 | 19.8 | 13.0 | siSaU |

4.9. TERRAIN SEISMICITY

In accordance with "SRPS EN 1998-2", the input parameters for seismic analysis are derived from the condition that the facility, with an average service life of 50 years, does not collapse, which corresponds to a seismic action with a probability of exceeding 10% over a period of 50 years. This earthquake has a return period of events of $T_{NCR} = 475$ years.

$$T_{NCR} = \frac{50}{\ln(1 - 0.10)} = 475.56 \approx 475 \text{ years}$$

The map of the Republic Seismological Institute - seismic hazard map of the Republic of Serbia, which is expressed in units of horizontal acceleration (g) was used to assess the seismicity of the terrain (**Photo 13**).

The value of the horizontal acceleration of soil oscillation (a_{gr}) is 0.10 g for the return period of 475 years.

According to soil typification, in accordance with "SRPS EN 1998-1", the soil can be characterized as "D" type soil - deposits of loose to medium cohesive soil or predominantly soft to firm cohesive soil with wave speed up to 180 m/s, N_{SPT} hammer blows up to 15 and undrained shear strength up to 70 kNm², and as "C" type soil - deposits of compacted or medium-compacted sand, gravel or stiff clay, with the speed of propagation of seismic waves in the range of 180 to 360 m/s, N_{SPT} hammer blows in the range of 15 to 50 and undrained shear strength ranging from 70 to 250 kNm².

It is recommended that soil type "E" - alluvial deposits with a thickness of 5 to 20 m, which is characterized by parameters as soil "C" or "D" type - be selected for the soil category.

The I type of elastic response spectrum is recommended.

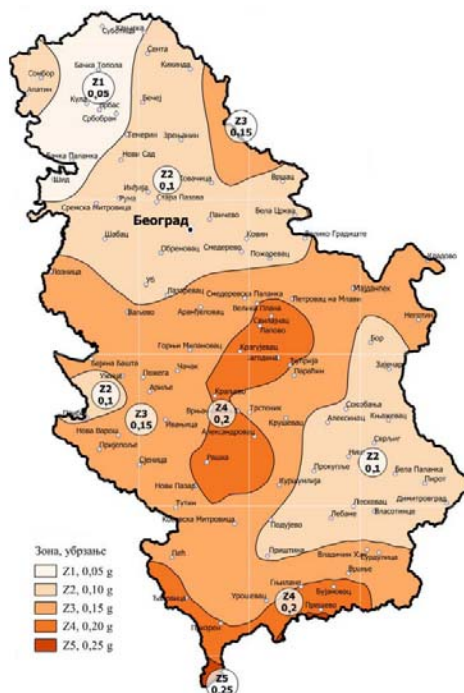


Photo 13 - Seismic hazard map of the Republic of Serbia expressed in units of horizontal acceleration for a return period of 475 years ("SRPS EN 1998-1/NA:2018")

4.10. RELEVANT LAYER PARAMETERS FOR GEOSTATIC CALCULATIONS

Descriptions of the properties of the layers, their characteristics of importance for the assessment of the geotechnical conditions of construction and foundation of the facility, are given in the previous chapters.

The determination of the terrain model and relevant soil parameters for geostatic calculations in the areas of facilities where the foundation will be made were adopted on the basis of laboratory and terrain tests, for the location of each individual facility and are shown in **Tables 37-51**.

Table 37 - Model 1. Overview of adopted soil parameters for facilities **1, 2, 3 and 4** (B-2)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | C_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| SaCIL | 2.0 | 2.0 | 18.0 | 17 | 10 | - | - | 1675 | - |
| saP | 10.0 | 8.0 | 15.6 | 33 | 0 | - | - | 3624 | - |

GWL=3.0 m

Table 38 - Model 3. Overview of adopted soil parameters for the facility **5** (B-4)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | C_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| SaSi | 1.3 | 1.3 | 18.0 | 23 | 2 | - | - | - | 2213 |
| SaP | 10.0 | 8.7 | 15.6 | 30 | 0 | - | - | - | 5405 |

GWL=3.0 m

Table 39 - Model 3. Overview of adopted soil parameters for the facility **9** (B-6)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| saSi | 1.0 | 1.0 | 18.0 | 23 | 2 | - | 1936 | - | - |
| SaP-SaU | 10.0 | 9.0 | 15.6 | 32 | 0 | - | 1880 | - | - |

GWL=3.0 m

Table 40 - Model 4. Overview of adopted soil parameters for the facility **10** (B-9)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| nt-šut | 1.4 | 1.4 | 18.0 | 17 | 0 | - | - | 1200 | - |
| SaSiL | 2.3 | 0.7 | 18.0 | 23 | 2 | - | - | 3205 | - |
| SaP | 10.0 | 7.7 | 15.6 | 32 | 0 | - | - | 3311 | - |

GWL=3.8 m

Table 41 - Model 5. Overview of adopted soil parameters for the facility **11** (B-11)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| nt-šut | 3.5 | 3.5 | 18.5 | 17 | 2 | - | - | 1200 | - |
| SaSi | 4.2 | 0.7 | 18.0 | 23 | 2 | - | - | 3205 | - |
| SaP | 10.0 | 5.8 | 15.6 | 32 | 0 | - | - | 2962 | - |

GWL=3.8 m

Table 42 - Model 6. Overview of adopted soil parameters for the facility **12** (B-12)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| nt-šut | 2.5 | 2.5 | 18.0 | 17 | 2 | - | - | 1200 | - |
| siSa | 4.5 | 2.0 | 18.0 | 23 | 2 | - | - | 3205 | - |
| SaP | 10.0 | 5.5 | 15.6 | 30 | 0 | - | - | 3258 | - |

GWL=3.8 m

Table 43 - Model 7. Overview of adopted soil parameters for the facility **15 first dilatation** (B-14)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| nt-org | 6.5 | 6.5 | 18.0 | 17 | 2 | 20 | - | 1202 | - |
| siSaP-siSa | 20.0 | 13.5 | 15.6 | 30 | 0 | - | - | 2936 | - |

GWL=3.0 m

Table 44 - Model 8. Overview of adopted soil parameters for the facility **15 third dilatation and 15a** (B-17)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| nt-org | 6.2 | 6.2 | 18.0 | 17 | 2 | 20 | - | 1202 | - |
| CIM | 7.5 | 1.3 | 17.6 | 7 | 13 | 27 | - | 1602 | - |
| SaU | 12.0 | 4.5 | 15.6 | 30 | 0 | - | - | 2936 | - |

GWL=3.0 m

Table 45 - Model 9. Overview of adopted soil parameters for the facility **16** (B-16)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| nt-org | 5.2 | 5.2 | 18.0 | 17 | 3 | 20 | - | 1202 | - |
| CIM | 6.2 | 1.0 | 17.6 | 7 | 13 | - | - | 2573 | - |
| SaU | 12.0 | 5.8 | 15.6 | 30 | 0 | - | - | 2936 | - |

GWL=3.0 m

Table 46 - Model 10. Overview of adopted soil parameters for the facility **19** (B-23)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| siSa | 2.0 | 2.0 | 18.0 | 24 | 2 | - | - | 1888 | - |
| siSaP | 10.0 | 8.0 | 15.6 | 34 | 0 | - | - | 4184 | - |

GWL=3.4 m

Table 47 - Model 11. Overview of adopted soil parameters for the facility **20** (B-26)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| nt-org | 6.6 | 6.6 | 18.0 | 17 | 3 | 14 | - | 1200 | - |
| CIM | 11.0 | 4.4 | 17.8 | 7 | 13 | - | - | 2573 | - |
| siSaP | 20.0 | 9.0 | 15.6 | 30 | 0 | - | - | 2760 | - |

GWL=3.8 m

Table 48 - Model 12. Overview of adopted soil parameters for the facility **21** (B-30)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| nt-org | 7.6 | 7.6 | 18.0 | 17 | 3 | 14 | - | 1200 | - |
| SaP | 10.2 | 2.6 | 15.6 | 30 | 0 | - | - | 2123 | - |

GWL=4.0 m

Table 49 - Model 13. Overview of adopted soil parameters for the facility **21** (B-31)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| nt-org | 9.8 | 9.8 | 18.0 | 17 | 3 | 14 | - | 1201 | - |
| SaP | 10.0 | 0.2 | 15.6 | 30 | 1 | - | - | 2123 | - |

GWL=4.0 m

Table 50 - Model 9. Overview of adopted soil parameters for the facility **25** (B-38)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| siSa | 1.0 | 1.0 | 18.0 | 23 | 3 | - | 993 | - | - |
| SaP | 10.0 | 9.0 | 15.6 | 30 | 0 | - | 1890 | - | - |

GWL=0.65 m

Table 51 - Model 15. Overview of adopted soil parameters for the facility **26** (B-33)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| saSi | 2.0 | 2.0 | 18.0 | 23 | 3 | - | - | 3354 | - |
| SaP | 10.0 | 8.0 | 15.6 | 30 | 0 | - | - | 4610 | - |

GWL=0.8 m

Table 52 - Model 16. Overview of adopted soil parameters for the facility **27** (B-36)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| saSi | 1.0 | 1.0 | 18.0 | 23 | 3 | - | - | 3354 | - |
| SaP | 10.0 | 9.0 | 15.6 | 30 | 0 | - | - | 4610 | - |

GWL=0.6 m

Table 53 - Model 17. Overview of adopted soil parameters for the facility **8** (cross section)

| Layer designation | Depth (m) | Thickness (m) | γ (kN/m ³) | ϕ (°) | c (kN/m ²) | c_u (kN/m ²) | M_{v25-50} (kN/m ²) | $M_{v50-100}$ (kN/m ²) | $M_{v100-200}$ (kN/m ²) |
|-------------------|-----------|---------------|-------------------------------|------------|--------------------------|----------------------------|-----------------------------------|------------------------------------|-------------------------------------|
| saSi | 1.5 | 1.5 | 18.0 | 23 | 2 | - | - | 1890 | - |
| SaP | 10.0 | 8.5 | 15.6 | 34 | 0 | - | - | 4180 | - |

GWL=3.0 m

The groundwater level was measured in relation to the absolute elevation of 75.89 above sea level, which means that the GWL is about 1-2 m above the GWL read at the time of investigation drilling.

5. GEOTECHNICAL CONDITIONS OF FACILITY CONSTRUCTION

The geotechnical conditions of the facility construction, as well as its general stability, are defined on the basis of:

- geotechnical characteristics of isolated environments involved in the foundation of the facility,
- analysis of the limit and permissible bearing capacity of the soil,
- analysis of predicted subsidence of the soil,
- analysis of embankment slope stability.

In this chapter, geostatic calculations were made, based on the results of which the impacts of facilities on the soil will be assessed.

5.1. TECHNICAL CHARACTERISTICS OF THE FACILITY

On the subject of the Regional Waste Management Center in Novi Sad, the construction of newly designed facilities and reconstruction/rehabilitation of existing facilities is planned.

All input data on the technical characteristics of the facilities were submitted by the Client, and are shown in **Table 54**.

Table 54 - Overview of the technical characteristics

| No. | Facility | Foundation | Df (m) | L (m) | B (m) | d (m) | Nu (kN) | Mxu (kN) | Myu (kN) | σ (kN) |
|---------|---|----------------------------------|-------------|-------------|-------------|------------|---------------|-----------------|--------------|---------------|
| 1 | Guardhouse | Strip | 0.8 | 4.0 | 0.5 | 0.3 | - | - | - | 84.04 |
| 2, 3, 4 | Truck scale with canopy | Strip | 1.3 | 5.0 | 1.0 1.2 | 0.8 | - | - | - | 91.05 |
| 5 | Administrative building P+1 | Spot footing | 0.8 | 1.75 1.6 | 1.75 1.6 | 0.4 0.4 | 440.86 341 | -28.23 35.16 | 6.94 2.27 | - - |
| 9 | Building for workers | Strip | 0.9 | 5.0 | 0.4 | 0.3 | - | - | - | 44.03 |
| 10 | Workshop | Spot footing | 1.1 | 2.8 | 1.4 | 0.4 | 295.5 | 88.1 | - | - |
| 11 | Warehouse | Spot footing | 1.1 | 2.8 | 1.4 | 0.4 | 332.8 | - | 26.7 | - |
| 12 | Canopy, Car wash for utility vehicles | Spot footing | 1.0 | 1.6 | 1.0 | 0.4 | 104.8 | 30.2 | - | - |
| 15.1 | MBT facility - first dilatation | Counter beam | 1.0 | 5.0 25.2 | 1.0 1.2 | 1.0 0.3 | - - | - - | - - | 65.5 |
| 15.2 | MBT facility - third dilatation - sorting plant | Counter beam | 1.0 | 42 | 1.0 | 1.0 | - | - | - | 65.5 |
| 16 | Substation next to the MBT facility | Strips | 0.9 | 14.5 | 0.5 | 0.3 | - | - | - | 136.2 |
| 18 | Warehouse for treated waste | Spot footings | 1.0 | 0.8 | 0.4 | - | - | - | - | 100 |
| 19 | Garage for vehicles | Spot footings | 1.35 | 2.4 | 1.2 | 0.4 | 222.7 | 68.1 | - | - |
| 20 | Existing waste sorting plant | Strip | 1.0 | 45.0 | 0.95 | 1.0 | - | - | - | 100 |
| | | Spot footing | 1.1 | 2.8 | 1.4 | 0.4 | | | | 100 |
| 21 | Hangar for baled waste | Spot footings - T1 | 0.95 | 1.8 | 1.0 | 0.4 | 94 | 27 | - | - |
| | | Spot footings - T2 | | 1.4 | 0.7 | | 34 | - | 14.2 | |
| 25 | PPPV command building | Strip - axis 2 Strip - axis D | 0.8 | 9.75 | 0.4 | 0.3 | - | - | - | 48.4 |
| 26 | Canopy for mechanization at the landfill | Spot footings | 1.8 | 1.75 | 1.75 | 0.4 | 309.2 | 64.8 | - | - |
| 8 | Fire tank | Slab | 0.9 1.45 | 10.9 6.5 | 5.8 5.55 | 0.4 | - | - | - | 100 |
| 27 | Retention of leachate | Slab | 0.4 | 35.8 | 35.2 | 0.4 | - | - | - | 100 |
| 15a | Digester | Slab | 1.25 | 24.5 | 19.0 | 0.5 | - | - | - | 100 |

5.2. SHALLOW FOUNDATION

Based on the adopted geotechnical models of the terrain, the shape and dimensions of the foundation, as well as the adopted foundation depths, the analyzes of the limit bearing capacities and prognostic soil subsidences were performed for the foundation variants on different types of foundations, previously listed in Table 54.

The calculation of the limit bearing capacity and prognostic soil subsidence was performed in the "GEO5" software, using the "Spreadfooting" software package. The analysis was carried out for the calculation approach 3 (DA3).

As the input data for geostatic calculations, we do not know the facilities no. 8 and 20 loads, but only the dimensions of the foundation and the foundation depth, geostatic calculations of the limit bearing capacity of the foundation soil were carried out for the case of an arbitrary load of 100 kN/m².

The obtained results of the calculation of bearing capacity and subsidence of the foundation soil are shown in Table 55.

Table 55 - Overview of the results of the analysis of bearing capacity and soil subsidence

| Facility | Df | L (m) | B (m) | B/L | subgrade (m) | Soil bearing capacity (Terzaghi) | | Soil bearing capacity (EC7) | | subsidence S (mm) |
|--|-----|----------|----------|-------|-----------------|--|---|--|---------------------------|-------------------------|
| | | | | | | q _r (kN/m ²) | q _a = q _r /3 (kN/m ²) | R _d (kN/m ²) | σ (kN/m ²) | |
| Guardhouse | 0.8 | 4.0 | 0.5 | 0.125 | 0 | 198.00 | 66.00 | 134.83 | 84.15 | 18.2 |
| Guardhouse - with subgrade | | | | | 0.7 | 309.50 | 103.20 | 207.89 | 84.15 | 5.7 |
| Truck scale with canopy - T1 | 1.3 | 5.0 | 1.0 | 0.20 | 0 | 269.30 | 89.80 | 221.95 | 91.24 | 17.9 |
| Truck scale with canopy - T1 with subgrade | | | | | 0.7 | 498.30 | 166.10 | 271.80 | 91.24 | 5.8 |
| Truck scale with canopy - T2 | | | 1.2 | 0.24 | 0 | 274.80 | 91.60 | 256.18 | 91.26 | 29.0 |
| Truck scale with canopy - T2 with subgrade | | | | | 0.7 | 512.60 | 170.90 | 303.56 | 91.26 | 12.1 |
| Administrative building P+1 - T1 | 0.8 | 1.75 | 1.75 | 1.00 | 0 | 293.10 | 97.70 | 258.93 | 165.12 | 22.0 |
| Administrative building P+1 - T1 with subgrade | | | | | 0.7 | 560.00 | 186.70 | 281.64 | 165.12 | 14.0 |
| Administrative building P+1 - T2 | | 1.6 | 1.6 | 1.00 | 0 | 285.00 | 95.00 | 246.20 | 161.06 | 32.1 |
| Administrative building P+1 - T2 with subgrade | | | | | 0.4 | 499.30 | 166.40 | 260.45 | 161.06 | 16.5 |
| Building for workers | 0.9 | 5.0 | 0.4 | 0.125 | 0 | 216.70 | 72.20 | 224.78 | 44.50 | 5.2 |
| Building for workers - with subgrade | | | | | 0.4 | 366.70 | 122.20 | 248.25 | 44.50 | 2.2 |
| Workshop | 0.9 | 2.8 | 1.4 | 0.50 | 0 | 182.00 | 60.70 | 188.65 | 135.69 | 25.4 |
| Workshop - with subgrade | | | | | 0.4 | 772.50 | 257.50 | 208.16 | 135.69 | 13.4 |
| Warehouse (B-11) | 1.1 | 2.8 | 1.4 | 0.52 | 0 | 197.20 | 65.70 | 110.64 | 100.86 | 55.7 |
| Warehouse - with subgrade (B-11) | | | | | 2.4 | 1481.20 | 493.70 | 309.58 | 100.86 | 3.4 |
| Warehouse (B-8) | | | | | 0 | 197.20 | 65.70 | 191.60 | 100.83 | 22.2 |
| Warehouse - with subgrade (B-8) | | | | | 0.7 | 707.00 | 235.70 | 215.98 | 100.83 | 12.3 |
| Canopy, Car wash for utility vehicles | 1.0 | 1.6 | 1.0 | 0.625 | 0 | 171.90 | 57.30 | 88.75 | 151.00 | 26.6 |
| Canopy, Car wash for utility vehicles - with subgrade | | | | | 1.6 | 1060.50 | 535.50 | 215.11 | 151.00 | 1.2 |
| MBT - first dilatation (B-13) | 1.0 | 56.2 | 1.0 | 0.02 | 0 | 157.10 | 52.40 | 91.92 | 65.50 | 31.0 |
| MBT - first dilatation (B-13) - with subgrade (B-13) | | | | | 6.0 | 1467.40 | 489.10 | 495.53 | 65.50 | 0.7 |
| MBT - first dilatation (B-15) | | | | | 0 | 157.10 | 52.40 | 175.54 | 65.50 | 21.8 |
| MBT - first dilatation (B-13) - with subgrade (B-15) | | | | | 0.7 | 954.50 | 318.20 | 224.31 | 65.50 | 6.6 |
| MBT - first dilatation - axis E (B-13) | | 25.2 | 1.2 | 0.05 | 0 | 157.10 | 52.40 | 91.57 | 65.50 | 51.6 |
| MBT - first dilatation - axis E - with subgrade (B-13) | | | | | 6.0 | 1567.40 | 522.50 | 427.57 | 65.50 | 1.2 |
| MBT - first dilatation - axis E (B-15) | | | | | 0 | 157.10 | 52.40 | 192.39 | 65.50 | 31.5 |
| MBT - first dilatation - axis E - with subgrade (B-15) | | | | | 0.7 | 1000.70 | 333.60 | 235.35 | 65.50 | 14.6 |
| MBT - third dilatation - sorting plant (B-19) | 1.0 | 42 | 1.0 | 0.02 | 0 | 166.30 | 55.40 | 96.37 | 65.50 | 44.3 |

| Facility | Df | L (m) | B (m) | B/L | subgrade (m) | Soil bearing capacity (Terzaghi) | | Soil bearing capacity (EC7) | | subsidence S (mm) |
|---|------|----------|----------|------|-----------------|-------------------------------------|---------------------------------------|-------------------------------|----------------------------------|-------------------------|
| | | | | | | q_f (kN/m ²) | $q_a = q_f/3$ (kN/m ²) | R_d (kN/m ²) | σ (kN/m ²) | |
| MBT - third dilatation - sorting plant - with subgrade (B-19) | | | | | 4.0 | 1433.30 | 477.80 | 343.51 | 65.50 | 1.1 |
| MBT - third dilatation - sorting plant (B-17) | | | | | 0 | 166.30 | 55.40 | 96.37 | 65.50 | 44.8 |
| MBT - third dilatation - sorting plant - with subgrade (B-17) | | | | | 6.0 | 1433.30 | 477.80 | 476.17 | 65.50 | 1.1 |
| Substation next to the MBT facility | | | | | 0 | 141.70 | 47.20 | 56.94 | 139.76 | 83.7 |
| Substation next to the MBT facility - with subgrade | 0.9 | 14.5 | 0.5 | 0.04 | 5.1 | 1094.60 | 364.90 | 371.41 | 142.64 | 1.8 |
| Garage for vehicles | | | | | 0 | 372.30 | 124.10 | 375.35 | 160.18 | 20.1 |
| Garage for vehicles - with subgrade | 1.35 | 2.4 | 1.2 | 0.5 | 0.7 | 804.20 | 268.10 | 420.19 | 160.18 | 6.5 |
| Existing waste sorting plant (strip) | | | | | 0 | 165.00 | 55.00 | 95.77 | 100.00 | 86.2 |
| Existing waste sorting plant (strip) - with subgrade | 1.0 | 45.0 | 1.0 | 0.2 | 5.6 | 1408.80 | 469.60 | 459.78 | 100.00 | 2.1 |
| Existing waste sorting plant (spot footing) | | | | | 0 | 208.90 | 69.60 | 116.18 | 112.09 | 75.8 |
| Existing waste sorting plant (spot footing) - with subgrade | 1.1 | 2.8 | 1.4 | 0.5 | 5.6 | 1723.10 | 574.40 | 440.97 | 112.09 | 1.8 |
| Hangar for baled waste 1 - PoS-T1 (B-30) | | | | | 0 | 182.00 | 60.70 | 92.91 | 120.02 | 32.7 |
| Hangar for baled waste 1 - PoS-T1 - with subgrade (B-30) | | | | | 5.0 | 1386.00 | 462.00 | 347.68 | 120.02 | 0.8 |
| Hangar for baled waste 1 - PoS-T2 (B-30) | 0.95 | 1.4 | 0.7 | 0.5 | 0 | 173.20 | 57.70 | 108.36 | 82.82 | 12.1 |
| Hangar for baled waste 2 - PoS-T1 (B-31) | | | | | 0 | 122.90 | 41.00 | 92.91 | 120.02 | 32.7 |
| Hangar for baled waste 2 - PoS-T2 (B-31) | | | | | 0 | 117.70 | 39.20 | 108.36 | 82.82 | 12.1 |
| PPPV command building | | | | | 0 | 222.70 | 74.20 | 142.06 | 48.50 | 14.6 |
| PPPV command building - with subgrade | 0.8 | 9.5 | 0.4 | 0.04 | 0.4 | 344.70 | 114.90 | 156.85 | 48.50 | 7.7 |
| Canopy for mechanization at the landfill | | | | | 0 | 500.40 | 166.80 | 327.08 | 145.25 | 19.6 |
| Canopy for mechanization at the landfill - with subgrade | 1.8 | 1.75 | 1.75 | 1.0 | 0.3 | 749.80 | 249.90 | 336.38 | 145.25 | 14.1 |
| Fire tank (slab 1) | 0.9 | 10.9 | 5.8 | 0.53 | 0 | 602.20 | 200.70 | 631.64 | 100.00 | 64.2 |
| Fire tank (slab 1) - with subgrade | 0.9 | 10.9 | 5.8 | 0.53 | 0.7 | 2282.20 | 760.70 | 646.88 | 100.00 | 50.4 |
| Fire tank (slab 2) | 1.45 | 6.5 | 5.55 | 0.85 | 0 | 688.40 | 229.50 | 834.09 | 100.00 | 28.4 |
| Retention of leachate | | | | | 0 | 2529.60 | 843.20 | 724.01 | 100.00 | 222.6 |
| Retention of leachate - with subgrade | 0.4 | 35.8 | 35.2 | 0.98 | 2.0 | 2121.60 | 707.20 | 1025.03 | 50.00 | 48.0 |
| Digester | | | | | 0 | 609.40 | 203.10 | 416.22 | 100.00 | 431.4 |
| Digester - with subgrade | 0.4 | 24.5 | 19.0 | 0.77 | 6.2 | 2537.00 | 845.70 | 884.11 | 60.00 | 52.6 |

The verification results are given in the **Attachment 1.8.4**.

As the facility loads were calculated according to the old rulebook, the permissible bearing capacity values from **Table 55**, calculated according to the Terzaghi method, are adopted as the reference bearing capacity values, while the values calculated according to EC7 represent limit bearing capacities that are significantly higher and can only be applied after calculating the forces from facilities according to valid EC standards, which figure in ULS and SLS combination.

Based on the calculation results, it can be seen that the values of the permissible bearing capacity according to Terzaghi, founded on the base soil as well as on the embankment, do not meet the conditions regarding the stability of the soil fracture under the foundation, it is necessary to install a subgrade m in order to transfer the load to the SaP sand layer.

In the case of facilities founded on a registered embankment, if one takes into account the data on the registered differential subsidence of the facility 20, which is founded on an embankment, as well as the fact that the registered embankment layer is of an extremely heterogeneous composition, the conclusion is that the foundation of the designed facilities on layer of filled soil is not allowed, and that it is necessary to implement measures to enable the safe foundation of the mentioned facilities.

Accordingly, in the case of facilities founded on natural soil (1, 2, 3, 4, 5, 9, 10, 8, 25, 26), it is necessary to install subgrade with an average thickness of 0.4-0.7 m.

Under the Retention of leachate due to the dimensions of the slab, it can be loaded with a 2 m thick subgrade with 50 kPa, which ensures that the subsidence of the facility is within the prescribed limits. In case the designed loads are greater than 50 kPa, it is necessary to consider the deep foundation of the facility.

For facilities 10, 11, 12, 15, 15a, 16, 20 and 21, which are planned to be built on an embankment, it is necessary to completely remove the embankment under the foundation in its complete thickness, and to replace the material with a quality non-coherent material (gravelly sand or sand). In the case of the digester 15a, which is located on a slab of quite large dimensions, the load from the facility must not exceed 60 kPa, which ensures that the subsidence of the facility is within the prescribed limits. In case the designed loads are greater than 60 kPa, it is necessary to consider the deep foundation of the facility.

Facility 20, which is existing, and for which differential subsidences have been registered that are still ongoing, and for which instability has been proven by calculations, must be rehabilitated by installing piles around the existing pillars that would take the forces from the pillars and transfer them under the embankment layer to the well-bearing sand layer SaP. Otherwise, it is necessary to remove the facility, replace the soil, and only after that begin the reconstruction of the facility.

Layers of the subgrade should be installed on the prepared subsoil, compacting the layers in a thickness of 0.25-0.30 m with the achieved compaction of 100% according to the modified Proctor $E=2700 \text{ kN/m}^3$. The compaction control should be carried out through the bulk density (calibrated sand). In case the subgrade is installed in the oscillation zone or below the GWL, it is necessary to secure it by covering it with geotextile. **Photo 14** shows a schematic view of the subgrade under the foundation.

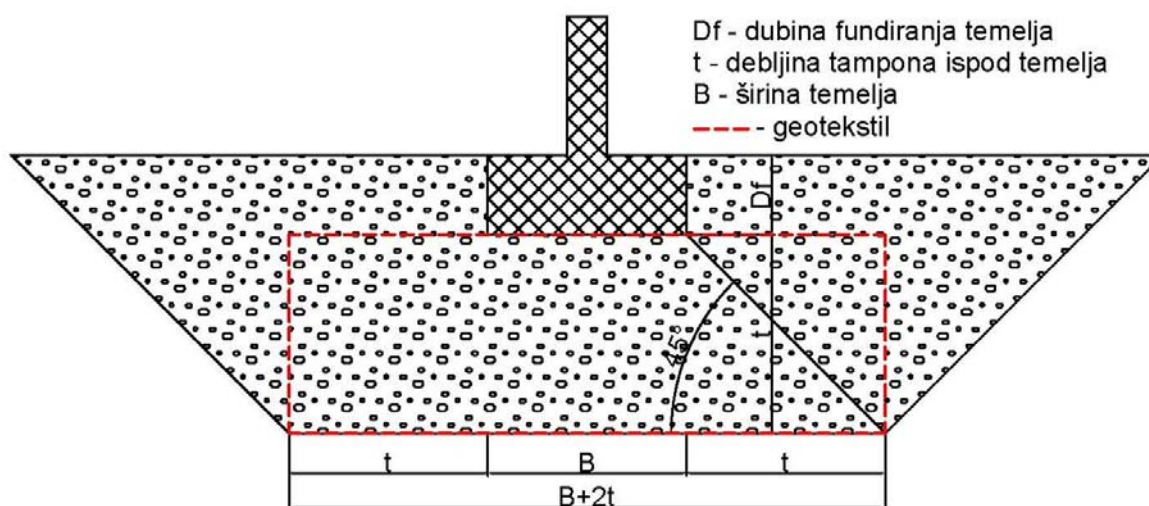


Photo 14 - Schematic view of the installed subgrade under the foundation with the simultaneous installation of geotextile

The results of the calculations are shown in the **Attachment 1.7.1**.

Additionally, in the next chapter of the study, an analysis of the bearing capacity of individual piles was performed as an alternative solution to replacing the material under the foundation.

The bearing capacities of individual piles of different diameters and depths will be analyzed in the next chapter of the Study.

5.3. DEEP FOUNDATION

Analyzes of the bearing capacity of individual piles were carried out on the basis of adopted foundation depths of pile heads, shapes and dimensions of piles and their proposed lengths.

The calculation of the permissible bearing capacity was performed in the "GEO5" software, using the "Pile" software package. The analysis was carried out for the calculation approach 2 (DA-2). Analytical analysis was selected during the calculation. The calculated values of the limit bearing capacity of the pile group are factored by the modeling coefficient γ_M which is 1.50 (SRPS EN 1997-1/NA 2020).

The obtained results of the calculation of the permissible soil bearing capacity for the proposed lengths and diameters of the piles are shown in **Table 56**.

Table 56 - Overview of the results of the analysis of bearing capacity and soil subsidence

| Facility | Pile length (m) | Pile diameter (m) | Results of the analysis of soil bearing capacity | | | | Settlement S (mm) |
|--|-----------------|-------------------|--|---------|---------|--------------------|-------------------|
| | | | Rs (kN) | Rb (kN) | Rc (kN) | Rc/γ_M (kN) | |
| 10. Workshop | 4.00 | 0.60 | 173.67 | 181.39 | 355.06 | 236,71 | 21.60 |
| | 4.00 | 0.80 | 231.56 | 322.48 | 554.03 | 369,35 | 25.70 |
| | 4.00 | 1.20 | 347.34 | 725.57 | 1072.91 | 715,27 | 20.60 |
| 11. Warehouse | 4.00 | 0.60 | 148.39 | 203.47 | 351.87 | 234,58 | 20.80 |
| | 4.00 | 0.80 | 332.80 | 332.80 | 559.89 | 373,26 | 27.20 |
| | 5.00 | 1.20 | 445.91 | 445.91 | 1317.38 | 878,25 | 25.80 |
| 12. Canopy with a car wash for utility vehicles | 4.00 | 0.60 | 124,07 | 203,19 | 327,26 | 218,17 | 24.80 |
| | 4.00 | 0.80 | 165,42 | 361,23 | 526,65 | 351,10 | 32.00 |
| | 4.00 | 1.20 | 248.13 | 812.76 | 1060,89 | 707,26 | 25.90 |
| 15.1 MBT facility - first dilatation | 7.00 | 0.60 | 209.42 | 48.61 | 258.03 | 172,02 | 3.90 |
| | 7.00 | 0.80 | 286.76 | 86.41 | 373.17 | 248,78 | 9.40 |
| | 8.00 | 1.20 | 485.66 | 233.08 | 718.74 | 479,16 | 11.60 |
| 15.2 MBT facility - third dilatation - sorting plant | 8.00 | 0.60 | 269.62 | 126.78 | 396.40 | 264,27 | 11.90 |
| | 8.00 | 0.80 | 386.92 | 225.39 | 612.31 | 408,21 | 16.60 |
| | 9.00 | 1.20 | 674.93 | 564.70 | 1239.63 | 826,42 | 20.70 |
| 16. Substation next to the MBT facility | 7.00 | 0.60 | 234.83 | 123.18 | 358.00 | 238,67 | 13.20 |
| | 7.00 | 0.80 | 336.70 | 218.98 | 555.69 | 370,46 | 16.60 |
| | 8.00 | 1.20 | 597.06 | 550.29 | 1147.35 | 764,90 | 21.60 |
| 20. Existing waste processing plant | 14.00 | 0.60 | 513.35 | 250.26 | 763.61 | 509,07 | 17.90 |
| | 14.00 | 0.80 | 806.37 | 444.91 | 1251.28 | 834,19 | 22.70 |
| | 14.00 | 1.20 | 1376.15 | 1001.04 | 2377.19 | 1584,79 | 35.90 |
| 21.1 Hangar for baled waste | 10.00 | 0.60 | 342.61 | 151.05 | 493.65 | 329,10 | 13.90 |
| | 10.00 | 0.80 | 488.65 | 268.53 | 757.17 | 504,78 | 19.30 |
| | 10.00 | 1.20 | 742.23 | 604.18 | 1346.17 | 897,45 | 26.90 |
| 21.2 Hangar for baled waste | 13.00 | 0.60 | 444.77 | 162.57 | 607.33 | 404,89 | 13.80 |
| | 13.00 | 0.80 | 593.04 | 289.01 | 882.05 | 588,03 | 16.20 |
| | 13.00 | 1.20 | 593.04 | 707.84 | 1804.69 | 1203,13 | 27.90 |
| 27. Retention of leachate | 4.00 | 0.60 | 97,18 | 97,98 | 195,16 | 130,11 | 14.00 |
| | 4.00 | 0.80 | 129,57 | 174,19 | 303,76 | 202,51 | 15.40 |
| | 4.00 | 1.20 | 194,36 | 391,93 | 586,29 | 390,86 | 12.10 |
| 15a Digester | 9.00 | 0.60 | 252,89 | 257,35 | 510,24 | 340,16 | 15.90 |
| | 9.00 | 0.80 | 391,21 | 457,51 | 848,72 | 565,81 | 24.20 |
| | 10.00 | 1.20 | 773,50 | 1086,97 | 1860,47 | 1240,31 | 33.00 |

The verification results are given in the **Attachment 1.7.2**.

5.4. ANALYSIS OF EMBANKMENT SLOPE STABILITY

Based on the adopted values of the physical and mechanical characteristics of the soil and the submitted cross-sections of the designed landfill cassettes and the body of the landfill, the cross-section of the cassette with a height of 4.57 m, the incline of the external slope 1:1.5 and the incline of the internal slope 1:2, as well as the incline of the landfill body 1 was adopted: 3. Calculations were performed in the licensed program package GEO5, in all respects according to the conditions and recommendations given in SRPS EN 1997-1 and SRPS EN 1997-1/ NA:2020, for limit equilibrium conditions, using three methods: Bishop, Spencer and Morgenstern-Price (**Table 57 and 58**).

Table 57. - Results of the analysis of the stability of the slope of the cassette according to EC7

| Facility | Embankment height | Slope incline | Stability analysis | | |
|-------------------|-------------------|---------------|--------------------|-------------|---------------------|
| | | | Bishop (%) | Spencer (%) | Morgenter-Price (%) |
| External cassette | 4.57 | 1:1.5 | 69.7 % | 69.7 % | 69.2 % |
| | | 1:2 | 66.2 % | 65.9 % | 65.5 % |
| Landfill body | 26 | 1:3 | 91.5 % | 91.6 % | 91.6 % |

Table 58. - Results of the analysis of the stability of the slope of the cassette according to FC

| Facility | Emabnkment height | Slope incline | Stability analysis | | |
|-------------------|-------------------|---------------|--------------------|--------------------|----------------------------|
| | | | Bishop (FC > 1.5) | Spencer (FC > 1.5) | Morgenter-Price (FC > 1.5) |
| External cassette | 4.57 | 1:1.5 | 1.83 | 1.97 | 1.55 |
| | | 1:2 | 1.83 | 1.98 | 1.55 |
| Landfill body | 26 | 1:3 | 1.84 | 1.99 | 1.55 |

The performed analyzes confirmed the stability of the embankment slope for the adopted heights and the embankment inclines.

When analyzing the stability of the slope of the cassette, the results of laboratory tests on a sand sample from the Svetorog landfill figure in the calculation, which will be presented in the following chapters of the Study. For the parameters of the landfill, the following parameters were adopted:

| γ (kN/m ³) | ϕ (°) | c (kN/m ²) |
|----------------------------------|---------------|-----------------------------|
| 18.0 | 19-20 | 3-5 |

It should be noted that the satisfactory safety factors obtained in table 58 were obtained by assuming a slightly better compacted material of the landfill body, so when defining the conditions for filling the landfill, it is necessary to prescribe the best possible technology and conditions that would ensure that the parameters of the embedded material at the landfill after testing are higher or equal to the parameters used when calculating slope stability.

After construction, the embankment slope must be protected from erosion by covering it with a layer of humus in a thickness of d=20-30 cm with compaction by adequate mechanization and greening, or by some other solution that will be processed as part of the Landfill Design. The outer sides of the cassettes, as well as the face of the landfill, must be covered and treated, in order to prevent spillage and movement of the installed material.

The results of the analyzes performed to check the stability of the embankment slope are given in the **Attachment 1.7.3**.

6. CONDITIONS AND RECOMMENDATIONS FOR THE CONSTRUCTION OF EMBANKMENTS AND ROADS

In parallel with the construction of the Regional Waste Management Center in Novi Sad, the construction of accompanying infrastructure facilities is planned, which requires the construction of embankments and roads.

As the landfill design plans to use a very large amount of material for the construction of the landfill, it is recommended that the embankments be built from incoherent materials for which there are a large number of registered landfills in the immediate and wider vicinity of the landfill.

According to the conditions and recommendations given in the Road Design and the Landfill Design, the possibility of building an embankment made of incoherent materials will be analyzed in the following text. For this purpose, a presentation and analysis of the results of all conducted terrain investigation and laboratory tests at the landfill location, as well as an analysis of two landfills and one quarry in the narrower and wider zone of the landfill, was performed, so that it would be possible to define the conditions and recommendations for the construction of the embankment.

6.1. CRITERIA FOR ASSESSING THE QUALITY OF MATERIALS

Based on the "Quality Control Plan for Testing Materials and Structures" (QCP RRSP dated 27-01-2017), conditions and recommendations were given for the selection of materials for the construction of cassette embankments and roads inside the landfill.

Table 57 - Conditions of usability of sand material for the construction of embankments and subgrade:

| Name | Request |
|---|--|
| Quality control of materials for the construction of embankments | |
| SRPS CEN ISO/TS 17892-1 – Determination of water (moisture) content, | close to optimal |
| SRPS EN 13286-2 – Test method for laboratory reference density and water content - Proctor compaction | |
| - For embankment up to 3 m | $\geq 1.5 \text{ Mg/m}^3$ |
| - For embankment over 3 m | $\geq 1.55 \text{ Mg/m}^3$ |
| - Optimum humidity | $< 25 \%$ |
| SRPS CEN ISO/TS 17892-4 – Determination of particle size distribution (%) (dry, wet sieving and fine particles hydrometering) | |
| - passage through the sieve 0.063 mm | $\leq 10\% (f_{10})$ |
| SRPS CEN ISO/TS 17892-12 – Determination of Atterberg limits - Atterberg limits for fine particles | non-plastic material |
| SRPS U.B1.024 – Determination of the combustible and organic matter content of a soil (<i>chemical method with H_2O_2</i>) | $< 3.0 \%$ |
| SRPS EN 13286-47 – Test Method for Determination of California Bearing Ratio, Immediate Bearing Index and Linear Swelling (CBR %) | CBR _{lab} $\geq 8.0\%$ Swelling $< 3.0 \%$ |

Table 60 - Conditions of usability of gravel-sand material for building subgrade under the foundation:

| Name | Request |
|---|--|
| Quality control of materials for the construction of embankments | |
| SRPS CEN ISO/TS 17892-1 – Determination of water (moisture) content, | close to optimal |
| SRPS EN 13286-2 – Test method for laboratory reference density and water content - Proctor compaction | is determined |
| SRPS CEN ISO/TS 17892-4 – Determination of particle size distribution (%) (dry, wet sieving and fine particles hydrometering) | |
| - passage through the sieve 0.063 mm | $\leq 8\% (f_8)$ |
| - degree of uniformity of granulometric composition | $C_u = 15-100$ |
| SRPS CEN ISO/TS 17892-12 – Determination of Atterberg limits - Atterberg limits for fine particles | non-plastic material |
| SRPS EN 1744-1 – Determination of organic matter content | the color of the 3% sodium hydroxide solution must not be darker than the standard |
| SRPS EN 13286-47 – Test Method for Determination of California Bearing Ratio, Immediate Bearing Index and Linear Swelling (CBR %) | CBR _{lab} $\geq 20 \%$ |

6.2. BORROW PITS AND QUARRIES

Based on the analysis of the material from the trial pits, as well as the material from the investigation boreholes, there is sandy material at the location of the landfill that can be used for the construction of future embankments within the scope of the landfill.

In addition, for the purposes of this Study, an analysis of the report on the testing of materials from landfills and quarries in the wider and narrower surroundings of the subject location of the landfill was performed, which aimed to define the conditions for the application of local borrow pits of materials for installation in embankments.

The spatial location of local borrow pits of materials for embankment construction are shown in **Photos 15 and 16**.



Photo 15 - Location of material borrow pits (<https://zoom.earth/>)



Photo16 - Location of material borrow pits (<https://zoom.earth/>)

6.2.1. ENGINEERING GEOLOGICAL RECONNAISSANCE OF THE TERRAIN AND RESULTS OF MATERIAL TESTING

Engineering geological reconnaissance was carried out by visiting the terrain, and for the purpose of determining the material borrow pits at three locations of the existing local borrow pits, namely:

1. Sand landfill on the bank of the Danube in Novi Sad, by the company "Karin Komerc" MD doo (**Photo 17**). Gravelly sand from the Danube riverbed is being excavated at the mentioned location. The borrow pit is located at a distance of ~ 14 km (source "Google Maps") from the future Regional Waste Management Center (**Photo 18**).



Photo 17 - "Karin Komerc" landfill

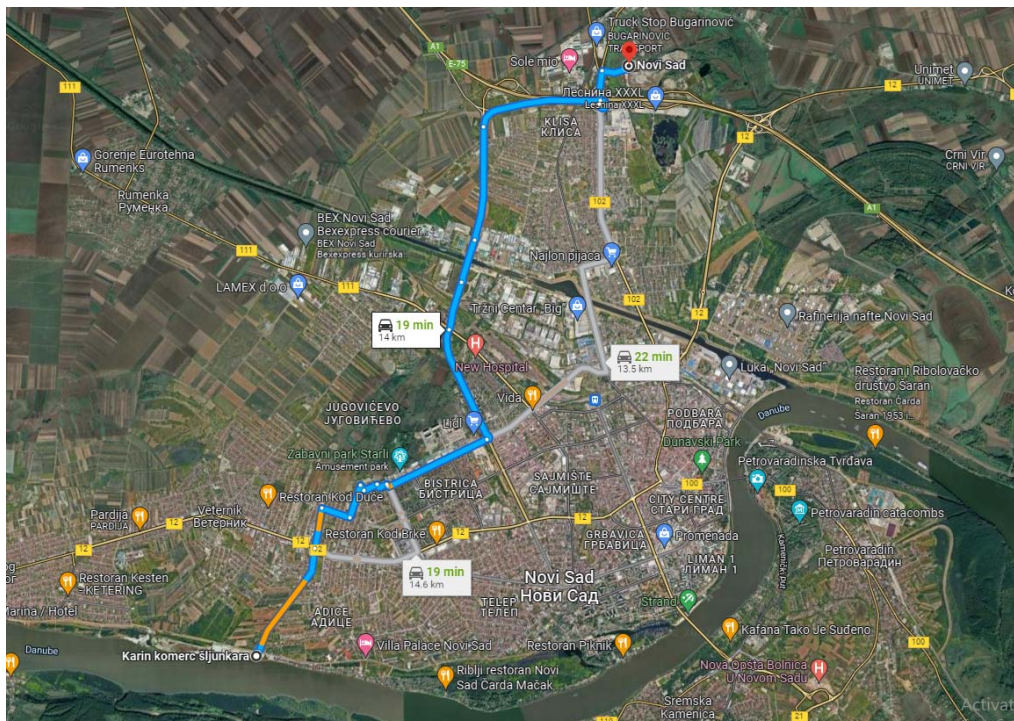


Photo 18 - Distance of the borrow pit from the future Regional Waste Management Center

2. Sand landfill on the bank of the Danube in Futog, by the company "Svetorog" doo (**Photo 19**). White gravelly sand from the Danube riverbed is being excavated at the mentioned location. The borrow pit is located at a distance of ~ 14.80 km (source "Google Maps") from the future Regional Waste Management Center (**Photo 20**).



Photo 19 - "Svetorog" landfill

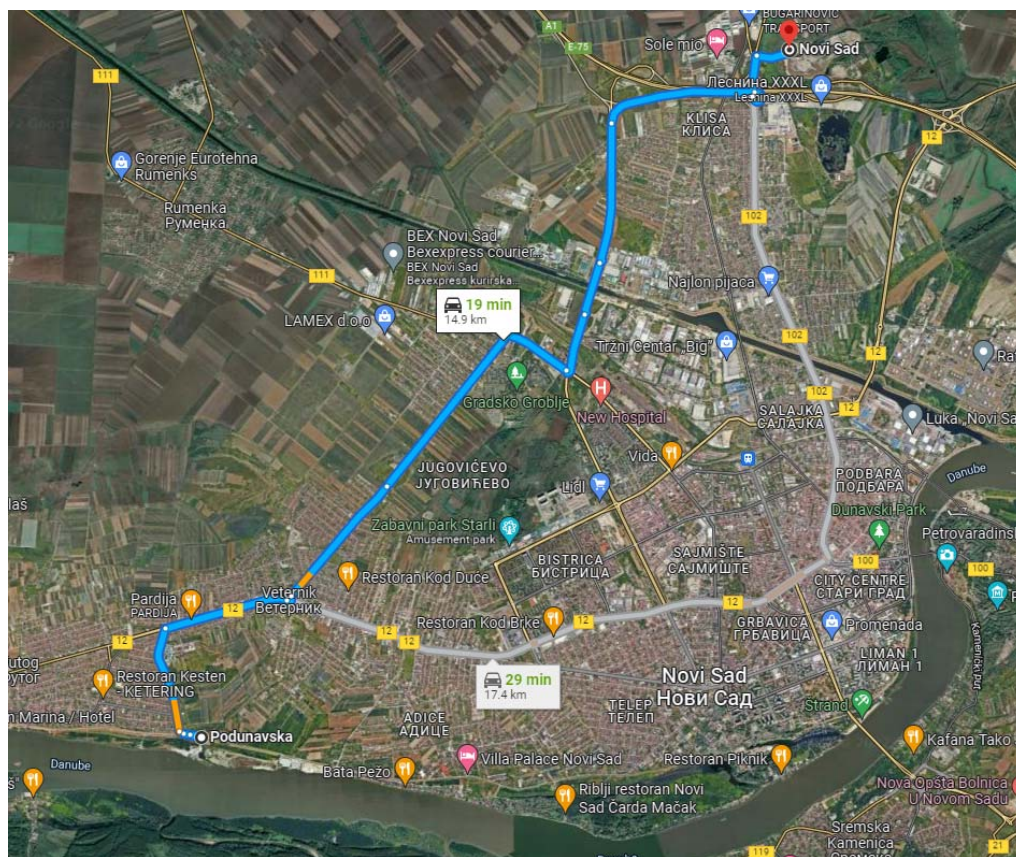


Photo 20 - Distance of the borrow pit from the future Regional Waste Management Center

3. "Kišnjeva glava" quarry in Rakovac (**Photo 21**). Excavation and exploitation of eruptive rock, trachyte, is carried out at the mentioned location. By processing the rock, stone aggregates of different fractions are obtained. The borrow pit is located at a distance of ~ 26.10 km (source "Google Maps") from the future Regional Waste Management Center (**Photo 22**).



Photo 21 - "Kišnjeva glava" quarry

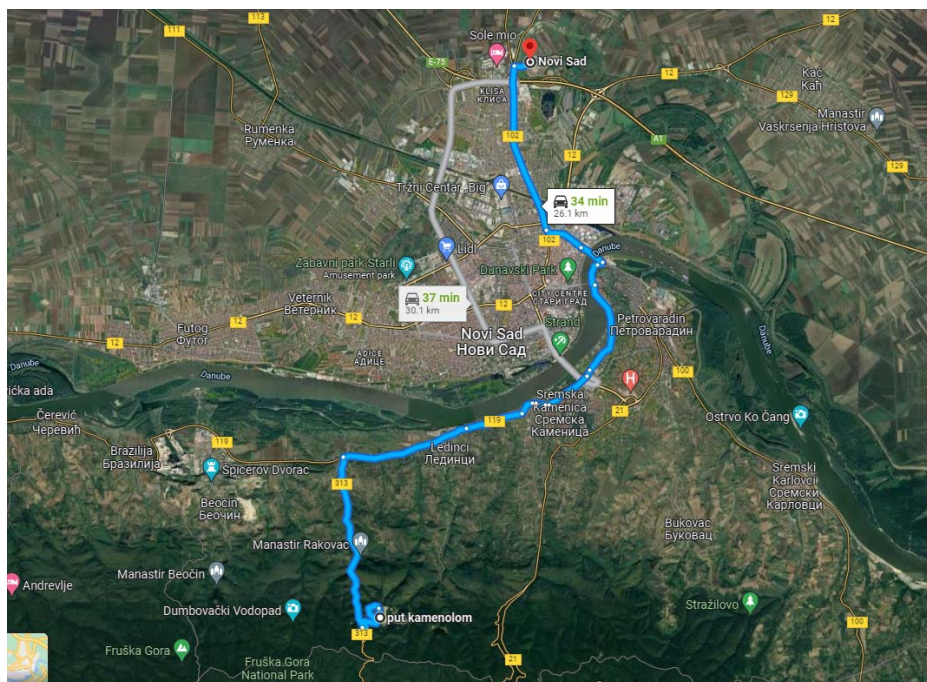


Photo 22 - Distance of the borrow pit from the future Regional Waste Management Center

On the basis of terrain identification and laboratory tests, soil classification was performed from the samples taken from the mentioned borrow pits.

6.3. LABORATORY TESTS ON SAMPLES FROM BORROW PITS

In order to define the physical and mechanical characteristics of the materials relevant for the assessment of quality and installation, laboratory geomechanical tests were carried out on samples taken at the locations of the dredged sand landfills.

All tests were performed according to valid SRPS EN standards.

The courses of the tests are shown in the form of appropriate diagrams and graphics in the Documentation Book as part of the **Attachment 1.6.** while the test results are shown in **Tables 61-64.**

Laboratory tests were performed on representative disturbed samples taken from the mentioned landfills, where a total of three (3) disturbed samples were included, of which one (1) from the "Svetorog" borrow pit in Futog, one (1) from the "Karin Komerc" borrow pit in Novi Sad and four (4) from the "Kišnjeva glava" quarry in Rakovac.

Table 61 - Display of test results of samples of dredged sand from the "Karin Komerc" borrow pit

| Percentage of fractions in the granulometric composition | |
|--|------|
| Clay (%) | 0.0 |
| Silt (%) | 0.2 |
| Sand (%) | 99.8 |
| Gravel (%) | 0.0 |
| Debris (%) | 0.0 |
| C _u (-) | 2.1 |
| C _c (-) | 1.1 |
| Proctor test | |
| ρ _{dmax} (t/m ³) | 1.60 |
| W _{opt} (%) | 16.6 |
| California Bearing Ratio (CBR) | |
| CBR (%) | 13.5 |

Table 62 - Display of test results of samples of dredged sand from the "Svetorog" borrow pit

| Percentage of fractions in the granulometric composition | |
|--|------|
| Clay (%) | 0.0 |
| Silt (%) | 0.7 |
| Sand (%) | 99.3 |
| Gravel (%) | 0.0 |
| Debris (%) | 0.0 |
| C _u (-) | 3.8 |
| C _c (-) | 1.0 |
| Shear resistance - direct shear | |
| φ (°) | 31 |
| c (kN/m ²) | 5 |
| Proctor test | |
| ρ _{dmax} (t/m ³) | 1.61 |
| W _{opt} (%) | 16.6 |
| California Bearing Ratio (CBR) | |
| CBR (%) | 8.0 |

Table 63 - Display of test results of stone aggregate samples 0/31.5 mm from the "Rakovac" quarry

| Physical and mechanical characteristics of crushed stone aggregate 0/31.50 mm | |
|--|--------|
| Method of determination of resistance to crushing - "Los Angeles" | 22.00 |
| Determination of weaker grains (%) | 0.00 |
| Grain Shape - Shape Index (%) | 29.00 |
| Sand equivalent testing (%) | 56.60 |
| Weight of wet sample before washing (g) | 212.20 |
| Mass of residue on sieve 0.063 mm after washing and drying (g) | 198.90 |
| Content of particles smaller than 0.063 mm (%) | 5.60 |
| Water content (%) | 0.70 |
| Determination of clay lump content (%) | 0.00 |
| Determination of the actual bulk density of the aggregate (kg/m ³) | 2711 |
| Determination of aggregate water absorption (%) | 1.60 |
| Determination of the bulk density of the aggregate in a loose state | 1600 |
| Magnesium sulfate testing (%) | 2.50 |
| Determination of combustible organic matter (%) | 0.00 |
| Grain size distribution Sieving method | |
| particles smaller than 0.063 mm (%) | 3.80 |
| particles smaller than 0.020 mm (%) | 2.00 |
| Compaction by Proctor reference bulk density (mg/m ³) | 2.17 |
| optimum water content (%) | 5.80 |
| California Bearing Ratio CBR _{lab} (%) | 205 |

Table 64 - Display of test results of stone aggregate samples 0/63 mm from the "Rakovac" quarry

| Physical and mechanical characteristics of crushed stone aggregate 0/63.00 mm | |
|--|--------|
| Method of determination of resistance to crushing - "Los Angeles" | 24.00 |
| Determination of weaker grains (%) | 0.00 |
| Grain Shape - Shape Index (%) | 33.00 |
| Sand equivalent testing (%) | 53.80 |
| Mass of wet sample before washing (g) | 202.80 |
| Mass of residue on sieve 0.063 mm after washing and drying (g) | 186.00 |
| Content of particles smaller than 0.063 mm (%) | 7.70 |
| Water content (%) | 0.70 |
| Determination of clay lump content (%) | 0.00 |
| Determination of the actual bulk density of the aggregate (kg/m ³) | 2700 |
| Determination of aggregate water absorption (%) | 1.40 |
| Determination of the bulk density of the aggregate in a loose state | 1480 |
| Magnesium sulfate testing (%) | 2.30 |
| Determination of combustible organic matter (%) | 0.00 |
| Grain size distribution Sieving method | |
| particles smaller than 0.063 mm (%) | 6.40 |
| particles smaller than 0.020 mm (%) | 3.00 |
| Compaction by Proctor reference bulk density (mg/m ³) | 2.27 |
| optimum water content (%) | 5.60 |
| California Bearing Ratio CBR _{lab} (%) | 205 |

Based on the results of the tests performed on the samples from the trial pits, shown in **Table 36**, it can be concluded that the tested materials in the trial pits from TP-1 to TP-9 and TP-11 **meet** the conditions of usability of incoherent material prescribed in **Table 59**, while the tested material in the trial pit TP-10 **does not meet** the conditions of usability of incoherent material,^{i.e.} it is approximately at the very limit of the prescribed values (the obtained value of the maximum dry bulk density $\rho_{dmax} = 1.51 \text{ t/m}^3$ does not meet the condition $\rho_{dmax} \geq 1.55 \text{ t/m}^3$).

Based on the results of the tests performed on the dredged sand taken from the local borrow pits under number 1 and 2, it can be concluded that the tested material **meets** the conditions of usability of incoherent material prescribed in **Table 59**.

With the newly performed excavation of trial pits in the narrower area of the landfill, it can be concluded that in the narrower area of the landfill it is possible to excavate sandy material registered in investigation boreholes and trial pits, as well as its use for the construction of embankments (in combination with the use of sand from local borrow pits).

6.4. METHOD STATEMENT FOR THE CONSTRUCTION OF THE EMBANKMENTS

The bringing and filling of material on the prepared subsoil or on the already built embankment layer can only begin after the lower layers have been taken over by the Supervisor. Before starting construction, it is necessary to remove the near-surface humus layer 0.4 m thick and to compact the subsoil.

Each individual layer must be spread in the longitudinal direction horizontally or at most in an incline equal to the designed longitudinal incline. In the transverse sense, each individual layer must have a two-sided or one-sided incline of 2 - 5% in order to drain away atmospheric water. Each individual layer must be filled according to the designed transverse profile. When filling, the crossings of the means of transport must be as evenly distributed as possible over the entire width of the subsoil. Make the embankment in horizontal layers up to 30 cm thick. Compaction of the embankment should be done with vibratory means with compaction until the required compaction is achieved.

Each layer of embankment must be compacted in its full width with a suitable mechanical means, whereby the compaction should generally be carried out from the edge towards the middle. All inaccessible places for mechanization or places where the use of heavy means for compaction would be inappropriate for other reasons (filling behind the facility, retaining walls, etc.) should be compacted with other suitable means or methods, the use of which will be approved by the Supervisor.

Before starting compaction, the sand must be wet or dried to a moisture content that is in accordance with the previous testing. If, after compaction and quality control, the next layer is not immediately poured, but is continued after a longer period of time, the bearing capacity and compaction of the already performed layer should be checked again before filling. In that case, the production of the next layer can only be started when the quality of the material, load-bearing capacity and compaction of the previous layer have been proven.

When there is a threat of rain during the day, the Supervisor will, as necessary, determine the suspension of further work on the embankments. Before pouring a new layer, it is necessary to roughen the smoothed surface in order to achieve the best bond between the layers. This also applies to other major interruptions of works on the construction of embankments (due to the end of the construction season, etc.). The work on pouring will be stopped at any time when it is not possible to achieve satisfactory results, especially due to rain, high groundwater or some other weather conditions. The embankment material must not be installed on frozen surfaces, nor must it be installed on snow and ice.

Quality control

The quality control of the works performed on the construction of the embankment layers is carried out according to:

Table 58 - Quality control of the performed works on the preparation of subsoil:

| Name | Request |
|---|---|
| Control of the compaction and bearing capacity of the subsoil | |
| SRPS CEN ISO/TS 17892-1 – Determination of water (moisture) content, SRPS U.B1.013 - Determination of density of soil in place by the drive-cylinder method or SRPS U.B1.015 - Determination of density of soil in place by the sond-cone method or SRPS U.B1.016 - Determination of density of soil in place by rubber-balloon method | close to optimal |
| autochthon soils composed of coherent earthen materials, where the designed embankment is not higher than 2.00 m | $S_z \geq 100\%$ |
| autochthon soils composed of coherent earthen materials, where the designed embankment is higher than 2.00 m | $S_z \geq 95\%$ |
| autochthon soils composed of incoherent earthen materials, where the designed embankment is not higher than 2.00 m | $S_z \geq 100\%$ |
| autochthon soils composed of incoherent earthen materials, where the designed embankment is higher than 2.00 m | $S_z \geq 95\%$ |
| RVS 08.03.04 (or TP BF-StB Part B 8.3) – Compaction control by means of the Dynamic Plate Load Test - E_{din} | E_{din} - it is determined on a trial section for each type of material |
| SRPS U.B1.047 - Determination of deformation by circular plate load test - E_{v1} | |
| For mixed materials up to 20% of stone material | it is determined on a trial section for each type of material |
| For mixed materials with 20-35% of stone materials | $E_{v1} \geq 20 \text{ MPa}$ |
| For mixed materials with 35-50% | $E_{v1} \geq 25 \text{ MPa}$ |
| For mixed materials over 50% of stone material | $E_{v1} \geq 35 \text{ MPa}$ |
| <i>NOTE: Correlation between E_{v1} and E_{din} is performed on a trial section for each type of material for the purposes of determining criterion values - requirements for E_{din}. Ms can be used only in special cases with the prior approval of the Supervisory Authority.</i> | |

Table 59 - Quality control of the performed works of the embankment layers

| Name | Request |
|--|---|
| Control of the compaction and bearing capacity of the constructed embankment layer | |
| SRPS CEN ISO/TS 17892-1 – Determination of water (moisture) content | is determined |
| SRPS U.B1.015 - Determination of density of soil in place by the sond-cone method or SRPS U.B1.016 - Determination of density of soil in place by rubber-balloon method | $S_z \geq 95\%$ in relation to the modified Proctor test |
| RVS 08.03.04 (or TP BF-StB Part B 8.3) – Compaction control by means of the Dynamic Plate Load Test - E_{din} | E_{din} - it is determined on a trial section for each type of material |
| SRPS U.B1.047 - Determination of deformation by circular plate load test (E_{v1} , E_{v2} , E_{v2}/E_{v1}) | Class 1. $E_{v2} \geq 80 \text{ MPa}$ Class 2. $E_{v2} \geq 100 \text{ MPa}$ Class 3. $E_{v2} \geq 120 \text{ MPa}$ Class 4. $E_{v2} \geq 140 \text{ MPa}$ |
| | $E_{v2}/E_{v1} \leq 3.0$ (if $E_{v1} > 0.5 \times E_{v2}$ then the ratio E_{v2}/E_{v1} cannot be applied for bearing capacity rating) |

6.5. METHOD STATEMENT FOR THE CONSTRUCTION OF THE ROADS

Road levels are defined according to the existing terrain, the groundwater level and the planned cassettes for waste disposal, which are formed by filling.

Drainage of traffic areas is through sewers and open canals and is the subject of a hydrotechnical design.

At the landfill, two types of structures are defined by the design of traffic roads: asphalt - on the plateaus, parking lots and part of the traffic roads (Axis 1, 2 and the greater part of Axis 3), and broken stone (part of Axis 3, Axis 4, 5 and 7 and access roads to the landfill cassettes).

The characteristics of asphalt roads and plateaus are as follows:

| | |
|-----------------------------------|-------|
| BNHS 16 | 8 cm |
| Crushed stone aggregate 0/31.5 mm | 15 cm |
| Crushed stone aggregate 0/63 mm | 20 cm |
| Sand | 50 cm |
| Total | 93cm |

The characteristics of the broken stone roads are as follows:

| | |
|-----------------------------------|-------|
| Crushed stone aggregate 0/31.5 mm | 20 cm |
| Crushed stone aggregate 0/63 mm | 20 cm |

Asphalt roads, plateaus and parking lots are bordered with 18/24 cm curbs, with a banking of +12 cm, while there are no borders on the broken stone roads.

Demolition of existing surfaces made of asphalt and concrete was processed with preparatory works.

7. CONCLUSIONS AND RECOMMENDATIONS

In order to collect data for the preparation of the study, earlier investigations were used and additional investigations and tests were carried out, which consisted of:

- Reconnaissance and engineering geological mapping of the terrain (~ 50 ha);
- Investigation drilling with engineering geological mapping of the core of investigation boreholes and taking samples for laboratory tests (42 investigation boreholes);
- Excavation of trial pits with engineering geological mapping of trial pits and taking samples for laboratory tests (11 trial pits);
- Performance of standard penetration tests - SPT (49 tests);
- Performance of cone penetration tests - CPTu (9 tests);
- Performance of dynamic penetration tests - DPSH-A (3 tests);

Based on the analysis of archival documentation and conducted investigations and tests, the following conclusions are reached:

- The geological structure of the terrain in the narrower investigation area is represented by Holocene sediments in the form of the *abandoned watercourse facies (am)* and the *bed and flood facies (alp)*. The *abandoned watercourse facies* is represented by brown-yellow organogenic-marsh clays, brown-gray ground water sands, silts locally clayed and clay with a loess-like appearance. The *flood facies* is represented by silty-sandy sediments in the shallower (younger) parts, and by brown to gray fine-grained sands in the deeper (older) parts. The sediments of the *bed facies* lie at the bottom of the flood facies or stagnant tributary facies, and are represented by grayish fine-grained to medium-grained clean sands (in the upper parts), which become coarser-grained with depth, and then turn into gray sandy gravels;
- The sediments of the abandoned watercourse facies, i.e. brown-yellow organogenic-marsh clays and ground water clays with a loess-like appearance, are characterized by lower water permeability. In such materials, occasional aquifers of small yield are formed, at a shallow depth from the surface of the terrain, and the nature of the material and the hydrogeological conditions that prevail in the terrain are such that they do not provide conditions for the formation of "real" aquifer, but rather water that is "trapped" in a layer with intergranular porosity. The material's filtration coefficient is about $k_f = 10^{-5} - 10^{-8}$ cm/s. Sediments of the abandoned watercourse facies, which are represented by brown-gray ground water sands, are characterized by intergranular porosity, while within them compacted aquifers with a free level are formed. Locally, they can also be under low pressure, due to roof poorly water-permeable organogenic-bog clays or ground water clays with a loess-like appearance. The material's filtration coefficient is about $k_f = 10^{-2} - 10^{-6}$ cm/s;
- The flood facies sediments, in the upper parts of the facies represented by ground water-sandy sediments, are characterized by intergranular porosity, while the material filtration coefficient is $k_f = 10^{-4} - 10^{-6}$ cm/s.
- The bed facies sediments, present at the floor of the previously mentioned facies and represented by grayish fine-grained to medium-grained clean sands in the upper parts, are characterized by increased primary intergranular porosity and increased water permeability, and their value of the filtration coefficient is around $k_f = 10^{-2} - 10^{-3}$ cm/s.
- After measuring the groundwater level in the excavated investigation boreholes and trial pits, GWL was measured in piezometers labeled with B-18/P-2, B-22/P-1 and B-36/P-3 on 20-09-2022, where the groundwater level was registered at a level of 74.53 meters above sea level. After comparing previously measured groundwater levels from archival documentation and the newly obtained values of the groundwater level, the elevation of the terrain with the maximum groundwater level was adopted, which is 75.89 m above sea level.

- The reconnaissance of the terrain in the area of newly designed facilities 1, 2, 3, 4, 5, 6, 7, 8, 8a, 8b, 18 and 19 established the planned filling of construction debris (mainly composed of blocks, bricks, concrete), which was not spread adequately over the surface of the terrain and does not compact the height of the embankment ~ 1-4 m. In the area of the newly designed facilities 15, 15a, 15b, 15c, 15d, 15e, 16, 20, 21, 22, 23 and 23a, municipal waste was deposited over which coherent materials (clay silty) were placed, and, in some parts, a broken stone. At facility 20 (Hall for Sorting Delivered Garbage) built on the aforementioned municipal waste, uneven subsidence of the foundations was registered by geodetic measurement of reference points, while damage to the facility's pillars, cracks in the floor slab and deformation of the floor slab at the junction of the slab and the facility's pillars can be seen on the facility itself, which indicates that the facility is not completely stable and needs to be repaired or removed as soon as possible to prevent damage.
- According to soil typification, in accordance with "SRPS EN 1998-1", the soil is characterized partly as "C" soil and partly as "D" type soil based on the investigation results. It is recommended that soil type "E" - alluvial deposits with a thickness of 5 to 20 m, which is characterized by parameters as soil "C" or "D" type - be selected for the soil category. The I type of elastic response spectrum is recommended. The value of the horizontal acceleration of soil oscillation (a_{gr}) is 0.10 g for the return period of 475 years.
- The calculation of the limit bearing capacity and prognostic soil subsidence was performed in the "GEO5" software, using the "Spreadfooting" software package. The analysis was carried out for the calculation approach 3 (DA3). The input data for the geostatic calculations were provided by the Client. Calculations of limit and permissible bearing capacities, as well as calculations of prognostic settlement were performed for the maximum loads taken from Structure design, while for facilities that did not have defined loads, the calculations were performed for the assumption of a load of 100 kPa;
- The loads from the facilities were calculated according to the old rulebook, and the values of the permissible bearing capacity calculated according to the Terzaghi method were adopted as authoritative values. The values calculated according to EC7 represent limit bearing capacities and can only be applied after the calculation of forces from facilities according to valid EC standards;
- Based on the calculation results, it can be seen that the values of the permissible bearing capacity according to Terzaghi, founded on the natural soil as well as on the embankment, do not meet the conditions regarding the stability of the soil fracture under the foundation, and it is necessary to install a subgrade in order to neutralize the influence of subsurface layers of lower bearing capacity and transfer the load to the SaP sand layer. Under the facilities founded on natural soil (1, 2, 3, 4, 5, 9, 10, 8, 25, 26), it is necessary to install subgrade with an average thickness of 0.4-0.7 m.
- Under the Retention of leachate due to the dimensions of the slab, it can be loaded with a 2 m thick buffer with 50 kPa, which ensures that the subsidence of the object is within the prescribed limits. In case the designed loads are greater than 50 kPa, it is necessary to consider the deep foundation of the facility.
- In the case of facilities founded on a registered embankment that is heterogeneous in composition, it is necessary to apply measures to enable the safe foundation of said facilities. Facilities 10, 11, 12, 15, 15a, 16, 20 and 21, which are planned to be built on an embankment, it is necessary to completely remove the embankment under the foundation, and to replace the material with a quality non-coherent material (gravelly sand or sand). In the case of the digester 15a, which is located on a slab of quite large dimensions and whose impacts on the soil are considerably deep, the load from the facility must not exceed 60 kPa, which ensures that the subsidence of the facility is within the prescribed limits. In case the designed loads are greater than 60 kPa, it is necessary to consider the deep foundation of the facility.
- Object 20, where differential subsidences are still ongoing, and for which instability is additionally proven by calculations, it is necessary to rehabilitate by installing piles around the existing pillars that would take the forces from the pillars and transfer them under the embankment layer to the well-bearing layer of SaP sand, or remove, replace the soil up to the SaP layer and only after that begin the reconstruction of the facility. The results of the calculations are shown in the **Attachment 1.7.1**.
- The calculation of the limit bearing capacity was performed in the "GEO5" software, using the "Pile" software package. The analysis was carried out for the calculation approach 2 (DA-2). Analytical analysis was selected during the calculation. The calculated values of the limit bearing capacity of the pile group are factored by the modeling coefficient γ_M which is 1.50 (SRPS EN 1997-1/NA 2020).
- The obtained results of the calculation of the permissible soil bearing capacity for the proposed lengths and diameters of the piles are shown in the **Attachment 1.7.2**.
- Based on the adopted values of the physical and mechanical characteristics of the soil and the submitted cross-sections of the designed landfill cassettes and the body of the landfill, the cross-section of the cassette with a height of 4.57 m, the incline of the external slope 1:1.5 and the incline of the internal slope 1:2, as well as the incline of the landfill body 1 was adopted: 3. Calculations were performed in the licensed program package GEO5, in all respects according to the conditions and recommendations given in SRPS EN 1997-1 and SRPS EN 1997-1/ NA:2020, for limit equilibrium conditions, using three methods: Bishop, Spencer and Morgenstern-Price.

- It should be noted that the satisfactory safety factors obtained in table XX were obtained by assuming a slightly better compacted material of the landfill body, so when defining the conditions for filling the landfill, it is necessary to prescribe the best possible technology and conditions that would ensure that the parameters of the embedded material at the landfill after testing are higher or equal to the parameters used when calculating slope stability.
- After construction, the embankment slope must be protected from erosion by covering it with a layer of humus in a thickness of $d=20-30$ cm with compaction by adequate mechanization and greening, or by some other solution that will be processed as part of the Landfill Design. The outer sides of the cassettes, as well as the face of the landfill, must be covered and treated, in order to prevent spillage and movement of the embedded material.
- As the landfill design plans to use a large amount of material for the construction of cassette embankments inside the landfill, it is recommended that the embankments be built from incoherent materials for which there are a large number of registered landfills in the immediate and wider vicinity.
- In **Chapter 8**, based on the analysis of the results of all terrain investigations and laboratory tests at the landfill location, as well as the analysis of materials taken from the locations of two landfills and one quarry in the narrow and wider zone of the city landfill, conditions and recommendations for the selection of materials for the construction of the cassette embankments and roads inside the landfill are given, according to the "Quality Control Plan for Testing Materials and Structures" (QCP RRSP dated 27-01-2017).
- According to the results of the tests performed on the samples from the trial pits, shown in **Table 36**, it can be concluded that the tested materials in the trial pits from TP-1 to TP-9 and TP-11 **meet** the conditions of usability of incoherent material prescribed in **Table 59**, while the tested material in the trial pit TP-10 **does not meet** the conditions of usability of incoherent material,^{i.e.} it is approximately at the very limit of the prescribed values (the obtained value of the maximum dry bulk density $\rho_{dmax} = 1.51$ t/m³ does not meet the condition $\rho_{dmax} \geq 1.55$ t/m³).
- Based on the results of the tests performed on the dredged sand taken from the local borrow pits under number 1 and 2, it can be concluded that the tested material **meets** the conditions of usability of incoherent material prescribed in **Table 59**.
- With the newly performed excavation of trial pits in the narrower area of the landfill, it can be concluded that in the narrower area of the landfill it is possible to excavate sandy material registered in investigation boreholes and trial pits, as well as its use for the construction of embankments (in combination with the use of sand from local borrow pits).

During the execution of the works, it is mandatory to carry out ongoing geotechnical supervision and ongoing quality control of the performed works by an accredited geomechanical laboratory. If, during the excavation, the presence of material is found that does not correspond to the geotechnical section of the terrain shown in this study, it is necessary to carry out immediate additional consultations with the authors of this study.



Responsible designer:
Nikola Dakić, M.Sc.Geol.Eng.
Licence number: 391 R032 18



Project associate:
Jelena Milić, M.Sc.Geol.Eng.





Project associate:
Aljoša Mitić, M.Sc.Geol.Eng.






1.6. GRAPHICAL DOCUMENTATION

1.6.1 THE FIELD LAYOUT WITH THE LOCATION OF THE INVESTIGATION WORKS

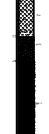
1.6.2 ENGINEERING GEOLOGICAL SECTION OF THE FIELD

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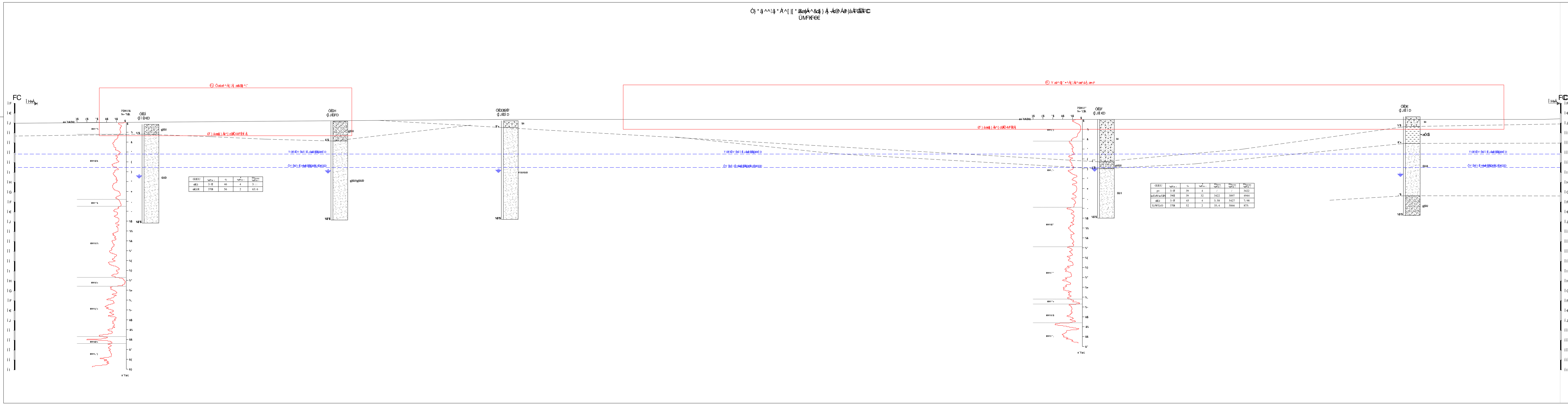


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| UeR | 370 | 52 | 2 | 35; 4 | 5846 | 875; |

| GUEU | $^m\text{P}10 +$ | $^i\lambda_1$ | $\frac{e}{^m\text{P}10 +}$ | $\frac{\text{Ox}_{522/422}}{^m\text{P}10 +}$ |
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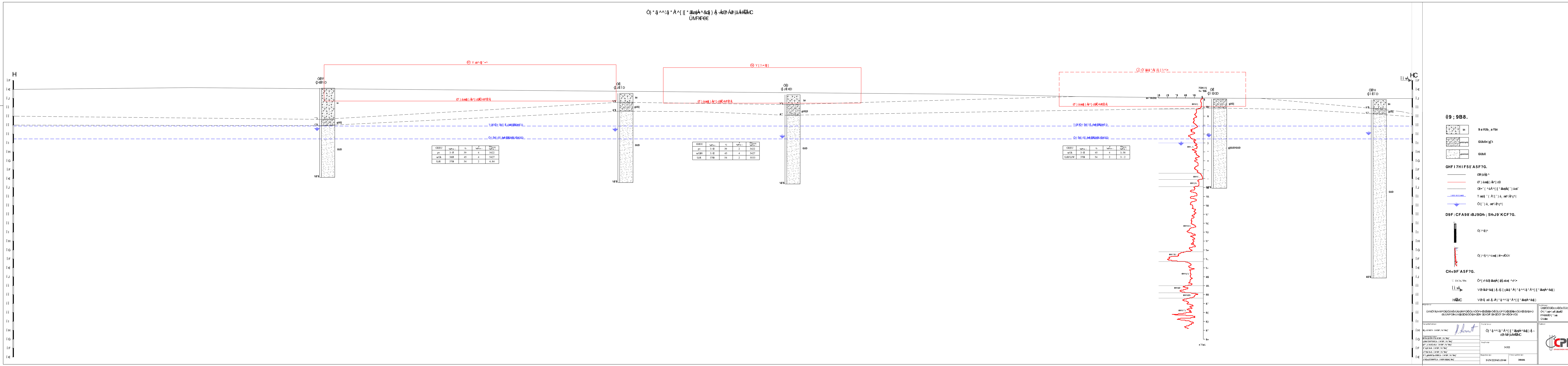
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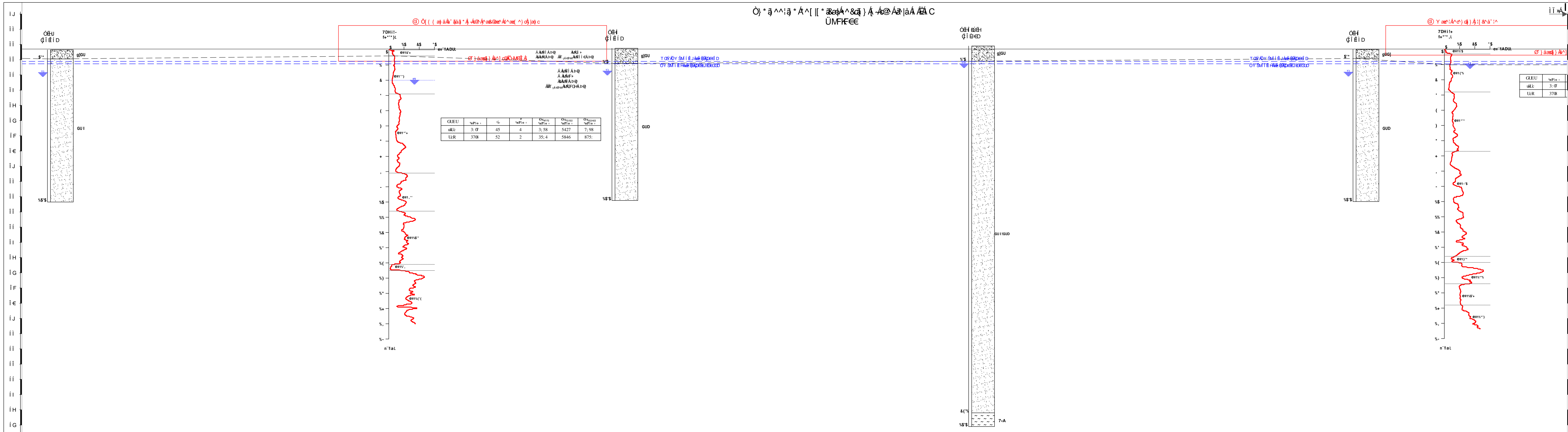
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Logo of the Construction Institute of the Republic of Serbia (CPL). The logo features a stylized 'C' and 'P' in grey, with a red 'L' in the middle. Below the letters, the text 'GRAĐEVINSKI INSTITUT' is written in red.





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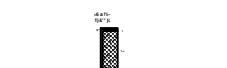
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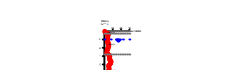
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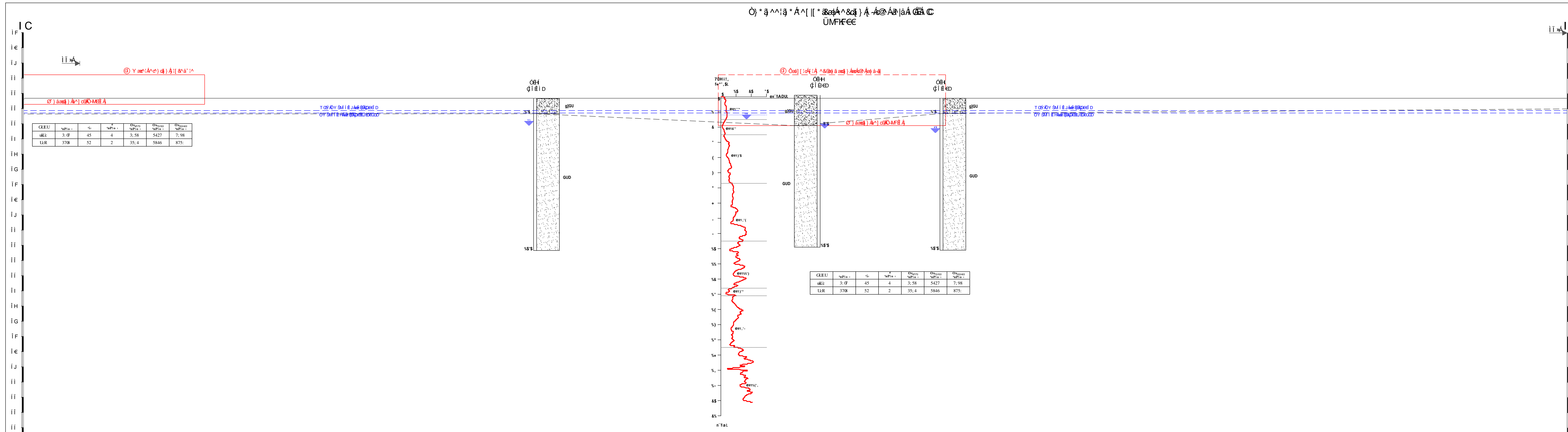
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Page 2 of 2

Logo of the Geotechnical Institute of the University of Zagreb (CPL). The logo features a stylized 'C' and 'P' in red and black, with the text 'CPL' in large black letters and 'GRAĐEVINSKI INSTITUT' in smaller red letters below it.



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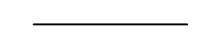


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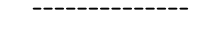
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$$|a| \in \{ |A| \} a, a \in A \setminus \{a\}$$


On the other hand, the set of all a_i is not a \mathcal{C}^* -algebra.

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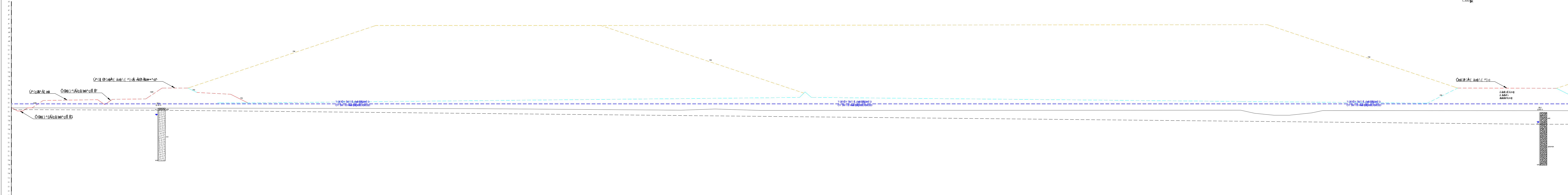
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1.7. GEOTECHNICAL CALCULATIONS

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 1. PORTIRNICA
 Description : Model 1 / B-2 Bez tampona
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.1.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy clay (CS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 10.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.68 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.62 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 0.80 \text{ m}$
 Depth of footing bottom $d = 0.80 \text{ m}$
 Foundation thickness $t = 0.30 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 4.00 \text{ m}$
 Strip footing width (x) $= 0.50 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

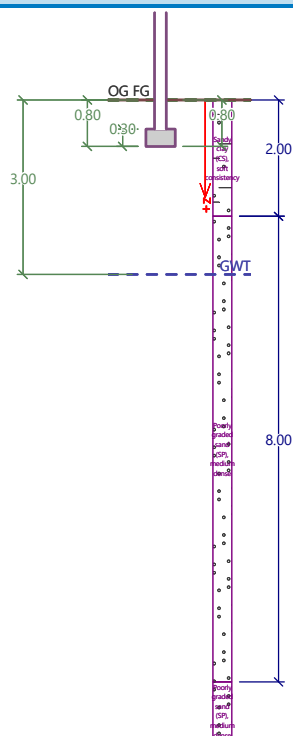
Volume of strip footing $= 0.15 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.40 \text{ m}^3/\text{m}$
 Volume of fill $= 0.15 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 2.00 | 0.00 .. 2.00 | Sandy clay (CS), soft consistency |  |
| 2 | 8.00 | 2.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 39.30 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 39.30 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 84.15 | 134.83 | 62.41 | Yes |
| ULS | No | 0.00 | 0.00 | 84.15 | 134.83 | 62.41 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 7.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.500 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.500 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.500 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.030$
 $s_c = 1.042$
 $s_\gamma = 0.963$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 134.835 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 2.78 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 0.53 \text{ m}$

Length of slip surface $l_{sp} = 1.34 \text{ m}$

Design bearing capacity of found.soil $R_d = 134.83 \text{ kPa}$

Extreme contact stress $\sigma = 84.15 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 1.28 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 15.14 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 2.78$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.80 | 0.85 | 0.05 | 1.05 | 15.26 | 63.61 | 1.89 |
| 2 | 0.85 | 0.90 | 0.05 | 1.05 | 16.19 | 52.74 | 1.57 |
| 3 | 0.90 | 0.95 | 0.05 | 1.05 | 17.11 | 44.57 | 1.33 |
| 4 | 0.95 | 1.00 | 0.05 | 1.05 | 18.04 | 39.18 | 1.17 |
| 5 | 1.00 | 1.05 | 0.05 | 1.05 | 18.96 | 34.86 | 1.04 |
| 6 | 1.05 | 1.10 | 0.05 | 1.05 | 19.89 | 31.19 | 0.93 |
| 7 | 1.10 | 1.20 | 0.10 | 1.05 | 21.27 | 26.84 | 1.60 |
| 8 | 1.20 | 1.30 | 0.10 | 1.05 | 23.12 | 22.23 | 1.32 |
| 9 | 1.30 | 1.40 | 0.10 | 1.05 | 24.97 | 18.86 | 1.12 |
| 10 | 1.40 | 1.50 | 0.10 | 1.05 | 26.82 | 16.33 | 0.97 |
| 11 | 1.50 | 1.60 | 0.10 | 1.05 | 28.67 | 14.38 | 0.86 |
| 12 | 1.60 | 1.70 | 0.10 | 1.05 | 30.52 | 12.83 | 0.76 |
| 13 | 1.70 | 1.95 | 0.25 | 1.05 | 33.76 | 10.90 | 1.62 |
| 14 | 1.95 | 2.00 | 0.05 | 1.05 | 36.54 | 9.49 | 0.28 |
| 15 | 2.00 | 2.20 | 0.20 | 2.83 | 38.56 | 8.65 | 0.48 |
| 16 | 2.20 | 2.45 | 0.25 | 2.83 | 42.07 | 7.37 | 0.51 |
| 17 | 2.45 | 2.70 | 0.25 | 2.83 | 45.97 | 6.30 | 0.44 |
| 18 | 2.70 | 2.93 | 0.23 | 2.83 | 49.74 | 5.50 | 0.33 |

Settlement of mid point of longitudinal edge = 11.3 mm

Settlement of mid point of transverse edge 1 = 18.2 mm

Settlement of mid point of transverse edge 2 = 18.2 mm

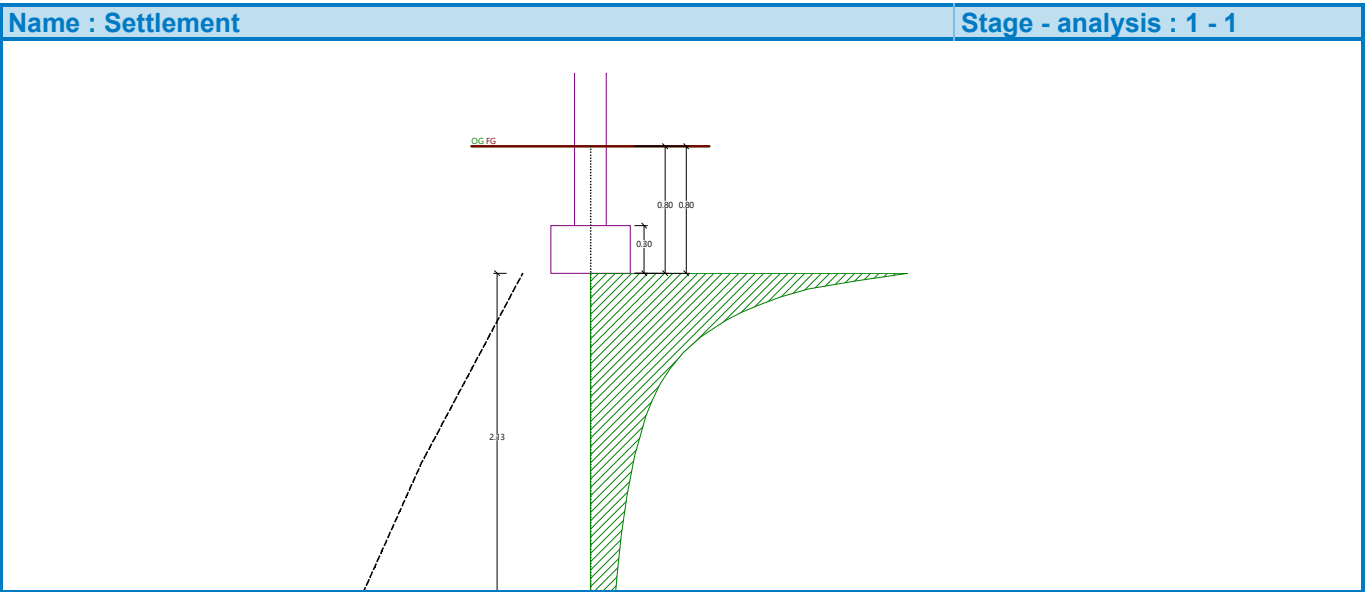
(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 1.45$ MPaFoundation in the longitudinal direction is rigid ($k=4457.63$)Foundation in the direction of width is rigid ($k=557.20$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 18.2 mm

Depth of influence zone = 2.13 m

Rotation in direction of width = 0.000 (tan*1000); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 1. PORTIRNICA
 Description : Model 1 / B-2 sa tamponom
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.1.2

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy clay (CS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 10.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.68 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.62 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 0.80 \text{ m}$
 Depth of footing bottom $d = 0.80 \text{ m}$
 Foundation thickness $t = 0.30 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 4.00 \text{ m}$
 Strip footing width (x) $= 0.50 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.




Volume of strip footing $= 0.15 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.40 \text{ m}^3/\text{m}$
 Volume of fill $= 0.15 \text{ m}^3/\text{m}$

Sand-gravel bed

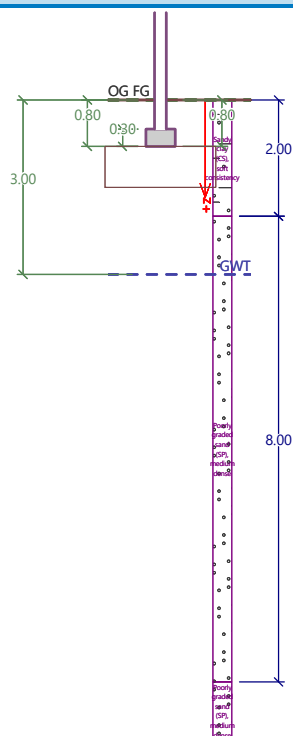
Soil used for the SG pad - Poorly graded gravel (GP), medium dense

SG pad overhangs foundation $d_{\text{sp}} = 0.70 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.70 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 2.00 | 0.00 .. 2.00 | Sandy clay (CS), soft consistency |  |
| 2 | 8.00 | 2.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Stage - analysis : 1 - 0



| No. | Load | | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|------|--------|------|---------|-------------|---------------------------|--------------------------|
| | new | change | | | | | |
| 1 | Yes | | ULS | Design | 39.30 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 39.30 | 0.00 | 0.00 |

The ground water table is at a depth of 3.00 m from the original terrain.

Type of analysis : analysis for drained conditions

Design situation : permanent

Load case verification

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 37.19 | 386.66 | 9.62 | Yes |
| ULS | No | 0.00 | 0.00 | 42.46 | 386.66 | 10.98 | Yes |

$$\begin{aligned}\varphi_d &= 23.134^\circ \\ c_d &= 1.042 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.500 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 13.764 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.900 \text{ m}\end{aligned}$$

$N_q = 8.781$
 $N_c = 18.213$
 $N_\gamma = 6.649$
 $s_q = 1.187$
 $s_c = 1.211$
 $s_\gamma = 0.858$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 386.662 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 38.60 \text{ kN/m}$

Computed weight of overburden $Z = 2.78 \text{ kN/m}$

Computation of bearing capacity performed below the sand-gravel bed.

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.83 \text{ m}$

Length of slip surface $l_{sp} = 8.29 \text{ m}$

Design bearing capacity of found.soil $R_d = 386.66 \text{ kPa}$

Extreme contact stress $\sigma = 42.46 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 10.07 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 40.93 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/m

Computed weight of overburden $Z = 2.78$ kN/m

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.80 | 0.85 | 0.05 | 45.00 | 15.26 | 63.61 | 0.06 |
| 2 | 0.85 | 0.90 | 0.05 | 45.00 | 16.19 | 52.74 | 0.05 |
| 3 | 0.90 | 0.95 | 0.05 | 45.00 | 17.11 | 44.57 | 0.04 |
| 4 | 0.95 | 1.00 | 0.05 | 45.00 | 18.04 | 39.18 | 0.04 |
| 5 | 1.00 | 1.05 | 0.05 | 45.00 | 18.96 | 34.86 | 0.03 |
| 6 | 1.05 | 1.10 | 0.05 | 45.00 | 19.89 | 31.19 | 0.03 |
| 7 | 1.10 | 1.20 | 0.10 | 45.00 | 21.27 | 26.84 | 0.05 |
| 8 | 1.20 | 1.30 | 0.10 | 45.00 | 23.12 | 22.23 | 0.04 |
| 9 | 1.30 | 1.40 | 0.10 | 45.00 | 24.97 | 18.86 | 0.04 |
| 10 | 1.40 | 1.50 | 0.10 | 45.00 | 26.82 | 16.33 | 0.03 |
| 11 | 1.50 | 1.60 | 0.10 | 1.05 | 28.67 | 14.38 | 0.86 |
| 12 | 1.60 | 1.70 | 0.10 | 1.05 | 30.52 | 12.83 | 0.76 |
| 13 | 1.70 | 1.95 | 0.25 | 1.05 | 33.76 | 10.90 | 1.62 |
| 14 | 1.95 | 2.00 | 0.05 | 1.05 | 36.54 | 9.49 | 0.28 |
| 15 | 2.00 | 2.20 | 0.20 | 2.83 | 38.56 | 8.65 | 0.48 |
| 16 | 2.20 | 2.30 | 0.10 | 2.83 | 40.90 | 7.73 | 0.21 |
| 17 | 2.30 | 2.45 | 0.15 | 2.83 | 42.85 | 7.13 | 0.30 |
| 18 | 2.45 | 2.70 | 0.25 | 2.83 | 45.97 | 6.30 | 0.44 |
| 19 | 2.70 | 2.93 | 0.23 | 2.83 | 49.74 | 5.50 | 0.33 |

Settlement of mid point of longitudinal edge = 3.6 mm

Settlement of mid point of transverse edge 1 = 7.5 mm

Settlement of mid point of transverse edge 2 = 7.5 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 27.78$ MPa

Foundation in the longitudinal direction is rigid ($k=233.28$)

Foundation in the direction of width is rigid ($k=29.16$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

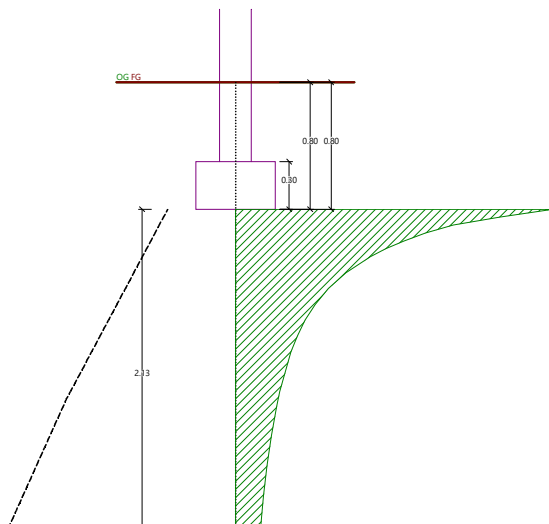
Foundation settlement = 5.7 mm

Depth of influence zone = 2.13 m

Rotation in direction of width = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 2, 3 i 4. KOLSKA VAGA SA NADSTREŠNICOM
 Description : Model 1 - B-2 - Temelj 1.0 m bez tampona
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.1.3

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy clay (CS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 10.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.68 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.62 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.30 \text{ m}$
 Depth of footing bottom $d = 1.30 \text{ m}$
 Foundation thickness $t = 0.80 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

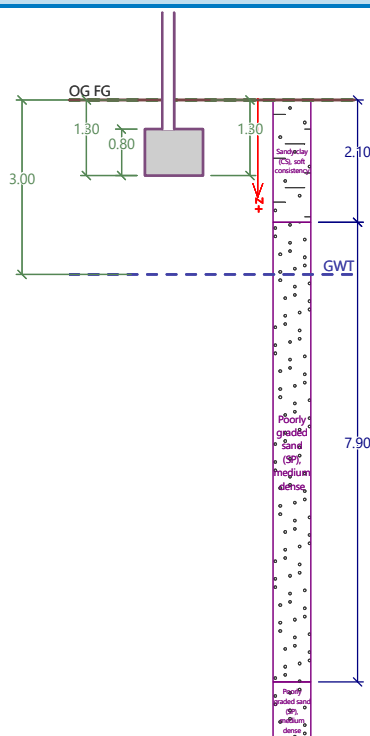
Volume of strip footing $= 0.80 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.30 \text{ m}^3/\text{m}$
 Volume of fill $= 0.40 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 2.10 | 0.00 .. 2.10 | Sandy clay (CS), soft consistency |  |
| 2 | 7.90 | 2.10 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|----------|------------------------|-----------------------|
| 1 | Yes | | ULS | Design | 67.40 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 67.40 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.09 | 0.00 | 91.24 | 221.95 | 41.11 | Yes |
| ULS | No | -0.09 | 0.00 | 91.24 | 221.95 | 41.11 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 18.776^\circ \\ c_d &= 3.833 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.500 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.007 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.820 \text{ m}\end{aligned}$$

$N_q = 5.672$
 $N_c = 13.742$
 $N_\gamma = 3.176$
 $s_q = 1.053$
 $s_c = 1.064$
 $s_\gamma = 0.951$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 221.948 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 7.40 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.27 \text{ m}$

Length of slip surface $l_{sp} = 3.44 \text{ m}$

Design bearing capacity of found.soil $R_d = 221.95 \text{ kPa}$

Extreme contact stress $\sigma = 91.24 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.090 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.090 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 9.43 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 33.58 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 7.40$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.30 | 1.35 | 0.05 | 1.05 | 24.51 | 49.43 | 1.47 |
| 2 | 1.35 | 1.40 | 0.05 | 1.05 | 25.44 | 45.21 | 1.35 |
| 3 | 1.40 | 1.45 | 0.05 | 1.05 | 26.36 | 40.02 | 1.19 |
| 4 | 1.45 | 1.50 | 0.05 | 1.05 | 27.29 | 36.07 | 1.07 |
| 5 | 1.50 | 1.55 | 0.05 | 1.05 | 28.21 | 33.04 | 0.98 |
| 6 | 1.55 | 1.60 | 0.05 | 1.05 | 29.14 | 30.56 | 0.91 |
| 7 | 1.60 | 1.70 | 0.10 | 1.05 | 30.52 | 27.51 | 1.64 |
| 8 | 1.70 | 1.80 | 0.10 | 1.05 | 32.38 | 24.06 | 1.43 |
| 9 | 1.80 | 1.90 | 0.10 | 1.05 | 34.22 | 21.26 | 1.27 |
| 10 | 1.90 | 2.00 | 0.10 | 1.05 | 36.08 | 18.97 | 1.13 |
| 11 | 2.00 | 2.10 | 0.10 | 1.05 | 37.92 | 17.08 | 1.02 |
| 12 | 2.10 | 2.20 | 0.10 | 2.83 | 39.63 | 15.51 | 0.43 |
| 13 | 2.20 | 2.45 | 0.25 | 2.83 | 42.36 | 13.45 | 0.93 |
| 14 | 2.45 | 2.70 | 0.25 | 2.83 | 46.26 | 11.16 | 0.77 |
| 15 | 2.70 | 2.95 | 0.25 | 2.83 | 50.16 | 9.52 | 0.66 |
| 16 | 2.95 | 3.00 | 0.05 | 2.83 | 52.50 | 8.71 | 0.12 |
| 17 | 3.00 | 3.20 | 0.20 | 2.83 | 53.45 | 8.17 | 0.45 |
| 18 | 3.20 | 3.45 | 0.25 | 2.83 | 54.71 | 7.31 | 0.50 |
| 19 | 3.45 | 3.70 | 0.25 | 2.83 | 56.11 | 6.53 | 0.45 |
| 20 | 3.70 | 3.88 | 0.18 | 2.83 | 57.31 | 5.98 | 0.10 |

Settlement of mid point of longitudinal edge = 11.3 mm

Settlement of mid point of transverse edge 1 = 21.2 mm

Settlement of mid point of transverse edge 2 = 12.9 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 1.88$ MPaFoundation in the longitudinal direction is rigid ($k=8183.97$)Foundation in the direction of width is rigid ($k=8183.97$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.090 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.090 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

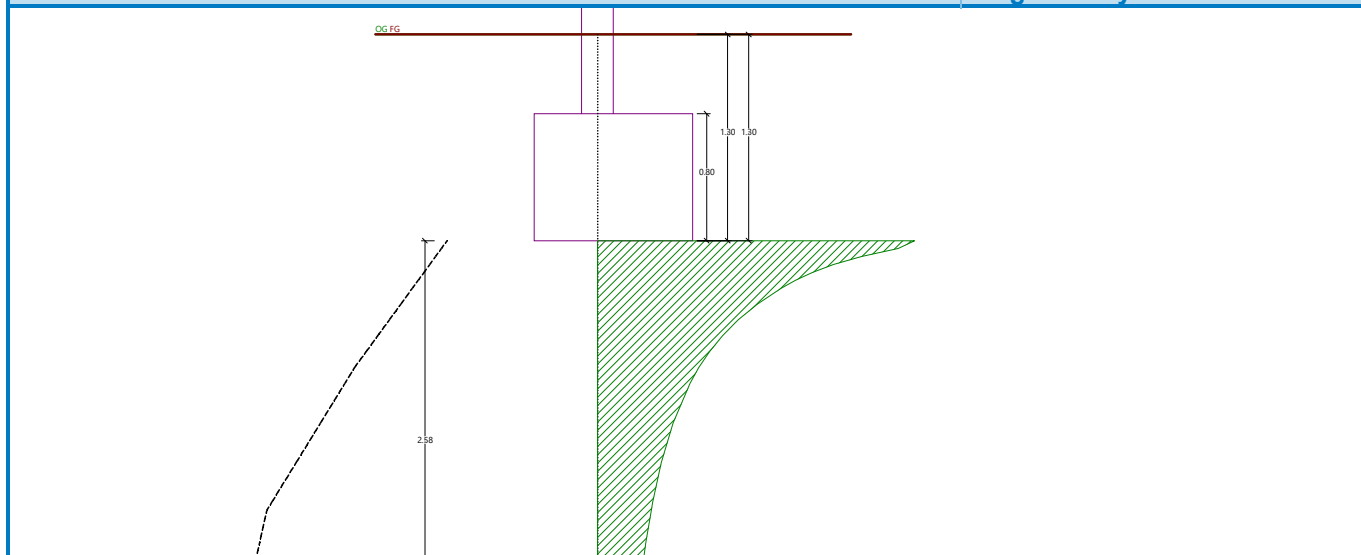
Foundation settlement = 17.9 mm

Depth of influence zone = 2.58 m

Rotation in direction of width = 8.366 (tan*1000); (4.8E-01 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 2, 3 i 4. KOLSKA VAGA SA NADSTREŠNICOM
 Description : Model 1 - B-2 - Temelj 1.0 m sa tamponom
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.1.4

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy clay (CS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 10.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.68 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.62 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.30 \text{ m}$
 Depth of footing bottom $d = 1.30 \text{ m}$
 Foundation thickness $t = 0.80 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.


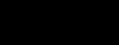

Volume of strip footing $= 0.80 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.30 \text{ m}^3/\text{m}$
 Volume of fill $= 0.40 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

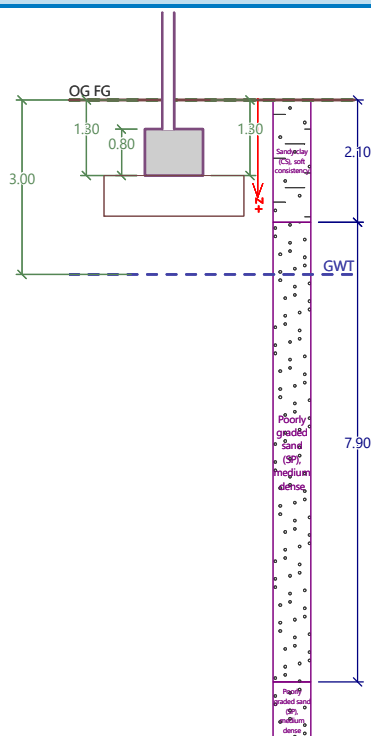
SG pad overhangs foundation $d_{\text{sp}} = 0.70 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.70 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 2.10 | 0.00 .. 2.10 | Sandy clay (CS), soft consistency |  |
| 2 | 7.90 | 2.10 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|----------|------------------------|-----------------------|
| 1 | Yes | | ULS | Design | 67.40 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 67.40 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.09 | 0.00 | 91.24 | 271.80 | 33.57 | Yes |
| ULS | No | -0.09 | 0.00 | 91.24 | 271.80 | 33.57 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 21.644^\circ \\ c_d &= 2.372 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.500 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.554 \text{ kN/m}^3 \\ b_{ef} &= 0.820 \text{ m}\end{aligned}$$

$N_q = 7.544$
 $N_c = 16.492$
 $N_\gamma = 5.193$
 $s_q = 1.060$
 $s_c = 1.070$
 $s_\gamma = 0.951$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 271.802 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 7.40 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.41 \text{ m}$

Length of slip surface $l_{sp} = 4.01 \text{ m}$

Design bearing capacity of found.soil $R_d = 271.80 \text{ kPa}$

Extreme contact stress $\sigma = 91.24 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.090 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.090 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 9.43 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 51.33 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 7.40$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.30 | 1.35 | 0.05 | 45.00 | 24.51 | 49.43 | 0.05 |
| 2 | 1.35 | 1.40 | 0.05 | 45.00 | 25.44 | 45.21 | 0.05 |
| 3 | 1.40 | 1.45 | 0.05 | 45.00 | 26.36 | 40.02 | 0.04 |
| 4 | 1.45 | 1.50 | 0.05 | 45.00 | 27.29 | 36.07 | 0.04 |
| 5 | 1.50 | 1.55 | 0.05 | 45.00 | 28.21 | 33.04 | 0.03 |
| 6 | 1.55 | 1.60 | 0.05 | 45.00 | 29.14 | 30.56 | 0.03 |
| 7 | 1.60 | 1.70 | 0.10 | 45.00 | 30.52 | 27.51 | 0.06 |
| 8 | 1.70 | 1.80 | 0.10 | 45.00 | 32.38 | 24.06 | 0.05 |
| 9 | 1.80 | 1.90 | 0.10 | 45.00 | 34.22 | 21.26 | 0.04 |
| 10 | 1.90 | 2.00 | 0.10 | 45.00 | 36.08 | 18.97 | 0.04 |
| 11 | 2.00 | 2.10 | 0.10 | 1.05 | 37.92 | 17.08 | 1.02 |
| 12 | 2.10 | 2.20 | 0.10 | 2.83 | 39.63 | 15.51 | 0.43 |
| 13 | 2.20 | 2.45 | 0.25 | 2.83 | 42.36 | 13.45 | 0.93 |
| 14 | 2.45 | 2.70 | 0.25 | 2.83 | 46.26 | 11.16 | 0.77 |
| 15 | 2.70 | 2.95 | 0.25 | 2.83 | 50.16 | 9.52 | 0.66 |
| 16 | 2.95 | 3.00 | 0.05 | 2.83 | 52.50 | 8.71 | 0.12 |
| 17 | 3.00 | 3.20 | 0.20 | 2.83 | 53.45 | 8.17 | 0.45 |
| 18 | 3.20 | 3.30 | 0.10 | 2.83 | 54.29 | 7.57 | 0.21 |
| 19 | 3.30 | 3.45 | 0.15 | 2.83 | 54.99 | 7.14 | 0.30 |
| 20 | 3.45 | 3.70 | 0.25 | 2.83 | 56.11 | 6.53 | 0.45 |
| 21 | 3.70 | 3.88 | 0.18 | 2.83 | 57.31 | 5.98 | 0.10 |

Settlement of mid point of longitudinal edge = 3.7 mm

Settlement of mid point of transverse edge 1 = 8.4 mm

Settlement of mid point of transverse edge 2 = 7.1 mm

(1-max.compressed edge; 2-min.compressed edge)

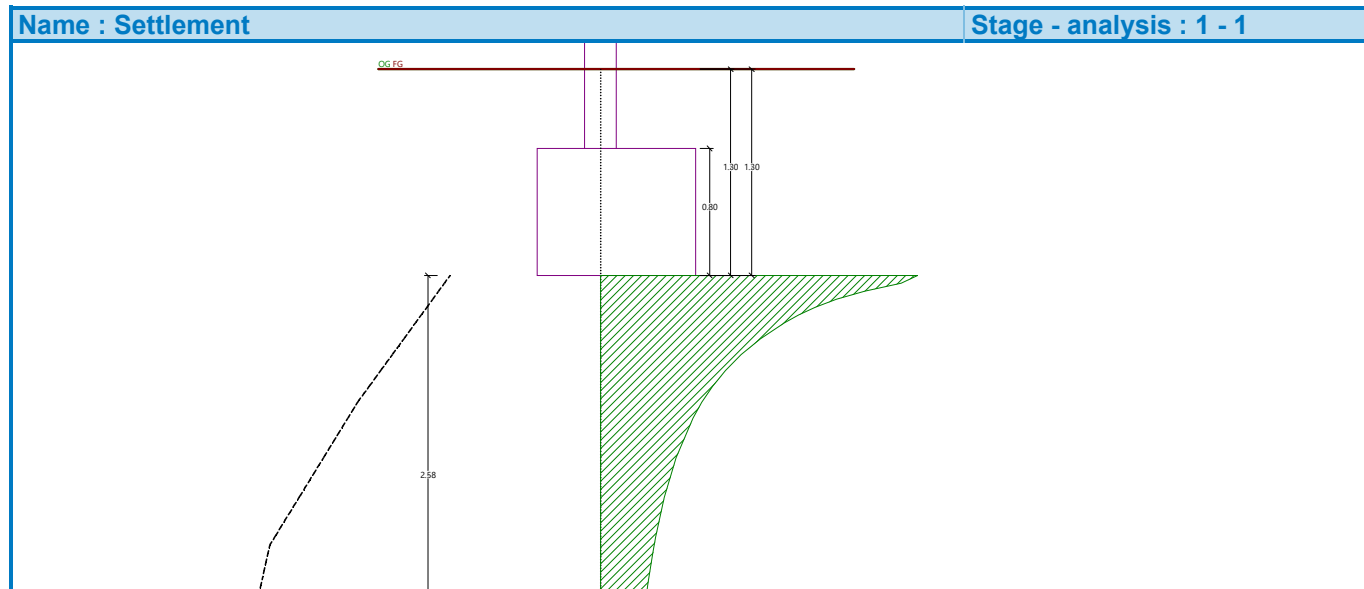
Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 23.49$ MPaFoundation in the longitudinal direction is rigid ($k=653.94$)Foundation in the direction of width is rigid ($k=653.94$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.090 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.090 < 0.333$ **Eccentricity of load is SATISFACTORY**

Overall settlement and rotation of foundation:

Foundation settlement = 5.8 mm

Depth of influence zone = 2.58 m

Rotation in direction of width = 1.355 (tan*1000); (7.8E-02 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 2, 3 i 4. KOLSKA VAGA SA NADSTREŠNICOM
 Description : Model 1, - B-2 - Temelj 1.2 m bez tampona
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.1.5

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy clay (CS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 10.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.68 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.30 \text{ m}$
 Depth of footing bottom $d = 1.30 \text{ m}$
 Foundation thickness $t = 0.80 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 1.20 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

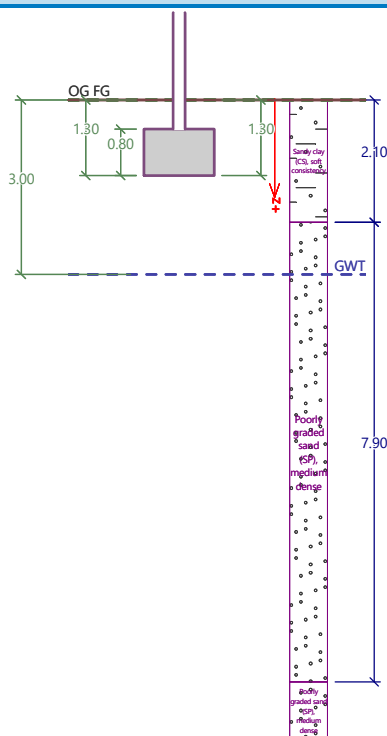
Volume of strip footing $= 0.96 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.56 \text{ m}^3/\text{m}$
 Volume of fill $= 0.50 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 2.10 | 0.00 .. 2.10 | Sandy clay (CS), soft consistency |  |
| 2 | 7.90 | 2.10 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 100.26 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 100.26 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 91.26 | 256.18 | 35.62 | Yes |
| ULS | No | 0.00 | 0.00 | 91.26 | 256.18 | 35.62 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 20.092^\circ \\ c_d &= 2.983 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.500 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 17.639 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.200 \text{ m}\end{aligned}$$

$N_q = 6.458$
 $N_c = 14.921$
 $N_\gamma = 3.993$
 $s_q = 1.082$
 $s_c = 1.098$
 $s_\gamma = 0.928$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 256.181 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 9.25 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.59 \text{ m}$

Length of slip surface $l_{sp} = 4.43 \text{ m}$

Design bearing capacity of found.soil $R_d = 256.18 \text{ kPa}$

Extreme contact stress $\sigma = 91.26 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 9.43 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 44.78 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/m

Computed weight of overburden $Z = 9.25$ kN/m

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.30 | 1.35 | 0.05 | 1.05 | 24.51 | 66.04 | 1.97 |
| 2 | 1.35 | 1.40 | 0.05 | 1.05 | 25.44 | 61.67 | 1.84 |
| 3 | 1.40 | 1.45 | 0.05 | 1.05 | 26.36 | 55.54 | 1.65 |
| 4 | 1.45 | 1.50 | 0.05 | 1.05 | 27.29 | 50.35 | 1.50 |
| 5 | 1.50 | 1.55 | 0.05 | 1.05 | 28.21 | 46.26 | 1.38 |
| 6 | 1.55 | 1.60 | 0.05 | 1.05 | 29.14 | 42.90 | 1.28 |
| 7 | 1.60 | 1.70 | 0.10 | 1.05 | 30.52 | 38.86 | 2.31 |
| 8 | 1.70 | 1.80 | 0.10 | 1.05 | 32.38 | 34.35 | 2.04 |
| 9 | 1.80 | 1.90 | 0.10 | 1.05 | 34.22 | 30.69 | 1.83 |
| 10 | 1.90 | 2.00 | 0.10 | 1.05 | 36.08 | 27.67 | 1.65 |
| 11 | 2.00 | 2.10 | 0.10 | 1.05 | 37.92 | 25.16 | 1.50 |
| 12 | 2.10 | 2.20 | 0.10 | 2.51 | 39.63 | 23.04 | 0.72 |
| 13 | 2.20 | 2.45 | 0.25 | 2.51 | 42.36 | 20.19 | 1.57 |
| 14 | 2.45 | 2.70 | 0.25 | 2.51 | 46.26 | 16.97 | 1.32 |
| 15 | 2.70 | 2.95 | 0.25 | 2.51 | 50.16 | 14.60 | 1.14 |
| 16 | 2.95 | 3.00 | 0.05 | 2.51 | 52.50 | 13.42 | 0.21 |
| 17 | 3.00 | 3.20 | 0.20 | 2.51 | 53.45 | 12.62 | 0.79 |
| 18 | 3.20 | 3.45 | 0.25 | 2.51 | 54.71 | 11.34 | 0.88 |
| 19 | 3.45 | 3.70 | 0.25 | 2.51 | 56.11 | 10.16 | 0.79 |
| 20 | 3.70 | 4.20 | 0.50 | 2.51 | 58.21 | 8.78 | 1.37 |
| 21 | 4.20 | 4.70 | 0.50 | 2.51 | 61.01 | 7.31 | 1.14 |
| 22 | 4.70 | 4.88 | 0.18 | 2.51 | 62.90 | 6.51 | 0.12 |

Settlement of mid point of longitudinal edge = 19.3 mm

Settlement of mid point of transverse edge 1 = 28.0 mm

Settlement of mid point of transverse edge 2 = 28.0 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 1.83$ MPa

Foundation in the longitudinal direction is rigid ($k=4844.71$)

Foundation in the direction of width is rigid ($k=8371.66$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

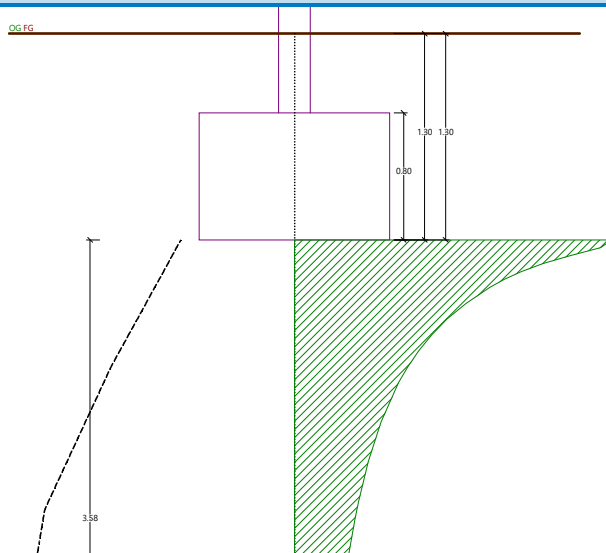
Foundation settlement = 29.0 mm

Depth of influence zone = 3.58 m

Rotation in direction of width = 0.000 (tan*1000); (1.7E-16 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 2, 3 i 4. KOLSKA VAGA SA NADSTREŠNICOM
 Description : Model 1, - B-2 - Temelj 1.2 m sa tamponom
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.3.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy clay (CS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 10.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.68 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.30 \text{ m}$
 Depth of footing bottom $d = 1.30 \text{ m}$
 Foundation thickness $t = 0.80 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 1.20 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.




Volume of strip footing $= 0.96 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.56 \text{ m}^3/\text{m}$
 Volume of fill $= 0.50 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

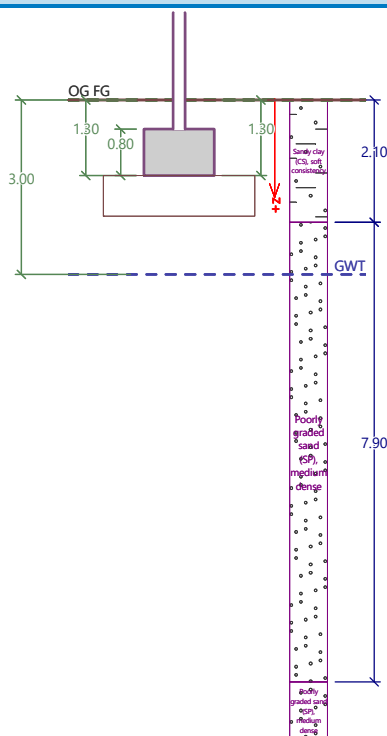
SG pad overhangs foundation $d_{\text{sp}} = 0.70 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.70 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 2.10 | 0.00 .. 2.10 | Sandy clay (CS), soft consistency |  |
| 2 | 7.90 | 2.10 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|----------|------------------------|-----------------------|
| 1 | Yes | | ULS | Design | 100.26 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 100.26 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 91.26 | 303.56 | 30.06 | Yes |
| ULS | No | 0.00 | 0.00 | 91.26 | 303.56 | 30.06 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 22.215^\circ \\ c_d &= 1.935 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.500 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.009 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.200 \text{ m}\end{aligned}$$

$N_q = 7.994$
 $N_c = 17.125$
 $N_\gamma = 5.713$
 $s_q = 1.091$
 $s_c = 1.104$
 $s_\gamma = 0.928$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 303.558 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 9.25 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.72 \text{ m}$

Length of slip surface $l_{sp} = 4.97 \text{ m}$

Design bearing capacity of found.soil $R_d = 303.56 \text{ kPa}$

Extreme contact stress $\sigma = 91.26 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 9.43 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 70.77 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/m

Computed weight of overburden $Z = 9.25$ kN/m

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.30 | 1.35 | 0.05 | 45.00 | 24.51 | 66.04 | 0.07 |
| 2 | 1.35 | 1.40 | 0.05 | 45.00 | 25.44 | 61.67 | 0.06 |
| 3 | 1.40 | 1.45 | 0.05 | 45.00 | 26.36 | 55.54 | 0.06 |
| 4 | 1.45 | 1.50 | 0.05 | 45.00 | 27.29 | 50.35 | 0.05 |
| 5 | 1.50 | 1.55 | 0.05 | 45.00 | 28.21 | 46.26 | 0.05 |
| 6 | 1.55 | 1.60 | 0.05 | 45.00 | 29.14 | 42.90 | 0.04 |
| 7 | 1.60 | 1.70 | 0.10 | 45.00 | 30.52 | 38.86 | 0.08 |
| 8 | 1.70 | 1.80 | 0.10 | 45.00 | 32.38 | 34.35 | 0.07 |
| 9 | 1.80 | 1.90 | 0.10 | 45.00 | 34.22 | 30.69 | 0.06 |
| 10 | 1.90 | 2.00 | 0.10 | 45.00 | 36.08 | 27.67 | 0.06 |
| 11 | 2.00 | 2.10 | 0.10 | 1.05 | 37.92 | 25.16 | 1.50 |
| 12 | 2.10 | 2.20 | 0.10 | 2.51 | 39.63 | 23.04 | 0.72 |
| 13 | 2.20 | 2.45 | 0.25 | 2.51 | 42.36 | 20.19 | 1.57 |
| 14 | 2.45 | 2.70 | 0.25 | 2.51 | 46.26 | 16.97 | 1.32 |
| 15 | 2.70 | 2.95 | 0.25 | 2.51 | 50.16 | 14.60 | 1.14 |
| 16 | 2.95 | 3.00 | 0.05 | 2.51 | 52.50 | 13.42 | 0.21 |
| 17 | 3.00 | 3.20 | 0.20 | 2.51 | 53.45 | 12.62 | 0.79 |
| 18 | 3.20 | 3.30 | 0.10 | 2.51 | 54.29 | 11.73 | 0.37 |
| 19 | 3.30 | 3.45 | 0.15 | 2.51 | 54.99 | 11.08 | 0.52 |
| 20 | 3.45 | 3.70 | 0.25 | 2.51 | 56.11 | 10.16 | 0.79 |
| 21 | 3.70 | 4.20 | 0.50 | 2.51 | 58.21 | 8.78 | 1.37 |
| 22 | 4.20 | 4.70 | 0.50 | 2.51 | 61.01 | 7.31 | 1.14 |
| 23 | 4.70 | 4.88 | 0.18 | 2.51 | 62.90 | 6.51 | 0.12 |

Settlement of mid point of longitudinal edge = 8.4 mm

Settlement of mid point of transverse edge 1 = 15.3 mm

Settlement of mid point of transverse edge 2 = 15.3 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 20.37$ MPa

Foundation in the longitudinal direction is rigid ($k=436.33$)

Foundation in the direction of width is rigid ($k=753.97$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

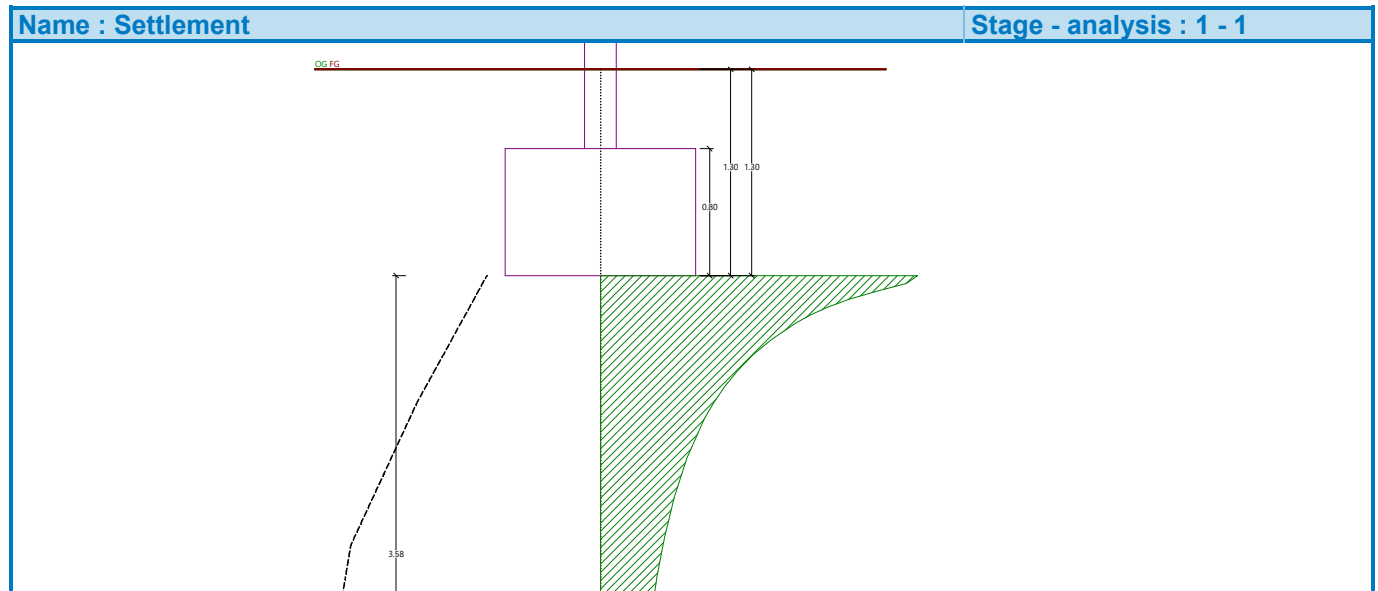
Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY**Overall settlement and rotation of foundation:**

Foundation settlement = 12.1 mm

Depth of influence zone = 3.58 m

Rotation in direction of width = 0.000 (tan*1000); (8.5E-17 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 5. UPRAVNA ZGRADA
 Description : Model 2, - B-4 - Temelj 1.75 x1.75 bez tampona
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.4

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 5.98 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 6.54 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.80 \text{ m}$
 Depth of footing bottom $d = 0.80 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.75 \text{ m}$
 Spread footing width $y = 1.75 \text{ m}$
 Column width in the direction of x $c_x = 0.25 \text{ m}$
 Column width in the direction of y $c_y = 0.25 \text{ m}$

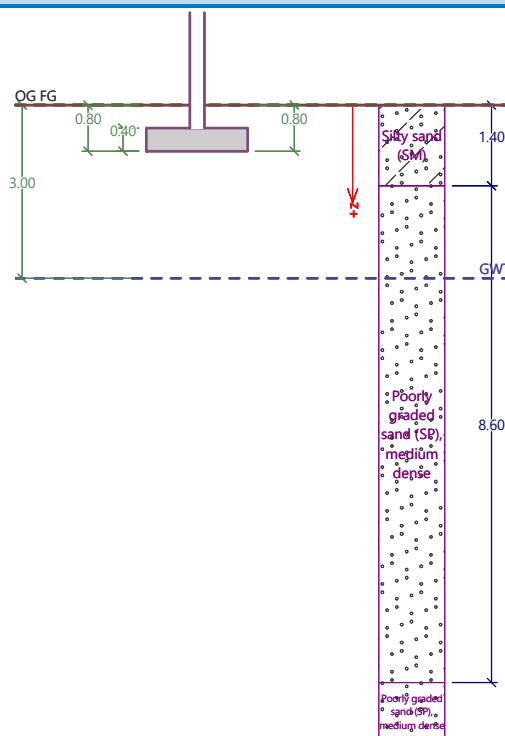
Spread footing volume $= 1.23 \text{ m}^3$
 Volume of excavation $= 2.45 \text{ m}^3$
 Volume of fill $= 1.20 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------------------------------|---|
| 1 | 1.40 | 0.00 .. 1.40 | Silty sand (SM) |  |
| 2 | 8.60 | 1.40 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 440.86 | -28.23 | 6.84 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 440.86 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.01 | 0.06 | 165.12 | 258.93 | 63.77 | Yes |
| ULS | No | -0.01 | 0.06 | 165.12 | 258.93 | 63.77 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 23.649^\circ \\ c_d &= 0.266 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 16.080 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.628 \text{ m}\end{aligned}$$

$N_q = 9.260$
 $N_c = 18.863$
 $N_\gamma = 7.235$
 $s_q = 1.380$
 $s_c = 1.426$
 $s_\gamma = 0.716$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 258.928 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 21.60 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.65 \text{ m}$

Length of slip surface $l_{sp} = 7.84 \text{ m}$

Design bearing capacity of found.soil $R_d = 258.93 \text{ kPa}$

Extreme contact stress $\sigma = 165.12 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.008 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.035 < 0.333$

Max. overall eccentricity $e_t = 0.036 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 4.61 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 165.65 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kNComputed weight of overburden $Z = 21.60$ kN**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.80 | 0.85 | 0.05 | 4.44 | 14.85 | 135.69 | 1.13 |
| 2 | 0.85 | 0.90 | 0.05 | 4.44 | 15.75 | 130.54 | 1.09 |
| 3 | 0.90 | 0.95 | 0.05 | 4.44 | 16.65 | 120.21 | 1.01 |
| 4 | 0.95 | 1.00 | 0.05 | 4.44 | 17.55 | 108.17 | 0.90 |
| 5 | 1.00 | 1.05 | 0.05 | 4.44 | 18.45 | 97.19 | 0.81 |
| 6 | 1.05 | 1.10 | 0.05 | 4.44 | 19.35 | 88.08 | 0.74 |
| 7 | 1.10 | 1.20 | 0.10 | 4.44 | 20.70 | 78.02 | 1.30 |
| 8 | 1.20 | 1.30 | 0.10 | 4.44 | 22.50 | 67.89 | 1.14 |
| 9 | 1.30 | 1.40 | 0.10 | 4.44 | 24.30 | 60.64 | 1.01 |
| 10 | 1.40 | 1.50 | 0.10 | 5.12 | 25.98 | 55.06 | 0.84 |
| 11 | 1.50 | 1.60 | 0.10 | 5.12 | 27.54 | 50.51 | 0.77 |
| 12 | 1.60 | 1.70 | 0.10 | 5.12 | 29.10 | 46.65 | 0.71 |
| 13 | 1.70 | 1.95 | 0.25 | 5.12 | 31.83 | 41.22 | 1.58 |
| 14 | 1.95 | 2.20 | 0.25 | 5.12 | 35.73 | 34.73 | 1.33 |
| 15 | 2.20 | 2.45 | 0.25 | 5.12 | 39.63 | 29.60 | 1.13 |
| 16 | 2.45 | 2.70 | 0.25 | 5.12 | 43.53 | 25.45 | 0.97 |
| 17 | 2.70 | 2.95 | 0.25 | 5.12 | 47.43 | 22.04 | 0.84 |
| 18 | 2.95 | 3.00 | 0.05 | 5.12 | 49.77 | 20.25 | 0.15 |
| 19 | 3.00 | 3.20 | 0.20 | 5.12 | 50.72 | 18.97 | 0.58 |
| 20 | 3.20 | 3.70 | 0.50 | 5.12 | 52.68 | 15.97 | 1.22 |
| 21 | 3.70 | 4.20 | 0.50 | 5.12 | 55.48 | 12.58 | 0.96 |
| 22 | 4.20 | 4.70 | 0.50 | 5.12 | 58.28 | 10.12 | 0.77 |
| 23 | 4.70 | 5.20 | 0.50 | 5.12 | 61.08 | 8.29 | 0.63 |
| 24 | 5.20 | 5.62 | 0.42 | 5.12 | 63.67 | 7.00 | 0.38 |

Settlement of mid point of edge x - 1 = 19.5 mm

Settlement of mid point of edge x - 2 = 19.5 mm

Settlement of mid point of edge y - 1 = 19.5 mm

Settlement of mid point of edge y - 2 = 19.5 mm

Settlement of foundation center point = 30.4 mm

Settlement of characteristic point = 22.0 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 4.86$ MPaFoundation in the longitudinal direction is rigid ($k=73.79$)Foundation in the direction of width is rigid ($k=73.79$)

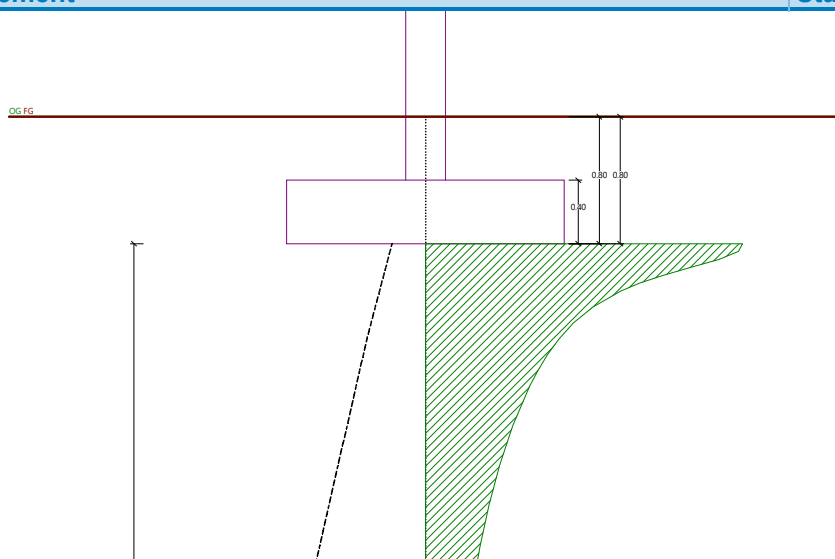
Verification of load eccentricityMax. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 22.0 mm

Depth of influence zone = 4.82 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement**Stage - analysis : 1 - 1**

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 5. UPRAVNA ZGRADA
 Description : Model 2, - B-4 - Temelj 1.75 x1.75 tamponom
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.4.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 5.98 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 6.54 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.80 \text{ m}$
 Depth of footing bottom $d = 0.80 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.75 \text{ m}$
 Spread footing width $y = 1.75 \text{ m}$
 Column width in the direction of x $c_x = 0.25 \text{ m}$
 Column width in the direction of y $c_y = 0.25 \text{ m}$




Spread footing volume $= 1.22 \text{ m}^3$
 Volume of excavation $= 2.45 \text{ m}^3$
 Volume of fill $= 1.20 \text{ m}^3$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

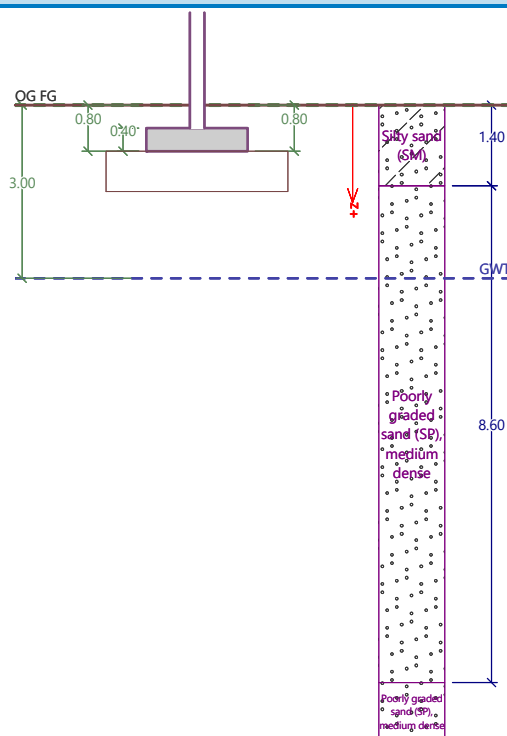
SG pad overhangs foundation $d_{\text{sp}} = 0.70 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.70 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---------------------------------------|---|
| 1 | 1.40 | 0.00 .. 1.40 | Silty sand (SM) |  |
| 2 | 8.60 | 1.40 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 440.86 | -28.23 | 6.84 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 440.86 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.01 | 0.06 | 165.12 | 281.64 | 58.63 | Yes |
| ULS | No | -0.01 | 0.06 | 165.12 | 281.64 | 58.63 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 24.353^\circ \\ c_d &= 0.173 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 16.342 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.628 \text{ m}\end{aligned}$$

$N_q = 9.963$
 $N_c = 19.801$
 $N_\gamma = 8.113$
 $s_q = 1.390$
 $s_c = 1.434$
 $s_\gamma = 0.716$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 281.637 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 21.60 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.73 \text{ m}$

Length of slip surface $l_{sp} = 8.17 \text{ m}$

Design bearing capacity of found.soil $R_d = 281.64 \text{ kPa}$

Extreme contact stress $\sigma = 165.12 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.008 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.035 < 0.333$

Max. overall eccentricity $e_t = 0.036 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 4.61 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 263.66 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 21.60$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.80 | 0.85 | 0.05 | 27.00 | 14.85 | 135.69 | 0.23 |
| 2 | 0.85 | 0.90 | 0.05 | 27.00 | 15.75 | 130.54 | 0.22 |
| 3 | 0.90 | 0.95 | 0.05 | 27.00 | 16.65 | 120.21 | 0.20 |
| 4 | 0.95 | 1.00 | 0.05 | 27.00 | 17.55 | 108.17 | 0.18 |
| 5 | 1.00 | 1.05 | 0.05 | 27.00 | 18.45 | 97.19 | 0.16 |
| 6 | 1.05 | 1.10 | 0.05 | 27.00 | 19.35 | 88.08 | 0.15 |
| 7 | 1.10 | 1.20 | 0.10 | 27.00 | 20.70 | 78.02 | 0.26 |
| 8 | 1.20 | 1.30 | 0.10 | 27.00 | 22.50 | 67.89 | 0.23 |
| 9 | 1.30 | 1.40 | 0.10 | 27.00 | 24.30 | 60.64 | 0.20 |
| 10 | 1.40 | 1.50 | 0.10 | 27.00 | 25.98 | 55.06 | 0.18 |
| 11 | 1.50 | 1.60 | 0.10 | 5.12 | 27.54 | 50.51 | 0.77 |
| 12 | 1.60 | 1.70 | 0.10 | 5.12 | 29.10 | 46.65 | 0.71 |
| 13 | 1.70 | 1.95 | 0.25 | 5.12 | 31.83 | 41.22 | 1.58 |
| 14 | 1.95 | 2.20 | 0.25 | 5.12 | 35.73 | 34.73 | 1.33 |
| 15 | 2.20 | 2.30 | 0.10 | 5.12 | 38.46 | 30.98 | 0.47 |
| 16 | 2.30 | 2.45 | 0.15 | 5.12 | 40.41 | 28.69 | 0.66 |
| 17 | 2.45 | 2.70 | 0.25 | 5.12 | 43.53 | 25.45 | 0.97 |
| 18 | 2.70 | 2.95 | 0.25 | 5.12 | 47.43 | 22.04 | 0.84 |
| 19 | 2.95 | 3.00 | 0.05 | 5.12 | 49.77 | 20.25 | 0.15 |
| 20 | 3.00 | 3.20 | 0.20 | 5.12 | 50.72 | 18.97 | 0.58 |
| 21 | 3.20 | 3.70 | 0.50 | 5.12 | 52.68 | 15.97 | 1.22 |
| 22 | 3.70 | 4.20 | 0.50 | 5.12 | 55.48 | 12.58 | 0.96 |
| 23 | 4.20 | 4.70 | 0.50 | 5.12 | 58.28 | 10.12 | 0.77 |
| 24 | 4.70 | 5.20 | 0.50 | 5.12 | 61.08 | 8.29 | 0.63 |
| 25 | 5.20 | 5.62 | 0.42 | 5.12 | 63.67 | 7.00 | 0.38 |

Settlement of mid point of edge x - 1 = 13.7 mm

Settlement of mid point of edge x - 2 = 13.7 mm

Settlement of mid point of edge y - 1 = 13.7 mm

Settlement of mid point of edge y - 2 = 13.7 mm

Settlement of foundation center point = 19.3 mm

Settlement of characteristic point = 14.0 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 14.66$ MPa

Foundation in the longitudinal direction is rigid ($k=24.43$)

Foundation in the direction of width is rigid ($k=24.43$)

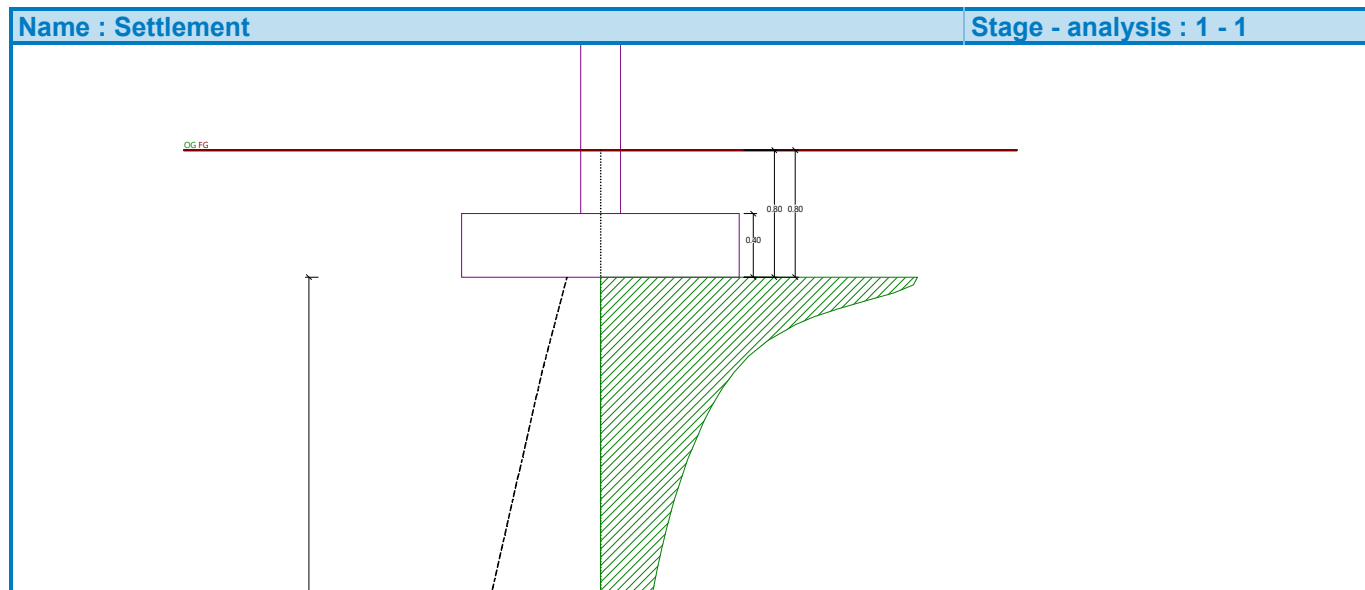
Verification of load eccentricityMax. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 14.0 mm

Depth of influence zone = 4.82 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 5. UPRAVNA ZGRADA
 Description : Model 2, - B-4 - Temelj 1.6 x1.6
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.5

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy silt (MS), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 2.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 6.54 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.80 \text{ m}$
 Depth of footing bottom $d = 0.80 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.60 \text{ m}$
 Spread footing width $y = 1.60 \text{ m}$
 Column width in the direction of x $c_x = 0.25 \text{ m}$
 Column width in the direction of y $c_y = 0.25 \text{ m}$

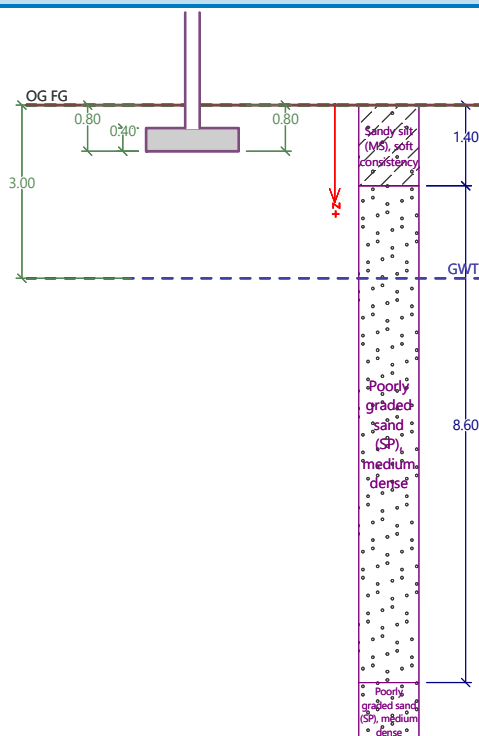
Spread footing volume = 1.02 m^3
 Volume of excavation = 2.05 m^3
 Volume of fill = 1.00 m^3

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------------------------------|---|
| 1 | 1.40 | 0.00 .. 1.40 | Sandy silt (MS), soft consistency |  |
| 2 | 8.60 | 1.40 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 341.00 | 35.16 | 2.27 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 341.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.01 | -0.10 | 161.06 | 246.20 | 65.42 | Yes |
| ULS | No | -0.01 | -0.10 | 161.06 | 246.20 | 65.42 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 23.536^\circ \\ c_d &= 0.293 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 16.432 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.404 \text{ m}\end{aligned}$$

$N_q = 9.153$
 $N_c = 18.718$
 $N_\gamma = 7.102$
 $s_q = 1.353$
 $s_c = 1.397$
 $s_\gamma = 0.735$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 246.197 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$
 Computed weight of overburden $Z = 17.98 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.41 \text{ m}$

Length of slip surface $l_{sp} = 7.12 \text{ m}$

Design bearing capacity of found.soil $R_d = 246.20 \text{ kPa}$

Extreme contact stress $\sigma = 161.06 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.004 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.061 < 0.333$

Max. overall eccentricity $e_t = 0.061 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 4.21 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 129.30 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 17.98$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.80 | 0.85 | 0.05 | 1.38 | 14.85 | 124.75 | 2.82 |
| 2 | 0.85 | 0.90 | 0.05 | 1.38 | 15.75 | 118.99 | 2.69 |
| 3 | 0.90 | 0.95 | 0.05 | 1.38 | 16.65 | 108.06 | 2.44 |
| 4 | 0.95 | 1.00 | 0.05 | 1.38 | 17.55 | 96.06 | 2.17 |
| 5 | 1.00 | 1.05 | 0.05 | 1.38 | 18.45 | 85.65 | 1.94 |
| 6 | 1.05 | 1.10 | 0.05 | 1.38 | 19.35 | 77.29 | 1.75 |
| 7 | 1.10 | 1.20 | 0.10 | 1.38 | 20.70 | 68.27 | 3.09 |
| 8 | 1.20 | 1.30 | 0.10 | 1.38 | 22.50 | 59.26 | 2.68 |
| 9 | 1.30 | 1.40 | 0.10 | 1.38 | 24.30 | 52.80 | 2.39 |
| 10 | 1.40 | 1.50 | 0.10 | 5.12 | 25.98 | 47.78 | 0.73 |
| 11 | 1.50 | 1.60 | 0.10 | 5.12 | 27.54 | 43.65 | 0.67 |
| 12 | 1.60 | 1.70 | 0.10 | 5.12 | 29.10 | 40.12 | 0.61 |
| 13 | 1.70 | 1.95 | 0.25 | 5.12 | 31.83 | 35.16 | 1.34 |
| 14 | 1.95 | 2.20 | 0.25 | 5.12 | 35.73 | 29.26 | 1.12 |
| 15 | 2.20 | 2.45 | 0.25 | 5.12 | 39.63 | 24.65 | 0.94 |
| 16 | 2.45 | 2.70 | 0.25 | 5.12 | 43.53 | 20.98 | 0.80 |
| 17 | 2.70 | 2.95 | 0.25 | 5.12 | 47.43 | 18.01 | 0.69 |
| 18 | 2.95 | 3.00 | 0.05 | 5.12 | 49.77 | 16.47 | 0.13 |
| 19 | 3.00 | 3.20 | 0.20 | 5.12 | 50.72 | 15.38 | 0.47 |
| 20 | 3.20 | 3.70 | 0.50 | 5.12 | 52.68 | 12.85 | 0.98 |
| 21 | 3.70 | 4.20 | 0.50 | 5.12 | 55.48 | 10.03 | 0.77 |
| 22 | 4.20 | 4.70 | 0.50 | 5.12 | 58.28 | 8.02 | 0.61 |
| 23 | 4.70 | 5.09 | 0.39 | 5.12 | 60.77 | 6.68 | 0.30 |

Settlement of mid point of edge x - 1 = 26.2 mm

Settlement of mid point of edge x - 2 = 26.2 mm

Settlement of mid point of edge y - 1 = 26.2 mm

Settlement of mid point of edge y - 2 = 26.2 mm

Settlement of foundation center point = 44.4 mm

Settlement of characteristic point = 32.1 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 3.55$ MPa

Foundation in the longitudinal direction is rigid ($k=132.20$)

Foundation in the direction of width is rigid ($k=132.20$)

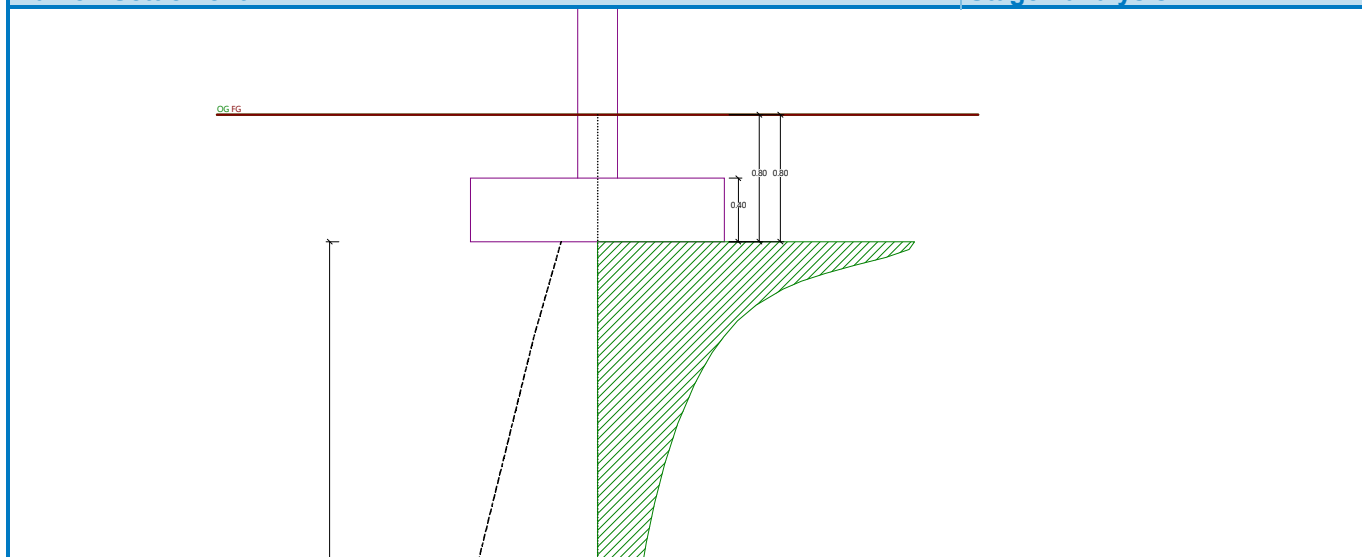
Verification of load eccentricityMax. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 32.1 mm

Depth of influence zone = 4.29 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement**Stage - analysis : 1 - 1**

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 5. UPRAVNA ZGRADA
 Description : Model 2, - B-4 - Temelj 1.6 x1.6 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.5.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

Sandy silt (MS), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 2.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 6.54 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.80 \text{ m}$
 Depth of footing bottom $d = 0.80 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.60 \text{ m}$
 Spread footing width $y = 1.60 \text{ m}$
 Column width in the direction of x $c_x = 0.25 \text{ m}$
 Column width in the direction of y $c_y = 0.25 \text{ m}$




Spread footing volume $= 1.02 \text{ m}^3$
 Volume of excavation $= 2.05 \text{ m}^3$
 Volume of fill $= 1.00 \text{ m}^3$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

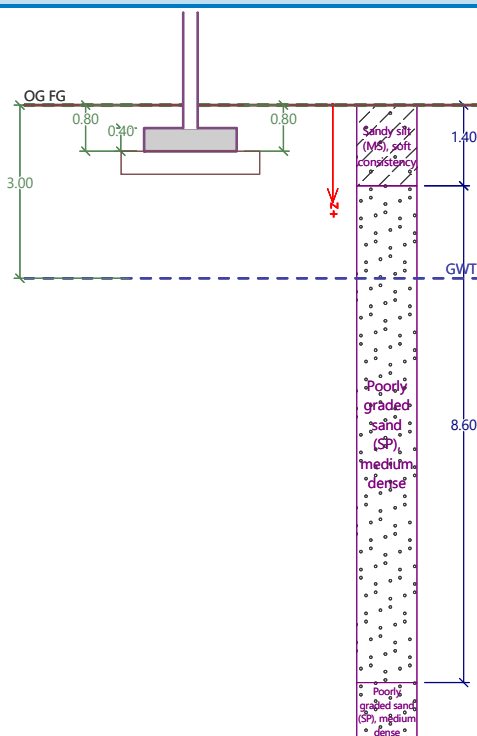
SG pad overhangs foundation $d_{\text{sp}} = 0.40 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.40 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------------------------------|---|
| 1 | 1.40 | 0.00 .. 1.40 | Sandy silt (MS), soft consistency |  |
| 2 | 8.60 | 1.40 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 341.00 | 35.16 | 2.27 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 341.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.01 | -0.10 | 161.06 | 260.45 | 61.84 | Yes |
| ULS | No | -0.01 | -0.10 | 161.06 | 260.45 | 61.84 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 24.027^\circ \\ c_d &= 0.223 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 16.573 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.404 \text{ m}\end{aligned}$$

$N_q = 9.630$
 $N_c = 19.360$
 $N_\gamma = 7.695$
 $s_q = 1.360$
 $s_c = 1.402$
 $s_\gamma = 0.735$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 260.448 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$
 Computed weight of overburden $Z = 17.98 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.46 \text{ m}$

Length of slip surface $l_{sp} = 7.34 \text{ m}$

Design bearing capacity of found.soil $R_d = 260.45 \text{ kPa}$

Extreme contact stress $\sigma = 161.06 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.004 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.061 < 0.333$

Max. overall eccentricity $e_t = 0.061 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 4.21 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 205.30 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kNComputed weight of overburden $Z = 17.98$ kN**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.80 | 0.85 | 0.05 | 27.00 | 14.85 | 124.75 | 0.21 |
| 2 | 0.85 | 0.90 | 0.05 | 27.00 | 15.75 | 118.99 | 0.20 |
| 3 | 0.90 | 0.95 | 0.05 | 27.00 | 16.65 | 108.06 | 0.18 |
| 4 | 0.95 | 1.00 | 0.05 | 27.00 | 17.55 | 96.06 | 0.16 |
| 5 | 1.00 | 1.05 | 0.05 | 27.00 | 18.45 | 85.65 | 0.14 |
| 6 | 1.05 | 1.10 | 0.05 | 27.00 | 19.35 | 77.29 | 0.13 |
| 7 | 1.10 | 1.20 | 0.10 | 27.00 | 20.70 | 68.27 | 0.23 |
| 8 | 1.20 | 1.30 | 0.10 | 1.38 | 22.50 | 59.26 | 2.68 |
| 9 | 1.30 | 1.40 | 0.10 | 1.38 | 24.30 | 52.80 | 2.39 |
| 10 | 1.40 | 1.50 | 0.10 | 5.12 | 25.98 | 47.78 | 0.73 |
| 11 | 1.50 | 1.60 | 0.10 | 5.12 | 27.54 | 43.65 | 0.67 |
| 12 | 1.60 | 1.70 | 0.10 | 5.12 | 29.10 | 40.12 | 0.61 |
| 13 | 1.70 | 1.95 | 0.25 | 5.12 | 31.83 | 35.16 | 1.34 |
| 14 | 1.95 | 2.00 | 0.05 | 5.12 | 34.17 | 31.31 | 0.24 |
| 15 | 2.00 | 2.20 | 0.20 | 5.12 | 36.12 | 28.74 | 0.88 |
| 16 | 2.20 | 2.45 | 0.25 | 5.12 | 39.63 | 24.65 | 0.94 |
| 17 | 2.45 | 2.70 | 0.25 | 5.12 | 43.53 | 20.98 | 0.80 |
| 18 | 2.70 | 2.95 | 0.25 | 5.12 | 47.43 | 18.01 | 0.69 |
| 19 | 2.95 | 3.00 | 0.05 | 5.12 | 49.77 | 16.47 | 0.13 |
| 20 | 3.00 | 3.20 | 0.20 | 5.12 | 50.72 | 15.38 | 0.47 |
| 21 | 3.20 | 3.70 | 0.50 | 5.12 | 52.68 | 12.85 | 0.98 |
| 22 | 3.70 | 4.20 | 0.50 | 5.12 | 55.48 | 10.03 | 0.77 |
| 23 | 4.20 | 4.70 | 0.50 | 5.12 | 58.28 | 8.02 | 0.61 |
| 24 | 4.70 | 5.09 | 0.39 | 5.12 | 60.77 | 6.68 | 0.30 |

Settlement of mid point of edge x - 1 = 16.0 mm

Settlement of mid point of edge x - 2 = 16.0 mm

Settlement of mid point of edge y - 1 = 16.0 mm

Settlement of mid point of edge y - 2 = 16.0 mm

Settlement of foundation center point = 24.3 mm

Settlement of characteristic point = 16.5 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 11.23$ MPaFoundation in the longitudinal direction is rigid ($k=41.72$)Foundation in the direction of width is rigid ($k=41.72$)

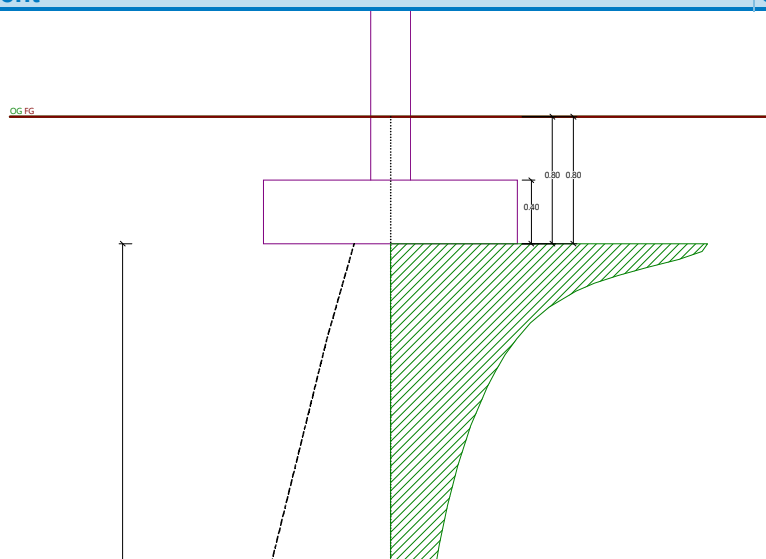
Verification of load eccentricityMax. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 16.5 mm

Depth of influence zone = 4.29 m

Rotation in direction of x = 0.000 (tan*1000); (6.4E-17 °)

Rotation in direction of y = 0.000 (tan*1000); (6.4E-17 °)

Name : Settlement**Stage - analysis : 1 - 1**

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 9. ZGRADA ZA RADNIKE
 Description : Model 3 - B-6
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.6

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy silt (MS), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 32.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 1.88 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 0.90 \text{ m}$
 Depth of footing bottom $d = 0.90 \text{ m}$
 Foundation thickness $t = 0.30 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 0.40 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

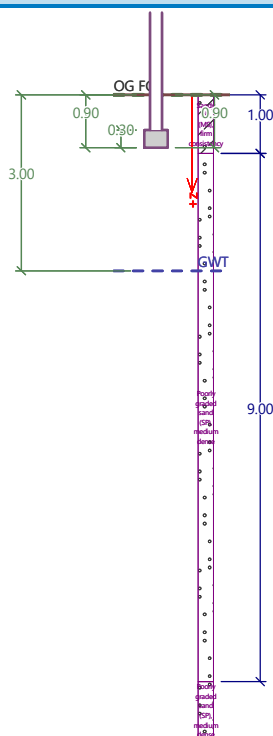
Volume of strip footing $= 0.12 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.36 \text{ m}^3/\text{m}$
 Volume of fill $= 0.12 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 1.00 | 0.00 .. 1.00 | Sandy silt (MS), firm consistency |  |
| 2 | 9.00 | 1.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 15.64 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 15.64 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 44.50 | 224.78 | 19.80 | Yes |
| ULS | No | 0.00 | 0.00 | 44.50 | 224.78 | 19.80 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 25.560^\circ \\ c_d &= 0.179 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 16.197 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.400 \text{ m}\end{aligned}$$

$N_q = 11.312$
 $N_c = 21.562$
 $N_\gamma = 9.864$
 $s_q = 1.035$
 $s_c = 1.038$
 $s_\gamma = 0.976$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 224.776 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 2.16 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 0.65 \text{ m}$

Length of slip surface $l_{sp} = 2.00 \text{ m}$

Design bearing capacity of found.soil $R_d = 224.78 \text{ kPa}$

Extreme contact stress $\sigma = 44.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 0.99 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 7.60 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 2.16$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.90 | 0.95 | 0.05 | 1.21 | 16.65 | 25.28 | 0.65 |
| 2 | 0.95 | 1.00 | 0.05 | 1.21 | 17.55 | 20.19 | 0.52 |
| 3 | 1.00 | 1.05 | 0.05 | 1.47 | 18.39 | 16.88 | 0.45 |
| 4 | 1.05 | 1.10 | 0.05 | 1.47 | 19.17 | 14.66 | 0.39 |
| 5 | 1.10 | 1.15 | 0.05 | 1.47 | 19.95 | 12.87 | 0.34 |
| 6 | 1.15 | 1.20 | 0.05 | 1.47 | 20.73 | 11.38 | 0.30 |
| 7 | 1.20 | 1.30 | 0.10 | 1.47 | 21.90 | 9.67 | 0.51 |
| 8 | 1.30 | 1.40 | 0.10 | 1.47 | 23.46 | 7.90 | 0.42 |
| 9 | 1.40 | 1.50 | 0.10 | 1.47 | 25.02 | 6.64 | 0.35 |
| 10 | 1.50 | 1.60 | 0.10 | 1.47 | 26.58 | 5.70 | 0.30 |
| 11 | 1.60 | 1.70 | 0.10 | 1.47 | 28.14 | 4.99 | 0.27 |
| 12 | 1.70 | 1.80 | 0.10 | 1.47 | 29.70 | 4.44 | 0.24 |
| 13 | 1.80 | 2.03 | 0.23 | 1.47 | 32.24 | 3.80 | 0.41 |

Settlement of mid point of longitudinal edge = 2.7 mm

Settlement of mid point of transverse edge 1 = 5.1 mm

Settlement of mid point of transverse edge 2 = 5.1 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 1.42$ MPaFoundation in the longitudinal direction is rigid ($k=8933.89$)Foundation in the direction of width is rigid ($k=571.77$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

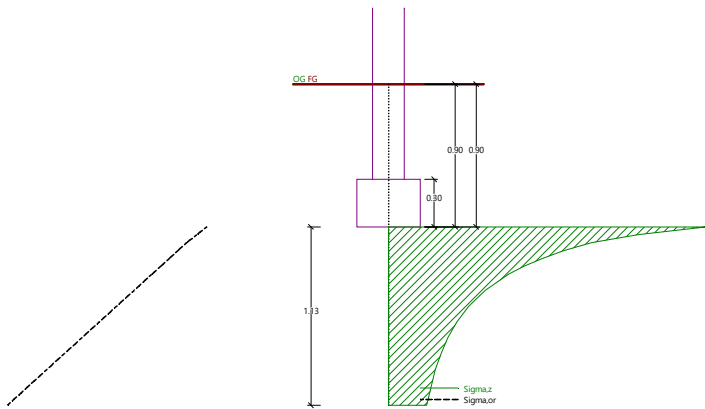
Foundation settlement = 5.2 mm

Depth of influence zone = 1.13 m

Rotation in direction of width = 0.000 (\tan^*1000); (0.0E+00 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 9. ZGRADA ZA RADNIKE
 Description : Model 3 - B-6 - tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.6.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy silt (MS), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 32.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 1.88 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 0.90 \text{ m}$
 Depth of footing bottom $d = 0.90 \text{ m}$
 Foundation thickness $t = 0.30 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 0.40 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.




Volume of strip footing $= 0.12 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.36 \text{ m}^3/\text{m}$
 Volume of fill $= 0.12 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

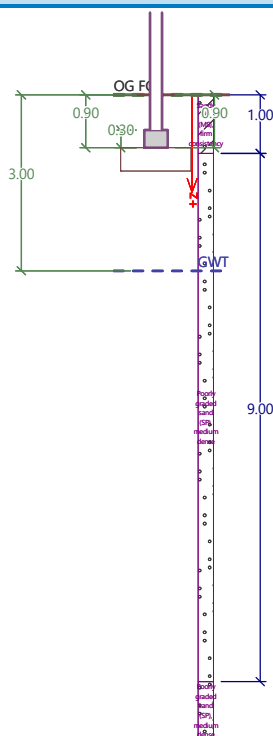
SG pad overhangs foundation $d_{\text{sp}} = 0.40 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.40 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 1.00 | 0.00 .. 1.00 | Sandy silt (MS), firm consistency |  |
| 2 | 9.00 | 1.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 15.64 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 15.64 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 44.50 | 248.25 | 17.93 | Yes |
| ULS | No | 0.00 | 0.00 | 44.50 | 248.25 | 17.93 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 26.362^\circ \\ c_d &= 0.117 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 17.687 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.400 \text{ m}\end{aligned}$$

$N_q = 12.323$
 $N_c = 22.847$
 $N_\gamma = 11.223$
 $s_q = 1.036$
 $s_c = 1.039$
 $s_\gamma = 0.976$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 248.246 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 2.16 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 0.67 \text{ m}$

Length of slip surface $l_{sp} = 2.10 \text{ m}$

Design bearing capacity of found.soil $R_d = 248.25 \text{ kPa}$

Extreme contact stress $\sigma = 44.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 0.99 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 10.96 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 2.16$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.90 | 0.95 | 0.05 | 27.00 | 16.65 | 25.28 | 0.04 |
| 2 | 0.95 | 1.00 | 0.05 | 27.00 | 17.55 | 20.19 | 0.03 |
| 3 | 1.00 | 1.05 | 0.05 | 27.00 | 18.39 | 16.88 | 0.03 |
| 4 | 1.05 | 1.10 | 0.05 | 27.00 | 19.17 | 14.66 | 0.02 |
| 5 | 1.10 | 1.15 | 0.05 | 27.00 | 19.95 | 12.87 | 0.02 |
| 6 | 1.15 | 1.20 | 0.05 | 27.00 | 20.73 | 11.38 | 0.02 |
| 7 | 1.20 | 1.30 | 0.10 | 27.00 | 21.90 | 9.67 | 0.03 |
| 8 | 1.30 | 1.40 | 0.10 | 1.47 | 23.46 | 7.90 | 0.42 |
| 9 | 1.40 | 1.50 | 0.10 | 1.47 | 25.02 | 6.64 | 0.35 |
| 10 | 1.50 | 1.60 | 0.10 | 1.47 | 26.58 | 5.70 | 0.30 |
| 11 | 1.60 | 1.70 | 0.10 | 1.47 | 28.14 | 4.99 | 0.27 |
| 12 | 1.70 | 1.80 | 0.10 | 1.47 | 29.70 | 4.44 | 0.24 |
| 13 | 1.80 | 2.03 | 0.23 | 1.47 | 32.24 | 3.80 | 0.41 |

Settlement of mid point of longitudinal edge = 0.9 mm

Settlement of mid point of transverse edge 1 = 2.8 mm

Settlement of mid point of transverse edge 2 = 2.8 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 16.15$ MPaFoundation in the longitudinal direction is rigid ($k=783.50$)Foundation in the direction of width is rigid ($k=50.14$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

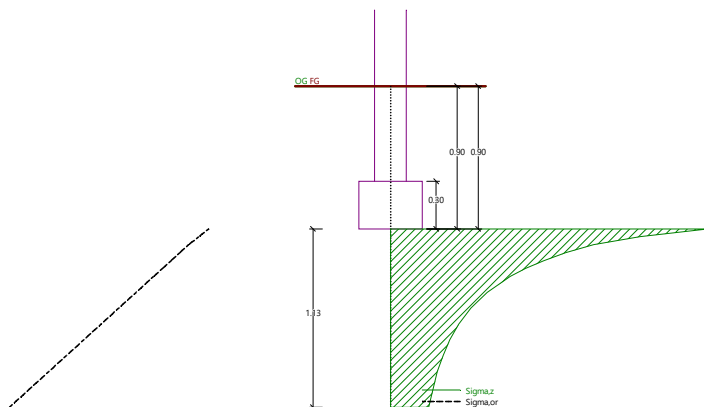
Foundation settlement = 2.2 mm

Depth of influence zone = 1.13 m

Rotation in direction of width = 0.000 (\tan^*1000); ($1.3E-16$ °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 10. RADIONICA
 Description : Model 4 - B-9
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.7

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 19.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 19.50 \text{ kN/m}^3$

Sandy silt (MS), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 23.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 32.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.31 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 25.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.90 \text{ m}$
 Depth of footing bottom $d = 0.90 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden





Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.80 \text{ m}$
 Spread footing width $y = 1.40 \text{ m}$
 Column width in the direction of x $c_x = 0.80 \text{ m}$
 Column width in the direction of y $c_y = 0.80 \text{ m}$

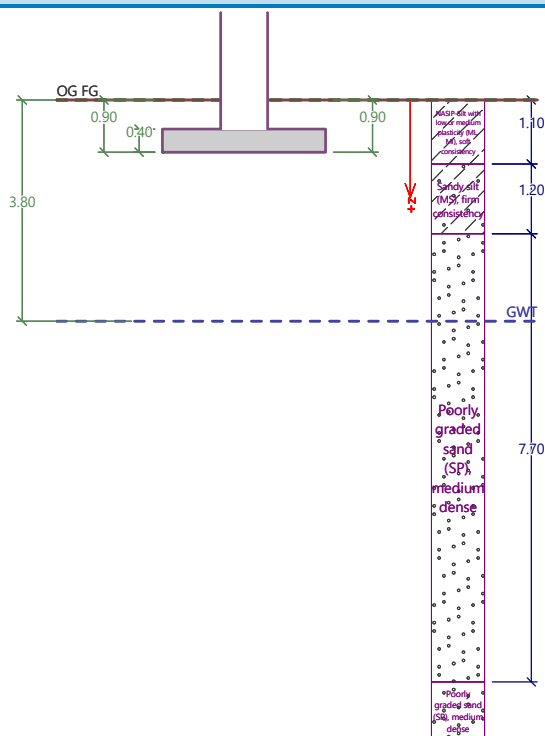
Spread footing volume = 1.57 m^3
 Volume of excavation = 3.53 m^3
 Volume of fill = 1.64 m^3

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 1.10 | 0.00 .. 1.10 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 1.20 | 1.10 .. 2.30 | Sandy silt (MS), firm consistency |  |
| 3 | 7.70 | 2.30 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 4 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 295.50 | 88.10 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 295.50 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | -0.27 | 135.69 | 188.65 | 71.93 | Yes |
| ULS | No | 0.00 | -0.27 | 135.69 | 188.65 | 71.93 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 21.080^\circ \\ c_d &= 0.914 \text{ kPa} \\ \gamma_{1\text{prum}} &= 19.500 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.026 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.862 \text{ m}\end{aligned}$$

$N_q = 7.128$
 $N_c = 15.897$
 $N_\gamma = 4.724$
 $s_q = 1.111$
 $s_c = 1.129$
 $s_\gamma = 0.908$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 188.650 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 31.98 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.93 \text{ m}$

Length of slip surface $l_{sp} = 5.45 \text{ m}$

Design bearing capacity of found.soil $R_d = 188.65 \text{ kPa}$

Extreme contact stress $\sigma = 135.69 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.192 < 0.333$

Max. overall eccentricity $e_t = 0.192 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 5.41 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 88.95 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 31.98$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.90 | 0.95 | 0.05 | 0.56 | 18.04 | 65.51 | 2.73 |
| 2 | 0.95 | 1.00 | 0.05 | 0.56 | 19.01 | 63.04 | 2.63 |
| 3 | 1.00 | 1.05 | 0.05 | 0.56 | 19.99 | 58.40 | 2.43 |
| 4 | 1.05 | 1.10 | 0.05 | 0.56 | 20.96 | 53.22 | 2.22 |
| 5 | 1.10 | 1.15 | 0.05 | 2.00 | 21.90 | 48.50 | 0.76 |
| 6 | 1.15 | 1.20 | 0.05 | 2.00 | 22.80 | 44.47 | 0.69 |
| 7 | 1.20 | 1.30 | 0.10 | 2.00 | 24.15 | 39.76 | 1.24 |
| 8 | 1.30 | 1.40 | 0.10 | 2.00 | 25.95 | 34.80 | 1.08 |
| 9 | 1.40 | 1.50 | 0.10 | 2.00 | 27.75 | 31.08 | 0.97 |
| 10 | 1.50 | 1.60 | 0.10 | 2.00 | 29.55 | 28.15 | 0.88 |
| 11 | 1.60 | 1.70 | 0.10 | 2.00 | 31.35 | 25.75 | 0.80 |
| 12 | 1.70 | 1.80 | 0.10 | 2.00 | 33.15 | 23.73 | 0.74 |
| 13 | 1.80 | 2.05 | 0.25 | 2.00 | 36.30 | 20.94 | 1.63 |
| 14 | 2.05 | 2.30 | 0.25 | 2.00 | 40.80 | 17.68 | 1.38 |
| 15 | 2.30 | 2.55 | 0.25 | 2.59 | 45.00 | 15.17 | 1.15 |
| 16 | 2.55 | 2.80 | 0.25 | 2.59 | 48.90 | 13.17 | 0.99 |
| 17 | 2.80 | 3.05 | 0.25 | 2.59 | 52.80 | 11.53 | 0.87 |
| 18 | 3.05 | 3.30 | 0.25 | 2.59 | 56.70 | 10.17 | 0.77 |
| 19 | 3.30 | 3.80 | 0.50 | 2.59 | 62.55 | 8.58 | 1.30 |
| 20 | 3.80 | 4.02 | 0.22 | 2.59 | 68.15 | 7.30 | 0.20 |

Settlement of mid point of edge x - 1 = 21.9 mm

Settlement of mid point of edge x - 2 = 21.9 mm

Settlement of mid point of edge y - 1 = 18.4 mm

Settlement of mid point of edge y - 2 = 18.4 mm

Settlement of foundation center point = 34.5 mm

Settlement of characteristic point = 25.4 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 1.97$ MPa

Foundation in the longitudinal direction is rigid ($k=44.49$)

Foundation in the direction of width is rigid ($k=355.90$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

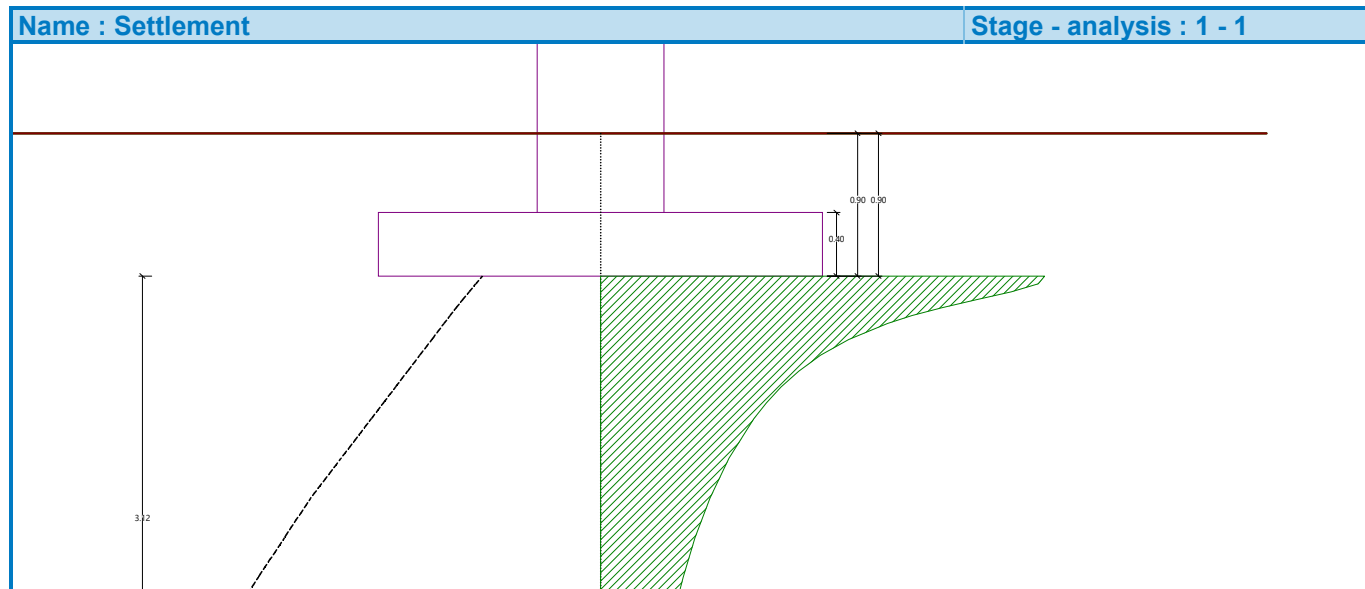
Eccentricity of load is SATISFACTORY**Overall settlement and rotation of foundation:**

Foundation settlement = 25.4 mm

Depth of influence zone = 3.12 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 10. RADIONICA
 Description : Model 4 - B-9 - tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.7.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 19.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 19.50 \text{ kN/m}^3$

Sandy silt (MS), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 23.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 32.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.31 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 25.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.90 \text{ m}$
 Depth of footing bottom $d = 0.90 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.80 \text{ m}$
 Spread footing width $y = 1.40 \text{ m}$
 Column width in the direction of x $c_x = 0.80 \text{ m}$
 Column width in the direction of y $c_y = 0.80 \text{ m}$
 Spread footing volume $= 1.57 \text{ m}^3$
 Volume of excavation $= 3.53 \text{ m}^3$
 Volume of fill $= 1.64 \text{ m}^3$



Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

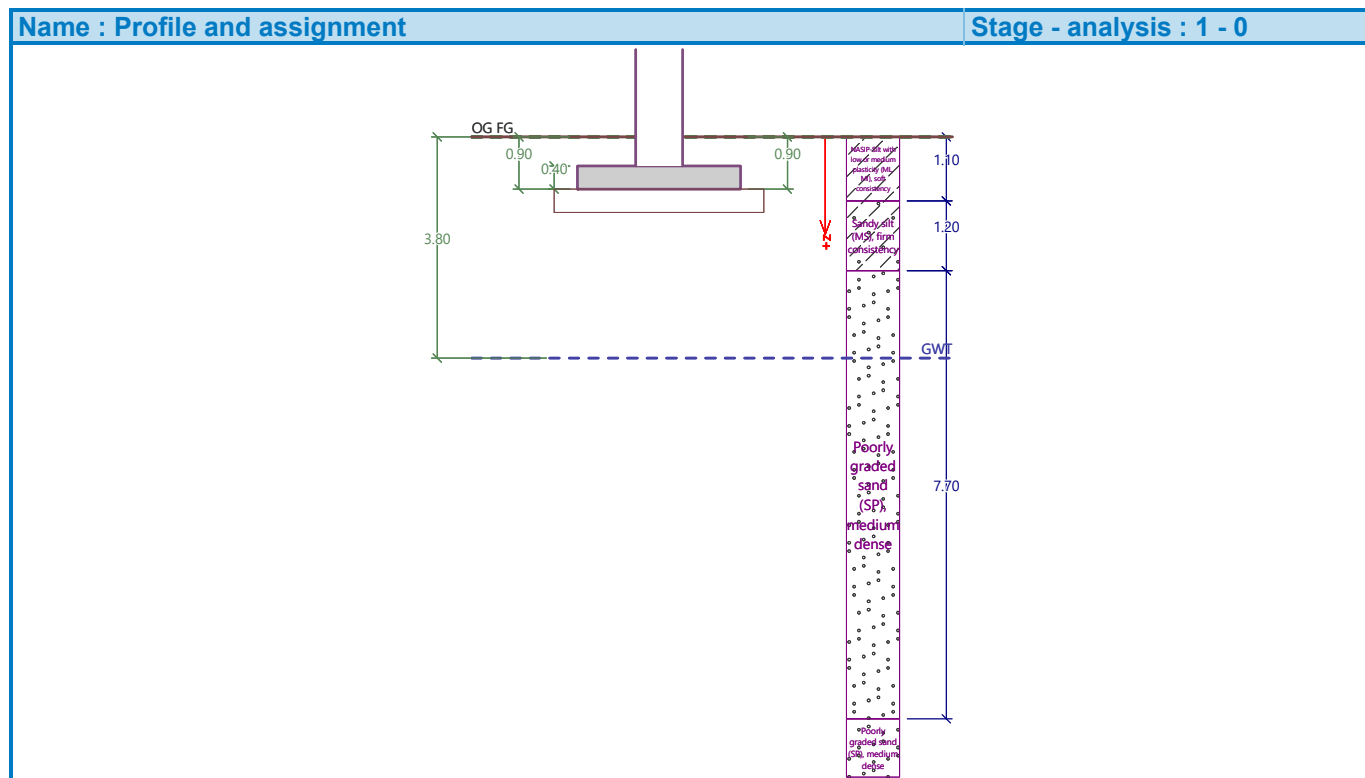
SG pad overhangs foundation $d_{\text{sp}} = 0.40 \text{ m}$

Sand-gravel pad depth $h_{\text{sp}} = 0.40 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 1.10 | 0.00 .. 1.10 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 1.20 | 1.10 .. 2.30 | Sandy silt (MS), firm consistency |  |

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---------|
| 3 | 7.70 | 2.30 .. 10.00 | Poorly graded sand (SP), medium dense | |
| 4 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense | |



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|----------------|------|---------|-----------|-------------------------|-------------------------|------------------------|------------------------|
| 1 | Yes | | ULS | Design | 295.50 | 88.10 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 295.50 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | -0.27 | 135.69 | 208.16 | 65.18 | Yes |

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | No | 0.00 | -0.27 | 135.69 | 208.16 | 65.18 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 22.025^\circ$
 $c_d = 0.796 \text{ kPa}$
 $\gamma_{1prum} = 19.500 \text{ kN/m}^3$
 $\gamma_{2prum} = 18.206 \text{ kN/m}^3$
 $b_{ef} = 0.862 \text{ m}$
 $N_q = 7.841$
 $N_c = 16.911$
 $N_\gamma = 5.535$
 $s_q = 1.115$
 $s_c = 1.132$
 $s_\gamma = 0.908$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 208.161 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 31.98 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.00 \text{ m}$

Length of slip surface $l_{sp} = 5.74 \text{ m}$

Design bearing capacity of found.soil $R_d = 208.16 \text{ kPa}$

Extreme contact stress $\sigma = 135.69 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.192 < 0.333$

Max. overall eccentricity $e_t = 0.192 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 5.41$ kNHorizontal bearing capacity $R_{dh} = 188.85$ kNExtreme horizontal force $H = 0.00$ kN**Bearing capacity in the horizontal direction is SATISFACTORY****Bearing capacity of foundation is SATISFACTORY****Verification No. 1****Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kNComputed weight of overburden $Z = 31.98$ kN**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.90 | 0.95 | 0.05 | 27.00 | 18.04 | 65.51 | 0.11 |
| 2 | 0.95 | 1.00 | 0.05 | 27.00 | 19.01 | 63.04 | 0.11 |
| 3 | 1.00 | 1.05 | 0.05 | 27.00 | 19.99 | 58.40 | 0.10 |
| 4 | 1.05 | 1.10 | 0.05 | 27.00 | 20.96 | 53.22 | 0.09 |
| 5 | 1.10 | 1.15 | 0.05 | 27.00 | 21.90 | 48.50 | 0.08 |
| 6 | 1.15 | 1.20 | 0.05 | 27.00 | 22.80 | 44.47 | 0.07 |
| 7 | 1.20 | 1.30 | 0.10 | 27.00 | 24.15 | 39.76 | 0.13 |
| 8 | 1.30 | 1.40 | 0.10 | 2.00 | 25.95 | 34.80 | 1.08 |
| 9 | 1.40 | 1.50 | 0.10 | 2.00 | 27.75 | 31.08 | 0.97 |
| 10 | 1.50 | 1.60 | 0.10 | 2.00 | 29.55 | 28.15 | 0.88 |
| 11 | 1.60 | 1.70 | 0.10 | 2.00 | 31.35 | 25.75 | 0.80 |
| 12 | 1.70 | 1.80 | 0.10 | 2.00 | 33.15 | 23.73 | 0.74 |
| 13 | 1.80 | 2.05 | 0.25 | 2.00 | 36.30 | 20.94 | 1.63 |
| 14 | 2.05 | 2.20 | 0.15 | 2.00 | 39.90 | 18.25 | 0.85 |
| 15 | 2.20 | 2.30 | 0.10 | 2.00 | 42.15 | 16.84 | 0.52 |
| 16 | 2.30 | 2.55 | 0.25 | 2.59 | 45.00 | 15.17 | 1.15 |
| 17 | 2.55 | 2.80 | 0.25 | 2.59 | 48.90 | 13.17 | 0.99 |
| 18 | 2.80 | 3.05 | 0.25 | 2.59 | 52.80 | 11.53 | 0.87 |
| 19 | 3.05 | 3.30 | 0.25 | 2.59 | 56.70 | 10.17 | 0.77 |
| 20 | 3.30 | 3.80 | 0.50 | 2.59 | 62.55 | 8.58 | 1.30 |
| 21 | 3.80 | 4.02 | 0.22 | 2.59 | 68.15 | 7.30 | 0.20 |

Settlement of mid point of edge x - 1 = 14.8 mm

Settlement of mid point of edge x - 2 = 14.8 mm

Settlement of mid point of edge y - 1 = 11.4 mm

Settlement of mid point of edge y - 2 = 11.4 mm

Settlement of foundation center point = 20.6 mm

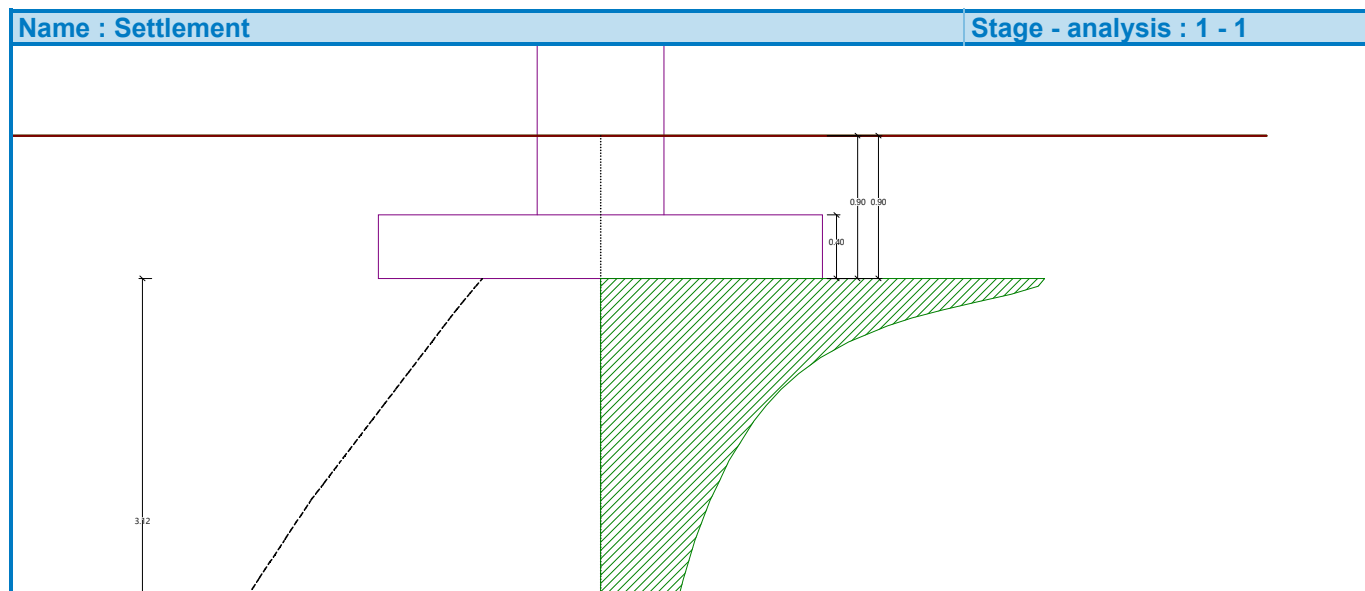
Settlement of characteristic point = 13.4 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{\text{def}} = 9.19 \text{ MPa}$ Foundation in the longitudinal direction is rigid ($k=9.52$)Foundation in the direction of width is rigid ($k=76.16$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 13.4 mm

Depth of influence zone = 3.12 m

Rotation in direction of x = 0.000 (\tan^*1000); ($3.6\text{E-}17^\circ$)Rotation in direction of y = 0.000 (\tan^*1000); ($7.3\text{E-}17^\circ$)

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 11. RADIONICA
 Description : Model 5 - B-11
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.8

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Sandy silt (MS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Sandy silt (MS), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 23.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 32.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.96 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.10 \text{ m}$
 Depth of footing bottom $d = 1.10 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden





Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.80 \text{ m}$
 Spread footing width $y = 1.40 \text{ m}$
 Column width in the direction of x $c_x = 0.80 \text{ m}$
 Column width in the direction of y $c_y = 0.80 \text{ m}$

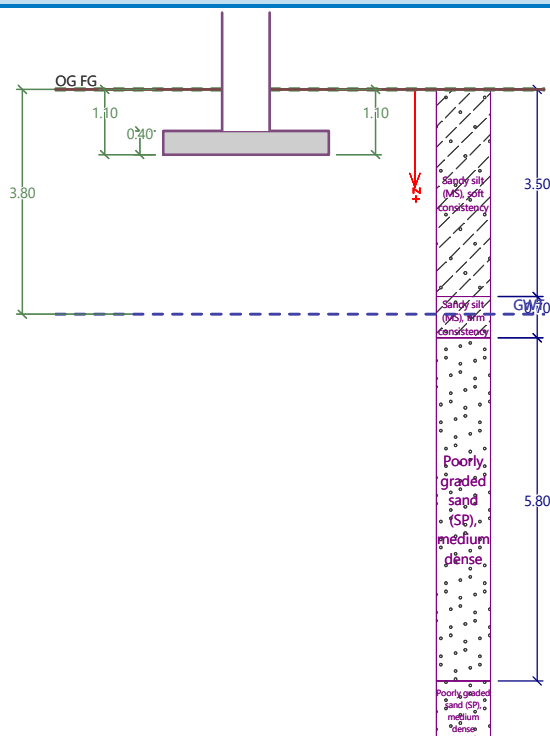
Spread footing volume $= 1.57 \text{ m}^3$
 Volume of excavation $= 4.31 \text{ m}^3$
 Volume of fill $= 2.30 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 3.50 | 0.00 .. 3.50 | Sandy silt (MS), soft consistency |  |
| 2 | 0.70 | 3.50 .. 4.20 | Sandy silt (MS), firm consistency |  |
| 3 | 5.80 | 4.20 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 4 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 332.80 | 0.00 | 26.70 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 332.80 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.07 | 0.00 | 100.86 | 110.64 | 91.16 | Yes |
| ULS | No | -0.07 | 0.00 | 100.86 | 110.64 | 91.16 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 1.429 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.500 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.500 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.400 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.125$
 $s_c = 1.175$
 $s_\gamma = 0.842$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 110.638 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$
 Computed weight of overburden $Z = 42.48 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.50 \text{ m}$

Length of slip surface $l_{sp} = 3.76 \text{ m}$

Design bearing capacity of found.soil $R_d = 110.64 \text{ kPa}$

Extreme contact stress $\sigma = 100.86 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.025 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.025 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.60 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 103.70 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 42.48$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.10 | 1.15 | 0.05 | 0.75 | 20.81 | 74.83 | 3.12 |
| 2 | 1.15 | 1.20 | 0.05 | 0.75 | 21.74 | 71.99 | 3.00 |
| 3 | 1.20 | 1.25 | 0.05 | 0.75 | 22.66 | 66.65 | 2.78 |
| 4 | 1.25 | 1.30 | 0.05 | 0.75 | 23.59 | 60.69 | 2.53 |
| 5 | 1.30 | 1.35 | 0.05 | 0.75 | 24.51 | 55.25 | 2.30 |
| 6 | 1.35 | 1.40 | 0.05 | 0.75 | 25.44 | 50.60 | 2.11 |
| 7 | 1.40 | 1.50 | 0.10 | 0.75 | 26.83 | 45.17 | 3.76 |
| 8 | 1.50 | 1.60 | 0.10 | 0.75 | 28.68 | 39.45 | 3.29 |
| 9 | 1.60 | 1.70 | 0.10 | 0.75 | 30.53 | 35.16 | 2.93 |
| 10 | 1.70 | 1.80 | 0.10 | 0.75 | 32.38 | 31.77 | 2.65 |
| 11 | 1.80 | 1.90 | 0.10 | 0.75 | 34.22 | 29.01 | 2.42 |
| 12 | 1.90 | 2.00 | 0.10 | 0.75 | 36.07 | 26.67 | 2.22 |
| 13 | 2.00 | 2.25 | 0.25 | 0.75 | 39.31 | 23.46 | 4.89 |
| 14 | 2.25 | 2.50 | 0.25 | 0.75 | 43.94 | 19.71 | 4.11 |
| 15 | 2.50 | 2.75 | 0.25 | 0.75 | 48.56 | 16.85 | 3.51 |
| 16 | 2.75 | 3.00 | 0.25 | 0.75 | 53.19 | 14.58 | 3.04 |
| 17 | 3.00 | 3.25 | 0.25 | 0.75 | 57.81 | 12.74 | 2.65 |
| 18 | 3.25 | 3.50 | 0.25 | 0.75 | 62.44 | 11.22 | 2.34 |
| 19 | 3.50 | 3.80 | 0.30 | 2.00 | 67.45 | 9.89 | 0.92 |
| 20 | 3.80 | 4.00 | 0.20 | 2.00 | 70.95 | 8.81 | 0.55 |
| 21 | 4.00 | 4.20 | 0.20 | 2.00 | 72.55 | 8.07 | 0.50 |
| 22 | 4.20 | 4.31 | 0.11 | 2.32 | 73.67 | 7.58 | 0.11 |

Settlement of mid point of edge x - 1 = 52.5 mm

Settlement of mid point of edge x - 2 = 52.5 mm

Settlement of mid point of edge y - 1 = 43.4 mm

Settlement of mid point of edge y - 2 = 43.4 mm

Settlement of foundation center point = 78.7 mm

Settlement of characteristic point = 55.7 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 0.89$ MPa

Foundation in the longitudinal direction is rigid ($k=98.76$)

Foundation in the direction of width is rigid ($k=790.05$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

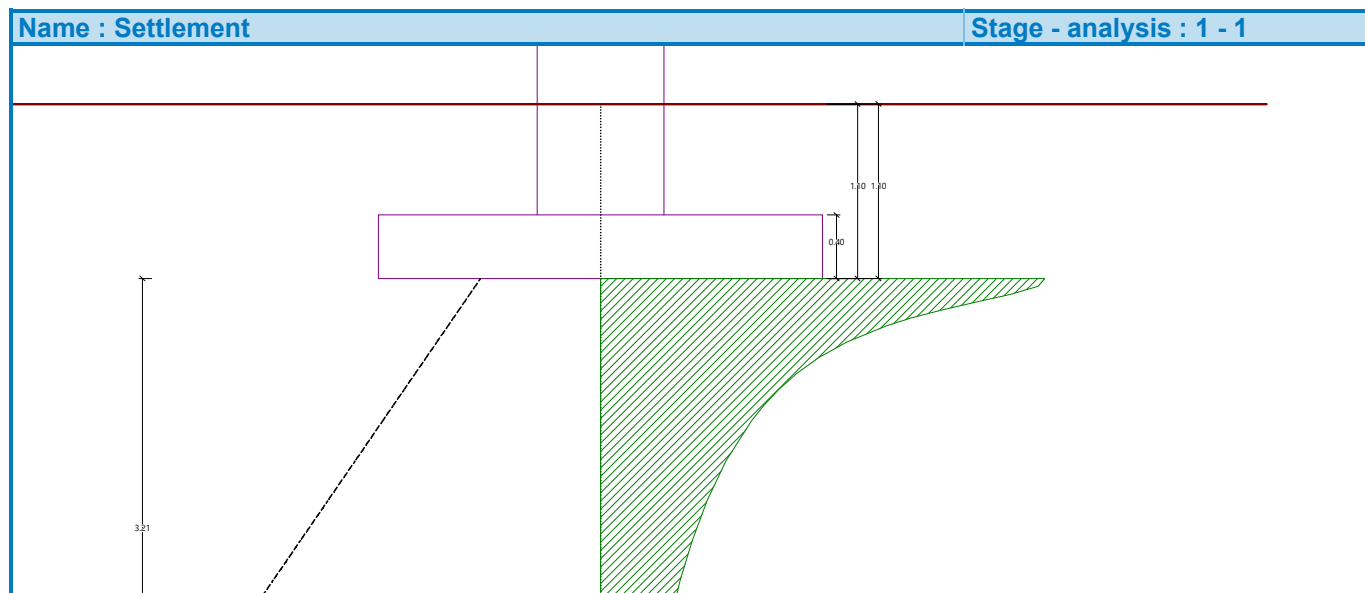
Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 55.7 mm

Depth of influence zone = 3.21 m

Rotation in direction of x = 0.000 (tan*1000); (2.9E-16 °)

Rotation in direction of y = 0.000 (tan*1000); (2.9E-16 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 11. RADIONICA
 Description : Model 5 - B-11 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.8.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Sandy silt (MS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Sandy silt (MS), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 23.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 32.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.96 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.10 \text{ m}$
 Depth of footing bottom $d = 1.10 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.80 \text{ m}$
 Spread footing width $y = 1.40 \text{ m}$
 Column width in the direction of x $c_x = 0.80 \text{ m}$
 Column width in the direction of y $c_y = 0.80 \text{ m}$
 Spread footing volume $= 1.57 \text{ m}^3$
 Volume of excavation $= 4.31 \text{ m}^3$
 Volume of fill $= 2.30 \text{ m}^3$



Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

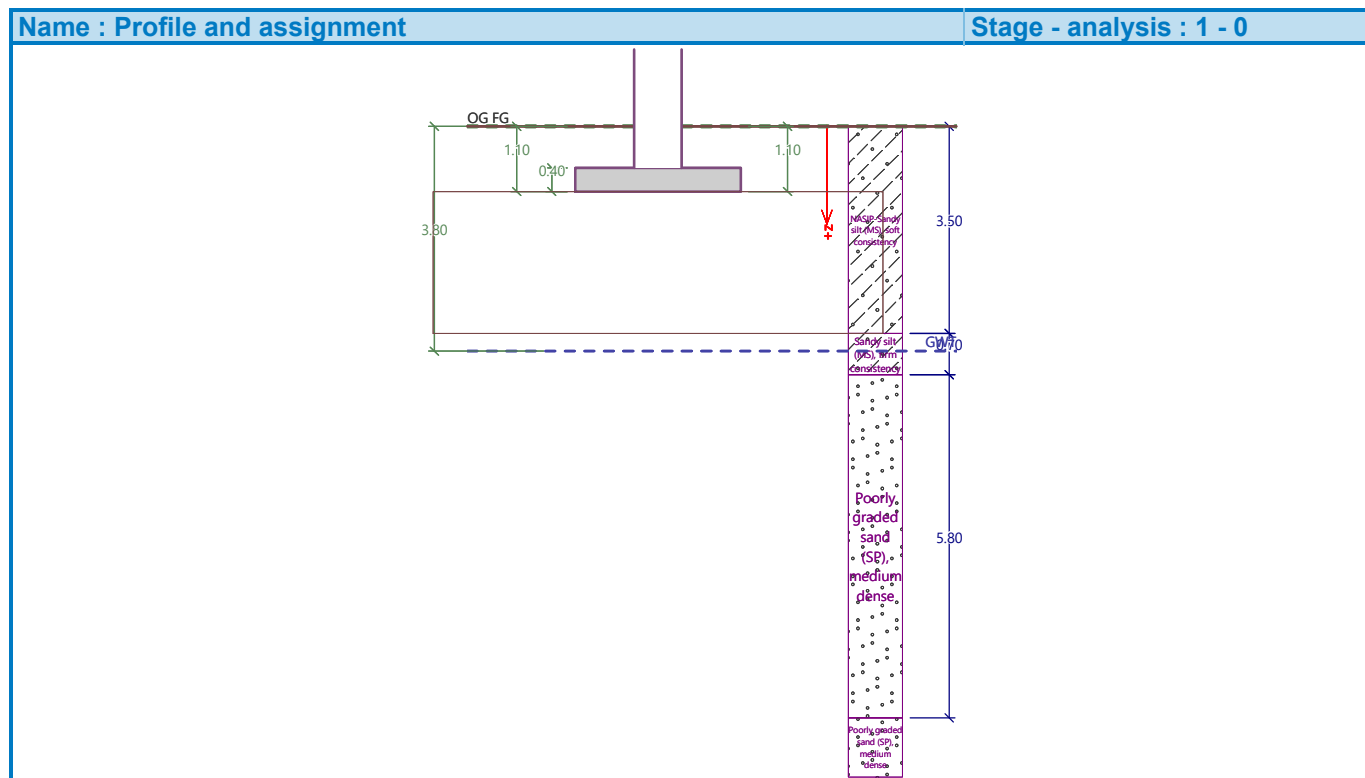
SG pad overhangs foundation $d_{\text{sp}} = 2.40 \text{ m}$

Sand-gravel pad depth $h_{\text{sp}} = 2.40 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 3.50 | 0.00 .. 3.50 | NASIP-Sandy silt (MS), soft consistency |  |
| 2 | 0.70 | 3.50 .. 4.20 | Sandy silt (MS), firm consistency |  |

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---------|
| 3 | 5.80 | 4.20 .. 10.00 | Poorly graded sand (SP), medium dense | |
| 4 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense | |



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|-----------|-------------------------|-------------------------|------------------------|------------------------|
| 1 | Yes | | ULS | Design | 332.80 | 0.00 | 26.70 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 332.80 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | -0.07 | 0.00 | 100.86 | 309.58 | 32.58 | Yes |

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | No | -0.07 | 0.00 | 100.86 | 309.58 | 32.58 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 23.192^\circ$
 $c_d = 0.542 \text{ kPa}$
 $\gamma_{1prum} = 18.500 \text{ kN/m}^3$
 $\gamma_{2prum} = 20.297 \text{ kN/m}^3$
 $b_{ef} = 1.400 \text{ m}$
 $N_q = 8.834$
 $N_c = 18.284$
 $N_\gamma = 6.712$
 $s_q = 1.207$
 $s_c = 1.234$
 $s_\gamma = 0.842$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 309.581 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 42.48 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.09 \text{ m}$

Length of slip surface $l_{sp} = 6.13 \text{ m}$

Design bearing capacity of found.soil $R_d = 309.58 \text{ kPa}$

Extreme contact stress $\sigma = 100.86 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.025 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.025 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.60 \text{ kN}$ Horizontal bearing capacity $R_{dh} = 216.81 \text{ kN}$ Extreme horizontal force $H = 0.00 \text{ kN}$ **Bearing capacity in the horizontal direction is SATISFACTORY****Bearing capacity of foundation is SATISFACTORY****Verification No. 1****Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00 \text{ kN}$ Computed weight of overburden $Z = 42.48 \text{ kN}$ **Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.10 | 1.15 | 0.05 | 45.00 | 20.81 | 74.83 | 0.07 |
| 2 | 1.15 | 1.20 | 0.05 | 45.00 | 21.74 | 71.99 | 0.07 |
| 3 | 1.20 | 1.25 | 0.05 | 45.00 | 22.66 | 66.65 | 0.07 |
| 4 | 1.25 | 1.30 | 0.05 | 45.00 | 23.59 | 60.69 | 0.06 |
| 5 | 1.30 | 1.35 | 0.05 | 45.00 | 24.51 | 55.25 | 0.06 |
| 6 | 1.35 | 1.40 | 0.05 | 45.00 | 25.44 | 50.60 | 0.05 |
| 7 | 1.40 | 1.50 | 0.10 | 45.00 | 26.83 | 45.17 | 0.09 |
| 8 | 1.50 | 1.60 | 0.10 | 45.00 | 28.68 | 39.45 | 0.08 |
| 9 | 1.60 | 1.70 | 0.10 | 45.00 | 30.53 | 35.16 | 0.07 |
| 10 | 1.70 | 1.80 | 0.10 | 45.00 | 32.38 | 31.77 | 0.06 |
| 11 | 1.80 | 1.90 | 0.10 | 45.00 | 34.22 | 29.01 | 0.06 |
| 12 | 1.90 | 2.00 | 0.10 | 45.00 | 36.07 | 26.67 | 0.05 |
| 13 | 2.00 | 2.25 | 0.25 | 45.00 | 39.31 | 23.46 | 0.12 |
| 14 | 2.25 | 2.50 | 0.25 | 45.00 | 43.94 | 19.71 | 0.10 |
| 15 | 2.50 | 2.75 | 0.25 | 45.00 | 48.56 | 16.85 | 0.08 |
| 16 | 2.75 | 3.00 | 0.25 | 45.00 | 53.19 | 14.58 | 0.07 |
| 17 | 3.00 | 3.25 | 0.25 | 45.00 | 57.81 | 12.74 | 0.06 |
| 18 | 3.25 | 3.50 | 0.25 | 45.00 | 62.44 | 11.22 | 0.06 |
| 19 | 3.50 | 3.80 | 0.30 | 2.00 | 67.45 | 9.89 | 0.92 |
| 20 | 3.80 | 4.00 | 0.20 | 2.00 | 70.95 | 8.81 | 0.55 |
| 21 | 4.00 | 4.20 | 0.20 | 2.00 | 72.55 | 8.07 | 0.50 |
| 22 | 4.20 | 4.31 | 0.11 | 2.32 | 73.67 | 7.58 | 0.11 |

Settlement of mid point of edge x - 1 = 4.2 mm

Settlement of mid point of edge x - 2 = 4.2 mm

Settlement of mid point of edge y - 1 = 2.7 mm

Settlement of mid point of edge y - 2 = 2.7 mm

Settlement of foundation center point = 5.4 mm

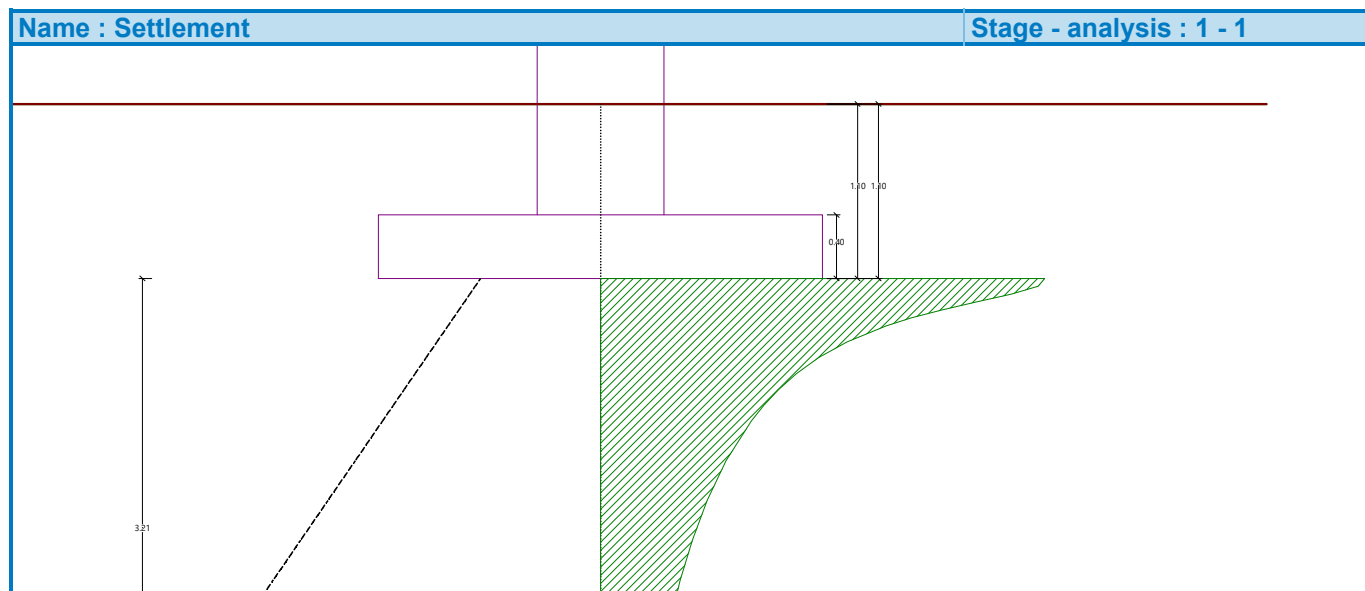
Settlement of characteristic point = 3.4 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{\text{def}} = 40.26 \text{ MPa}$ Foundation in the longitudinal direction is rigid ($k=2.17$)Foundation in the direction of width is rigid ($k=17.38$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 3.4 mm

Depth of influence zone = 3.21 m

Rotation in direction of x = 0.000 (\tan^*1000); (0.0E+00 °)Rotation in direction of y = 0.000 (\tan^*1000); (0.0E+00 °)

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 11. RADIONICA
 Description : Model 5 - B-8
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.8.2

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Sandy silt (MS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Sandy silt (MS), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 23.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 32.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.96 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.10 \text{ m}$
 Depth of footing bottom $d = 1.10 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden





Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.80 \text{ m}$
 Spread footing width $y = 1.40 \text{ m}$
 Column width in the direction of x $c_x = 0.80 \text{ m}$
 Column width in the direction of y $c_y = 0.80 \text{ m}$

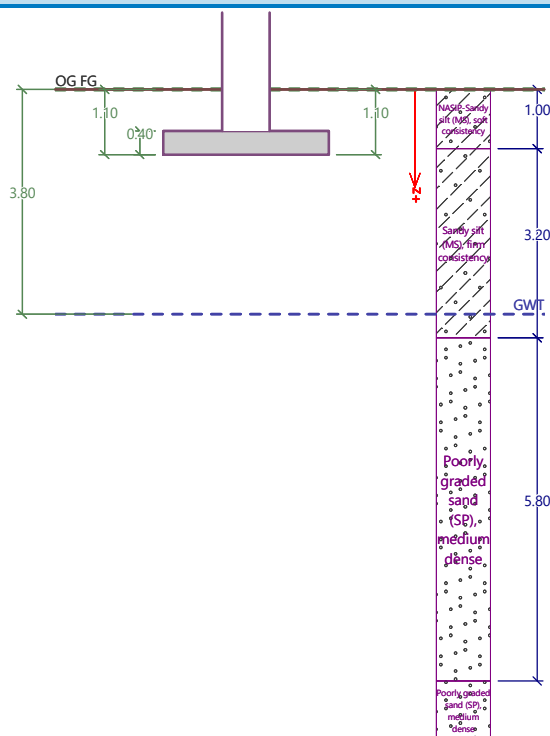
Spread footing volume $= 1.57 \text{ m}^3$
 Volume of excavation $= 4.31 \text{ m}^3$
 Volume of fill $= 2.30 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 1.00 | 0.00 .. 1.00 | NASIP-Sandy silt (MS), soft consistency |  |
| 2 | 3.20 | 1.00 .. 4.20 | Sandy silt (MS), firm consistency |  |
| 3 | 5.80 | 4.20 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 4 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 332.80 | 0.00 | 26.70 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 332.80 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.07 | 0.00 | 100.83 | 191.60 | 52.63 | Yes |
| ULS | No | -0.07 | 0.00 | 100.83 | 191.60 | 52.63 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 18.756^\circ \\ c_d &= 1.429 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.455 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.400 \text{ m}\end{aligned}$$

$N_q = 5.661$
 $N_c = 13.725$
 $N_\gamma = 3.165$
 $s_q = 1.169$
 $s_c = 1.206$
 $s_\gamma = 0.842$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 191.601 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 42.37 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.77 \text{ m}$

Length of slip surface $l_{sp} = 4.82 \text{ m}$

Design bearing capacity of found.soil $R_d = 191.60 \text{ kPa}$

Extreme contact stress $\sigma = 100.83 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.025 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.025 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.33 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 139.04 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 42.37$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.10 | 1.15 | 0.05 | 2.00 | 20.75 | 74.86 | 1.17 |
| 2 | 1.15 | 1.20 | 0.05 | 2.00 | 21.65 | 72.01 | 1.12 |
| 3 | 1.20 | 1.25 | 0.05 | 2.00 | 22.55 | 66.67 | 1.04 |
| 4 | 1.25 | 1.30 | 0.05 | 2.00 | 23.45 | 60.71 | 0.95 |
| 5 | 1.30 | 1.35 | 0.05 | 2.00 | 24.35 | 55.27 | 0.86 |
| 6 | 1.35 | 1.40 | 0.05 | 2.00 | 25.25 | 50.62 | 0.79 |
| 7 | 1.40 | 1.50 | 0.10 | 2.00 | 26.60 | 45.19 | 1.41 |
| 8 | 1.50 | 1.60 | 0.10 | 2.00 | 28.40 | 39.46 | 1.23 |
| 9 | 1.60 | 1.70 | 0.10 | 2.00 | 30.20 | 35.17 | 1.10 |
| 10 | 1.70 | 1.80 | 0.10 | 2.00 | 32.00 | 31.78 | 0.99 |
| 11 | 1.80 | 1.90 | 0.10 | 2.00 | 33.80 | 29.01 | 0.90 |
| 12 | 1.90 | 2.00 | 0.10 | 2.00 | 35.60 | 26.68 | 0.83 |
| 13 | 2.00 | 2.25 | 0.25 | 2.00 | 38.75 | 23.46 | 1.83 |
| 14 | 2.25 | 2.50 | 0.25 | 2.00 | 43.25 | 19.72 | 1.54 |
| 15 | 2.50 | 2.75 | 0.25 | 2.00 | 47.75 | 16.85 | 1.31 |
| 16 | 2.75 | 3.00 | 0.25 | 2.00 | 52.25 | 14.58 | 1.14 |
| 17 | 3.00 | 3.25 | 0.25 | 2.00 | 56.75 | 12.74 | 0.99 |
| 18 | 3.25 | 3.50 | 0.25 | 2.00 | 61.25 | 11.22 | 0.87 |
| 19 | 3.50 | 3.80 | 0.30 | 2.00 | 66.20 | 9.89 | 0.92 |
| 20 | 3.80 | 4.00 | 0.20 | 2.00 | 69.70 | 8.82 | 0.55 |
| 21 | 4.00 | 4.20 | 0.20 | 2.00 | 71.30 | 8.07 | 0.50 |
| 22 | 4.20 | 4.35 | 0.15 | 2.32 | 72.52 | 7.53 | 0.18 |

Settlement of mid point of edge x - 1 = 21.6 mm

Settlement of mid point of edge x - 2 = 21.6 mm

Settlement of mid point of edge y - 1 = 17.4 mm

Settlement of mid point of edge y - 2 = 17.4 mm

Settlement of foundation center point = 31.6 mm

Settlement of characteristic point = 22.2 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 2.01$ MPa

Foundation in the longitudinal direction is rigid ($k=43.55$)

Foundation in the direction of width is rigid ($k=348.43$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

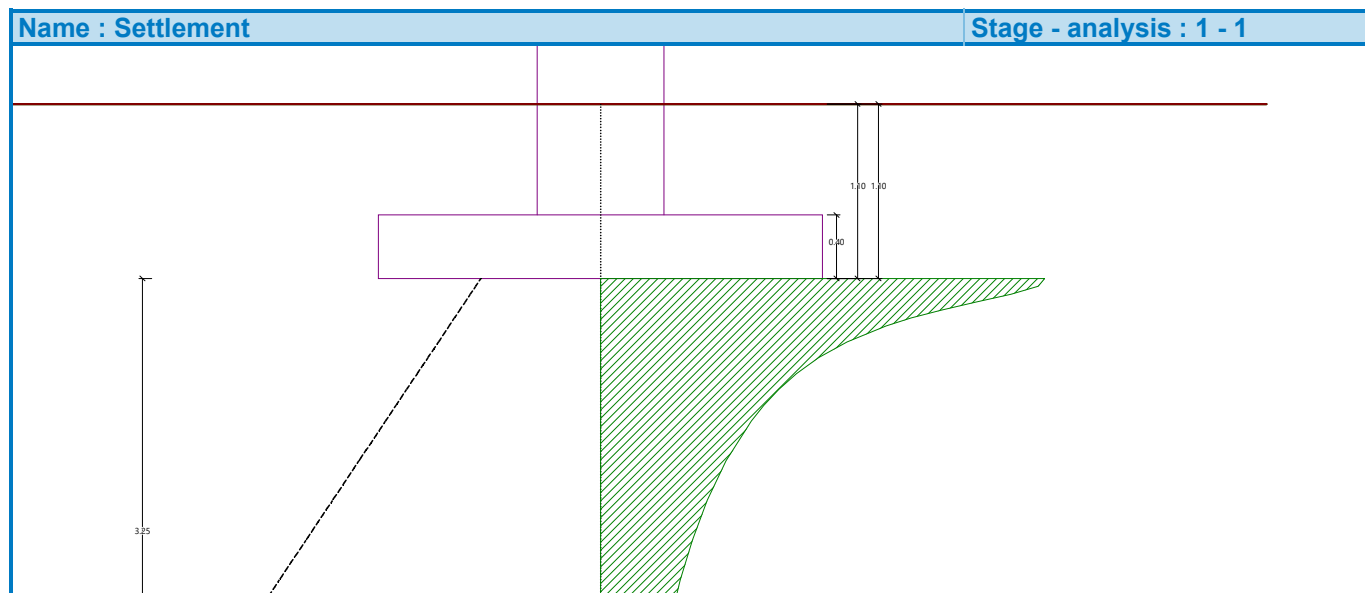
Overall settlement and rotation of foundation:

Foundation settlement = 22.2 mm

Depth of influence zone = 3.25 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 11. RADIONICA
 Description : Model 5 - B-8 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.8.3

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Sandy silt (MS), soft consistency

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Sandy silt (MS), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 23.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 32.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.96 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.10 \text{ m}$
 Depth of footing bottom $d = 1.10 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.80 \text{ m}$
 Spread footing width $y = 1.40 \text{ m}$
 Column width in the direction of x $c_x = 0.80 \text{ m}$
 Column width in the direction of y $c_y = 0.80 \text{ m}$
 Spread footing volume $= 1.57 \text{ m}^3$
 Volume of excavation $= 4.31 \text{ m}^3$
 Volume of fill $= 2.30 \text{ m}^3$



Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

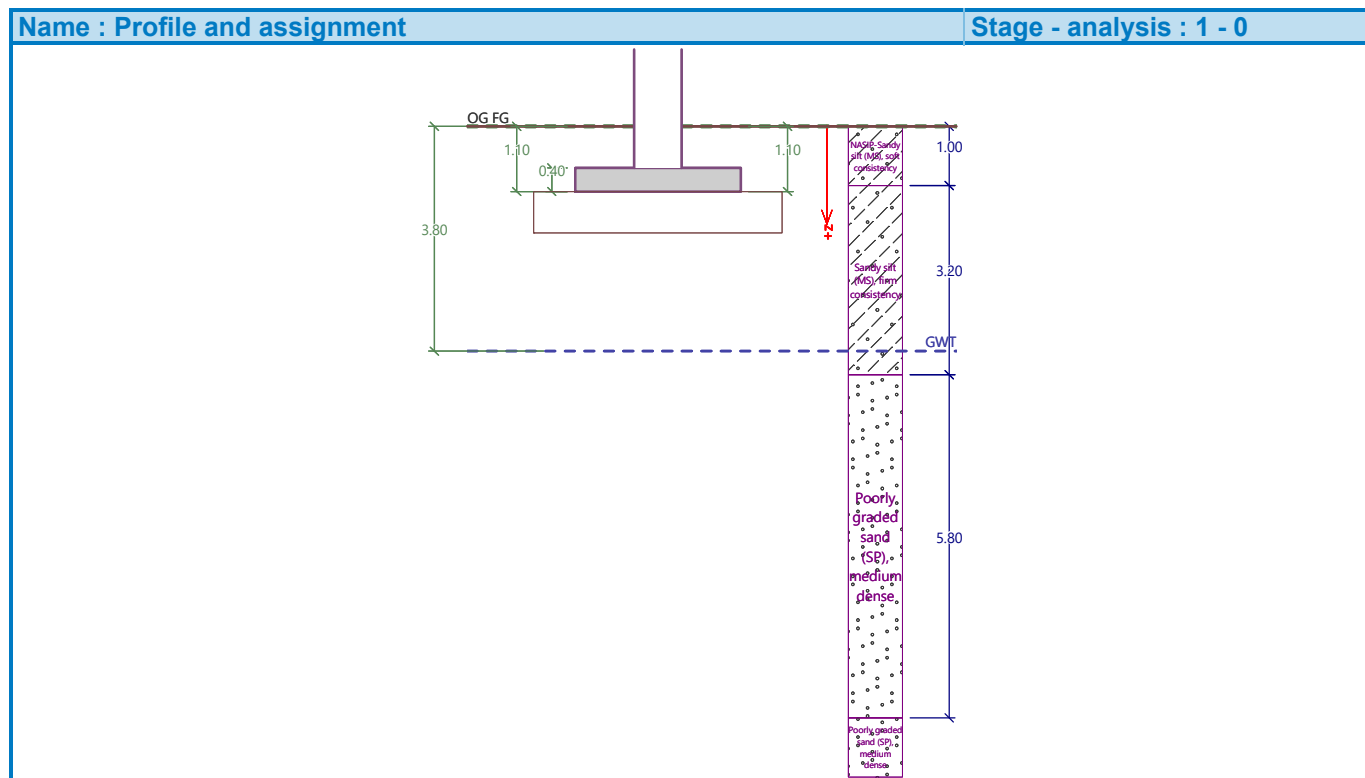
SG pad overhangs foundation $d_{\text{sp}} = 0.70 \text{ m}$

Sand-gravel pad depth $h_{\text{sp}} = 0.70 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 1.00 | 0.00 .. 1.00 | NASIP-Sandy silt (MS), soft consistency |  |
| 2 | 3.20 | 1.00 .. 4.20 | Sandy silt (MS), firm consistency |  |

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---------|
| 3 | 5.80 | 4.20 .. 10.00 | Poorly graded sand (SP), medium dense | |
| 4 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense | |



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|-----------|-------------------------|-------------------------|------------------------|------------------------|
| 1 | Yes | | ULS | Design | 332.80 | 0.00 | 26.70 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 332.80 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | -0.07 | 0.00 | 100.83 | 215.98 | 46.69 | Yes |

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | No | -0.07 | 0.00 | 100.83 | 215.98 | 46.69 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 19.864^\circ$
 $c_d = 1.273 \text{ kPa}$
 $\gamma_{1prum} = 18.455 \text{ kN/m}^3$
 $\gamma_{2prum} = 18.635 \text{ kN/m}^3$
 $b_{ef} = 1.400 \text{ m}$
 $N_q = 6.313$
 $N_c = 14.707$
 $N_\gamma = 3.839$
 $s_q = 1.179$
 $s_c = 1.213$
 $s_\gamma = 0.842$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 215.978 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 42.37 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.85 \text{ m}$

Length of slip surface $l_{sp} = 5.11 \text{ m}$

Design bearing capacity of found.soil $R_d = 215.98 \text{ kPa}$

Extreme contact stress $\sigma = 100.83 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.025 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.025 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.33 \text{ kN}$ Horizontal bearing capacity $R_{dh} = 216.49 \text{ kN}$ Extreme horizontal force $H = 0.00 \text{ kN}$ **Bearing capacity in the horizontal direction is SATISFACTORY****Bearing capacity of foundation is SATISFACTORY****Verification No. 1****Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00 \text{ kN}$ Computed weight of overburden $Z = 42.37 \text{ kN}$ **Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.10 | 1.15 | 0.05 | 45.00 | 20.75 | 74.86 | 0.07 |
| 2 | 1.15 | 1.20 | 0.05 | 45.00 | 21.65 | 72.01 | 0.07 |
| 3 | 1.20 | 1.25 | 0.05 | 45.00 | 22.55 | 66.67 | 0.07 |
| 4 | 1.25 | 1.30 | 0.05 | 45.00 | 23.45 | 60.71 | 0.06 |
| 5 | 1.30 | 1.35 | 0.05 | 45.00 | 24.35 | 55.27 | 0.06 |
| 6 | 1.35 | 1.40 | 0.05 | 45.00 | 25.25 | 50.62 | 0.05 |
| 7 | 1.40 | 1.50 | 0.10 | 45.00 | 26.60 | 45.19 | 0.09 |
| 8 | 1.50 | 1.60 | 0.10 | 45.00 | 28.40 | 39.46 | 0.08 |
| 9 | 1.60 | 1.70 | 0.10 | 45.00 | 30.20 | 35.17 | 0.07 |
| 10 | 1.70 | 1.80 | 0.10 | 45.00 | 32.00 | 31.78 | 0.06 |
| 11 | 1.80 | 1.90 | 0.10 | 2.00 | 33.80 | 29.01 | 0.90 |
| 12 | 1.90 | 2.00 | 0.10 | 2.00 | 35.60 | 26.68 | 0.83 |
| 13 | 2.00 | 2.25 | 0.25 | 2.00 | 38.75 | 23.46 | 1.83 |
| 14 | 2.25 | 2.50 | 0.25 | 2.00 | 43.25 | 19.72 | 1.54 |
| 15 | 2.50 | 2.75 | 0.25 | 2.00 | 47.75 | 16.85 | 1.31 |
| 16 | 2.75 | 2.90 | 0.15 | 2.00 | 51.35 | 14.99 | 0.70 |
| 17 | 2.90 | 3.00 | 0.10 | 2.00 | 53.60 | 13.97 | 0.44 |
| 18 | 3.00 | 3.25 | 0.25 | 2.00 | 56.75 | 12.74 | 0.99 |
| 19 | 3.25 | 3.50 | 0.25 | 2.00 | 61.25 | 11.22 | 0.87 |
| 20 | 3.50 | 3.80 | 0.30 | 2.00 | 66.20 | 9.89 | 0.92 |
| 21 | 3.80 | 4.00 | 0.20 | 2.00 | 69.70 | 8.82 | 0.55 |
| 22 | 4.00 | 4.20 | 0.20 | 2.00 | 71.30 | 8.07 | 0.50 |
| 23 | 4.20 | 4.35 | 0.15 | 2.32 | 72.52 | 7.53 | 0.18 |

Settlement of mid point of edge x - 1 = 14.2 mm

Settlement of mid point of edge x - 2 = 14.2 mm

Settlement of mid point of edge y - 1 = 10.6 mm

Settlement of mid point of edge y - 2 = 10.6 mm

Settlement of foundation center point = 18.2 mm

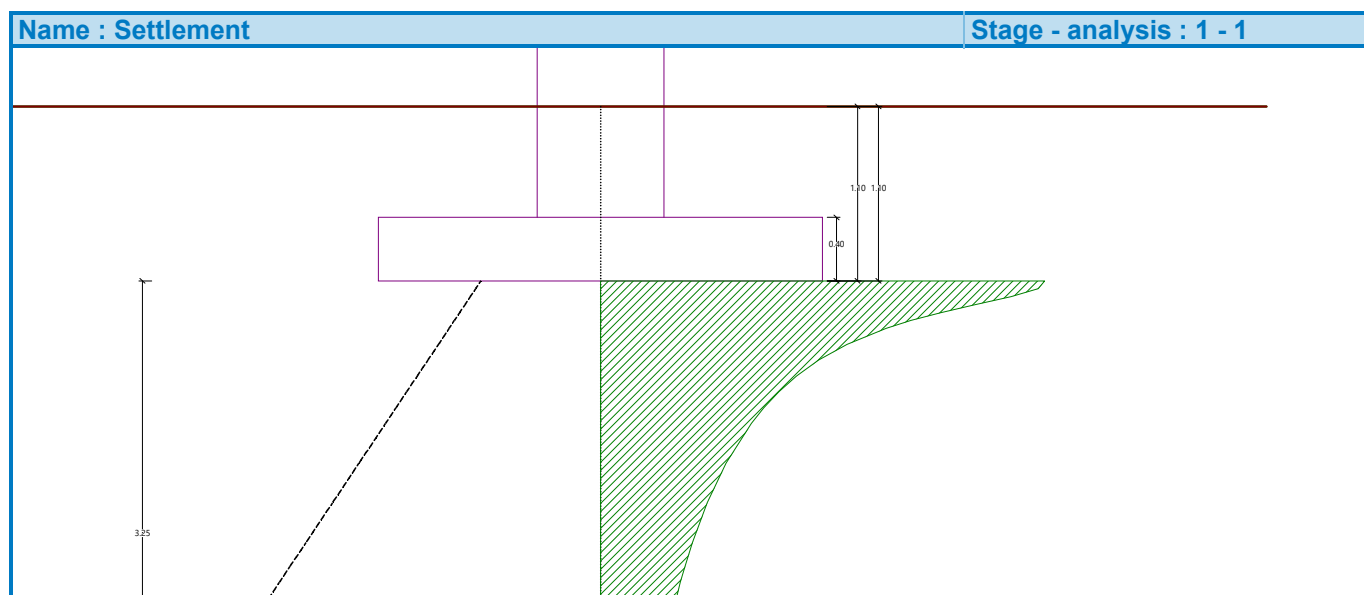
Settlement of characteristic point = 12.3 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{\text{def}} = 21.57 \text{ MPa}$ Foundation in the longitudinal direction is rigid ($k=4.06$)Foundation in the direction of width is rigid ($k=32.45$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 12.3 mm

Depth of influence zone = 3.25 m

Rotation in direction of x = 0.000 (\tan^*1000); (0.0E+00 °)Rotation in direction of y = 0.000 (\tan^*1000); (0.0E+00 °)

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 12. NADSTREŠNICA SA PERIONICOM KOMUNALNIH VOZILA
 Description : Model 6 - B-12
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.9

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 23.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.26 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden





Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.60 \text{ m}$
 Spread footing width $y = 1.00 \text{ m}$
 Column width in the direction of x $c_x = 0.40 \text{ m}$
 Column width in the direction of y $c_y = 0.40 \text{ m}$

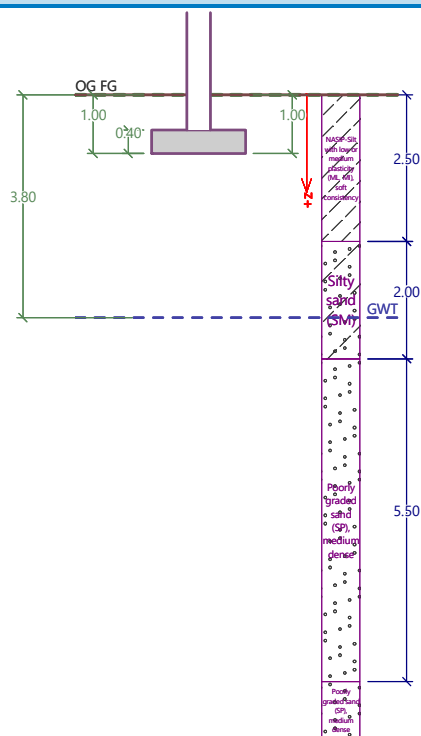
Spread footing volume = 0.64 m^3
 Volume of excavation = 1.60 m^3
 Volume of fill = 0.86 m^3

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 2.50 | 0.00 .. 2.50 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 2.00 | 2.50 .. 4.50 | Silty sand (SM) |  |
| 3 | 5.50 | 4.50 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 4 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 104.80 | 30.20 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 104.80 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | -0.25 | 151.00 | 88.75 | 170.15 | No |
| ULS | No | 0.00 | -0.25 | 151.00 | 88.75 | 170.15 | No |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 1.429 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.498 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.074$
 $s_c = 1.104$
 $s_\gamma = 0.907$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 88.749 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 15.55 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.07 \text{ m}$

Length of slip surface $l_{sp} = 2.68 \text{ m}$

Design bearing capacity of found.soil $R_d = 88.75 \text{ kPa}$

Extreme contact stress $\sigma = 151.00 \text{ kPa}$

Bearing capacity in the vertical direction is NOT SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.251 < 0.333$

Max. overall eccentricity $e_t = 0.251 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 4.08 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 34.65 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is NOT SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kNComputed weight of overburden $Z = 15.55$ kN**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 56.14 | 2.34 |
| 2 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 51.65 | 2.15 |
| 3 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 44.83 | 1.87 |
| 4 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 38.74 | 1.61 |
| 5 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 34.04 | 1.42 |
| 6 | 1.25 | 1.30 | 0.05 | 0.56 | 22.95 | 30.48 | 1.27 |
| 7 | 1.30 | 1.40 | 0.10 | 0.56 | 24.30 | 26.68 | 2.22 |
| 8 | 1.40 | 1.50 | 0.10 | 0.56 | 26.10 | 22.82 | 1.90 |
| 9 | 1.50 | 1.60 | 0.10 | 0.56 | 27.90 | 19.95 | 1.66 |
| 10 | 1.60 | 1.70 | 0.10 | 0.56 | 29.70 | 17.67 | 1.47 |
| 11 | 1.70 | 1.80 | 0.10 | 0.56 | 31.50 | 15.78 | 1.32 |
| 12 | 1.80 | 1.90 | 0.10 | 0.56 | 33.30 | 14.19 | 1.18 |
| 13 | 1.90 | 2.15 | 0.25 | 0.56 | 36.45 | 12.03 | 2.51 |
| 14 | 2.15 | 2.40 | 0.25 | 0.56 | 40.95 | 9.58 | 2.00 |
| 15 | 2.40 | 2.50 | 0.10 | 0.56 | 44.10 | 8.25 | 0.69 |
| 16 | 2.50 | 2.65 | 0.15 | 2.38 | 46.35 | 7.50 | 0.35 |
| 17 | 2.65 | 2.90 | 0.25 | 2.38 | 49.95 | 6.46 | 0.50 |
| 18 | 2.90 | 3.02 | 0.12 | 2.38 | 53.32 | 5.67 | 0.10 |

Settlement of mid point of edge x - 1 = 24.3 mm

Settlement of mid point of edge x - 2 = 24.3 mm

Settlement of mid point of edge y - 1 = 21.4 mm

Settlement of mid point of edge y - 2 = 21.4 mm

Settlement of foundation center point = 37.7 mm

Settlement of characteristic point = 26.6 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 0.75$ MPaFoundation in the longitudinal direction is rigid ($k=628.33$)Foundation in the direction of width is rigid ($k=2573.64$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 26.6 mm

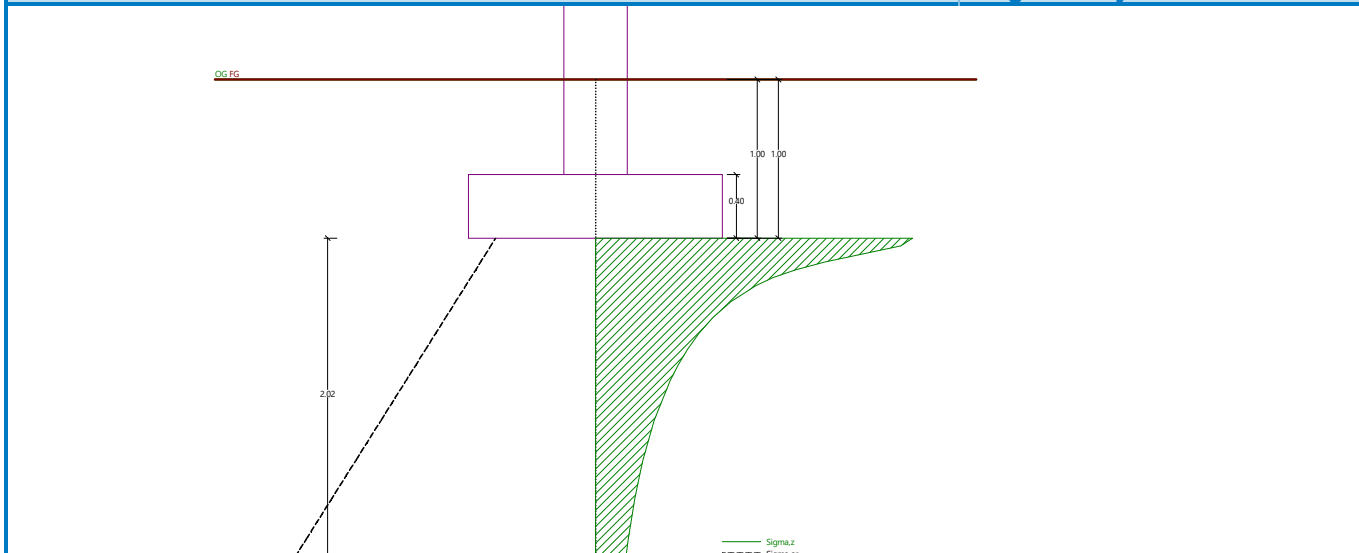
Depth of influence zone = 2.02 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 12. NADSTREŠNICA SA PERIONICOM KOMUNALNIH VOZILA
 Description : Model 6 - B-12 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.9.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 23.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.21 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 3.26 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.60 \text{ m}$
 Spread footing width $y = 1.00 \text{ m}$
 Column width in the direction of x $c_x = 0.40 \text{ m}$
 Column width in the direction of y $c_y = 0.40 \text{ m}$
 Spread footing volume $= 0.64 \text{ m}^3$
 Volume of excavation $= 1.60 \text{ m}^3$
 Volume of fill $= 0.86 \text{ m}^3$



Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

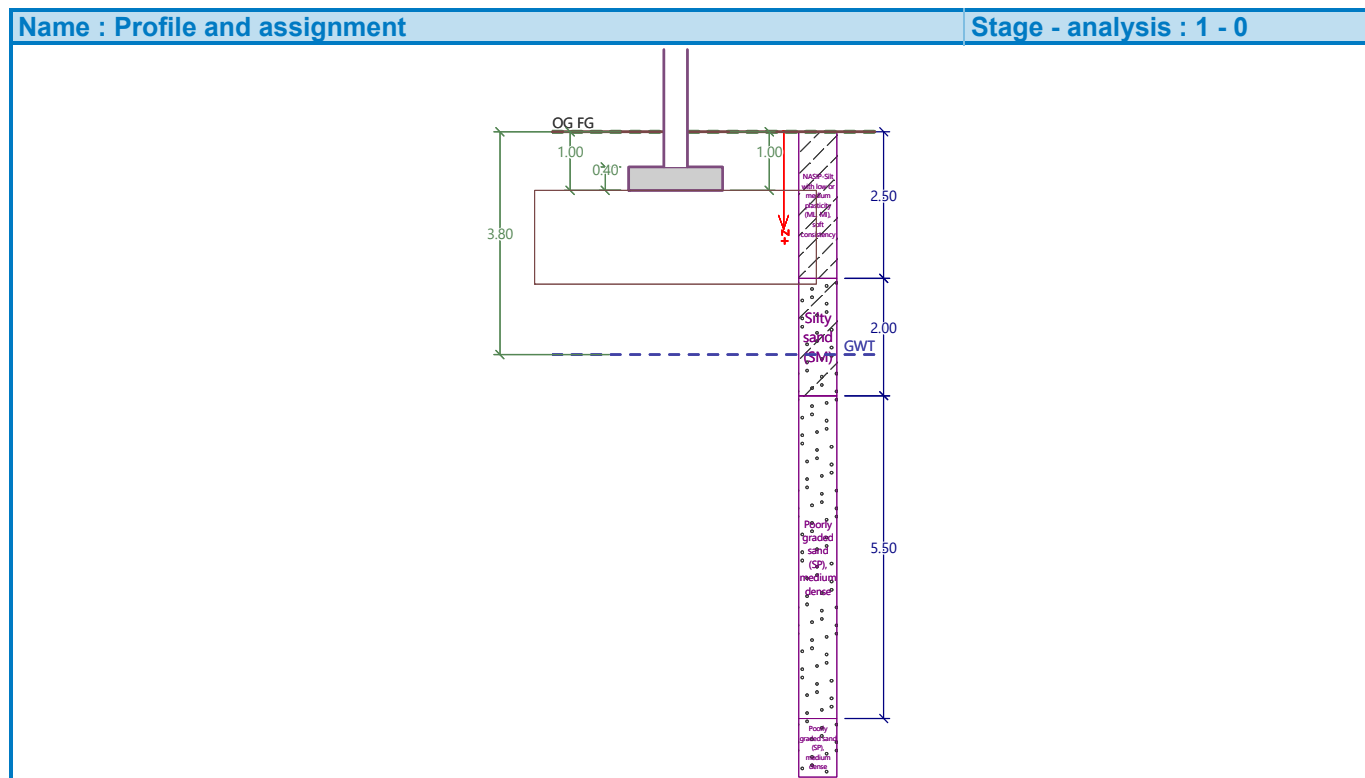
SG pad overhangs foundation $d_{\text{sp}} = 1.60 \text{ m}$

Sand-gravel pad depth $h_{\text{sp}} = 1.60 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 2.50 | 0.00 .. 2.50 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 2.00 | 2.50 .. 4.50 | Silty sand (SM) |  |

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---------|
| 3 | 5.50 | 4.50 .. 10.00 | Poorly graded sand (SP), medium dense | |
| 4 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense | |



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|----------------|------|---------|-----------|-------------------------|-------------------------|------------------------|------------------------|
| 1 | Yes | | ULS | Design | 104.80 | 30.20 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 104.80 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | -0.25 | 151.00 | 215.11 | 70.20 | Yes |

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | No | 0.00 | -0.25 | 151.00 | 215.11 | 70.20 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 22.970^\circ$
 $c_d = 0.562 \text{ kPa}$
 $\gamma_{1prum} = 18.000 \text{ kN/m}^3$
 $\gamma_{2prum} = 20.037 \text{ kN/m}^3$
 $b_{ef} = 0.498 \text{ m}$
 $N_q = 8.635$
 $N_c = 18.012$
 $N_\gamma = 6.472$
 $s_q = 1.121$
 $s_c = 1.137$
 $s_\gamma = 0.907$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 215.109 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 15.55 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.48 \text{ m}$

Length of slip surface $l_{sp} = 4.32 \text{ m}$

Design bearing capacity of found.soil $R_d = 215.11 \text{ kPa}$

Extreme contact stress $\sigma = 151.00 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.251 < 0.333$

Max. overall eccentricity $e_t = 0.251 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 4.08 \text{ kN}$ Horizontal bearing capacity $R_{dh} = 71.49 \text{ kN}$ Extreme horizontal force $H = 0.00 \text{ kN}$ **Bearing capacity in the horizontal direction is SATISFACTORY****Bearing capacity of foundation is SATISFACTORY****Verification No. 1****Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00 \text{ kN}$ Computed weight of overburden $Z = 15.55 \text{ kN}$ **Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 45.00 | 18.45 | 56.14 | 0.06 |
| 2 | 1.05 | 1.10 | 0.05 | 45.00 | 19.35 | 51.65 | 0.05 |
| 3 | 1.10 | 1.15 | 0.05 | 45.00 | 20.25 | 44.83 | 0.04 |
| 4 | 1.15 | 1.20 | 0.05 | 45.00 | 21.15 | 38.74 | 0.04 |
| 5 | 1.20 | 1.25 | 0.05 | 45.00 | 22.05 | 34.04 | 0.03 |
| 6 | 1.25 | 1.30 | 0.05 | 45.00 | 22.95 | 30.48 | 0.03 |
| 7 | 1.30 | 1.40 | 0.10 | 45.00 | 24.30 | 26.68 | 0.05 |
| 8 | 1.40 | 1.50 | 0.10 | 45.00 | 26.10 | 22.82 | 0.05 |
| 9 | 1.50 | 1.60 | 0.10 | 45.00 | 27.90 | 19.95 | 0.04 |
| 10 | 1.60 | 1.70 | 0.10 | 45.00 | 29.70 | 17.67 | 0.04 |
| 11 | 1.70 | 1.80 | 0.10 | 45.00 | 31.50 | 15.78 | 0.03 |
| 12 | 1.80 | 1.90 | 0.10 | 45.00 | 33.30 | 14.19 | 0.03 |
| 13 | 1.90 | 2.15 | 0.25 | 45.00 | 36.45 | 12.03 | 0.06 |
| 14 | 2.15 | 2.40 | 0.25 | 45.00 | 40.95 | 9.58 | 0.05 |
| 15 | 2.40 | 2.50 | 0.10 | 45.00 | 44.10 | 8.25 | 0.02 |
| 16 | 2.50 | 2.65 | 0.15 | 45.00 | 46.35 | 7.50 | 0.02 |
| 17 | 2.65 | 2.90 | 0.25 | 2.38 | 49.95 | 6.46 | 0.50 |
| 18 | 2.90 | 3.02 | 0.12 | 2.38 | 53.32 | 5.67 | 0.10 |

Settlement of mid point of edge x - 1 = 1.4 mm

Settlement of mid point of edge x - 2 = 1.4 mm

Settlement of mid point of edge y - 1 = 1.0 mm

Settlement of mid point of edge y - 2 = 1.0 mm

Settlement of foundation center point = 2.0 mm

Settlement of characteristic point = 1.2 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 41.88 \text{ MPa}$

Foundation in the longitudinal direction is rigid ($k=11.19$)

Foundation in the direction of width is rigid ($k=45.84$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

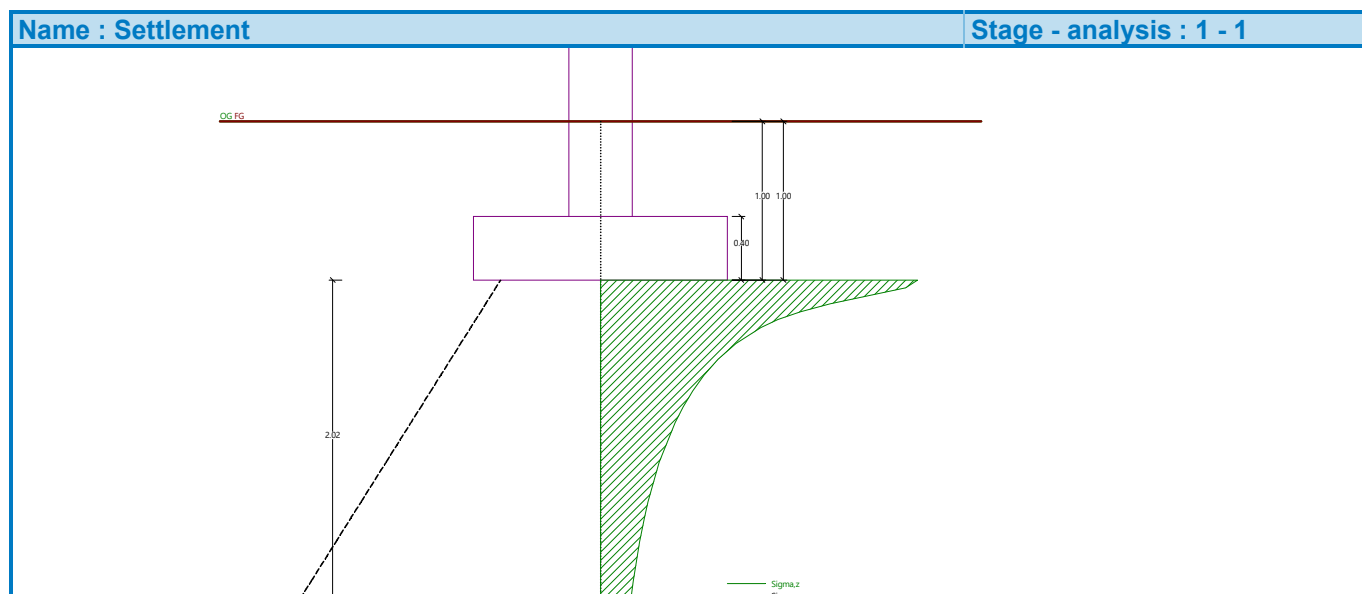
Overall settlement and rotation of foundation:

Foundation settlement = 1.2 mm

Depth of influence zone = 2.02 m

Rotation in direction of x = 0.000 (\tan^*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (\tan^*1000); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - prva dilatacija
 Description : Model 7 - B-13
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.10

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Sand with trace of fines (S-F), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

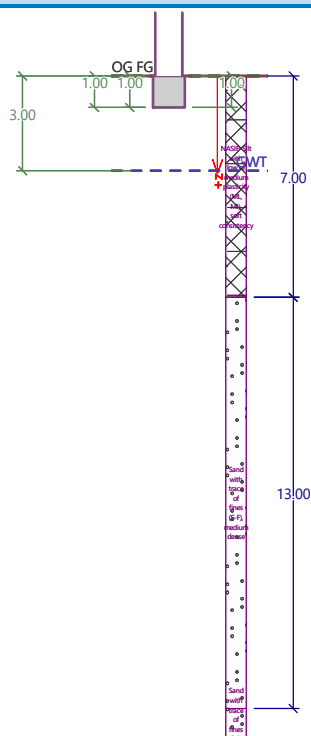
Volume of strip footing $= 1.00 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.00 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 7.00 | 0.00 .. 7.00 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 13.00 | 7.00 .. 20.00 | Sand with trace of fines (S-F), medium dense |  |
| 3 | - | 20.00 .. ∞ | Sand with trace of fines (S-F), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 65.50 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 65.50 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 91.92 | 71.26 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 91.92 | 71.26 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 1.429 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.000 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.048$
 $s_c = 1.067$
 $s_\gamma = 0.940$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 91.917 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.07 \text{ m}$

Length of slip surface $l_{sp} = 2.68 \text{ m}$

Design bearing capacity of found.soil $R_d = 91.92 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 23.82 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 0.00$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 46.28 | 1.93 |
| 2 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 42.36 | 1.76 |
| 3 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 37.56 | 1.56 |
| 4 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 33.90 | 1.41 |
| 5 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 31.13 | 1.30 |
| 6 | 1.25 | 1.30 | 0.05 | 0.56 | 22.95 | 28.86 | 1.20 |
| 7 | 1.30 | 1.40 | 0.10 | 0.56 | 24.30 | 26.09 | 2.17 |
| 8 | 1.40 | 1.50 | 0.10 | 0.56 | 26.10 | 22.97 | 1.91 |
| 9 | 1.50 | 1.60 | 0.10 | 0.56 | 27.90 | 20.45 | 1.70 |
| 10 | 1.60 | 1.70 | 0.10 | 0.56 | 29.70 | 18.37 | 1.53 |
| 11 | 1.70 | 1.80 | 0.10 | 0.56 | 31.50 | 16.64 | 1.39 |
| 12 | 1.80 | 1.90 | 0.10 | 0.56 | 33.30 | 15.19 | 1.27 |
| 13 | 1.90 | 2.15 | 0.25 | 0.56 | 36.45 | 13.26 | 2.76 |
| 14 | 2.15 | 2.40 | 0.25 | 0.56 | 40.95 | 11.07 | 2.31 |
| 15 | 2.40 | 2.65 | 0.25 | 0.56 | 45.45 | 9.47 | 1.97 |
| 16 | 2.65 | 2.90 | 0.25 | 0.56 | 49.95 | 8.25 | 1.72 |
| 17 | 2.90 | 3.00 | 0.10 | 0.56 | 53.10 | 7.54 | 0.63 |
| 18 | 3.00 | 3.15 | 0.15 | 0.56 | 54.60 | 7.11 | 0.89 |
| 19 | 3.15 | 3.40 | 0.25 | 0.56 | 56.20 | 6.49 | 1.35 |
| 20 | 3.40 | 3.54 | 0.14 | 0.56 | 57.75 | 5.98 | 0.18 |

Settlement of mid point of longitudinal edge = 19.5 mm

Settlement of mid point of transverse edge 1 = 32.8 mm

Settlement of mid point of transverse edge 2 = 32.8 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 0.56$ MPaFoundation in the longitudinal direction is rigid ($k=53571.43$)Foundation in the direction of width is rigid ($k=53571.43$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

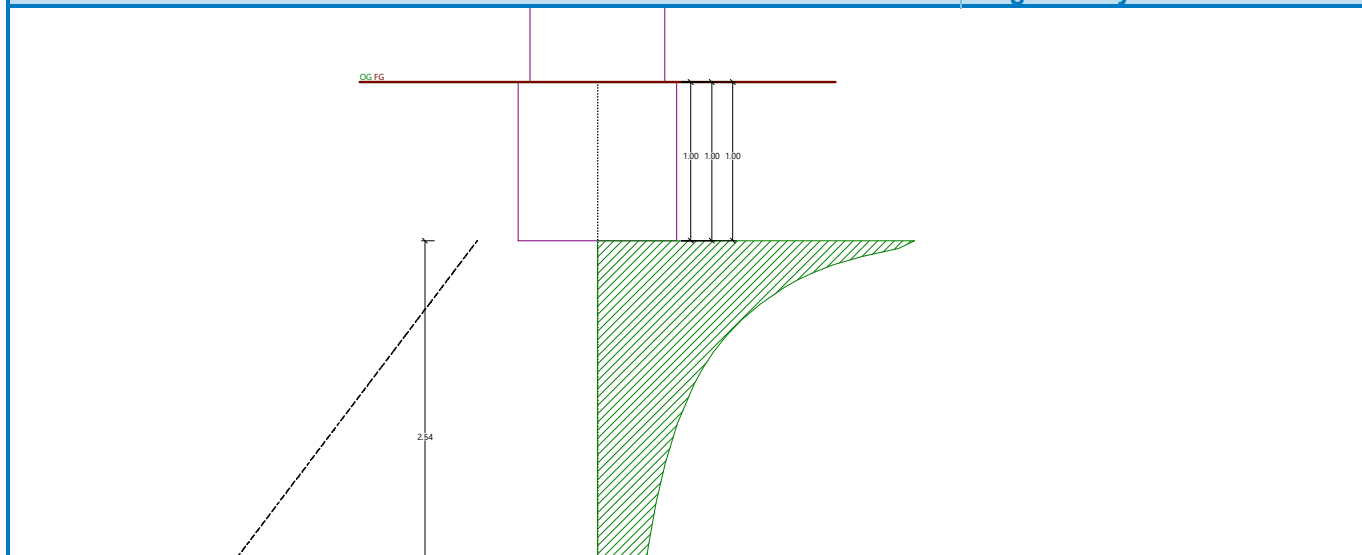
Foundation settlement = 31.0 mm

Depth of influence zone = 2.54 m

Rotation in direction of width = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - prva dilatacija
 Description : Model 7 - B-13 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.10.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Sand with trace of fines (S-F), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.




Volume of strip footing $= 1.00 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.00 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

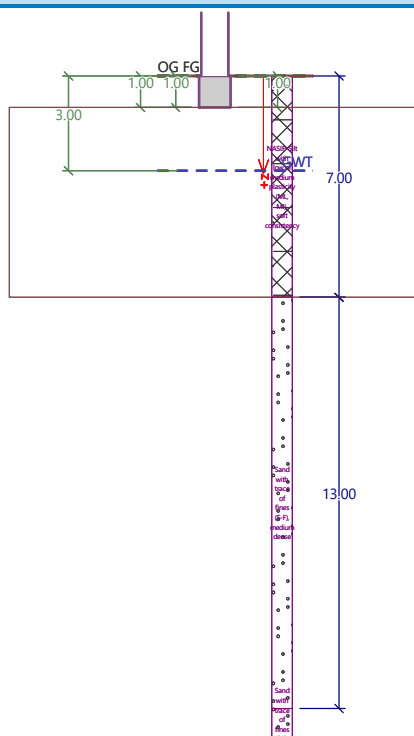
SG pad overhangs foundation $d_{sp} = 6.00 \text{ m}$
 Sand-gravel pad depth $h_{sp} = 6.00 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 7.00 | 0.00 .. 7.00 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 13.00 | 7.00 .. 20.00 | Sand with trace of fines (S-F), medium dense |  |
| 3 | - | 20.00 .. ∞ | Sand with trace of fines (S-F), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 65.50 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 65.50 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 495.53 | 13.22 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 495.53 | 13.22 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 28.960^\circ \\ c_d &= 0.026 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 21.452 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.000 \text{ m}\end{aligned}$$

$N_q = 16.371$
 $N_c = 27.775$
 $N_\gamma = 17.012$
 $s_q = 1.097$
 $s_c = 1.103$
 $s_\gamma = 0.940$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 495.526 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.88 \text{ m}$

Length of slip surface $l_{sp} = 6.14 \text{ m}$

Design bearing capacity of found.soil $R_d = 495.53 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 43.06 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 0.00$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 45.00 | 18.45 | 46.28 | 0.05 |
| 2 | 1.05 | 1.10 | 0.05 | 45.00 | 19.35 | 42.36 | 0.04 |
| 3 | 1.10 | 1.15 | 0.05 | 45.00 | 20.25 | 37.56 | 0.04 |
| 4 | 1.15 | 1.20 | 0.05 | 45.00 | 21.15 | 33.90 | 0.03 |
| 5 | 1.20 | 1.25 | 0.05 | 45.00 | 22.05 | 31.13 | 0.03 |
| 6 | 1.25 | 1.30 | 0.05 | 45.00 | 22.95 | 28.86 | 0.03 |
| 7 | 1.30 | 1.40 | 0.10 | 45.00 | 24.30 | 26.09 | 0.05 |
| 8 | 1.40 | 1.50 | 0.10 | 45.00 | 26.10 | 22.97 | 0.05 |
| 9 | 1.50 | 1.60 | 0.10 | 45.00 | 27.90 | 20.45 | 0.04 |
| 10 | 1.60 | 1.70 | 0.10 | 45.00 | 29.70 | 18.37 | 0.04 |
| 11 | 1.70 | 1.80 | 0.10 | 45.00 | 31.50 | 16.64 | 0.03 |
| 12 | 1.80 | 1.90 | 0.10 | 45.00 | 33.30 | 15.19 | 0.03 |
| 13 | 1.90 | 2.15 | 0.25 | 45.00 | 36.45 | 13.26 | 0.07 |
| 14 | 2.15 | 2.40 | 0.25 | 45.00 | 40.95 | 11.07 | 0.06 |
| 15 | 2.40 | 2.65 | 0.25 | 45.00 | 45.45 | 9.47 | 0.05 |
| 16 | 2.65 | 2.90 | 0.25 | 45.00 | 49.95 | 8.25 | 0.04 |
| 17 | 2.90 | 3.00 | 0.10 | 45.00 | 53.10 | 7.54 | 0.02 |
| 18 | 3.00 | 3.15 | 0.15 | 45.00 | 54.60 | 7.11 | 0.02 |
| 19 | 3.15 | 3.40 | 0.25 | 45.00 | 56.20 | 6.49 | 0.03 |
| 20 | 3.40 | 3.54 | 0.14 | 45.00 | 57.75 | 5.98 | 0.00 |

Settlement of mid point of longitudinal edge = 0.5 mm

Settlement of mid point of transverse edge 1 = 0.8 mm

Settlement of mid point of transverse edge 2 = 0.8 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 45.00$ MPaFoundation in the longitudinal direction is rigid ($k=666.67$)Foundation in the direction of width is rigid ($k=666.67$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

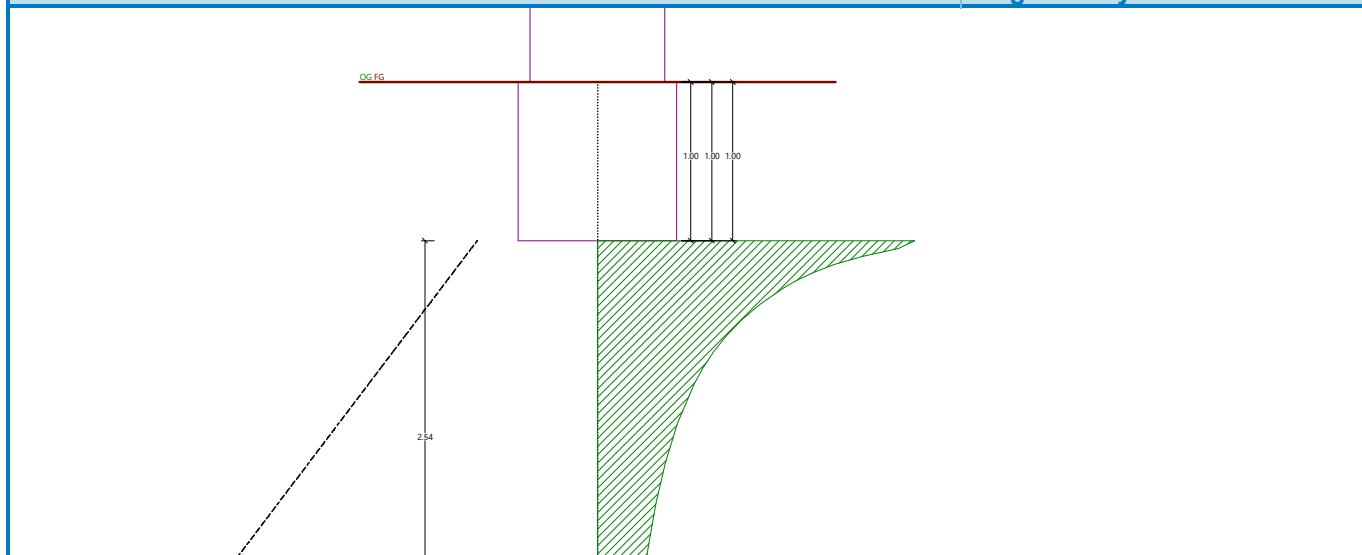
Foundation settlement = 0.7 mm

Depth of influence zone = 2.54 m

Rotation in direction of width = 0.000 (tan*1000); (1.3E-17 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - prva dilatacija
 Description : Model 7 - B-15
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.10.2

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Sand with trace of fines (S-F), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

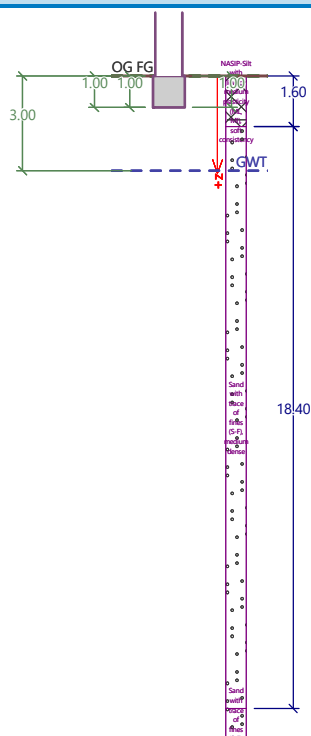
Volume of strip footing $= 1.00 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.00 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 1.60 | 0.00 .. 1.60 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 18.40 | 1.60 .. 20.00 | Sand with trace of fines (S-F), medium dense |  |
| 3 | - | 20.00 .. ∞ | Sand with trace of fines (S-F), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 65.50 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 65.50 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 175.54 | 37.31 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 175.54 | 37.31 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 20.641^\circ \\ c_d &= 0.526 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 17.131 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.000 \text{ m}\end{aligned}$$

$N_q = 6.821$
 $N_c = 15.453$
 $N_\gamma = 4.385$
 $s_q = 1.071$
 $s_c = 1.083$
 $s_\gamma = 0.940$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 175.541 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.35 \text{ m}$

Length of slip surface $l_{sp} = 3.80 \text{ m}$

Design bearing capacity of found.soil $R_d = 175.54 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 23.82 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 0.00$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 46.28 | 1.93 |
| 2 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 42.36 | 1.76 |
| 3 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 37.56 | 1.56 |
| 4 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 33.90 | 1.41 |
| 5 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 31.13 | 1.30 |
| 6 | 1.25 | 1.30 | 0.05 | 0.56 | 22.95 | 28.86 | 1.20 |
| 7 | 1.30 | 1.40 | 0.10 | 0.56 | 24.30 | 26.09 | 2.17 |
| 8 | 1.40 | 1.50 | 0.10 | 0.56 | 26.10 | 22.97 | 1.91 |
| 9 | 1.50 | 1.60 | 0.10 | 0.56 | 27.90 | 20.45 | 1.70 |
| 10 | 1.60 | 1.70 | 0.10 | 2.18 | 29.58 | 18.37 | 0.62 |
| 11 | 1.70 | 1.80 | 0.10 | 2.18 | 31.14 | 16.64 | 0.57 |
| 12 | 1.80 | 1.90 | 0.10 | 2.18 | 32.70 | 15.19 | 0.52 |
| 13 | 1.90 | 2.15 | 0.25 | 2.18 | 35.43 | 13.26 | 1.13 |
| 14 | 2.15 | 2.40 | 0.25 | 2.18 | 39.33 | 11.07 | 0.94 |
| 15 | 2.40 | 2.65 | 0.25 | 2.18 | 43.23 | 9.47 | 0.81 |
| 16 | 2.65 | 2.90 | 0.25 | 2.18 | 47.13 | 8.25 | 0.70 |
| 17 | 2.90 | 3.00 | 0.10 | 2.18 | 49.86 | 7.54 | 0.26 |
| 18 | 3.00 | 3.15 | 0.15 | 2.18 | 51.06 | 7.11 | 0.36 |
| 19 | 3.15 | 3.40 | 0.25 | 2.18 | 52.18 | 6.49 | 0.55 |
| 20 | 3.40 | 3.71 | 0.31 | 2.18 | 53.74 | 5.80 | 0.35 |

Settlement of mid point of longitudinal edge = 13.8 mm

Settlement of mid point of transverse edge 1 = 20.2 mm

Settlement of mid point of transverse edge 2 = 20.2 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 1.52$ MPaFoundation in the longitudinal direction is rigid ($k=19738.57$)Foundation in the direction of width is rigid ($k=19738.57$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

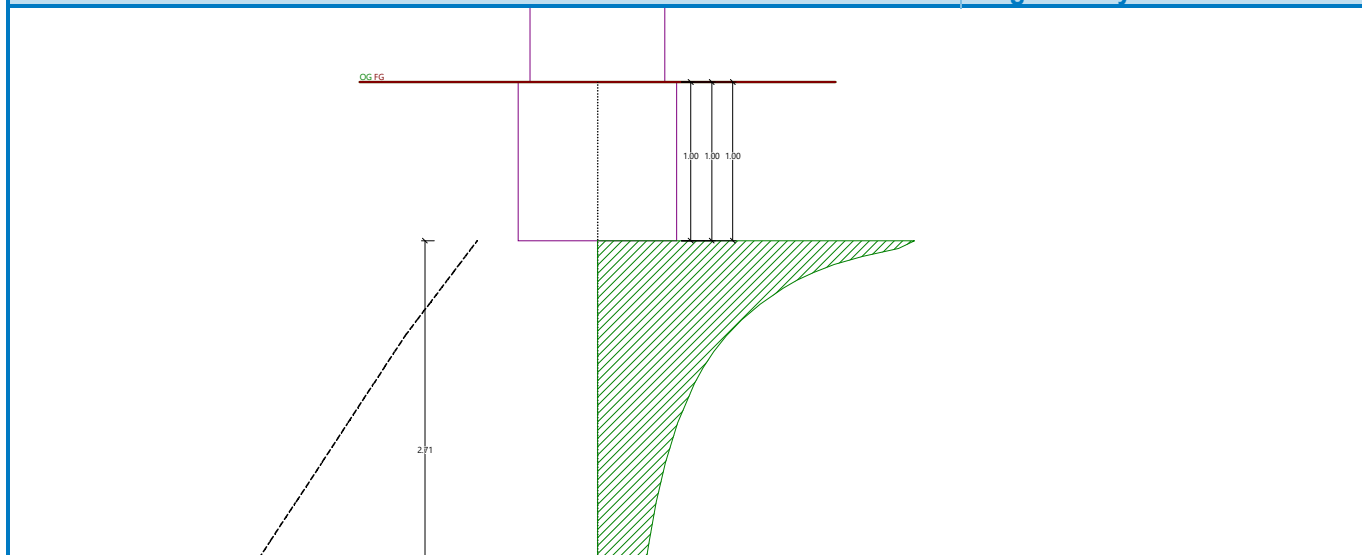
Foundation settlement = 21.8 mm

Depth of influence zone = 2.71 m

Rotation in direction of width = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - prva dilatacija
 Description : Model 7 - B-15 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.10.3

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Sand with trace of fines (S-F), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 5.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.




Volume of strip footing $= 1.00 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.00 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

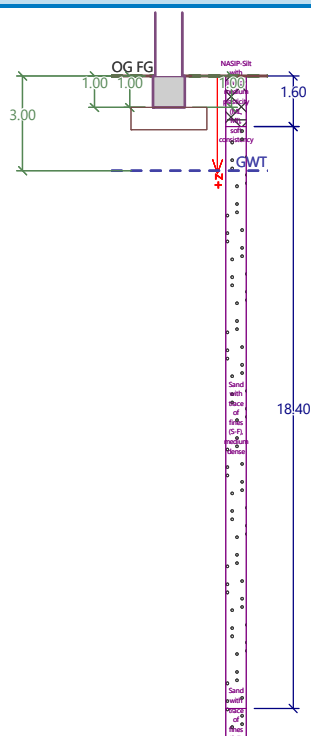
SG pad overhangs foundation $d_{\text{sp}} = 0.70 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.70 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 1.60 | 0.00 .. 1.60 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 18.40 | 1.60 .. 20.00 | Sand with trace of fines (S-F), medium dense |  |
| 3 | - | 20.00 .. ∞ | Sand with trace of fines (S-F), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|----------|------------------------|-----------------------|
| 1 | Yes | | ULS | Design | 65.50 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 65.50 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 224.31 | 29.20 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 224.31 | 29.20 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 22.819^\circ \\ c_d &= 0.321 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 17.922 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.000 \text{ m}\end{aligned}$$

$N_q = 8.502$
 $N_c = 17.830$
 $N_\gamma = 6.313$
 $s_q = 1.078$
 $s_c = 1.088$
 $s_\gamma = 0.940$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 224.313 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.47 \text{ m}$

Length of slip surface $l_{sp} = 4.28 \text{ m}$

Design bearing capacity of found.soil $R_d = 224.31 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 43.06 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 0.00$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 45.00 | 18.45 | 46.28 | 0.05 |
| 2 | 1.05 | 1.10 | 0.05 | 45.00 | 19.35 | 42.36 | 0.04 |
| 3 | 1.10 | 1.15 | 0.05 | 45.00 | 20.25 | 37.56 | 0.04 |
| 4 | 1.15 | 1.20 | 0.05 | 45.00 | 21.15 | 33.90 | 0.03 |
| 5 | 1.20 | 1.25 | 0.05 | 45.00 | 22.05 | 31.13 | 0.03 |
| 6 | 1.25 | 1.30 | 0.05 | 45.00 | 22.95 | 28.86 | 0.03 |
| 7 | 1.30 | 1.40 | 0.10 | 45.00 | 24.30 | 26.09 | 0.05 |
| 8 | 1.40 | 1.50 | 0.10 | 45.00 | 26.10 | 22.97 | 0.05 |
| 9 | 1.50 | 1.60 | 0.10 | 45.00 | 27.90 | 20.45 | 0.04 |
| 10 | 1.60 | 1.70 | 0.10 | 45.00 | 29.58 | 18.37 | 0.04 |
| 11 | 1.70 | 1.80 | 0.10 | 2.18 | 31.14 | 16.64 | 0.57 |
| 12 | 1.80 | 1.90 | 0.10 | 2.18 | 32.70 | 15.19 | 0.52 |
| 13 | 1.90 | 2.15 | 0.25 | 2.18 | 35.43 | 13.26 | 1.13 |
| 14 | 2.15 | 2.40 | 0.25 | 2.18 | 39.33 | 11.07 | 0.94 |
| 15 | 2.40 | 2.65 | 0.25 | 2.18 | 43.23 | 9.47 | 0.81 |
| 16 | 2.65 | 2.70 | 0.05 | 2.18 | 45.57 | 8.68 | 0.15 |
| 17 | 2.70 | 2.90 | 0.20 | 2.18 | 47.52 | 8.14 | 0.55 |
| 18 | 2.90 | 3.00 | 0.10 | 2.18 | 49.86 | 7.54 | 0.26 |
| 19 | 3.00 | 3.15 | 0.15 | 2.18 | 51.06 | 7.11 | 0.36 |
| 20 | 3.15 | 3.40 | 0.25 | 2.18 | 52.18 | 6.49 | 0.55 |
| 21 | 3.40 | 3.71 | 0.31 | 2.18 | 53.74 | 5.80 | 0.35 |

Settlement of mid point of longitudinal edge = 4.1 mm

Settlement of mid point of transverse edge 1 = 8.8 mm

Settlement of mid point of transverse edge 2 = 8.8 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 21.63$ MPaFoundation in the longitudinal direction is rigid ($k=1387.03$)Foundation in the direction of width is rigid ($k=1387.03$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY**

Overall settlement and rotation of foundation:

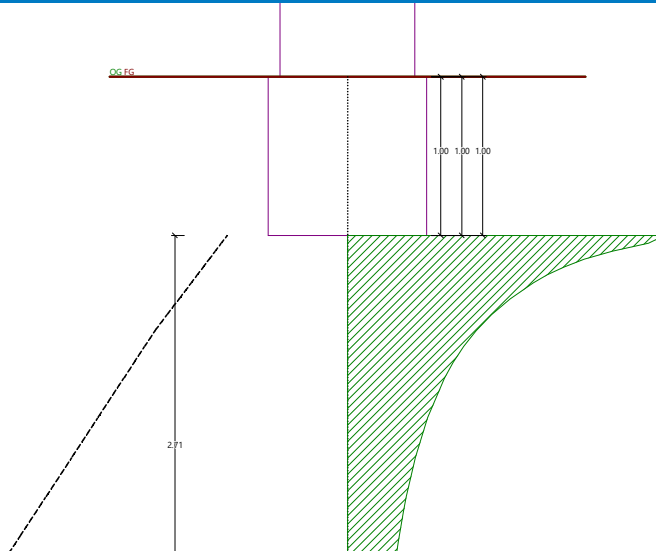
Foundation settlement = 6.6 mm

Depth of influence zone = 2.71 m

Rotation in direction of width = 0.000 (tan*1000); (1.0E-16 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - prva dilatacija - trake unutar objekta - osa E
 Description : Model 7 - B-13
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.11

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Sand with trace of fines (S-F), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 25.20 \text{ m}$
 Strip footing width (x) $= 1.20 \text{ m}$
 Column width in the direction of x $= 0.30 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

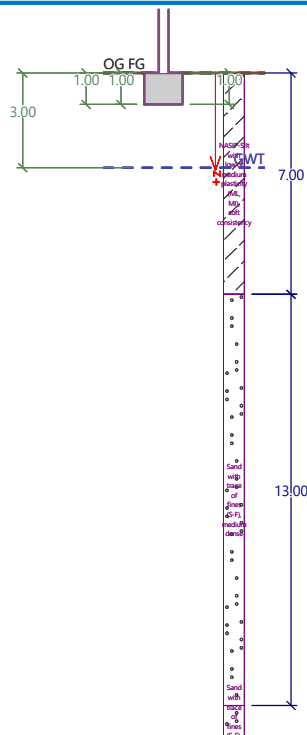
Volume of strip footing $= 1.20 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.20 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 7.00 | 0.00 .. 7.00 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 13.00 | 7.00 .. 20.00 | Sand with trace of fines (S-F), medium dense |  |
| 3 | - | 20.00 .. ∞ | Sand with trace of fines (S-F), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 78.60 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 78.60 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 91.57 | 71.53 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 91.57 | 71.53 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 1.429 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.200 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.011$
 $s_c = 1.016$
 $s_\gamma = 0.986$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 91.569 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.28 \text{ m}$

Length of slip surface $l_{sp} = 3.22 \text{ m}$

Design bearing capacity of found.soil $R_d = 91.57 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 27.31 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/m

Computed weight of overburden $Z = 0.00$ kN/m

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 46.69 | 1.95 |
| 2 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 43.70 | 1.82 |
| 3 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 39.60 | 1.65 |
| 4 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 36.28 | 1.51 |
| 5 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 33.82 | 1.41 |
| 6 | 1.25 | 1.30 | 0.05 | 0.56 | 22.95 | 31.93 | 1.33 |
| 7 | 1.30 | 1.40 | 0.10 | 0.56 | 24.30 | 29.78 | 2.48 |
| 8 | 1.40 | 1.50 | 0.10 | 0.56 | 26.10 | 27.42 | 2.29 |
| 9 | 1.50 | 1.60 | 0.10 | 0.56 | 27.90 | 25.50 | 2.13 |
| 10 | 1.60 | 1.70 | 0.10 | 0.56 | 29.70 | 23.85 | 1.99 |
| 11 | 1.70 | 1.80 | 0.10 | 0.56 | 31.50 | 22.41 | 1.87 |
| 12 | 1.80 | 1.90 | 0.10 | 0.56 | 33.30 | 21.13 | 1.76 |
| 13 | 1.90 | 2.15 | 0.25 | 0.56 | 36.45 | 19.27 | 4.01 |
| 14 | 2.15 | 2.40 | 0.25 | 0.56 | 40.95 | 17.01 | 3.54 |
| 15 | 2.40 | 2.65 | 0.25 | 0.56 | 45.45 | 15.19 | 3.17 |
| 16 | 2.65 | 2.90 | 0.25 | 0.56 | 49.95 | 13.69 | 2.85 |
| 17 | 2.90 | 3.00 | 0.10 | 0.56 | 53.10 | 12.78 | 1.06 |
| 18 | 3.00 | 3.15 | 0.15 | 0.56 | 54.60 | 12.20 | 1.52 |
| 19 | 3.15 | 3.40 | 0.25 | 0.56 | 56.20 | 11.35 | 2.36 |
| 20 | 3.40 | 3.90 | 0.50 | 0.56 | 59.20 | 10.04 | 4.18 |
| 21 | 3.90 | 4.40 | 0.50 | 0.56 | 63.20 | 8.59 | 3.58 |
| 22 | 4.40 | 4.90 | 0.50 | 0.56 | 67.20 | 7.46 | 3.11 |
| 23 | 4.90 | 4.92 | 0.02 | 0.56 | 69.26 | 6.94 | 0.00 |

Settlement of mid point of longitudinal edge = 23.7 mm

Settlement of mid point of transverse edge 1 = 46.8 mm

Settlement of mid point of transverse edge 2 = 46.8 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 0.56$ MPa

Foundation in the longitudinal direction is rigid ($k=31001.98$)

Foundation in the direction of width is rigid ($k=53571.43$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

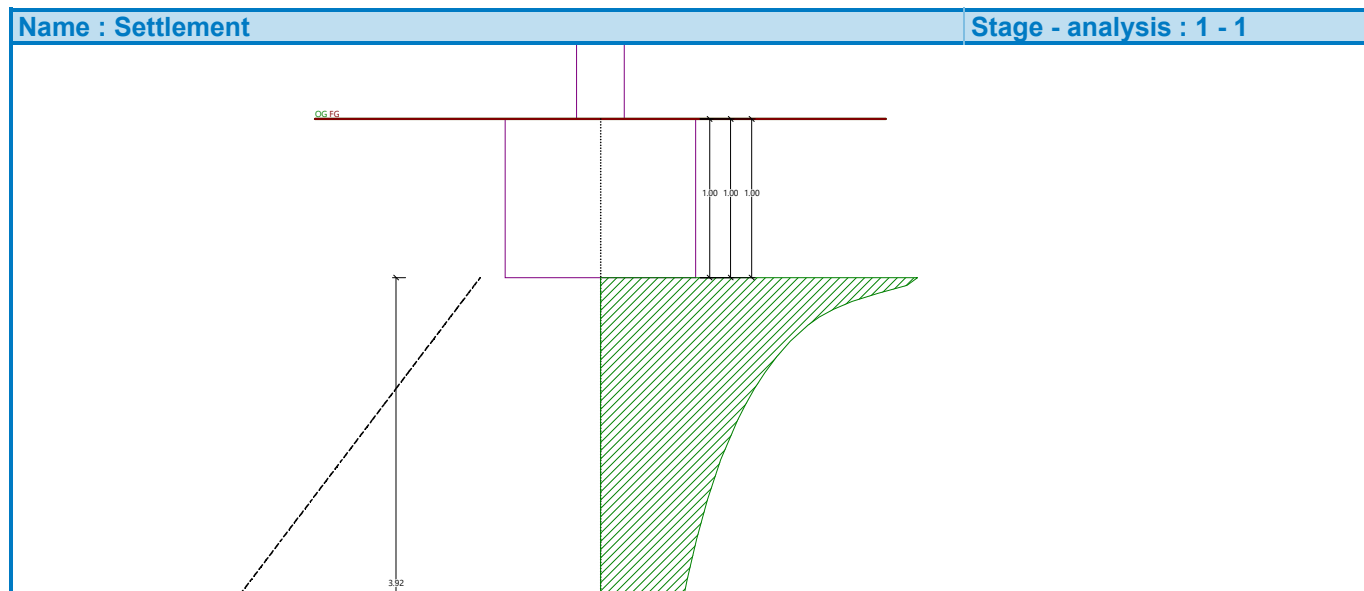
Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY**Overall settlement and rotation of foundation:**

Foundation settlement = 51.6 mm

Depth of influence zone = 3.92 m

Rotation in direction of width = 0.000 (tan*1000); (0.0E+00 °)

**Dimensioning No. 1**

Analysis carried out with automatic selection of the most unfavourable load cases.

Verification of longitudinal reinforcement of foundation in the direction of x $0.45 \text{ m} \leq 0.50 \text{ m}$ Maximum offset of the foundation is smaller than $0.50 \cdot \text{thickness of foundation}$. Reinforcement is not required.**Spread footing for punching shear failure check**

Column normal force = 78.60 kN

Maximum resistance at the column perimeter

| | |
|---|---------------------------------|
| Force transferred into found. soil | = 19.65 kN |
| Force transferred by shear strength of foundation | = 58.95 kN |
| Considered column perimeter | $u_0 = 2.00 \text{ m}$ |
| Shear resistance at the column perimeter | $V_{Ed,max} = 0.03 \text{ MPa}$ |
| Resistance at the column perimeter | $V_{Rd,max} = 2.94 \text{ MPa}$ |

Spread footing for punching shear is SATISFACTORY

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - prva dilatacija - trake unutar objekta - osa E
 Description : Model 7 - B-13 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.11.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Sand with trace of fines (S-F), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 25.20 \text{ m}$
 Strip footing width (x) $= 1.20 \text{ m}$
 Column width in the direction of x $= 0.30 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.




Volume of strip footing $= 1.20 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.20 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

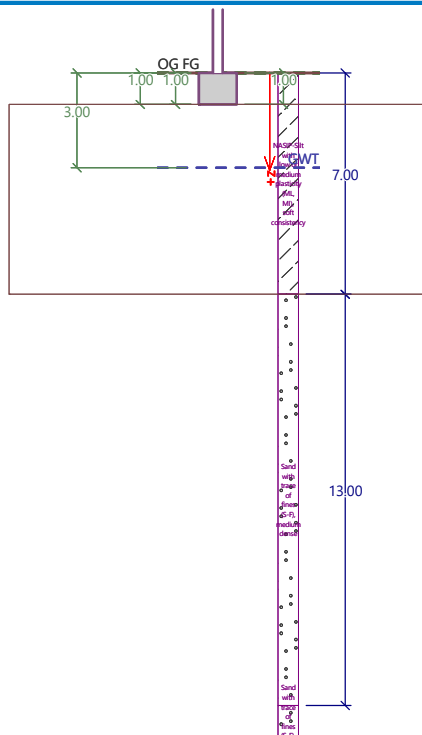
SG pad overhangs foundation $d_{\text{sp}} = 6.00 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 6.00 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 7.00 | 0.00 .. 7.00 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 13.00 | 7.00 .. 20.00 | Sand with trace of fines (S-F), medium dense |  |
| 3 | - | 20.00 .. ∞ | Sand with trace of fines (S-F), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 78.60 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 78.60 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 427.57 | 15.32 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 427.57 | 15.32 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 27.475^\circ \\ c_d &= 0.157 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 21.164 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.200 \text{ m}\end{aligned}$$

$N_q = 13.899$
 $N_c = 24.804$
 $N_\gamma = 13.415$
 $s_q = 1.022$
 $s_c = 1.024$
 $s_\gamma = 0.986$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 427.573 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.12 \text{ m}$

Length of slip surface $l_{sp} = 6.72 \text{ m}$

Design bearing capacity of found.soil $R_d = 427.57 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 50.40 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/m

Computed weight of overburden $Z = 0.00$ kN/m

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 45.00 | 18.45 | 46.69 | 0.05 |
| 2 | 1.05 | 1.10 | 0.05 | 45.00 | 19.35 | 43.70 | 0.04 |
| 3 | 1.10 | 1.15 | 0.05 | 45.00 | 20.25 | 39.60 | 0.04 |
| 4 | 1.15 | 1.20 | 0.05 | 45.00 | 21.15 | 36.28 | 0.04 |
| 5 | 1.20 | 1.25 | 0.05 | 45.00 | 22.05 | 33.82 | 0.03 |
| 6 | 1.25 | 1.30 | 0.05 | 45.00 | 22.95 | 31.93 | 0.03 |
| 7 | 1.30 | 1.40 | 0.10 | 45.00 | 24.30 | 29.78 | 0.06 |
| 8 | 1.40 | 1.50 | 0.10 | 45.00 | 26.10 | 27.42 | 0.05 |
| 9 | 1.50 | 1.60 | 0.10 | 45.00 | 27.90 | 25.50 | 0.05 |
| 10 | 1.60 | 1.70 | 0.10 | 45.00 | 29.70 | 23.85 | 0.05 |
| 11 | 1.70 | 1.80 | 0.10 | 45.00 | 31.50 | 22.41 | 0.04 |
| 12 | 1.80 | 1.90 | 0.10 | 45.00 | 33.30 | 21.13 | 0.04 |
| 13 | 1.90 | 2.15 | 0.25 | 45.00 | 36.45 | 19.27 | 0.10 |
| 14 | 2.15 | 2.40 | 0.25 | 45.00 | 40.95 | 17.01 | 0.09 |
| 15 | 2.40 | 2.65 | 0.25 | 45.00 | 45.45 | 15.19 | 0.08 |
| 16 | 2.65 | 2.90 | 0.25 | 45.00 | 49.95 | 13.69 | 0.07 |
| 17 | 2.90 | 3.00 | 0.10 | 45.00 | 53.10 | 12.78 | 0.03 |
| 18 | 3.00 | 3.15 | 0.15 | 45.00 | 54.60 | 12.20 | 0.04 |
| 19 | 3.15 | 3.40 | 0.25 | 45.00 | 56.20 | 11.35 | 0.06 |
| 20 | 3.40 | 3.90 | 0.50 | 45.00 | 59.20 | 10.04 | 0.10 |
| 21 | 3.90 | 4.40 | 0.50 | 45.00 | 63.20 | 8.59 | 0.09 |
| 22 | 4.40 | 4.90 | 0.50 | 45.00 | 67.20 | 7.46 | 0.07 |
| 23 | 4.90 | 4.92 | 0.02 | 45.00 | 69.26 | 6.94 | 0.00 |

Settlement of mid point of longitudinal edge = 0.6 mm

Settlement of mid point of transverse edge 1 = 1.1 mm

Settlement of mid point of transverse edge 2 = 1.1 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 45.00$ MPa

Foundation in the longitudinal direction is rigid ($k=385.80$)

Foundation in the direction of width is rigid ($k=666.67$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

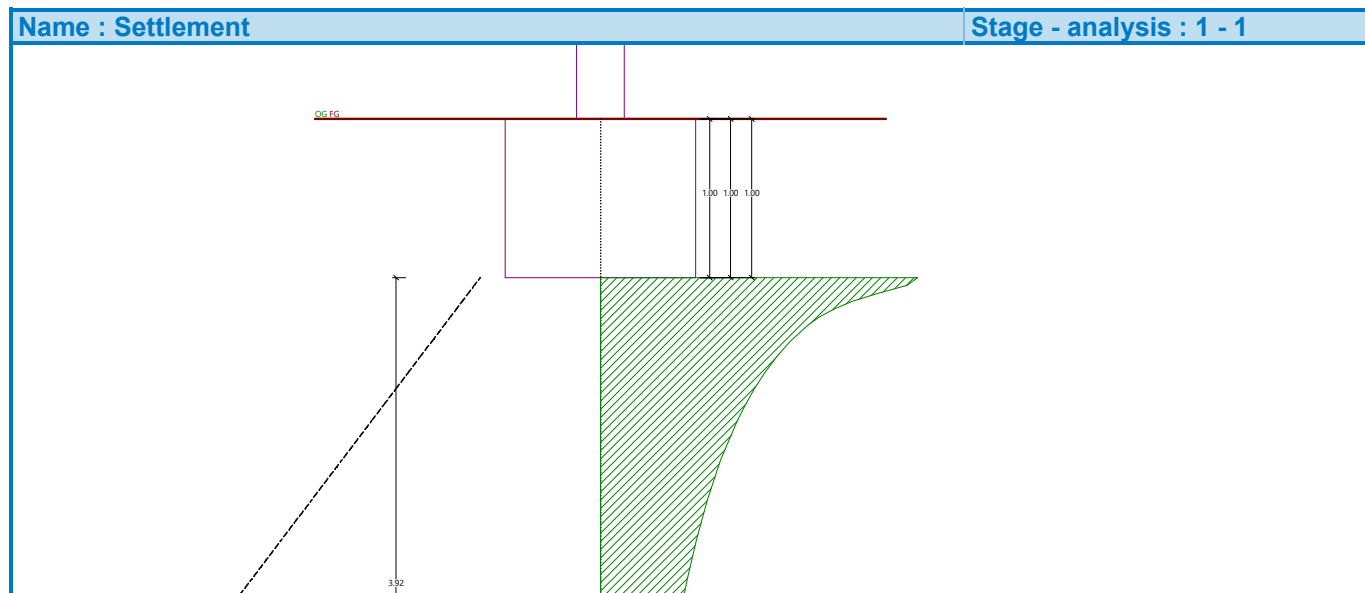
Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY**Overall settlement and rotation of foundation:**

Foundation settlement = 1.2 mm

Depth of influence zone = 3.92 m

Rotation in direction of width = 0.000 (tan*1000); (4.2E-17 °)

**Dimensioning No. 1**

Analysis carried out with automatic selection of the most unfavourable load cases.

Verification of longitudinal reinforcement of foundation in the direction of x $0.45 \text{ m} \leq 0.50 \text{ m}$ Maximum offset of the foundation is smaller than $0.50 \cdot \text{thickness of foundation}$. Reinforcement is not required.**Spread footing for punching shear failure check**

Column normal force = 78.60 kN

Maximum resistance at the column perimeter

| | |
|---|-----------------------------------|
| Force transferred into found. soil | = 19.65 kN |
| Force transferred by shear strength of foundation | = 58.95 kN |
| Considered column perimeter | $u_0 = 2.00 \text{ m}$ |
| Shear resistance at the column perimeter | $V_{Ed, \max} = 0.03 \text{ MPa}$ |
| Resistance at the column perimeter | $V_{Rd, \max} = 2.94 \text{ MPa}$ |

Spread footing for punching shear is SATISFACTORY

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - prva dilatacija - trake unutar objekta - osa E
 Description : Model 7 - B-15
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.11.2

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Sand with trace of fines (S-F), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 25.20 \text{ m}$
 Strip footing width (x) $= 1.20 \text{ m}$
 Column width in the direction of x $= 0.30 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

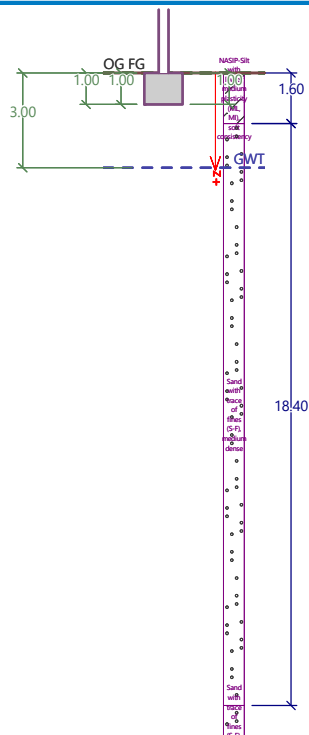
Volume of strip footing $= 1.20 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.20 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 1.60 | 0.00 .. 1.60 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 18.40 | 1.60 .. 20.00 | Sand with trace of fines (S-F), medium dense |  |
| 3 | - | 20.00 .. ∞ | Sand with trace of fines (S-F), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 78.60 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 78.60 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 192.39 | 34.05 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 192.39 | 34.05 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 21.435^\circ \\ c_d &= 0.424 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 16.885 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.200 \text{ m}\end{aligned}$$

$N_q = 7.387$
 $N_c = 16.268$
 $N_\gamma = 5.015$
 $s_q = 1.017$
 $s_c = 1.020$
 $s_\gamma = 0.986$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 192.392 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.68 \text{ m}$

Length of slip surface $l_{sp} = 4.76 \text{ m}$

Design bearing capacity of found.soil $R_d = 192.39 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 27.31 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/m

Computed weight of overburden $Z = 0.00$ kN/m

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 46.69 | 1.95 |
| 2 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 43.70 | 1.82 |
| 3 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 39.60 | 1.65 |
| 4 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 36.28 | 1.51 |
| 5 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 33.82 | 1.41 |
| 6 | 1.25 | 1.30 | 0.05 | 0.56 | 22.95 | 31.93 | 1.33 |
| 7 | 1.30 | 1.40 | 0.10 | 0.56 | 24.30 | 29.78 | 2.48 |
| 8 | 1.40 | 1.50 | 0.10 | 0.56 | 26.10 | 27.42 | 2.29 |
| 9 | 1.50 | 1.60 | 0.10 | 0.56 | 27.90 | 25.50 | 2.13 |
| 10 | 1.60 | 1.70 | 0.10 | 2.18 | 29.58 | 23.85 | 0.81 |
| 11 | 1.70 | 1.80 | 0.10 | 2.18 | 31.14 | 22.41 | 0.76 |
| 12 | 1.80 | 1.90 | 0.10 | 2.18 | 32.70 | 21.13 | 0.72 |
| 13 | 1.90 | 2.15 | 0.25 | 2.18 | 35.43 | 19.27 | 1.64 |
| 14 | 2.15 | 2.40 | 0.25 | 2.18 | 39.33 | 17.01 | 1.45 |
| 15 | 2.40 | 2.65 | 0.25 | 2.18 | 43.23 | 15.19 | 1.29 |
| 16 | 2.65 | 2.90 | 0.25 | 2.18 | 47.13 | 13.69 | 1.16 |
| 17 | 2.90 | 3.00 | 0.10 | 2.18 | 49.86 | 12.78 | 0.43 |
| 18 | 3.00 | 3.15 | 0.15 | 2.18 | 51.06 | 12.20 | 0.62 |
| 19 | 3.15 | 3.40 | 0.25 | 2.18 | 52.18 | 11.35 | 0.97 |
| 20 | 3.40 | 3.90 | 0.50 | 2.18 | 54.28 | 10.04 | 1.71 |
| 21 | 3.90 | 4.40 | 0.50 | 2.18 | 57.08 | 8.59 | 1.46 |
| 22 | 4.40 | 4.90 | 0.50 | 2.18 | 59.88 | 7.46 | 1.27 |
| 23 | 4.90 | 5.28 | 0.38 | 2.18 | 62.35 | 6.65 | 0.64 |

Settlement of mid point of longitudinal edge = 15.9 mm

Settlement of mid point of transverse edge 1 = 27.0 mm

Settlement of mid point of transverse edge 2 = 27.0 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 1.69$ MPa

Foundation in the longitudinal direction is rigid ($k=10300.48$)

Foundation in the direction of width is rigid ($k=17799.22$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

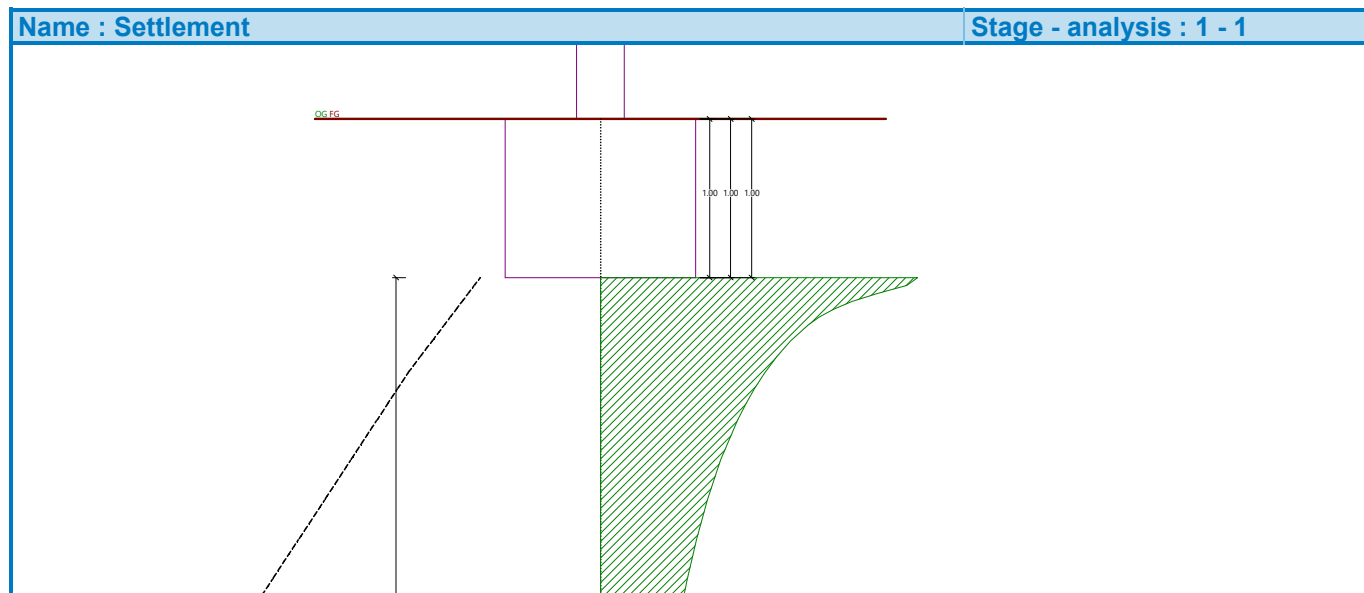
Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY**Overall settlement and rotation of foundation:**

Foundation settlement = 31.5 mm

Depth of influence zone = 4.28 m

Rotation in direction of width = 0.000 (tan*1000); (3.4E-16 °)

**Dimensioning No. 1**

Analysis carried out with automatic selection of the most unfavourable load cases.

Verification of longitudinal reinforcement of foundation in the direction of x $0.45 \text{ m} \leq 0.50 \text{ m}$ Maximum offset of the foundation is smaller than $0.50 \cdot \text{thickness of foundation}$. Reinforcement is not required.**Spread footing for punching shear failure check**

Column normal force = 78.60 kN

Maximum resistance at the column perimeter

| | |
|---|-----------------------------------|
| Force transferred into found. soil | = 19.65 kN |
| Force transferred by shear strength of foundation | = 58.95 kN |
| Considered column perimeter | $u_0 = 2.00 \text{ m}$ |
| Shear resistance at the column perimeter | $V_{Ed, \max} = 0.03 \text{ MPa}$ |
| Resistance at the column perimeter | $V_{Rd, \max} = 2.94 \text{ MPa}$ |

Spread footing for punching shear is SATISFACTORY

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - prva dilatacija - trake unutar objekta - osa E tampon
 Description : Model 7 - B-15
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.11.3

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Sand with trace of fines (S-F), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.50 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.50 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 25.20 \text{ m}$
 Strip footing width (x) $= 1.20 \text{ m}$
 Column width in the direction of x $= 0.30 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.




Volume of strip footing $= 1.20 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.20 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

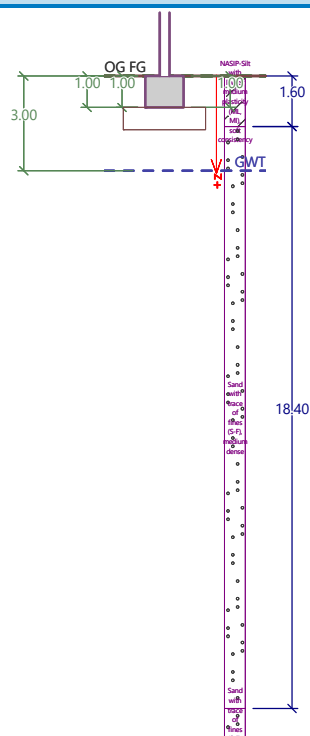
SG pad overhangs foundation $d_{\text{sp}} = 0.70 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.70 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 1.60 | 0.00 .. 1.60 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 18.40 | 1.60 .. 20.00 | Sand with trace of fines (S-F), medium dense |  |
| 3 | - | 20.00 .. ∞ | Sand with trace of fines (S-F), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 78.60 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 78.60 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 235.35 | 27.83 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 235.35 | 27.83 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 23.165^\circ \\ c_d &= 0.264 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 17.432 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.200 \text{ m}\end{aligned}$$

$N_q = 8.809$
 $N_c = 18.251$
 $N_\gamma = 6.683$
 $s_q = 1.019$
 $s_c = 1.021$
 $s_\gamma = 0.986$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 235.348 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.79 \text{ m}$

Length of slip surface $l_{sp} = 5.24 \text{ m}$

Design bearing capacity of found.soil $R_d = 235.35 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 50.40 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/m

Computed weight of overburden $Z = 0.00$ kN/m

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 45.00 | 18.45 | 46.69 | 0.05 |
| 2 | 1.05 | 1.10 | 0.05 | 45.00 | 19.35 | 43.70 | 0.04 |
| 3 | 1.10 | 1.15 | 0.05 | 45.00 | 20.25 | 39.60 | 0.04 |
| 4 | 1.15 | 1.20 | 0.05 | 45.00 | 21.15 | 36.28 | 0.04 |
| 5 | 1.20 | 1.25 | 0.05 | 45.00 | 22.05 | 33.82 | 0.03 |
| 6 | 1.25 | 1.30 | 0.05 | 45.00 | 22.95 | 31.93 | 0.03 |
| 7 | 1.30 | 1.40 | 0.10 | 45.00 | 24.30 | 29.78 | 0.06 |
| 8 | 1.40 | 1.50 | 0.10 | 45.00 | 26.10 | 27.42 | 0.05 |
| 9 | 1.50 | 1.60 | 0.10 | 45.00 | 27.90 | 25.50 | 0.05 |
| 10 | 1.60 | 1.70 | 0.10 | 45.00 | 29.58 | 23.85 | 0.05 |
| 11 | 1.70 | 1.80 | 0.10 | 2.18 | 31.14 | 22.41 | 0.76 |
| 12 | 1.80 | 1.90 | 0.10 | 2.18 | 32.70 | 21.13 | 0.72 |
| 13 | 1.90 | 2.15 | 0.25 | 2.18 | 35.43 | 19.27 | 1.64 |
| 14 | 2.15 | 2.40 | 0.25 | 2.18 | 39.33 | 17.01 | 1.45 |
| 15 | 2.40 | 2.65 | 0.25 | 2.18 | 43.23 | 15.19 | 1.29 |
| 16 | 2.65 | 2.70 | 0.05 | 2.18 | 45.57 | 14.24 | 0.24 |
| 17 | 2.70 | 2.90 | 0.20 | 2.18 | 47.52 | 13.56 | 0.92 |
| 18 | 2.90 | 3.00 | 0.10 | 2.18 | 49.86 | 12.78 | 0.43 |
| 19 | 3.00 | 3.15 | 0.15 | 2.18 | 51.06 | 12.20 | 0.62 |
| 20 | 3.15 | 3.40 | 0.25 | 2.18 | 52.18 | 11.35 | 0.97 |
| 21 | 3.40 | 3.90 | 0.50 | 2.18 | 54.28 | 10.04 | 1.71 |
| 22 | 3.90 | 4.40 | 0.50 | 2.18 | 57.08 | 8.59 | 1.46 |
| 23 | 4.40 | 4.90 | 0.50 | 2.18 | 59.88 | 7.46 | 1.27 |
| 24 | 4.90 | 5.28 | 0.38 | 2.18 | 62.35 | 6.65 | 0.64 |

Settlement of mid point of longitudinal edge = 5.6 mm

Settlement of mid point of transverse edge 1 = 15.2 mm

Settlement of mid point of transverse edge 2 = 15.2 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 16.91$ MPa

Foundation in the longitudinal direction is rigid ($k=1026.94$)

Foundation in the direction of width is rigid ($k=1774.56$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

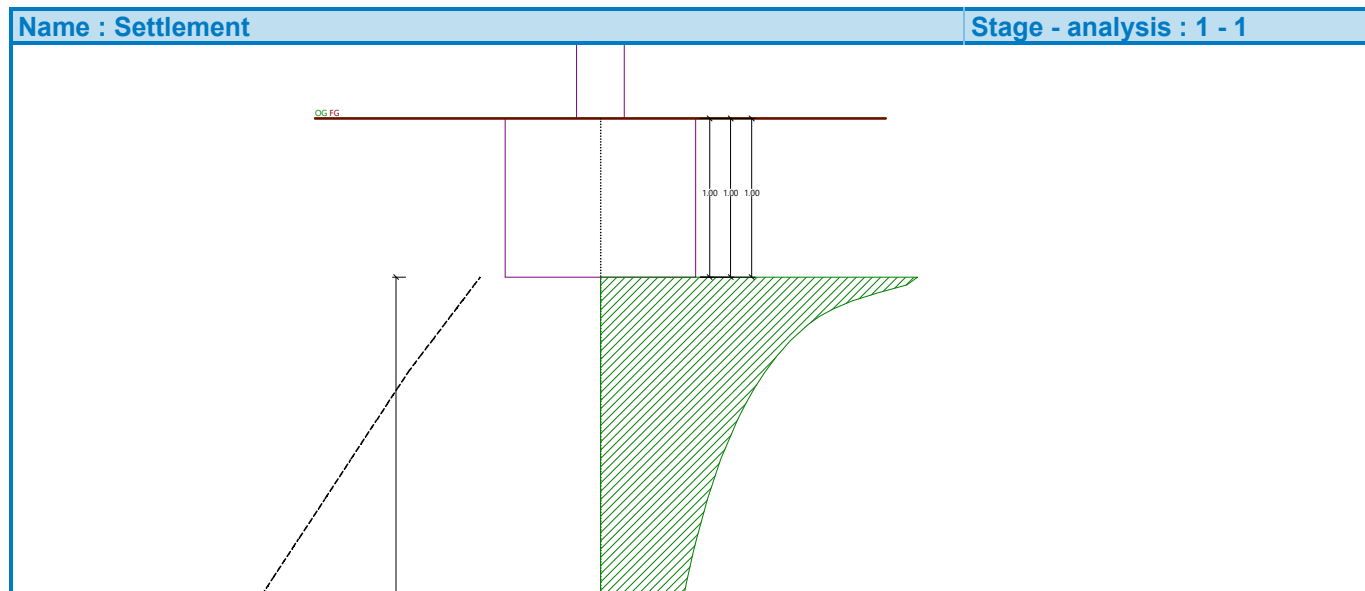
Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity

 $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 14.6 mm

Depth of influence zone = 4.28 m

Rotation in direction of width = 0.000 (\tan^*1000); ($8.5E-17^\circ$)

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - treća dilatacija - Sortirnica
 Description : Model 8 - B-19
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.12

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 7.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 13.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 1.60 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile





Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 42.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

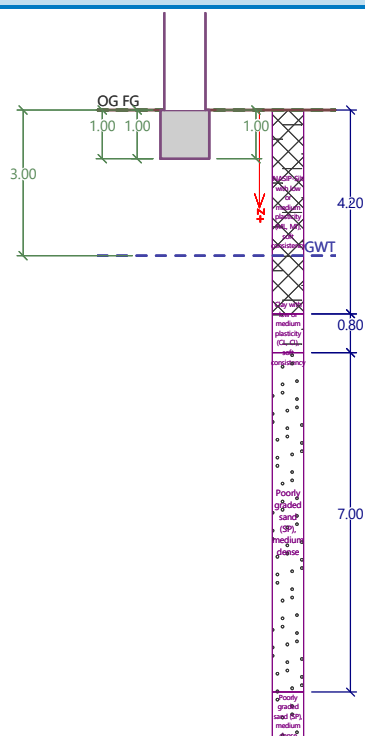
Volume of strip footing $= 1.00 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.00 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 4.20 | 0.00 .. 4.20 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 0.80 | 4.20 .. 5.00 | Clay with low or medium plasticity (CL, CI), soft consistency |  |
| 3 | 7.00 | 5.00 .. 12.00 | Poorly graded sand (SP), medium dense |  |
| 4 | - | 12.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 65.50 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 65.50 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 96.37 | 67.97 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 96.37 | 67.97 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 2.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3\end{aligned}$$

$b_{ef} = 1.000 \text{ m}$
 $N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.006$
 $s_c = 1.008$
 $s_\gamma = 0.993$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 96.365 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.07 \text{ m}$

Length of slip surface $l_{sp} = 2.68 \text{ m}$

Design bearing capacity of found.soil $R_d = 96.37 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 24.53 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 0.00$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 46.29 | 1.93 |
| 2 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 42.43 | 1.77 |
| 3 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 37.79 | 1.57 |
| 4 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 34.41 | 1.43 |
| 5 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 31.98 | 1.33 |
| 6 | 1.25 | 1.30 | 0.05 | 0.56 | 22.95 | 30.09 | 1.25 |
| 7 | 1.30 | 1.40 | 0.10 | 0.56 | 24.30 | 27.89 | 2.32 |
| 8 | 1.40 | 1.50 | 0.10 | 0.56 | 26.10 | 25.43 | 2.12 |
| 9 | 1.50 | 1.60 | 0.10 | 0.56 | 27.90 | 23.41 | 1.95 |
| 10 | 1.60 | 1.70 | 0.10 | 0.56 | 29.70 | 21.69 | 1.81 |
| 11 | 1.70 | 1.80 | 0.10 | 0.56 | 31.50 | 20.21 | 1.68 |
| 12 | 1.80 | 1.90 | 0.10 | 0.56 | 33.30 | 18.92 | 1.58 |
| 13 | 1.90 | 2.15 | 0.25 | 0.56 | 36.45 | 17.12 | 3.57 |
| 14 | 2.15 | 2.40 | 0.25 | 0.56 | 40.95 | 14.99 | 3.12 |
| 15 | 2.40 | 2.65 | 0.25 | 0.56 | 45.45 | 13.33 | 2.78 |
| 16 | 2.65 | 2.90 | 0.25 | 0.56 | 49.95 | 12.01 | 2.50 |
| 17 | 2.90 | 3.00 | 0.10 | 0.56 | 53.10 | 11.21 | 0.93 |
| 18 | 3.00 | 3.15 | 0.15 | 0.56 | 54.60 | 10.72 | 1.34 |
| 19 | 3.15 | 3.40 | 0.25 | 0.56 | 56.20 | 10.00 | 2.08 |
| 20 | 3.40 | 3.90 | 0.50 | 0.56 | 59.20 | 8.90 | 3.71 |
| 21 | 3.90 | 4.20 | 0.30 | 0.56 | 62.40 | 7.91 | 1.98 |
| 22 | 4.20 | 4.40 | 0.20 | 0.75 | 64.36 | 7.39 | 0.92 |
| 23 | 4.40 | 4.67 | 0.27 | 0.75 | 66.16 | 6.95 | 0.63 |

Settlement of mid point of longitudinal edge = 19.8 mm

Settlement of mid point of transverse edge 1 = 38.8 mm

Settlement of mid point of transverse edge 2 = 38.8 mm

(1-max.compressed edge; 2-min.compressed edge)

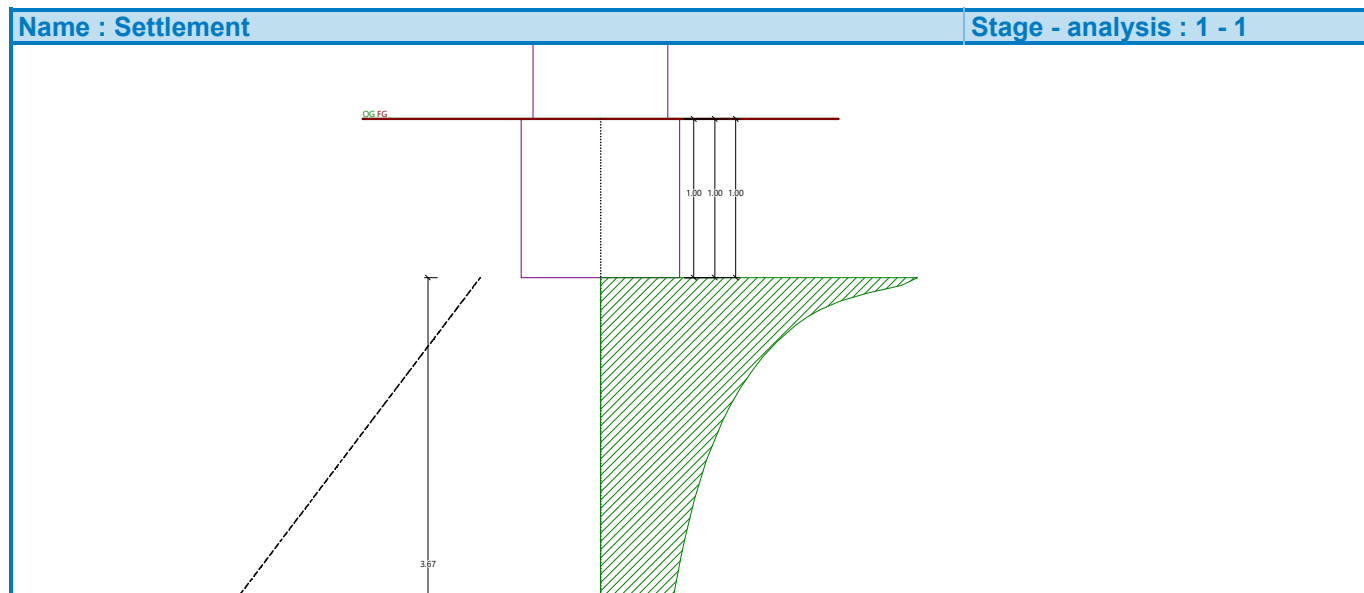
Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 0.58$ MPaFoundation in the longitudinal direction is rigid ($k=52164.96$)Foundation in the direction of width is rigid ($k=52164.96$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY**Overall settlement and rotation of foundation:**

Foundation settlement = 44.3 mm

Depth of influence zone = 3.67 m

Rotation in direction of width = 0.000 (tan*1000); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - treća dilatacija - Sortirnica
 Description : Model 8 - B-19 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.12.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 7.00^\circ$
 Cohesion of soil : $c_{ef} = 13.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.60 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 42.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.


Volume of strip footing $= 1.00 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.00 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

SG pad overhangs foundation $d_{sp} = 4.00 \text{ m}$
 Sand-gravel pad depth $h_{sp} = 4.00 \text{ m}$

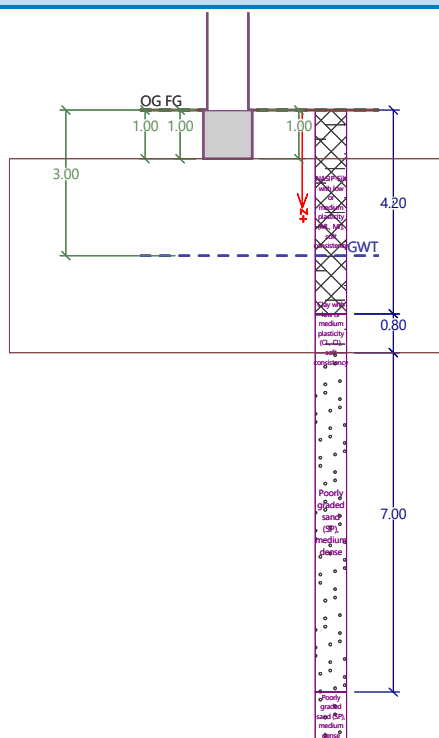
Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 4.20 | 0.00 .. 4.20 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---------|
| 2 | 0.80 | 4.20 .. 5.00 | Clay with low or medium plasticity (CL, CI), soft consistency | |
| 3 | 7.00 | 5.00 .. 12.00 | Poorly graded sand (SP), medium dense | |
| 4 | - | 12.00 .. ∞ | Poorly graded sand (SP), medium dense | |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|----------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 65.50 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 65.50 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1**Load case verification**

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 343.51 | 19.07 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 343.51 | 19.07 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 26.260^\circ$
 $c_d = 0.397 \text{ kPa}$
 $\gamma_{1prum} = 18.000 \text{ kN/m}^3$
 $\gamma_{2prum} = 20.564 \text{ kN/m}^3$
 $b_{ef} = 1.000 \text{ m}$
 $N_q = 12.188$
 $N_c = 22.677$
 $N_\gamma = 11.039$
 $s_q = 1.011$
 $s_c = 1.011$
 $s_\gamma = 0.993$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 343.510 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.68 \text{ m}$

Length of slip surface $l_{sp} = 5.23 \text{ m}$

Design bearing capacity of found.soil $R_d = 343.51 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Horizontal bearing capacity check**

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$ Horizontal bearing capacity $R_{dh} = 43.06 \text{ kN}$ Extreme horizontal force $H = 0.00 \text{ kN}$ **Bearing capacity in the horizontal direction is SATISFACTORY****Bearing capacity of foundation is SATISFACTORY****Verification No. 1****Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$ Computed weight of overburden $Z = 0.00 \text{ kN/m}$ **Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 45.00 | 18.45 | 46.29 | 0.05 |
| 2 | 1.05 | 1.10 | 0.05 | 45.00 | 19.35 | 42.43 | 0.04 |
| 3 | 1.10 | 1.15 | 0.05 | 45.00 | 20.25 | 37.79 | 0.04 |
| 4 | 1.15 | 1.20 | 0.05 | 45.00 | 21.15 | 34.41 | 0.03 |
| 5 | 1.20 | 1.25 | 0.05 | 45.00 | 22.05 | 31.98 | 0.03 |
| 6 | 1.25 | 1.30 | 0.05 | 45.00 | 22.95 | 30.09 | 0.03 |
| 7 | 1.30 | 1.40 | 0.10 | 45.00 | 24.30 | 27.89 | 0.06 |
| 8 | 1.40 | 1.50 | 0.10 | 45.00 | 26.10 | 25.43 | 0.05 |
| 9 | 1.50 | 1.60 | 0.10 | 45.00 | 27.90 | 23.41 | 0.05 |
| 10 | 1.60 | 1.70 | 0.10 | 45.00 | 29.70 | 21.69 | 0.04 |
| 11 | 1.70 | 1.80 | 0.10 | 45.00 | 31.50 | 20.21 | 0.04 |
| 12 | 1.80 | 1.90 | 0.10 | 45.00 | 33.30 | 18.92 | 0.04 |
| 13 | 1.90 | 2.15 | 0.25 | 45.00 | 36.45 | 17.12 | 0.09 |
| 14 | 2.15 | 2.40 | 0.25 | 45.00 | 40.95 | 14.99 | 0.07 |
| 15 | 2.40 | 2.65 | 0.25 | 45.00 | 45.45 | 13.33 | 0.07 |
| 16 | 2.65 | 2.90 | 0.25 | 45.00 | 49.95 | 12.01 | 0.06 |
| 17 | 2.90 | 3.00 | 0.10 | 45.00 | 53.10 | 11.21 | 0.02 |
| 18 | 3.00 | 3.15 | 0.15 | 45.00 | 54.60 | 10.72 | 0.03 |
| 19 | 3.15 | 3.40 | 0.25 | 45.00 | 56.20 | 10.00 | 0.05 |
| 20 | 3.40 | 3.90 | 0.50 | 45.00 | 59.20 | 8.90 | 0.09 |
| 21 | 3.90 | 4.20 | 0.30 | 45.00 | 62.40 | 7.91 | 0.05 |
| 22 | 4.20 | 4.40 | 0.20 | 45.00 | 64.36 | 7.39 | 0.03 |
| 23 | 4.40 | 4.67 | 0.27 | 45.00 | 66.16 | 6.95 | 0.02 |

Settlement of mid point of longitudinal edge = 0.5 mm

Settlement of mid point of transverse edge 1 = 0.9 mm

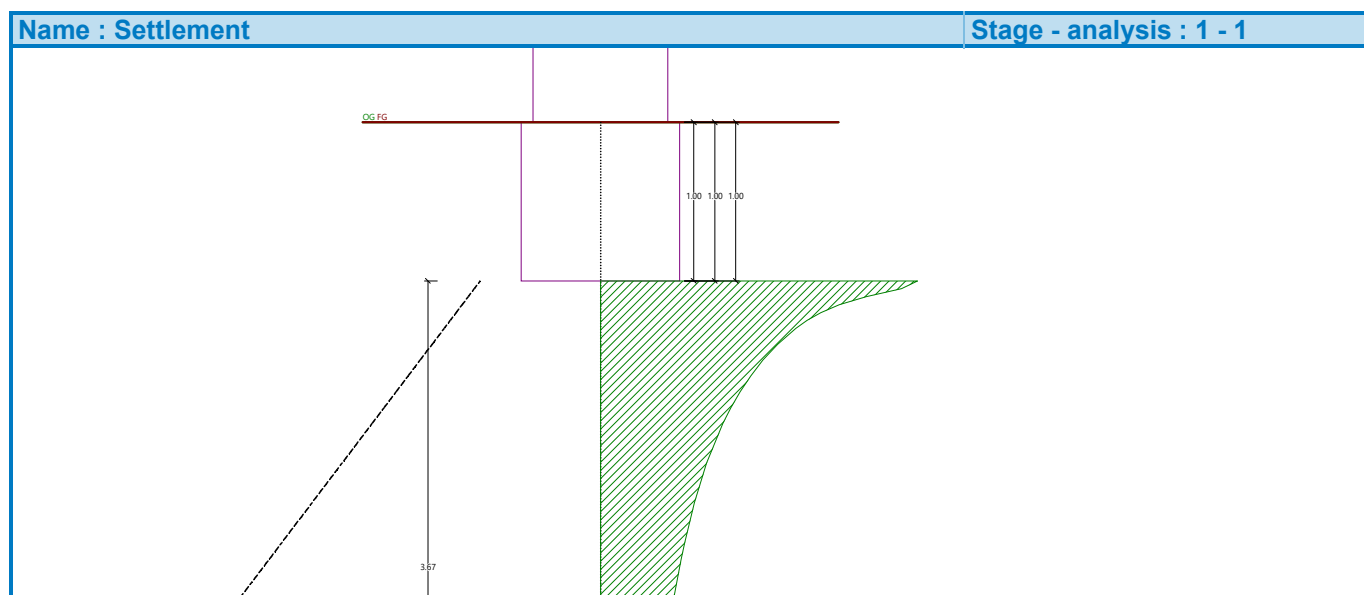
Settlement of mid point of transverse edge 2 = 0.9 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 45.00$ MPaFoundation in the longitudinal direction is rigid ($k=666.67$)Foundation in the direction of width is rigid ($k=666.67$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 1.1 mm

Depth of influence zone = 3.67 m

Rotation in direction of width = 0.000 ($\tan \cdot 1000$); ($4.5E-17^\circ$)

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - treća dilatacija - Sortirnica
 Description : Model 8 - B-17
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.12.2

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 7.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 13.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 1.60 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile





Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 42.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

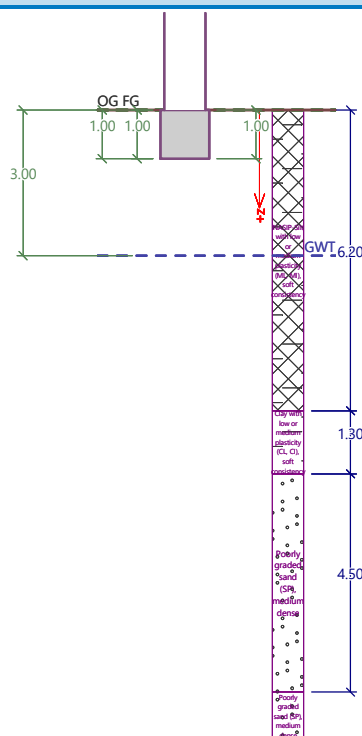
Volume of strip footing $= 1.00 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.00 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 6.20 | 0.00 .. 6.20 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 1.30 | 6.20 .. 7.50 | Clay with low or medium plasticity (CL, CI), soft consistency |  |
| 3 | 4.50 | 7.50 .. 12.00 | Poorly graded sand (SP), medium dense |  |
| 4 | - | 12.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 65.50 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 65.50 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 96.37 | 67.97 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 96.37 | 67.97 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 2.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3\end{aligned}$$

$b_{ef} = 1.000 \text{ m}$
 $N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.006$
 $s_c = 1.008$
 $s_\gamma = 0.993$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 96.365 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.07 \text{ m}$

Length of slip surface $l_{sp} = 2.68 \text{ m}$

Design bearing capacity of found.soil $R_d = 96.37 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 24.53 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 0.00$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 46.29 | 1.93 |
| 2 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 42.43 | 1.77 |
| 3 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 37.79 | 1.57 |
| 4 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 34.41 | 1.43 |
| 5 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 31.98 | 1.33 |
| 6 | 1.25 | 1.30 | 0.05 | 0.56 | 22.95 | 30.09 | 1.25 |
| 7 | 1.30 | 1.40 | 0.10 | 0.56 | 24.30 | 27.89 | 2.32 |
| 8 | 1.40 | 1.50 | 0.10 | 0.56 | 26.10 | 25.43 | 2.12 |
| 9 | 1.50 | 1.60 | 0.10 | 0.56 | 27.90 | 23.41 | 1.95 |
| 10 | 1.60 | 1.70 | 0.10 | 0.56 | 29.70 | 21.69 | 1.81 |
| 11 | 1.70 | 1.80 | 0.10 | 0.56 | 31.50 | 20.21 | 1.68 |
| 12 | 1.80 | 1.90 | 0.10 | 0.56 | 33.30 | 18.92 | 1.58 |
| 13 | 1.90 | 2.15 | 0.25 | 0.56 | 36.45 | 17.12 | 3.57 |
| 14 | 2.15 | 2.40 | 0.25 | 0.56 | 40.95 | 14.99 | 3.12 |
| 15 | 2.40 | 2.65 | 0.25 | 0.56 | 45.45 | 13.33 | 2.78 |
| 16 | 2.65 | 2.90 | 0.25 | 0.56 | 49.95 | 12.01 | 2.50 |
| 17 | 2.90 | 3.00 | 0.10 | 0.56 | 53.10 | 11.21 | 0.93 |
| 18 | 3.00 | 3.15 | 0.15 | 0.56 | 54.60 | 10.72 | 1.34 |
| 19 | 3.15 | 3.40 | 0.25 | 0.56 | 56.20 | 10.00 | 2.08 |
| 20 | 3.40 | 3.90 | 0.50 | 0.56 | 59.20 | 8.90 | 3.71 |
| 21 | 3.90 | 4.40 | 0.50 | 0.56 | 63.20 | 7.70 | 3.21 |
| 22 | 4.40 | 4.67 | 0.27 | 0.56 | 66.26 | 6.95 | 0.79 |

Settlement of mid point of longitudinal edge = 19.8 mm

Settlement of mid point of transverse edge 1 = 39.4 mm

Settlement of mid point of transverse edge 2 = 39.4 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 0.56$ MPaFoundation in the longitudinal direction is rigid ($k=53571.43$)Foundation in the direction of width is rigid ($k=53571.43$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY**

Overall settlement and rotation of foundation:

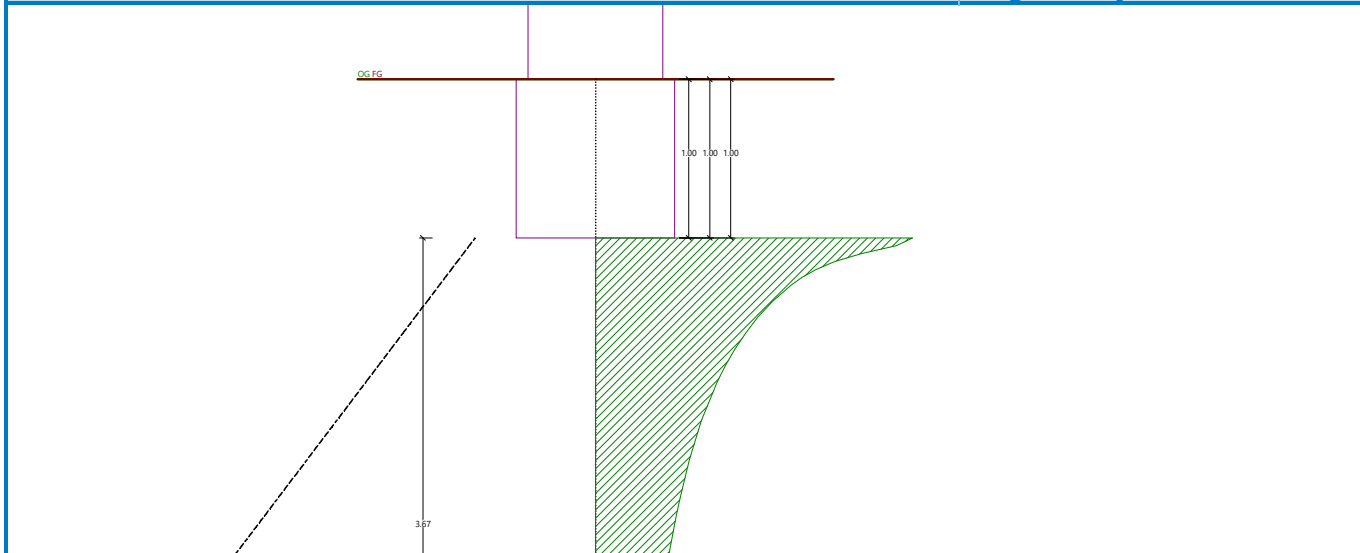
Foundation settlement = 44.8 mm

Depth of influence zone = 3.67 m

Rotation in direction of width = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15. Objekat MBT - treća dilatacija - Sortirnica tampon
 Description : Model 8 - B-17
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.12.3

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 7.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 13.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 1.60 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 42.00 \text{ m}$
 Strip footing width (x) $= 1.00 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.


Volume of strip footing $= 1.00 \text{ m}^3/\text{m}$
 Volume of excavation $= 1.00 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

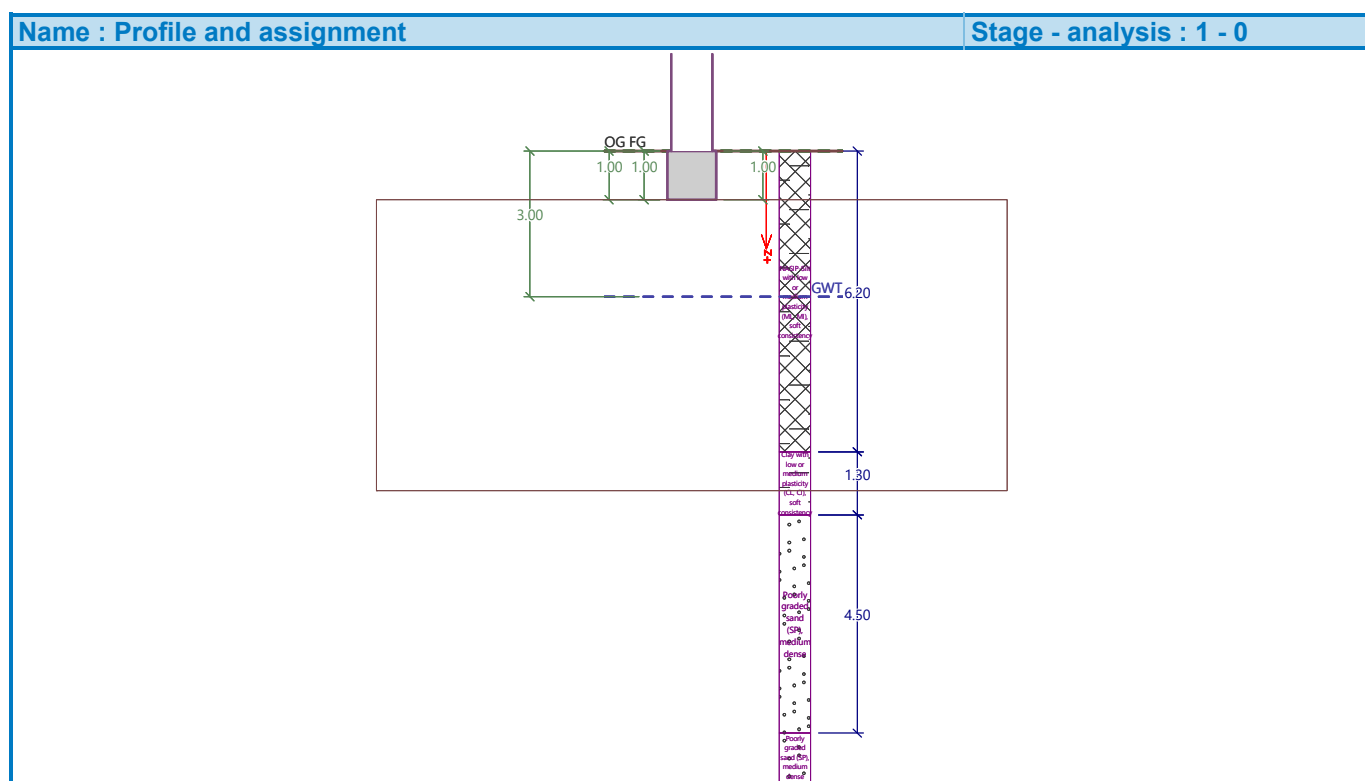
SG pad overhangs foundation $d_{\text{sp}} = 6.00 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 6.00 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 6.20 | 0.00 .. 6.20 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |

| | |
|--------------|---|
| Nikola Dakić | Gradska deponija u novom Sadu 15. Objekat MBT - treća dilatacija - Sortirnica tampon |
|--------------|---|

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---------|
| 2 | 1.30 | 6.20 .. 7.50 | Clay with low or medium plasticity (CL, CI), soft consistency | |
| 3 | 4.50 | 7.50 .. 12.00 | Poorly graded sand (SP), medium dense | |
| 4 | - | 12.00 .. ∞ | Poorly graded sand (SP), medium dense | |



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|----------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 65.50 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 65.50 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1**Load case verification**

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 65.50 | 476.17 | 13.76 | Yes |
| ULS | No | 0.00 | 0.00 | 65.50 | 476.17 | 13.76 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 28.960^\circ$
 $c_d = 0.039 \text{ kPa}$
 $\gamma_{1prum} = 18.000 \text{ kN/m}^3$
 $\gamma_{2prum} = 20.959 \text{ kN/m}^3$
 $b_{ef} = 1.000 \text{ m}$
 $N_q = 16.371$
 $N_c = 27.775$
 $N_\gamma = 17.012$
 $s_q = 1.012$
 $s_c = 1.012$
 $s_\gamma = 0.993$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 476.166 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.88 \text{ m}$

Length of slip surface $l_{sp} = 6.14 \text{ m}$

Design bearing capacity of found.soil $R_d = 476.17 \text{ kPa}$

Extreme contact stress $\sigma = 65.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Horizontal bearing capacity check**

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.37 \text{ kN}$ Horizontal bearing capacity $R_{dh} = 43.06 \text{ kN}$ Extreme horizontal force $H = 0.00 \text{ kN}$ **Bearing capacity in the horizontal direction is SATISFACTORY****Bearing capacity of foundation is SATISFACTORY****Verification No. 1****Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$ Computed weight of overburden $Z = 0.00 \text{ kN/m}$ **Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.00 | 1.05 | 0.05 | 45.00 | 18.45 | 46.29 | 0.05 |
| 2 | 1.05 | 1.10 | 0.05 | 45.00 | 19.35 | 42.43 | 0.04 |
| 3 | 1.10 | 1.15 | 0.05 | 45.00 | 20.25 | 37.79 | 0.04 |
| 4 | 1.15 | 1.20 | 0.05 | 45.00 | 21.15 | 34.41 | 0.03 |
| 5 | 1.20 | 1.25 | 0.05 | 45.00 | 22.05 | 31.98 | 0.03 |
| 6 | 1.25 | 1.30 | 0.05 | 45.00 | 22.95 | 30.09 | 0.03 |
| 7 | 1.30 | 1.40 | 0.10 | 45.00 | 24.30 | 27.89 | 0.06 |
| 8 | 1.40 | 1.50 | 0.10 | 45.00 | 26.10 | 25.43 | 0.05 |
| 9 | 1.50 | 1.60 | 0.10 | 45.00 | 27.90 | 23.41 | 0.05 |
| 10 | 1.60 | 1.70 | 0.10 | 45.00 | 29.70 | 21.69 | 0.04 |
| 11 | 1.70 | 1.80 | 0.10 | 45.00 | 31.50 | 20.21 | 0.04 |
| 12 | 1.80 | 1.90 | 0.10 | 45.00 | 33.30 | 18.92 | 0.04 |
| 13 | 1.90 | 2.15 | 0.25 | 45.00 | 36.45 | 17.12 | 0.09 |
| 14 | 2.15 | 2.40 | 0.25 | 45.00 | 40.95 | 14.99 | 0.07 |
| 15 | 2.40 | 2.65 | 0.25 | 45.00 | 45.45 | 13.33 | 0.07 |
| 16 | 2.65 | 2.90 | 0.25 | 45.00 | 49.95 | 12.01 | 0.06 |
| 17 | 2.90 | 3.00 | 0.10 | 45.00 | 53.10 | 11.21 | 0.02 |
| 18 | 3.00 | 3.15 | 0.15 | 45.00 | 54.60 | 10.72 | 0.03 |
| 19 | 3.15 | 3.40 | 0.25 | 45.00 | 56.20 | 10.00 | 0.05 |
| 20 | 3.40 | 3.90 | 0.50 | 45.00 | 59.20 | 8.90 | 0.09 |
| 21 | 3.90 | 4.40 | 0.50 | 45.00 | 63.20 | 7.70 | 0.08 |
| 22 | 4.40 | 4.67 | 0.27 | 45.00 | 66.26 | 6.95 | 0.02 |

Settlement of mid point of longitudinal edge = 0.5 mm

Settlement of mid point of transverse edge 1 = 0.9 mm

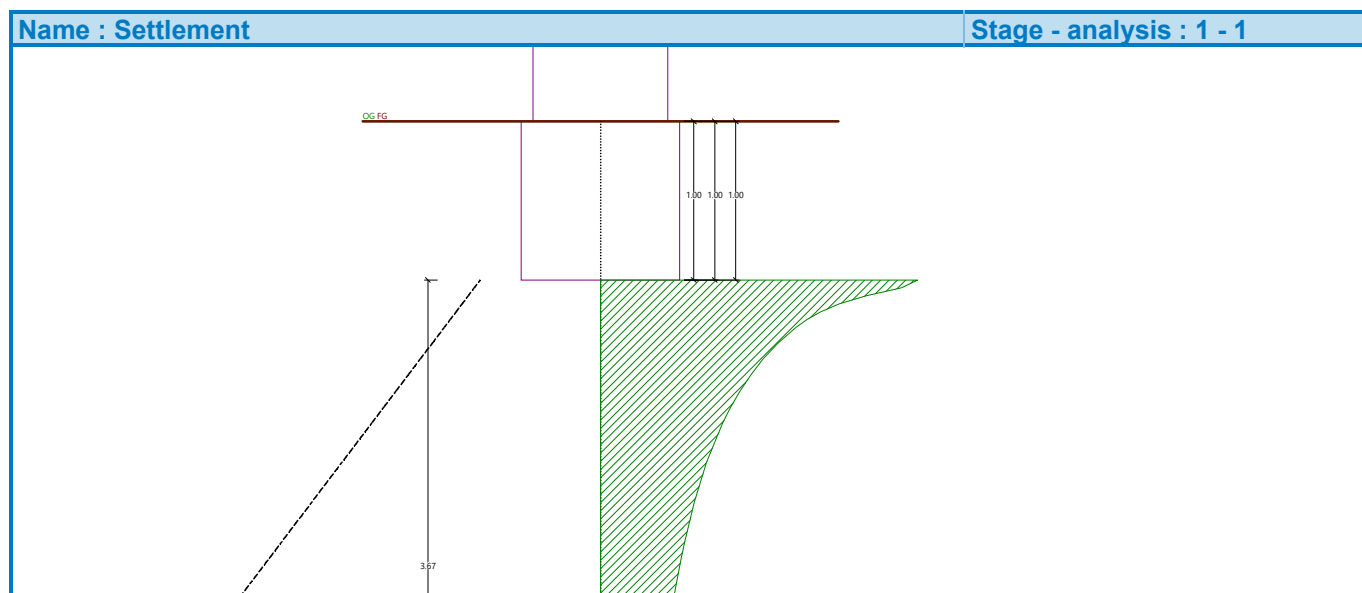
Settlement of mid point of transverse edge 2 = 0.9 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 45.00$ MPaFoundation in the longitudinal direction is rigid ($k=666.67$)Foundation in the direction of width is rigid ($k=666.67$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 1.1 mm

Depth of influence zone = 3.67 m

Rotation in direction of width = 0.000 (\tan^*1000); ($5.1E-17^\circ$)

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 16. TRAFOSTANICA UZ OBJEKAT MBT
 Description : Model 9
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.13

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

nt-komunalni otpad

Unit weight : $\gamma = 10.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 10.00 \text{ kN/m}^3$

CIM

Nikola Dakić

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 8.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 10.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 1.60 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 17.60 \text{ kN/m}^3$

SaU

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 33.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 4.45 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

Foundation

Foundation type: strip footing

Depth from original ground surface $h_z = 0.90 \text{ m}$
 Depth of footing bottom $d = 0.90 \text{ m}$
 Foundation thickness $t = 0.30 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure





Foundation type: strip footing

Overall strip footing length $= 14.50 \text{ m}$
 Strip footing width (x) $= 0.50 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

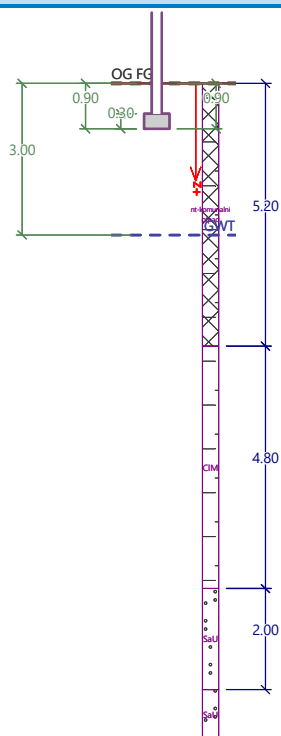
Volume of strip footing $= 0.15 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.45 \text{ m}^3/\text{m}$
 Volume of fill $= 0.18 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|--------------------|---|
| 1 | 5.20 | 0.00 .. 5.20 | nt-komunalni otpad |  |
| 2 | 4.80 | 5.20 .. 10.00 | CIM |  |
| 3 | 2.00 | 10.00 .. 12.00 | SaU |  |
| 4 | - | 12.00 .. ∞ | SaU |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|----------|------------------------|-----------------------|
| 1 | Yes | | ULS | Design | 68.08 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 68.08 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 139.76 | 56.94 | 245.45 | No |
| ULS | No | 0.00 | 0.00 | 139.76 | 56.94 | 245.45 | No |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 2.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 10.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 10.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.500 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.008$
 $s_c = 1.011$
 $s_\gamma = 0.990$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 56.941 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 1.80 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 0.53 \text{ m}$

Length of slip surface $l_{sp} = 1.34 \text{ m}$

Design bearing capacity of found.soil $R_d = 56.94 \text{ kPa}$

Extreme contact stress $\sigma = 139.76 \text{ kPa}$

Bearing capacity in the vertical direction is NOT SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 0.80 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 18.96 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is NOT SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/mComputed weight of overburden $Z = 1.80$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.90 | 0.95 | 0.05 | 0.56 | 9.25 | 119.95 | 5.00 |
| 2 | 0.95 | 1.00 | 0.05 | 0.56 | 9.75 | 99.62 | 4.15 |
| 3 | 1.00 | 1.05 | 0.05 | 0.56 | 10.25 | 84.71 | 3.53 |
| 4 | 1.05 | 1.10 | 0.05 | 0.56 | 10.75 | 75.31 | 3.14 |
| 5 | 1.10 | 1.15 | 0.05 | 0.56 | 11.25 | 68.02 | 2.83 |
| 6 | 1.15 | 1.20 | 0.05 | 0.56 | 11.75 | 61.93 | 2.58 |
| 7 | 1.20 | 1.30 | 0.10 | 0.56 | 12.50 | 54.71 | 4.56 |
| 8 | 1.30 | 1.40 | 0.10 | 0.56 | 13.50 | 46.97 | 3.91 |
| 9 | 1.40 | 1.50 | 0.10 | 0.56 | 14.50 | 41.15 | 3.43 |
| 10 | 1.50 | 1.60 | 0.10 | 0.56 | 15.50 | 36.63 | 3.05 |
| 11 | 1.60 | 1.70 | 0.10 | 0.56 | 16.50 | 33.04 | 2.75 |
| 12 | 1.70 | 1.80 | 0.10 | 0.56 | 17.50 | 30.10 | 2.51 |
| 13 | 1.80 | 2.05 | 0.25 | 0.56 | 19.25 | 26.24 | 5.47 |
| 14 | 2.05 | 2.30 | 0.25 | 0.56 | 21.75 | 21.92 | 4.57 |
| 15 | 2.30 | 2.55 | 0.25 | 0.56 | 24.25 | 18.77 | 3.91 |
| 16 | 2.55 | 2.80 | 0.25 | 0.56 | 26.75 | 16.35 | 3.41 |
| 17 | 2.80 | 3.00 | 0.20 | 0.56 | 29.00 | 14.59 | 2.43 |
| 18 | 3.00 | 3.05 | 0.05 | 0.56 | 30.00 | 13.74 | 0.57 |
| 19 | 3.05 | 3.30 | 0.25 | 0.56 | 30.00 | 12.86 | 2.68 |
| 20 | 3.30 | 3.80 | 0.50 | 0.56 | 30.00 | 11.08 | 4.61 |
| 21 | 3.80 | 4.30 | 0.50 | 0.56 | 30.00 | 9.21 | 3.84 |
| 22 | 4.30 | 4.80 | 0.50 | 0.56 | 30.00 | 7.82 | 3.26 |
| 23 | 4.80 | 5.20 | 0.40 | 0.56 | 30.00 | 6.86 | 2.29 |
| 24 | 5.20 | 5.30 | 0.10 | 0.75 | 30.38 | 6.40 | 0.40 |
| 25 | 5.30 | 5.80 | 0.50 | 0.75 | 32.66 | 5.94 | 1.86 |
| 26 | 5.80 | 6.30 | 0.50 | 0.75 | 36.46 | 5.28 | 1.65 |
| 27 | 6.30 | 6.98 | 0.68 | 0.75 | 40.96 | 4.67 | 1.33 |

Settlement of mid point of longitudinal edge = 46.9 mm

Settlement of mid point of transverse edge 1 = 84.9 mm

Settlement of mid point of transverse edge 2 = 84.9 mm

(1-max.compressed edge; 2-min.compressed edge)

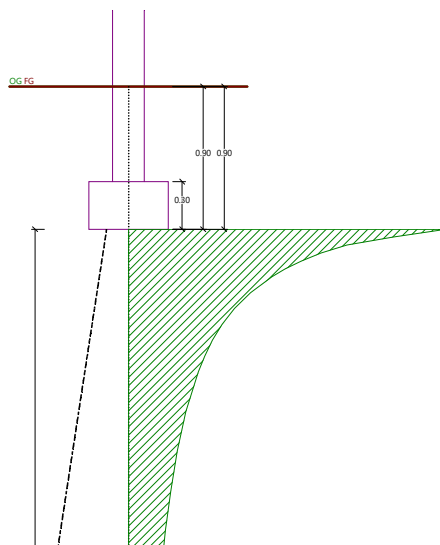
Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 0.58$ MPaFoundation in the longitudinal direction is rigid ($k=11145.04$)Foundation in the direction of width is rigid ($k=1393.13$)

Verification of load eccentricityMax. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 83.7 mm

Depth of influence zone = 6.08 m

Rotation in direction of width = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement**Stage - analysis : 1 - 1**

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 16. TRAFOSTANICA UZ OBJEKAT MBT
 Description : Model 9 - B-16 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.13.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Nikola Dakić

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 7.00^\circ$
 Cohesion of soil : $c_{ef} = 13.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.60 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 2.94 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

Foundation

Foundation type: strip footing

Depth from original ground surface $h_z = 0.90 \text{ m}$
 Depth of footing bottom $d = 0.90 \text{ m}$
 Foundation thickness $t = 0.30 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure

Foundation type: strip footing

Overall strip footing length $= 14.50 \text{ m}$
 Strip footing width (x) $= 0.50 \text{ m}$
 Column width in the direction of x $= 0.20 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.


Volume of strip footing $= 0.15 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.45 \text{ m}^3/\text{m}$
 Volume of fill $= 0.18 \text{ m}^3/\text{m}$

Sand-gravel bed

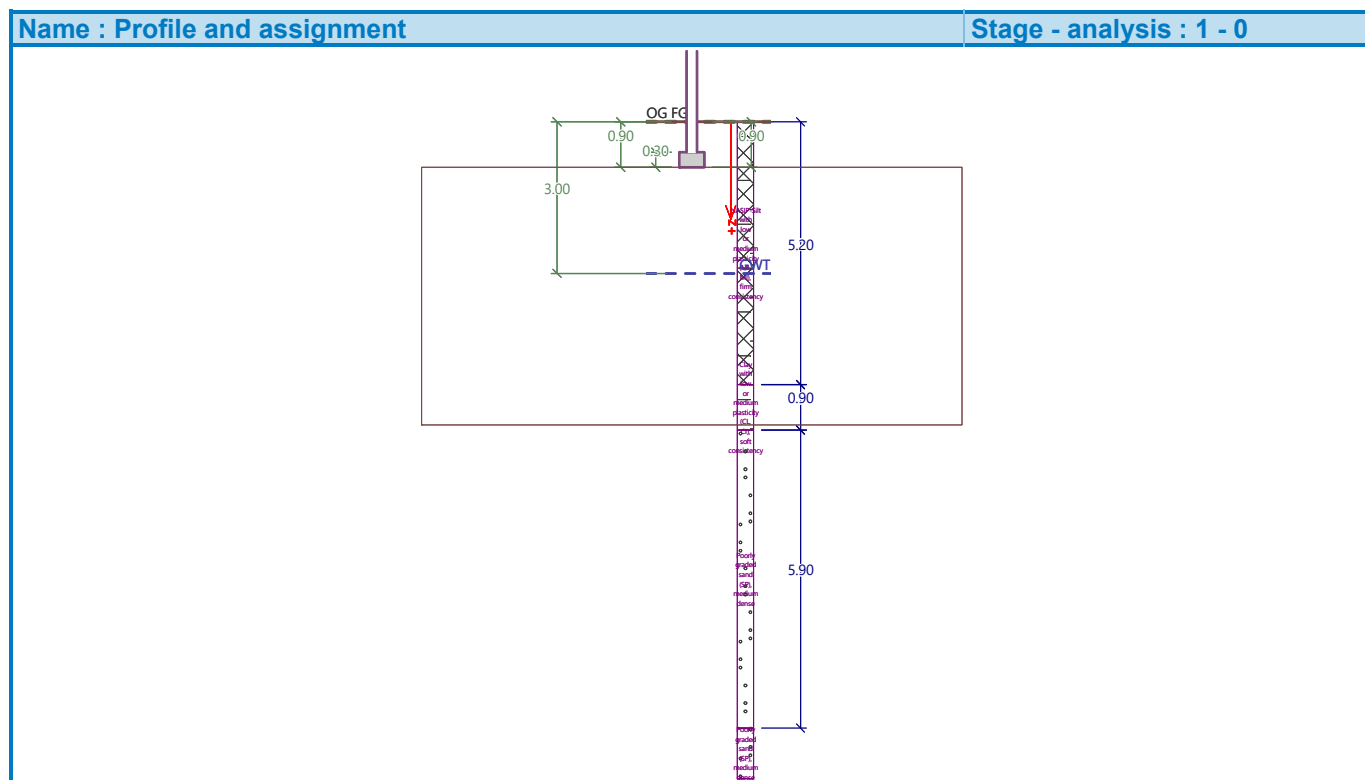
Soil used for the SG pad - Poorly graded gravel (GP), medium dense

SG pad overhangs foundation $d_{sp} = 5.10 \text{ m}$
 Sand-gravel pad depth $h_{sp} = 5.10 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 5.20 | 0.00 .. 5.20 | NASIP-Silt with low or medium plasticity (ML, MI), firm consistency |  |

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---------|
| 2 | 0.90 | 5.20 .. 6.10 | Clay with low or medium plasticity (CL, CI), soft consistency | |
| 3 | 5.90 | 6.10 .. 12.00 | Poorly graded sand (SP), medium dense | |
| 4 | - | 12.00 .. ∞ | Poorly graded sand (SP), medium dense | |



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|----------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 68.08 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 68.08 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1**Load case verification**

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 142.64 | 371.41 | 38.40 | Yes |
| ULS | No | 0.00 | 0.00 | 142.64 | 371.41 | 38.40 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 29.256^\circ$
 $c_d = 0.000 \text{ kPa}$
 $\gamma_{1prum} = 18.000 \text{ kN/m}^3$
 $\gamma_{2prum} = 21.000 \text{ kN/m}^3$
 $b_{ef} = 0.500 \text{ m}$
 $N_q = 16.921$
 $N_c = 28.422$
 $N_\gamma = 17.837$
 $s_q = 1.017$
 $s_c = 1.018$
 $s_\gamma = 0.990$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 371.413 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 3.24 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 0.95 \text{ m}$

Length of slip surface $l_{sp} = 3.13 \text{ m}$

Design bearing capacity of found.soil $R_d = 371.41 \text{ kPa}$

Extreme contact stress $\sigma = 142.64 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Horizontal bearing capacity check**

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 1.43 \text{ kN}$ Horizontal bearing capacity $R_{dh} = 41.38 \text{ kN}$ Extreme horizontal force $H = 0.00 \text{ kN}$ **Bearing capacity in the horizontal direction is SATISFACTORY****Bearing capacity of foundation is SATISFACTORY****Verification No. 1****Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$ Computed weight of overburden $Z = 3.24 \text{ kN/m}$ **Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.90 | 0.95 | 0.05 | 45.00 | 16.65 | 115.98 | 0.12 |
| 2 | 0.95 | 1.00 | 0.05 | 45.00 | 17.55 | 96.33 | 0.10 |
| 3 | 1.00 | 1.05 | 0.05 | 45.00 | 18.45 | 81.91 | 0.08 |
| 4 | 1.05 | 1.10 | 0.05 | 45.00 | 19.35 | 72.82 | 0.07 |
| 5 | 1.10 | 1.15 | 0.05 | 45.00 | 20.25 | 65.77 | 0.07 |
| 6 | 1.15 | 1.20 | 0.05 | 45.00 | 21.15 | 59.89 | 0.06 |
| 7 | 1.20 | 1.30 | 0.10 | 45.00 | 22.50 | 52.90 | 0.11 |
| 8 | 1.30 | 1.40 | 0.10 | 45.00 | 24.30 | 45.42 | 0.09 |
| 9 | 1.40 | 1.50 | 0.10 | 45.00 | 26.10 | 39.79 | 0.08 |
| 10 | 1.50 | 1.60 | 0.10 | 45.00 | 27.90 | 35.42 | 0.07 |
| 11 | 1.60 | 1.70 | 0.10 | 45.00 | 29.70 | 31.95 | 0.06 |
| 12 | 1.70 | 1.80 | 0.10 | 45.00 | 31.50 | 29.10 | 0.06 |
| 13 | 1.80 | 2.05 | 0.25 | 45.00 | 34.65 | 25.38 | 0.13 |
| 14 | 2.05 | 2.30 | 0.25 | 45.00 | 39.15 | 21.20 | 0.11 |
| 15 | 2.30 | 2.55 | 0.25 | 45.00 | 43.65 | 18.15 | 0.09 |
| 16 | 2.55 | 2.80 | 0.25 | 45.00 | 48.15 | 15.81 | 0.08 |
| 17 | 2.80 | 3.00 | 0.20 | 45.00 | 52.20 | 14.11 | 0.06 |
| 18 | 3.00 | 3.05 | 0.05 | 45.00 | 54.20 | 13.28 | 0.01 |
| 19 | 3.05 | 3.30 | 0.25 | 45.00 | 55.40 | 12.44 | 0.06 |
| 20 | 3.30 | 3.80 | 0.50 | 45.00 | 58.40 | 10.71 | 0.11 |
| 21 | 3.80 | 4.30 | 0.50 | 45.00 | 62.40 | 8.90 | 0.09 |
| 22 | 4.30 | 4.80 | 0.50 | 45.00 | 66.40 | 7.57 | 0.08 |
| 23 | 4.80 | 4.86 | 0.06 | 45.00 | 68.63 | 6.94 | 0.00 |

Settlement of mid point of longitudinal edge = 0.9 mm

Settlement of mid point of transverse edge 1 = 1.8 mm

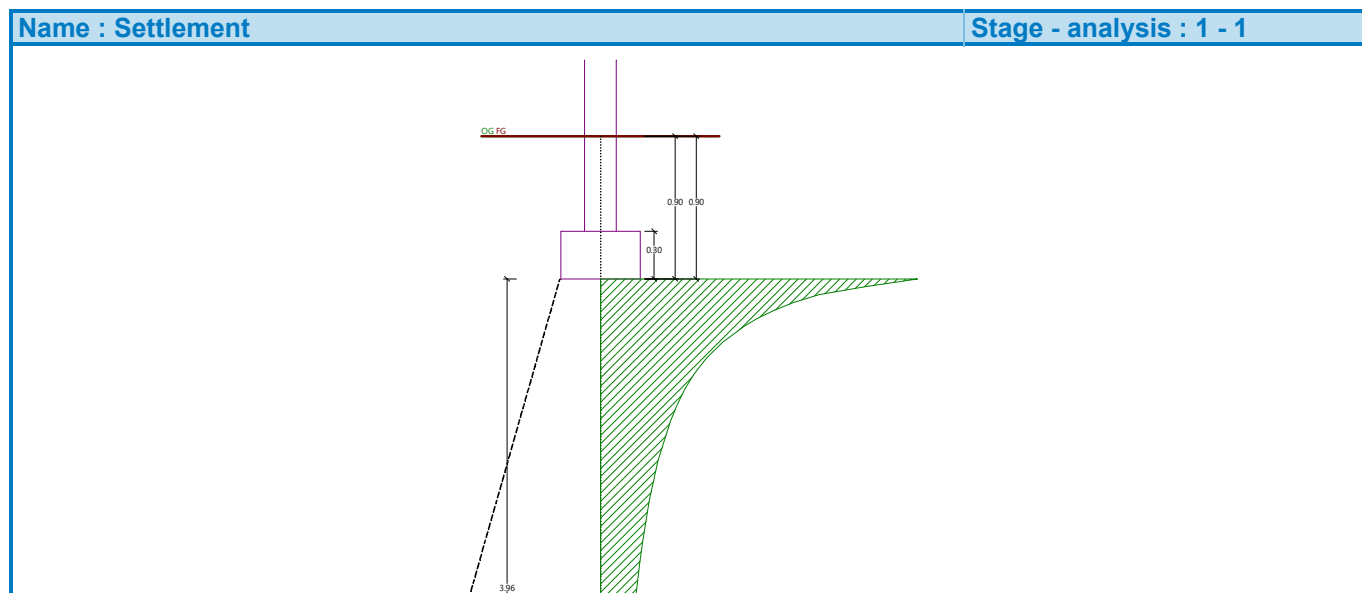
Settlement of mid point of transverse edge 2 = 1.8 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{\text{def}} = 45.00 \text{ MPa}$ Foundation in the longitudinal direction is rigid ($k=144.00$)Foundation in the direction of width is rigid ($k=18.00$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 1.8 mm

Depth of influence zone = 3.96 m

Rotation in direction of width = 0.000 ($\tan \cdot 1000$); ($3.6\text{E-}16^\circ$)

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 19. GARAŽA ZA VOZILA
 Description : Model 10 - B-23
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.14

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.89 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 34.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 4.18 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.35 \text{ m}$
 Depth of footing bottom $d = 1.35 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.40 \text{ m}$
 Spread footing width $y = 1.20 \text{ m}$
 Column width in the direction of x $c_x = 0.80 \text{ m}$
 Column width in the direction of y $c_y = 0.80 \text{ m}$

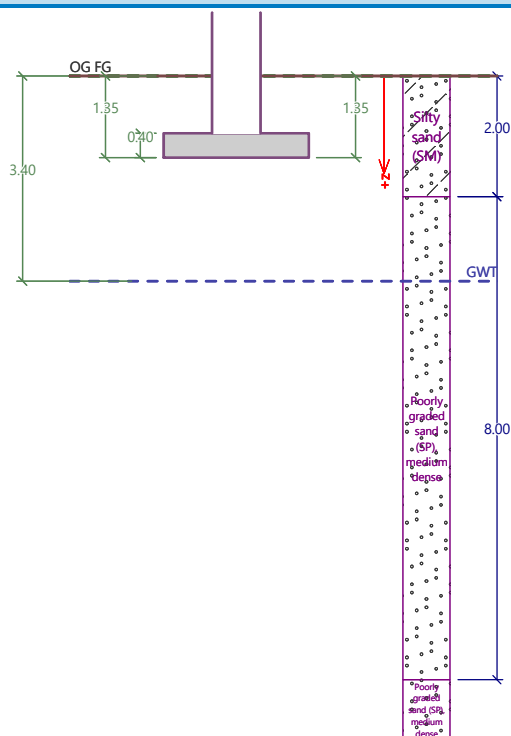
Spread footing volume $= 1.15 \text{ m}^3$
 Volume of excavation $= 3.89 \text{ m}^3$
 Volume of fill $= 2.13 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------------------------------|---|
| 1 | 2.00 | 0.00 .. 2.00 | Silty sand (SM) |  |
| 2 | 8.00 | 2.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 222.70 | 68.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 222.70 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.40 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | -0.26 | 160.18 | 375.35 | 42.67 | Yes |
| ULS | No | 0.00 | -0.26 | 160.18 | 375.35 | 42.67 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 25.699^\circ \\ c_d &= 0.386 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 16.798 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.679 \text{ m}\end{aligned}$$

$N_q = 11.480$
 $N_c = 21.777$
 $N_\gamma = 10.087$
 $s_q = 1.123$
 $s_c = 1.134$
 $s_\gamma = 0.915$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 375.351 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$
 Computed weight of overburden $Z = 38.30 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.97 \text{ m}$

Length of slip surface $l_{sp} = 6.05 \text{ m}$

Design bearing capacity of found.soil $R_d = 375.35 \text{ kPa}$

Extreme contact stress $\sigma = 160.18 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.217 < 0.333$

Max. overall eccentricity $e_t = 0.217 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.05 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 97.01 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 38.30$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.35 | 1.40 | 0.05 | 1.40 | 24.75 | 65.60 | 1.74 |
| 2 | 1.40 | 1.45 | 0.05 | 1.40 | 25.65 | 62.19 | 1.65 |
| 3 | 1.45 | 1.50 | 0.05 | 1.40 | 26.55 | 56.35 | 1.49 |
| 4 | 1.50 | 1.55 | 0.05 | 1.40 | 27.45 | 50.39 | 1.33 |
| 5 | 1.55 | 1.60 | 0.05 | 1.40 | 28.35 | 45.29 | 1.20 |
| 6 | 1.60 | 1.65 | 0.05 | 1.40 | 29.25 | 41.09 | 1.09 |
| 7 | 1.65 | 1.75 | 0.10 | 1.40 | 30.60 | 36.35 | 1.92 |
| 8 | 1.75 | 1.85 | 0.10 | 1.40 | 32.40 | 31.42 | 1.66 |
| 9 | 1.85 | 1.95 | 0.10 | 1.40 | 34.20 | 27.74 | 1.47 |
| 10 | 1.95 | 2.00 | 0.05 | 1.40 | 35.55 | 25.48 | 0.67 |
| 11 | 2.00 | 2.05 | 0.05 | 3.27 | 36.39 | 24.18 | 0.29 |
| 12 | 2.05 | 2.15 | 0.10 | 3.27 | 37.56 | 22.44 | 0.54 |
| 13 | 2.15 | 2.25 | 0.10 | 3.27 | 39.12 | 20.42 | 0.49 |
| 14 | 2.25 | 2.50 | 0.25 | 3.27 | 41.85 | 17.66 | 1.06 |
| 15 | 2.50 | 2.75 | 0.25 | 3.27 | 45.75 | 14.49 | 0.87 |
| 16 | 2.75 | 3.00 | 0.25 | 3.27 | 49.65 | 12.13 | 0.73 |
| 17 | 3.00 | 3.25 | 0.25 | 3.27 | 53.55 | 10.30 | 0.62 |
| 18 | 3.25 | 3.40 | 0.15 | 3.27 | 56.67 | 9.12 | 0.33 |
| 19 | 3.40 | 3.50 | 0.10 | 3.27 | 58.12 | 8.48 | 0.20 |
| 20 | 3.50 | 3.75 | 0.25 | 3.27 | 59.10 | 7.70 | 0.46 |
| 21 | 3.75 | 4.08 | 0.33 | 3.27 | 60.71 | 6.67 | 0.33 |

Settlement of mid point of edge x - 1 = 17.8 mm

Settlement of mid point of edge x - 2 = 17.8 mm

Settlement of mid point of edge y - 1 = 14.9 mm

Settlement of mid point of edge y - 2 = 14.9 mm

Settlement of foundation center point = 28.1 mm

Settlement of characteristic point = 20.1 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 2.34$ MPa

Foundation in the longitudinal direction is rigid ($k=59.26$)

Foundation in the direction of width is rigid ($k=474.07$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

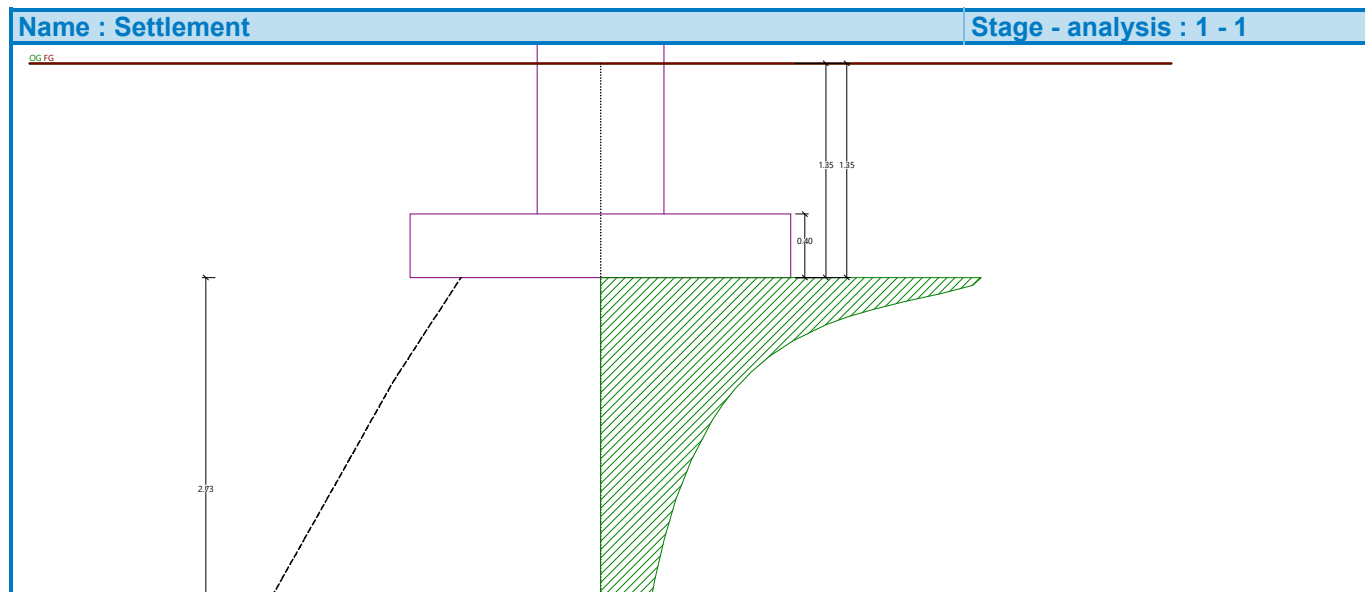
Overall settlement and rotation of foundation:

Foundation settlement = 20.1 mm

Depth of influence zone = 2.73 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 19. GARAŽA ZA VOZILA
 Description : Model 10 - B-23 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.14.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.89 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 34.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 4.18 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.35 \text{ m}$
 Depth of footing bottom $d = 1.35 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.40 \text{ m}$
 Spread footing width $y = 1.20 \text{ m}$
 Column width in the direction of x $c_x = 0.80 \text{ m}$
 Column width in the direction of y $c_y = 0.80 \text{ m}$


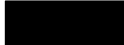

Spread footing volume $= 1.15 \text{ m}^3$
 Volume of excavation $= 3.89 \text{ m}^3$
 Volume of fill $= 2.13 \text{ m}^3$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

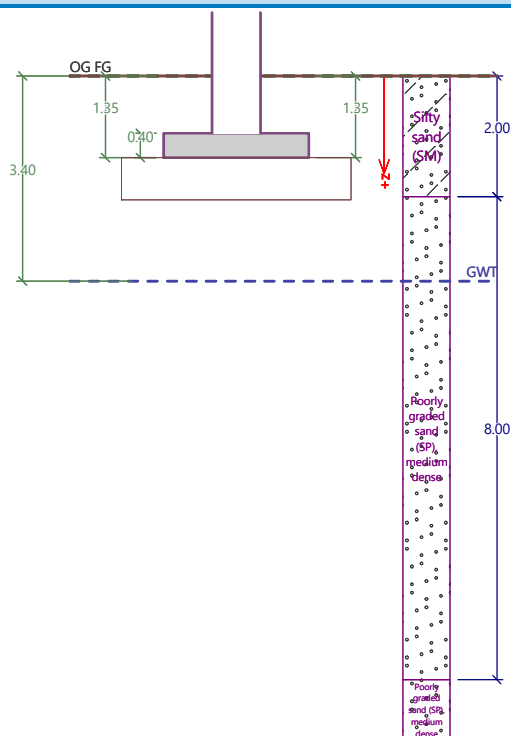
SG pad overhangs foundation $d_{\text{sp}} = 0.70 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.70 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------------------------------|---|
| 1 | 2.00 | 0.00 .. 2.00 | Silty sand (SM) |  |
| 2 | 8.00 | 2.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 222.70 | 68.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 222.70 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.40 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | -0.26 | 160.18 | 420.19 | 38.12 | Yes |
| ULS | No | 0.00 | -0.26 | 160.18 | 420.19 | 38.12 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 26.707^\circ \\ c_d &= 0.250 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 17.171 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.679 \text{ m}\end{aligned}$$

$N_q = 12.788$
 $N_c = 23.431$
 $N_\gamma = 11.861$
 $s_q = 1.127$
 $s_c = 1.138$
 $s_\gamma = 0.915$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 420.188 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 38.30 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.05 \text{ m}$

Length of slip surface $l_{sp} = 6.43 \text{ m}$

Design bearing capacity of found.soil $R_d = 420.19 \text{ kPa}$

Extreme contact stress $\sigma = 160.18 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.217 < 0.333$

Max. overall eccentricity $e_t = 0.217 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.05 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 152.26 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 38.30$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.35 | 1.40 | 0.05 | 27.00 | 24.75 | 65.60 | 0.11 |
| 2 | 1.40 | 1.45 | 0.05 | 27.00 | 25.65 | 62.19 | 0.10 |
| 3 | 1.45 | 1.50 | 0.05 | 27.00 | 26.55 | 56.35 | 0.09 |
| 4 | 1.50 | 1.55 | 0.05 | 27.00 | 27.45 | 50.39 | 0.08 |
| 5 | 1.55 | 1.60 | 0.05 | 27.00 | 28.35 | 45.29 | 0.08 |
| 6 | 1.60 | 1.65 | 0.05 | 27.00 | 29.25 | 41.09 | 0.07 |
| 7 | 1.65 | 1.75 | 0.10 | 27.00 | 30.60 | 36.35 | 0.12 |
| 8 | 1.75 | 1.85 | 0.10 | 27.00 | 32.40 | 31.42 | 0.10 |
| 9 | 1.85 | 1.95 | 0.10 | 27.00 | 34.20 | 27.74 | 0.09 |
| 10 | 1.95 | 2.00 | 0.05 | 27.00 | 35.55 | 25.48 | 0.04 |
| 11 | 2.00 | 2.05 | 0.05 | 27.00 | 36.39 | 24.18 | 0.04 |
| 12 | 2.05 | 2.15 | 0.10 | 3.27 | 37.56 | 22.44 | 0.54 |
| 13 | 2.15 | 2.25 | 0.10 | 3.27 | 39.12 | 20.42 | 0.49 |
| 14 | 2.25 | 2.50 | 0.25 | 3.27 | 41.85 | 17.66 | 1.06 |
| 15 | 2.50 | 2.75 | 0.25 | 3.27 | 45.75 | 14.49 | 0.87 |
| 16 | 2.75 | 3.00 | 0.25 | 3.27 | 49.65 | 12.13 | 0.73 |
| 17 | 3.00 | 3.25 | 0.25 | 3.27 | 53.55 | 10.30 | 0.62 |
| 18 | 3.25 | 3.40 | 0.15 | 3.27 | 56.67 | 9.12 | 0.33 |
| 19 | 3.40 | 3.50 | 0.10 | 3.27 | 58.12 | 8.48 | 0.20 |
| 20 | 3.50 | 3.75 | 0.25 | 3.27 | 59.10 | 7.70 | 0.46 |
| 21 | 3.75 | 4.08 | 0.33 | 3.27 | 60.71 | 6.67 | 0.33 |

Settlement of mid point of edge x - 1 = 7.5 mm

Settlement of mid point of edge x - 2 = 7.5 mm

Settlement of mid point of edge y - 1 = 5.5 mm

Settlement of mid point of edge y - 2 = 5.5 mm

Settlement of foundation center point = 9.7 mm

Settlement of characteristic point = 6.5 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 15.68$ MPa

Foundation in the longitudinal direction is rigid ($k=8.86$)

Foundation in the direction of width is rigid ($k=70.88$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

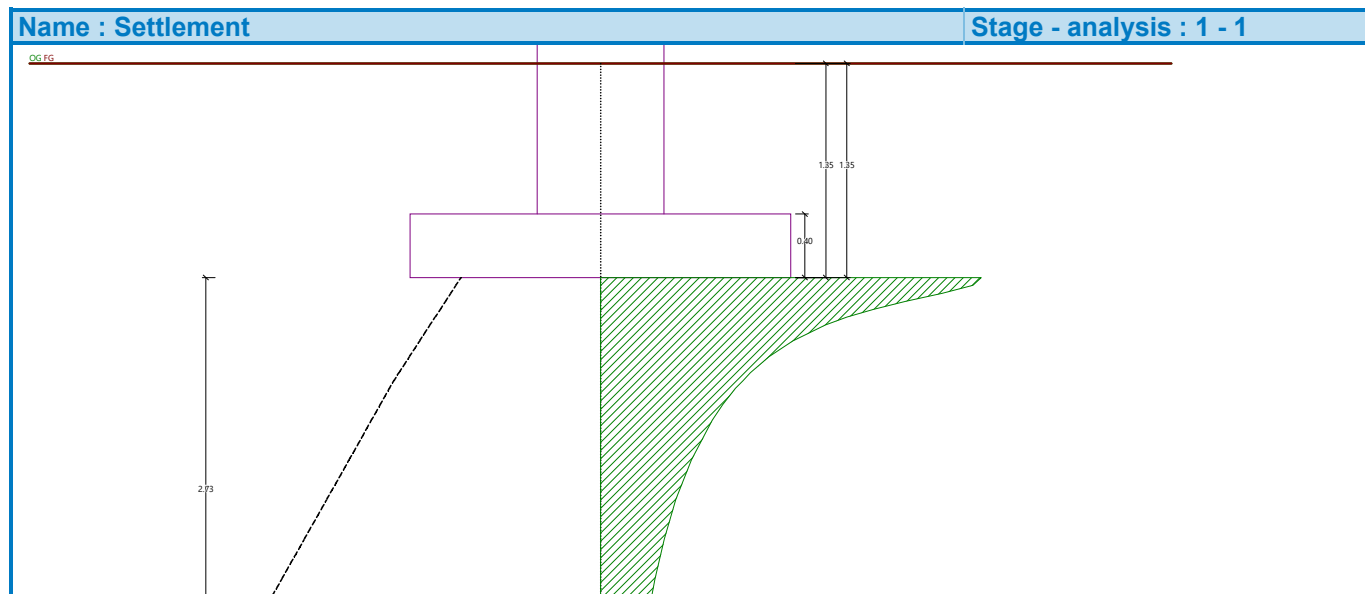
Overall settlement and rotation of foundation:

Foundation settlement = 6.5 mm

Depth of influence zone = 2.73 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 20. POSTOJEĆE POSTROJENJE ZA RAZVRSTAVANJE OTPADA
 Description : Model 11 - B-26
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.15

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 7.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 13.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.57 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.76 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile





Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 45.00 \text{ m}$
 Strip footing width (x) $= 0.95 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

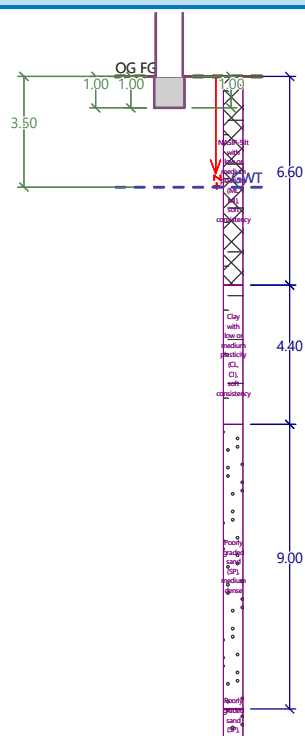
Volume of strip footing $= 0.95 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.95 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 6.60 | 0.00 .. 6.60 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 4.40 | 6.60 .. 11.00 | Clay with low or medium plasticity (CL, CI), soft consistency |  |
| 3 | 9.00 | 11.00 .. 20.00 | Poorly graded sand (SP), medium dense |  |
| 4 | - | 20.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 95.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 95.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.50 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 100.00 | 95.77 | 104.42 | No |
| ULS | No | 0.00 | 0.00 | 100.00 | 95.77 | 104.42 | No |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 2.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3\end{aligned}$$

$b_{ef} = 0.950 \text{ m}$
 $N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.005$
 $s_c = 1.007$
 $s_\gamma = 0.994$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 95.767 \text{ kPa}$

Analysis carried out with automatic selection of the most unfavourable load cases.

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle
 Most unfavorable load case No. 1. (ULS)

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.02 \text{ m}$
 Length of slip surface $l_{sp} = 2.55 \text{ m}$

Design bearing capacity of found.soil $R_d = 95.77 \text{ kPa}$
 Extreme contact stress $\sigma = 100.00 \text{ kPa}$

Bearing capacity in the vertical direction is NOT SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$
 Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$
 Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Most unfavorable load case No. 1. (ULS)
 Earth resistance: at rest
 Design magnitude of earth resistance $S_{pd} = 6.05 \text{ kN}$
 Horizontal bearing capacity $R_{dh} = 31.32 \text{ kN}$
 Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is NOT SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00$ kN/m

Computed weight of overburden $Z = 0.00$ kN/m

Settlement of mid point of longitudinal edge = 38.7 mm

Settlement of mid point of transverse edge 1 = 77.9 mm

Settlement of mid point of transverse edge 2 = 77.9 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 0.56$ MPa

Foundation in the longitudinal direction is rigid ($k=62483.08$)

Foundation in the direction of width is rigid ($k=53571.43$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

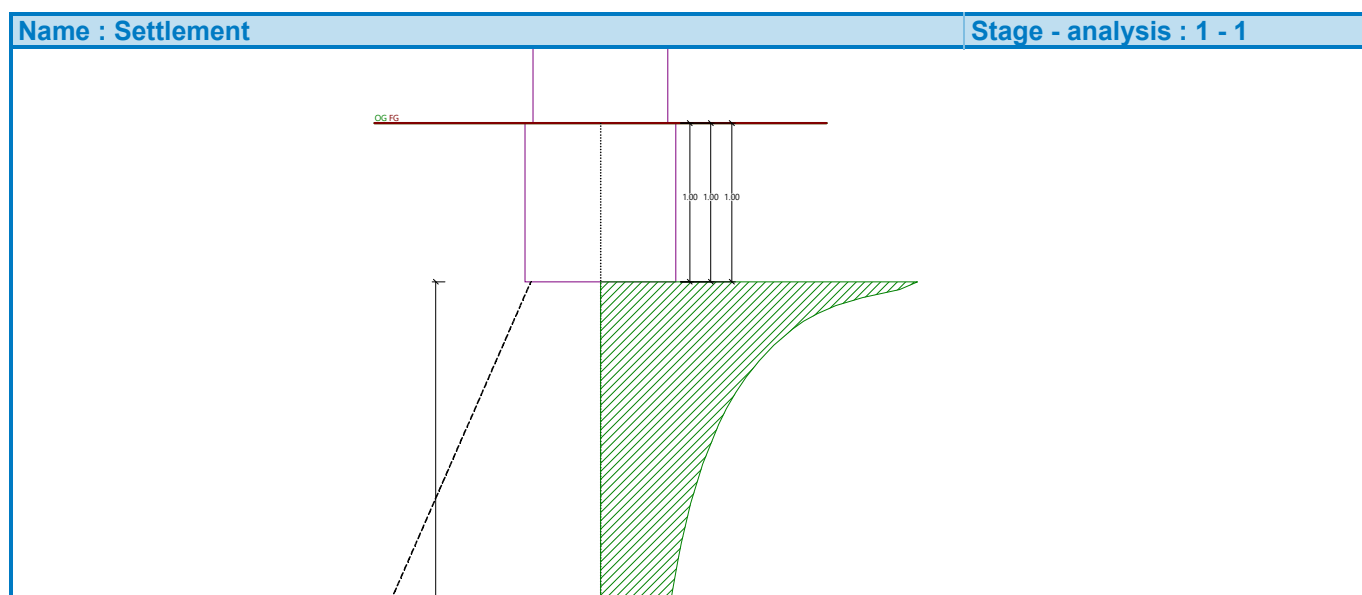
Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

Foundation settlement = 86.2 mm

Depth of influence zone = 5.00 m

Rotation in direction of width = 0.000 ($\tan \cdot 1000$); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 20. POSTOJEĆE POSTROJENJE ZA RAZVRSTAVANJE OTPADA
 Description : Model 11 - B-26 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.15.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 7.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 13.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.57 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.76 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 1.00 \text{ m}$
 Depth of footing bottom $d = 1.00 \text{ m}$
 Foundation thickness $t = 1.00 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 45.00 \text{ m}$
 Strip footing width (x) $= 0.95 \text{ m}$
 Column width in the direction of x $= 0.85 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.


Volume of strip footing $= 0.95 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.95 \text{ m}^3/\text{m}$
 Volume of fill $= 0.00 \text{ m}^3/\text{m}$

Sand-gravel bed

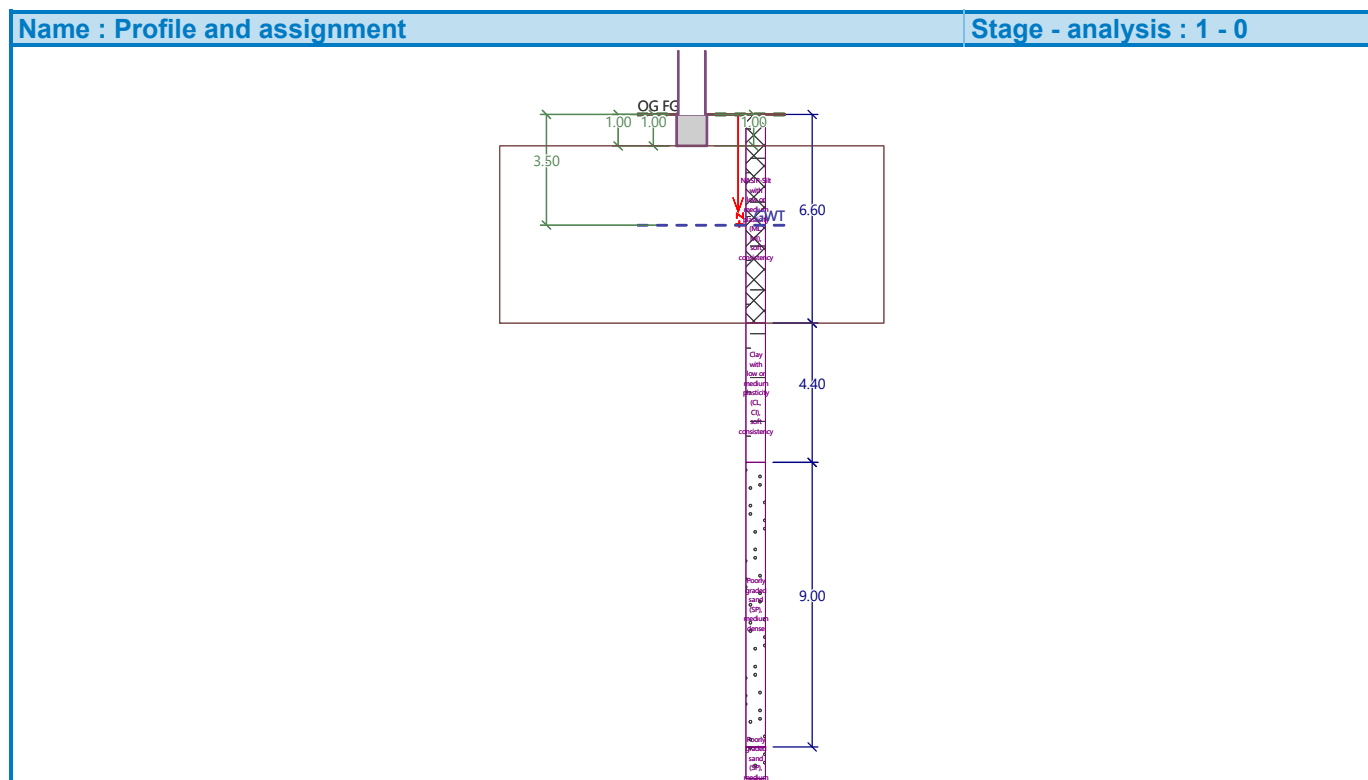
Soil used for the SG pad - Poorly graded gravel (GP), medium dense

SG pad overhangs foundation $d_{\text{sp}} = 5.60 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 5.60 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 6.60 | 0.00 .. 6.60 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---------|
| 2 | 4.40 | 6.60 .. 11.00 | Clay with low or medium plasticity (CL, CI), soft consistency | |
| 3 | 9.00 | 11.00 .. 20.00 | Poorly graded sand (SP), medium dense | |
| 4 | - | 20.00 .. ∞ | Poorly graded sand (SP), medium dense | |



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|----------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 95.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 95.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.50 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1**Load case verification**

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 100.00 | 459.78 | 21.75 | Yes |
| ULS | No | 0.00 | 0.00 | 100.00 | 459.78 | 21.75 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 28.833^\circ$
 $c_d = 0.056 \text{ kPa}$
 $\gamma_{1prum} = 18.000 \text{ kN/m}^3$
 $\gamma_{2prum} = 20.941 \text{ kN/m}^3$
 $b_{ef} = 0.950 \text{ m}$
 $N_q = 16.140$
 $N_c = 27.502$
 $N_\gamma = 16.669$
 $s_q = 1.010$
 $s_c = 1.011$
 $s_\gamma = 0.994$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 459.782 \text{ kPa}$

Analysis carried out with automatic selection of the most unfavourable load cases.

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle
 Most unfavorable load case No. 1. (ULS)

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.77 \text{ m}$
 Length of slip surface $l_{sp} = 5.79 \text{ m}$

Design bearing capacity of found.soil $R_d = 459.78 \text{ kPa}$
 Extreme contact stress $\sigma = 100.00 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$
 Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Most unfavorable load case No. 1. (ULS)

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.05 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 59.27 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 0.00 \text{ kN/m}$

Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Settlement of mid point of longitudinal edge $= 0.9 \text{ mm}$

Settlement of mid point of transverse edge 1 $= 1.9 \text{ mm}$

Settlement of mid point of transverse edge 2 $= 1.9 \text{ mm}$

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:

Computed weighted average modulus of deformation $E_{def} = 45.00 \text{ MPa}$

Foundation in the longitudinal direction is rigid ($k=777.57$)

Foundation in the direction of width is rigid ($k=666.67$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

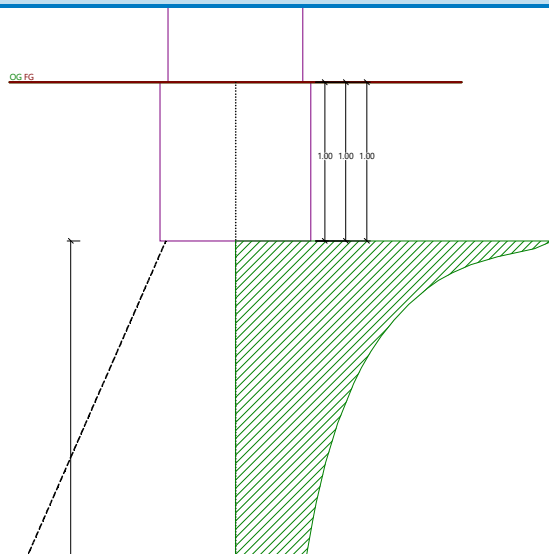
Foundation settlement $= 2.1 \text{ mm}$

Depth of influence zone $= 5.00 \text{ m}$

Rotation in direction of width $= 0.000 \text{ (tan*1000)}; (2.7\text{E-}17^\circ)$

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 20. POSTOJEĆE POSTROJENJE ZA RAZVRSTAVANJE OTPADA
 Description : Model 11 - B-26 samac
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.15.2

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 7.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 13.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.57 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.76 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.10 \text{ m}$
 Depth of footing bottom $d = 1.10 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden





Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.80 \text{ m}$
 Spread footing width $y = 1.40 \text{ m}$
 Column width in the direction of x $c_x = 0.40 \text{ m}$
 Column width in the direction of y $c_y = 0.40 \text{ m}$

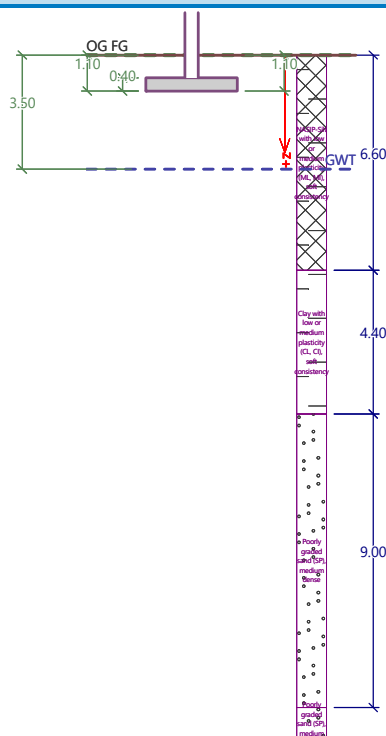
Spread footing volume = 1.57 m^3
 Volume of excavation = 4.31 m^3
 Volume of fill = 2.63 m^3

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---|---|
| 1 | 6.60 | 0.00 .. 6.60 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 4.40 | 6.60 .. 11.00 | Clay with low or medium plasticity (CL, CI), soft consistency |  |
| 3 | 9.00 | 11.00 .. 20.00 | Poorly graded sand (SP), medium dense |  |
| 4 | - | 20.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 392.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 392.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.50 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 112.09 | 116.18 | 96.48 | Yes |
| ULS | No | 0.00 | 0.00 | 112.09 | 116.18 | 96.48 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 2.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.400 \text{ m}\end{aligned}$$

| | | |
|------------|---|-------------|
| N_q | = | 3.500 |
| N_c | = | 10.222 |
| N_γ | = | 1.223 |
| s_q | = | 1.119 |
| s_c | = | 1.166 |
| s_γ | = | 0.850 |
| d_q | = | 1.000 |
| d_c | = | 1.000 |
| d_γ | = | 1.000 |
| i_q | = | 1.000 |
| i_c | = | 1.000 |
| i_γ | = | 1.000 |
| b_q | = | 1.000 |
| b_c | = | 1.000 |
| b_γ | = | 1.000 |
| g_q | = | 1.000 |
| g_c | = | 1.000 |
| g_γ | = | 1.000 |
| R_d | = | 116.181 kPa |

Analysis carried out with automatic selection of the most unfavourable load cases.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 47.38$ kN

Vertical bearing capacity check

Shape of contact stress : rectangle

Most unfavorable load case No. 1. (ULS)

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.50$ m

Length of slip surface $l_{sp} = 3.76$ m

Design bearing capacity of found.soil $R_d = 116.18$ kPa

Extreme contact stress $\sigma = 112.09$ kPa

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Most unfavorable load case No. 1. (ULS)

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.42$ kN

Horizontal bearing capacity $R_{dh} = 122.28$ kN

Extreme horizontal force $H = 0.00$ kN

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 47.38$ kN

Settlement of mid point of edge x - 1 = 73.6 mm

Settlement of mid point of edge x - 2 = 73.6 mm

Settlement of mid point of edge y - 1 = 59.6 mm

Settlement of mid point of edge y - 2 = 59.6 mm

Settlement of foundation center point = 106.6 mm

Settlement of characteristic point = 75.8 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:

Computed weighted average modulus of deformation $E_{def} = 0.56$ MPa

Foundation in the longitudinal direction is rigid ($k=156.18$)

Foundation in the direction of width is rigid ($k=1249.48$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

Foundation settlement = 75.8 mm

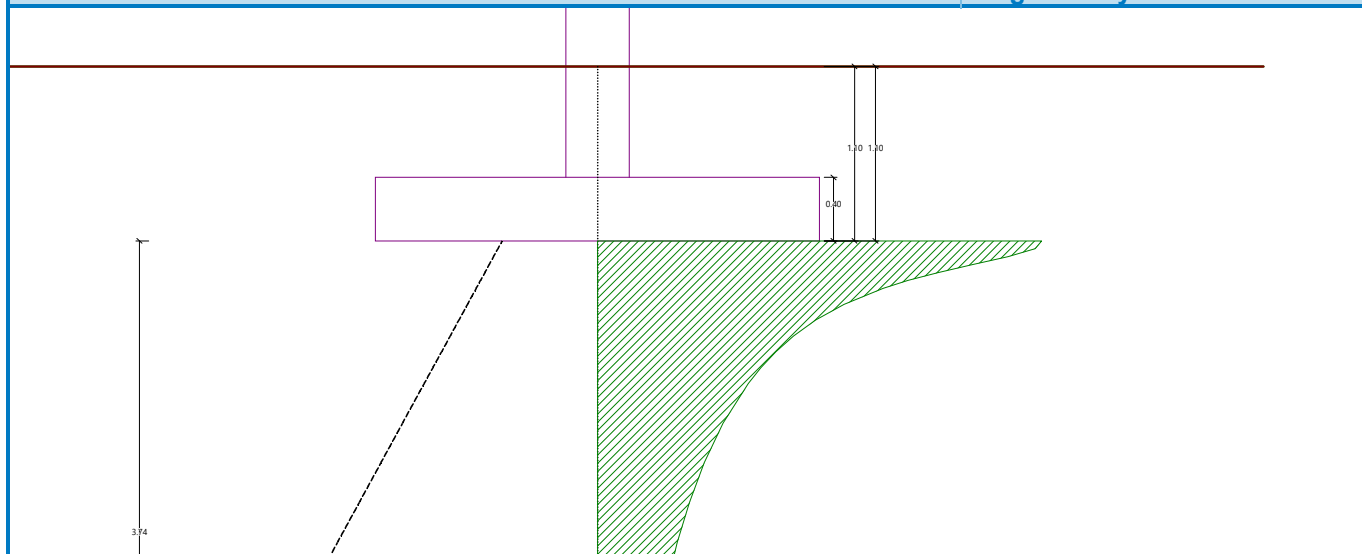
Depth of influence zone = 3.74 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 20. POSTOJEĆE POSTROJENJE ZA RAZVRSTAVANJE OTPADA
 Description : Model 11 - B-26 samac - tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.15.3

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 7.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 13.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.57 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.76 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.10 \text{ m}$
 Depth of footing bottom $d = 1.10 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 2.80 \text{ m}$
 Spread footing width $y = 1.40 \text{ m}$
 Column width in the direction of x $c_x = 0.40 \text{ m}$
 Column width in the direction of y $c_y = 0.40 \text{ m}$
 Spread footing volume $= 1.57 \text{ m}^3$
 Volume of excavation $= 4.31 \text{ m}^3$
 Volume of fill $= 2.63 \text{ m}^3$



Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

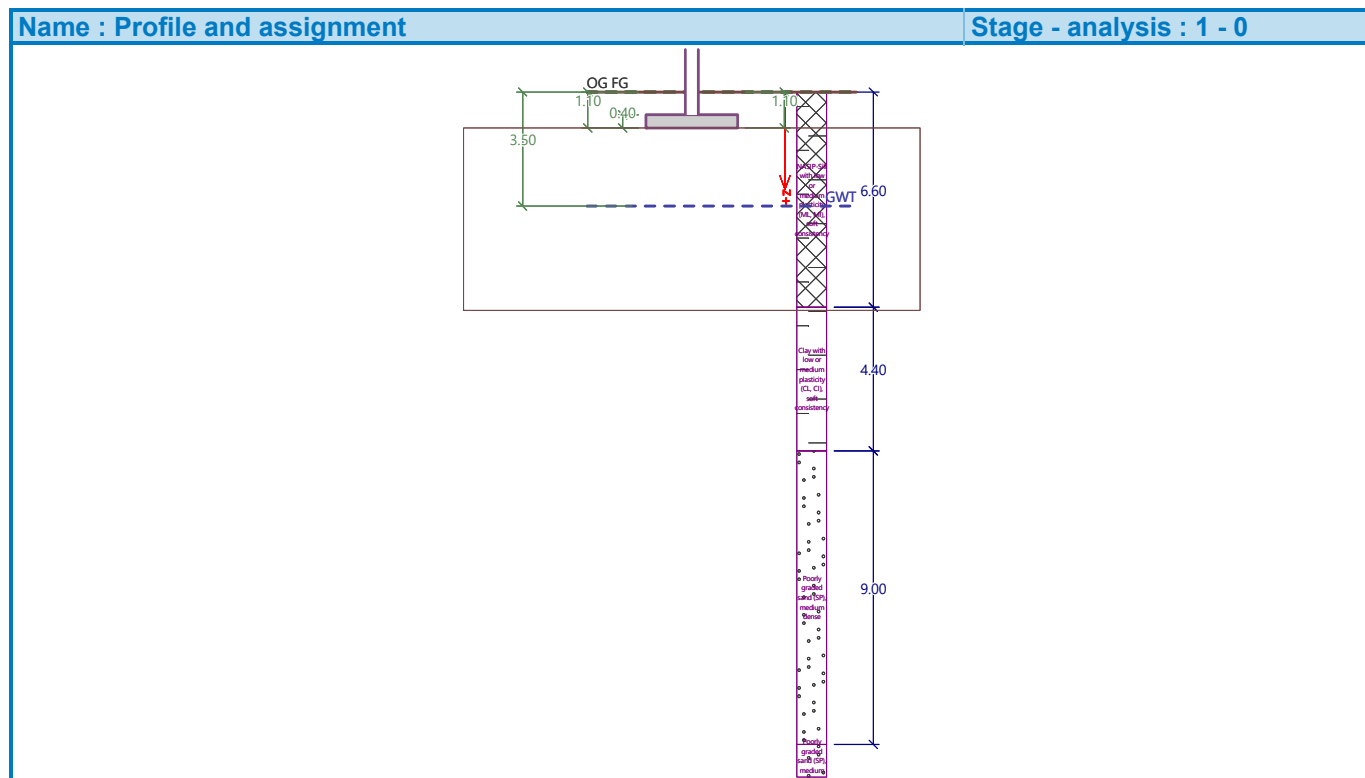
SG pad overhangs foundation $d_{\text{sp}} = 5.60 \text{ m}$

Sand-gravel pad depth $h_{\text{sp}} = 5.60 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 6.60 | 0.00 .. 6.60 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 4.40 | 6.60 .. 11.00 | Clay with low or medium plasticity (CL, CI), soft consistency |  |

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---------|
| 3 | 9.00 | 11.00 .. 20.00 | Poorly graded sand (SP), medium dense | |
| 4 | - | 20.00 .. ∞ | Poorly graded sand (SP), medium dense | |



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|----------------|------|---------|-----------|-------------------------|-------------------------|------------------------|------------------------|
| 1 | Yes | | ULS | Design | 392.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 392.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.50 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 112.09 | 440.97 | 25.42 | Yes |

| Name | Self w. in favor | e_x [m] | e_y [m] | σ [kPa] | R_d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|--------------|--------------|-------------------|----------------|--------------------|-----------------|
| ULS | No | 0.00 | 0.00 | 112.09 | 440.97 | 25.42 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 26.260^\circ$
 $c_d = 0.397 \text{ kPa}$
 $\gamma_{1\text{prum}} = 18.000 \text{ kN/m}^3$
 $\gamma_{2\text{prum}} = 20.564 \text{ kN/m}^3$
 $b_{ef} = 1.400 \text{ m}$
 $N_q = 12.188$
 $N_c = 22.677$
 $N_\gamma = 11.039$
 $s_q = 1.221$
 $s_c = 1.241$
 $s_\gamma = 0.850$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 440.970 \text{ kPa}$

Analysis carried out with automatic selection of the most unfavourable load cases.

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 47.38 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Most unfavorable load case No. 1. (ULS)

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.35 \text{ m}$

Length of slip surface $l_{sp} = 7.32 \text{ m}$

Design bearing capacity of found.soil $R_d = 440.97 \text{ kPa}$

Extreme contact stress $\sigma = 112.09 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Most unfavorable load case No. 1. (ULS)

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 6.42 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 252.54 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 47.38 \text{ kN}$

Settlement of mid point of edge x - 1 = 1.8 mm

Settlement of mid point of edge x - 2 = 1.8 mm

Settlement of mid point of edge y - 1 = 1.4 mm

Settlement of mid point of edge y - 2 = 1.4 mm

Settlement of foundation center point = 2.6 mm

Settlement of characteristic point = 1.8 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 45.00 \text{ MPa}$

Foundation in the longitudinal direction is rigid ($k=1.94$)

Foundation in the direction of width is rigid ($k=15.55$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

Foundation settlement = 1.8 mm

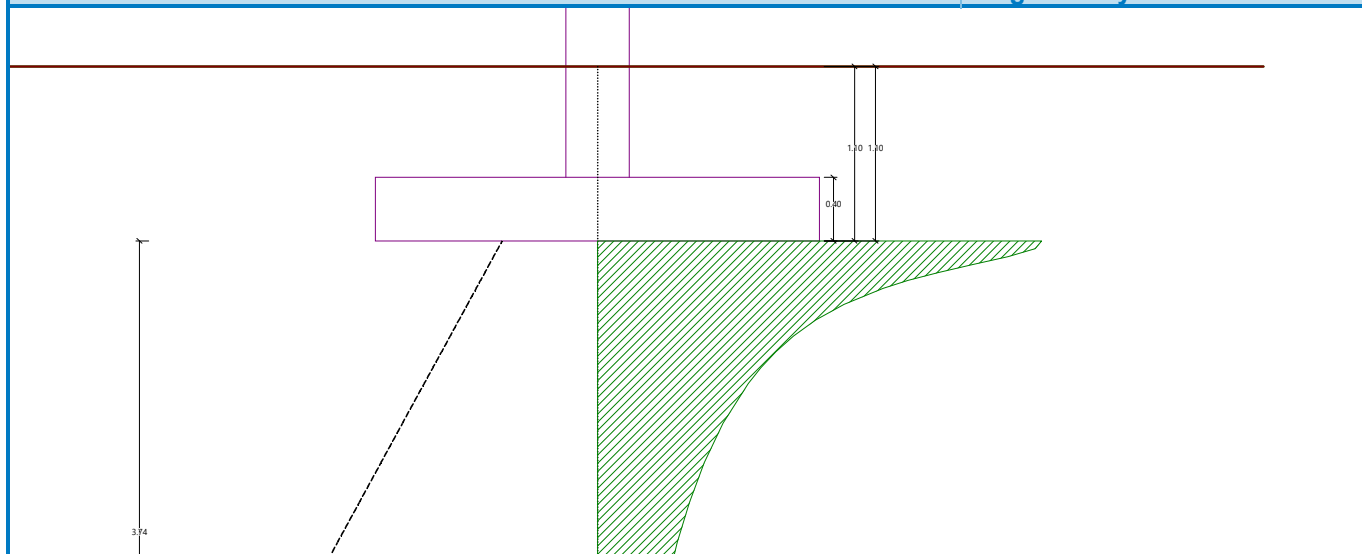
Depth of influence zone = 3.74 m

Rotation in direction of x = 0.000 (\tan^*1000); ($1.8E-17^\circ$)

Rotation in direction of y = 0.000 (\tan^*1000); ($9.1E-18^\circ$)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 21. HANGAR ZA BALIRANI OTPAD
 Description : Model 12, - hangar bliži objektu 20. PoS-T1 - B-30
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.16

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.12 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.95 \text{ m}$
 Depth of footing bottom $d = 0.95 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.80 \text{ m}$
 Spread footing width $y = 1.00 \text{ m}$
 Column width in the direction of x $c_x = 0.50 \text{ m}$
 Column width in the direction of y $c_y = 0.50 \text{ m}$

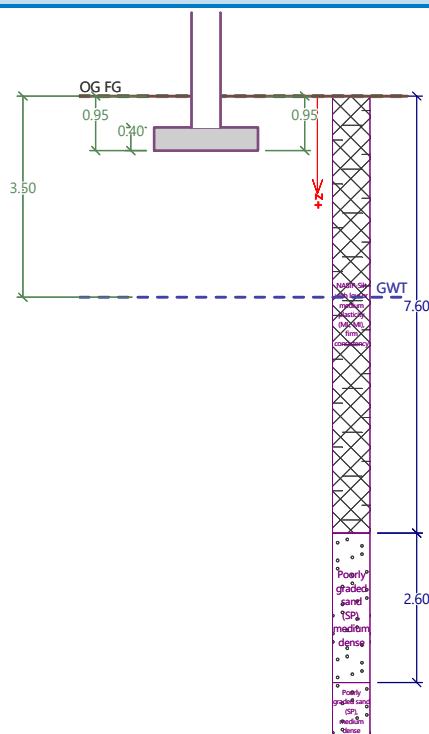
Spread footing volume $= 0.72 \text{ m}^3$
 Volume of excavation $= 1.71 \text{ m}^3$
 Volume of fill $= 0.85 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 7.60 | 0.00 .. 7.60 | NASIP-Silt with low or medium plasticity (ML, MI), firm consistency |  |
| 2 | 2.60 | 7.60 .. 10.20 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.20 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 94.00 | 27.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 94.00 | 27.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.50 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | -0.25 | 120.02 | 92.91 | 129.18 | No |
| ULS | No | 0.00 | -0.25 | 120.02 | 92.91 | 129.18 | No |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 2.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.506 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.067$
 $s_c = 1.094$
 $s_\gamma = 0.916$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 92.905 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$
 Computed weight of overburden $Z = 15.34 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.07 \text{ m}$

Length of slip surface $l_{sp} = 2.68 \text{ m}$

Design bearing capacity of found.soil $R_d = 92.91 \text{ kPa}$

Extreme contact stress $\sigma = 120.02 \text{ kPa}$

Bearing capacity in the vertical direction is NOT SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.247 < 0.333$

Max. overall eccentricity $e_t = 0.247 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 3.82 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 32.52 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is NOT SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 15.34$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.95 | 1.00 | 0.05 | 0.56 | 17.55 | 69.27 | 2.89 |
| 2 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 62.12 | 2.59 |
| 3 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 53.03 | 2.21 |
| 4 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 45.79 | 1.91 |
| 5 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 40.29 | 1.68 |
| 6 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 36.02 | 1.50 |
| 7 | 1.25 | 1.35 | 0.10 | 0.56 | 23.40 | 31.28 | 2.61 |
| 8 | 1.35 | 1.45 | 0.10 | 0.56 | 25.20 | 26.35 | 2.20 |
| 9 | 1.45 | 1.55 | 0.10 | 0.56 | 27.00 | 22.67 | 1.89 |
| 10 | 1.55 | 1.65 | 0.10 | 0.56 | 28.80 | 19.78 | 1.65 |
| 11 | 1.65 | 1.75 | 0.10 | 0.56 | 30.60 | 17.46 | 1.46 |
| 12 | 1.75 | 1.85 | 0.10 | 0.56 | 32.40 | 15.55 | 1.30 |
| 13 | 1.85 | 2.10 | 0.25 | 0.56 | 35.55 | 13.06 | 2.72 |
| 14 | 2.10 | 2.35 | 0.25 | 0.56 | 40.05 | 10.31 | 2.15 |
| 15 | 2.35 | 2.60 | 0.25 | 0.56 | 44.55 | 8.36 | 1.74 |
| 16 | 2.60 | 2.85 | 0.25 | 0.56 | 49.05 | 6.92 | 1.44 |
| 17 | 2.85 | 3.06 | 0.21 | 0.56 | 53.17 | 5.90 | 0.83 |

Tension was excluded during the analysis.

Dimensions of spread footing after excluding stretched edges:

Spread footing length (x) = 1.80 m

Spread footing width (y) = 0.76 m

Settlement of mid point of edge x - 1 = 41.6 mm

Settlement of mid point of edge x - 2 = 16.0 mm

Settlement of mid point of edge y - 1 = 21.7 mm

Settlement of mid point of edge y - 2 = 21.7 mm

Settlement of foundation center point = 42.5 mm

Settlement of characteristic point = 32.7 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 0.56$ MPa

Foundation in the longitudinal direction is rigid ($k=587.89$)

Foundation in the direction of width is rigid ($k=3428.57$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.247 < 0.333$

Max. overall eccentricity $e_t = 0.247 < 0.333$

Eccentricity of load is SATISFACTORY

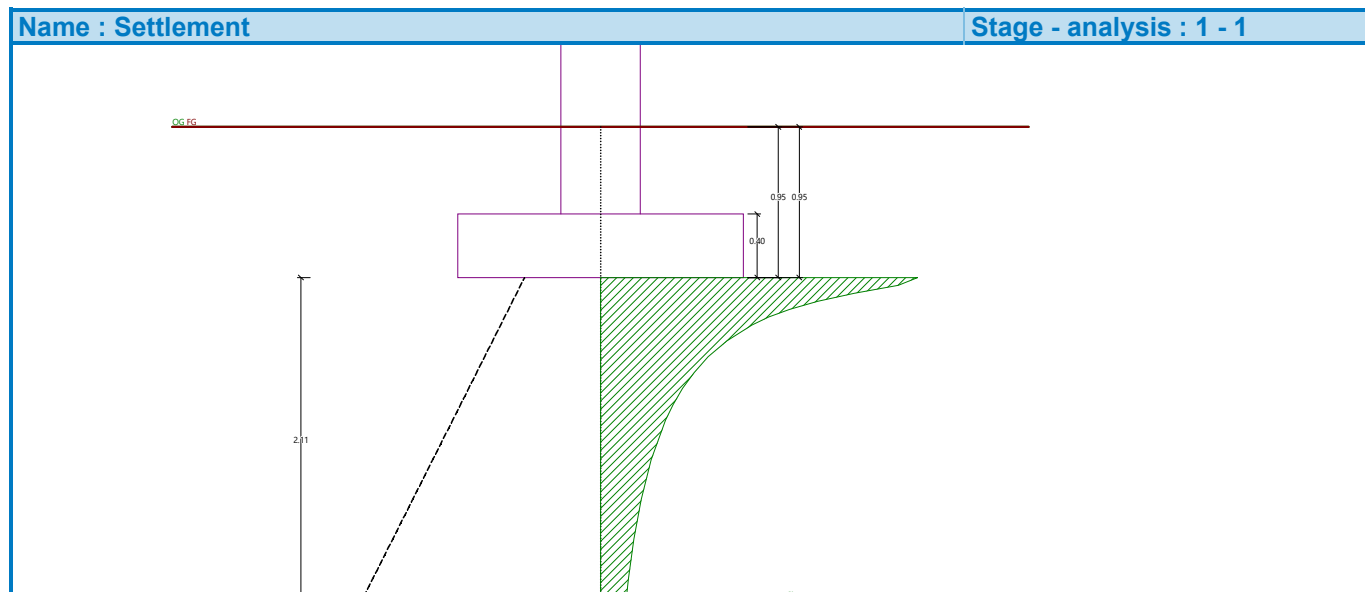
Overall settlement and rotation of foundation:

Foundation settlement = 32.7 mm

Depth of influence zone = 2.11 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 25.555 (tan*1000); (1.5E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 21. HANGAR ZA BALIRANI OTPAD
 Description : Model 12, - hangar bliži objektu 20. PoS-T1 - B-30 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.16.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.12 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.95 \text{ m}$
 Depth of footing bottom $d = 0.95 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.80 \text{ m}$
 Spread footing width $y = 1.00 \text{ m}$
 Column width in the direction of x $c_x = 0.50 \text{ m}$
 Column width in the direction of y $c_y = 0.50 \text{ m}$




Spread footing volume $= 0.72 \text{ m}^3$
 Volume of excavation $= 1.71 \text{ m}^3$
 Volume of fill $= 0.85 \text{ m}^3$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

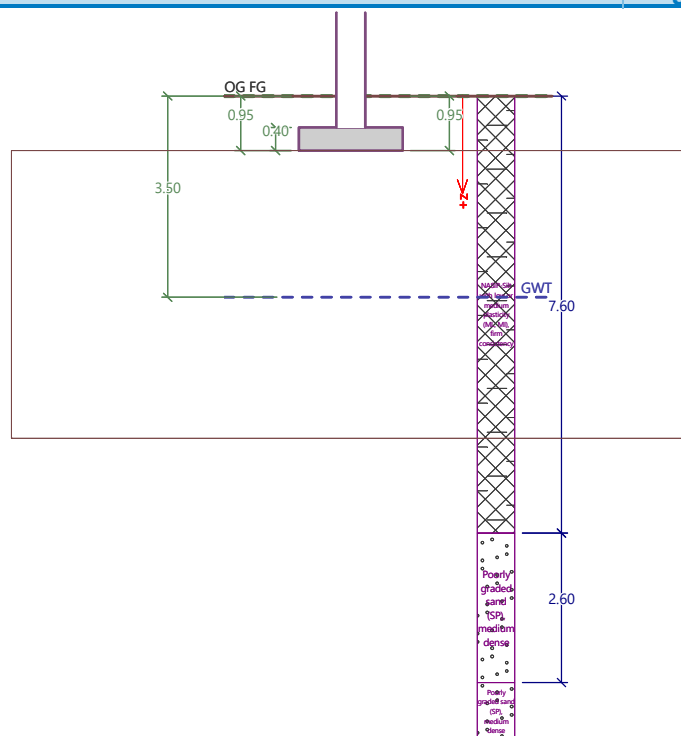
SG pad overhangs foundation $d_{\text{sp}} = 5.00 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 5.00 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---|---|
| 1 | 7.60 | 0.00 .. 7.60 | NASIP-Silt with low or medium plasticity (ML, MI), firm consistency |  |
| 2 | 2.60 | 7.60 .. 10.20 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.20 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 94.00 | 27.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 94.00 | 27.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.50 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | -0.25 | 120.02 | 347.68 | 34.52 | Yes |
| ULS | No | 0.00 | -0.25 | 120.02 | 347.68 | 34.52 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 27.685^\circ \\ c_d &= 0.207 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 20.777 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.506 \text{ m}\end{aligned}$$

$N_q = 14.220$
 $N_c = 25.197$
 $N_\gamma = 13.873$
 $s_q = 1.131$
 $s_c = 1.141$
 $s_\gamma = 0.916$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 347.681 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$
 Computed weight of overburden $Z = 15.35 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.78 \text{ m}$

Length of slip surface $l_{sp} = 5.69 \text{ m}$

Design bearing capacity of found.soil $R_d = 347.68 \text{ kPa}$

Extreme contact stress $\sigma = 120.02 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.247 < 0.333$

Max. overall eccentricity $e_t = 0.247 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 3.82 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 65.07 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 15.35$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.95 | 1.00 | 0.05 | 45.00 | 17.55 | 69.27 | 0.07 |
| 2 | 1.00 | 1.05 | 0.05 | 45.00 | 18.45 | 62.12 | 0.06 |
| 3 | 1.05 | 1.10 | 0.05 | 45.00 | 19.35 | 53.03 | 0.05 |
| 4 | 1.10 | 1.15 | 0.05 | 45.00 | 20.25 | 45.79 | 0.05 |
| 5 | 1.15 | 1.20 | 0.05 | 45.00 | 21.15 | 40.29 | 0.04 |
| 6 | 1.20 | 1.25 | 0.05 | 45.00 | 22.05 | 36.02 | 0.04 |
| 7 | 1.25 | 1.35 | 0.10 | 45.00 | 23.40 | 31.28 | 0.06 |
| 8 | 1.35 | 1.45 | 0.10 | 45.00 | 25.20 | 26.35 | 0.05 |
| 9 | 1.45 | 1.55 | 0.10 | 45.00 | 27.00 | 22.67 | 0.05 |
| 10 | 1.55 | 1.65 | 0.10 | 45.00 | 28.80 | 19.78 | 0.04 |
| 11 | 1.65 | 1.75 | 0.10 | 45.00 | 30.60 | 17.46 | 0.03 |
| 12 | 1.75 | 1.85 | 0.10 | 45.00 | 32.40 | 15.55 | 0.03 |
| 13 | 1.85 | 2.10 | 0.25 | 45.00 | 35.55 | 13.06 | 0.07 |
| 14 | 2.10 | 2.35 | 0.25 | 45.00 | 40.05 | 10.31 | 0.05 |
| 15 | 2.35 | 2.60 | 0.25 | 45.00 | 44.55 | 8.36 | 0.04 |
| 16 | 2.60 | 2.85 | 0.25 | 45.00 | 49.05 | 6.92 | 0.03 |
| 17 | 2.85 | 3.06 | 0.21 | 45.00 | 53.17 | 5.90 | 0.02 |

Tension was excluded during the analysis.

Dimensions of spread footing after excluding stretched edges:

Spread footing length (x) = 1.80 m

Spread footing width (y) = 0.76 m

Settlement of mid point of edge x - 1 = 1.0 mm

Settlement of mid point of edge x - 2 = 0.4 mm

Settlement of mid point of edge y - 1 = 0.5 mm

Settlement of mid point of edge y - 2 = 0.5 mm

Settlement of foundation center point = 1.0 mm

Settlement of characteristic point = 0.8 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 45.00$ MPa

Foundation in the longitudinal direction is rigid ($k=7.32$)

Foundation in the direction of width is rigid ($k=42.67$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.247 < 0.333$

Max. overall eccentricity $e_t = 0.247 < 0.333$

Eccentricity of load is SATISFACTORY

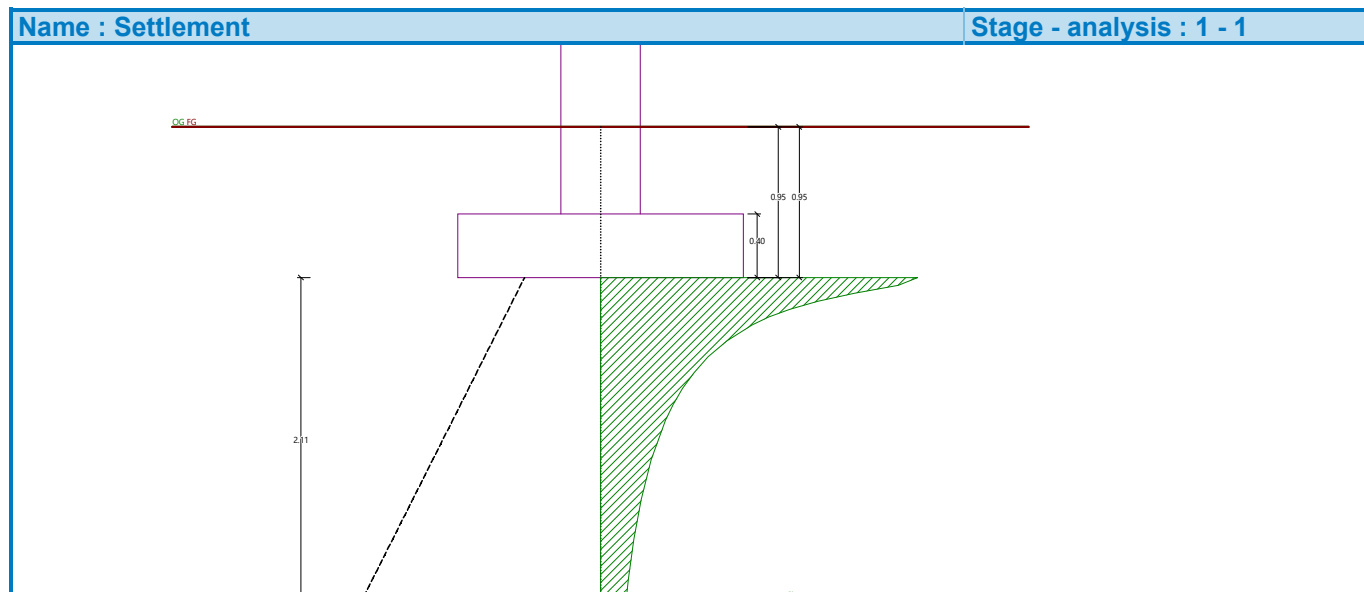
Overall settlement and rotation of foundation:

Foundation settlement = 0.8 mm

Depth of influence zone = 2.11 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.613 (tan*1000); (3.5E-02 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 21. HANGAR ZA BALIRANI OTPAD
 Description : Model 12, - hangar bliži objektu 20. PoS-T2 - B-30
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.17

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.12 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.95 \text{ m}$
 Depth of footing bottom $d = 0.95 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.40 \text{ m}$
 Spread footing width $y = 0.70 \text{ m}$
 Column width in the direction of x $c_x = 0.50 \text{ m}$
 Column width in the direction of y $c_y = 0.50 \text{ m}$

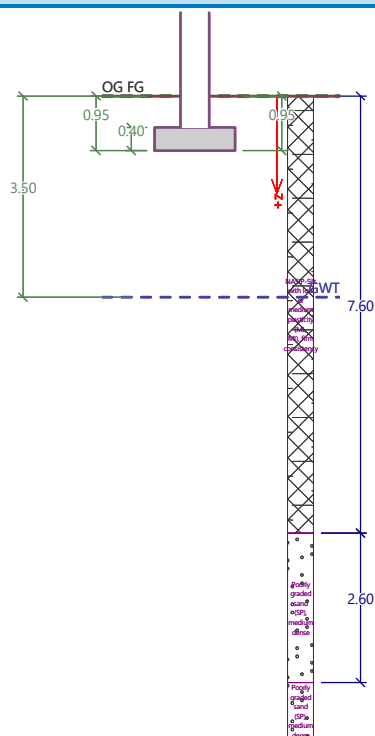
Spread footing volume $= 0.39 \text{ m}^3$
 Volume of excavation $= 0.93 \text{ m}^3$
 Volume of fill $= 0.40 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 7.60 | 0.00 .. 7.60 | NASIP-Silt with low or medium plasticity (ML, MI), firm consistency |  |
| 2 | 2.60 | 7.60 .. 10.20 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.20 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 34.00 | 0.00 | 14.20 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 34.00 | 0.00 | 14.20 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.50 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.34 | 0.00 | 82.82 | 108.36 | 76.43 | Yes |
| ULS | No | -0.34 | 0.00 | 82.82 | 108.36 | 76.43 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 2.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.700 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.234$
 $s_c = 1.327$
 $s_\gamma = 0.705$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 108.355 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 7.23 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 0.75 \text{ m}$

Length of slip surface $l_{sp} = 1.88 \text{ m}$

Design bearing capacity of found.soil $R_d = 108.36 \text{ kPa}$

Extreme contact stress $\sigma = 82.82 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.246 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.246 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 2.67 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 13.83 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 7.23$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.95 | 1.00 | 0.05 | 0.56 | 17.55 | 36.45 | 1.52 |
| 2 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 31.33 | 1.31 |
| 3 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 25.32 | 1.06 |
| 4 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 21.10 | 0.88 |
| 5 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 18.22 | 0.76 |
| 6 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 16.11 | 0.67 |
| 7 | 1.25 | 1.35 | 0.10 | 0.56 | 23.40 | 13.84 | 1.15 |
| 8 | 1.35 | 1.45 | 0.10 | 0.56 | 25.20 | 11.48 | 0.96 |
| 9 | 1.45 | 1.55 | 0.10 | 0.56 | 27.00 | 9.69 | 0.81 |
| 10 | 1.55 | 1.65 | 0.10 | 0.56 | 28.80 | 8.28 | 0.69 |
| 11 | 1.65 | 1.75 | 0.10 | 0.56 | 30.60 | 7.15 | 0.60 |
| 12 | 1.75 | 1.85 | 0.10 | 0.56 | 32.40 | 6.23 | 0.52 |
| 13 | 1.85 | 2.10 | 0.25 | 0.56 | 35.55 | 5.06 | 1.05 |
| 14 | 2.10 | 2.19 | 0.09 | 0.56 | 38.62 | 4.13 | 0.11 |

Tension was excluded during the analysis.

Dimensions of spread footing after excluding stretched edges:

Spread footing length (x) = 1.07 m

Spread footing width (y) = 0.70 m

Settlement of mid point of edge x - 1 = 11.1 mm

Settlement of mid point of edge x - 2 = 11.1 mm

Settlement of mid point of edge y - 1 = 19.5 mm

Settlement of mid point of edge y - 2 = 1.2 mm

Settlement of foundation center point = 19.7 mm

Settlement of characteristic point = 12.1 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 0.56$ MPa

Foundation in the longitudinal direction is rigid ($k=1249.48$)

Foundation in the direction of width is rigid ($k=9995.84$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.246 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.246 < 0.333$

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

Foundation settlement = 12.1 mm

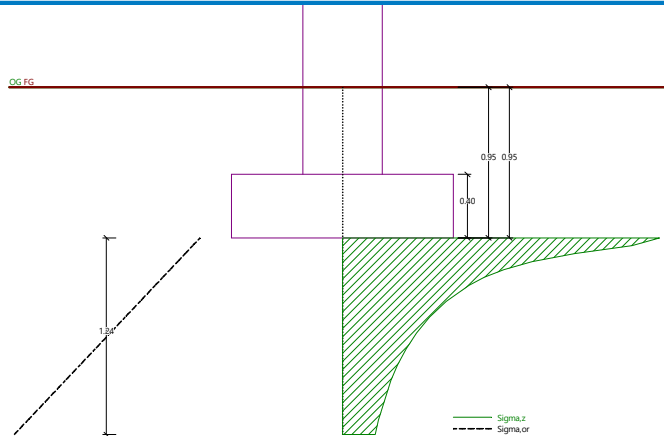
Depth of influence zone = 1.24 m

Rotation in direction of x = 13.035 (tan*1000); (7.5E-01 °)

Rotation in direction of y = 0.000 (tan*1000); (2.9E-16 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 21. HANGAR ZA BALIRANI OTPAD
 Description : Model 13, - hangar dalji od objekta 20. PoS-T2 - B-31
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.18

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.12 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.95 \text{ m}$
 Depth of footing bottom $d = 0.95 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.80 \text{ m}$
 Spread footing width $y = 1.00 \text{ m}$
 Column width in the direction of x $c_x = 0.50 \text{ m}$
 Column width in the direction of y $c_y = 0.50 \text{ m}$

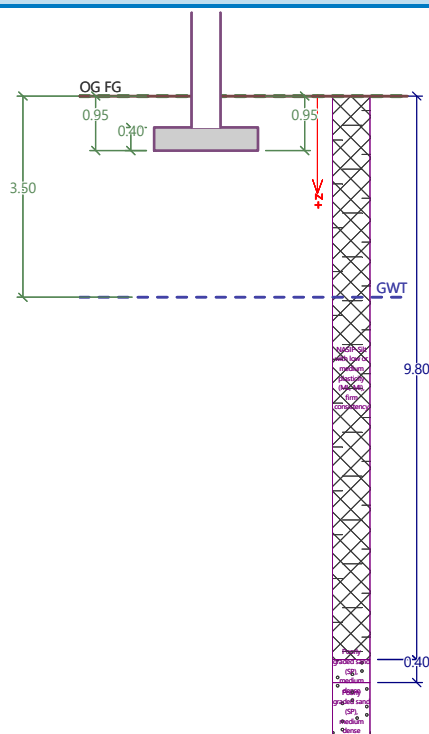
Spread footing volume $= 0.72 \text{ m}^3$
 Volume of excavation $= 1.71 \text{ m}^3$
 Volume of fill $= 0.85 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 9.80 | 0.00 .. 9.80 | NASIP-Silt with low or medium plasticity (ML, MI), firm consistency |  |
| 2 | 0.40 | 9.80 .. 10.20 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.20 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 94.00 | 27.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 94.00 | 27.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.50 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | -0.25 | 120.02 | 92.91 | 129.18 | No |
| ULS | No | 0.00 | -0.25 | 120.02 | 92.91 | 129.18 | No |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 2.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.506 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.067$
 $s_c = 1.094$
 $s_\gamma = 0.916$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 92.905 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$
 Computed weight of overburden $Z = 15.34 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 1.07 \text{ m}$

Length of slip surface $l_{sp} = 2.68 \text{ m}$

Design bearing capacity of found.soil $R_d = 92.91 \text{ kPa}$

Extreme contact stress $\sigma = 120.02 \text{ kPa}$

Bearing capacity in the vertical direction is NOT SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.247 < 0.333$

Max. overall eccentricity $e_t = 0.247 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 3.82 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 32.52 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is NOT SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 15.34$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.95 | 1.00 | 0.05 | 0.56 | 17.55 | 69.27 | 2.89 |
| 2 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 62.12 | 2.59 |
| 3 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 53.03 | 2.21 |
| 4 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 45.79 | 1.91 |
| 5 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 40.29 | 1.68 |
| 6 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 36.02 | 1.50 |
| 7 | 1.25 | 1.35 | 0.10 | 0.56 | 23.40 | 31.28 | 2.61 |
| 8 | 1.35 | 1.45 | 0.10 | 0.56 | 25.20 | 26.35 | 2.20 |
| 9 | 1.45 | 1.55 | 0.10 | 0.56 | 27.00 | 22.67 | 1.89 |
| 10 | 1.55 | 1.65 | 0.10 | 0.56 | 28.80 | 19.78 | 1.65 |
| 11 | 1.65 | 1.75 | 0.10 | 0.56 | 30.60 | 17.46 | 1.46 |
| 12 | 1.75 | 1.85 | 0.10 | 0.56 | 32.40 | 15.55 | 1.30 |
| 13 | 1.85 | 2.10 | 0.25 | 0.56 | 35.55 | 13.06 | 2.72 |
| 14 | 2.10 | 2.35 | 0.25 | 0.56 | 40.05 | 10.31 | 2.15 |
| 15 | 2.35 | 2.60 | 0.25 | 0.56 | 44.55 | 8.36 | 1.74 |
| 16 | 2.60 | 2.85 | 0.25 | 0.56 | 49.05 | 6.92 | 1.44 |
| 17 | 2.85 | 3.06 | 0.21 | 0.56 | 53.17 | 5.90 | 0.83 |

Tension was excluded during the analysis.

Dimensions of spread footing after excluding stretched edges:

Spread footing length (x) = 1.80 m

Spread footing width (y) = 0.76 m

Settlement of mid point of edge x - 1 = 41.6 mm

Settlement of mid point of edge x - 2 = 16.0 mm

Settlement of mid point of edge y - 1 = 21.7 mm

Settlement of mid point of edge y - 2 = 21.7 mm

Settlement of foundation center point = 42.5 mm

Settlement of characteristic point = 32.7 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 0.56$ MPa

Foundation in the longitudinal direction is rigid ($k=587.89$)

Foundation in the direction of width is rigid ($k=3428.57$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.247 < 0.333$

Max. overall eccentricity $e_t = 0.247 < 0.333$

Eccentricity of load is SATISFACTORY

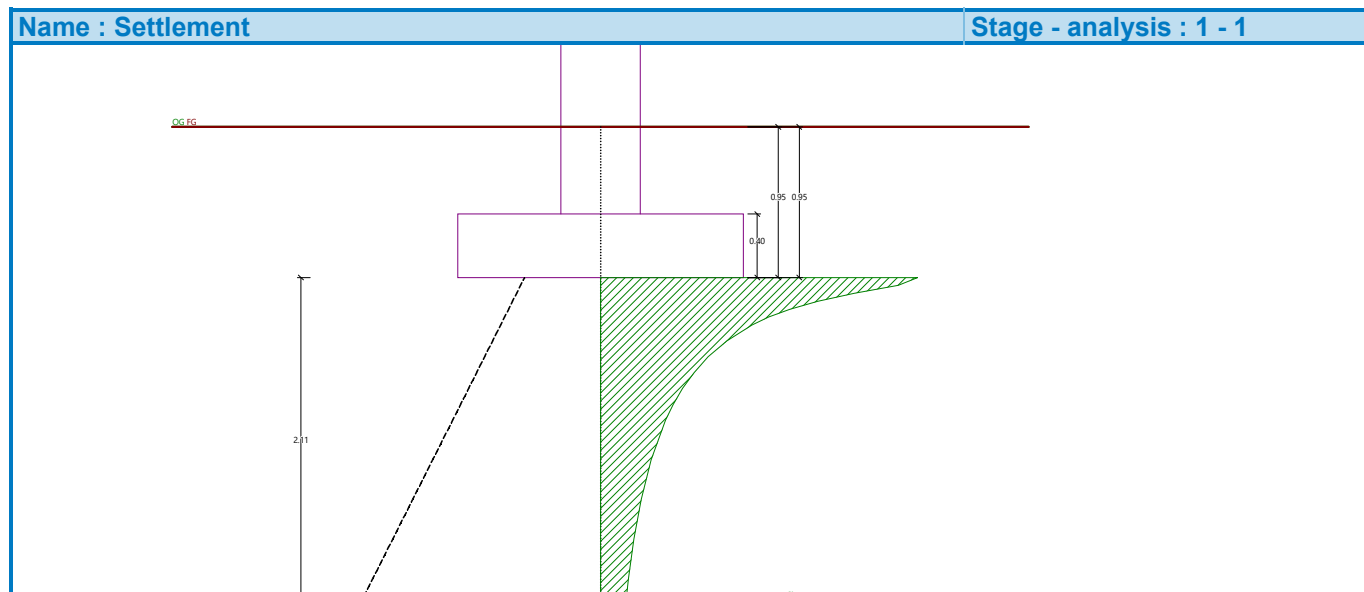
Overall settlement and rotation of foundation:

Foundation settlement = 32.7 mm

Depth of influence zone = 2.11 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 25.555 (tan*1000); (1.5E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 21. HANGAR ZA BALIRANI OTPAD
 Description : Model 13, - hangar dalji od objekta 20. PoS-T2 - B-31
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.19

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), firm consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.20 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 2.12 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 50.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.95 \text{ m}$
 Depth of footing bottom $d = 0.95 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.40 \text{ m}$
 Spread footing width $y = 0.70 \text{ m}$
 Column width in the direction of x $c_x = 0.50 \text{ m}$
 Column width in the direction of y $c_y = 0.50 \text{ m}$

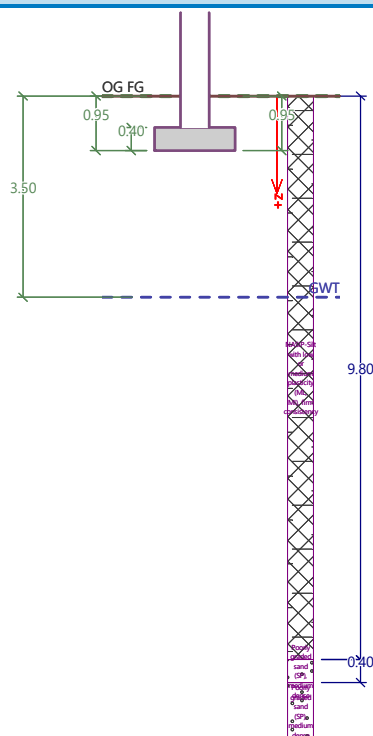
Spread footing volume $= 0.39 \text{ m}^3$
 Volume of excavation $= 0.93 \text{ m}^3$
 Volume of fill $= 0.40 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 9.80 | 0.00 .. 9.80 | NASIP-Silt with low or medium plasticity (ML, MI), firm consistency |  |
| 2 | 0.40 | 9.80 .. 10.20 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.20 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 34.00 | 0.00 | 14.20 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 34.00 | 0.00 | 14.20 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.50 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | -0.34 | 0.00 | 82.82 | 108.36 | 76.43 | Yes |
| ULS | No | -0.34 | 0.00 | 82.82 | 108.36 | 76.43 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 13.744^\circ \\ c_d &= 2.143 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 18.000 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.700 \text{ m}\end{aligned}$$

$N_q = 3.500$
 $N_c = 10.222$
 $N_\gamma = 1.223$
 $s_q = 1.234$
 $s_c = 1.327$
 $s_\gamma = 0.705$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 108.355 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 7.23 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 0.75 \text{ m}$

Length of slip surface $l_{sp} = 1.88 \text{ m}$

Design bearing capacity of found.soil $R_d = 108.36 \text{ kPa}$

Extreme contact stress $\sigma = 82.82 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.246 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.246 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 2.67 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 13.83 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 0.00$ kN

Computed weight of overburden $Z = 7.23$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.95 | 1.00 | 0.05 | 0.56 | 17.55 | 36.45 | 1.52 |
| 2 | 1.00 | 1.05 | 0.05 | 0.56 | 18.45 | 31.33 | 1.31 |
| 3 | 1.05 | 1.10 | 0.05 | 0.56 | 19.35 | 25.32 | 1.06 |
| 4 | 1.10 | 1.15 | 0.05 | 0.56 | 20.25 | 21.10 | 0.88 |
| 5 | 1.15 | 1.20 | 0.05 | 0.56 | 21.15 | 18.22 | 0.76 |
| 6 | 1.20 | 1.25 | 0.05 | 0.56 | 22.05 | 16.11 | 0.67 |
| 7 | 1.25 | 1.35 | 0.10 | 0.56 | 23.40 | 13.84 | 1.15 |
| 8 | 1.35 | 1.45 | 0.10 | 0.56 | 25.20 | 11.48 | 0.96 |
| 9 | 1.45 | 1.55 | 0.10 | 0.56 | 27.00 | 9.69 | 0.81 |
| 10 | 1.55 | 1.65 | 0.10 | 0.56 | 28.80 | 8.28 | 0.69 |
| 11 | 1.65 | 1.75 | 0.10 | 0.56 | 30.60 | 7.15 | 0.60 |
| 12 | 1.75 | 1.85 | 0.10 | 0.56 | 32.40 | 6.23 | 0.52 |
| 13 | 1.85 | 2.10 | 0.25 | 0.56 | 35.55 | 5.06 | 1.05 |
| 14 | 2.10 | 2.19 | 0.09 | 0.56 | 38.62 | 4.13 | 0.11 |

Tension was excluded during the analysis.

Dimensions of spread footing after excluding stretched edges:

Spread footing length (x) = 1.07 m

Spread footing width (y) = 0.70 m

Settlement of mid point of edge x - 1 = 11.1 mm

Settlement of mid point of edge x - 2 = 11.1 mm

Settlement of mid point of edge y - 1 = 19.5 mm

Settlement of mid point of edge y - 2 = 1.2 mm

Settlement of foundation center point = 19.7 mm

Settlement of characteristic point = 12.1 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 0.56$ MPa

Foundation in the longitudinal direction is rigid ($k=1249.48$)

Foundation in the direction of width is rigid ($k=9995.84$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.246 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.246 < 0.333$

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

Foundation settlement = 12.1 mm

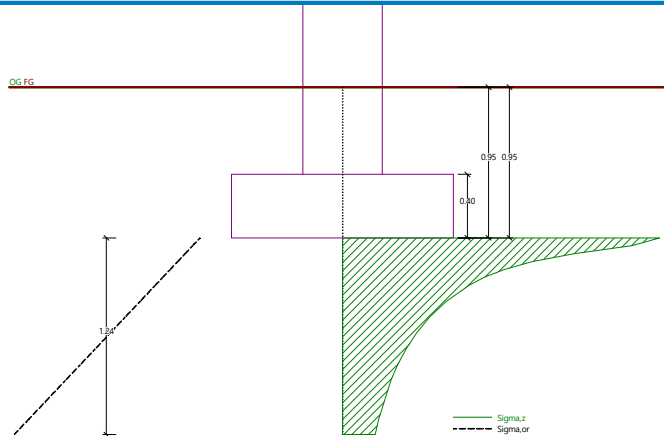
Depth of influence zone = 1.24 m

Rotation in direction of x = 13.035 (tan*1000); (7.5E-01 °)

Rotation in direction of y = 0.000 (tan*1000); (2.9E-16 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 25. KOMANDNA ZGRADA PPPV
 Description : Model 14 - B-38
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.20

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 0.99 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 1.89 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 0.80 \text{ m}$
 Depth of footing bottom $d = 0.80 \text{ m}$
 Foundation thickness $t = 0.30 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 9.50 \text{ m}$
 Strip footing width (x) $= 0.55 \text{ m}$
 Column width in the direction of x $= 0.40 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.

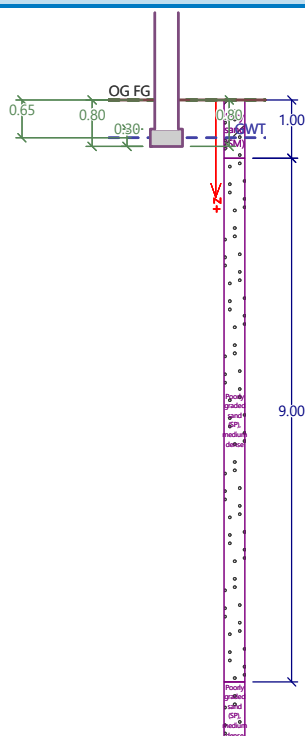
Volume of strip footing $= 0.16 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.44 \text{ m}^3/\text{m}$
 Volume of fill $= 0.08 \text{ m}^3/\text{m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 1.00 | 0.00 .. 1.00 | Silty sand (SM) |  |
| 2 | 9.00 | 1.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 26.15 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 26.15 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 0.65 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 48.50 | 142.06 | 34.14 | Yes |
| ULS | No | 0.00 | 0.00 | 47.97 | 142.06 | 33.77 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 23.577^\circ \\ c_d &= 0.424 \text{ kPa} \\ \gamma_{1\text{prum}} &= 16.125 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 6.506 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.550 \text{ m}\end{aligned}$$

$N_q = 9.192$
 $N_c = 18.770$
 $N_\gamma = 7.150$
 $s_q = 1.023$
 $s_c = 1.026$
 $s_\gamma = 0.983$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 142.064 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = -0.83 \text{ kN/m}$
 Computed weight of overburden $Z = 1.35 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 0.83 \text{ m}$

Length of slip surface $l_{sp} = 2.46 \text{ m}$

Design bearing capacity of found.soil $R_d = 142.06 \text{ kPa}$

Extreme contact stress $\sigma = 48.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 1.14 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 11.38 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = -0.83$ kN/m

Computed weight of overburden $Z = 1.35$ kN/m

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.80 | 0.85 | 0.05 | 0.74 | 13.10 | 33.01 | 1.67 |
| 2 | 0.85 | 0.90 | 0.05 | 0.74 | 13.50 | 27.85 | 1.41 |
| 3 | 0.90 | 0.95 | 0.05 | 0.74 | 13.90 | 23.82 | 1.20 |
| 4 | 0.95 | 1.00 | 0.05 | 0.74 | 14.30 | 21.30 | 1.08 |
| 5 | 1.00 | 1.05 | 0.05 | 1.48 | 14.64 | 19.38 | 0.51 |
| 6 | 1.05 | 1.10 | 0.05 | 1.48 | 14.92 | 17.76 | 0.47 |
| 7 | 1.10 | 1.20 | 0.10 | 1.48 | 15.34 | 15.81 | 0.84 |
| 8 | 1.20 | 1.30 | 0.10 | 1.48 | 15.90 | 13.67 | 0.72 |
| 9 | 1.30 | 1.40 | 0.10 | 1.48 | 16.46 | 12.00 | 0.64 |
| 10 | 1.40 | 1.50 | 0.10 | 1.48 | 17.02 | 10.68 | 0.57 |
| 11 | 1.50 | 1.60 | 0.10 | 1.48 | 17.58 | 9.61 | 0.51 |
| 12 | 1.60 | 1.70 | 0.10 | 1.48 | 18.14 | 8.72 | 0.46 |
| 13 | 1.70 | 1.95 | 0.25 | 1.48 | 19.12 | 7.55 | 1.00 |
| 14 | 1.95 | 2.20 | 0.25 | 1.48 | 20.52 | 6.23 | 0.82 |
| 15 | 2.20 | 2.45 | 0.25 | 1.48 | 21.92 | 5.27 | 0.70 |
| 16 | 2.45 | 2.70 | 0.25 | 1.48 | 23.32 | 4.55 | 0.60 |
| 17 | 2.70 | 2.95 | 0.25 | 1.48 | 24.72 | 3.98 | 0.53 |
| 18 | 2.95 | 3.20 | 0.25 | 1.48 | 26.12 | 3.53 | 0.47 |
| 19 | 3.20 | 3.56 | 0.36 | 1.48 | 27.83 | 3.10 | 0.41 |

Settlement of mid point of longitudinal edge = 7.8 mm

Settlement of mid point of transverse edge 1 = 13.9 mm

Settlement of mid point of transverse edge 2 = 13.9 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 1.32$ MPa

Foundation in the longitudinal direction is rigid ($k=3696.01$)

Foundation in the direction of width is rigid ($k=614.92$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

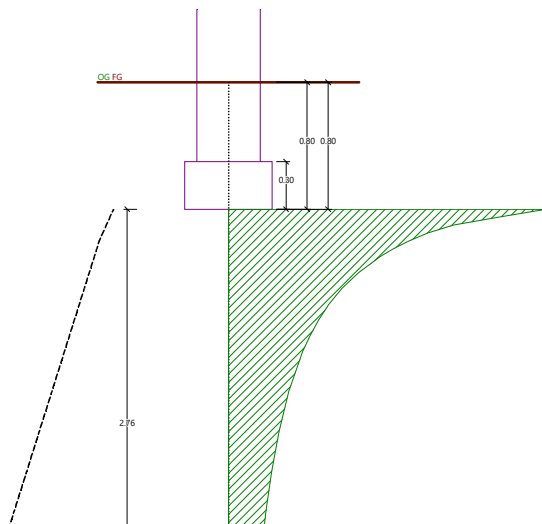
Foundation settlement = 14.6 mm

Depth of influence zone = 2.76 m

Rotation in direction of width = 0.000 (tan*1000); (1.9E-16 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 25. KOMANDNA ZGRADA PPPV
 Description : Model 14 - B-38 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.20.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 0.99 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 1.89 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: strip footing**

Depth from original ground surface $h_z = 0.80 \text{ m}$
 Depth of footing bottom $d = 0.80 \text{ m}$
 Foundation thickness $t = 0.30 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: strip footing**

Overall strip footing length $= 9.50 \text{ m}$
 Strip footing width (x) $= 0.55 \text{ m}$
 Column width in the direction of x $= 0.40 \text{ m}$

Inserted loading is considered per unit length of continuous footing span.




Volume of strip footing $= 0.16 \text{ m}^3/\text{m}$
 Volume of excavation $= 0.44 \text{ m}^3/\text{m}$
 Volume of fill $= 0.08 \text{ m}^3/\text{m}$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

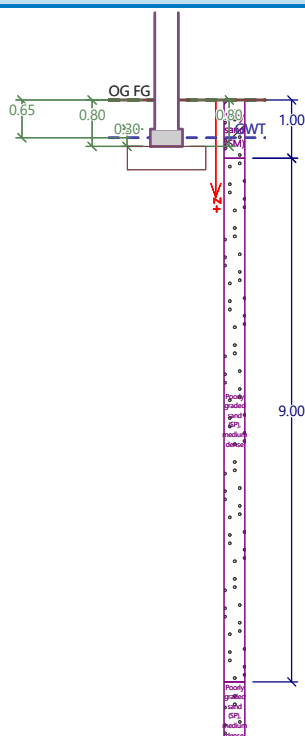
SG pad overhangs foundation $d_{\text{sp}} = 0.40 \text{ m}$
 Sand-gravel pad depth $h_{\text{sp}} = 0.40 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 1.00 | 0.00 .. 1.00 | Silty sand (SM) |  |
| 2 | 9.00 | 1.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN/m] | M _y [kNm/m] | H _x [kN/m] |
|-----|-----|-------------|------|---------|-------------|---------------------------|--------------------------|
| 1 | Yes | | ULS | Design | 26.15 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 26.15 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 0.65 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 48.50 | 156.85 | 30.92 | Yes |
| ULS | No | 0.00 | 0.00 | 47.97 | 156.85 | 30.59 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 24.558^\circ \\ c_d &= 0.273 \text{ kPa} \\ \gamma_{1\text{prum}} &= 16.125 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 7.391 \text{ kN/m}^3 \\ b_{\text{ef}} &= 0.550 \text{ m}\end{aligned}$$

$N_q = 10.178$
 $N_c = 20.086$
 $N_\gamma = 8.388$
 $s_q = 1.024$
 $s_c = 1.027$
 $s_\gamma = 0.983$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 156.851 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed self weight of strip foundation $G = -0.83 \text{ kN/m}$
 Computed weight of overburden $Z = 1.35 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 0.86 \text{ m}$

Length of slip surface $l_{sp} = 2.59 \text{ m}$

Design bearing capacity of found.soil $R_d = 156.85 \text{ kPa}$

Extreme contact stress $\sigma = 48.50 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 1.14 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 16.08 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = -0.83$ kN/mComputed weight of overburden $Z = 1.35$ kN/m**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.80 | 0.85 | 0.05 | 27.00 | 13.10 | 33.01 | 0.06 |
| 2 | 0.85 | 0.90 | 0.05 | 27.00 | 13.50 | 27.85 | 0.05 |
| 3 | 0.90 | 0.95 | 0.05 | 27.00 | 13.90 | 23.82 | 0.04 |
| 4 | 0.95 | 1.00 | 0.05 | 27.00 | 14.30 | 21.30 | 0.04 |
| 5 | 1.00 | 1.05 | 0.05 | 27.00 | 14.64 | 19.38 | 0.03 |
| 6 | 1.05 | 1.10 | 0.05 | 27.00 | 14.92 | 17.76 | 0.03 |
| 7 | 1.10 | 1.20 | 0.10 | 27.00 | 15.34 | 15.81 | 0.05 |
| 8 | 1.20 | 1.30 | 0.10 | 1.48 | 15.90 | 13.67 | 0.72 |
| 9 | 1.30 | 1.40 | 0.10 | 1.48 | 16.46 | 12.00 | 0.64 |
| 10 | 1.40 | 1.50 | 0.10 | 1.48 | 17.02 | 10.68 | 0.57 |
| 11 | 1.50 | 1.60 | 0.10 | 1.48 | 17.58 | 9.61 | 0.51 |
| 12 | 1.60 | 1.70 | 0.10 | 1.48 | 18.14 | 8.72 | 0.46 |
| 13 | 1.70 | 1.95 | 0.25 | 1.48 | 19.12 | 7.55 | 1.00 |
| 14 | 1.95 | 2.00 | 0.05 | 1.48 | 19.96 | 6.67 | 0.18 |
| 15 | 2.00 | 2.20 | 0.20 | 1.48 | 20.66 | 6.12 | 0.65 |
| 16 | 2.20 | 2.45 | 0.25 | 1.48 | 21.92 | 5.27 | 0.70 |
| 17 | 2.45 | 2.70 | 0.25 | 1.48 | 23.32 | 4.55 | 0.60 |
| 18 | 2.70 | 2.95 | 0.25 | 1.48 | 24.72 | 3.98 | 0.53 |
| 19 | 2.95 | 3.20 | 0.25 | 1.48 | 26.12 | 3.53 | 0.47 |
| 20 | 3.20 | 3.56 | 0.36 | 1.48 | 27.83 | 3.10 | 0.41 |

Settlement of mid point of longitudinal edge = 3.7 mm

Settlement of mid point of transverse edge 1 = 9.0 mm

Settlement of mid point of transverse edge 2 = 9.0 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 10.62$ MPaFoundation in the longitudinal direction is rigid ($k=458.52$)Foundation in the direction of width is rigid ($k=76.29$)**Verification of load eccentricity**Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

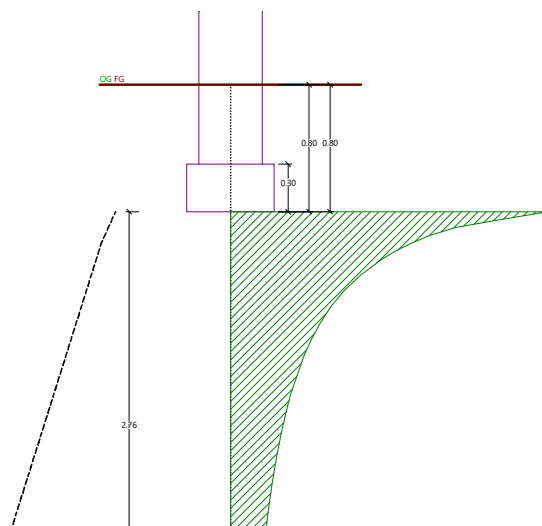
Foundation settlement = 7.7 mm

Depth of influence zone = 2.76 m

Rotation in direction of width = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement

Stage - analysis : 1 - 1



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 26. NADSTREŠNICA ZA MEHANIZACIJU NA DEPONIJI
 Description : Model 15 - B-33
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.21

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 3.35 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 4.61 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 15.60 \text{ kN/m}^3$

Foundation

Foundation type: centric spread footing

Depth from original ground surface $h_z = 1.80 \text{ m}$
 Depth of footing bottom $d = 1.80 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure

Foundation type: centric spread footing

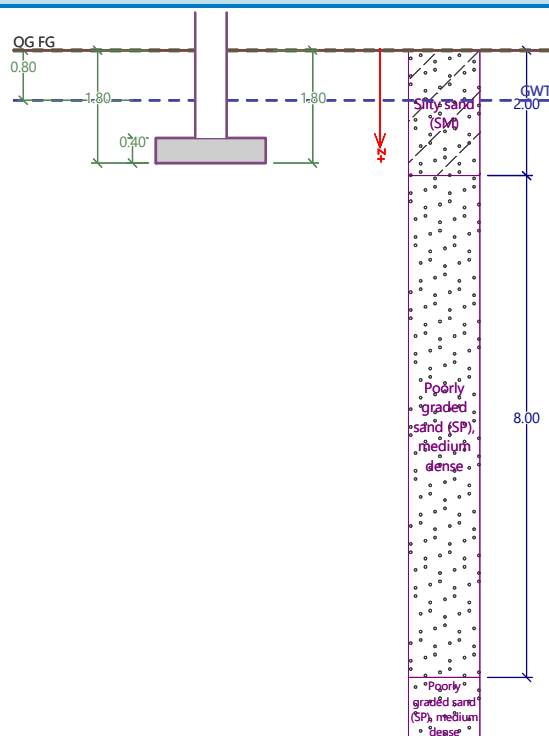
Spread footing length $x = 1.75 \text{ m}$
 Spread footing width $y = 1.75 \text{ m}$
 Column width in the direction of x $c_x = 0.50 \text{ m}$
 Column width in the direction of y $c_y = 0.50 \text{ m}$
 Spread footing volume $= 1.23 \text{ m}^3$
 Volume of excavation $= 5.51 \text{ m}^3$
 Volume of fill $= 3.94 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 2.00 | 0.00 .. 2.00 | Silty sand (SM) |  |
| 2 | 8.00 | 2.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 309.20 | 64.80 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 309.20 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 0.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | -0.18 | 145.25 | 327.08 | 44.41 | Yes |
| ULS | No | 0.00 | -0.19 | 143.95 | 326.78 | 44.05 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 24.422^\circ \\ c_d &= 0.129 \text{ kPa} \\ \gamma_{1\text{prum}} &= 12.444 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 5.895 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.381 \text{ m}\end{aligned}$$

$N_q = 10.035$
 $N_c = 19.897$
 $N_\gamma = 8.205$
 $s_q = 1.326$
 $s_c = 1.362$
 $s_\gamma = 0.763$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 327.081 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = -12.25 \text{ kN}$

Computed weight of overburden $Z = 54.00 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.73 \text{ m}$

Length of slip surface $l_{sp} = 8.20 \text{ m}$

Design bearing capacity of found.soil $R_d = 327.08 \text{ kPa}$

Extreme contact stress $\sigma = 145.25 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.107 < 0.333$

Max. overall eccentricity $e_t = 0.107 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 8.87 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 133.22 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = -12.25$ kN

Computed weight of overburden $Z = 54.00$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.80 | 1.85 | 0.05 | 2.49 | 22.60 | 91.57 | 1.37 |
| 2 | 1.85 | 1.90 | 0.05 | 2.49 | 23.00 | 88.01 | 1.31 |
| 3 | 1.90 | 1.95 | 0.05 | 2.49 | 23.40 | 80.85 | 1.21 |
| 4 | 1.95 | 2.00 | 0.05 | 2.49 | 23.80 | 72.48 | 1.08 |
| 5 | 2.00 | 2.05 | 0.05 | 3.61 | 24.14 | 64.87 | 0.70 |
| 6 | 2.05 | 2.10 | 0.05 | 3.61 | 24.42 | 58.56 | 0.64 |
| 7 | 2.10 | 2.20 | 0.10 | 3.61 | 24.84 | 51.61 | 1.12 |
| 8 | 2.20 | 2.30 | 0.10 | 3.61 | 25.40 | 44.61 | 0.97 |
| 9 | 2.30 | 2.40 | 0.10 | 3.61 | 25.96 | 39.57 | 0.86 |
| 10 | 2.40 | 2.50 | 0.10 | 3.61 | 26.52 | 35.66 | 0.77 |
| 11 | 2.50 | 2.60 | 0.10 | 3.61 | 27.08 | 32.44 | 0.70 |
| 12 | 2.60 | 2.70 | 0.10 | 3.61 | 27.64 | 29.70 | 0.64 |
| 13 | 2.70 | 2.95 | 0.25 | 3.61 | 28.62 | 25.84 | 1.40 |
| 14 | 2.95 | 3.20 | 0.25 | 3.61 | 30.02 | 21.28 | 1.15 |
| 15 | 3.20 | 3.45 | 0.25 | 3.61 | 31.42 | 17.77 | 0.96 |
| 16 | 3.45 | 3.70 | 0.25 | 3.61 | 32.82 | 15.02 | 0.81 |
| 17 | 3.70 | 3.95 | 0.25 | 3.61 | 34.22 | 12.85 | 0.70 |
| 18 | 3.95 | 4.20 | 0.25 | 3.61 | 35.62 | 11.11 | 0.60 |
| 19 | 4.20 | 4.70 | 0.50 | 3.61 | 37.72 | 9.17 | 0.99 |
| 20 | 4.70 | 5.20 | 0.50 | 3.61 | 40.52 | 7.19 | 0.78 |
| 21 | 5.20 | 5.70 | 0.50 | 3.61 | 43.32 | 5.80 | 0.63 |
| 22 | 5.70 | 6.02 | 0.32 | 3.61 | 45.61 | 4.93 | 0.21 |

Settlement of mid point of edge x - 1 = 16.9 mm

Settlement of mid point of edge x - 2 = 16.9 mm

Settlement of mid point of edge y - 1 = 16.9 mm

Settlement of mid point of edge y - 2 = 16.9 mm

Settlement of foundation center point = 26.7 mm

Settlement of characteristic point = 19.6 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 3.43$ MPa

Foundation in the longitudinal direction is rigid ($k=104.42$)

Foundation in the direction of width is rigid ($k=104.42$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

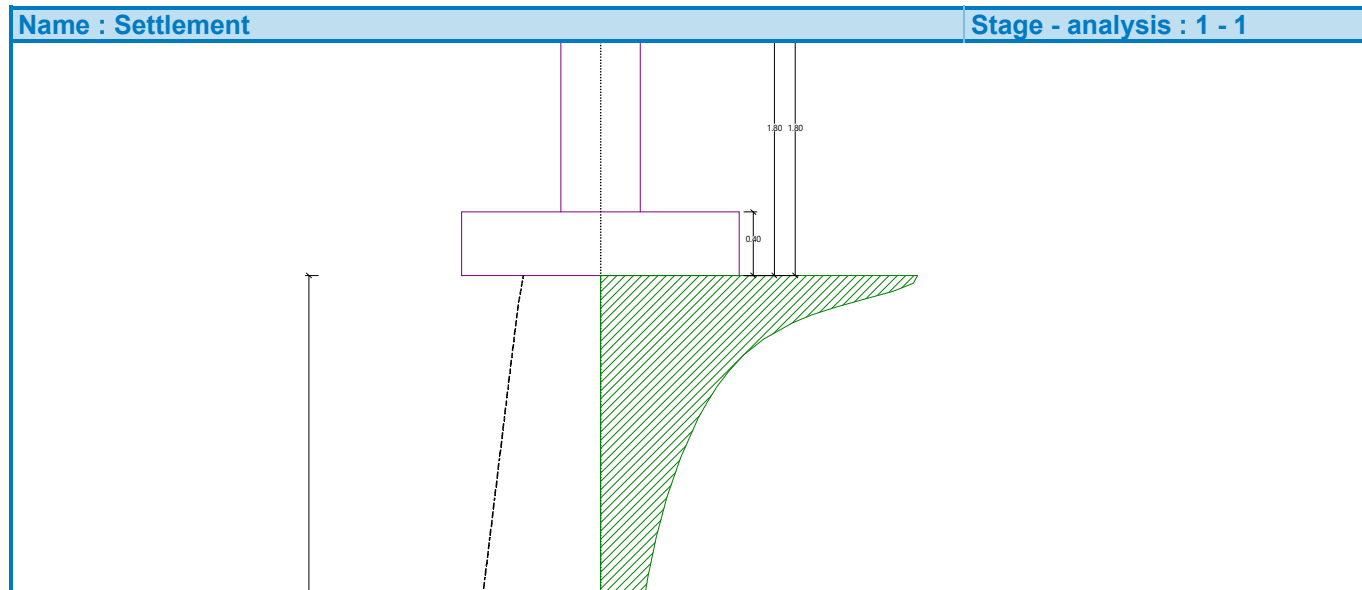
Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 19.6 mm

Depth of influence zone = 4.22 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)



Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 26. NADSTREŠNICA ZA MEHANIZACIJU NA DEPONIJI
 Description : Model 15 - B-33 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.21.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 3.35 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 4.61 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.80 \text{ m}$
 Depth of footing bottom $d = 1.80 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 1.75 \text{ m}$
 Spread footing width $y = 1.75 \text{ m}$
 Column width in the direction of x $c_x = 0.50 \text{ m}$
 Column width in the direction of y $c_y = 0.50 \text{ m}$

Spread footing volume $= 1.23 \text{ m}^3$
 Volume of excavation $= 5.51 \text{ m}^3$
 Volume of fill $= 3.94 \text{ m}^3$


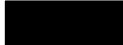

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

SG pad overhangs foundation $d_{\text{sp}} = 0.30 \text{ m}$

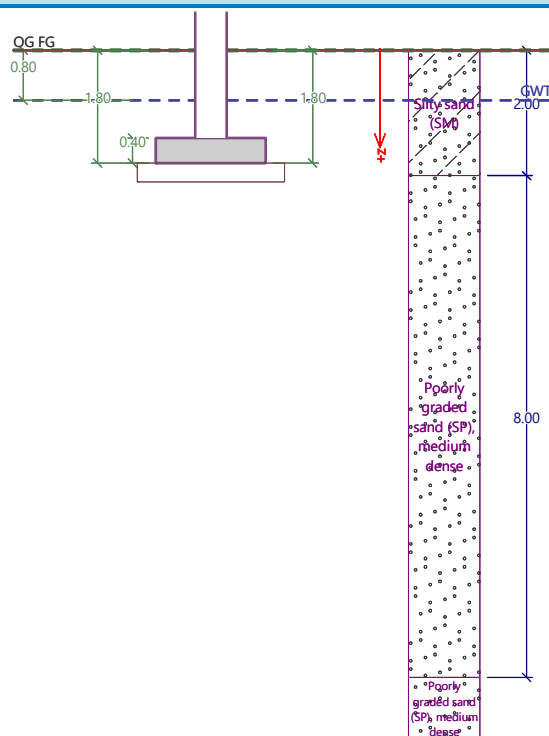
Sand-gravel pad depth $h_{\text{sp}} = 0.30 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------------------------------|---|
| 1 | 2.00 | 0.00 .. 2.00 | Silty sand (SM) |  |
| 2 | 8.00 | 2.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|--------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 309.20 | 64.80 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 309.20 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 0.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | -0.18 | 145.25 | 336.38 | 43.18 | Yes |
| ULS | No | 0.00 | -0.19 | 143.95 | 336.06 | 42.83 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 24.675^\circ \\ c_d &= 0.086 \text{ kPa} \\ \gamma_{1\text{prum}} &= 12.444 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 6.034 \text{ kN/m}^3 \\ b_{\text{ef}} &= 1.381 \text{ m}\end{aligned}$$

$N_q = 10.304$
 $N_c = 20.252$
 $N_\gamma = 8.549$
 $s_q = 1.329$
 $s_c = 1.365$
 $s_\gamma = 0.763$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 336.380 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = -12.25 \text{ kN}$

Computed weight of overburden $Z = 54.00 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 2.76 \text{ m}$

Length of slip surface $l_{sp} = 8.31 \text{ m}$

Design bearing capacity of found.soil $R_d = 336.38 \text{ kPa}$

Extreme contact stress $\sigma = 145.25 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.107 < 0.333$

Max. overall eccentricity $e_t = 0.107 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 8.87 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 205.46 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = -12.25$ kN

Computed weight of overburden $Z = 54.00$ kN

Settlement and rotation of foundation - partial results

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.80 | 1.85 | 0.05 | 27.00 | 22.60 | 91.57 | 0.15 |
| 2 | 1.85 | 1.90 | 0.05 | 27.00 | 23.00 | 88.01 | 0.15 |
| 3 | 1.90 | 1.95 | 0.05 | 27.00 | 23.40 | 80.85 | 0.13 |
| 4 | 1.95 | 2.00 | 0.05 | 27.00 | 23.80 | 72.48 | 0.12 |
| 5 | 2.00 | 2.05 | 0.05 | 27.00 | 24.14 | 64.87 | 0.11 |
| 6 | 2.05 | 2.10 | 0.05 | 27.00 | 24.42 | 58.56 | 0.10 |
| 7 | 2.10 | 2.20 | 0.10 | 3.61 | 24.84 | 51.61 | 1.12 |
| 8 | 2.20 | 2.30 | 0.10 | 3.61 | 25.40 | 44.61 | 0.97 |
| 9 | 2.30 | 2.40 | 0.10 | 3.61 | 25.96 | 39.57 | 0.86 |
| 10 | 2.40 | 2.50 | 0.10 | 3.61 | 26.52 | 35.66 | 0.77 |
| 11 | 2.50 | 2.60 | 0.10 | 3.61 | 27.08 | 32.44 | 0.70 |
| 12 | 2.60 | 2.70 | 0.10 | 3.61 | 27.64 | 29.70 | 0.64 |
| 13 | 2.70 | 2.95 | 0.25 | 3.61 | 28.62 | 25.84 | 1.40 |
| 14 | 2.95 | 3.20 | 0.25 | 3.61 | 30.02 | 21.28 | 1.15 |
| 15 | 3.20 | 3.45 | 0.25 | 3.61 | 31.42 | 17.77 | 0.96 |
| 16 | 3.45 | 3.70 | 0.25 | 3.61 | 32.82 | 15.02 | 0.81 |
| 17 | 3.70 | 3.90 | 0.20 | 3.61 | 34.08 | 13.04 | 0.57 |
| 18 | 3.90 | 3.95 | 0.05 | 3.61 | 34.78 | 12.08 | 0.13 |
| 19 | 3.95 | 4.20 | 0.25 | 3.61 | 35.62 | 11.11 | 0.60 |
| 20 | 4.20 | 4.70 | 0.50 | 3.61 | 37.72 | 9.17 | 0.99 |
| 21 | 4.70 | 5.20 | 0.50 | 3.61 | 40.52 | 7.19 | 0.78 |
| 22 | 5.20 | 5.70 | 0.50 | 3.61 | 43.32 | 5.80 | 0.63 |
| 23 | 5.70 | 6.02 | 0.32 | 3.61 | 45.61 | 4.93 | 0.21 |

Settlement of mid point of edge x - 1 = 13.6 mm

Settlement of mid point of edge x - 2 = 13.6 mm

Settlement of mid point of edge y - 1 = 13.6 mm

Settlement of mid point of edge y - 2 = 13.6 mm

Settlement of foundation center point = 20.2 mm

Settlement of characteristic point = 14.1 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**

Computed weighted average modulus of deformation $E_{def} = 9.03$ MPa

Foundation in the longitudinal direction is rigid ($k=39.66$)

Foundation in the direction of width is rigid ($k=39.66$)

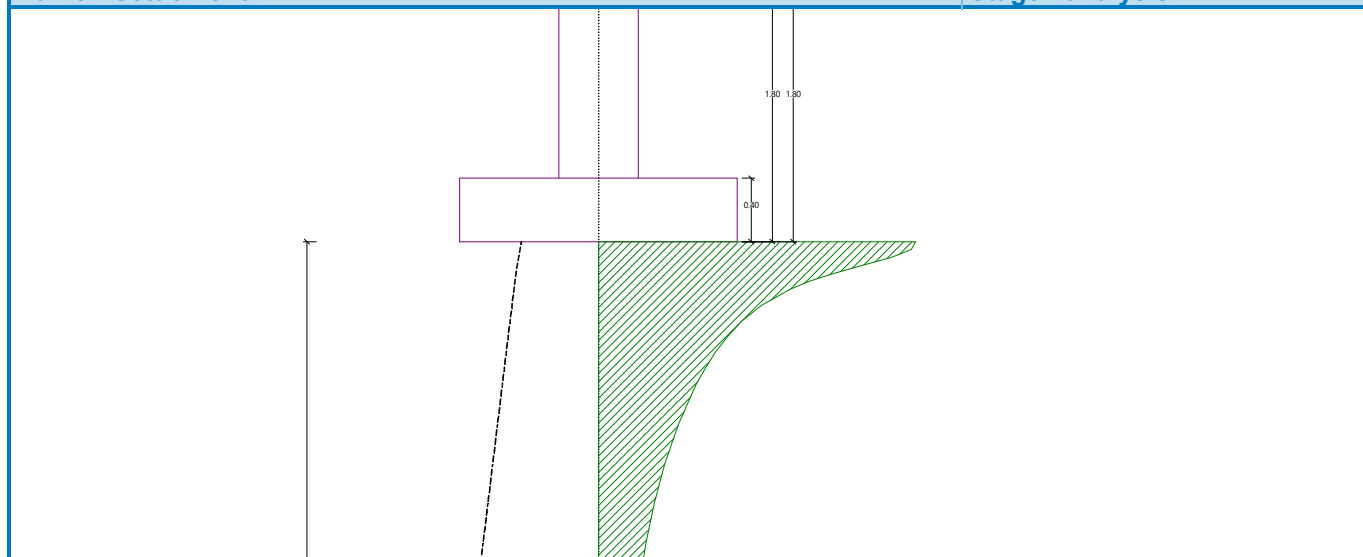
Verification of load eccentricityMax. eccentricity in direction of base length $e_x = 0.000 < 0.333$ Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$ Max. overall eccentricity $e_t = 0.000 < 0.333$ **Eccentricity of load is SATISFACTORY****Overall settlement and rotation of foundation:**

Foundation settlement = 14.1 mm

Depth of influence zone = 4.22 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)

Name : Settlement**Stage - analysis : 1 - 1**

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15a. Digestor
 Description : Model 15 - B-17
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.22

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 7.00^\circ$
 Cohesion of soil : $c_{ef} = 13.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.40 \text{ m}$
 Depth of footing bottom $d = 0.40 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden


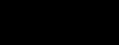


Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 24.50 \text{ m}$
 Spread footing width $y = 19.00 \text{ m}$
 Column width in the direction of x $c_x = 24.50 \text{ m}$
 Column width in the direction of y $c_y = 19.00 \text{ m}$

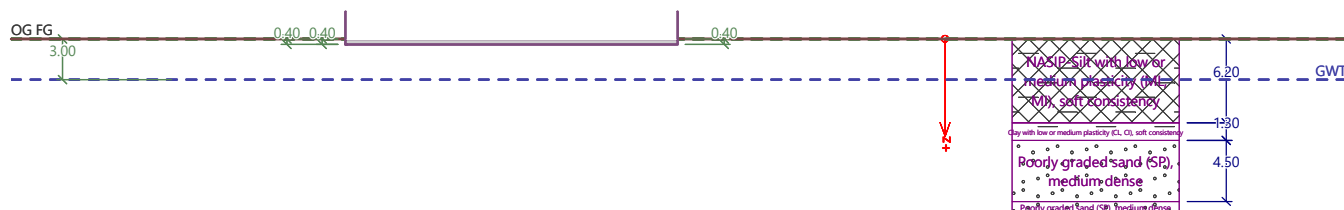
Spread footing volume = 186.20 m^3
 Volume of excavation = 186.20 m^3
 Volume of fill = 0.00 m^3

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 6.20 | 0.00 .. 6.20 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 1.30 | 6.20 .. 7.50 | Clay with low or medium plasticity (CL, CI), soft consistency |  |
| 3 | 4.50 | 7.50 .. 12.00 | Poorly graded sand (SP), medium dense |  |
| 4 | - | 12.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|----------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 48450.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 48450.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

The settlement is not analyzed.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 104.08 | 416.22 | 25.01 | Yes |
| ULS | No | 0.00 | 0.00 | 104.08 | 416.22 | 25.01 | Yes |

Analysis of bearing capacity - partial results

$$\varphi_d = 21.984^\circ$$

$$c_d = 0.750 \text{ kPa}$$

$$\gamma_{1prum} = 18.000 \text{ kN/m}^3$$

$$\gamma_{2prum} = 8.155 \text{ kN/m}^3$$

$b_{ef} = 19.000 \text{ m}$
 $N_q = 7.809$
 $N_c = 16.865$
 $N_\gamma = 5.498$
 $s_q = 1.290$
 $s_c = 1.333$
 $s_\gamma = 0.767$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 416.223 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$
 Computed weight of overburden $Z = 0.00 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 27.05 \text{ m}$

Length of slip surface $l_{sp} = 77.65 \text{ m}$

Design bearing capacity of found.soil $R_d = 416.22 \text{ kPa}$

Extreme contact stress $\sigma = 104.08 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 19.36 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 12866.98 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 15a. Digestor
 Description : Model 15 - B-17
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.22

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

NASIP-Silt with low or medium plasticity (ML, MI), soft consistency

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 17.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Clay with low or medium plasticity (CL, CI), soft consistency

Unit weight : $\gamma = 17.60 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 7.00^\circ$
 Cohesion of soil : $c_{ef} = 13.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 17.60 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.40 \text{ m}$
 Depth of footing bottom $d = 0.40 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 24.50 \text{ m}$
 Spread footing width $y = 19.00 \text{ m}$
 Column width in the direction of x $c_x = 24.50 \text{ m}$
 Column width in the direction of y $c_y = 19.00 \text{ m}$




Spread footing volume $= 186.20 \text{ m}^3$
 Volume of excavation $= 186.20 \text{ m}^3$
 Volume of fill $= 0.00 \text{ m}^3$

Sand-gravel bed

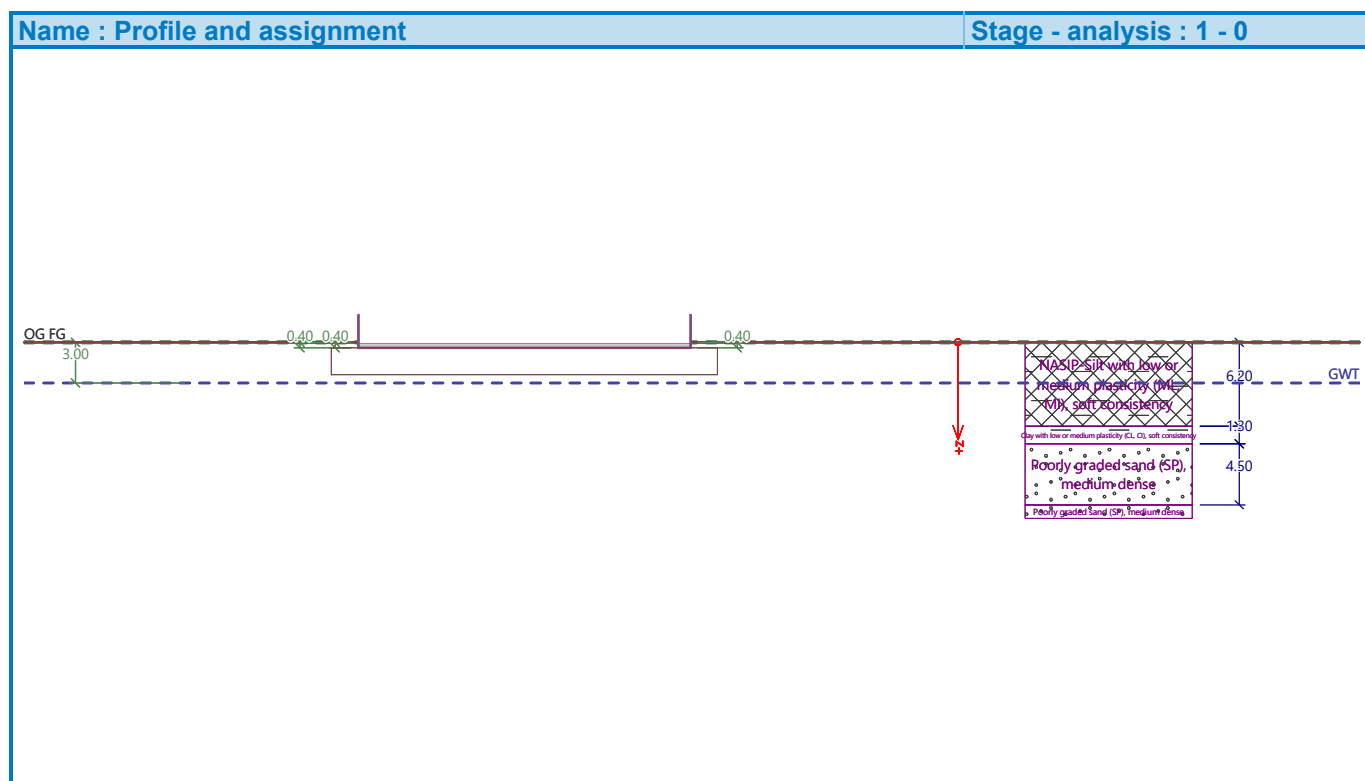
Soil used for the SG pad - Poorly graded gravel (GP), medium dense

SG pad overhangs foundation $d_{sp} = 2.00 \text{ m}$
 Sand-gravel pad depth $h_{sp} = 2.00 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---|---|
| 1 | 6.20 | 0.00 .. 6.20 | NASIP-Silt with low or medium plasticity (ML, MI), soft consistency |  |
| 2 | 1.30 | 6.20 .. 7.50 | Clay with low or medium plasticity (CL, CI), soft consistency |  |
| 3 | 4.50 | 7.50 .. 12.00 | Poorly graded sand (SP), medium dense |  |

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---------|
| 4 | - | 12.00 .. ∞ | Poorly graded sand (SP), medium dense | |



Load

| No. | Load | | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|------|--------|------|---------|-----------|-------------------------|-------------------------|------------------------|------------------------|
| | new | change | | | | | | | |
| 1 | Yes | | ULS | Design | 48450.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 48450.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

The settlement is not analyzed.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|---------------------|-----------------------|-----------------------|------------|-------------------------|--------------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 104.08 | 440.20 | 23.64 | Yes |
| ULS | No | 0.00 | 0.00 | 104.08 | 440.20 | 23.64 | Yes |

Analysis of bearing capacity - partial results

$\varphi_d = 22.340^\circ$
 $c_d = 0.696 \text{ kPa}$
 $\gamma_{1\text{prum}} = 18.000 \text{ kN/m}^3$
 $\gamma_{2\text{prum}} = 8.202 \text{ kN/m}^3$
 $b_{ef} = 19.000 \text{ m}$
 $N_q = 8.096$
 $N_c = 17.267$
 $N_\gamma = 5.832$
 $s_q = 1.295$
 $s_c = 1.336$
 $s_\gamma = 0.767$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 440.201 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 0.00 \text{ kN}$

Computed weight of overburden $Z = 0.00 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 27.41 \text{ m}$

Length of slip surface $l_{sp} = 79.18 \text{ m}$

Design bearing capacity of found.soil $R_d = 440.20 \text{ kPa}$

Extreme contact stress $\sigma = 104.08 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 19.36 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 27159.40 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 27. RETENZIJA PROCEDNIH VODA
 Description : Model 15 - B-36
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.23

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|------|-----|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 | [-] |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 | [-] |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 | [-] |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 | [-] |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 15.60 \text{ kN/m}^3$

Foundation

Foundation type: centric spread footing

Depth from original ground surface $h_z = 0.40 \text{ m}$
 Depth of footing bottom $d = 0.40 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile




Geometry of structure

Foundation type: centric spread footing

Spread footing length $x = 35.80 \text{ m}$
 Spread footing width $y = 35.20 \text{ m}$
 Column width in the direction of x $c_x = 35.80 \text{ m}$
 Column width in the direction of y $c_y = 35.20 \text{ m}$

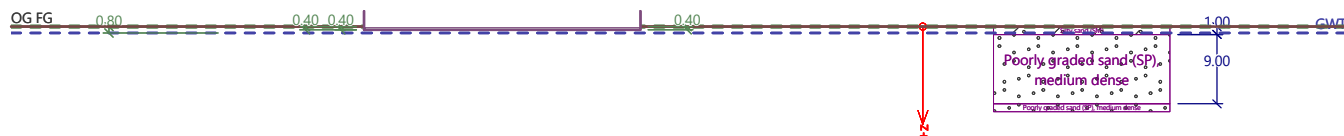
Spread footing volume = 504.06 m^3
 Volume of excavation = 504.06 m^3
 Volume of fill = 0.00 m^3

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 1.00 | 0.00 .. 1.00 | Silty sand (SM) |  |
| 2 | 9.00 | 1.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|----------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 75609.60 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 75609.60 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 0.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

The settlement is not analyzed.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 69.60 | 724.01 | 9.61 | Yes |
| ULS | No | 0.00 | 0.00 | 72.96 | 724.01 | 10.08 | Yes |

Analysis of bearing capacity - partial results

$$\varphi_d = 24.737^\circ$$

$$c_d = 0.019 \text{ kPa}$$

$$\gamma_{1prum} = 18.000 \text{ kN/m}^3$$

$$\gamma_{2prum} = 5.768 \text{ kN/m}^3$$

$b_{ef} = 35.200 \text{ m}$
 $N_q = 10.371$
 $N_c = 20.340$
 $N_\gamma = 8.635$
 $s_q = 1.411$
 $s_c = 1.455$
 $s_\gamma = 0.705$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 724.007 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 16331.67 \text{ kN}$
 Computed weight of overburden $Z = 0.00 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 55.62 \text{ m}$

Length of slip surface $l_{sp} = 167.80 \text{ m}$

Design bearing capacity of found.soil $R_d = 724.01 \text{ kPa}$

Extreme contact stress $\sigma = 72.96 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 30.88 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 32514.80 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 27. RETENZIJA PROCEDNIH VODA
 Description : Model 15 - B-36 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.23.1

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 15.60 \text{ kN/m}^3$

Foundation

Foundation type: centric spread footing

Depth from original ground surface $h_z = 0.40 \text{ m}$
 Depth of footing bottom $d = 0.40 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure

Foundation type: centric spread footing




Spread footing length $x = 35.80 \text{ m}$
 Spread footing width $y = 35.20 \text{ m}$
 Column width in the direction of x $c_x = 35.80 \text{ m}$
 Column width in the direction of y $c_y = 35.20 \text{ m}$
 Spread footing volume $= 504.06 \text{ m}^3$
 Volume of excavation $= 504.06 \text{ m}^3$
 Volume of fill $= 0.00 \text{ m}^3$

Sand-gravel bed

Soil used for the SG pad - Poorly graded sand (SP), medium dense

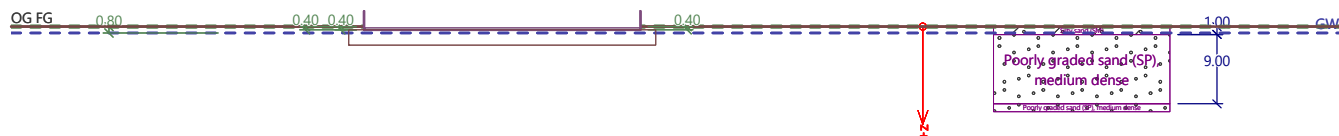
SG pad overhangs foundation $d_{sp} = 2.00 \text{ m}$
 Sand-gravel pad depth $h_{sp} = 2.00 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------------------------------|---|
| 1 | 1.00 | 0.00 .. 1.00 | Silty sand (SM) |  |
| 2 | 9.00 | 1.00 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|----------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 75609.60 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 75609.60 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 0.80 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

The settlement is not analyzed.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 69.60 | 724.93 | 9.60 | Yes |
| ULS | No | 0.00 | 0.00 | 72.96 | 724.93 | 10.06 | Yes |

Analysis of bearing capacity - partial results

$$\varphi_d = 24.755^\circ$$

$$c_d = 0.013 \text{ kPa}$$

$$\gamma_{1\text{prum}} = 18.000 \text{ kN/m}^3$$

$$\gamma_{2\text{prum}} = 5.760 \text{ kN/m}^3$$

$b_{ef} = 35.200 \text{ m}$
 $N_q = 10.391$
 $N_c = 20.366$
 $N_\gamma = 8.660$
 $s_q = 1.412$
 $s_c = 1.456$
 $s_\gamma = 0.705$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 724.932 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 16331.67 \text{ kN}$
 Computed weight of overburden $Z = 0.00 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 55.75 \text{ m}$

Length of slip surface $l_{sp} = 168.39 \text{ m}$

Design bearing capacity of found.soil $R_d = 724.93 \text{ kPa}$

Extreme contact stress $\sigma = 72.96 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 30.88 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 40541.07 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 8. PROTIVPOŽARNI REZERVOAR
 Description : Model 10 - B-23 ploca 1
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.24

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.89 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 34.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 4.18 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.90 \text{ m}$
 Depth of footing bottom $d = 0.90 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 10.90 \text{ m}$
 Spread footing width $y = 5.80 \text{ m}$
 Column width in the direction of x $c_x = 10.90 \text{ m}$
 Column width in the direction of y $c_y = 5.80 \text{ m}$

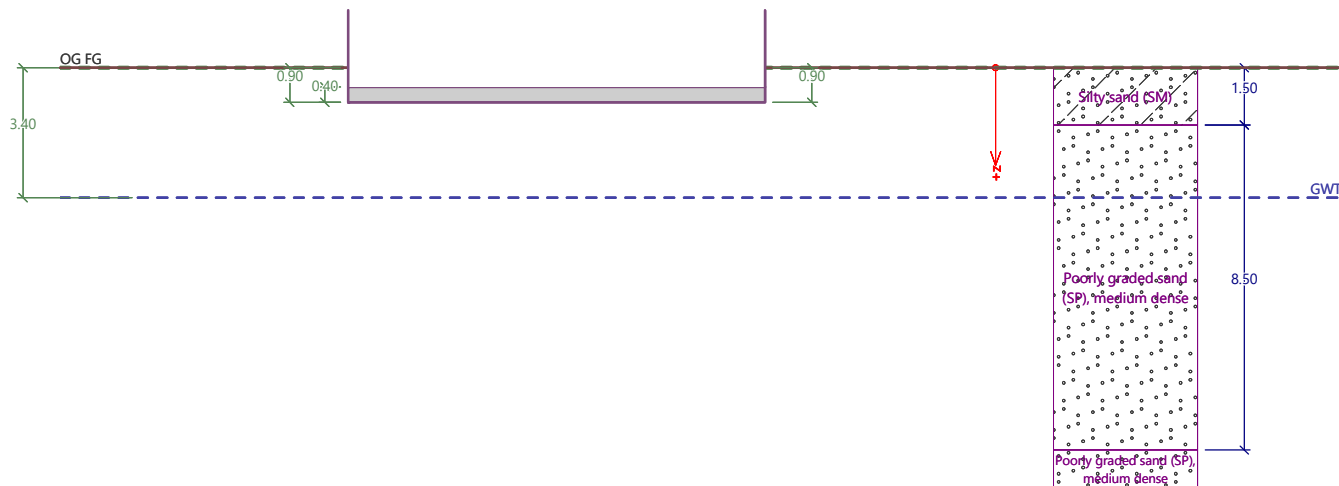
Spread footing volume = 25.29 m^3
 Volume of excavation = 56.90 m^3
 Volume of fill = 0.00 m^3

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------------------------------|---|
| 1 | 1.50 | 0.00 .. 1.50 | Silty sand (SM) |  |
| 2 | 8.50 | 1.50 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|---------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 3161.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 3161.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.40 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 59.60 | 631.64 | 9.44 | Yes |
| ULS | No | 0.00 | 0.00 | 62.96 | 631.64 | 9.97 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 27.888^\circ \\ c_d &= 0.067 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 9.601 \text{ kN/m}^3 \\ b_{\text{ef}} &= 5.800 \text{ m}\end{aligned}$$

$N_q = 14.540$
 $N_c = 25.585$
 $N_\gamma = 14.330$
 $s_q = 1.249$
 $s_c = 1.267$
 $s_\gamma = 0.840$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 631.638 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 819.33 \text{ kN}$
 Computed weight of overburden $Z = 0.00 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 10.41 \text{ m}$

Length of slip surface $l_{sp} = 33.36 \text{ m}$

Design bearing capacity of found.soil $R_d = 631.64 \text{ kPa}$

Extreme contact stress $\sigma = 62.96 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 17.81 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 1387.63 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 606.91$ kNComputed weight of overburden $Z = 0.00$ kN**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.90 | 0.95 | 0.05 | 1.40 | 16.65 | 43.40 | 1.15 |
| 2 | 0.95 | 1.00 | 0.05 | 1.40 | 17.55 | 43.40 | 1.15 |
| 3 | 1.00 | 1.05 | 0.05 | 1.40 | 18.45 | 43.39 | 1.15 |
| 4 | 1.05 | 1.10 | 0.05 | 1.40 | 19.35 | 43.38 | 1.15 |
| 5 | 1.10 | 1.15 | 0.05 | 1.40 | 20.25 | 43.37 | 1.15 |
| 6 | 1.15 | 1.20 | 0.05 | 1.40 | 21.15 | 43.35 | 1.15 |
| 7 | 1.20 | 1.30 | 0.10 | 1.40 | 22.50 | 43.29 | 2.29 |
| 8 | 1.30 | 1.40 | 0.10 | 1.40 | 24.30 | 43.18 | 2.28 |
| 9 | 1.40 | 1.50 | 0.10 | 1.40 | 26.10 | 43.04 | 2.28 |
| 10 | 1.50 | 1.60 | 0.10 | 3.27 | 27.78 | 42.85 | 1.03 |
| 11 | 1.60 | 1.70 | 0.10 | 3.27 | 29.34 | 42.61 | 1.02 |
| 12 | 1.70 | 1.80 | 0.10 | 3.27 | 30.90 | 42.34 | 1.01 |
| 13 | 1.80 | 2.05 | 0.25 | 3.27 | 33.63 | 41.74 | 2.50 |
| 14 | 2.05 | 2.30 | 0.25 | 3.27 | 37.53 | 40.75 | 2.44 |
| 15 | 2.30 | 2.55 | 0.25 | 3.27 | 41.43 | 39.59 | 2.37 |
| 16 | 2.55 | 2.80 | 0.25 | 3.27 | 45.33 | 38.32 | 2.29 |
| 17 | 2.80 | 3.05 | 0.25 | 3.27 | 49.23 | 36.97 | 2.21 |
| 18 | 3.05 | 3.30 | 0.25 | 3.27 | 53.13 | 35.56 | 2.13 |
| 19 | 3.30 | 3.40 | 0.10 | 3.27 | 55.86 | 34.57 | 0.83 |
| 20 | 3.40 | 3.80 | 0.40 | 3.27 | 57.76 | 33.15 | 3.17 |
| 21 | 3.80 | 4.30 | 0.50 | 3.27 | 60.28 | 30.64 | 3.66 |
| 22 | 4.30 | 4.80 | 0.50 | 3.27 | 63.08 | 27.97 | 3.35 |
| 23 | 4.80 | 5.30 | 0.50 | 3.27 | 65.88 | 25.48 | 3.05 |
| 24 | 5.30 | 5.80 | 0.50 | 3.27 | 68.68 | 23.20 | 2.77 |
| 25 | 5.80 | 6.30 | 0.50 | 3.27 | 71.48 | 21.12 | 2.53 |
| 26 | 6.30 | 7.30 | 1.00 | 3.27 | 75.68 | 18.46 | 4.42 |
| 27 | 7.30 | 8.30 | 1.00 | 3.27 | 81.28 | 15.43 | 3.69 |
| 28 | 8.30 | 9.30 | 1.00 | 3.27 | 86.88 | 12.99 | 3.11 |
| 29 | 9.30 | 10.00 | 0.70 | 3.27 | 91.64 | 11.30 | 1.89 |
| 30 | 10.00 | 10.30 | 0.30 | 3.27 | 94.44 | 10.43 | 0.75 |
| 31 | 10.30 | 10.62 | 0.32 | 3.27 | 96.18 | 9.94 | 0.23 |

Settlement of mid point of edge x - 1 = 38.1 mm

Settlement of mid point of edge x - 2 = 38.1 mm

Settlement of mid point of edge y - 1 = 30.8 mm

Settlement of mid point of edge y - 2 = 30.8 mm

Settlement of foundation center point = 64.2 mm

Settlement of characteristic point = 44.0 mm

(1-max.compressed edge; 2-min.compressed edge)

Foundation stiffness:

Foundation in the longitudinal direction is deformable ($k=0.48$)

Foundation in the direction of width is rigid ($k=3.21$)

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Foundation settlement = 64.2 mm

Depth of influence zone = 9.72 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)

[illegible]

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 8. PROTIVPOŽARNI REZERVOAR
 Description : Model 10 - B-23 ploca 1 tampon
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.24

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.89 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 34.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 4.18 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 0.90 \text{ m}$
 Depth of footing bottom $d = 0.90 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden

Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 10.90 \text{ m}$
 Spread footing width $y = 5.80 \text{ m}$
 Column width in the direction of x $c_x = 10.90 \text{ m}$
 Column width in the direction of y $c_y = 5.80 \text{ m}$




Spread footing volume $= 25.29 \text{ m}^3$
 Volume of excavation $= 56.90 \text{ m}^3$
 Volume of fill $= 0.00 \text{ m}^3$

Sand-gravel bed

Soil used for the SG pad - Poorly graded gravel (GP), medium dense

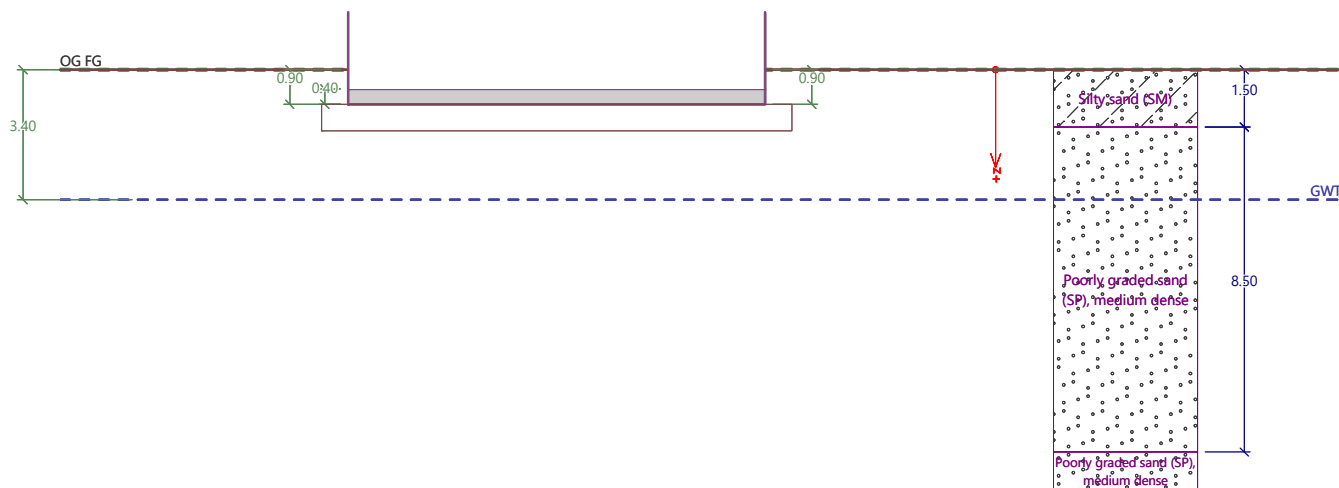
SG pad overhangs foundation $d_{sp} = 0.70 \text{ m}$
 Sand-gravel pad depth $h_{sp} = 0.70 \text{ m}$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------------------------------|---|
| 1 | 1.50 | 0.00 .. 1.50 | Silty sand (SM) |  |
| 2 | 8.50 | 1.50 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|---------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 3161.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 3161.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.40 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 59.60 | 646.88 | 9.21 | Yes |
| ULS | No | 0.00 | 0.00 | 62.96 | 646.88 | 9.73 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 28.053^\circ \\ c_d &= 0.045 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 9.635 \text{ kN/m}^3 \\ b_{\text{ef}} &= 5.800 \text{ m}\end{aligned}$$

$N_q = 14.806$
 $N_c = 25.908$
 $N_\gamma = 14.715$
 $s_q = 1.250$
 $s_c = 1.268$
 $s_\gamma = 0.840$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 646.885 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 819.33 \text{ kN}$
 Computed weight of overburden $Z = 0.00 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 10.49 \text{ m}$

Length of slip surface $l_{sp} = 33.74 \text{ m}$

Design bearing capacity of found.soil $R_d = 646.88 \text{ kPa}$

Extreme contact stress $\sigma = 62.96 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 17.81 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 2128.47 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 606.91$ kNComputed weight of overburden $Z = 0.00$ kN**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 0.90 | 0.95 | 0.05 | 27.00 | 16.65 | 43.40 | 0.07 |
| 2 | 0.95 | 1.00 | 0.05 | 27.00 | 17.55 | 43.40 | 0.07 |
| 3 | 1.00 | 1.05 | 0.05 | 27.00 | 18.45 | 43.39 | 0.07 |
| 4 | 1.05 | 1.10 | 0.05 | 27.00 | 19.35 | 43.38 | 0.07 |
| 5 | 1.10 | 1.15 | 0.05 | 27.00 | 20.25 | 43.37 | 0.07 |
| 6 | 1.15 | 1.20 | 0.05 | 27.00 | 21.15 | 43.35 | 0.07 |
| 7 | 1.20 | 1.30 | 0.10 | 27.00 | 22.50 | 43.29 | 0.14 |
| 8 | 1.30 | 1.40 | 0.10 | 27.00 | 24.30 | 43.18 | 0.14 |
| 9 | 1.40 | 1.50 | 0.10 | 27.00 | 26.10 | 43.04 | 0.14 |
| 10 | 1.50 | 1.60 | 0.10 | 27.00 | 27.78 | 42.85 | 0.14 |
| 11 | 1.60 | 1.70 | 0.10 | 3.27 | 29.34 | 42.61 | 1.02 |
| 12 | 1.70 | 1.80 | 0.10 | 3.27 | 30.90 | 42.34 | 1.01 |
| 13 | 1.80 | 2.05 | 0.25 | 3.27 | 33.63 | 41.74 | 2.50 |
| 14 | 2.05 | 2.30 | 0.25 | 3.27 | 37.53 | 40.75 | 2.44 |
| 15 | 2.30 | 2.50 | 0.20 | 3.27 | 41.04 | 39.72 | 1.90 |
| 16 | 2.50 | 2.55 | 0.05 | 3.27 | 42.99 | 39.10 | 0.47 |
| 17 | 2.55 | 2.80 | 0.25 | 3.27 | 45.33 | 38.32 | 2.29 |
| 18 | 2.80 | 3.05 | 0.25 | 3.27 | 49.23 | 36.97 | 2.21 |
| 19 | 3.05 | 3.30 | 0.25 | 3.27 | 53.13 | 35.56 | 2.13 |
| 20 | 3.30 | 3.40 | 0.10 | 3.27 | 55.86 | 34.57 | 0.83 |
| 21 | 3.40 | 3.80 | 0.40 | 3.27 | 57.76 | 33.15 | 3.17 |
| 22 | 3.80 | 4.30 | 0.50 | 3.27 | 60.28 | 30.64 | 3.66 |
| 23 | 4.30 | 4.80 | 0.50 | 3.27 | 63.08 | 27.97 | 3.35 |
| 24 | 4.80 | 5.30 | 0.50 | 3.27 | 65.88 | 25.48 | 3.05 |
| 25 | 5.30 | 5.80 | 0.50 | 3.27 | 68.68 | 23.20 | 2.77 |
| 26 | 5.80 | 6.30 | 0.50 | 3.27 | 71.48 | 21.12 | 2.53 |
| 27 | 6.30 | 7.30 | 1.00 | 3.27 | 75.68 | 18.46 | 4.42 |
| 28 | 7.30 | 8.30 | 1.00 | 3.27 | 81.28 | 15.43 | 3.69 |
| 29 | 8.30 | 9.30 | 1.00 | 3.27 | 86.88 | 12.99 | 3.11 |
| 30 | 9.30 | 10.00 | 0.70 | 3.27 | 91.64 | 11.30 | 1.89 |
| 31 | 10.00 | 10.30 | 0.30 | 3.27 | 94.44 | 10.43 | 0.75 |
| 32 | 10.30 | 10.62 | 0.32 | 3.27 | 96.18 | 9.94 | 0.23 |

Settlement of mid point of edge x - 1 = 31.2 mm

Settlement of mid point of edge x - 2 = 31.2 mm

Settlement of mid point of edge y - 1 = 23.9 mm

Settlement of mid point of edge y - 2 = 23.9 mm

Settlement of foundation center point = 50.4 mm

Settlement of characteristic point = 30.9 mm

(1-max.compressed edge; 2-min.compressed edge)

Foundation stiffness:

Foundation in the longitudinal direction is deformable ($k=0.23$)

Foundation in the direction of width is rigid ($k=1.56$)

Verification of load eccentricity

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:

Depth of influence zone = 9.72 m

Rotation in direction of x = 0.000 (tan*1000); (0.0E+00 °)

Rotation in direction of y = 0.000 (tan*1000); (0.0E+00 °)

| Name : Settlement | Stage - analysis : 1 - 1 |
|-------------------|--------------------------|
| | |
| | |
| | |
| | |

Spread footing verification

Input data

Project

Task : Gradska deponija u novom Sadu
 Part : 8. PROTIVPOŽARNI REZERVOAR
 Description : Model 10 - B-23 Ploca 2
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 10.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.24.2

Settings

(input for current task)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
 Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
 Restriction of influence zone : by percentage of Sigma, Or
 Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
 Analysis of uplift : Standard
 Allowable eccentricity : 0.333
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.40 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |
| Partial factor on unconfined strength : | $\gamma_v =$ | 1.40 [-] | |

Soil parameters

Silty sand (SM)

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 23.00^\circ$
 Cohesion of soil : $c_{ef} = 2.00 \text{ kPa}$
 Oedometric modulus : $E_{oed} = 1.89 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 34.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 4.18 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Poorly graded gravel (GP), medium dense

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 35.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Oedometric modulus : $E_{\text{oed}} = 30.00 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 21.00 \text{ kN/m}^3$

Foundation**Foundation type: centric spread footing**

Depth from original ground surface $h_z = 1.45 \text{ m}$
 Depth of footing bottom $d = 1.45 \text{ m}$
 Foundation thickness $t = 0.40 \text{ m}$
 Incl. of finished grade $s_1 = 0.00^\circ$
 Incl. of footing bottom $s_2 = 0.00^\circ$

Overburden




Type: from geological profile

Geometry of structure**Foundation type: centric spread footing**

Spread footing length $x = 6.50 \text{ m}$
 Spread footing width $y = 5.55 \text{ m}$
 Column width in the direction of x $c_x = 6.50 \text{ m}$
 Column width in the direction of y $c_y = 5.55 \text{ m}$

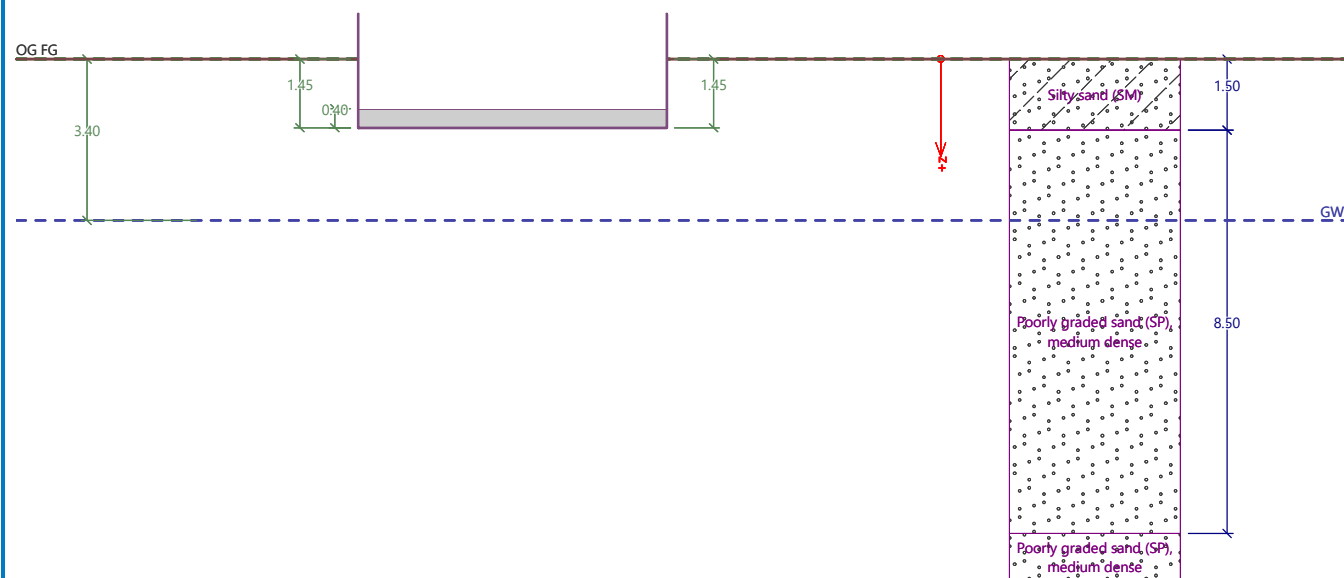
Spread footing volume $= 14.43 \text{ m}^3$
 Volume of excavation $= 52.31 \text{ m}^3$
 Volume of fill $= 0.00 \text{ m}^3$

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------------------------------|---|
| 1 | 1.50 | 0.00 .. 1.50 | Silty sand (SM) |  |
| 2 | 8.50 | 1.50 .. 10.00 | Poorly graded sand (SP), medium dense |  |
| 3 | - | 10.00 .. ∞ | Poorly graded sand (SP), medium dense |  |

Name : Profile and assignment

Stage - analysis : 1 - 0



Load

| No. | new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-----|-------------|------|---------|---------|----------------------|----------------------|---------------------|---------------------|
| 1 | Yes | | ULS | Design | 2164.50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | Yes | | SLS | Service | 2164.50 | 0.00 | 0.00 | 0.00 | 0.00 |

Ground water table

The ground water table is at a depth of 3.40 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

| Name | Self w. in favor | e _x [m] | e _y [m] | σ [kPa] | R _d [kPa] | Utilization [%] | Is satisfactory |
|------|------------------|--------------------|--------------------|---------|----------------------|-----------------|-----------------|
| ULS | Yes | 0.00 | 0.00 | 69.60 | 834.09 | 8.34 | Yes |
| ULS | No | 0.00 | 0.00 | 72.96 | 834.09 | 8.75 | Yes |

Analysis of bearing capacity - partial results

$$\begin{aligned}\varphi_d &= 28.312^\circ \\ c_d &= 0.006 \text{ kPa} \\ \gamma_{1\text{prum}} &= 18.000 \text{ kN/m}^3 \\ \gamma_{2\text{prum}} &= 8.695 \text{ kN/m}^3 \\ b_{\text{ef}} &= 5.550 \text{ m}\end{aligned}$$

$N_q = 15.234$
 $N_c = 26.423$
 $N_\gamma = 15.336$
 $s_q = 1.405$
 $s_c = 1.433$
 $s_\gamma = 0.744$
 $d_q = 1.000$
 $d_c = 1.000$
 $d_\gamma = 1.000$
 $i_q = 1.000$
 $i_c = 1.000$
 $i_\gamma = 1.000$
 $b_q = 1.000$
 $b_c = 1.000$
 $b_\gamma = 1.000$
 $g_q = 1.000$
 $g_c = 1.000$
 $g_\gamma = 1.000$
 $R_d = 834.093 \text{ kPa}$

Analysis carried out for the load case No. 1. (ULS)

Computed weight of spread footing $G = 467.53 \text{ kN}$
 Computed weight of overburden $Z = 0.00 \text{ kN}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 10.14 \text{ m}$

Length of slip surface $l_{sp} = 32.78 \text{ m}$

Design bearing capacity of found.soil $R_d = 834.09 \text{ kPa}$

Extreme contact stress $\sigma = 72.96 \text{ kPa}$

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: at rest

Design magnitude of earth resistance $S_{pd} = 30.43 \text{ kN}$

Horizontal bearing capacity $R_{dh} = 934.59 \text{ kN}$

Extreme horizontal force $H = 0.00 \text{ kN}$

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Verification No. 1**Settlement and rotation of foundation - input data**

Analysis carried out for the load case No. 2.(SLS)

Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).

Stress at the footing bottom considered from the finished grade.

Computed weight of spread footing $G = 346.32$ kNComputed weight of overburden $Z = 0.00$ kN**Settlement and rotation of foundation - partial results**

| Layer No. | Origin [m] | End [m] | Thickness [m] | E_{def} [MPa] | σ_{or} [kPa] | $\Delta\sigma_z$ [kPa] | Settlement [mm] |
|-----------|------------|---------|---------------|-----------------|---------------------|------------------------|-----------------|
| 1 | 1.45 | 1.50 | 0.05 | 1.40 | 26.55 | 43.49 | 1.15 |
| 2 | 1.50 | 1.55 | 0.05 | 3.27 | 27.39 | 43.43 | 0.52 |
| 3 | 1.55 | 1.60 | 0.05 | 3.27 | 28.17 | 43.23 | 0.52 |
| 4 | 1.60 | 1.65 | 0.05 | 3.27 | 28.95 | 42.86 | 0.51 |
| 5 | 1.65 | 1.70 | 0.05 | 3.27 | 29.73 | 42.29 | 0.51 |
| 6 | 1.70 | 1.75 | 0.05 | 3.27 | 30.51 | 41.54 | 0.50 |
| 7 | 1.75 | 1.85 | 0.10 | 3.27 | 31.68 | 40.12 | 0.96 |
| 8 | 1.85 | 1.95 | 0.10 | 3.27 | 33.24 | 38.01 | 0.91 |
| 9 | 1.95 | 2.05 | 0.10 | 3.27 | 34.80 | 35.83 | 0.86 |
| 10 | 2.05 | 2.15 | 0.10 | 3.27 | 36.36 | 33.73 | 0.81 |
| 11 | 2.15 | 2.25 | 0.10 | 3.27 | 37.92 | 31.81 | 0.76 |
| 12 | 2.25 | 2.35 | 0.10 | 3.27 | 39.48 | 30.08 | 0.72 |
| 13 | 2.35 | 2.60 | 0.25 | 3.27 | 42.21 | 27.62 | 1.65 |
| 14 | 2.60 | 2.85 | 0.25 | 3.27 | 46.11 | 24.73 | 1.48 |
| 15 | 2.85 | 3.10 | 0.25 | 3.27 | 50.01 | 22.54 | 1.35 |
| 16 | 3.10 | 3.35 | 0.25 | 3.27 | 53.91 | 20.81 | 1.24 |
| 17 | 3.35 | 3.40 | 0.05 | 3.27 | 56.25 | 19.92 | 0.24 |
| 18 | 3.40 | 3.60 | 0.20 | 3.27 | 57.20 | 19.27 | 0.92 |
| 19 | 3.60 | 3.85 | 0.25 | 3.27 | 58.46 | 18.21 | 1.09 |
| 20 | 3.85 | 4.35 | 0.50 | 3.27 | 60.56 | 16.73 | 2.00 |
| 21 | 4.35 | 4.85 | 0.50 | 3.27 | 63.36 | 15.05 | 1.80 |
| 22 | 4.85 | 5.35 | 0.50 | 3.27 | 66.16 | 13.64 | 1.63 |
| 23 | 5.35 | 5.85 | 0.50 | 3.27 | 68.96 | 12.42 | 1.49 |
| 24 | 5.85 | 6.35 | 0.50 | 3.27 | 71.76 | 11.33 | 1.36 |
| 25 | 6.35 | 6.85 | 0.50 | 3.27 | 74.56 | 10.37 | 1.24 |
| 26 | 6.85 | 7.85 | 1.00 | 3.27 | 78.76 | 9.14 | 2.19 |
| 27 | 7.85 | 7.97 | 0.12 | 3.27 | 81.89 | 8.29 | 0.03 |

Settlement of mid point of edge x - 1 = 24.5 mm

Settlement of mid point of edge x - 2 = 24.5 mm

Settlement of mid point of edge y - 1 = 23.3 mm

Settlement of mid point of edge y - 2 = 23.3 mm

Settlement of foundation center point = 43.5 mm

Settlement of characteristic point = 28.4 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results**Foundation stiffness:**Computed weighted average modulus of deformation $E_{def} = 3.25$ MPa

Foundation in the longitudinal direction is rigid ($k=2.15$)

Foundation in the direction of width is rigid ($k=3.46$)

Verification of load eccentricity

Max. eccentricity in direction of base length $e_x = 0.000 < 0.333$

Max. eccentricity in direction of base width $e_y = 0.000 < 0.333$

Max. overall eccentricity $e_t = 0.000 < 0.333$

Eccentricity of load is SATISFACTORY

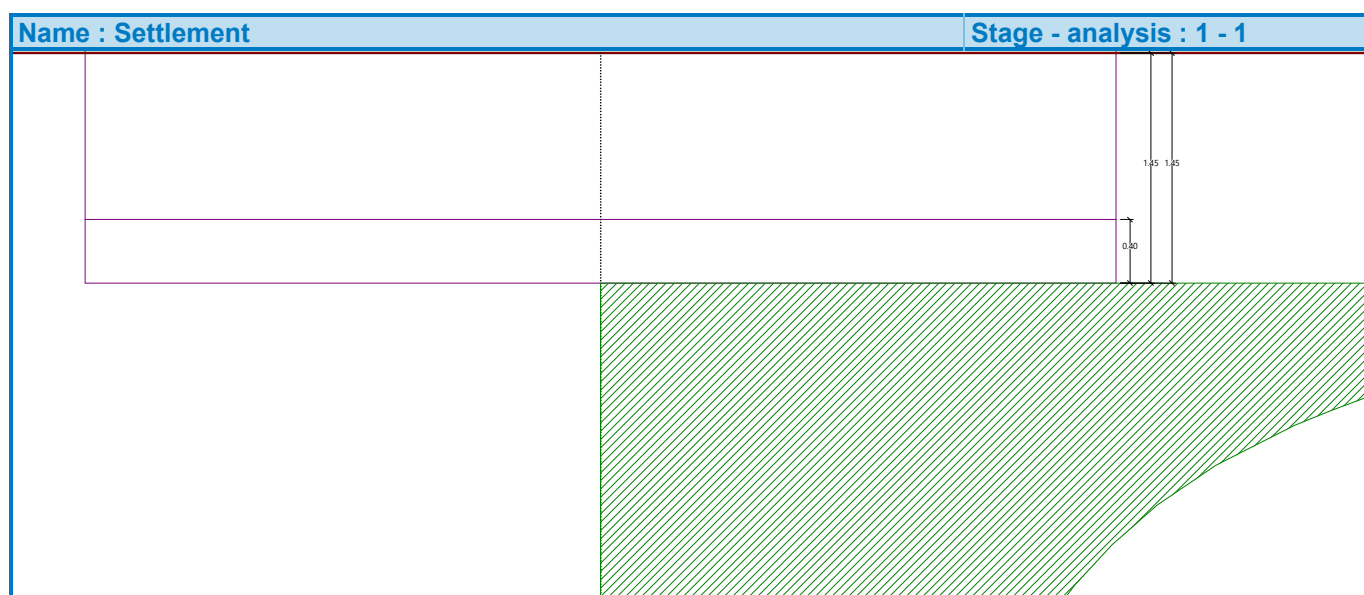
Overall settlement and rotation of foundation:

Foundation settlement = 28.4 mm

Depth of influence zone = 6.52 m

Rotation in direction of x = 0.000 (\tan^*1000); ($3.1E-17^\circ$)

Rotation in direction of y = 0.000 (\tan^*1000); ($0.0E+00^\circ$)



"CENTRALNA PUTNA LABORATORIJA"DOO

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21203 Veternik, Novi Sad, Srbija

PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat : Gradska deponija u Novom Sadu

Napomena: Provera sleganja - Retenzija procednih voda

Oblik Temelja : Pravougaonik

Df= 0.40 m

B=35.20 m

L=35.80 m

Sproj= 100.00 kPa

PODACI O ANGAZOVANOM TLU :

(usvojeno)

| Sloj | Debljina(m) | Gama (kN/m3) | Mv (kN/m2) |
|------|-------------|--------------|------------|
| 1 | 0.80 | 21.00 | 50000 |
| 2 | 1.60 | 10.00 | 50000 |
| 3 | 35.00 | 10.00 | 4610 |

PRORACUN GEOLOSKOG PRITISKA :

| Br. | Dubina(m) | h(m) | Gama (kN/m3) | Gama*h (kN/m3) | GP (kN/m2) |
|-----|-----------|------|--------------|----------------|------------|
| 1 | 0.40 | 0.40 | 21.00 | 8.40 | 8.40 |
| 2 | 0.80 | 0.40 | 21.00 | 8.40 | 16.80 |
| 3 | 1.60 | 0.80 | 10.00 | 8.00 | 24.80 |
| 4 | 2.40 | 0.80 | 10.00 | 8.00 | 32.80 |
| 5 | 3.49 | 1.09 | 10.00 | 10.94 | 43.74 |
| 6 | 4.59 | 1.09 | 10.00 | 10.94 | 54.67 |
| 7 | 5.68 | 1.09 | 10.00 | 10.94 | 65.61 |
| 8 | 6.78 | 1.09 | 10.00 | 10.94 | 76.55 |
| 9 | 7.87 | 1.09 | 10.00 | 10.94 | 87.49 |
| 10 | 8.96 | 1.09 | 10.00 | 10.94 | 98.42 |
| 11 | 10.06 | 1.09 | 10.00 | 10.94 | 109.36 |
| 12 | 11.15 | 1.09 | 10.00 | 10.94 | 120.30 |
| 13 | 12.24 | 1.09 | 10.00 | 10.94 | 131.24 |
| 14 | 13.34 | 1.09 | 10.00 | 10.94 | 142.18 |
| 15 | 14.43 | 1.09 | 10.00 | 10.94 | 153.11 |
| 16 | 15.53 | 1.09 | 10.00 | 10.94 | 164.05 |
| 17 | 16.62 | 1.09 | 10.00 | 10.94 | 174.99 |
| 18 | 17.71 | 1.09 | 10.00 | 10.94 | 185.93 |
| 19 | 18.81 | 1.09 | 10.00 | 10.94 | 196.86 |
| 20 | 19.90 | 1.09 | 10.00 | 10.94 | 207.80 |
| 21 | 20.99 | 1.09 | 10.00 | 10.94 | 218.74 |
| 22 | 22.09 | 1.09 | 10.00 | 10.94 | 229.68 |
| 23 | 23.18 | 1.09 | 10.00 | 10.94 | 240.61 |
| 24 | 24.27 | 1.09 | 10.00 | 10.94 | 251.55 |
| 25 | 25.37 | 1.09 | 10.00 | 10.94 | 262.49 |
| 26 | 26.46 | 1.09 | 10.00 | 10.94 | 273.43 |
| 27 | 27.56 | 1.09 | 10.00 | 10.94 | 284.36 |
| 28 | 28.65 | 1.09 | 10.00 | 10.94 | 295.30 |
| 29 | 29.74 | 1.09 | 10.00 | 10.94 | 306.24 |
| 30 | 30.84 | 1.09 | 10.00 | 10.94 | 317.18 |
| 31 | 31.93 | 1.09 | 10.00 | 10.94 | 328.11 |
| 32 | 33.02 | 1.09 | 10.00 | 10.94 | 339.05 |
| 33 | 34.12 | 1.09 | 10.00 | 10.94 | 349.99 |
| 34 | 35.21 | 1.09 | 10.00 | 10.94 | 360.93 |
| 35 | 36.31 | 1.09 | 10.00 | 10.94 | 371.86 |
| 36 | 37.40 | 1.09 | 10.00 | 10.94 | 382.80 |

Projektovano opterecenje Sp= 100.00 kPa

Rastrecenje usled iskopa Pz= 8.40 kPa

Sr=Sp-Pz Sr= 91.60 kPa

Prilog br.

[illegible]

* * * * *

B=35.20 m L=35.80 m
b=17.60 m a=35.80 m

[illegible]

* * * * *

B=35.20 m L=35.80 m
b=17.90 m a=35.20 m

| Br. | z(m) | z/b | Sz/q | d _p (kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|--|-------|------|-------|----------------------|------|---------|----------|
| 1 | 0.20 | 0.01 | 0.500 | 45.80 | 0.40 | 50000 | 0.037 |
| 2 | 0.80 | 0.04 | 0.500 | 45.80 | 0.80 | 50000 | 0.073 |
| 3 | 1.60 | 0.09 | 0.500 | 45.79 | 0.80 | 50000 | 0.073 |
| 4 | 2.55 | 0.14 | 0.499 | 45.74 | 1.09 | 4610 | 1.085 |
| 5 | 3.64 | 0.20 | 0.498 | 45.63 | 1.09 | 4610 | 1.083 |
| 6 | 4.73 | 0.26 | 0.496 | 45.45 | 1.09 | 4610 | 1.078 |
| 7 | 5.83 | 0.33 | 0.493 | 45.16 | 1.09 | 4610 | 1.072 |
| 8 | 6.92 | 0.39 | 0.489 | 44.78 | 1.09 | 4610 | 1.062 |
| 9 | 8.02 | 0.45 | 0.484 | 44.29 | 1.09 | 4610 | 1.051 |
| 10 | 9.11 | 0.51 | 0.477 | 43.71 | 1.09 | 4610 | 1.037 |
| 11 | 10.20 | 0.57 | 0.470 | 43.03 | 1.09 | 4610 | 1.021 |
| 12 | 11.30 | 0.63 | 0.461 | 42.27 | 1.09 | 4610 | 1.003 |
| 13 | 12.39 | 0.69 | 0.452 | 41.44 | 1.09 | 4610 | 0.983 |
| 14 | 13.48 | 0.75 | 0.443 | 40.54 | 1.09 | 4610 | 0.962 |
| 15 | 14.58 | 0.81 | 0.432 | 39.61 | 1.09 | 4610 | 0.940 |
| 16 | 15.67 | 0.88 | 0.422 | 38.63 | 1.09 | 4610 | 0.917 |
| 17 | 16.77 | 0.94 | 0.411 | 37.63 | 1.09 | 4610 | 0.893 |
| 18 | 17.86 | 1.00 | 0.400 | 36.62 | 1.09 | 4610 | 0.869 |
| UKUPNO SLEGANJE IVICNE/d.strana/TACKE S= 15.238 cm | | | | | | | |

Prilog br.

B=35.20 m L=35.80 m
b=17.60 m a=17.90 m

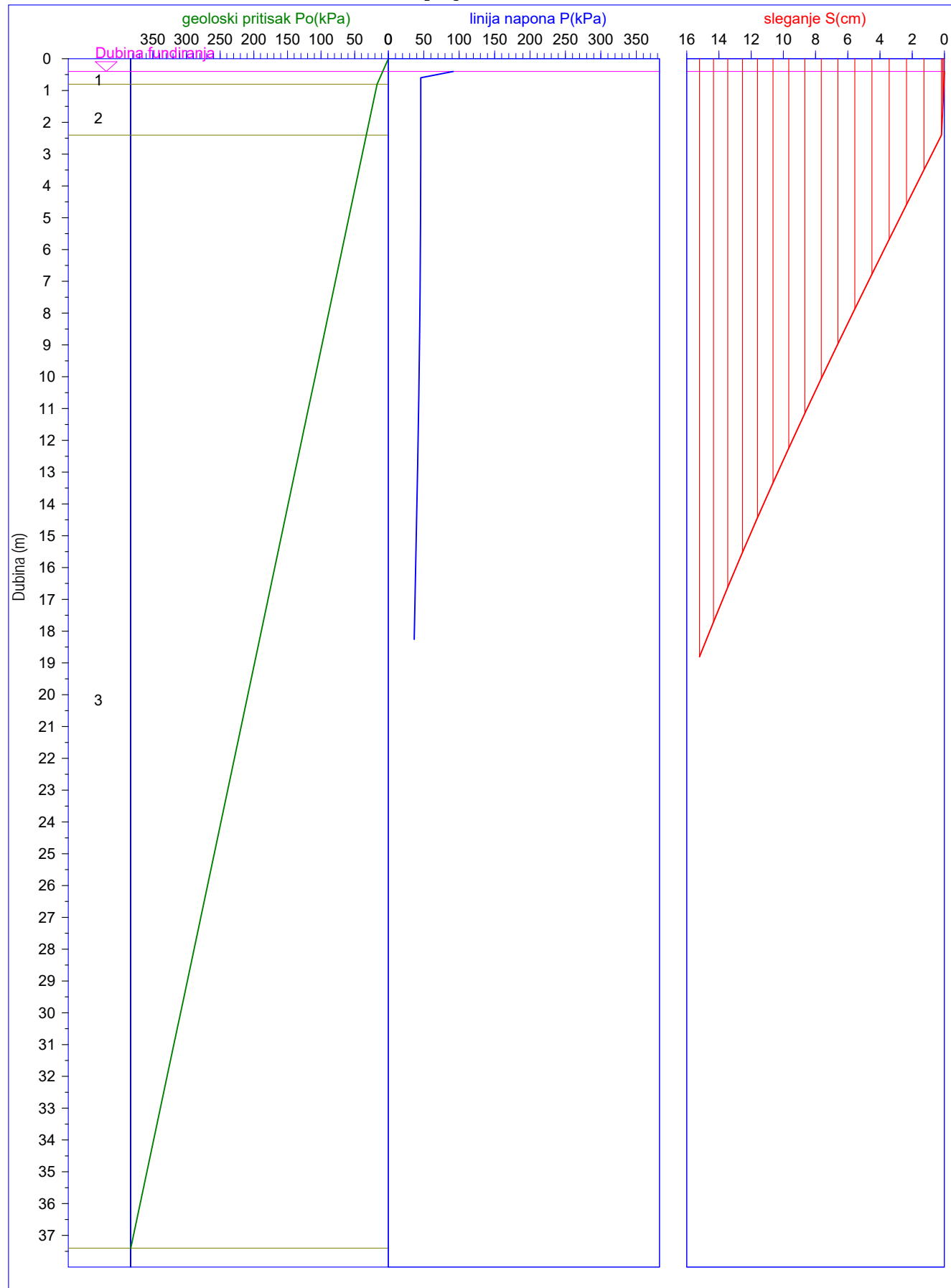
| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|-------|------|-------|---------|------|---------|----------|
| 1 | 0.20 | 0.01 | 1.000 | 91.60 | 0.40 | 50000 | 0.073 |
| 2 | 0.80 | 0.05 | 1.000 | 91.59 | 0.80 | 50000 | 0.147 |
| 3 | 1.60 | 0.09 | 0.999 | 91.55 | 0.80 | 50000 | 0.146 |
| 4 | 2.55 | 0.14 | 0.998 | 91.40 | 1.09 | 4610 | 2.169 |
| 5 | 3.64 | 0.21 | 0.994 | 91.04 | 1.09 | 4610 | 2.160 |
| 6 | 4.73 | 0.27 | 0.987 | 90.41 | 1.09 | 4610 | 2.145 |
| 7 | 5.83 | 0.33 | 0.977 | 89.47 | 1.09 | 4610 | 2.123 |
| 8 | 6.92 | 0.39 | 0.963 | 88.21 | 1.09 | 4610 | 2.093 |
| 9 | 8.02 | 0.46 | 0.946 | 86.63 | 1.09 | 4610 | 2.055 |
| 10 | 9.11 | 0.52 | 0.925 | 84.75 | 1.09 | 4610 | 2.011 |
| 11 | 10.20 | 0.58 | 0.902 | 82.61 | 1.09 | 4610 | 1.960 |
| 12 | 11.30 | 0.64 | 0.876 | 80.24 | 1.09 | 4610 | 1.904 |
| 13 | 12.39 | 0.70 | 0.848 | 77.71 | 1.09 | 4610 | 1.844 |
| 14 | 13.48 | 0.77 | 0.819 | 75.04 | 1.09 | 4610 | 1.780 |
| 15 | 14.58 | 0.83 | 0.789 | 72.29 | 1.09 | 4610 | 1.715 |
| 16 | 15.67 | 0.89 | 0.759 | 69.50 | 1.09 | 4610 | 1.649 |
| 17 | 16.77 | 0.95 | 0.728 | 66.70 | 1.09 | 4610 | 1.583 |
| 18 | 17.86 | 1.01 | 0.698 | 63.92 | 1.09 | 4610 | 1.517 |
| 19 | 18.95 | 1.08 | 0.668 | 61.18 | 1.09 | 4610 | 1.452 |
| 20 | 20.05 | 1.14 | 0.639 | 58.51 | 1.09 | 4610 | 1.388 |
| 21 | 21.14 | 1.20 | 0.610 | 55.92 | 1.09 | 4610 | 1.327 |
| 22 | 22.23 | 1.26 | 0.583 | 53.41 | 1.09 | 4610 | 1.267 |
| 23 | 23.33 | 1.33 | 0.557 | 51.00 | 1.09 | 4610 | 1.210 |
| 24 | 24.42 | 1.39 | 0.532 | 48.69 | 1.09 | 4610 | 1.155 |

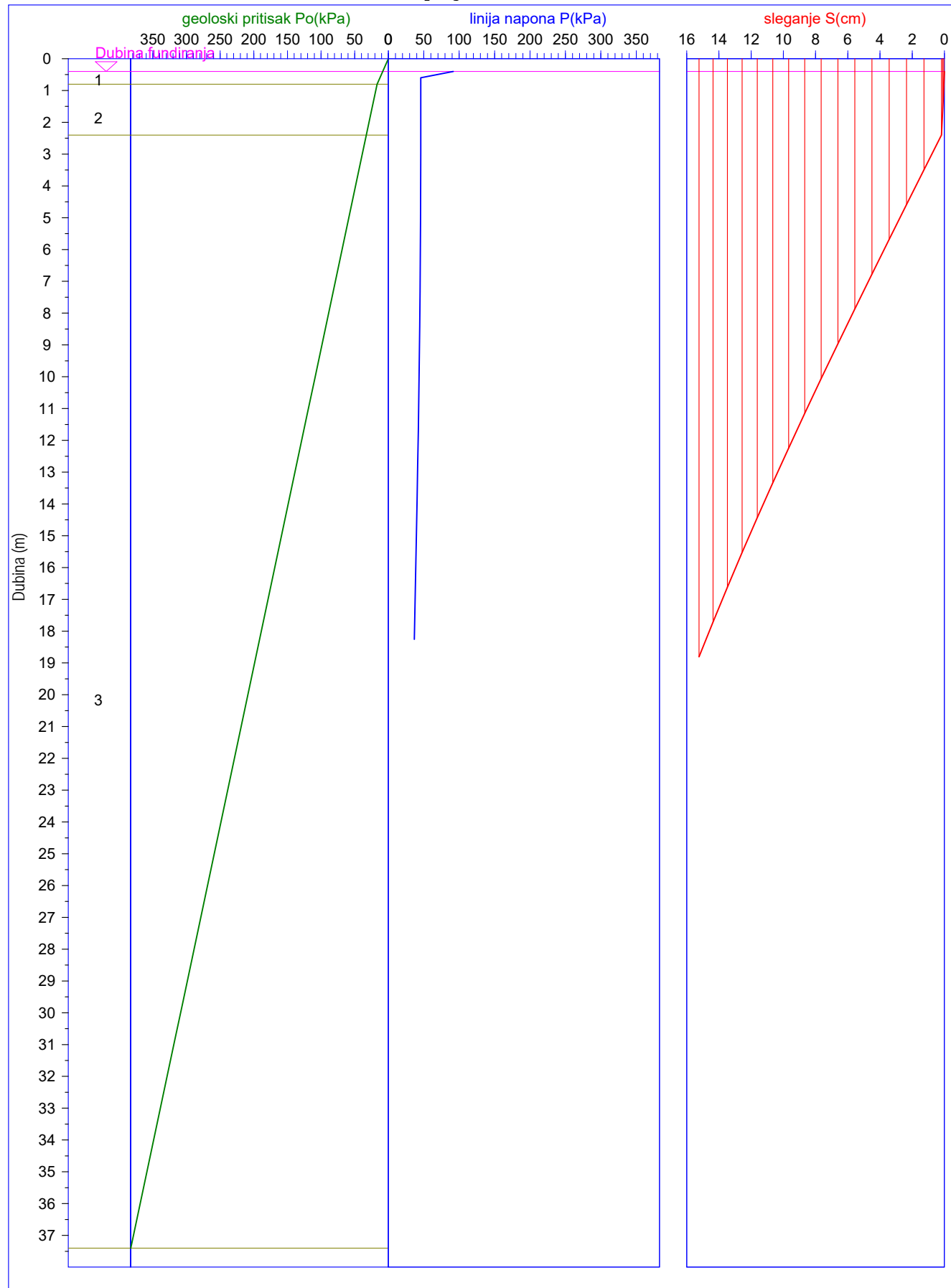
UKUPNO SLEGANJE CENTRICNE TACKE S= 36.871 cm

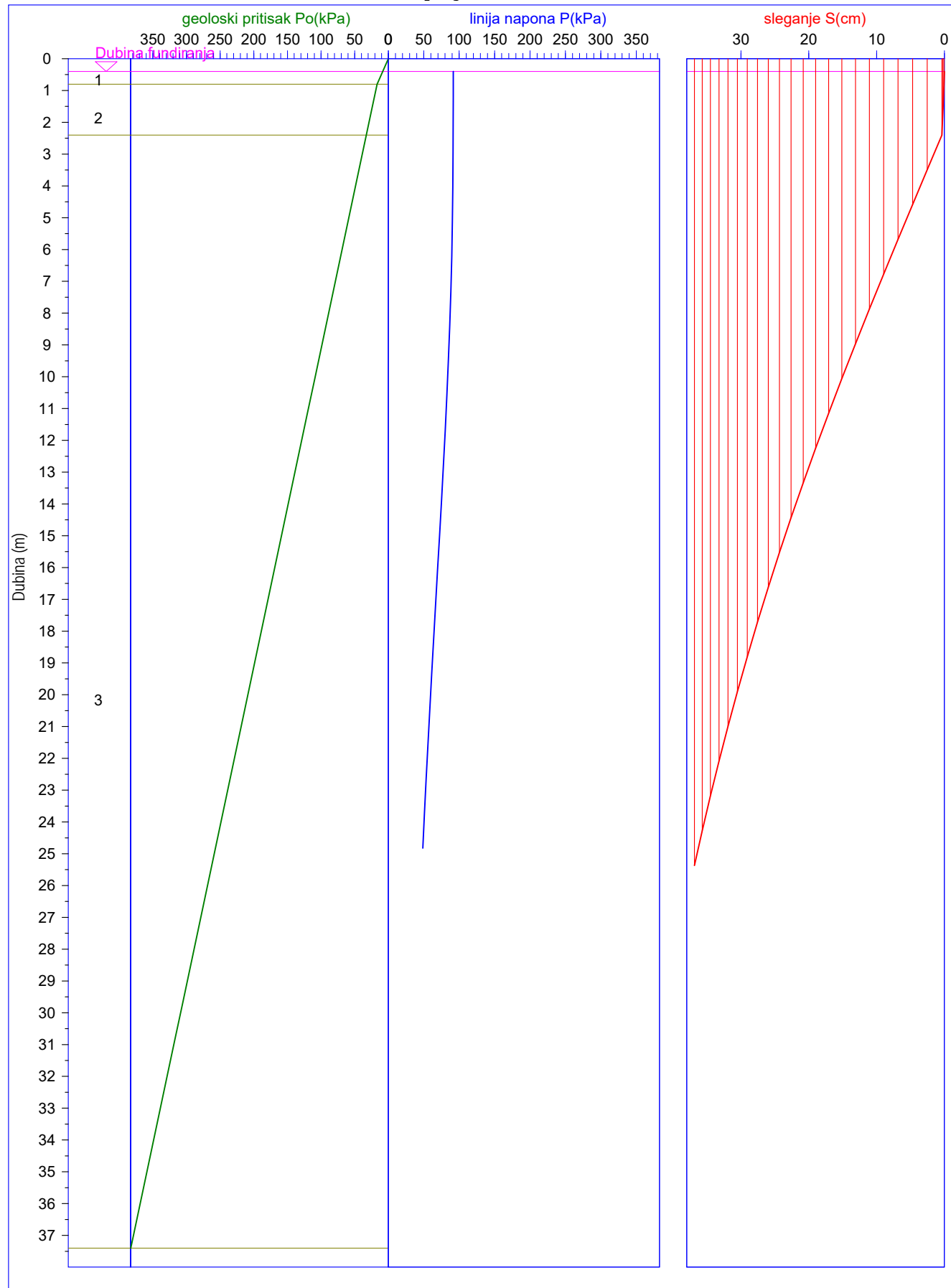
B=35.20 m L=35.80 m
b=17.60 m a=17.90 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|-------|------|-------|---------|------|---------|----------|
| 1 | 0.20 | 0.01 | 1.000 | 91.60 | 0.40 | 50000 | 0.073 |
| 2 | 0.80 | 0.05 | 1.000 | 91.56 | 0.80 | 50000 | 0.146 |
| 3 | 1.60 | 0.09 | 0.996 | 91.26 | 0.80 | 50000 | 0.146 |
| 4 | 2.55 | 0.14 | 0.986 | 90.33 | 1.09 | 4610 | 2.143 |
| 5 | 3.64 | 0.21 | 0.964 | 88.34 | 1.09 | 4610 | 2.096 |
| 6 | 4.73 | 0.27 | 0.933 | 85.46 | 1.09 | 4610 | 2.028 |
| 7 | 5.83 | 0.33 | 0.895 | 81.96 | 1.09 | 4610 | 1.945 |
| 8 | 6.92 | 0.39 | 0.853 | 78.13 | 1.09 | 4610 | 1.854 |
| 9 | 8.02 | 0.46 | 0.810 | 74.21 | 1.09 | 4610 | 1.761 |
| 10 | 9.11 | 0.52 | 0.768 | 70.37 | 1.09 | 4610 | 1.670 |
| 11 | 10.20 | 0.58 | 0.728 | 66.71 | 1.09 | 4610 | 1.583 |
| 12 | 11.30 | 0.64 | 0.691 | 63.27 | 1.09 | 4610 | 1.501 |
| 13 | 12.39 | 0.70 | 0.656 | 60.07 | 1.09 | 4610 | 1.425 |
| 14 | 13.48 | 0.77 | 0.623 | 57.10 | 1.09 | 4610 | 1.355 |
| 15 | 14.58 | 0.83 | 0.593 | 54.34 | 1.09 | 4610 | 1.289 |
| 16 | 15.67 | 0.89 | 0.565 | 51.78 | 1.09 | 4610 | 1.229 |
| 17 | 16.77 | 0.95 | 0.539 | 49.41 | 1.09 | 4610 | 1.172 |
| 18 | 17.86 | 1.01 | 0.515 | 47.19 | 1.09 | 4610 | 1.120 |
| 19 | 18.95 | 1.08 | 0.493 | 45.12 | 1.09 | 4610 | 1.071 |
| 20 | 20.05 | 1.14 | 0.471 | 43.18 | 1.09 | 4610 | 1.024 |

UKUPNO SLEGANJE KARAKTERISTICNE TACKE S= 26.630 cm



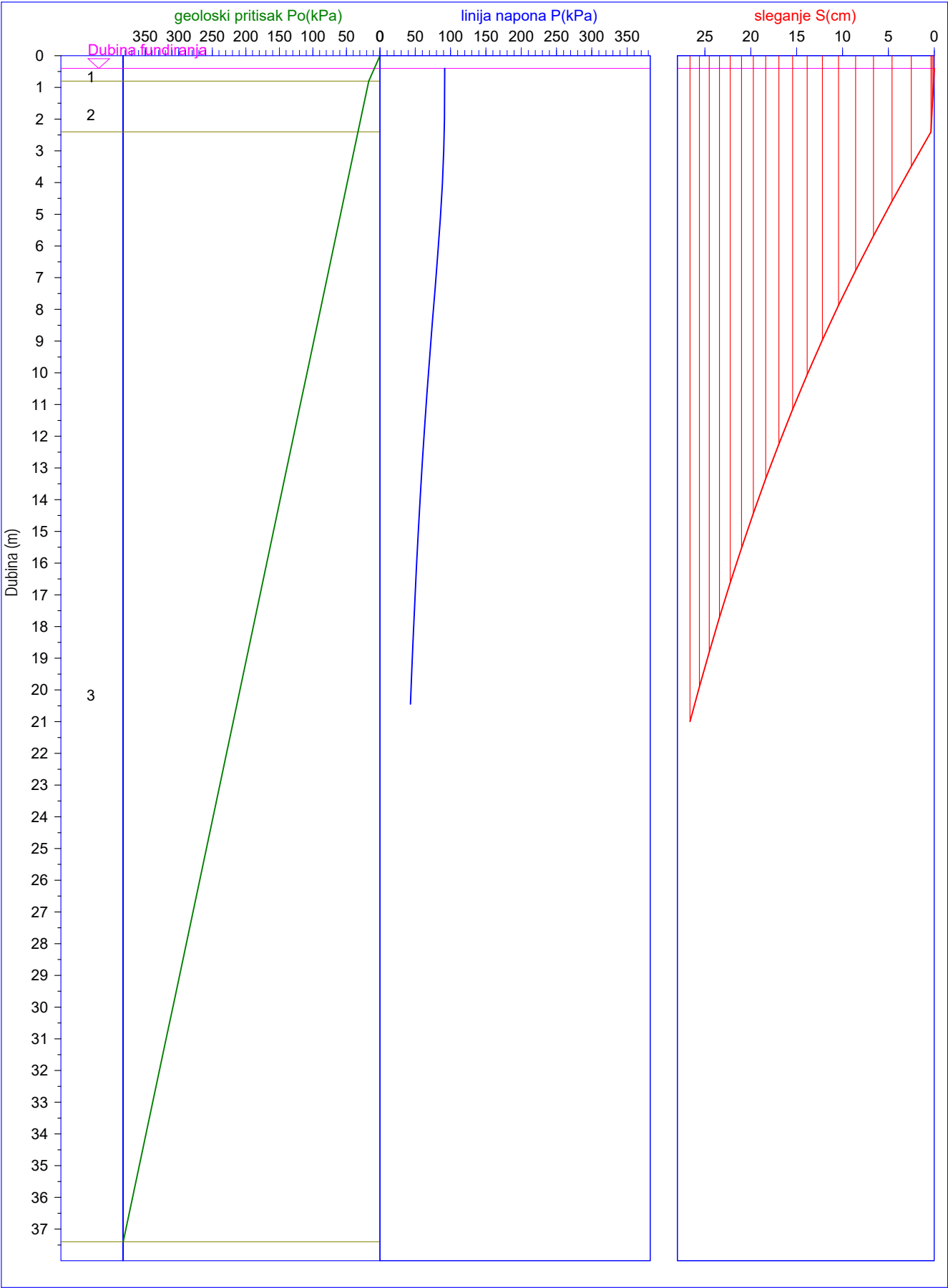




PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat: Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Retenzija procednih voda

Oblik Temelja : Pravougaonik (Karakteristicna Tacka)
Df= 0.40 m B=35.20 m L=35.80 m Sproj= 100.00 kPa



"CENTRALNA PUTNA LABORATORIJA"DOO

ul. Zivorada Petrovica 13,
21203 Veternik, Novi Sad, Srbija

PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat : Gradska deponija u Novom Sadu

Napomena: Provera sleganja - Retenzija procednih voda

Oblik Temelja : Pravougaonik

Df= 0.40 m

B=35.20 m

L=35.80 m

Sproj= 50.00 kPa

PODACI O ANGAZOVANOM TLU :

(usvojeno)

| Sloj | Debljina(m) | Gama (kN/m3) | Mv (kN/m2) |
|------|-------------|--------------|------------|
| 1 | 0.80 | 21.00 | 50000 |
| 2 | 1.60 | 10.00 | 50000 |
| 3 | 35.00 | 10.00 | 4610 |

PRORACUN GEOLOSKOG PRITISKA :

| Br. | Dubina(m) | h(m) | Gama (kN/m3) | Gama*h (kN/m3) | GP (kN/m2) |
|-----|-----------|------|--------------|----------------|------------|
| 1 | 0.40 | 0.40 | 21.00 | 8.40 | 8.40 |
| 2 | 0.80 | 0.40 | 21.00 | 8.40 | 16.80 |
| 3 | 1.60 | 0.80 | 10.00 | 8.00 | 24.80 |
| 4 | 2.40 | 0.80 | 10.00 | 8.00 | 32.80 |
| 5 | 3.49 | 1.09 | 10.00 | 10.94 | 43.74 |
| 6 | 4.59 | 1.09 | 10.00 | 10.94 | 54.67 |
| 7 | 5.68 | 1.09 | 10.00 | 10.94 | 65.61 |
| 8 | 6.78 | 1.09 | 10.00 | 10.94 | 76.55 |
| 9 | 7.87 | 1.09 | 10.00 | 10.94 | 87.49 |
| 10 | 8.96 | 1.09 | 10.00 | 10.94 | 98.42 |
| 11 | 10.06 | 1.09 | 10.00 | 10.94 | 109.36 |
| 12 | 11.15 | 1.09 | 10.00 | 10.94 | 120.30 |
| 13 | 12.24 | 1.09 | 10.00 | 10.94 | 131.24 |
| 14 | 13.34 | 1.09 | 10.00 | 10.94 | 142.18 |
| 15 | 14.43 | 1.09 | 10.00 | 10.94 | 153.11 |
| 16 | 15.53 | 1.09 | 10.00 | 10.94 | 164.05 |
| 17 | 16.62 | 1.09 | 10.00 | 10.94 | 174.99 |
| 18 | 17.71 | 1.09 | 10.00 | 10.94 | 185.93 |
| 19 | 18.81 | 1.09 | 10.00 | 10.94 | 196.86 |
| 20 | 19.90 | 1.09 | 10.00 | 10.94 | 207.80 |
| 21 | 20.99 | 1.09 | 10.00 | 10.94 | 218.74 |
| 22 | 22.09 | 1.09 | 10.00 | 10.94 | 229.68 |
| 23 | 23.18 | 1.09 | 10.00 | 10.94 | 240.61 |
| 24 | 24.27 | 1.09 | 10.00 | 10.94 | 251.55 |
| 25 | 25.37 | 1.09 | 10.00 | 10.94 | 262.49 |
| 26 | 26.46 | 1.09 | 10.00 | 10.94 | 273.43 |
| 27 | 27.56 | 1.09 | 10.00 | 10.94 | 284.36 |
| 28 | 28.65 | 1.09 | 10.00 | 10.94 | 295.30 |
| 29 | 29.74 | 1.09 | 10.00 | 10.94 | 306.24 |
| 30 | 30.84 | 1.09 | 10.00 | 10.94 | 317.18 |
| 31 | 31.93 | 1.09 | 10.00 | 10.94 | 328.11 |
| 32 | 33.02 | 1.09 | 10.00 | 10.94 | 339.05 |
| 33 | 34.12 | 1.09 | 10.00 | 10.94 | 349.99 |
| 34 | 35.21 | 1.09 | 10.00 | 10.94 | 360.93 |
| 35 | 36.31 | 1.09 | 10.00 | 10.94 | 371.86 |
| 36 | 37.40 | 1.09 | 10.00 | 10.94 | 382.80 |

Projektovano opterecenje Sp= 50.00 kPa
 Rastrecenje usled iskopa Pz= 8.40 kPa
 Sr=Sp-Pz Sr= 41.60 kPa

B=35.20 m L=35.80 m
b=35.20 m a=35.80 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|------|------|-------|---------|------|---------|----------|
| 1 | 0.20 | 0.01 | 0.250 | 10.40 | 0.40 | 50000 | 0.008 |
| 2 | 0.80 | 0.02 | 0.250 | 10.40 | 0.80 | 50000 | 0.017 |
| 3 | 1.60 | 0.05 | 0.250 | 10.40 | 0.80 | 50000 | 0.017 |
| 4 | 2.55 | 0.07 | 0.250 | 10.40 | 1.09 | 4610 | 0.247 |
| 5 | 3.64 | 0.10 | 0.250 | 10.39 | 1.09 | 4610 | 0.247 |

UKUPNO SLEGANJE UGAONE TACKE S= 0.535 cm

B=35.20 m L=35.80 m
b=17.60 m a=35.80 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|------|------|-------|---------|------|---------|----------|
| 1 | 0.20 | 0.01 | 0.500 | 20.80 | 0.40 | 50000 | 0.017 |
| 2 | 0.80 | 0.05 | 0.500 | 20.80 | 0.80 | 50000 | 0.033 |
| 3 | 1.60 | 0.09 | 0.500 | 20.79 | 0.80 | 50000 | 0.033 |
| 4 | 2.55 | 0.14 | 0.499 | 20.77 | 1.09 | 4610 | 0.493 |
| 5 | 3.64 | 0.21 | 0.498 | 20.72 | 1.09 | 4610 | 0.492 |
| 6 | 4.73 | 0.27 | 0.496 | 20.63 | 1.09 | 4610 | 0.490 |
| 7 | 5.83 | 0.33 | 0.493 | 20.50 | 1.09 | 4610 | 0.486 |
| 8 | 6.92 | 0.39 | 0.488 | 20.32 | 1.09 | 4610 | 0.482 |
| 9 | 8.02 | 0.46 | 0.483 | 20.09 | 1.09 | 4610 | 0.477 |
| 10 | 9.11 | 0.52 | 0.476 | 19.82 | 1.09 | 4610 | 0.470 |

UKUPNO SLEGANJE IVICNE/k.strana/TACKE S= 3.472 cm

B=35.20 m L=35.80 m
b=17.90 m a=35.20 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|------|------|-------|---------|------|---------|----------|
| 1 | 0.20 | 0.01 | 0.500 | 20.80 | 0.40 | 50000 | 0.017 |
| 2 | 0.80 | 0.04 | 0.500 | 20.80 | 0.80 | 50000 | 0.033 |
| 3 | 1.60 | 0.09 | 0.500 | 20.79 | 0.80 | 50000 | 0.033 |
| 4 | 2.55 | 0.14 | 0.499 | 20.77 | 1.09 | 4610 | 0.493 |
| 5 | 3.64 | 0.20 | 0.498 | 20.72 | 1.09 | 4610 | 0.492 |
| 6 | 4.73 | 0.26 | 0.496 | 20.64 | 1.09 | 4610 | 0.490 |
| 7 | 5.83 | 0.33 | 0.493 | 20.51 | 1.09 | 4610 | 0.487 |
| 8 | 6.92 | 0.39 | 0.489 | 20.34 | 1.09 | 4610 | 0.482 |
| 9 | 8.02 | 0.45 | 0.484 | 20.12 | 1.09 | 4610 | 0.477 |
| 10 | 9.11 | 0.51 | 0.477 | 19.85 | 1.09 | 4610 | 0.471 |

UKUPNO SLEGANJE IVICNE/d.strana/TACKE S= 3.475 cm

B=35.20 m L=35.80 m
b=17.60 m a=17.90 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|-------|------|-------|---------|------|---------|----------|
| 1 | 0.20 | 0.01 | 1.000 | 41.60 | 0.40 | 50000 | 0.033 |
| 2 | 0.80 | 0.05 | 1.000 | 41.60 | 0.80 | 50000 | 0.067 |
| 3 | 1.60 | 0.09 | 0.999 | 41.58 | 0.80 | 50000 | 0.067 |
| 4 | 2.55 | 0.14 | 0.998 | 41.51 | 1.09 | 4610 | 0.985 |
| 5 | 3.64 | 0.21 | 0.994 | 41.34 | 1.09 | 4610 | 0.981 |
| 6 | 4.73 | 0.27 | 0.987 | 41.06 | 1.09 | 4610 | 0.974 |
| 7 | 5.83 | 0.33 | 0.977 | 40.63 | 1.09 | 4610 | 0.964 |
| 8 | 6.92 | 0.39 | 0.963 | 40.06 | 1.09 | 4610 | 0.950 |
| 9 | 8.02 | 0.46 | 0.946 | 39.34 | 1.09 | 4610 | 0.933 |
| 10 | 9.11 | 0.52 | 0.925 | 38.49 | 1.09 | 4610 | 0.913 |
| 11 | 10.20 | 0.58 | 0.902 | 37.52 | 1.09 | 4610 | 0.890 |
| 12 | 11.30 | 0.64 | 0.876 | 36.44 | 1.09 | 4610 | 0.865 |
| 13 | 12.39 | 0.70 | 0.848 | 35.29 | 1.09 | 4610 | 0.837 |
| 14 | 13.48 | 0.77 | 0.819 | 34.08 | 1.09 | 4610 | 0.809 |
| 15 | 14.58 | 0.83 | 0.789 | 32.83 | 1.09 | 4610 | 0.779 |
| 16 | 15.67 | 0.89 | 0.759 | 31.56 | 1.09 | 4610 | 0.749 |

UKUPNO SLEGANJE CENTRICNE TACKE S= 11.796 cm

PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

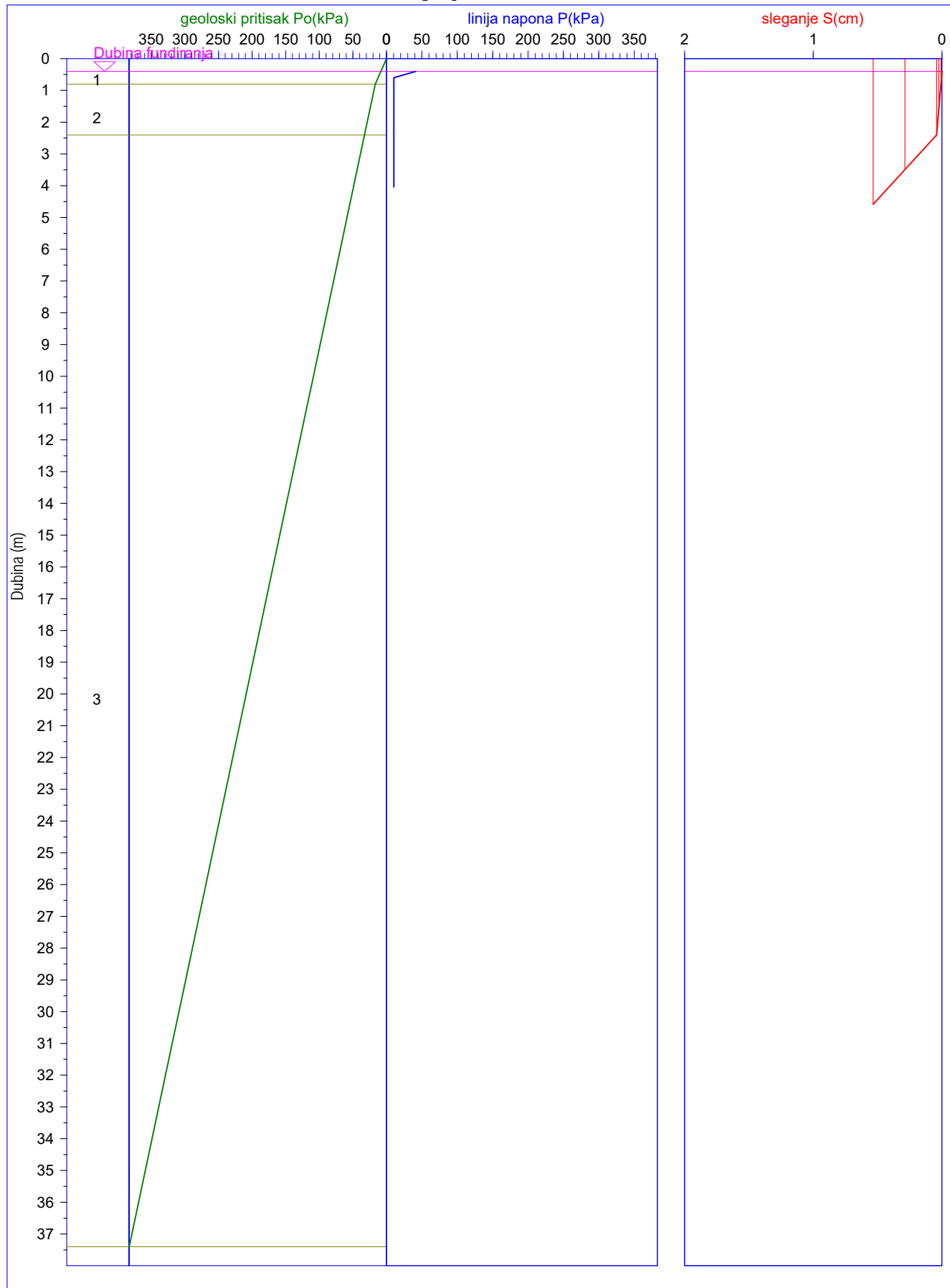
Objekat: Gradska deponija u Novom Sadu

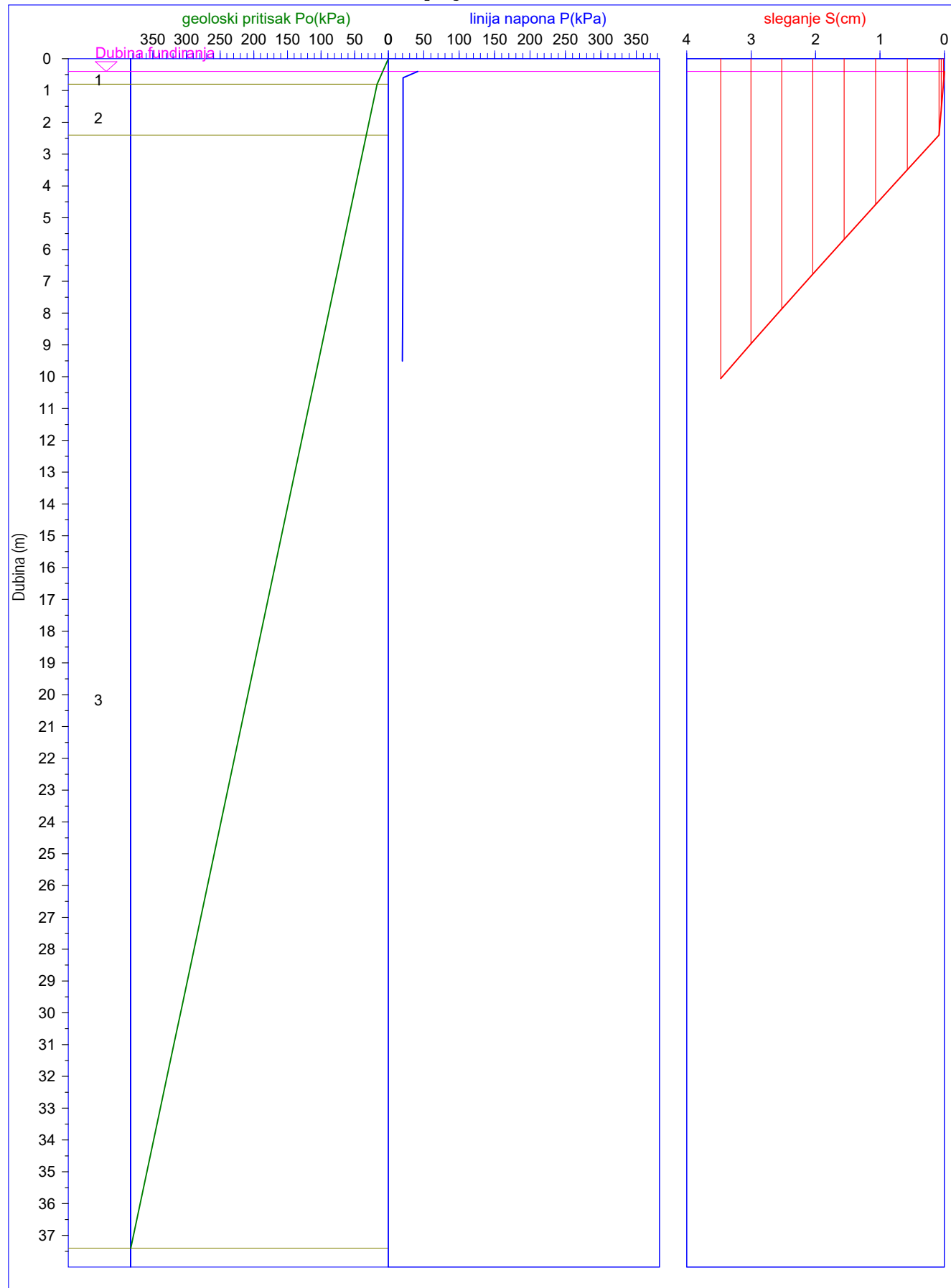
Napomena: Provera slaganja - Retenzija procednih voda

Oblik Temelja : Pravougaonik

(Ugaona Tacka)

Df= 0.40 m B=35.20 m L=35.80 m Sproj= 50.00 kPa



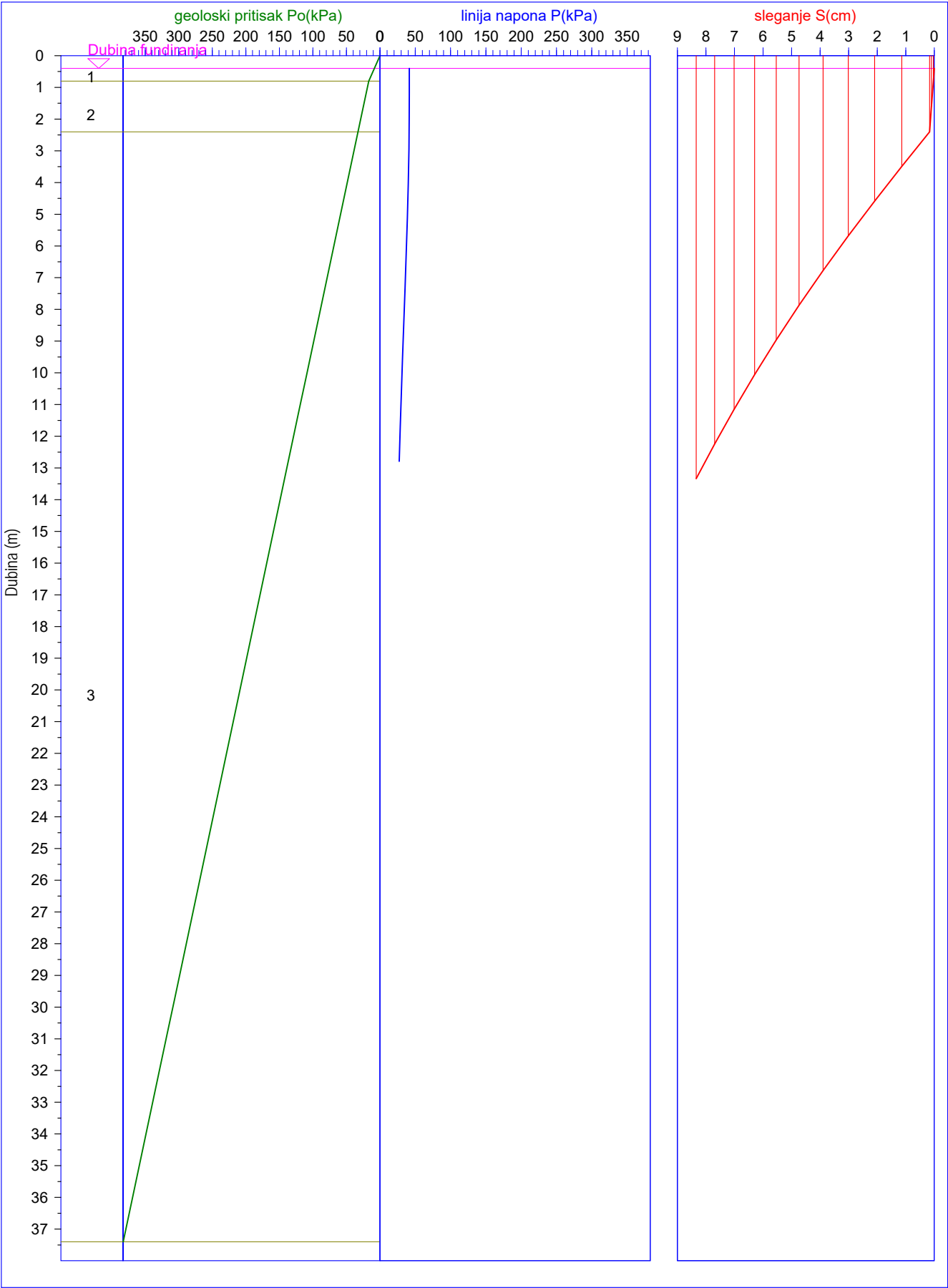




PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat: Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Retenzija procednih voda

Oblik Temelja : Pravougaonik (Karakteristicna Tacka)
Df= 0.40 m B=35.20 m L=35.80 m Sproj= 50.00 kPa



"CENTRALNA PUTNA LABORATORIJA"DOO

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PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat : Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Digestor

Oblik Temelja : Pravougaonik

Df= 0.40 m
B=19.00 m
L=24.50 m

Sproj= 100.00 kPa

PODACI O ANGAZOVANOM TLU : (usvojeno)

| Sloj | Debljina(m) | Gama (kN/m3) | Mv (kN/m2) |
|------|-------------|--------------|------------|
| 1 | 3.00 | 18.00 | 1200 |
| 2 | 3.20 | 10.00 | 1200 |
| 3 | 1.30 | 10.00 | 1600 |
| 4 | 20.00 | 10.00 | 2940 |

PRORACUN GEOLOSKOG PRITISKA :

| Br. | Dubina(m) | h(m) | Gama (kN/m3) | Gama*h (kN/m3) | GP (kN/m2) |
|-----|-----------|------|--------------|----------------|------------|
| 1 | 0.40 | 0.40 | 18.00 | 7.20 | 7.20 |
| 2 | 1.27 | 0.87 | 18.00 | 15.60 | 22.80 |
| 3 | 2.13 | 0.87 | 18.00 | 15.60 | 38.40 |
| 4 | 3.00 | 0.87 | 18.00 | 15.60 | 54.00 |
| 5 | 4.07 | 1.07 | 10.00 | 10.67 | 64.67 |
| 6 | 5.13 | 1.07 | 10.00 | 10.67 | 75.33 |
| 7 | 6.20 | 1.07 | 10.00 | 10.67 | 86.00 |
| 8 | 6.85 | 0.65 | 10.00 | 6.50 | 92.50 |
| 9 | 7.50 | 0.65 | 10.00 | 6.50 | 99.00 |
| 10 | 8.55 | 1.05 | 10.00 | 10.53 | 109.53 |
| 11 | 9.61 | 1.05 | 10.00 | 10.53 | 120.05 |
| 12 | 10.66 | 1.05 | 10.00 | 10.53 | 130.58 |
| 13 | 11.71 | 1.05 | 10.00 | 10.53 | 141.11 |
| 14 | 12.76 | 1.05 | 10.00 | 10.53 | 151.63 |
| 15 | 13.82 | 1.05 | 10.00 | 10.53 | 162.16 |
| 16 | 14.87 | 1.05 | 10.00 | 10.53 | 172.68 |
| 17 | 15.92 | 1.05 | 10.00 | 10.53 | 183.21 |
| 18 | 16.97 | 1.05 | 10.00 | 10.53 | 193.74 |
| 19 | 18.03 | 1.05 | 10.00 | 10.53 | 204.26 |
| 20 | 19.08 | 1.05 | 10.00 | 10.53 | 214.79 |
| 21 | 20.13 | 1.05 | 10.00 | 10.53 | 225.32 |
| 22 | 21.18 | 1.05 | 10.00 | 10.53 | 235.84 |
| 23 | 22.24 | 1.05 | 10.00 | 10.53 | 246.37 |
| 24 | 23.29 | 1.05 | 10.00 | 10.53 | 256.89 |
| 25 | 24.34 | 1.05 | 10.00 | 10.53 | 267.42 |
| 26 | 25.39 | 1.05 | 10.00 | 10.53 | 277.95 |
| 27 | 26.45 | 1.05 | 10.00 | 10.53 | 288.47 |
| 28 | 27.50 | 1.05 | 10.00 | 10.53 | 299.00 |

Projektovano opterecenje Sp= 100.00 kPa
Rastrecenje usled iskopa Pz= 7.20 kPa
Sr=Sp-Pz Sr= 92.80 kPa

B=19.00 m L=24.50 m
b=19.00 m a=24.50 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.02 | 0.250 | 23.20 | 0.87 | 1200 | 1.676 |
| 2 | 1.30 | 0.07 | 0.250 | 23.20 | 0.87 | 1200 | 1.675 |
| 3 | 2.17 | 0.11 | 0.250 | 23.18 | 0.87 | 1200 | 1.674 |
| 4 | 3.13 | 0.16 | 0.249 | 23.14 | 1.07 | 1200 | 2.057 |
| 5 | 4.20 | 0.22 | 0.249 | 23.07 | 1.07 | 1200 | 2.050 |
| 6 | 5.27 | 0.28 | 0.247 | 22.95 | 1.07 | 1200 | 2.040 |
| 7 | 6.13 | 0.32 | 0.246 | 22.81 | 0.65 | 1600 | 0.927 |
| 8 | 6.78 | 0.36 | 0.244 | 22.69 | 0.65 | 1600 | 0.922 |
| 9 | 7.63 | 0.40 | 0.242 | 22.49 | 1.05 | 2940 | 0.805 |
| 10 | 8.68 | 0.46 | 0.239 | 22.21 | 1.05 | 2940 | 0.795 |

UKUPNO SLEGANJE UGAONE TACKE S= 14.621 cm

B=19.00 m L=24.50 m
b= 9.50 m a=24.50 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|-------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.05 | 0.500 | 46.40 | 0.87 | 1200 | 3.351 |
| 2 | 1.30 | 0.14 | 0.499 | 46.35 | 0.87 | 1200 | 3.347 |
| 3 | 2.17 | 0.23 | 0.498 | 46.17 | 0.87 | 1200 | 3.335 |
| 4 | 3.13 | 0.33 | 0.493 | 45.76 | 1.07 | 1200 | 4.068 |
| 5 | 4.20 | 0.44 | 0.485 | 44.99 | 1.07 | 1200 | 3.999 |
| 6 | 5.27 | 0.55 | 0.473 | 43.90 | 1.07 | 1200 | 3.902 |
| 7 | 6.13 | 0.64 | 0.461 | 42.82 | 0.65 | 1600 | 1.740 |
| 8 | 6.78 | 0.71 | 0.452 | 41.92 | 0.65 | 1600 | 1.703 |
| 9 | 7.63 | 0.80 | 0.438 | 40.63 | 1.05 | 2940 | 1.455 |
| 10 | 8.68 | 0.91 | 0.420 | 38.95 | 1.05 | 2940 | 1.395 |
| 11 | 9.73 | 1.02 | 0.401 | 37.22 | 1.05 | 2940 | 1.332 |
| 12 | 10.78 | 1.14 | 0.382 | 35.47 | 1.05 | 2940 | 1.270 |
| 13 | 11.84 | 1.25 | 0.364 | 33.76 | 1.05 | 2940 | 1.209 |
| 14 | 12.89 | 1.36 | 0.346 | 32.09 | 1.05 | 2940 | 1.149 |

UKUPNO SLEGANJE IVICNE/k.strana/TACKE S= 33.254 cm

B=19.00 m L=24.50 m
b=12.25 m a=19.00 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|-------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.04 | 0.500 | 46.40 | 0.87 | 1200 | 3.351 |
| 2 | 1.30 | 0.11 | 0.500 | 46.37 | 0.87 | 1200 | 3.349 |
| 3 | 2.17 | 0.18 | 0.499 | 46.28 | 0.87 | 1200 | 3.342 |
| 4 | 3.13 | 0.26 | 0.496 | 46.04 | 1.07 | 1200 | 4.093 |
| 5 | 4.20 | 0.34 | 0.491 | 45.59 | 1.07 | 1200 | 4.052 |
| 6 | 5.27 | 0.43 | 0.484 | 44.90 | 1.07 | 1200 | 3.991 |
| 7 | 6.13 | 0.50 | 0.476 | 44.18 | 0.65 | 1600 | 1.795 |
| 8 | 6.78 | 0.55 | 0.469 | 43.54 | 0.65 | 1600 | 1.769 |
| 9 | 7.63 | 0.62 | 0.459 | 42.60 | 1.05 | 2940 | 1.525 |
| 10 | 8.68 | 0.71 | 0.445 | 41.29 | 1.05 | 2940 | 1.478 |
| 11 | 9.73 | 0.79 | 0.429 | 39.85 | 1.05 | 2940 | 1.427 |
| 12 | 10.78 | 0.88 | 0.413 | 38.32 | 1.05 | 2940 | 1.372 |
| 13 | 11.84 | 0.97 | 0.396 | 36.75 | 1.05 | 2940 | 1.316 |
| 14 | 12.89 | 1.05 | 0.379 | 35.15 | 1.05 | 2940 | 1.258 |
| 15 | 13.94 | 1.14 | 0.362 | 33.55 | 1.05 | 2940 | 1.201 |

UKUPNO SLEGANJE IVICNE/d.strana/TACKE S= 35.320 cm

B=19.00 m L=24.50 m
b= 9.50 m a=12.25 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|-------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.05 | 1.000 | 92.80 | 0.87 | 1200 | 6.702 |
| 2 | 1.30 | 0.14 | 0.999 | 92.67 | 0.87 | 1200 | 6.693 |
| 3 | 2.17 | 0.23 | 0.994 | 92.22 | 0.87 | 1200 | 6.660 |
| 4 | 3.13 | 0.33 | 0.982 | 91.15 | 1.07 | 1200 | 8.102 |
| 5 | 4.20 | 0.44 | 0.961 | 89.15 | 1.07 | 1200 | 7.924 |
| 6 | 5.27 | 0.55 | 0.930 | 86.31 | 1.07 | 1200 | 7.672 |
| 7 | 6.13 | 0.64 | 0.900 | 83.50 | 0.65 | 1600 | 3.392 |
| 8 | 6.78 | 0.71 | 0.874 | 81.12 | 0.65 | 1600 | 3.296 |
| 9 | 7.63 | 0.80 | 0.838 | 77.77 | 1.05 | 2940 | 2.784 |
| 10 | 8.68 | 0.91 | 0.791 | 73.38 | 1.05 | 2940 | 2.627 |
| 11 | 9.73 | 1.02 | 0.742 | 68.89 | 1.05 | 2940 | 2.466 |
| 12 | 10.78 | 1.14 | 0.694 | 64.42 | 1.05 | 2940 | 2.306 |
| 13 | 11.84 | 1.25 | 0.647 | 60.08 | 1.05 | 2940 | 2.151 |
| 14 | 12.89 | 1.36 | 0.603 | 55.92 | 1.05 | 2940 | 2.002 |
| 15 | 13.94 | 1.47 | 0.560 | 52.00 | 1.05 | 2940 | 1.862 |
| 16 | 14.99 | 1.58 | 0.521 | 48.33 | 1.05 | 2940 | 1.730 |
| 17 | 16.05 | 1.69 | 0.484 | 44.92 | 1.05 | 2940 | 1.608 |
| 18 | 17.10 | 1.80 | 0.450 | 41.76 | 1.05 | 2940 | 1.495 |
| 19 | 18.15 | 1.91 | 0.419 | 38.86 | 1.05 | 2940 | 1.391 |

UKUPNO SLEGANJE CENTRICNE TACKE S= 72.866 cm

Prilog br.

B=19.00 m L=24.50 m
b= 9.50 m a=12.25 m

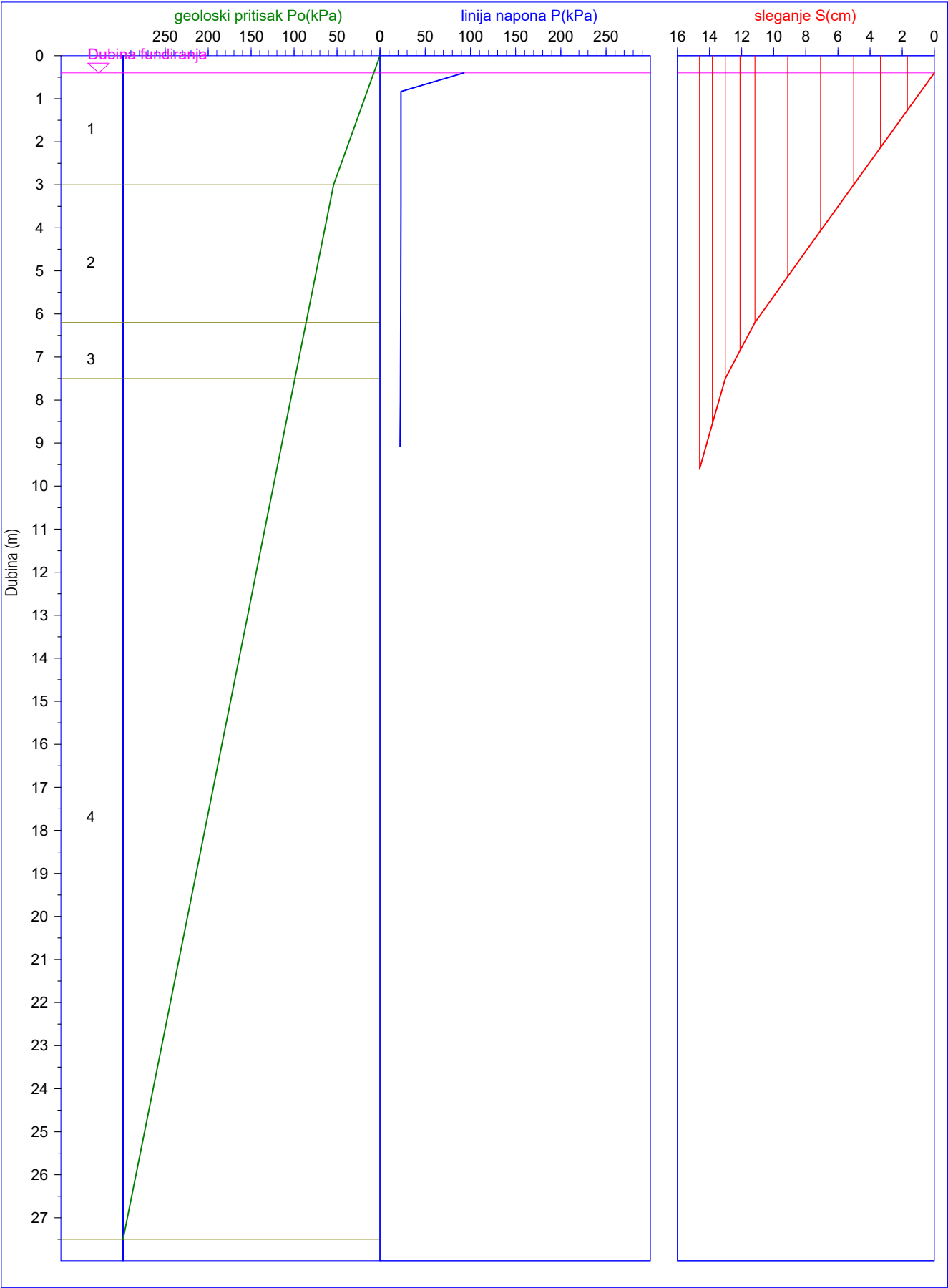
| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|-------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.05 | 1.000 | 92.77 | 0.87 | 1200 | 6.700 |
| 2 | 1.30 | 0.14 | 0.991 | 91.96 | 0.87 | 1200 | 6.641 |
| 3 | 2.17 | 0.23 | 0.965 | 89.51 | 0.87 | 1200 | 6.464 |
| 4 | 3.13 | 0.33 | 0.916 | 85.00 | 1.07 | 1200 | 7.555 |
| 5 | 4.20 | 0.44 | 0.850 | 78.87 | 1.07 | 1200 | 7.011 |
| 6 | 5.27 | 0.55 | 0.782 | 72.56 | 1.07 | 1200 | 6.449 |
| 7 | 6.13 | 0.64 | 0.730 | 67.73 | 0.65 | 1600 | 2.752 |
| 8 | 6.78 | 0.71 | 0.693 | 64.32 | 0.65 | 1600 | 2.613 |
| 9 | 7.63 | 0.80 | 0.649 | 60.18 | 1.05 | 2940 | 2.155 |
| 10 | 8.68 | 0.91 | 0.599 | 55.58 | 1.05 | 2940 | 1.990 |
| 11 | 9.73 | 1.02 | 0.555 | 51.49 | 1.05 | 2940 | 1.844 |
| 12 | 10.78 | 1.14 | 0.515 | 47.84 | 1.05 | 2940 | 1.713 |
| 13 | 11.84 | 1.25 | 0.480 | 44.55 | 1.05 | 2940 | 1.595 |
| 14 | 12.89 | 1.36 | 0.448 | 41.58 | 1.05 | 2940 | 1.489 |
| 15 | 13.94 | 1.47 | 0.419 | 38.87 | 1.05 | 2940 | 1.392 |
| 16 | 14.99 | 1.58 | 0.392 | 36.40 | 1.05 | 2940 | 1.303 |

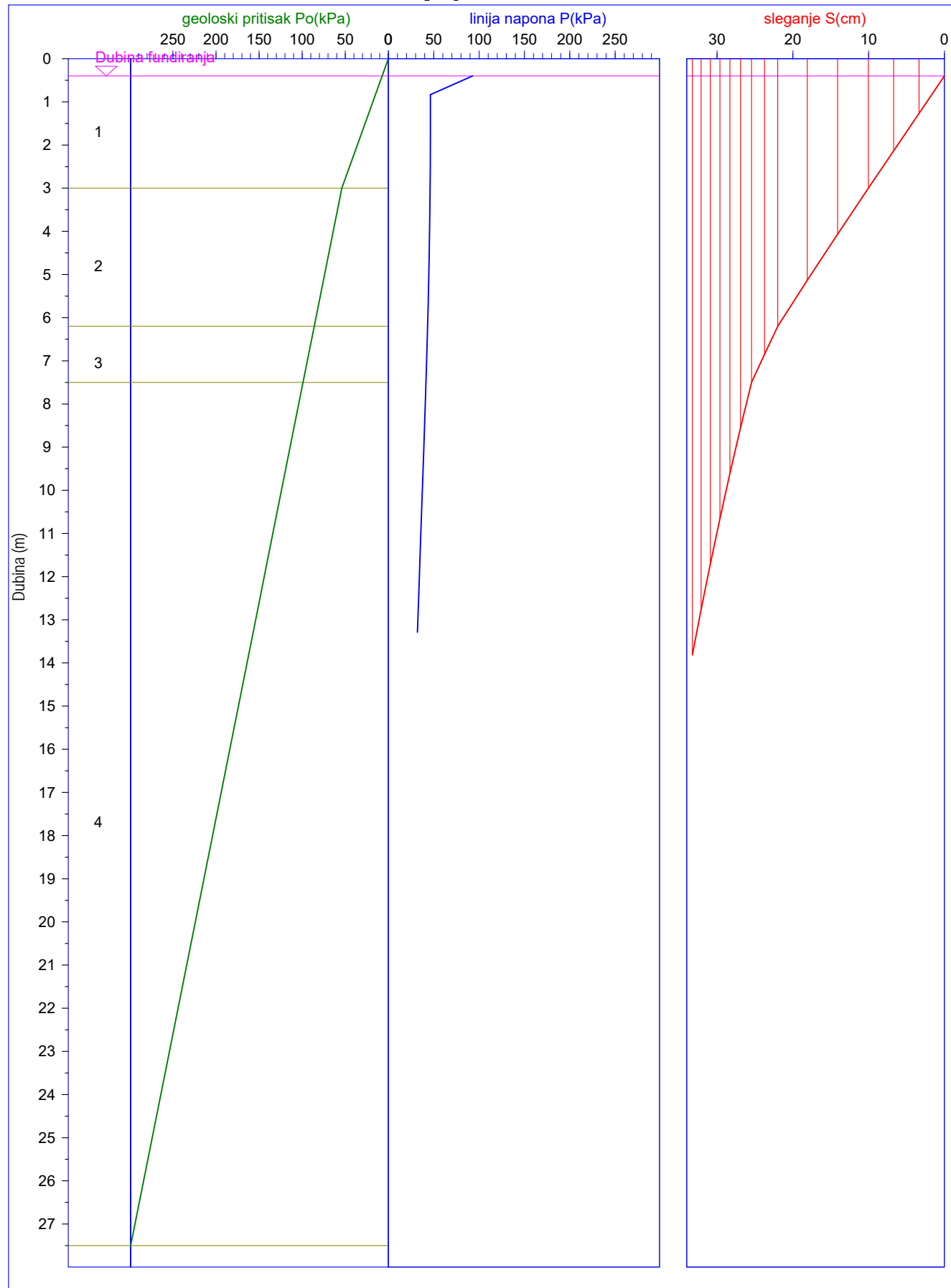
UKUPNO SLEGANJE KARAKTERISTICNE TACKE S= 59.666 cm

PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat: Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Digestor

Oblik Temelja : Pravougaonik (Ugaona Tacka)
Df= 0.40 m B=19.00 m L=24.50 m Sproj= 100.00 kPa





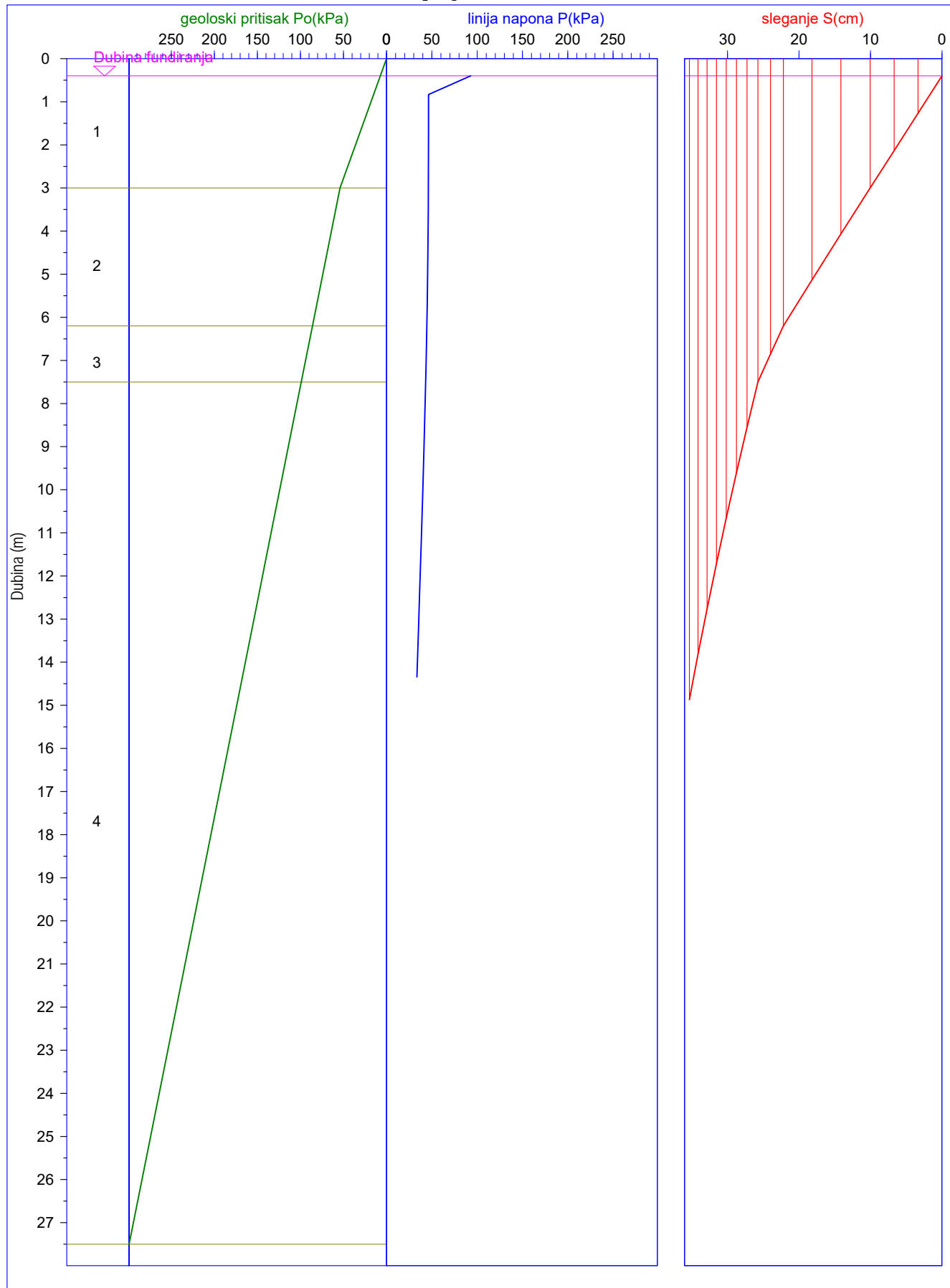
PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat: Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Digestor

Oblik Temelja : Pravougaonik

(Ivicna Tacka po duzjoj strani)

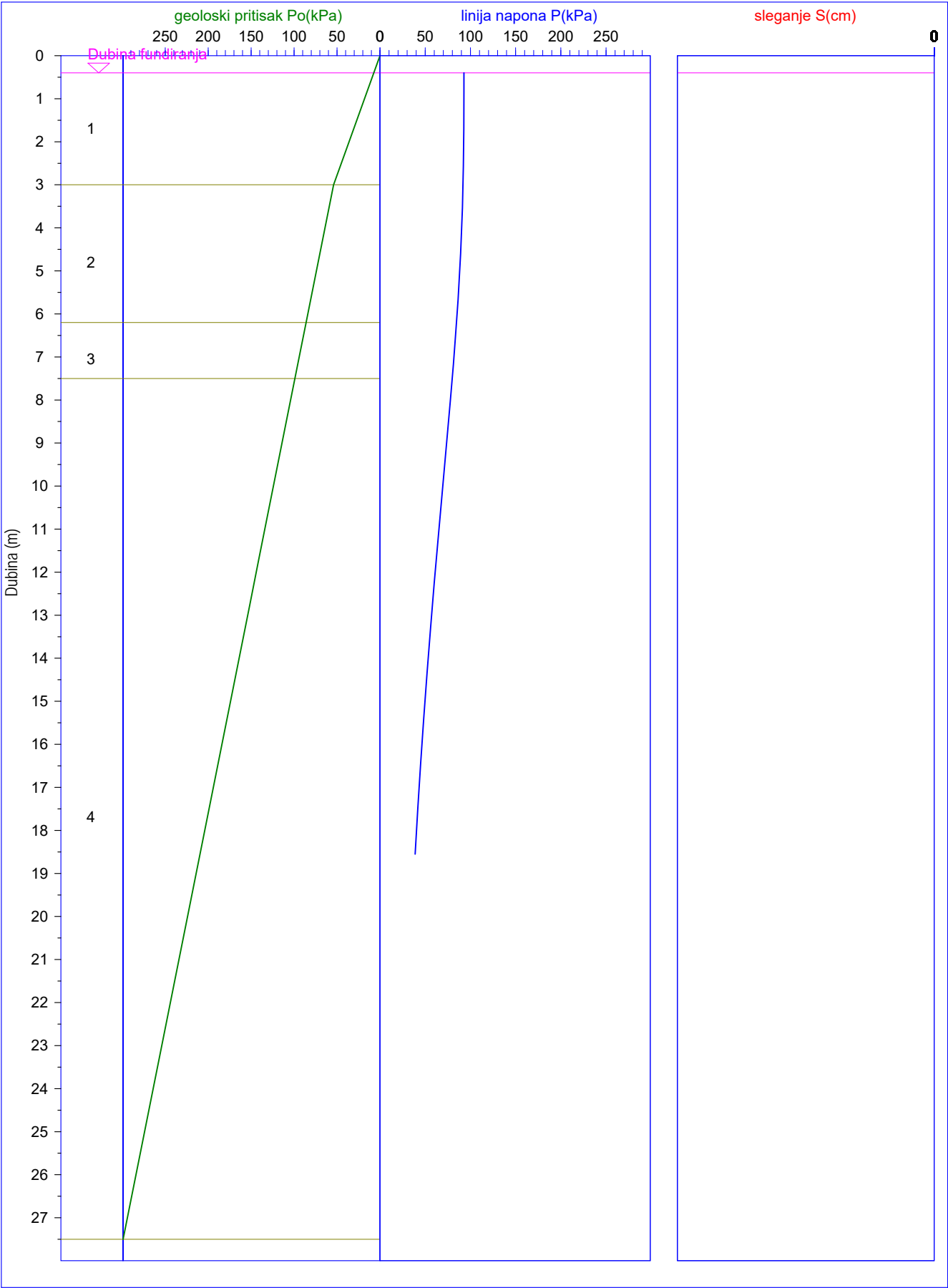
Df= 0.40 m B=19.00 m L=24.50 m Sproj= 100.00 kPa



PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat: Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Digestor

Oblik Temelja : Pravougaonik (Centricna Tacka)
Df= 0.40 m B=19.00 m L=24.50 m Sproj= 100.00 kPa



"CENTRALNA PUTNA LABORATORIJA"DOOul. Zivorada Petrovica 13,
21203 Veternik, Novi Sad, Srbija**PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA**Objekat : Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Digestor

Oblik Temelja : Pravougaonik

Df= 0.40 m
B=19.00 m
L=24.50 m

Sproj= 60.00 kPa

PODACI O ANGAZOVANOM TLU : (usvojeno)

| Sloj | Debljina(m) | Gama (kN/m3) | Mv (kN/m2) |
|------|-------------|--------------|------------|
| 1 | 3.00 | 21.00 | 50000 |
| 2 | 3.20 | 10.00 | 50000 |
| 3 | 1.30 | 10.00 | 1600 |
| 4 | 20.00 | 10.00 | 2940 |

PRORACUN GEOLOSKOG PRITISKA :

| Br. | Dubina(m) | h(m) | Gama (kN/m3) | Gama*h (kN/m3) | GP (kN/m2) |
|-----|-----------|------|--------------|----------------|------------|
| 1 | 0.40 | 0.40 | 21.00 | 8.40 | 8.40 |
| 2 | 1.27 | 0.87 | 21.00 | 18.20 | 26.60 |
| 3 | 2.13 | 0.87 | 21.00 | 18.20 | 44.80 |
| 4 | 3.00 | 0.87 | 21.00 | 18.20 | 63.00 |
| 5 | 4.07 | 1.07 | 10.00 | 10.67 | 73.67 |
| 6 | 5.13 | 1.07 | 10.00 | 10.67 | 84.33 |
| 7 | 6.20 | 1.07 | 10.00 | 10.67 | 95.00 |
| 8 | 6.85 | 0.65 | 10.00 | 6.50 | 101.50 |
| 9 | 7.50 | 0.65 | 10.00 | 6.50 | 108.00 |
| 10 | 8.55 | 1.05 | 10.00 | 10.53 | 118.53 |
| 11 | 9.61 | 1.05 | 10.00 | 10.53 | 129.05 |
| 12 | 10.66 | 1.05 | 10.00 | 10.53 | 139.58 |
| 13 | 11.71 | 1.05 | 10.00 | 10.53 | 150.11 |
| 14 | 12.76 | 1.05 | 10.00 | 10.53 | 160.63 |
| 15 | 13.82 | 1.05 | 10.00 | 10.53 | 171.16 |
| 16 | 14.87 | 1.05 | 10.00 | 10.53 | 181.68 |
| 17 | 15.92 | 1.05 | 10.00 | 10.53 | 192.21 |
| 18 | 16.97 | 1.05 | 10.00 | 10.53 | 202.74 |
| 19 | 18.03 | 1.05 | 10.00 | 10.53 | 213.26 |
| 20 | 19.08 | 1.05 | 10.00 | 10.53 | 223.79 |
| 21 | 20.13 | 1.05 | 10.00 | 10.53 | 234.32 |
| 22 | 21.18 | 1.05 | 10.00 | 10.53 | 244.84 |
| 23 | 22.24 | 1.05 | 10.00 | 10.53 | 255.37 |
| 24 | 23.29 | 1.05 | 10.00 | 10.53 | 265.89 |
| 25 | 24.34 | 1.05 | 10.00 | 10.53 | 276.42 |
| 26 | 25.39 | 1.05 | 10.00 | 10.53 | 286.95 |
| 27 | 26.45 | 1.05 | 10.00 | 10.53 | 297.47 |
| 28 | 27.50 | 1.05 | 10.00 | 10.53 | 308.00 |

Projektovano opterecenje Sp= 60.00 kPa
Rastrecenje usled iskopa Pz= 8.40 kPa
Sr=Sp-Pz Sr= 51.60 kPa

B=19.00 m L=24.50 m
b=19.00 m a=24.50 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.02 | 0.250 | 12.90 | 0.87 | 50000 | 0.022 |
| 2 | 1.30 | 0.07 | 0.250 | 12.90 | 0.87 | 50000 | 0.022 |
| 3 | 2.17 | 0.11 | 0.250 | 12.89 | 0.87 | 50000 | 0.022 |
| 4 | 3.13 | 0.16 | 0.249 | 12.87 | 1.07 | 50000 | 0.027 |

UKUPNO SLEGANJE UGAONE TACKE S= 0.095 cm

B=19.00 m L=24.50 m
b= 9.50 m a=24.50 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.05 | 0.500 | 25.80 | 0.87 | 50000 | 0.045 |
| 2 | 1.30 | 0.14 | 0.499 | 25.77 | 0.87 | 50000 | 0.045 |
| 3 | 2.17 | 0.23 | 0.498 | 25.67 | 0.87 | 50000 | 0.045 |
| 4 | 3.13 | 0.33 | 0.493 | 25.44 | 1.07 | 50000 | 0.054 |
| 5 | 4.20 | 0.44 | 0.485 | 25.02 | 1.07 | 50000 | 0.053 |
| 6 | 5.27 | 0.55 | 0.473 | 24.41 | 1.07 | 50000 | 0.052 |
| 7 | 6.13 | 0.64 | 0.461 | 23.81 | 0.65 | 1600 | 0.967 |
| 8 | 6.78 | 0.71 | 0.452 | 23.31 | 0.65 | 1600 | 0.947 |
| 9 | 7.63 | 0.80 | 0.438 | 22.59 | 1.05 | 2940 | 0.809 |

UKUPNO SLEGANJE IVICNE/k.strana/TACKE S= 3.017 cm

B=19.00 m L=24.50 m
b=12.25 m a=19.00 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.04 | 0.500 | 25.80 | 0.87 | 50000 | 0.045 |
| 2 | 1.30 | 0.11 | 0.500 | 25.79 | 0.87 | 50000 | 0.045 |
| 3 | 2.17 | 0.18 | 0.499 | 25.73 | 0.87 | 50000 | 0.045 |
| 4 | 3.13 | 0.26 | 0.496 | 25.60 | 1.07 | 50000 | 0.055 |
| 5 | 4.20 | 0.34 | 0.491 | 25.35 | 1.07 | 50000 | 0.054 |
| 6 | 5.27 | 0.43 | 0.484 | 24.97 | 1.07 | 50000 | 0.053 |
| 7 | 6.13 | 0.50 | 0.476 | 24.57 | 0.65 | 1600 | 0.998 |
| 8 | 6.78 | 0.55 | 0.469 | 24.21 | 0.65 | 1600 | 0.984 |
| 9 | 7.63 | 0.62 | 0.459 | 23.69 | 1.05 | 2940 | 0.848 |

UKUPNO SLEGANJE IVICNE/d.strana/TACKE S= 3.126 cm

B=19.00 m L=24.50 m
b= 9.50 m a=12.25 m

| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|-------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.05 | 1.000 | 51.60 | 0.87 | 50000 | 0.089 |
| 2 | 1.30 | 0.14 | 0.999 | 51.53 | 0.87 | 50000 | 0.089 |
| 3 | 2.17 | 0.23 | 0.994 | 51.28 | 0.87 | 50000 | 0.089 |
| 4 | 3.13 | 0.33 | 0.982 | 50.68 | 1.07 | 50000 | 0.108 |
| 5 | 4.20 | 0.44 | 0.961 | 49.57 | 1.07 | 50000 | 0.106 |
| 6 | 5.27 | 0.55 | 0.930 | 47.99 | 1.07 | 50000 | 0.102 |
| 7 | 6.13 | 0.64 | 0.900 | 46.43 | 0.65 | 1600 | 1.886 |
| 8 | 6.78 | 0.71 | 0.874 | 45.11 | 0.65 | 1600 | 1.832 |
| 9 | 7.63 | 0.80 | 0.838 | 43.24 | 1.05 | 2940 | 1.548 |
| 10 | 8.68 | 0.91 | 0.791 | 40.80 | 1.05 | 2940 | 1.461 |
| 11 | 9.73 | 1.02 | 0.742 | 38.30 | 1.05 | 2940 | 1.371 |
| 12 | 10.78 | 1.14 | 0.694 | 35.82 | 1.05 | 2940 | 1.282 |
| 13 | 11.84 | 1.25 | 0.647 | 33.40 | 1.05 | 2940 | 1.196 |
| 14 | 12.89 | 1.36 | 0.603 | 31.09 | 1.05 | 2940 | 1.113 |

UKUPNO SLEGANJE CENTRICNE TACKE S= 12.275 cm

B=19.00 m L=24.50 m
b= 9.50 m a=12.25 m

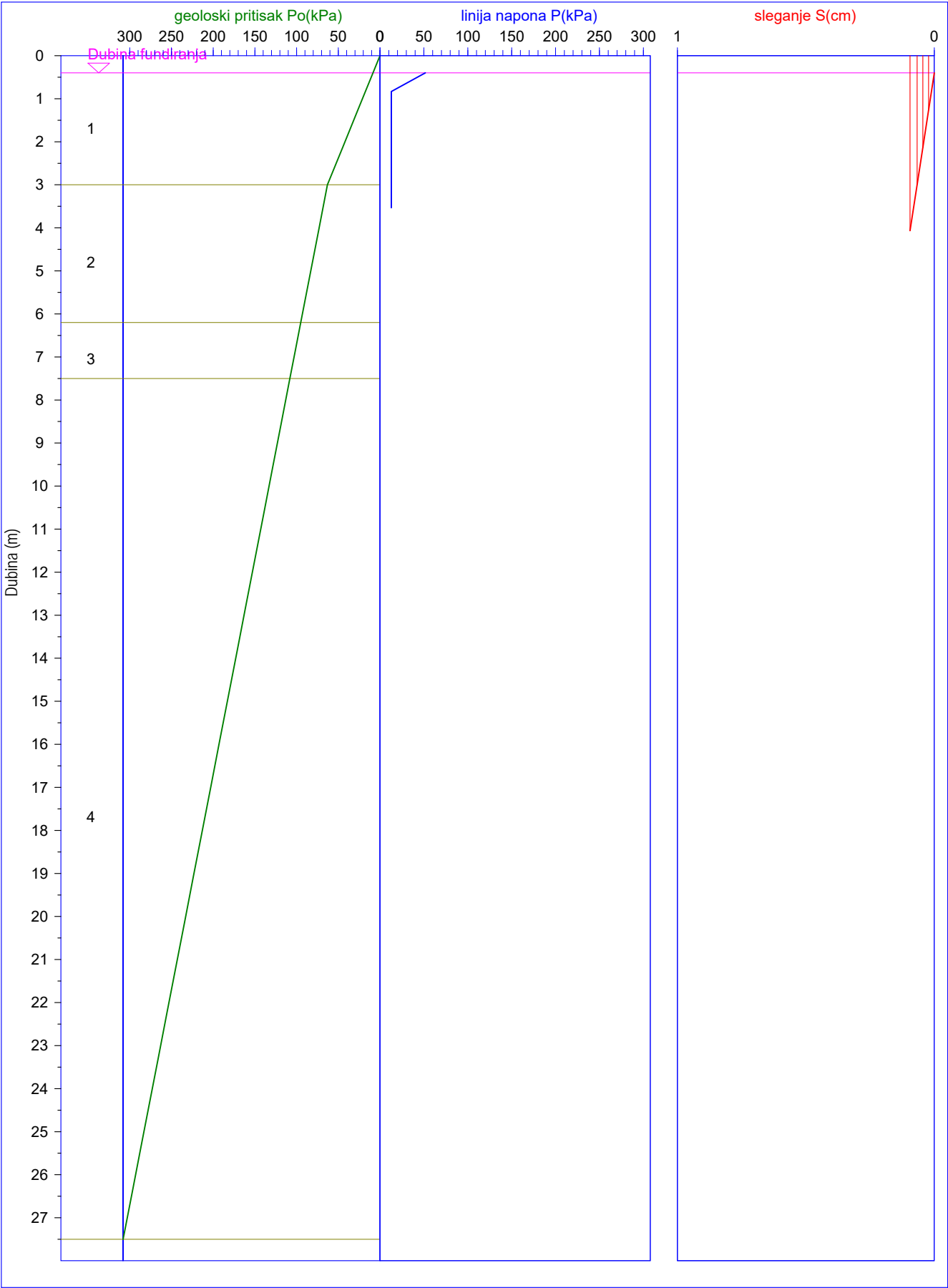
| Br. | z(m) | z/b | Sz/q | dp(kPa) | h(m) | Mv(kPa) | Sleg(cm) |
|-----|-------|------|-------|---------|------|---------|----------|
| 1 | 0.43 | 0.05 | 1.000 | 51.58 | 0.87 | 50000 | 0.089 |
| 2 | 1.30 | 0.14 | 0.991 | 51.13 | 0.87 | 50000 | 0.089 |
| 3 | 2.17 | 0.23 | 0.965 | 49.77 | 0.87 | 50000 | 0.086 |
| 4 | 3.13 | 0.33 | 0.916 | 47.26 | 1.07 | 50000 | 0.101 |
| 5 | 4.20 | 0.44 | 0.850 | 43.86 | 1.07 | 50000 | 0.094 |
| 6 | 5.27 | 0.55 | 0.782 | 40.34 | 1.07 | 50000 | 0.086 |
| 7 | 6.13 | 0.64 | 0.730 | 37.66 | 0.65 | 1600 | 1.530 |
| 8 | 6.78 | 0.71 | 0.693 | 35.76 | 0.65 | 1600 | 1.453 |
| 9 | 7.63 | 0.80 | 0.649 | 33.46 | 1.05 | 2940 | 1.198 |
| 10 | 8.68 | 0.91 | 0.599 | 30.91 | 1.05 | 2940 | 1.107 |
| 11 | 9.73 | 1.02 | 0.555 | 28.63 | 1.05 | 2940 | 1.025 |
| 12 | 10.78 | 1.14 | 0.515 | 26.60 | 1.05 | 2940 | 0.952 |

UKUPNO SLEGANJE KARAKTERISTICNE TACKE S= 7.810 cm

PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat: Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Digestor

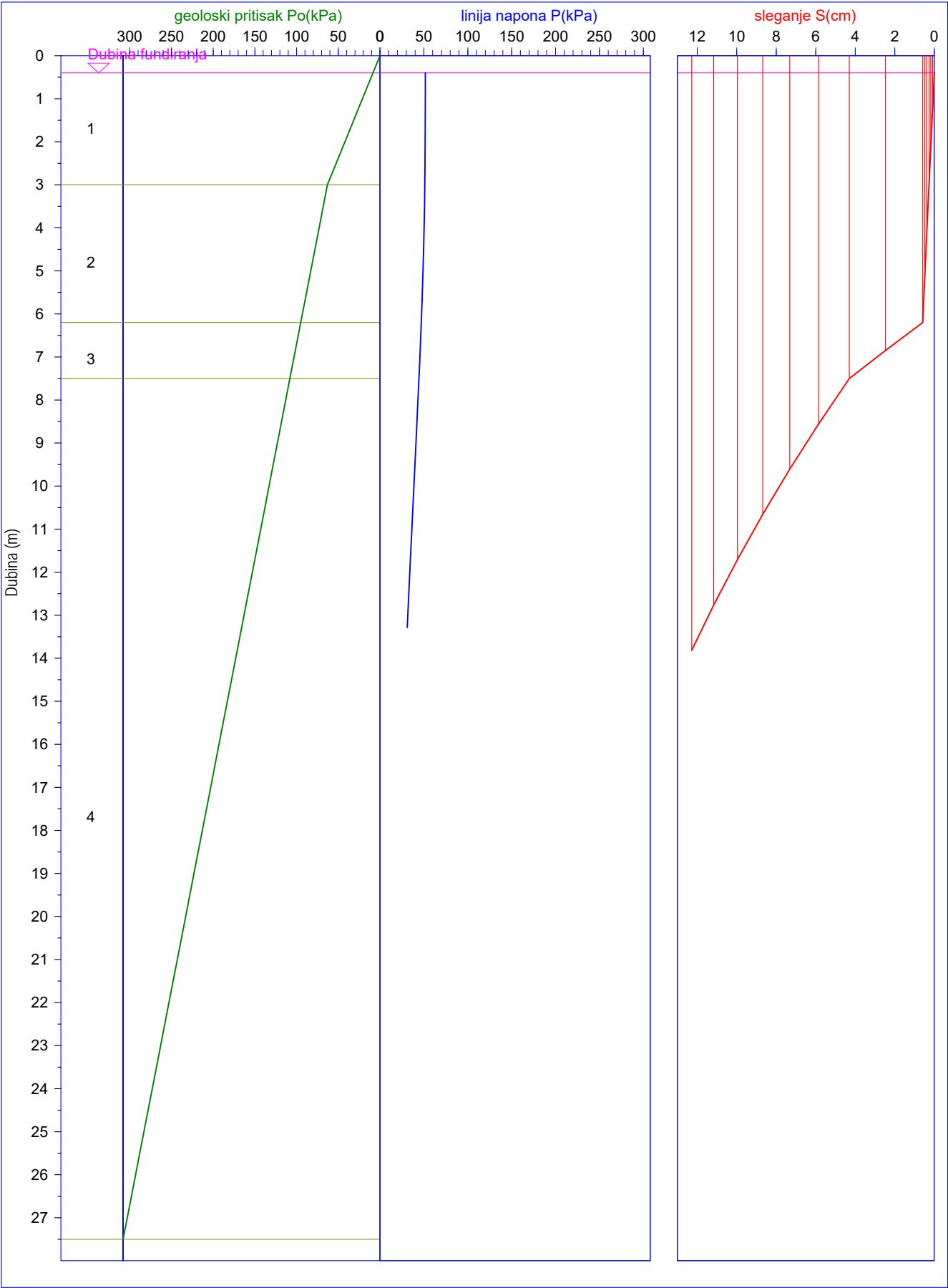
Oblik Temelja : Pravougaonik (Ugaona Tacka)
Df= 0.40 m B=19.00 m L=24.50 m Sproj= 60.00 kPa



PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat: Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Digestor

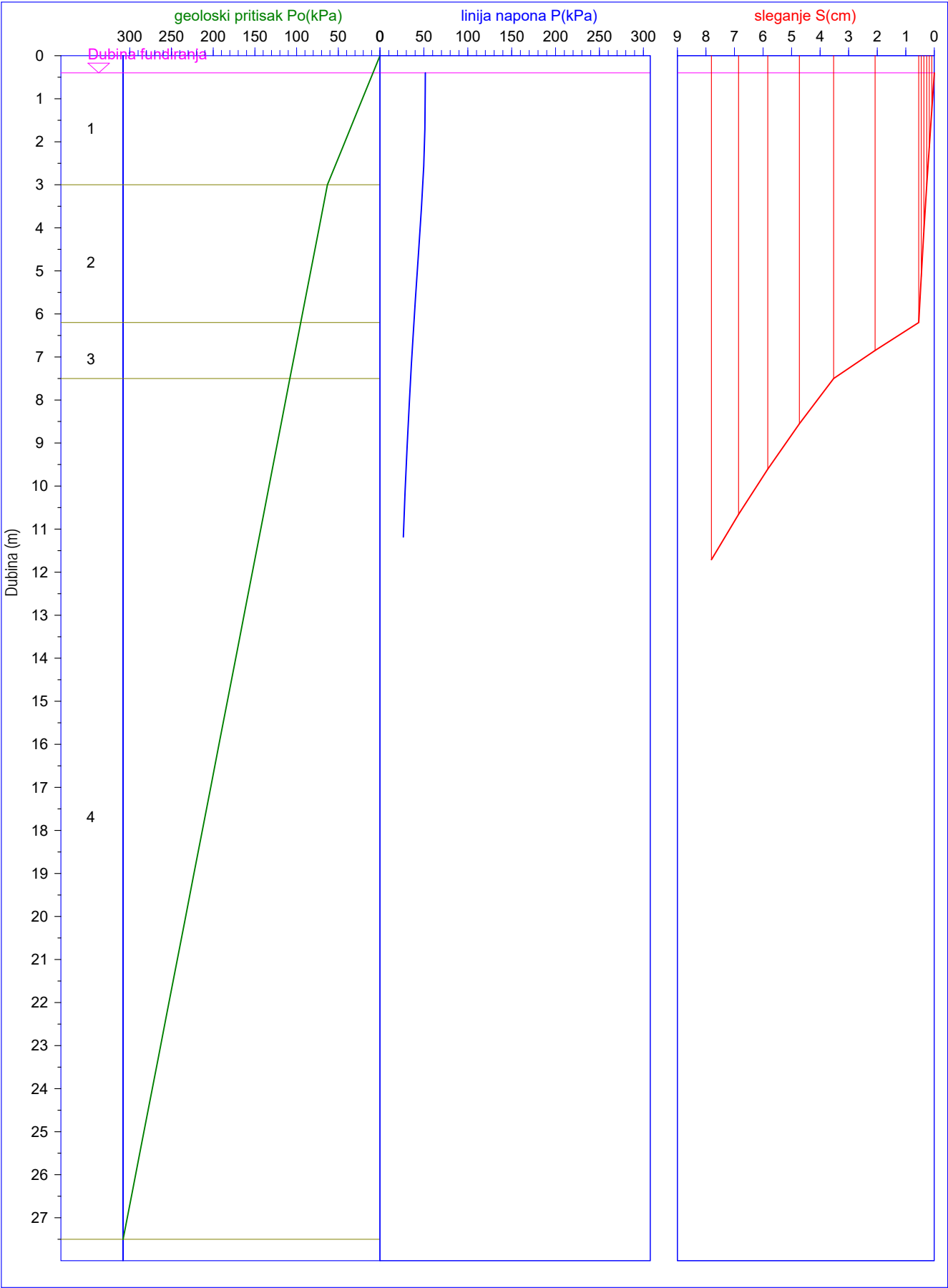
Oblik Temelja : Pravougaonik (Centricna Tacka)
Df= 0.40 m B=19.00 m L=24.50 m Sproj= 60.00 kPa



PROGNOZNI PRORACUN SLEGANJA TEMELJNOG TLA

Objekat: Gradska deponija u Novom Sadu
Napomena: Provera sleganja - Digestor

Oblik Temelja : Pravougaonik (Karakteristicna Tacka)
Df= 0.40 m B=19.00 m L=24.50 m Sproj= 60.00 kPa



| PROJEKTOVANI OBJEKTI | | PONDERISANE VREDNOSTI PARAMETARA TLA | | | | PPODACI O TEMELJIMA | | | | GRANIČNO OPTEREĆENJE | | | | DOZVOLJENO OPTEREĆENJE | | |
|----------------------|---|---|--------------|--------------|----------|---------------------|----------|----------|------------------|----------------------|-----|-----|------------|------------------------|------------|----------|
| br. | Objekat | NPV (m) | γ (kN/m3) | c (kN/m2) | φ (°) | Df (m) | B (m) | L (m) | Oblik temelja | Nc | Nq | Ny | qf (kN/m2) | qa= qf/2 | qa= qf/2.5 | qa= qf/3 |
| 1 | Portirnica | 3.00 | 18.50 | 10 | 17 | 0.80 | 0.50 | 4.00 | traka | 14 | 6.2 | 3 | 198.0 | 99.0 | 79.2 | 66.0 |
| 2,3,4 | Kolska vaga | 3.00 | 18.50 | 10 | 17 | 1.30 | 1.00 | 5.00 | traka | 14 | 6.2 | 3 | 269.3 | 134.6 | 107.7 | 89.8 |
| | | 3.00 | 18.50 | 10 | 17 | 1.30 | 1.20 | 5.00 | traka | 14 | 6.2 | 3 | 274.8 | 137.4 | 109.9 | 91.6 |
| 5 | Upravna zgrada T1 | 3.00 | 18.00 | 2 | 23 | 0.80 | 1.75 | 1.75 | kvadrat | 21 | 10 | 7.5 | 293.1 | 146.6 | 117.2 | 97.7 |
| 5 | Upravna zgrada T2 | 3.00 | 18.00 | 2 | 23 | 0.80 | 1.60 | 1.60 | kvadrat | 21 | 10 | 7.5 | 285.0 | 142.5 | 114.0 | 95.0 |
| 9 | Zgrada za radnike | 3.80 | 18.00 | 2 | 23 | 0.90 | 0.40 | 10.00 | traka | 21 | 10 | 7.5 | 216.7 | 108.4 | 86.7 | 72.2 |
| 10 | Radionica | 3.80 | 19.50 | 2 | 17 | 0.90 | 1.40 | 2.80 | avougaor | 14 | 6.2 | 3 | 182.0 | 91.0 | 72.8 | 60.7 |
| 11 | Magacin B-8 | 3.80 | 18.50 | 2 | 17 | 1.10 | 1.40 | 2.80 | avougaor | 14 | 6.2 | 3 | 197.2 | 98.6 | 78.9 | 65.7 |
| | Magacin B-11 | 3.80 | 18.50 | 2 | 17 | 1.10 | 1.40 | 2.80 | avougaor | 14 | 6.2 | 3 | 197.2 | 98.6 | 78.9 | 65.7 |
| 12 | Nadstrešnica za komunalna vozila | 3.80 | 18.00 | 2 | 17 | 1.00 | 1.00 | 1.60 | avougaor | 14 | 6.2 | 3 | 171.9 | 85.9 | 68.7 | 57.3 |
| 15.1. | MBT - prva dilatacija B-13 | 3.00 | 18.00 | 2 | 17 | 1.00 | 1.00 | 5.00 | traka | 14 | 6.2 | 3 | 157.1 | 78.5 | 62.8 | 52.4 |
| | | 3.00 | 18.00 | 2 | 17 | 1.00 | 1.20 | 5.00 | traka | 14 | 6.2 | 3 | 162.5 | 81.2 | 65.0 | 54.2 |
| | MBT - prva dilatacija B-15 | 3.00 | 18.00 | 2 | 17 | 1.00 | 1.00 | 5.00 | traka | 14 | 6.2 | 3 | 157.1 | 78.5 | 62.8 | 52.4 |
| | | 3.00 | 18.00 | 2 | 17 | 1.00 | 1.20 | 5.00 | traka | 14 | 6.2 | 3 | 162.5 | 81.2 | 65.0 | 54.2 |
| 15.2. | MBT - prva dilatacija osa E B-13 | 3.00 | 18.00 | 2 | 17 | 1.00 | 1.00 | 42.00 | traka | 14 | 6.2 | 3 | 157.1 | 78.5 | 62.8 | 52.4 |
| | MBT - prva dilatacija osa E B-15 | 3.00 | 18.00 | 2 | 17 | 1.00 | 1.00 | 42.00 | traka | 14 | 6.2 | 3 | 157.1 | 78.5 | 62.8 | 52.4 |
| | MBT-treća dilatacija-sortirnica B-17 | 3.00 | 18.00 | 3 | 17 | 1.00 | 1.00 | 42.00 | traka | 14 | 6.2 | 3 | 166.3 | 83.2 | 66.5 | 55.4 |
| | MBT-treća dilatacija-sortirnica B-19 | 3.00 | 18.00 | 3 | 17 | 1.00 | 1.00 | 42.00 | traka | 14 | 6.2 | 3 | 166.3 | 83.2 | 66.5 | 55.4 |
| 16 | MBT-trafostanica | 3.00 | 18.00 | 3 | 17 | 0.90 | 0.50 | 14.50 | traka | 14 | 6.2 | 3 | 141.7 | 70.8 | 56.7 | 47.2 |
| 19 | Garaža za vozila | 3.40 | 18.00 | 2 | 23 | 1.35 | 1.20 | 2.40 | avougaor | 21 | 10 | 7.5 | 372.3 | 186.2 | 148.9 | 124.1 |
| 20 | Postojeće postrojenje za razvrstavanje otpada - traka | 3.50 | 18.00 | 3 | 17 | 1.00 | 0.95 | 45.00 | traka | 14 | 6.2 | 3 | 165.0 | 82.5 | 66.0 | 55.0 |
| | Postojeće postrojenje za razvrstavanje otpada - samac | 3.50 | 18.00 | 3 | 17 | 1.10 | 1.40 | 2.80 | avougaor | 14 | 6.2 | 3 | 208.9 | 104.4 | 83.5 | 69.6 |
| 21 | Hangar za balirani otpad 1 PoS T1 | 3.50 | 18.00 | 3 | 17 | 0.95 | 1.00 | 1.80 | avougaor | 14 | 6.2 | 3 | 182.0 | 91.0 | 72.8 | 60.7 |
| | Hangar za balirani 1 otpad T2 | 3.50 | 18.00 | 3 | 17 | 0.95 | 0.70 | 1.40 | avougaor | 14 | 6.2 | 3 | 173.2 | 86.6 | 69.3 | 57.7 |
| 21 | Hangar za balirani otpad 1 PoS T1 | 3.50 | 10.00 | 3 | 17 | 0.95 | 1.00 | 1.80 | avougaor | 14 | 6.2 | 3 | 122.9 | 61.5 | 49.2 | 41.0 |
| 21 | Hangar za balirani otpad 2 PoS T2 | 3.50 | 10.00 | 3 | 17 | 0.95 | 0.70 | 1.40 | avougaor | 14 | 6.2 | 3 | 117.7 | 58.9 | 47.1 | 39.2 |
| 25 | Komandna zgrada PPPV | 0.65 | 18.00 | 3 | 23 | 0.80 | 0.55 | 9.50 | traka | 21 | 10 | 7.5 | 222.7 | 111.4 | 89.1 | 74.2 |
| 26 | Nadstrešnica za mehanizaciju na deponiji | 0.80 | 18.00 | 3 | 23 | 1.80 | 1.75 | 1.75 | kvadrat | 21 | 10 | 7.5 | 500.4 | 250.2 | 200.2 | 166.8 |
| 8 | Protivpozarni rezervoar 1 | 3.40 | 18.00 | 2 | 23 | 0.90 | 5.80 | 10.90 | avougaor | 21 | 10 | 7.5 | 602.2 | 301.1 | 240.9 | 200.7 |
| | Protivpozarni rezervoar 2 | 3.40 | 18 | 2 | 23 | 1.45 | 5.55 | 6.50 | avougaor | 21 | 10 | 7.5 | 688.4 | 344.2 | 275.4 | 229.5 |
| 27 | Retenzija procedne vode | 0.80 | 18 | 3 | 23 | 0.4 | 35.20 | 35.80 | avougaor | 21 | 10 | 7.5 | 2529.6 | 1264.8 | 1011.8 | 843.2 |
| 15a | Digestor | 3.00 | 18 | 3 | 17 | 0.4 | 19.00 | 24.50 | avougaor | 14 | 6.2 | 3 | 609.4 | 304.7 | 243.8 | 203.1 |

| br. | PROJEKTOVANI OBJEKTI SA TAMPONOM | NPV (m) | γ (kN/m3) | c (kN/m2) | φ (°) | Df (m) | B (m) | L (m) | Oblik temelja | Nc | Nq | Ny | qf (kN/m2) | qa= qf/2 | qa= qf/2.5 | qa= qf/3 |
|-------|---|---------|--------------|--------------|----------|-----------|----------|----------|------------------|------|------|------|------------|----------|------------|----------|
| 1 | Portirnica | 3.00 | 19.70 | 6 | 24 | 0.80 | 0.50 | 4.00 | traka | 23 | 11.2 | 8.5 | 309.5 | 154.7 | 123.8 | 103.2 |
| 2,3,4 | Kolska vaga | 3.00 | 18.10 | 4 | 26 | 1.30 | 1.00 | 5.00 | traka | 26.4 | 13.6 | 12 | 498.3 | 249.2 | 199.3 | 166.1 |
| | | 3.00 | 17.80 | 4 | 26 | 1.30 | 1.20 | 5.00 | traka | 26.4 | 13.6 | 12 | 512.6 | 256.3 | 205.0 | 170.9 |
| 5 | Upravna zgrada T1 | 3.00 | 17.00 | 0 | 30 | 0.80 | 1.75 | 1.75 | kvadrat | 35.4 | 22.8 | 21 | 560.0 | 280.0 | 224.0 | 186.7 |
| 5 | Upravna zgrada T2 | 3.00 | 16.80 | 1 | 29 | 0.80 | 1.60 | 1.60 | kvadrat | 32.6 | 19.6 | 18 | 499.3 | 249.7 | 199.7 | 166.4 |
| 9 | Zgrada za radnike | 3.80 | 18.30 | 1 | 28 | 0.90 | 0.40 | 10.00 | traka | 30.4 | 17.6 | 15.5 | 366.7 | 183.3 | 146.7 | 122.2 |
| 10 | Radionica | 3.80 | 18.30 | 1 | 31 | 0.90 | 1.40 | 2.80 | avougaor | 37.8 | 25.6 | 24 | 772.5 | 386.3 | 309.0 | 257.5 |
| 11 | Magacin B-8 | 3.80 | 19.60 | 1 | 29 | 1.10 | 1.40 | 2.80 | avougaor | 32.6 | 19.6 | 18 | 707.0 | 353.5 | 282.8 | 235.7 |
| | Magacin B-11 | 3.80 | 21.10 | 0 | 34 | 1.10 | 1.40 | 2.80 | avougaor | 50.6 | 39 | 39 | 1481.2 | 740.6 | 592.5 | 493.7 |
| 12 | Nadstrešnica za komunalna vozila | 3.80 | 21.00 | 0 | 33 | 1.00 | 1.00 | 1.60 | avougaor | 45.6 | 34 | 33 | 1060.5 | 530.3 | 424.2 | 353.5 |
| 15.1. | MBT - prva dilatacija B-13 | 3.00 | 21.50 | 0 | 35 | 1.00 | 1.00 | 5.00 | traka | 56.4 | 45 | 46.5 | 1467.4 | 733.7 | 587.0 | 489.1 |
| | | 3.00 | 21.50 | 0 | 35 | 1.00 | 1.20 | 5.00 | traka | 56.4 | 45 | 46.5 | 1567.4 | 783.7 | 626.9 | 522.5 |
| | MBT - prva dilatacija B-15 | 3.00 | 18.90 | 0 | 33 | 1.00 | 1.00 | 5.00 | traka | 45.6 | 34 | 33 | 954.5 | 477.2 | 381.8 | 318.2 |
| | | 3.00 | 18.60 | 0 | 33 | 1.00 | 1.20 | 5.00 | traka | 45.6 | 34 | 33 | 1000.7 | 500.3 | 400.3 | 333.6 |
| | MBT - prva dilatacija osa E B-13 | 3.00 | 21.50 | 0 | 35 | 1.00 | 1.20 | 25.20 | traka | 56.4 | 45 | 46.5 | 1567.4 | 783.7 | 626.9 | 522.5 |
| 15.2. | MBT - prva dilatacija osa E B-15 | 3.00 | 18.60 | 0 | 33 | 1.00 | 1.20 | 25.20 | traka | 45.6 | 34 | 33 | 1000.7 | 500.3 | 400.3 | 333.6 |
| | MBT-treća dilatacija-sortirnica B-17 | 3.00 | 21.00 | 0 | 35 | 1.00 | 1.00 | 42.00 | traka | 56.4 | 45 | 46.5 | 1433.3 | 716.6 | 573.3 | 477.8 |
| | MBT-treća dilatacija-sortirnica B-19 | 3.00 | 21.00 | 0 | 35 | 1.00 | 1.00 | 42.00 | traka | 56.4 | 45 | 46.5 | 1433.3 | 716.6 | 573.3 | 477.8 |
| 16 | MBT-trafostanica | 3.00 | 21.00 | 0 | 35 | 0.90 | 0.50 | 14.50 | traka | 56.4 | 45 | 46.5 | 1094.6 | 547.3 | 437.9 | 364.9 |
| 19 | Garaža za vozila | 3.40 | 17.60 | 1 | 30 | 1.35 | 1.20 | 2.40 | avougaor | 35.4 | 22.8 | 21 | 804.2 | 402.1 | 321.7 | 268.1 |
| 20 | Postojeće postrojenje za razvrstavanje otpada - traka | 3.50 | 21.00 | 0 | 35 | 1.00 | 0.95 | 45.00 | traka | 56.4 | 45 | 46.5 | 1408.8 | 704.4 | 563.5 | 469.6 |
| | Postojeće postrojenje za razvrstavanje otpada - samac | 3.50 | 21.00 | 0 | 35 | 1.10 | 1.40 | 2.80 | avougaor | 56.4 | 45 | 46.5 | 1723.1 | 861.5 | 689.2 | 574.4 |
| 21 | Hangar za balirani otpad T1 | 3.50 | 21.00 | 0 | 35 | 0.95 | 1.00 | 1.80 | avougaor | 56.4 | 45 | 46.5 | 1386.0 | 693.0 | 554.4 | 462.0 |
| 25 | Komandna zgrada PPPV | 0.65 | 17.70 | 1 | 28 | 0.80 | 0.55 | 9.50 | traka | 30.4 | 17.6 | 15.5 | 344.7 | 172.4 | 137.9 | 114.9 |
| 26 | Nadstrešnica za mehanizaciju na deponiji | 0.80 | 16.70 | 1 | 28 | 1.80 | 1.75 | 1.75 | kvadrat | 30.4 | 17.6 | 15.5 | 749.8 | 374.9 | 299.9 | 249.9 |
| 8 | Protivpozarni rezervoar 2 | 3.40 | 16.20 | 0 | 33 | 1.45 | 5.55 | 6.50 | avougaor | 45.6 | 34 | 33 | 2282.2 | 1141.1 | 912.9 | 760.7 |
| 27 | Retenzija procedne vode | 0.80 | 15.60 | 0 | 30 | 0.4 | 35.20 | 35.80 | avougaor | 21 | 10 | 7.5 | 2121.6 | 1060.8 | 848.6 | 707.2 |
| 15a | Digestor | 3.00 | 16.20 | 1 | 28 | 0.4 | 19.00 | 24.50 | avougaor | 30.4 | 17.6 | 15.5 | 2537.0 | 1268.5 | 1014.8 | 845.7 |

Određivanje ponderisanih vrednosti c i φ iz modela:

 $c = (c1 \cdot H1 + c2 \cdot H2 \dots) / (H1 + H2 + \dots)$
 $\text{tg } \varphi = (c1 \cdot H1 + c2 \cdot H2 \dots) / (H1 + H2 + \dots)$

 $c_m = 0.66 \cdot c$
 $\text{tg } \varphi_m = 0.66 \cdot \text{tg } \varphi$

Traka $q_f = 0.66 \cdot c_m \cdot N' \cdot c + \gamma \cdot D_f \cdot N' \cdot q + 0.5 \cdot \gamma \cdot B \cdot N' \cdot \gamma$
 Kvadr: $q_f = 1.3 \cdot 0.66 \cdot c_m \cdot N' \cdot c + \gamma \cdot D_f \cdot N' \cdot q + 0.4 \cdot \gamma \cdot B \cdot N' \cdot \gamma$
 Pravou: $q_f = (1.3 \cdot 0.3 \cdot B / L) \cdot 0.66 \cdot c_m \cdot N' \cdot c + \gamma \cdot D_f \cdot N' \cdot q + 0.5 \cdot \gamma \cdot B \cdot N' \cdot \gamma$

Prilog 1.8.60

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 10. Radionica
Description : Model 4
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - šut

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,80 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

saSiL

Unit weight : $\gamma = 14,30 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,67 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 14,30 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 20,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60$ m

Length $l = 4,00$ m

Calculated cross-sectional characteristics

Area $A = 2,83E-01$ m²

Moment of inertia $I = 6,36E-03$ m⁴





Location

Off ground height $h = -1,30$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---------------|---|
| 1 | 1,40 | 0,00 .. 1,40 | nt - šut |  |
| 2 | 0,90 | 1,40 .. 2,30 | saSiL |  |
| 3 | 7,70 | 2,30 .. 10,00 | SaP |  |
| 4 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 355,06 | 88,10 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out with automatic selection of the most unfavourable load cases.

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Most unfavorable load case No. 1. (Load No. 1)

Pile skin bearing capacity $R_s = 173,67$ kN

Pile base bearing capacity $R_b = 181,39$ kN

Pile bearing capacity $R_c = 355,06$ kN

Ultimate vertical force $V_d = 355,06$ kN

$$R_c = 355,06 \text{ kN} > 355,06 \text{ kN} = V_d$$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,98$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

| | |
|---|------------------|
| Correction factor for stiffness of bearing stratum | $C_b = 1,33$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,15$ |
| Proportion of applied load transferred to pile base | $\beta = 0,16$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $l_0 = 0,18$ |
| Correction factor for pile compressibility | $R_k = 1,00$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,89$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 226,57 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 3,3 \text{ mm}$ |
| Total resistance | $R_c = 390,57 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 21,6 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 10. Radionica
Description : Model 4
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - šut

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,80 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

saSiL

Unit weight : $\gamma = 14,30 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,67 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 14,30 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 20,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80$ m

Length $l = 4,00$ m

Calculated cross-sectional characteristics

Area $A = 5,03E-01$ m²

Moment of inertia $I = 2,01E-02$ m⁴





Location

Off ground height $h = -1,30$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---------------|---|
| 1 | 1,40 | 0,00 .. 1,40 | nt - šut |  |
| 2 | 0,90 | 1,40 .. 2,30 | saSiL |  |
| 3 | 7,70 | 2,30 .. 10,00 | SaP |  |
| 4 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 554,03 | 88,10 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out with automatic selection of the most unfavourable load cases.

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Most unfavorable load case No. 1. (Load No. 1)

Pile skin bearing capacity $R_s = 231,56$ kN

Pile base bearing capacity $R_b = 322,48$ kN

Pile bearing capacity $R_c = 554,03$ kN

Ultimate vertical force $V_d = 554,03$ kN

$$R_c = 554,03 \text{ kN} > 554,03 \text{ kN} = V_d$$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,98$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

| | |
|---|------------------|
| Correction factor for stiffness of bearing stratum | $C_b = 1,20$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,18$ |
| Proportion of applied load transferred to pile base | $\beta = 0,17$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,20$ |
| Correction factor for pile compressibility | $R_k = 1,00$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,89$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 306,08 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 3,2 \text{ mm}$ |
| Total resistance | $R_c = 609,44 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 25,7 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 10. Radionica
Description : Model 4
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - šut

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,80 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

saSiL

Unit weight : $\gamma = 14,30 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,67 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 14,30 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 20,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20$ m

Length $l = 4,00$ m

Calculated cross-sectional characteristics

Area $A = 1,13E+00$ m²

Moment of inertia $I = 1,02E-01$ m⁴





Location

Off ground height $h = -1,30$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|-------------------|---------------|---|
| 1 | 1,40 | 0,00 .. 1,40 | nt - šut |  |
| 2 | 0,90 | 1,40 .. 2,30 | saSiL |  |
| 3 | 7,70 | 2,30 .. 10,00 | SaP |  |
| 4 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 1072,91 | 88,10 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 347,34$ kN

Pile base bearing capacity $R_b = 725,57$ kN

Pile bearing capacity $R_c = 1072,91$ kN

Ultimate vertical force $V_d = 1072,91$ kN

$$R_c = 1072,91 \text{ kN} < 1072,91 \text{ kN} = V_d$$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,98$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

Correction factor for stiffness of bearing stratum $C_b = 1,20$

| | |
|---|------------------|
| Base-load proportion for incompressible pile | $\beta_0 = 0,45$ |
| Proportion of applied load transferred to pile base | $\beta = 0,42$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,26$ |
| Correction factor for pile compressibility | $R_k = 1,00$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,89$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 661,33 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 5,3 \text{ mm}$ |
| Total resistance | $R_c = 1180,20 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 20,6 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 11. Magacin
Description : Model 5
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - šut

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,80 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

saSiL

Unit weight : $\gamma = 14,30 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,67 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 14,30 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 20,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60$ m

Length $l = 4,00$ m

Calculated cross-sectional characteristics

Area $A = 2,83E-01$ m²

Moment of inertia $I = 6,36E-03$ m⁴





Location

Off ground height $h = -1,70$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---------------|---|
| 1 | 3,50 | 0,00 .. 3,50 | nt - šut |  |
| 2 | 0,70 | 3,50 .. 4,20 | saSiL |  |
| 3 | 5,80 | 4,20 .. 10,00 | SaP |  |
| 4 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 351,87 | 0,00 | 26,70 | 0,00 | 3,90 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 148,39$ kN

Pile base bearing capacity $R_b = 203,47$ kN

Pile bearing capacity $R_c = 351,87$ kN

Ultimate vertical force $V_d = 351,87$ kN

$$R_c = 351,87 \text{ kN} < 351,87 \text{ kN} = V_d$$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,98$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

Correction factor for stiffness of bearing stratum $C_b = 2,00$

| | |
|---|------------------|
| Base-load proportion for incompressible pile | $\beta_0 = 0,15$ |
| Proportion of applied load transferred to pile base | $\beta = 0,24$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $l_0 = 0,18$ |
| Correction factor for pile compressibility | $R_k = 1,00$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,90$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 214,28 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 3,9 \text{ mm}$ |
| Total resistance | $R_c = 387,05 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 20,8 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 11. Magacin
Description : Model 5
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - šut

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,80 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

saSiL

Unit weight : $\gamma = 14,30 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,67 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 14,30 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 20,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80$ m

Length $l = 4,00$ m

Calculated cross-sectional characteristics

Area $A = 5,03E-01$ m²

Moment of inertia $I = 2,01E-02$ m⁴





Location

Off ground height $h = -1,70$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---------------|---|
| 1 | 3,50 | 0,00 .. 3,50 | nt - šut |  |
| 2 | 0,70 | 3,50 .. 4,20 | saSiL |  |
| 3 | 5,80 | 4,20 .. 10,00 | SaP |  |
| 4 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 559,89 | 0,00 | 26,70 | 0,00 | 3,90 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 198,16$ kN

Pile base bearing capacity $R_b = 361,73$ kN

Pile bearing capacity $R_c = 559,89$ kN

Ultimate vertical force $V_d = 559,89$ kN

$R_c = 559,89$ kN $>$ $559,89$ kN $= V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,99$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

Correction factor for stiffness of bearing stratum $C_b = 1,62$

| | |
|---|------------------|
| Base-load proportion for incompressible pile | $\beta_0 = 0,18$ |
| Proportion of applied load transferred to pile base | $\beta = 0,23$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,20$ |
| Correction factor for pile compressibility | $R_k = 1,00$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,90$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 282,17 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 3,8 \text{ mm}$ |
| Total resistance | $R_c = 615,88 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 27,2 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 11. Magacin
Description : Model 5
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - šut

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,80 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

saSiL

Unit weight : $\gamma = 14,30 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,67 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 14,30 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 20,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20$ m

Length $l = 5,00$ m

Calculated cross-sectional characteristics

Area $A = 1,13E+00$ m²

Moment of inertia $I = 1,02E-01$ m⁴





Location

Off ground height $h = -1,70$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---------------|---|
| 1 | 3,50 | 0,00 .. 3,50 | nt - šut |  |
| 2 | 0,70 | 3,50 .. 4,20 | saSiL |  |
| 3 | 5,80 | 4,20 .. 10,00 | SaP |  |
| 4 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 1317,38 | 0,00 | 26,70 | 0,00 | 3,90 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 445,91$ kN

Pile base bearing capacity $R_b = 871,47$ kN

Pile bearing capacity $R_c = 1317,38$ kN

Ultimate vertical force $V_d = 1317,38$ kN

$$R_c = 1317,38 \text{ kN} < 1317,38 \text{ kN} = V_d$$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,98$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

Correction factor for stiffness of bearing stratum $C_b = 1,45$

| | |
|---|------------------|
| Base-load proportion for incompressible pile | $\beta_0 = 0,32$ |
| Proportion of applied load transferred to pile base | $\beta = 0,36$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,23$ |
| Correction factor for pile compressibility | $R_k = 1,01$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,90$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 764,08 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 5,7 \text{ mm}$ |
| Total resistance | $R_c = 1449,12 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 25,8 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 12. Nadstrešnica sa perionicom za komunalna vozila
Description : Model 6
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - šut

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,80 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

siSa

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 3,21 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 23,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60$ m

Length $l = 4,00$ m

Calculated cross-sectional characteristics

Area $A = 2,83E-01$ m²

Moment of inertia $I = 6,36E-03$ m⁴





Location

Off ground height $h = -1,00$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---------------|---|
| 1 | 2,50 | 0,00 .. 2,50 | nt - šut |  |
| 2 | 2,00 | 2,50 .. 4,50 | siSa |  |
| 3 | 5,50 | 4,50 .. 10,00 | SaP |  |
| 4 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 327,26 | 30,20 | 0,00 | 0,00 | 3,00 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 124,07$ kN

Pile base bearing capacity $R_b = 203,19$ kN

Pile bearing capacity $R_c = 327,26$ kN

Ultimate vertical force $V_d = 327,26$ kN

$$R_c = 327,26 \text{ kN} < 327,26 \text{ kN} = V_d$$

Pile bearing capacity is NOT SATISFACTORY

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 12. Nadstrešnica sa perionicom za komunalna vozila
Description : Model 6
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - šut

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,80 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

siSa

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 3,21 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 23,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80 \text{ m}$

Length $l = 4,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 5,03\text{E-}01 \text{ m}^2$

Moment of inertia $I = 2,01\text{E-}02 \text{ m}^4$





Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 2,50 | 0,00 .. 2,50 | nt - šut |  |
| 2 | 2,00 | 2,50 .. 4,50 | siSa |  |
| 3 | 5,50 | 4,50 .. 10,00 | SaP |  |
| 4 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 526,65 | 30,20 | 0,00 | 0,00 | 3,00 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 165,42 \text{ kN}$

Pile base bearing capacity $R_b = 361,23 \text{ kN}$

Pile bearing capacity $R_c = 526,65 \text{ kN}$

Ultimate vertical force $V_d = 526,65 \text{ kN}$

$$R_c = 526,65 \text{ kN} < 526,65 \text{ kN} = V_d$$

Pile bearing capacity is NOT SATISFACTORY

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 12. Nadstrešnica sa perionicom za komunalna vozila
Description : Model 6
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - šut

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 0,80 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

siSa

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 3,21 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 23,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20$ m

Length $l = 4,00$ m

Calculated cross-sectional characteristics

Area $A = 1,13E+00$ m²

Moment of inertia $I = 1,02E-01$ m⁴





Location

Off ground height $h = -1,00$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---------------|---|
| 1 | 2,50 | 0,00 .. 2,50 | nt - šut |  |
| 2 | 2,00 | 2,50 .. 4,50 | siSa |  |
| 3 | 5,50 | 4,50 .. 10,00 | SaP |  |
| 4 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 1060,89 | 30,20 | 0,00 | 0,00 | 3,00 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 248,13$ kN

Pile base bearing capacity $R_b = 812,76$ kN

Pile bearing capacity $R_c = 1060,89$ kN

Ultimate vertical force $V_d = 1060,89$ kN

$$R_c = 1060,89 \text{ kN} < 1060,89 \text{ kN} = V_d$$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,98$

Correction factor for Poisson's ratio of soil $C_v = 0,80$

Correction factor for stiffness of bearing stratum $C_b = 1,45$

| | |
|---|------------------|
| Base-load proportion for incompressible pile | $\beta_0 = 0,45$ |
| Proportion of applied load transferred to pile base | $\beta = 0,52$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,26$ |
| Correction factor for pile compressibility | $R_k = 1,00$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,91$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 565,69 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 6,4 \text{ mm}$ |
| Total resistance | $R_c = 1166,98 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 25,9 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 15.1 Objekat MBT - prva dilatacija
Description : Model 7
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

siSa-siSaP

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 3,21 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 23,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60 \text{ m}$

Length $l = 7,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 2,83\text{E-}01 \text{ m}^2$

Moment of inertia $I = 6,36\text{E-}03 \text{ m}^4$




Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,50 | 0,00 .. 6,50 | nt - org |  |
| 2 | 13,50 | 6,50 .. 20,00 | siSa-siSaP |  |
| 3 | - | 20,00 .. ∞ | siSa-siSaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 258,03 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 209,42 \text{ kN}$

Pile base bearing capacity $R_b = 48,61 \text{ kN}$

Pile bearing capacity $R_c = 258,03 \text{ kN}$

Ultimate vertical force $V_d = 258,03 \text{ kN}$

$R_c = 258,03 \text{ kN} < 258,03 \text{ kN} = V_d$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,96$

Correction factor for Poisson's ratio of soil $C_v = 0,80$

Correction factor for stiffness of bearing stratum $C_b = 2,67$

Base-load proportion for incompressible pile $\beta_0 = 0,10$

Proportion of applied load transferred to pile base $\beta = 0,20$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,13$

Correction factor for pile compressibility $R_k = 1,01$

Correction factor for finite depth of layer on a rigid base $R_h = 1,00$

Correction factor for Poisson's ratio of soil

$$R_v = 0,91$$

Analysis of load settlement curve - results

Load at the onset of mobilization of skin friction $R_{yu} = 283,83 \text{ kN}$

The settlement for the force R_{yu} $s_y = 3,9 \text{ mm}$

Total resistance $R_c = 283,83 \text{ kN}$

Maximum settlement $s_{lim} = 3,9 \text{ mm}$

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 15.1 Objekat MBT - prva dilatacija
Description : Model 7
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

siSa-siSaP

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 3,21 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 23,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80 \text{ m}$

Length $l = 7,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 5,03\text{E-}01 \text{ m}^2$

Moment of inertia $I = 2,01\text{E-}02 \text{ m}^4$




Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,50 | 0,00 .. 6,50 | nt - org |  |
| 2 | 13,50 | 6,50 .. 20,00 | siSa-siSaP |  |
| 3 | - | 20,00 .. ∞ | siSa-siSaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 373,17 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 286,76 \text{ kN}$

Pile base bearing capacity $R_b = 86,41 \text{ kN}$

Pile bearing capacity $R_c = 373,17 \text{ kN}$

Ultimate vertical force $V_d = 373,17 \text{ kN}$

$R_c = 373,17 \text{ kN} > 373,17 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,97$

Correction factor for Poisson's ratio of soil $C_v = 0,80$

Correction factor for stiffness of bearing stratum $C_b = 2,30$

Base-load proportion for incompressible pile $\beta_0 = 0,12$

Proportion of applied load transferred to pile base $\beta = 0,21$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,16$

Correction factor for pile compressibility $R_k = 1,00$

Correction factor for finite depth of layer on a rigid base $R_h = 1,00$

Correction factor for Poisson's ratio of soil

$$R_v = 0,91$$

Analysis of load settlement curve - results

Load at the onset of mobilization of skin friction $R_{yu} = 401,25 \text{ kN}$

The settlement for the force R_{yu} $s_y = 4,4 \text{ mm}$

Total resistance $R_c = 410,49 \text{ kN}$

Maximum settlement $s_{lim} = 9,4 \text{ mm}$

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 15.1 Objekat MBT - prva dilatacija
Description : Model 7
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

siSa-siSaP

Unit weight : $\gamma = 18,50 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 3,21 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,50 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 23,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20 \text{ m}$

Length $l = 8,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 1,13\text{E}+00 \text{ m}^2$

Moment of inertia $I = 1,02\text{E}-01 \text{ m}^4$




Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,50 | 0,00 .. 6,50 | nt - org |  |
| 2 | 13,50 | 6,50 .. 20,00 | siSa-siSaP |  |
| 3 | - | 20,00 .. ∞ | siSa-siSaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 718,74 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 485,66 \text{ kN}$

Pile base bearing capacity $R_b = 233,08 \text{ kN}$

Pile bearing capacity $R_c = 718,74 \text{ kN}$

Ultimate vertical force $V_d = 718,74 \text{ kN}$

$R_c = 718,74 \text{ kN} > 718,74 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,97$

Correction factor for Poisson's ratio of soil $C_v = 0,80$

Correction factor for stiffness of bearing stratum $C_b = 1,79$

Base-load proportion for incompressible pile $\beta_0 = 0,15$

Proportion of applied load transferred to pile base $\beta = 0,21$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,18$

Correction factor for pile compressibility $R_k = 1,01$

Correction factor for finite depth of layer on a rigid base $R_h = 1,00$

Correction factor for Poisson's ratio of soil

$$R_v = 0,91$$

Analysis of load settlement curve - results

Load at the onset of mobilization of skin friction $R_{yu} = 679,85 \text{ kN}$

The settlement for the force R_{yu} $s_y = 4,2 \text{ mm}$

Total resistance $R_c = 790,62 \text{ kN}$

Maximum settlement $s_{lim} = 11,6 \text{ mm}$

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 15.2 Objekat MBT - treća dilatacija - sortirnica
Description : Model 8
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIM

Unit weight : $\gamma = 18,40 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,32 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,40 \text{ kN/m}^3$
Cohesion of soil : $c_u = 27,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,93$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

SaU

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$

Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{\text{oed}} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{\text{ef}} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60 \text{ m}$

Length $l = 8,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 2,83\text{E-}01 \text{ m}^2$

Moment of inertia $I = 6,36\text{E-}03 \text{ m}^4$


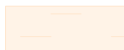


Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,20 | 0,00 .. 6,20 | nt - org |  |
| 2 | 1,30 | 6,20 .. 7,50 | CIM |  |
| 3 | 4,50 | 7,50 .. 12,00 | SaU |  |
| 4 | - | 12,00 .. ∞ | SaU |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 396,40 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 269,62 \text{ kN}$

Pile base bearing capacity $R_b = 126,78 \text{ kN}$

Pile bearing capacity $R_c = 396,40 \text{ kN}$

Ultimate vertical force $V_d = 396,40 \text{ kN}$

$R_c = 396,40 \text{ kN} > 396,40 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

| | |
|---|------------------|
| Correction factor for pile compressibility | $C_k = 0,96$ |
| Correction factor for Poisson's ratio of soil | $C_v = 0,80$ |
| Correction factor for stiffness of bearing stratum | $C_b = 3,40$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,09$ |
| Proportion of applied load transferred to pile base | $\beta = 0,24$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,12$ |
| Correction factor for pile compressibility | $R_k = 1,03$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,91$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 388,22 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 4,7 \text{ mm}$ |
| Total resistance | $R_c = 436,04 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 11,9 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 15.2 Objekat MBT - treća dilatacija - sortirnica
Description : Model 8
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIM

Unit weight : $\gamma = 18,40 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,32 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,40 \text{ kN/m}^3$
Cohesion of soil : $c_u = 27,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,93$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

SaU

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$

Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{\text{oed}} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{\text{ef}} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80 \text{ m}$

Length $l = 8,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 5,03\text{E-}01 \text{ m}^2$

Moment of inertia $I = 2,01\text{E-}02 \text{ m}^4$


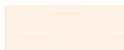


Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,20 | 0,00 .. 6,20 | nt - org |  |
| 2 | 1,30 | 6,20 .. 7,50 | CIM |  |
| 3 | 4,50 | 7,50 .. 12,00 | SaU |  |
| 4 | - | 12,00 .. ∞ | SaU |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 612,31 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 386,92 \text{ kN}$

Pile base bearing capacity $R_b = 225,39 \text{ kN}$

Pile bearing capacity $R_c = 612,31 \text{ kN}$

Ultimate vertical force $V_d = 612,31 \text{ kN}$

$R_c = 612,31 \text{ kN} < 612,31 \text{ kN} = V_d$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

| | |
|---|------------------|
| Correction factor for pile compressibility | $C_k = 0,96$ |
| Correction factor for Poisson's ratio of soil | $C_v = 0,80$ |
| Correction factor for stiffness of bearing stratum | $C_b = 2,92$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,10$ |
| Proportion of applied load transferred to pile base | $\beta = 0,23$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,15$ |
| Correction factor for pile compressibility | $R_k = 1,00$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,91$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 550,07 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 5,5 \text{ mm}$ |
| Total resistance | $R_c = 673,54 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 16,6 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 15.2 Objekat MBT - treća dilatacija - sortirnica
Description : Model 8
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIM

Unit weight : $\gamma = 18,40 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,32 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,40 \text{ kN/m}^3$
Cohesion of soil : $c_u = 27,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,93$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

SaU

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$

Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{\text{oed}} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{\text{ef}} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20 \text{ m}$

Length $l = 9,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 1,13\text{E}+00 \text{ m}^2$

Moment of inertia $I = 1,02\text{E}-01 \text{ m}^4$


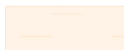


Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,20 | 0,00 .. 6,20 | nt - org |  |
| 2 | 1,30 | 6,20 .. 7,50 | CIM |  |
| 3 | 4,50 | 7,50 .. 12,00 | SaU |  |
| 4 | - | 12,00 .. ∞ | SaU |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 1239,63 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 674,93 \text{ kN}$

Pile base bearing capacity $R_b = 564,70 \text{ kN}$

Pile bearing capacity $R_c = 1239,63 \text{ kN}$

Ultimate vertical force $V_d = 1239,63 \text{ kN}$

$R_c = 1239,63 \text{ kN} < 1239,63 \text{ kN} = V_d$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

| | |
|---|------------------|
| Correction factor for pile compressibility | $C_k = 0,97$ |
| Correction factor for Poisson's ratio of soil | $C_v = 0,80$ |
| Correction factor for stiffness of bearing stratum | $C_b = 2,20$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,14$ |
| Proportion of applied load transferred to pile base | $\beta = 0,24$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,18$ |
| Correction factor for pile compressibility | $R_k = 1,01$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,91$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 975,92 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 5,6 \text{ mm}$ |
| Total resistance | $R_c = 1363,59 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 20,7 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 16. Trafostanica uz objekat MBT
Description : Model 9
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIM

Unit weight : $\gamma = 18,40 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,32 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,40 \text{ kN/m}^3$
Cohesion of soil : $c_u = 27,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,93$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

SaU

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$

Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{\text{oed}} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{\text{ef}} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60 \text{ m}$

Length $l = 7,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 2,83\text{E-}01 \text{ m}^2$

Moment of inertia $I = 6,36\text{E-}03 \text{ m}^4$


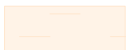


Location

Off ground height $h = -0,90 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 5,20 | 0,00 .. 5,20 | nt - org |  |
| 2 | 1,00 | 5,20 .. 6,20 | CIM |  |
| 3 | 5,80 | 6,20 .. 12,00 | SaU |  |
| 4 | - | 12,00 .. ∞ | SaU |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 358,00 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 234,83 \text{ kN}$

Pile base bearing capacity $R_b = 123,18 \text{ kN}$

Pile bearing capacity $R_c = 358,00 \text{ kN}$

Ultimate vertical force $V_d = 358,00 \text{ kN}$

$R_c = 358,00 \text{ kN} > 358,00 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

| | |
|---|------------------|
| Correction factor for pile compressibility | $C_k = 0,96$ |
| Correction factor for Poisson's ratio of soil | $C_v = 0,80$ |
| Correction factor for stiffness of bearing stratum | $C_b = 2,95$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,10$ |
| Proportion of applied load transferred to pile base | $\beta = 0,22$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,13$ |
| Correction factor for pile compressibility | $R_k = 1,01$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,91$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 329,38 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 4,5 \text{ mm}$ |
| Total resistance | $R_c = 393,80 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 13,2 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 16. Trafostanica uz objekat MBT
Description : Model 9
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIM

Unit weight : $\gamma = 18,40 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,32 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,40 \text{ kN/m}^3$
Cohesion of soil : $c_u = 27,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,93$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

SaU

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$

Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{\text{oed}} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{\text{ef}} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80 \text{ m}$

Length $l = 7,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 5,03\text{E-}01 \text{ m}^2$

Moment of inertia $I = 2,01\text{E-}02 \text{ m}^4$


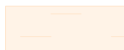


Location

Off ground height $h = -0,90 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 5,20 | 0,00 .. 5,20 | nt - org |  |
| 2 | 1,00 | 5,20 .. 6,20 | CIM |  |
| 3 | 5,80 | 6,20 .. 12,00 | SaU |  |
| 4 | - | 12,00 .. ∞ | SaU |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 555,69 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 336,70 \text{ kN}$

Pile base bearing capacity $R_b = 218,98 \text{ kN}$

Pile bearing capacity $R_c = 555,69 \text{ kN}$

Ultimate vertical force $V_d = 555,69 \text{ kN}$

$R_c = 555,69 \text{ kN} < 555,69 \text{ kN} = V_d$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

| | |
|---|------------------|
| Correction factor for pile compressibility | $C_k = 0,97$ |
| Correction factor for Poisson's ratio of soil | $C_v = 0,80$ |
| Correction factor for stiffness of bearing stratum | $C_b = 2,52$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,12$ |
| Proportion of applied load transferred to pile base | $\beta = 0,23$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,16$ |
| Correction factor for pile compressibility | $R_k = 1,00$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,91$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 483,84 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 5,3 \text{ mm}$ |
| Total resistance | $R_c = 611,25 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 16,6 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 16. Trafostanica uz objekat MBT
Description : Model 9
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIM

Unit weight : $\gamma = 18,40 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,32 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,40 \text{ kN/m}^3$
Cohesion of soil : $c_u = 27,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,93$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

SaU

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$

Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{\text{oed}} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{\text{ef}} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20 \text{ m}$

Length $l = 8,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 1,13\text{E}+00 \text{ m}^2$

Moment of inertia $I = 1,02\text{E}-01 \text{ m}^4$


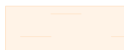


Location

Off ground height $h = -0,90 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 5,20 | 0,00 .. 5,20 | nt - org |  |
| 2 | 1,00 | 5,20 .. 6,20 | CIM |  |
| 3 | 5,80 | 6,20 .. 12,00 | SaU |  |
| 4 | - | 12,00 .. ∞ | SaU |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 1147,35 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 597,06 \text{ kN}$

Pile base bearing capacity $R_b = 550,29 \text{ kN}$

Pile bearing capacity $R_c = 1147,35 \text{ kN}$

Ultimate vertical force $V_d = 1147,35 \text{ kN}$

$R_c = 1147,35 \text{ kN} < 1147,35 \text{ kN} = V_d$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

| | |
|---|------------------|
| Correction factor for pile compressibility | $C_k = 0,97$ |
| Correction factor for Poisson's ratio of soil | $C_v = 0,80$ |
| Correction factor for stiffness of bearing stratum | $C_b = 1,92$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,15$ |
| Proportion of applied load transferred to pile base | $\beta = 0,23$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,18$ |
| Correction factor for pile compressibility | $R_k = 1,01$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,91$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 851,30 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 5,2 \text{ mm}$ |
| Total resistance | $R_c = 1262,08 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 21,6 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 20. Postojeće postrojenje za razvrstavanje otpada
Description : Model 11
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIM

Unit weight : $\gamma = 18,40 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,32 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,40 \text{ kN/m}^3$
Cohesion of soil : $c_u = 27,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,93$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

siSaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$

Poisson's ratio : $\nu = 0,25$
 Oedometric modulus : $E_{\text{oed}} = 3,62 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15,60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60 \text{ m}$

Length $l = 14,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 2,83\text{E-}01 \text{ m}^2$

Moment of inertia $I = 6,36\text{E-}03 \text{ m}^4$


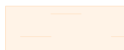


Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,60 | 0,00 .. 6,60 | nt - org |  |
| 2 | 4,40 | 6,60 .. 11,00 | CIM |  |
| 3 | 9,00 | 11,00 .. 20,00 | siSaP |  |
| 4 | - | 20,00 .. ∞ | siSaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 763,61 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 513,35 \text{ kN}$

Pile base bearing capacity $R_b = 250,26 \text{ kN}$

Pile bearing capacity $R_c = 763,61 \text{ kN}$

Ultimate vertical force $V_d = 763,61 \text{ kN}$

$R_c = 763,61 \text{ kN} > 763,61 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

| | |
|---|------------------|
| Correction factor for pile compressibility | $C_k = 0,93$ |
| Correction factor for Poisson's ratio of soil | $C_v = 0,81$ |
| Correction factor for stiffness of bearing stratum | $C_b = 3,87$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,06$ |
| Proportion of applied load transferred to pile base | $\beta = 0,19$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,07$ |
| Correction factor for pile compressibility | $R_k = 1,11$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,92$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 694,92 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 5,7 \text{ mm}$ |
| Total resistance | $R_c = 839,98 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 17,9 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 20. Postojeće postrojenje za razvrstavanje otpada
Description : Model 11
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIM

Unit weight : $\gamma = 18,40 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,32 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,40 \text{ kN/m}^3$
Cohesion of soil : $c_u = 27,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,93$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

siSaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$

Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{\text{oed}} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{\text{sat}} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{\text{ef}} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80 \text{ m}$

Length $l = 14,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 5,03\text{E-}01 \text{ m}^2$

Moment of inertia $I = 2,01\text{E-}02 \text{ m}^4$


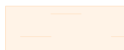


Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,60 | 0,00 .. 6,60 | nt - org |  |
| 2 | 4,40 | 6,60 .. 11,00 | CIM |  |
| 3 | 9,00 | 11,00 .. 20,00 | siSaP |  |
| 4 | - | 20,00 .. ∞ | siSaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 1251,28 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 806,37 \text{ kN}$

Pile base bearing capacity $R_b = 444,91 \text{ kN}$

Pile bearing capacity $R_c = 1251,28 \text{ kN}$

Ultimate vertical force $V_d = 1251,28 \text{ kN}$

$R_c = 1251,28 \text{ kN} > 1251,28 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

| | |
|---|------------------|
| Correction factor for pile compressibility | $C_k = 0,94$ |
| Correction factor for Poisson's ratio of soil | $C_v = 0,81$ |
| Correction factor for stiffness of bearing stratum | $C_b = 3,45$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,08$ |
| Proportion of applied load transferred to pile base | $\beta = 0,20$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,09$ |
| Correction factor for pile compressibility | $R_k = 1,08$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,92$ |

Analysis of load settlement curve - results

| | |
|--|-------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 1115,37 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 7,2 \text{ mm}$ |
| Total resistance | $R_c = 1376,41 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 22,7 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 20. Postojeće postrojenje za razvrstavanje otpada
Description : Model 11
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIM

Unit weight : $\gamma = 18,40 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,32 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,40 \text{ kN/m}^3$
Cohesion of soil : $c_u = 27,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,93$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

siSaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$

Poisson's ratio : $\nu = 0,25$
 Oedometric modulus : $E_{\text{oed}} = 3,62 \text{ MPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15,60 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{\text{ef}} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20 \text{ m}$

Length $l = 14,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 1,13\text{E}+00 \text{ m}^2$

Moment of inertia $I = 1,02\text{E}-01 \text{ m}^4$


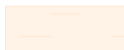


Location

Off ground height $h = -1,00 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,60 | 0,00 .. 6,60 | nt - org |  |
| 2 | 4,40 | 6,60 .. 11,00 | CIM |  |
| 3 | 9,00 | 11,00 .. 20,00 | siSaP |  |
| 4 | - | 20,00 .. ∞ | siSaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 2377,19 | 0,00 | 0,00 | 0,00 | 0,00 |

Ground water table

The ground water table is at a depth of 3,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 1376,15 \text{ kN}$

Pile base bearing capacity $R_b = 1001,04 \text{ kN}$

Pile bearing capacity $R_c = 2377,19 \text{ kN}$

Ultimate vertical force $V_d = 2377,19 \text{ kN}$

$R_c = 2377,19 \text{ kN} > 2377,19 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

| | |
|---|------------------|
| Correction factor for pile compressibility | $C_k = 0,95$ |
| Correction factor for Poisson's ratio of soil | $C_v = 0,81$ |
| Correction factor for stiffness of bearing stratum | $C_b = 2,87$ |
| Base-load proportion for incompressible pile | $\beta_0 = 0,10$ |
| Proportion of applied load transferred to pile base | $\beta = 0,21$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,13$ |
| Correction factor for pile compressibility | $R_k = 1,03$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,92$ |

Analysis of load settlement curve - results

| | |
|--|-------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 1918,65 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 9,6 \text{ mm}$ |
| Total resistance | $R_c = 2614,91 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 35,9 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 21.1 Hangar za balirani otpad
Description : Model 12
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60 \text{ m}$

Length $l = 10,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 2,83\text{E-}01 \text{ m}^2$

Moment of inertia $I = 6,36\text{E-}03 \text{ m}^4$


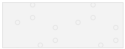
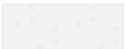
Location

Off ground height $h = -0,95 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 7,60 | 0,00 .. 7,60 | nt - org |  |
| 2 | 2,60 | 7,60 .. 10,20 | SaP |  |
| 3 | - | 10,20 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 493,65 | 27,00 | 0,00 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 4,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 342,61 \text{ kN}$

Pile base bearing capacity $R_b = 151,05 \text{ kN}$

Pile bearing capacity $R_c = 493,65 \text{ kN}$

Ultimate vertical force $V_d = 493,65 \text{ kN}$

$R_c = 493,65 \text{ kN} > 493,65 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,95$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

Correction factor for stiffness of bearing stratum $C_b = 2,98$

Base-load proportion for incompressible pile $\beta_0 = 0,08$

Proportion of applied load transferred to pile base $\beta = 0,18$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,10$

Correction factor for pile compressibility $R_k = 1,05$

Correction factor for finite depth of layer on a rigid base $R_h = 1,00$

Correction factor for Poisson's ratio of soil

$$R_v = 0,90$$

Analysis of load settlement curve - results

Load at the onset of mobilization of skin friction $R_{yu} = 459,72 \text{ kN}$

The settlement for the force R_{yu} $s_y = 4,6 \text{ mm}$

Total resistance $R_c = 543,02 \text{ kN}$

Maximum settlement $s_{lim} = 13,9 \text{ mm}$

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 21.1 Hangar za balirani otpad
Description : Model 12
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80 \text{ m}$

Length $l = 10,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 5,03\text{E-}01 \text{ m}^2$

Moment of inertia $I = 2,01\text{E-}02 \text{ m}^4$


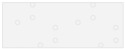
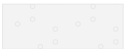
Location

Off ground height $h = -0,95 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 7,60 | 0,00 .. 7,60 | nt - org |  |
| 2 | 2,60 | 7,60 .. 10,20 | SaP |  |
| 3 | - | 10,20 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 757,17 | 27,00 | 0,00 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 4,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 488,65 \text{ kN}$

Pile base bearing capacity $R_b = 268,53 \text{ kN}$

Pile bearing capacity $R_c = 757,17 \text{ kN}$

Ultimate vertical force $V_d = 757,17 \text{ kN}$

$$R_c = 757,17 \text{ kN} > 757,17 \text{ kN} = V_d$$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,96$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

Correction factor for stiffness of bearing stratum $C_b = 2,64$

Base-load proportion for incompressible pile $\beta_0 = 0,09$

Proportion of applied load transferred to pile base $\beta = 0,19$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,12$

Correction factor for pile compressibility $R_k = 1,02$

Correction factor for finite depth of layer on a rigid base $R_h = 1,00$

Correction factor for Poisson's ratio of soil

$$R_v = 0,90$$

Analysis of load settlement curve - results

Load at the onset of mobilization of skin friction $R_{yu} = 660,03 \text{ kN}$

The settlement for the force R_{yu} $s_y = 5,6 \text{ mm}$

Total resistance $R_c = 832,89 \text{ kN}$

Maximum settlement $s_{lim} = 19,3 \text{ mm}$

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 21.1 Hangar za balirani otpad
Description : Model 12
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20 \text{ m}$

Length $l = 10,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 1,13\text{E}+00 \text{ m}^2$

Moment of inertia $I = 1,02\text{E}-01 \text{ m}^4$


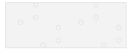
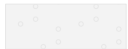
Location

Off ground height $h = -0,95 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 7,60 | 0,00 .. 7,60 | nt - org |  |
| 2 | 2,60 | 7,60 .. 10,20 | SaP |  |
| 3 | - | 10,20 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 1346,41 | 27,00 | 0,00 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 4,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 742,23 \text{ kN}$

Pile base bearing capacity $R_b = 604,18 \text{ kN}$

Pile bearing capacity $R_c = 1346,41 \text{ kN}$

Ultimate vertical force $V_d = 1346,41 \text{ kN}$

$R_c = 1346,41 \text{ kN} > 1346,41 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,97$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

Correction factor for stiffness of bearing stratum $C_b = 2,16$

Base-load proportion for incompressible pile $\beta_0 = 0,13$

Proportion of applied load transferred to pile base $\beta = 0,21$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,17$

Correction factor for pile compressibility $R_k = 1,00$

Correction factor for finite depth of layer on a rigid base $R_h = 1,00$

Correction factor for Poisson's ratio of soil

$$R_v = 0,90$$

Analysis of load settlement curve - results

Load at the onset of mobilization of skin friction $R_{yu} = 1033,49 \text{ kN}$

The settlement for the force R_{yu} $s_y = 6,6 \text{ mm}$

Total resistance $R_c = 1481,05 \text{ kN}$

Maximum settlement $s_{lim} = 26,9 \text{ mm}$

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 21.2 Hangar za balirani otpad
Description : Model 13
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60 \text{ m}$

Length $l = 13,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 2,83\text{E-}01 \text{ m}^2$

Moment of inertia $I = 6,36\text{E-}03 \text{ m}^4$


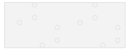
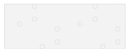
Location

Off ground height $h = -0,95 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 9,80 | 0,00 .. 9,80 | nt - org |  |
| 2 | 0,20 | 9,80 .. 10,00 | SaP |  |
| 3 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 607,33 | 0,00 | 14,20 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 4,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 444,77 \text{ kN}$

Pile base bearing capacity $R_b = 162,57 \text{ kN}$

Pile bearing capacity $R_c = 607,33 \text{ kN}$

Ultimate vertical force $V_d = 607,33 \text{ kN}$

$R_c = 607,33 \text{ kN} > 607,33 \text{ kN} = V_d$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,94$

Correction factor for Poisson's ratio of soil $C_v = 0,80$

Correction factor for stiffness of bearing stratum $C_b = 3,38$

Base-load proportion for incompressible pile $\beta_0 = 0,07$

Proportion of applied load transferred to pile base $\beta = 0,17$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,08$

Correction factor for pile compressibility $R_k = 1,10$

Correction factor for finite depth of layer on a rigid base $R_h = 1,00$

Correction factor for Poisson's ratio of soil

$$R_v = 0,90$$

Analysis of load settlement curve - results

Load at the onset of mobilization of skin friction $R_{yu} = 588,19 \text{ kN}$

The settlement for the force R_{yu} $s_y = 4,9 \text{ mm}$

Total resistance $R_c = 668,07 \text{ kN}$

Maximum settlement $s_{lim} = 13,8 \text{ mm}$

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 21.2 Hangar za balirani otpad
Description : Model 13
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80 \text{ m}$

Length $l = 13,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 5,03\text{E-}01 \text{ m}^2$

Moment of inertia $I = 2,01\text{E-}02 \text{ m}^4$


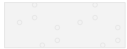
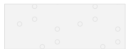
Location

Off ground height $h = -0,95 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 9,80 | 0,00 .. 9,80 | nt - org |  |
| 2 | 0,20 | 9,80 .. 10,00 | SaP |  |
| 3 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load new | Load change | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|-------------|----------------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| 1 | Yes | | Load No. 1 | Design | 882,05 | 0,00 | 14,20 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 4,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 593,04 \text{ kN}$

Pile base bearing capacity $R_b = 289,01 \text{ kN}$

Pile bearing capacity $R_c = 882,05 \text{ kN}$

Ultimate vertical force $V_d = 882,05 \text{ kN}$

$$R_c = 882,05 \text{ kN} > 882,05 \text{ kN} = V_d$$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,94$

Correction factor for Poisson's ratio of soil $C_v = 0,80$

Correction factor for stiffness of bearing stratum $C_b = 3,02$

Base-load proportion for incompressible pile $\beta_0 = 0,08$

Proportion of applied load transferred to pile base $\beta = 0,18$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,10$

Correction factor for pile compressibility $R_k = 1,07$

Correction factor for finite depth of layer on a rigid base $R_h = 1,00$

Correction factor for Poisson's ratio of soil

$$R_v = 0,90$$

Analysis of load settlement curve - results

Load at the onset of mobilization of skin friction $R_{yu} = 799,74 \text{ kN}$

The settlement for the force R_{yu} $s_y = 5,1 \text{ mm}$

Total resistance $R_c = 970,26 \text{ kN}$

Maximum settlement $s_{lim} = 16,2 \text{ mm}$

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 21.2 Hangar za balirani otpad
Description : Model 13
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt - org

Unit weight : $\gamma = 10,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 10,00 \text{ kN/m}^3$
Cohesion of soil : $c_u = 20,00 \text{ kPa}$
Adhesion factor : $\alpha = 0,97$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 3,62 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20$ m

Length $l = 14,00$ m

Calculated cross-sectional characteristics

Area $A = 1,13E+00$ m²

Moment of inertia $I = 1,02E-01$ m⁴


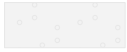
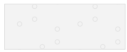
Location

Off ground height $h = -0,95$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|-------------------|---------------|---|
| 1 | 9,80 | 0,00 .. 9,80 | nt - org |  |
| 2 | 0,20 | 9,80 .. 10,00 | SaP |  |
| 3 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | new | Load change | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|-----|----------------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| 1 | Yes | | Load No. 1 | Design | 1804,69 | 0,00 | 14,20 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 4,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 1096,84$ kN

Pile base bearing capacity $R_b = 707,84$ kN

Pile bearing capacity $R_c = 1804,69$ kN

Ultimate vertical force $V_d = 1804,69$ kN

$R_c = 1804,69$ kN < $1804,69$ kN = V_d

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,95$

Correction factor for Poisson's ratio of soil $C_v = 0,79$

Correction factor for stiffness of bearing stratum $C_b = 2,45$

Base-load proportion for incompressible pile $\beta_0 = 0,10$

Proportion of applied load transferred to pile base $\beta = 0,18$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,13$

Correction factor for pile compressibility $R_k = 1,03$

Correction factor for finite depth of layer on a rigid base $R_h = 1,00$

Correction factor for Poisson's ratio of soil

$$R_v = 0,90$$

Analysis of load settlement curve - results

Load at the onset of mobilization of skin friction $R_{yu} = 1464,58 \text{ kN}$

The settlement for the force R_{yu} $s_y = 6,9 \text{ mm}$

Total resistance $R_c = 1985,16 \text{ kN}$

Maximum settlement $s_{lim} = 27,9 \text{ mm}$

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 27. Retenzija procedne vode
Description : Model 15
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

saSi

Unit weight : $\gamma = 18,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 3,35 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,00 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 23,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 4,61 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular




Dimensions

Diameter $d = 0,60 \text{ m}$
Length $l = 4,00 \text{ m}$

Calculated cross-sectional characteristicsArea $A = 2,83E-01 \text{ m}^2$ Moment of inertia $I = 6,36E-03 \text{ m}^4$ **Location**Off ground height $h = -0,95 \text{ m}$ Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------|---|
| 1 | 1,00 | 0,00 .. 1,00 | saSi |  |
| 2 | 9,00 | 1,00 .. 10,00 | SaP |  |
| 3 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-------------|----------------|------------|--------|-----------|-------------------------|-------------------------|------------------------|------------------------|
| 1 | Yes | | Load No. 1 | Design | 195,16 | 0,00 | 14,20 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 0,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1**Verification of bearing capacity : NAVFAC DM 7.2**

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 97,18 \text{ kN}$ Pile base bearing capacity $R_b = 97,98 \text{ kN}$ Pile bearing capacity $R_c = 195,16 \text{ kN}$ Ultimate vertical force $V_d = 195,16 \text{ kN}$ $R_c = 195,16 \text{ kN} > 195,16 \text{ kN} = V_d$ **Pile bearing capacity is SATISFACTORY****Verification No. 1****Analysis of load settlement curve - partial results**Correction factor for pile compressibility $C_k = 0,98$ Correction factor for Poisson's ratio of soil $C_v = 0,79$ Correction factor for stiffness of bearing stratum $C_b = 1,01$ Base-load proportion for incompressible pile $\beta_0 = 0,15$ Proportion of applied load transferred to pile base $\beta = 0,12$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,18$ Correction factor for pile compressibility $R_k = 1,00$ Correction factor for finite depth of layer on a rigid base $R_h = 1,00$ Correction factor for Poisson's ratio of soil $R_v = 0,89$

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 121,22 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 1,6 \text{ mm}$ |
| Total resistance | $R_c = 214,68 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 14,0 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 27. Retenzija procedne vode
Description : Model 15
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

saSi

Unit weight : $\gamma = 18,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 3,35 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,00 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 23,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 4,61 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular




Dimensions

Diameter $d = 0,80 \text{ m}$
Length $l = 4,00 \text{ m}$

Calculated cross-sectional characteristicsArea $A = 5,03E-01 \text{ m}^2$ Moment of inertia $I = 2,01E-02 \text{ m}^4$ **Location**Off ground height $h = -0,95 \text{ m}$ Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------|---|
| 1 | 1,00 | 0,00 .. 1,00 | saSi |  |
| 2 | 9,00 | 1,00 .. 10,00 | SaP |  |
| 3 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-------------|----------------|------------|--------|-----------|-------------------------|-------------------------|------------------------|------------------------|
| 1 | Yes | | Load No. 1 | Design | 303,76 | 0,00 | 14,20 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 0,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1**Verification of bearing capacity : NAVFAC DM 7.2**

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 129,57 \text{ kN}$ Pile base bearing capacity $R_b = 174,19 \text{ kN}$ Pile bearing capacity $R_c = 303,76 \text{ kN}$ Ultimate vertical force $V_d = 303,76 \text{ kN}$ $R_c = 303,76 \text{ kN} > 303,76 \text{ kN} = V_d$ **Pile bearing capacity is SATISFACTORY****Verification No. 1****Analysis of load settlement curve - partial results**Correction factor for pile compressibility $C_k = 0,98$ Correction factor for Poisson's ratio of soil $C_v = 0,79$ Correction factor for stiffness of bearing stratum $C_b = 1,00$ Base-load proportion for incompressible pile $\beta_0 = 0,18$ Proportion of applied load transferred to pile base $\beta = 0,14$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,20$ Correction factor for pile compressibility $R_k = 1,01$ Correction factor for finite depth of layer on a rigid base $R_h = 1,00$ Correction factor for Poisson's ratio of soil $R_v = 0,89$

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 165,62 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 1,7 \text{ mm}$ |
| Total resistance | $R_c = 334,14 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 15,4 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 27. Retenzija procedne vode
Description : Model 15
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

saSi

Unit weight : $\gamma = 18,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,30$
Oedometric modulus : $E_{oed} = 3,35 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,00 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 23,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 4,61 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular




Dimensions

Diameter $d = 1,20 \text{ m}$
Length $l = 4,00 \text{ m}$

Calculated cross-sectional characteristicsArea $A = 1,13E+00 \text{ m}^2$ Moment of inertia $I = 1,02E-01 \text{ m}^4$ **Location**Off ground height $h = -0,95 \text{ m}$ Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-----------------------------|----------------|---------------|---|
| 1 | 1,00 | 0,00 .. 1,00 | saSi |  |
| 2 | 9,00 | 1,00 .. 10,00 | SaP |  |
| 3 | - | 10,00 .. ∞ | SaP |  |

Load

| No. | Load new | Load change | Name | Type | N [kN] | M _x [kNm] | M _y [kNm] | H _x [kN] | H _y [kN] |
|-----|-------------|----------------|------------|--------|-----------|-------------------------|-------------------------|------------------------|------------------------|
| 1 | Yes | | Load No. 1 | Design | 586,29 | 0,00 | 14,20 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 0,80 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1**Verification of bearing capacity : NAVFAC DM 7.2**

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 194,36 \text{ kN}$ Pile base bearing capacity $R_b = 391,93 \text{ kN}$ Pile bearing capacity $R_c = 586,29 \text{ kN}$ Ultimate vertical force $V_d = 586,29 \text{ kN}$ $R_c = 586,29 \text{ kN} > 586,29 \text{ kN} = V_d$ **Pile bearing capacity is SATISFACTORY****Verification No. 1****Analysis of load settlement curve - partial results**Correction factor for pile compressibility $C_k = 0,98$ Correction factor for Poisson's ratio of soil $C_v = 0,79$ Correction factor for stiffness of bearing stratum $C_b = 1,00$ Base-load proportion for incompressible pile $\beta_0 = 0,45$ Proportion of applied load transferred to pile base $\beta = 0,35$

Influence coefficients of settlement :

Basic - dependent on ratio l/d $I_0 = 0,26$ Correction factor for pile compressibility $R_k = 1,01$ Correction factor for finite depth of layer on a rigid base $R_h = 1,00$ Correction factor for Poisson's ratio of soil $R_v = 0,89$

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 329,31 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 2,5 \text{ mm}$ |
| Total resistance | $R_c = 644,92 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 12,1 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 15a. Digestor
Description : Model
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt

Unit weight : $\gamma = 18,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,00 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIL

Unit weight : $\gamma = 17,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,60 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 17,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 2,94 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,60$ m

Length $l = 9,00$ m

Calculated cross-sectional characteristics

Area $A = 2,83E-01$ m²

Moment of inertia $I = 6,36E-03$ m⁴


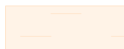


Location

Off ground height $h = -0,40$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|------------------|---------------|---|
| 1 | 6,20 | 0,00 .. 6,20 | nt |  |
| 2 | 1,30 | 6,20 .. 7,50 | CIL |  |
| 3 | 4,50 | 7,50 .. 12,00 | SaP |  |
| 4 | - | 12,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 510,24 | 0,00 | 14,20 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 9,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 252,89$ kN

Pile base bearing capacity $R_b = 257,35$ kN

Pile bearing capacity $R_c = 510,24$ kN

Ultimate vertical force $V_d = 510,24$ kN

$$R_c = 510,24 \text{ kN} > 510,24 \text{ kN} = V_d$$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,95$

Correction factor for Poisson's ratio of soil $C_v = 0,85$

Correction factor for stiffness of bearing stratum $C_b = 3,68$

| | |
|---|------------------|
| Base-load proportion for incompressible pile | $\beta_0 = 0,09$ |
| Proportion of applied load transferred to pile base | $\beta = 0,25$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,10$ |
| Correction factor for pile compressibility | $R_k = 1,04$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,94$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 372,05 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 3,9 \text{ mm}$ |
| Total resistance | $R_c = 561,26 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 15,9 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 15a. Digestor
Description : Model
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt

Unit weight : $\gamma = 18,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,00 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIL

Unit weight : $\gamma = 17,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,60 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 17,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 2,94 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 0,80 \text{ m}$

Length $l = 9,00 \text{ m}$

Calculated cross-sectional characteristics

Area $A = 5,03\text{E-}01 \text{ m}^2$

Moment of inertia $I = 2,01\text{E-}02 \text{ m}^4$


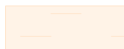


Location

Off ground height $h = -0,40 \text{ m}$

Depth of finished grade $h_z = 0,00 \text{ m}$

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer $t \text{ [m]}$ | Depth $z \text{ [m]}$ | Assigned soil | Pattern |
|-----|---------------------------------------|--------------------------|---------------|---|
| 1 | 6,20 | 0,00 .. 6,20 | nt |  |
| 2 | 1,30 | 6,20 .. 7,50 | CIL |  |
| 3 | 4,50 | 7,50 .. 12,00 | SaP |  |
| 4 | - | 12,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 848,72 | 0,00 | 14,20 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 12,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 391,21 \text{ kN}$

Pile base bearing capacity $R_b = 457,51 \text{ kN}$

Pile bearing capacity $R_c = 848,72 \text{ kN}$

Ultimate vertical force $V_d = 848,72 \text{ kN}$

$$R_c = 848,72 \text{ kN} < 848,72 \text{ kN} = V_d$$

Pile bearing capacity is NOT SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,96$

Correction factor for Poisson's ratio of soil $C_v = 0,85$

Correction factor for stiffness of bearing stratum $C_b = 3,18$

| | |
|---|------------------|
| Base-load proportion for incompressible pile | $\beta_0 = 0,10$ |
| Proportion of applied load transferred to pile base | $\beta = 0,25$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $I_0 = 0,14$ |
| Correction factor for pile compressibility | $R_k = 1,01$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,94$ |

Analysis of load settlement curve - results

| | |
|--|------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 572,74 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 5,3 \text{ mm}$ |
| Total resistance | $R_c = 933,59 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 24,2 \text{ mm}$ |

Pile verification

Input data

Project

Task : Gradska deponija u novom Sadu
Part : 15a. Digestor
Description : Model
Customer : Safege doo
Author : Milić Jelena, dipl. inž. geol.
Date : 17.10.2022.
Project ID : GEL-001-419.1-22

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : $\gamma_{M0} = 1,00$
Timber structures : EN 1995-1-1 (EC5)
Partial factor for timber property : $\gamma_M = 1,30$
Modif. factor of load duration and moisture content : $k_{mod} = 0,50$
Coeff. of effective width for shear stress : $k_{cr} = 0,67$

Pile

Analysis for drained conditions : NAVFAC DM 7.2
Load settlement curve : linear (Poulos)
Horizontal bearing capacity : Elastic subsoil (p-y method)
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

| Partial factors on actions (A) | | | |
|--------------------------------|--------------|--------------|------------|
| Permanent design situation | | | |
| | | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1,35 [-] | 1,00 [-] |

| Partial factors for resistances (R) | | | |
|---|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on shaft resistance : | $\gamma_s =$ | 1,10 [-] | |
| Partial factor on base resistance : | $\gamma_b =$ | 1,10 [-] | |
| Partial factor on resistance in tension : | $\gamma_{st} =$ | 1,15 [-] | |

Soil parameters

nt

Unit weight : $\gamma = 18,00 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,20 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 18,00 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 17,00^\circ$

CIL

Unit weight : $\gamma = 17,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,40$
Oedometric modulus : $E_{oed} = 1,60 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 17,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 7,00^\circ$

SaP

Unit weight : $\gamma = 15,60 \text{ kN/m}^3$
Poisson's ratio : $\nu = 0,25$
Oedometric modulus : $E_{oed} = 2,94 \text{ MPa}$
Saturated unit weight : $\gamma_{sat} = 15,60 \text{ kN/m}^3$
Angle of internal friction : $\varphi_{ef} = 30,00^\circ$

Geometry

Pile profile: circular

Dimensions

Diameter $d = 1,20$ m

Length $l = 10,00$ m

Calculated cross-sectional characteristics

Area $A = 1,13E+00$ m²

Moment of inertia $I = 1,02E-01$ m⁴


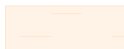


Location

Off ground height $h = -0,40$ m

Depth of finished grade $h_z = 0,00$ m

Technology: Bored piles

Geological profile and assigned soils

| No. | Thickness of layer t [m] | Depth z [m] | Assigned soil | Pattern |
|-----|-------------------------------|-------------------|---------------|---|
| 1 | 6,20 | 0,00 .. 6,20 | nt |  |
| 2 | 1,30 | 6,20 .. 7,50 | CIL |  |
| 3 | 4,50 | 7,50 .. 12,00 | SaP |  |
| 4 | - | 12,00 .. ∞ | SaP |  |

Load

| No. | Load | | Name | Type | N [kN] | M_x [kNm] | M_y [kNm] | H_x [kN] | H_y [kN] |
|-----|------|--------|------------|--------|-----------|----------------|----------------|---------------|---------------|
| | new | change | | | | | | | |
| 1 | Yes | | Load No. 1 | Design | 1860,47 | 0,00 | 14,20 | 50,00 | 2,95 |

Ground water table

The ground water table is at a depth of 3,00 m from the original terrain.

Global settings

Analysis of vertical bearing capacity : analytical solution

Analysis type : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification methodology : without reduction of soil parameters

Verification No. 1

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out for the load case number1. (Load No. 1)

Factor determining critical depth $k_{dc} = 18,00$

Verification of compressive pile:

Pile skin bearing capacity $R_s = 773,50$ kN

Pile base bearing capacity $R_b = 1086,97$ kN

Pile bearing capacity $R_c = 1860,47$ kN

Ultimate vertical force $V_d = 1860,47$ kN

$$R_c = 1860,47 \text{ kN} > 1860,47 \text{ kN} = V_d$$

Pile bearing capacity is SATISFACTORY

Verification No. 1

Analysis of load settlement curve - partial results

Correction factor for pile compressibility $C_k = 0,96$

Correction factor for Poisson's ratio of soil $C_v = 0,84$

Correction factor for stiffness of bearing stratum $C_b = 2,41$

| | |
|---|------------------|
| Base-load proportion for incompressible pile | $\beta_0 = 0,13$ |
| Proportion of applied load transferred to pile base | $\beta = 0,25$ |

Influence coefficients of settlement :

| | |
|---|--------------|
| Basic - dependent on ratio l/d | $l_0 = 0,17$ |
| Correction factor for pile compressibility | $R_k = 1,02$ |
| Correction factor for finite depth of layer on a rigid base | $R_h = 1,00$ |
| Correction factor for Poisson's ratio of soil | $R_v = 0,93$ |

Analysis of load settlement curve - results

| | |
|--|-------------------------------|
| Load at the onset of mobilization of skin friction | $R_{yu} = 1130,20 \text{ kN}$ |
| The settlement for the force R_{yu} | $s_y = 6,2 \text{ mm}$ |
| Total resistance | $R_c = 2046,52 \text{ kN}$ |
| Maximum settlement | $s_{lim} = 33,0 \text{ mm}$ |

Slope stability analysis

Input data

Project

Task : Gradska deponija u Novom Sadu
 Part : ANALIZA STABILNOSTI KOSINA KASETA I DEPONOVANOG OTPADA
 Description : Deponija seizmika
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 18.10.2022.
 Project ID : GEL-001-419.1-22
 Project number : 1.8.4.50

Settings

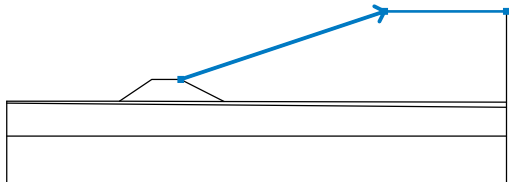
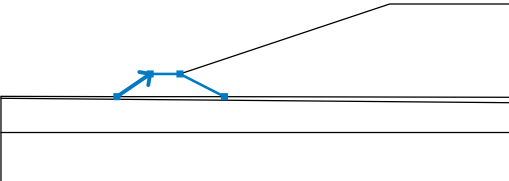
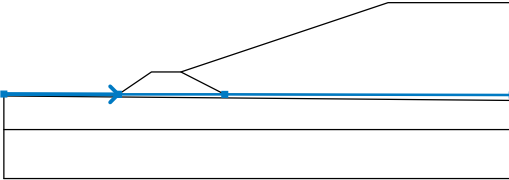
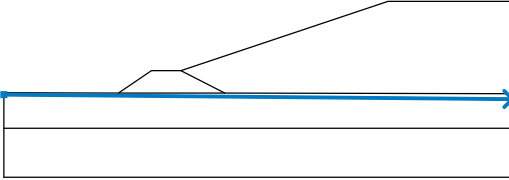
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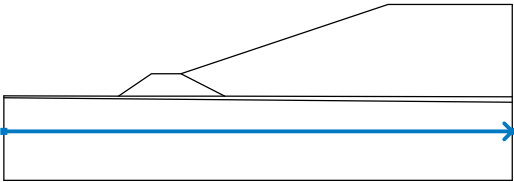
Stability analysis

Earthquake analysis : Standard
 Verification methodology : Safety factors (ASD)

| Safety factors | | |
|--------------------------|----------|----------|
| Seismic design situation | | |
| Safety factor : | $SF_s =$ | 1.10 [-] |

Interface

| No. | Interface location | Coordinates of interface points [m] | | | | | |
|-----|---|-------------------------------------|-------|--------|-------|--------|-------|
| | | x | z | x | z | x | z |
| 1 |  | 36.20 | 11.80 | 78.60 | 26.00 | 104.00 | 26.00 |
| | | | | | | | |
| 2 |  | 23.43 | 7.23 | 30.20 | 11.80 | 36.20 | 11.80 |
| | | 45.20 | 7.20 | | | | |
| 3 |  | 0.00 | 7.28 | 23.40 | 7.23 | 23.43 | 7.23 |
| | | 45.20 | 7.20 | 104.00 | 7.08 | | |
| 4 |  | 0.00 | 6.88 | 104.00 | 5.99 | | |
| | | | | | | | |

| No. | Interface location | Coordinates of interface points [m] | | | | | |
|-----|---|-------------------------------------|------|--------|------|---|---|
| | | x | z | x | z | x | z |
| 5 |  | 0.00 | 0.00 | 104.00 | 0.00 | | |

Soil parameters**OTPAD-Silt with low or medium plasticity (ML, MI), soft consistency**

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 20.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

KASETA-Sand with trace of fines (S-F), dense

Unit weight : $\gamma = 16.10 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 31.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 16.10 \text{ kN/m}^3$

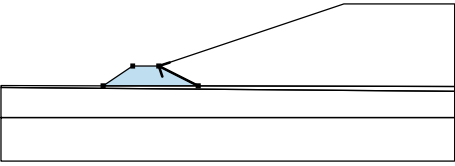
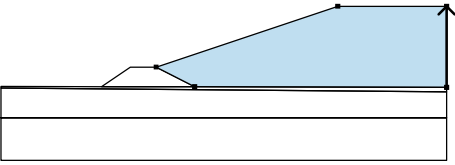
Sandy silt (MS), soft consistency

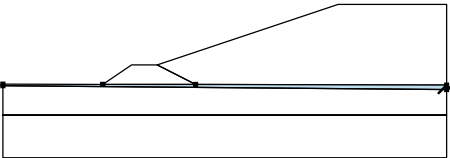

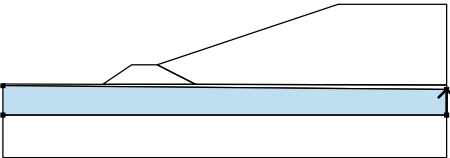
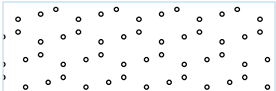
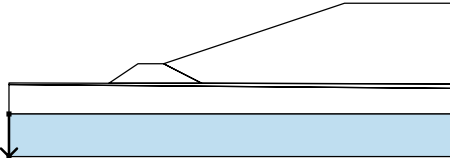
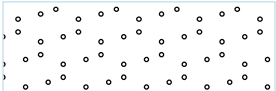
Unit weight : $\gamma = 14.30 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 20.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 10.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 14.30 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 34.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

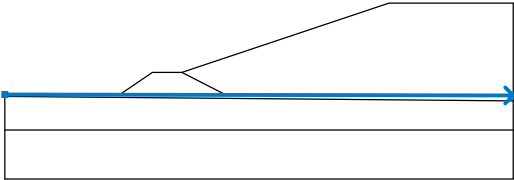
Assigning and surfaces

| No. | Surface position | Coordinates of surface points [m] | | | | Assigned soil |
|-----|---|-----------------------------------|-------|--------|-------|---|
| | | x | z | x | z | |
| 1 |  | 45.20 | 7.20 | 36.20 | 11.80 | KASETA-Sand with trace of fines (S-F), dense |
| | | 30.20 | 11.80 | 23.43 | 7.23 | |
| 2 |  | 104.00 | 7.08 | 104.00 | 26.00 | OTPAD-Silt with low or medium plasticity (ML, MI), soft consistency |
| | | 78.60 | 26.00 | 36.20 | 11.80 | |
| | | 45.20 | 7.20 | | | |

| No. | Surface position | Coordinates of surface points [m] | | | | Assigned soil |
|-----|---|-----------------------------------|--------|--------|--------|--|
| | | x | z | x | z | |
| 3 |  | 104.00 | 5.99 | 104.00 | 7.08 | Sandy silt (MS), soft consistency  |
| | | 45.20 | 7.20 | 23.43 | 7.23 | |
| | | 23.40 | 7.23 | 0.00 | 7.28 | |
| | | 0.00 | 6.88 | | | |
| 4 |  | 104.00 | 0.00 | 104.00 | 5.99 | Poorly graded sand (SP), medium dense  |
| | | 0.00 | 6.88 | 0.00 | 0.00 | |
| 5 |  | 0.00 | 0.00 | 0.00 | -10.00 | Poorly graded sand (SP), medium dense  |
| | | 104.00 | -10.00 | 104.00 | 0.00 | |

Water

Water type : GWT

| No. | GWT location | Coordinates of GWT points [m] | | | | | |
|-----|---|-------------------------------|------|--------|------|---|---|
| | | x | z | x | z | x | z |
| 1 |  | 0.00 | 7.28 | 104.00 | 7.07 | | |
| | | | | | | | |

Earthquake

Horizontal seismic coefficient : $K_h = 0.0900$

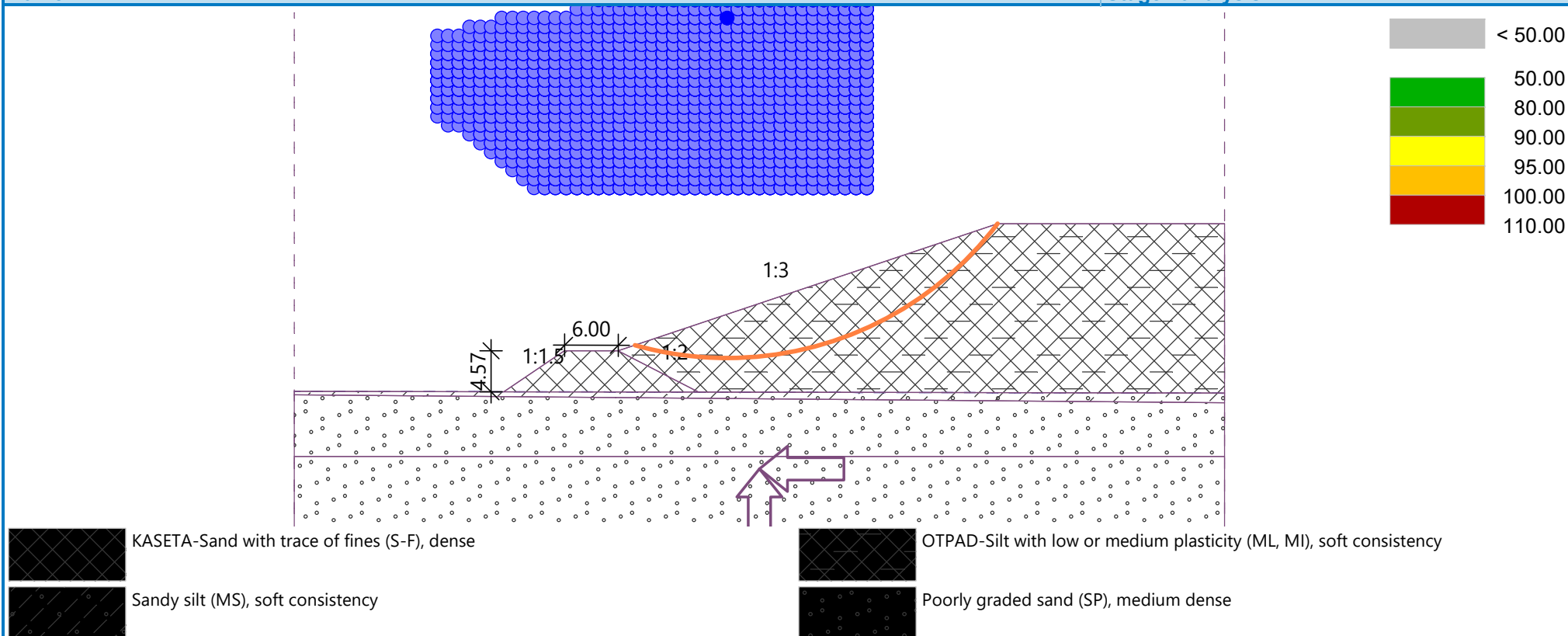
Vertical seismic coefficient : $K_v = 0.0690$

Settings of the stage of construction

Design situation : seismic

Name :

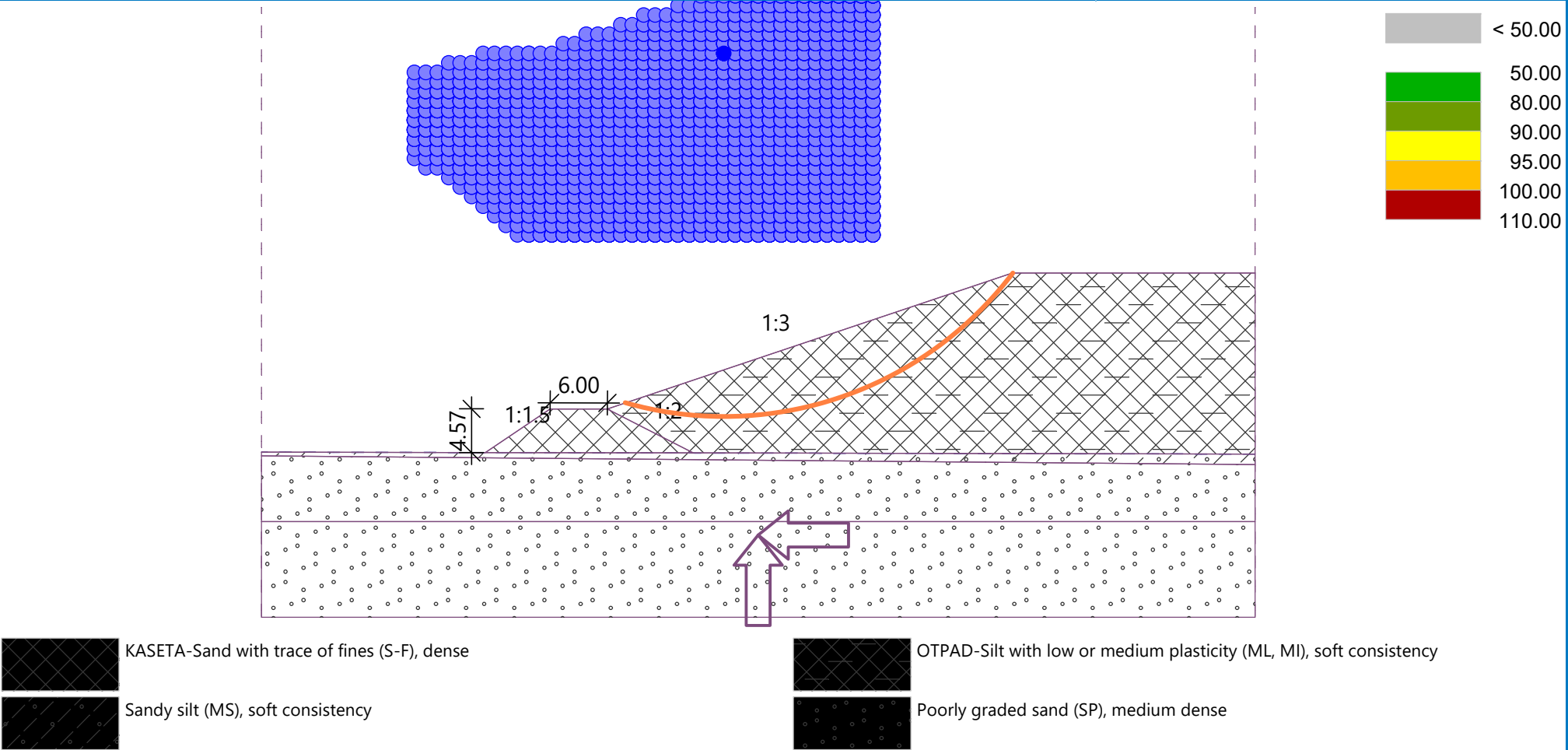
Stage - analysis : 1 - 1



Slip surface after grid search.

Slope stability verification (Bishop)Sum of active forces : $F_a = 1174.88$ kN/mSum of passive forces : $F_p = 1358.46$ kN/mSliding moment : $M_a = 44645.44$ kNm/mResisting moment : $M_p = 51621.44$ kNm/mFactor of safety = $1.16 > 1.10$ **Slope stability ACCEPTABLE**

Name : Stage - analysis : 1 - 1



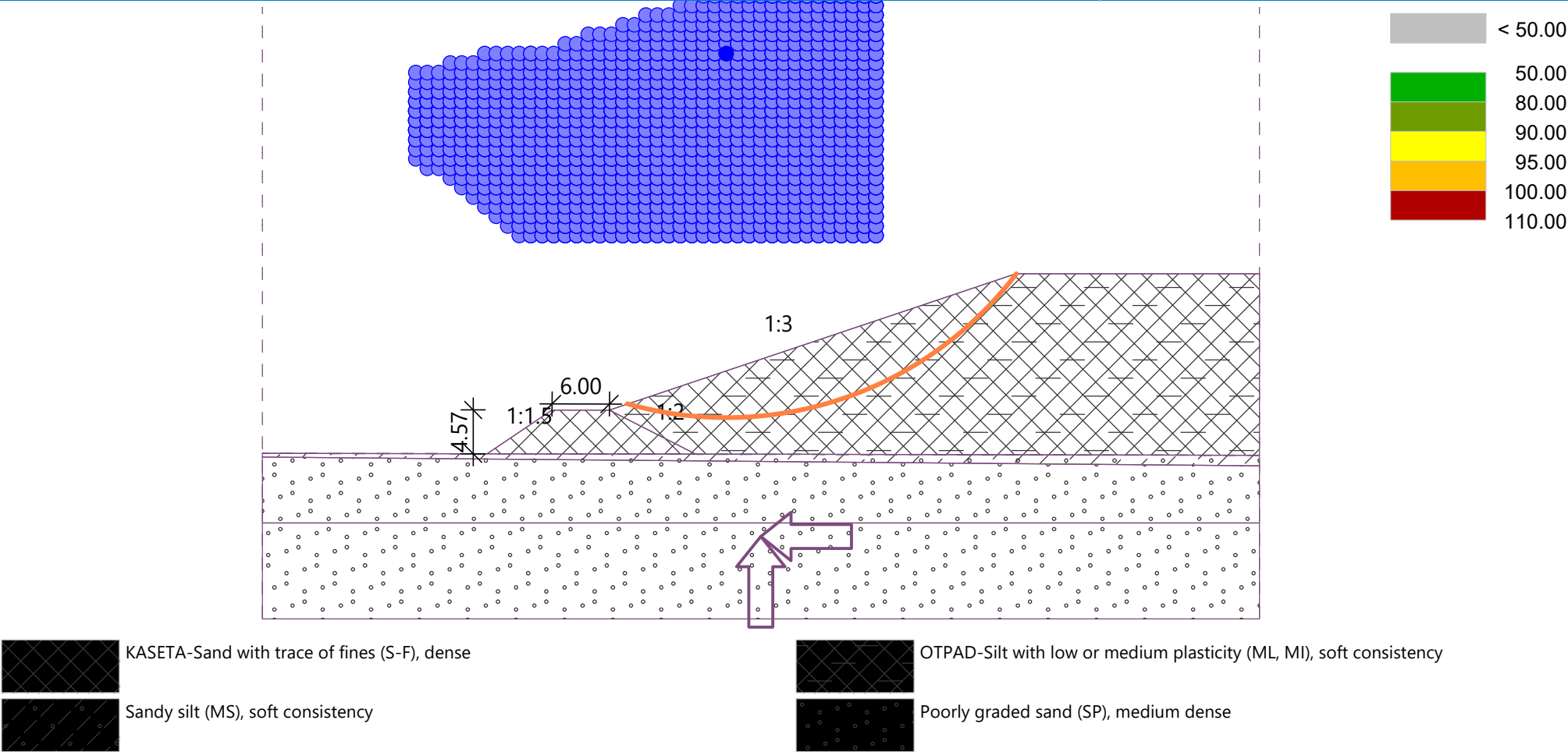
Slip surface after grid search.

Slope stability verification (Spencer)

Factor of safety = 1.16 > 1.10

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



Slip surface after grid search.

Slope stability verification (Morgenstern-Price)

Factor of safety = 1.16 > 1.10

Slope stability ACCEPTABLE

Slope stability analysis

Input data

Project

Task : Gradska deponija u Novom Sadu
 Part : ANALIZA STABILNOSTI KOSINA KASETA I DEPONOVANOG OTPADA
 Description : Spoljšnji nasip kasete deponije
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 18.10.2022.
 Project ID : GEL-001-419.1-22
 Project number :

Settings

(input for current task)

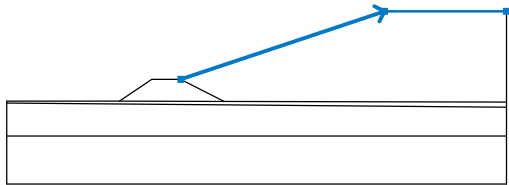
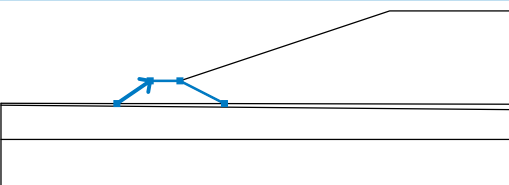
Stability analysis

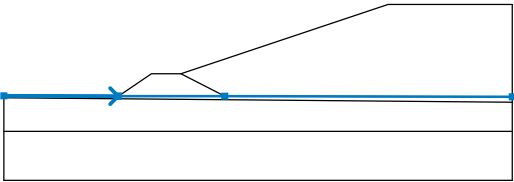
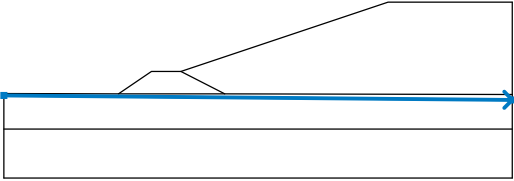
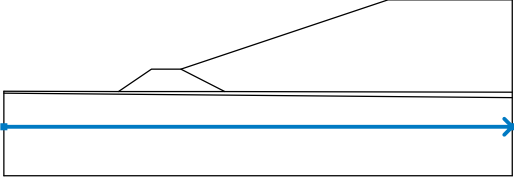
Earthquake analysis : Standard
 Verification methodology : according to EN 1997
 Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

| Partial factors on actions (A) | | | | | |
|--------------------------------|--------------|--------------|------------|--------------|------------|
| Permanent design situation | | | | | |
| | | State STR | | State GEO | |
| | | Unfavourable | Favourable | Unfavourable | Favourable |
| Permanent actions : | $\gamma_G =$ | 1.35 [-] | 1.00 [-] | 1.00 [-] | 1.00 [-] |
| Variable actions : | $\gamma_Q =$ | 1.50 [-] | 0.00 [-] | 1.30 [-] | 0.00 [-] |
| Water load : | $\gamma_w =$ | | | 1.00 [-] | |

| Partial factors for soil parameters (M) | | | |
|--|-----------------|----------|--|
| Permanent design situation | | | |
| Partial factor on internal friction : | $\gamma_\phi =$ | 1.25 [-] | |
| Partial factor on effective cohesion : | $\gamma_c =$ | 1.25 [-] | |
| Partial factor on undrained shear strength : | $\gamma_{cu} =$ | 1.40 [-] | |

Interface

| No. | Interface location | Coordinates of interface points [m] | | | | | |
|-----|---|-------------------------------------|-------|-------|-------|--------|-------|
| | | x | z | x | z | x | z |
| 1 |  | 36.20 | 11.80 | 78.60 | 26.00 | 104.00 | 26.00 |
| 2 |  | 23.43 | 7.23 | 30.20 | 11.80 | 36.20 | 11.80 |
| | | 45.20 | 7.20 | | | | |

| No. | Interface location | Coordinates of interface points [m] | | | | | |
|-----|---|-------------------------------------|------|--------|------|-------|------|
| | | x | z | x | z | x | z |
| 3 |  | 0.00 | 7.28 | 23.40 | 7.23 | 23.43 | 7.23 |
| | | 45.20 | 7.20 | 104.00 | 7.08 | | |
| 4 |  | 0.00 | 6.88 | 104.00 | 5.99 | | |
| | | | | | | | |
| 5 |  | 0.00 | 0.00 | 104.00 | 0.00 | | |
| | | | | | | | |

Soil parameters**OTPAD-Silt with low or medium plasticity (ML, MI), soft consistency**

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 19.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

KASETA-Sand with trace of fines (S-F), dense

Unit weight : $\gamma = 16.10 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 31.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 16.10 \text{ kN/m}^3$

Sandy silt (MS), soft consistency

Unit weight : $\gamma = 14.30 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 20.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 10.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 14.30 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 34.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

Assigning and surfaces

| No. | Surface position | Coordinates of surface points [m] | | | | Assigned soil |
|-----|------------------|-----------------------------------|--------|--------|--------|---|
| | | x | z | x | z | |
| 1 | | 45.20 | 7.20 | 36.20 | 11.80 | KASETA-Sand with trace of fines (S-F), dense |
| | | 30.20 | 11.80 | 23.43 | 7.23 | |
| 2 | | 104.00 | 7.08 | 104.00 | 26.00 | OTPAD-Silt with low or medium plasticity (ML, MI), soft consistency |
| | | 78.60 | 26.00 | 36.20 | 11.80 | |
| | | 45.20 | 7.20 | | | |
| 3 | | 104.00 | 5.99 | 104.00 | 7.08 | Sandy silt (MS), soft consistency |
| | | 45.20 | 7.20 | 23.43 | 7.23 | |
| | | 23.40 | 7.23 | 0.00 | 7.28 | |
| | | 0.00 | 6.88 | | | |
| 4 | | 104.00 | 0.00 | 104.00 | 5.99 | Poorly graded sand (SP), medium dense |
| | | 0.00 | 6.88 | 0.00 | 0.00 | |
| 5 | | 0.00 | 0.00 | 0.00 | -10.00 | Poorly graded sand (SP), medium dense |
| | | 104.00 | -10.00 | 104.00 | 0.00 | |

Water

Water type : GWT

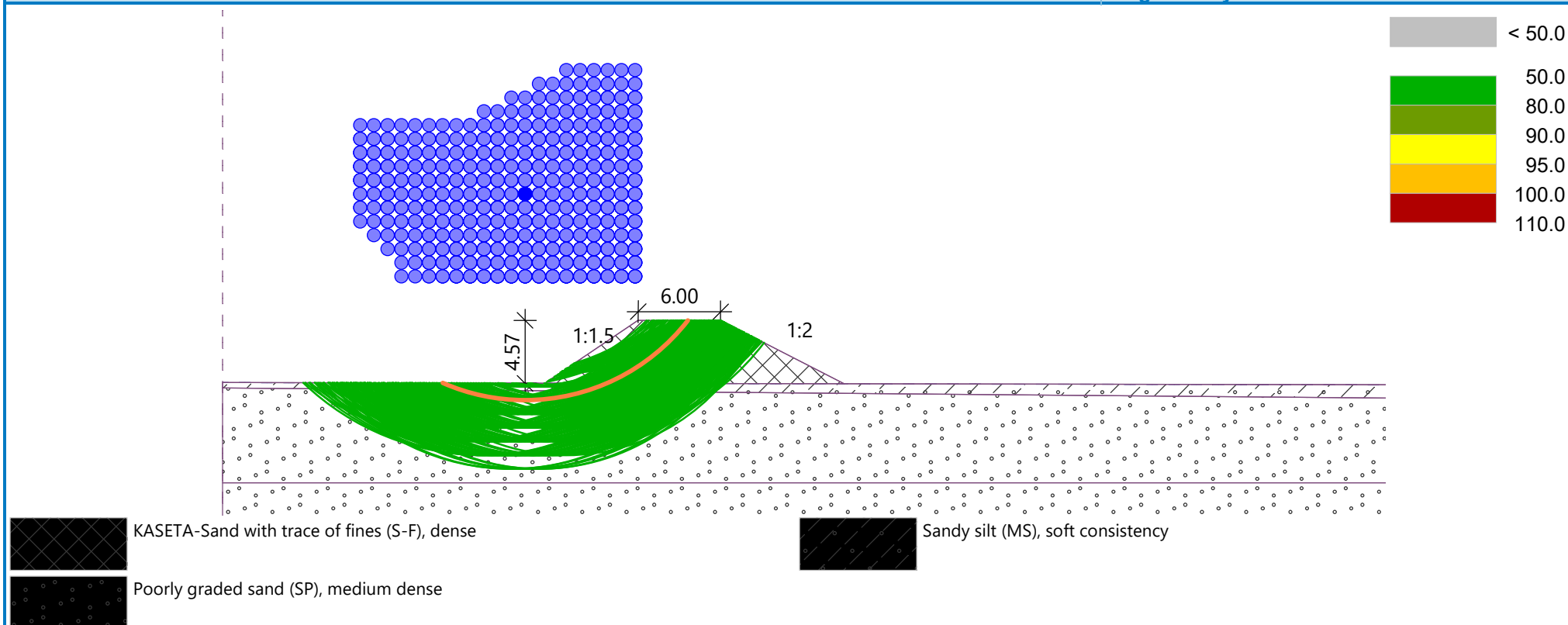
| No. | GWT location | Coordinates of GWT points [m] | | | | | |
|-----|--------------|-------------------------------|------|--------|------|---|---|
| | | x | z | x | z | x | z |
| 1 | | 0.00 | 7.28 | 104.00 | 7.07 | | |
| | | | | | | | |

Settings of the stage of construction

Design situation : permanent

Name :

Stage - analysis : 1 - 1



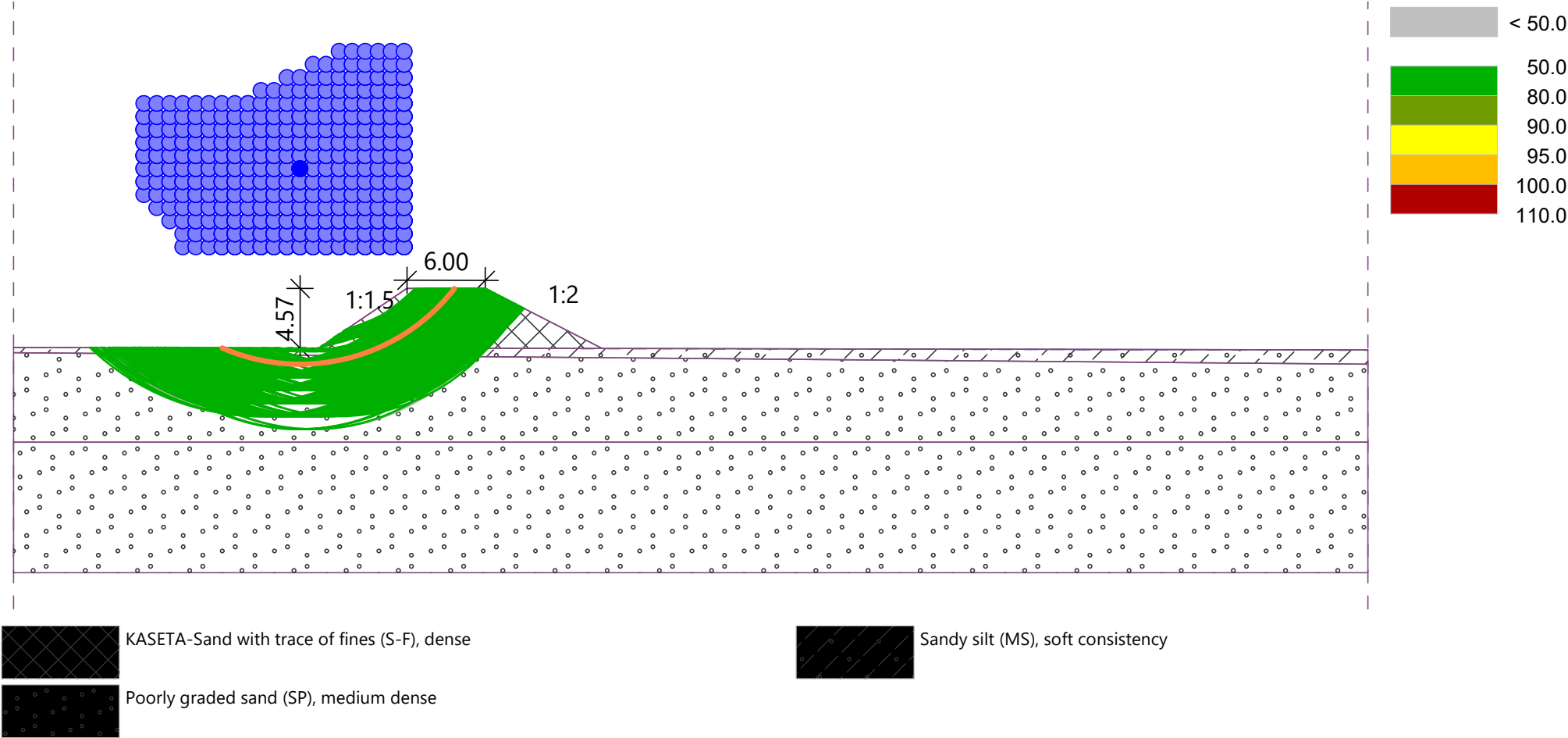
Slip surface after grid search.

Slope stability verification (Bishop)Sum of active forces : $F_a = 156.97$ kN/mSum of passive forces : $F_p = 225.24$ kN/mSliding moment : $M_a = 2354.62$ kNm/mResisting moment : $M_p = 3378.61$ kNm/m

Utilization : 69.7 %

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



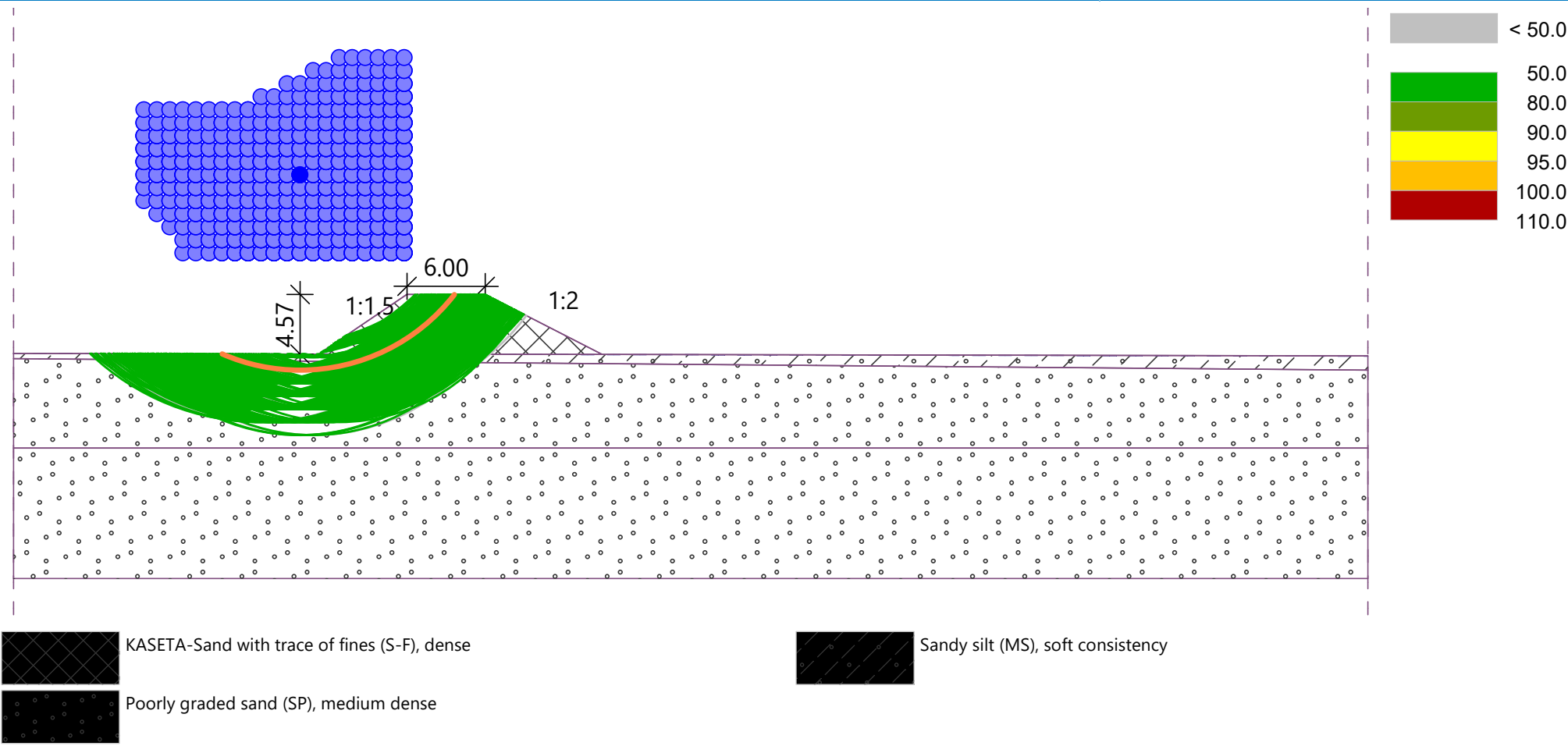
Slip surface after grid search.

Slope stability verification (Spencer)

Utilization : 69.7 %

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



Slip surface after grid search.

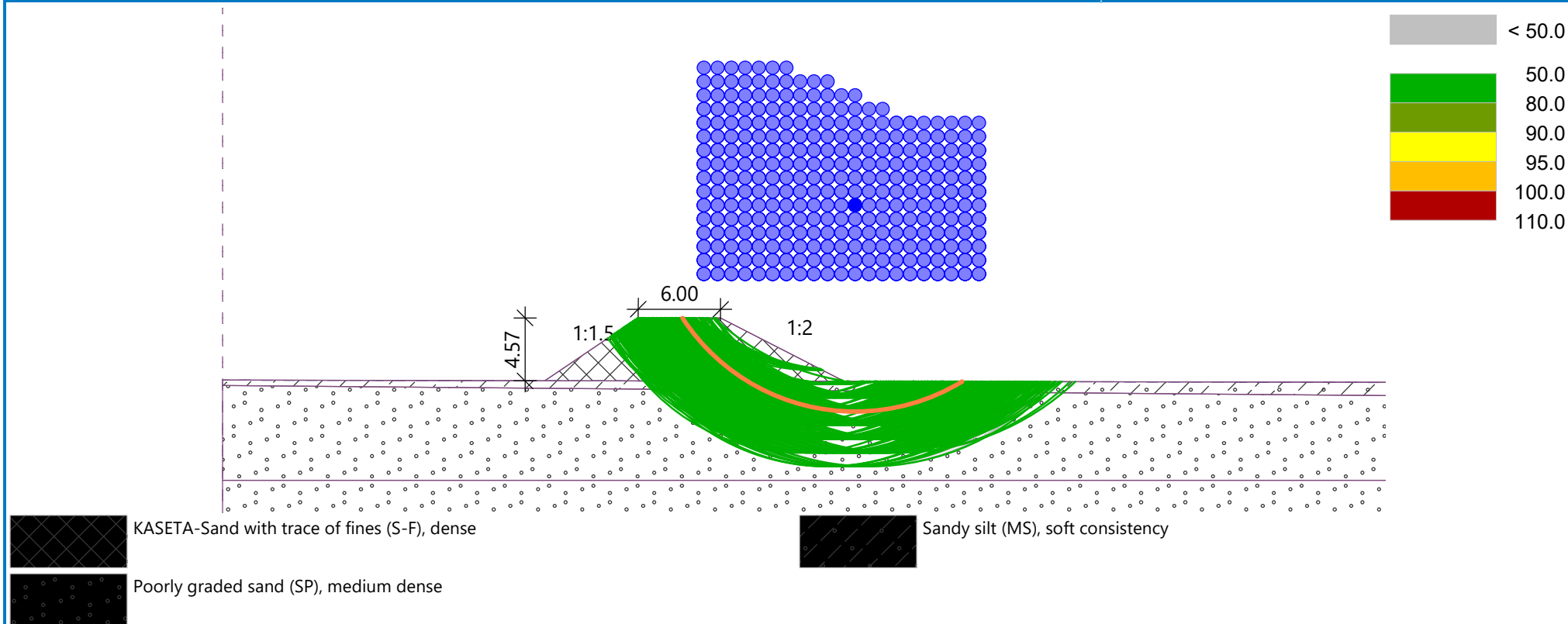
Slope stability verification (Morgenstern-Price)

Utilization : 69.2 %

Slope stability ACCEPTABLE

Name :

Stage - analysis : 1 - 1



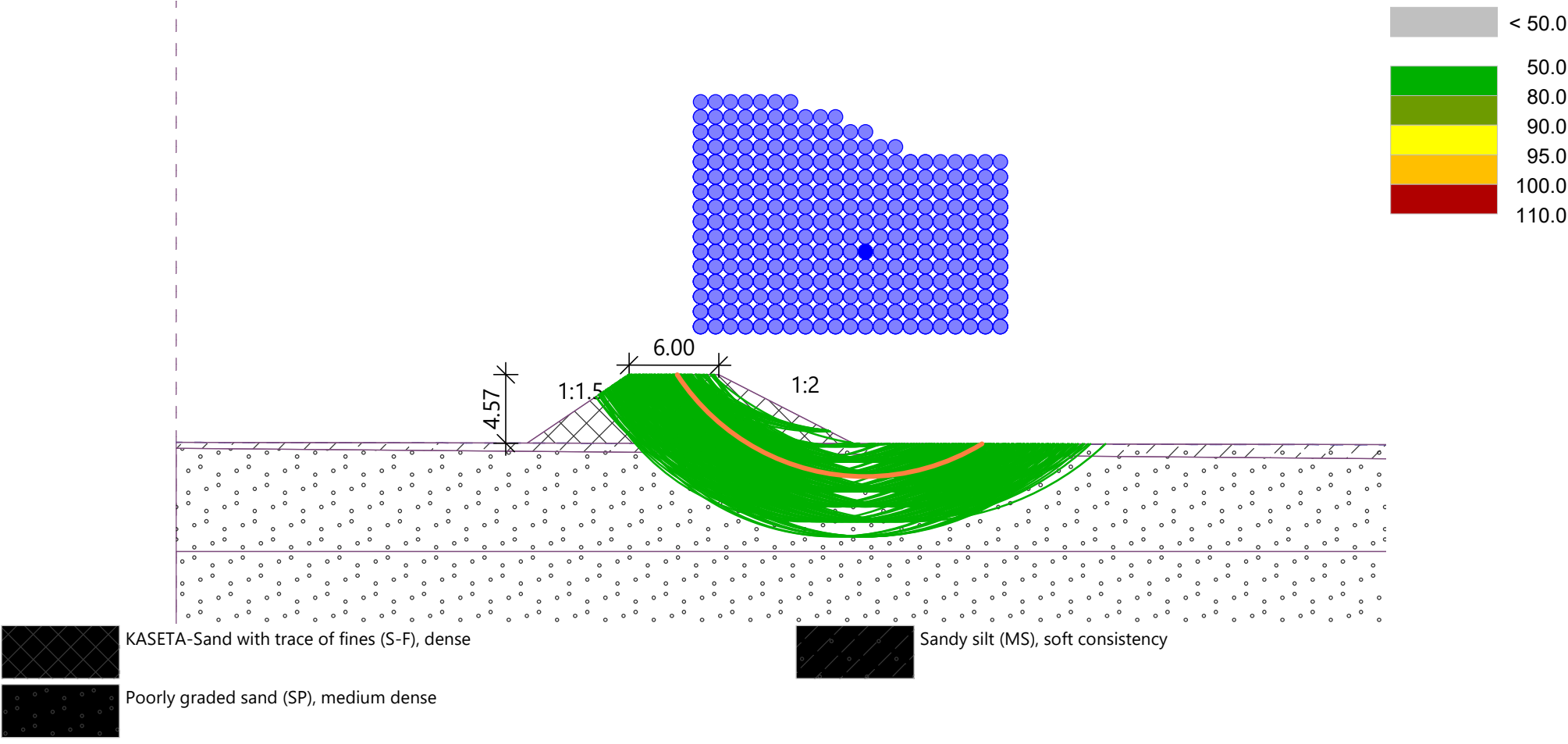
Slip surface after grid search.

Slope stability verification (Bishop)Sum of active forces : $F_a = 192.46$ kN/mSum of passive forces : $F_p = 290.83$ kN/mSliding moment : $M_a = 2886.88$ kNm/mResisting moment : $M_p = 4362.52$ kNm/m

Utilization : 66.2 %

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



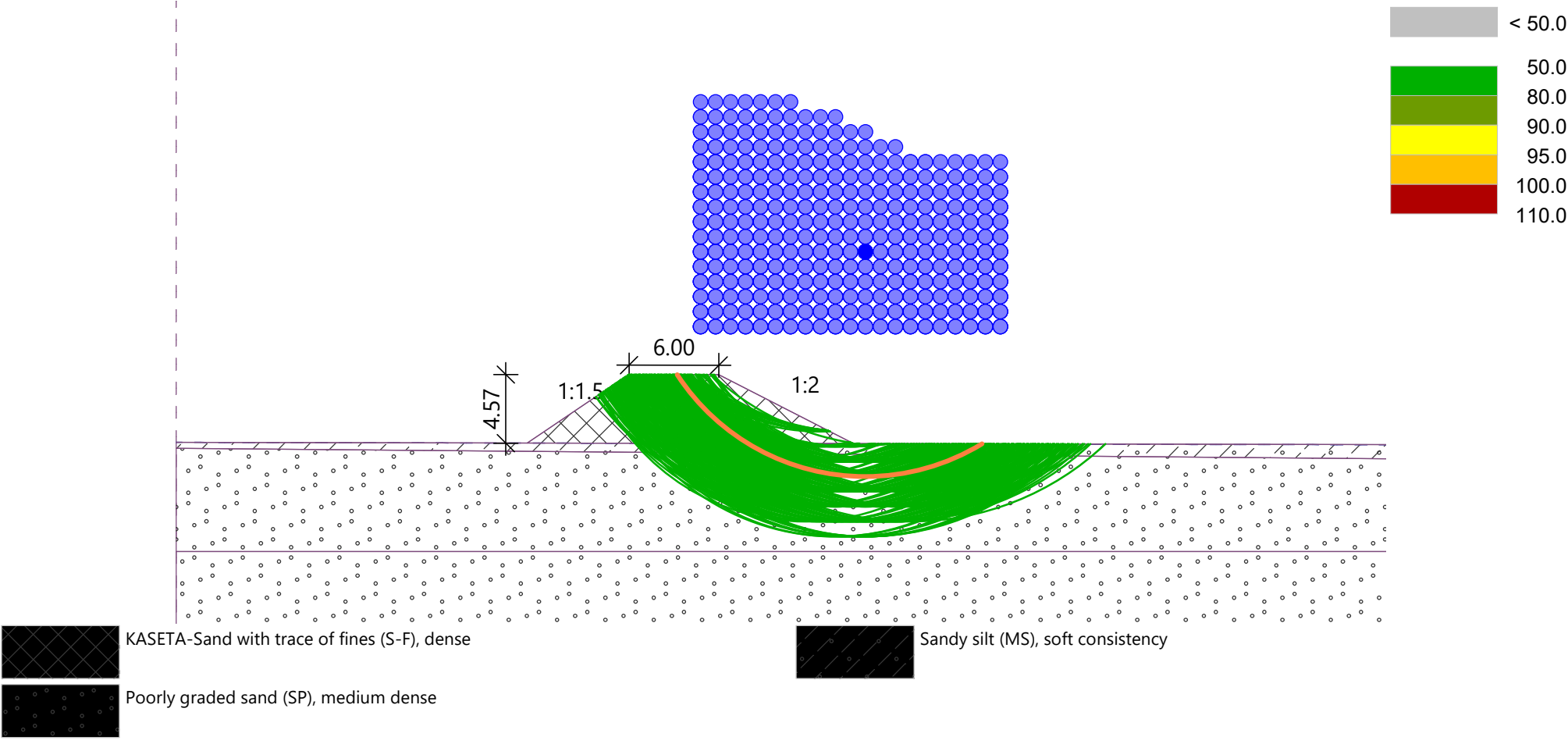
Slip surface after grid search.

Slope stability verification (Spencer)

Utilization : 65.9 %

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



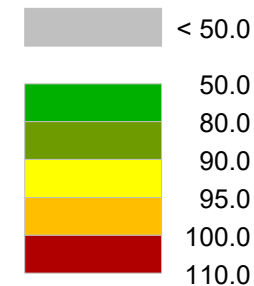
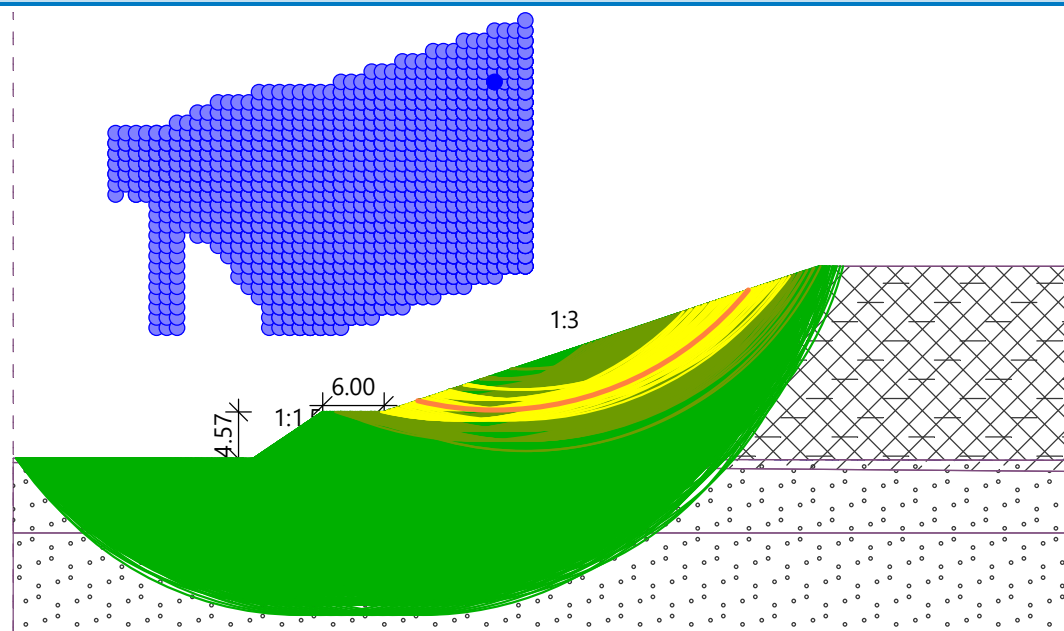
Slip surface after grid search.

Slope stability verification (Morgenstern-Price)

Utilization : 65.5 %

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



KASETA-Sand with trace of fines (S-F), dense



OTPAD-Silt with low or medium plasticity (ML, MI), soft consistency



Sandy silt (MS), soft consistency



Poorly graded sand (SP), medium dense

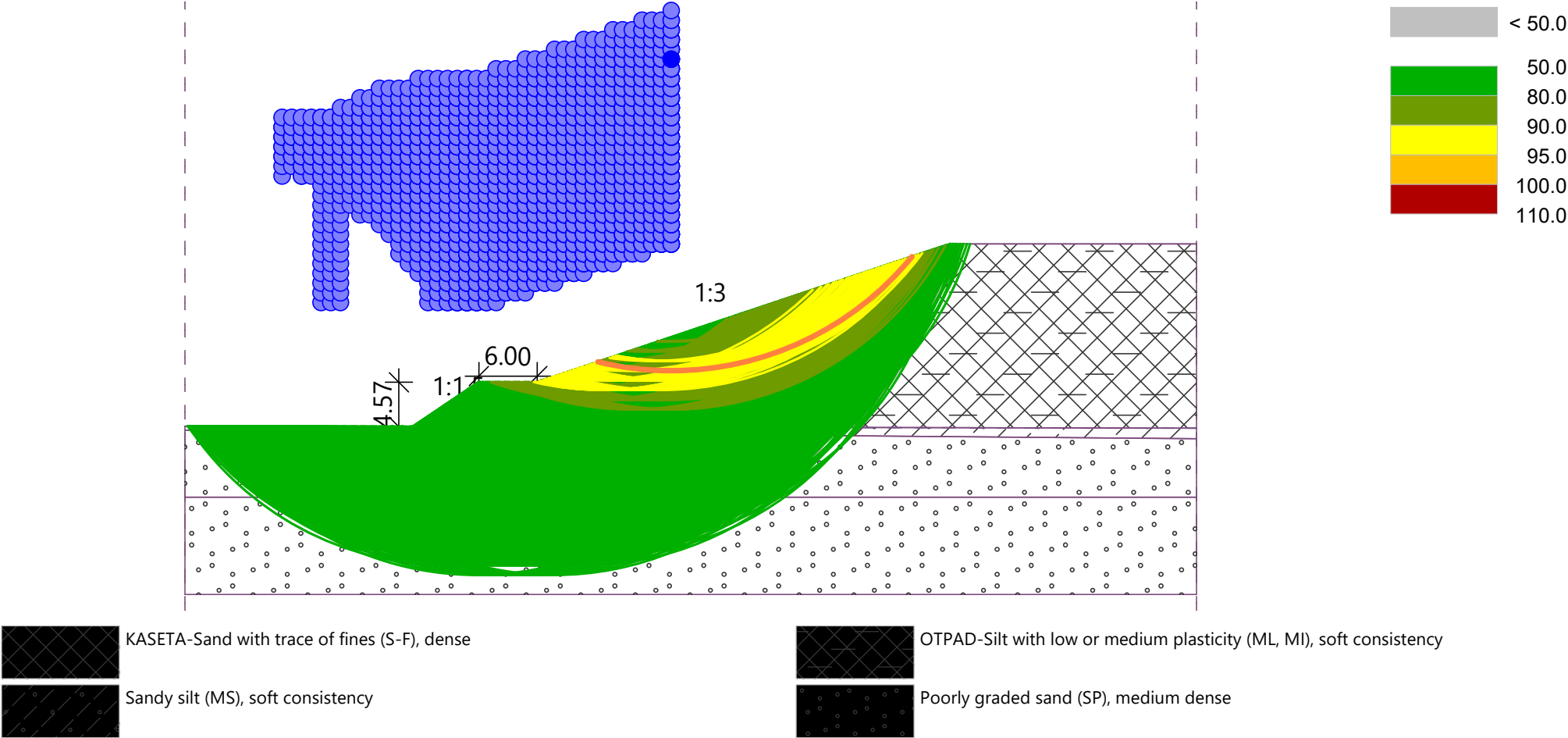
Slip surface after grid search.

Slope stability verification (Bishop)Sum of active forces : $F_a = 583.98$ kN/mSum of passive forces : $F_p = 638.39$ kN/mSliding moment : $M_a = 18687.32$ kNm/mResisting moment : $M_p = 20428.63$ kNm/m

Utilization : 91.5 %

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



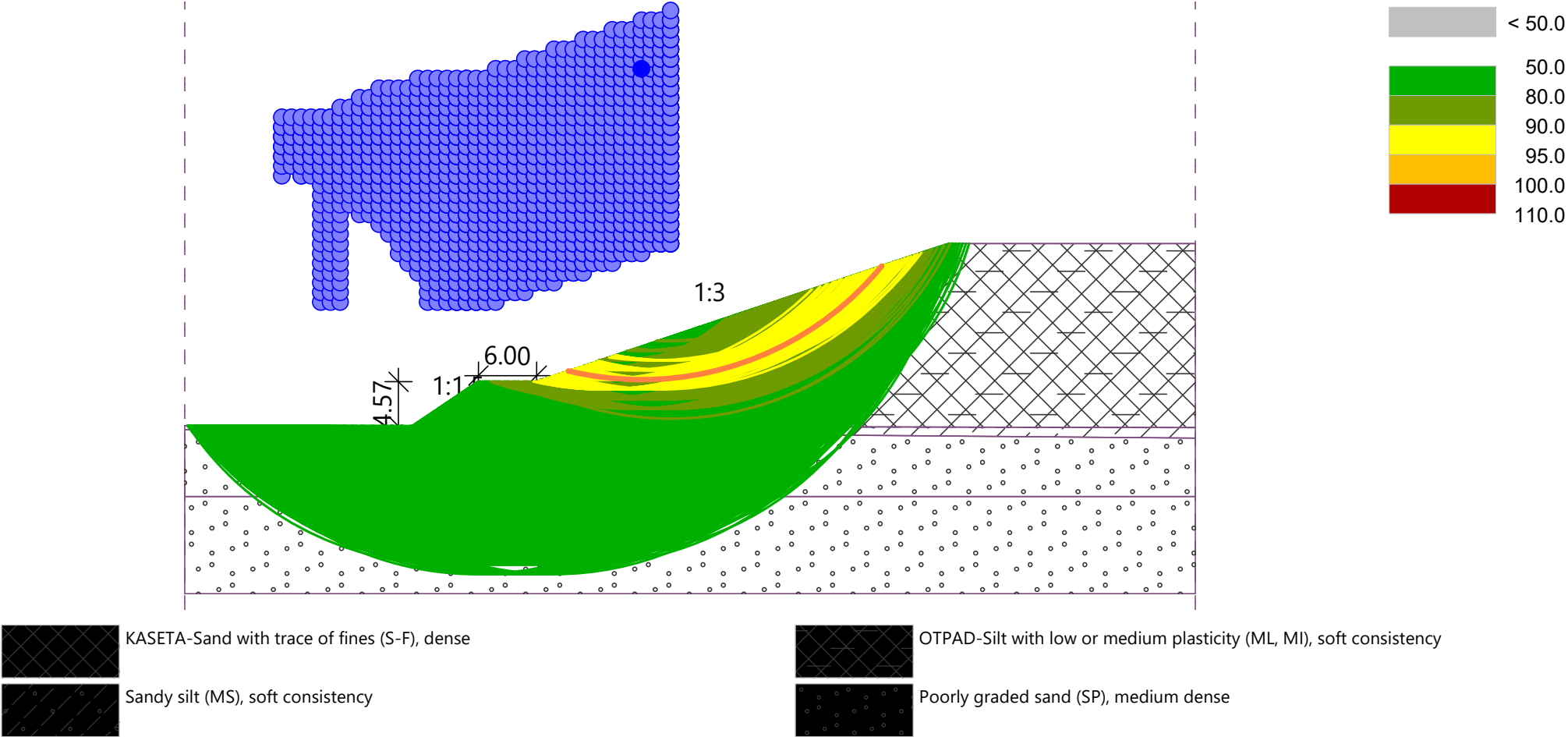
Slip surface after grid search.

Slope stability verification (Spencer)

Utilization : 91.6 %

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



Slip surface after grid search.

Slope stability verification (Morgenstern-Price)

Utilization : 91.6 %

Slope stability ACCEPTABLE

Slope stability analysis

Input data

Project

Task : Gradska deponija u Novom Sadu
 Part : ANALIZA STABILNOSTI KOSINA KASETA I DEPONOVANOG OTPADA
 Description : Spoljšnji nasip kasete deponije
 Customer : Safege doo
 Author : Nikola Dakić
 Date : 18.10.2022.
 Project ID : GEL-001-419.1-22
 Project number :

Settings

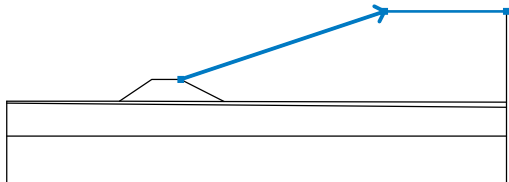
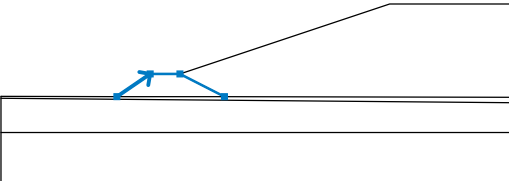
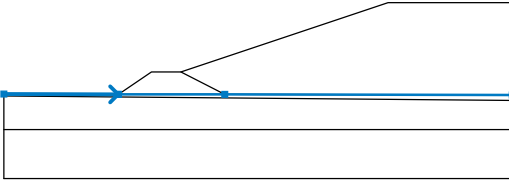
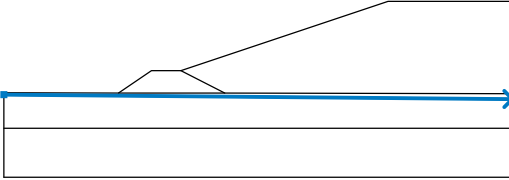
Standard - safety factors

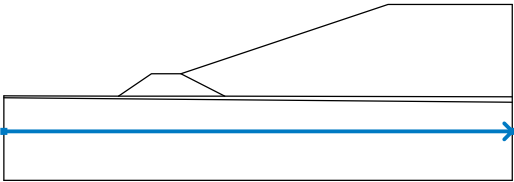
Stability analysis

Earthquake analysis : Standard
 Verification methodology : Safety factors (ASD)

| Safety factors | | | |
|----------------------------|----------|------|-----|
| Permanent design situation | | | |
| Safety factor : | $SF_s =$ | 1.50 | [-] |

Interface

| No. | Interface location | Coordinates of interface points [m] | | | | | |
|-----|---|-------------------------------------|-------|--------|-------|--------|-------|
| | | x | z | x | z | x | z |
| 1 |  | 36.20 | 11.80 | 78.60 | 26.00 | 104.00 | 26.00 |
| | | | | | | | |
| 2 |  | 23.43 | 7.23 | 30.20 | 11.80 | 36.20 | 11.80 |
| | | 45.20 | 7.20 | | | | |
| 3 |  | 0.00 | 7.28 | 23.40 | 7.23 | 23.43 | 7.23 |
| | | 45.20 | 7.20 | 104.00 | 7.08 | | |
| 4 |  | 0.00 | 6.88 | 104.00 | 5.99 | | |
| | | | | | | | |

| No. | Interface location | Coordinates of interface points [m] | | | | | |
|-----|---|-------------------------------------|------|--------|------|---|---|
| | | x | z | x | z | x | z |
| 5 |  | 0.00 | 0.00 | 104.00 | 0.00 | | |

Soil parameters**OTPAD-Silt with low or medium plasticity (ML, MI), soft consistency**

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 20.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 18.00 \text{ kN/m}^3$

KASETA-Sand with trace of fines (S-F), dense

Unit weight : $\gamma = 16.10 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 31.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 16.10 \text{ kN/m}^3$

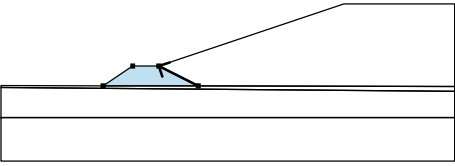
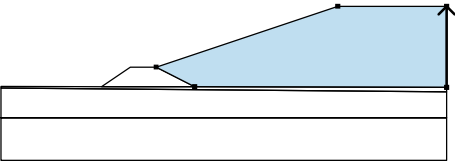
Sandy silt (MS), soft consistency

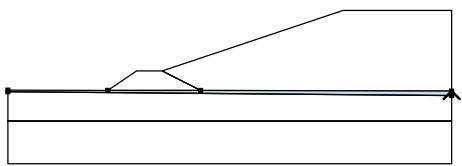
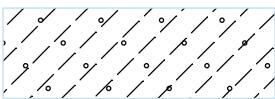
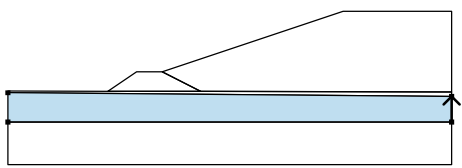
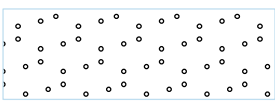
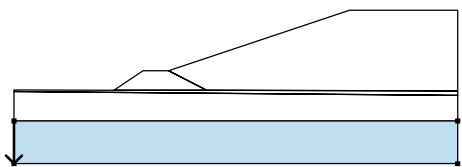
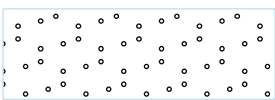
Unit weight : $\gamma = 14.30 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 20.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 10.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 14.30 \text{ kN/m}^3$

Poorly graded sand (SP), medium dense

Unit weight : $\gamma = 15.60 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{\text{ef}} = 34.00^\circ$
 Cohesion of soil : $c_{\text{ef}} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{\text{sat}} = 15.60 \text{ kN/m}^3$

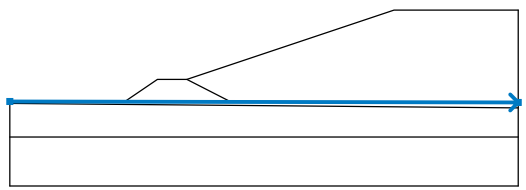
Assigning and surfaces

| No. | Surface position | Coordinates of surface points [m] | | | | Assigned soil |
|-----|---|-----------------------------------|-------|--------|-------|---|
| | | x | z | x | z | |
| 1 |  | 45.20 | 7.20 | 36.20 | 11.80 | KASETA-Sand with trace of fines (S-F), dense |
| | | 30.20 | 11.80 | 23.43 | 7.23 | |
| 2 |  | 104.00 | 7.08 | 104.00 | 26.00 | OTPAD-Silt with low or medium plasticity (ML, MI), soft consistency |
| | | 78.60 | 26.00 | 36.20 | 11.80 | |
| | | 45.20 | 7.20 | | | |

| No. | Surface position | Coordinates of surface points [m] | | | | Assigned soil |
|-----|---|-----------------------------------|--------|--------|--------|--|
| | | x | z | x | z | |
| 3 |  | 104.00 | 5.99 | 104.00 | 7.08 | Sandy silt (MS), soft consistency  |
| | | 45.20 | 7.20 | 23.43 | 7.23 | |
| | | 23.40 | 7.23 | 0.00 | 7.28 | |
| | | 0.00 | 6.88 | | | |
| 4 |  | 104.00 | 0.00 | 104.00 | 5.99 | Poorly graded sand (SP), medium dense  |
| | | 0.00 | 6.88 | 0.00 | 0.00 | |
| 5 |  | 0.00 | 0.00 | 0.00 | -10.00 | Poorly graded sand (SP), medium dense  |
| | | 104.00 | -10.00 | 104.00 | 0.00 | |

Water

Water type : GWT

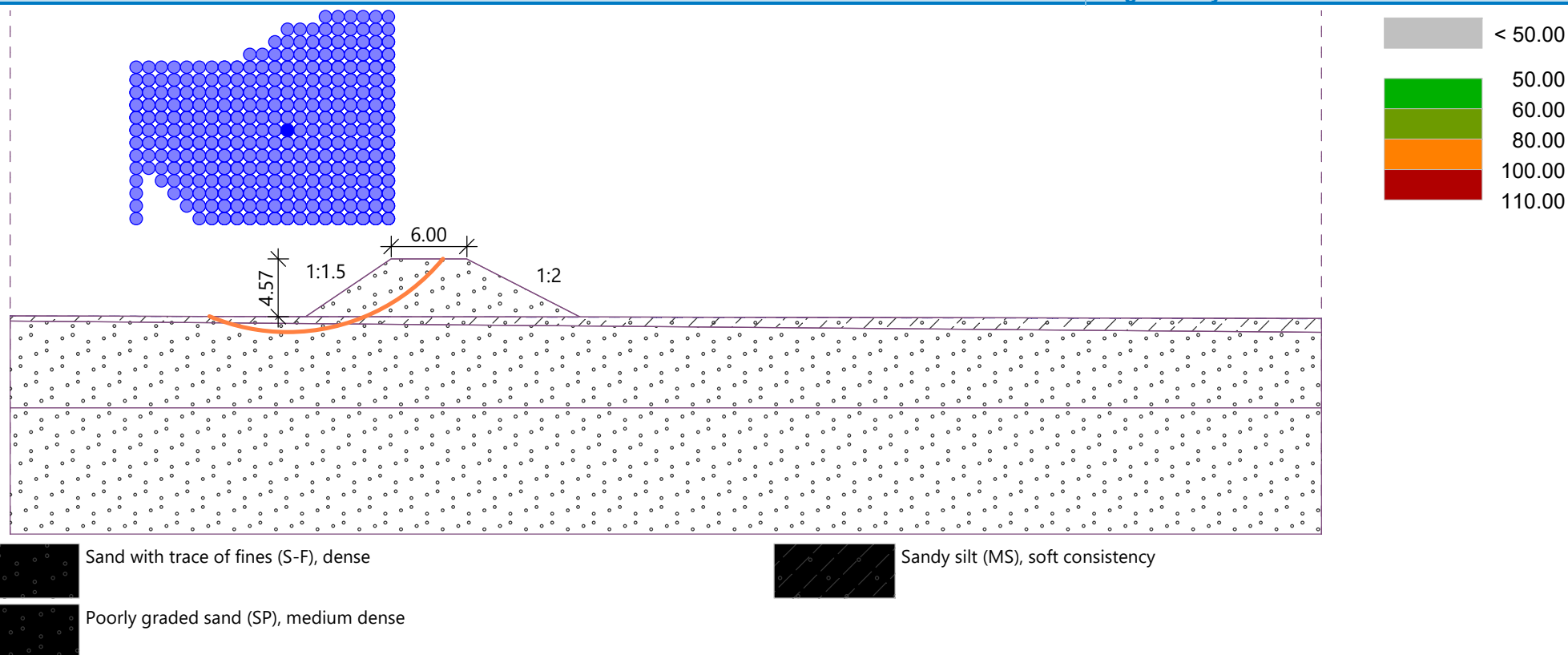
| No. | GWT location | Coordinates of GWT points [m] | | | | | |
|-----|---|-------------------------------|------|--------|------|---|---|
| | | x | z | x | z | x | z |
| 1 |  | 0.00 | 7.28 | 104.00 | 7.07 | | |
| | | | | | | | |

Settings of the stage of construction

Design situation : permanent

Name :

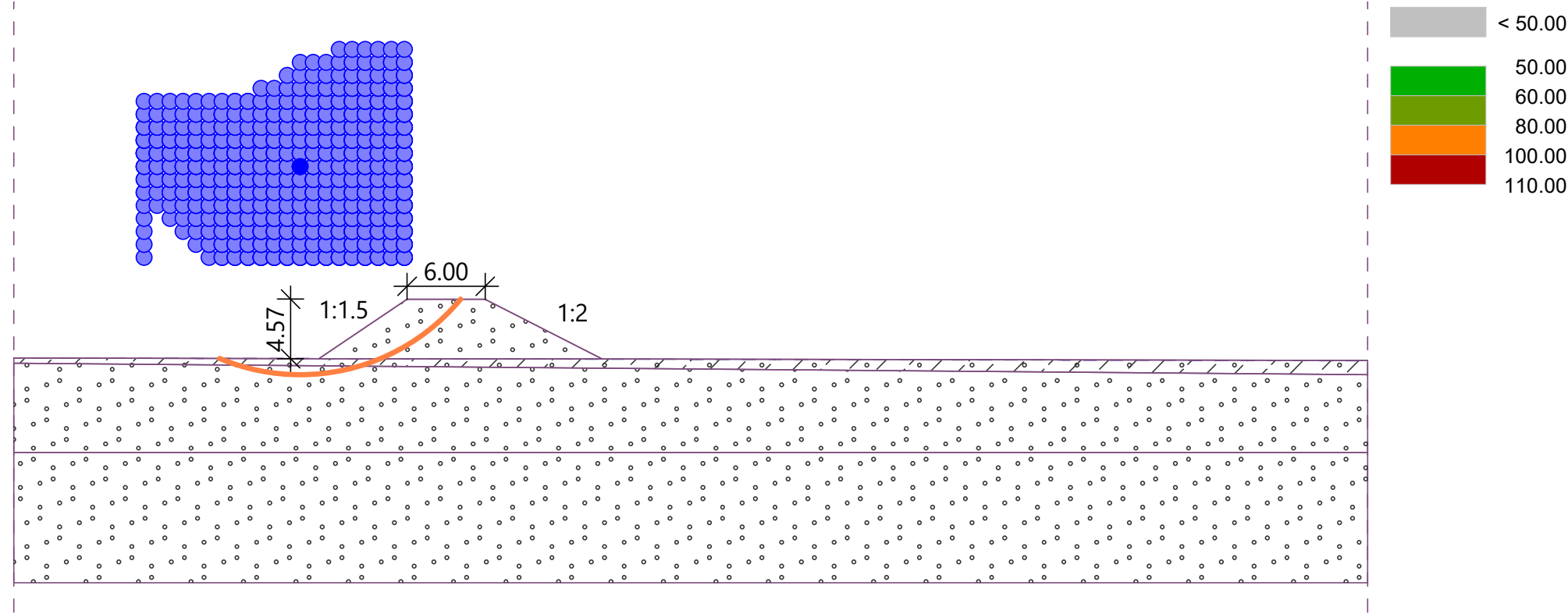
Stage - analysis : 1 - 1



Slip surface after grid search.

Slope stability verification (Bishop)Sum of active forces : $F_a = 163.28 \text{ kN/m}$ Sum of passive forces : $F_p = 298.56 \text{ kN/m}$ Sliding moment : $M_a = 2612.41 \text{ kNm/m}$ Resisting moment : $M_p = 4776.89 \text{ kNm/m}$ Factor of safety = $1.83 > 1.50$ **Slope stability ACCEPTABLE**

Name : Stage - analysis : 1 - 1



Sand with trace of fines (S-F), dense

Poorly graded sand (SP), medium dense

Sandy silt (MS), soft consistency

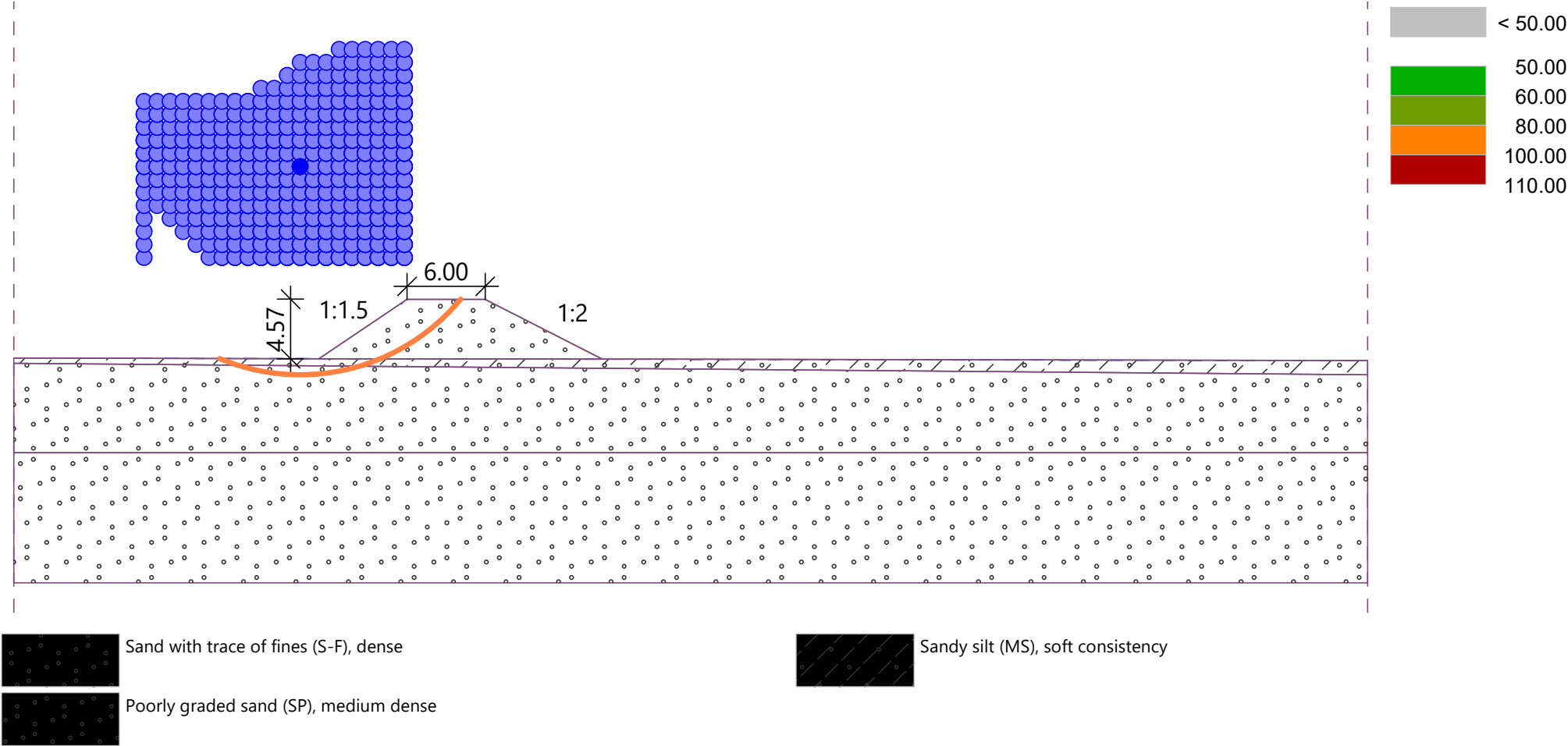
Slip surface after grid search.

Slope stability verification (Spencer)

Factor of safety = 1.83 > 1.50

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



Slip surface after grid search.

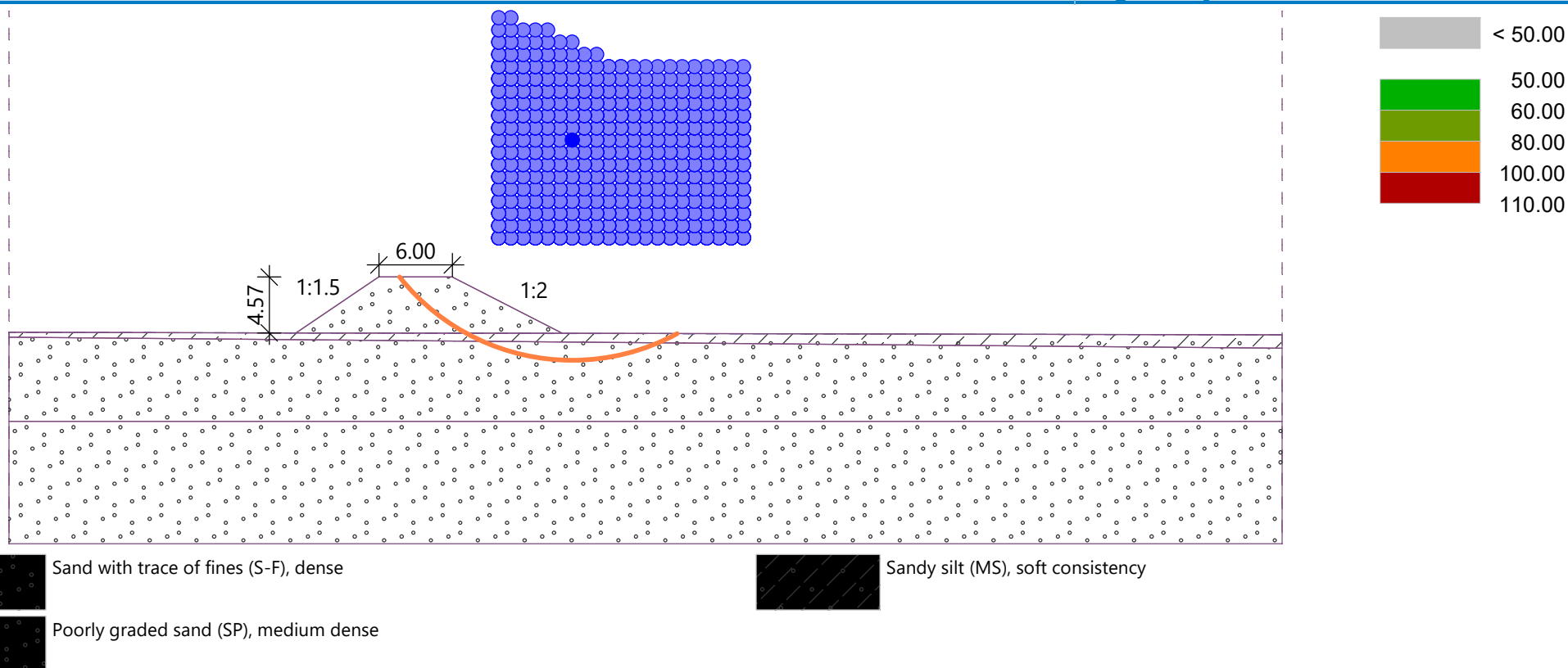
Slope stability verification (Morgenstern-Price)

Factor of safety = 1.84 > 1.50

Slope stability ACCEPTABLE

Name :

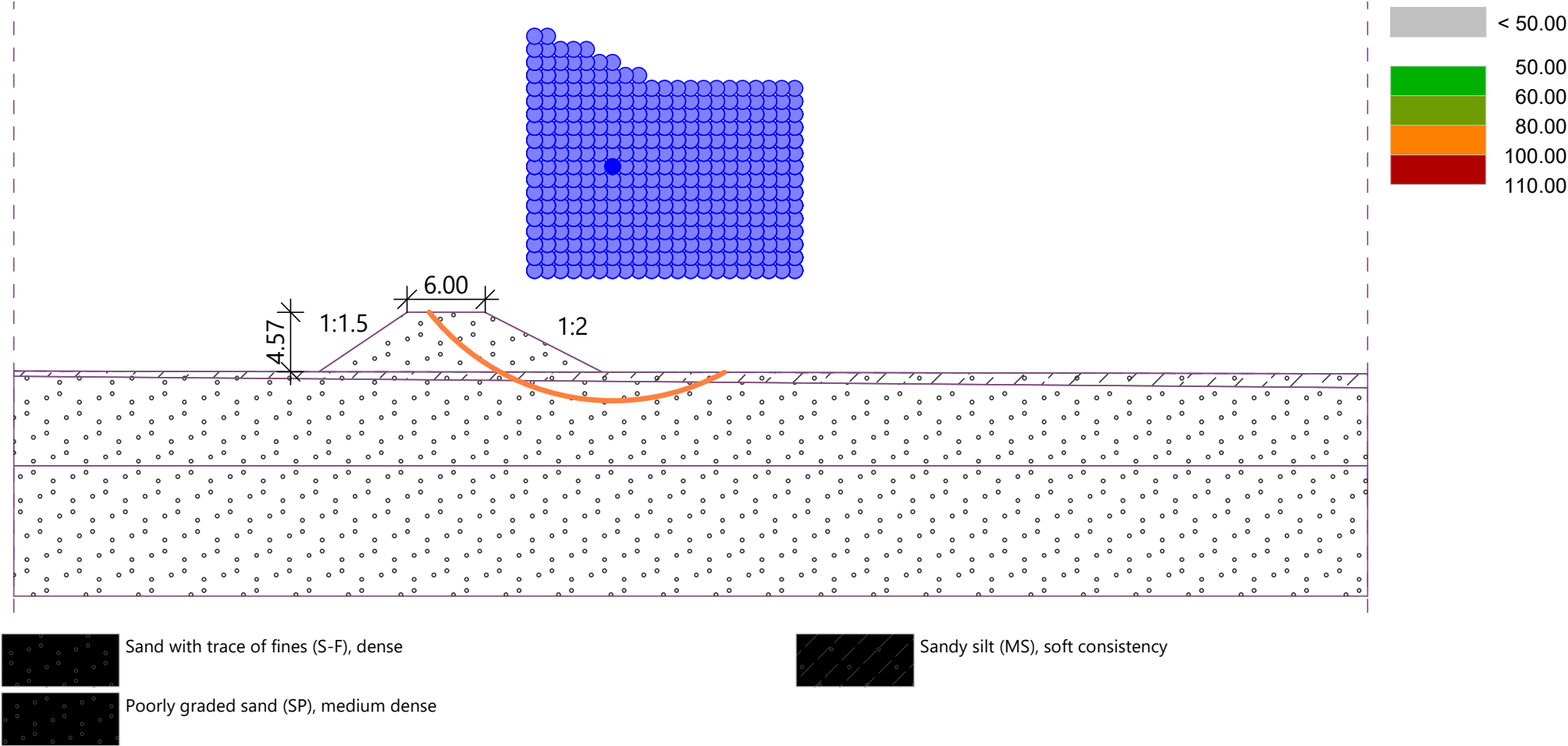
Stage - analysis : 1 - 1



Slip surface after grid search.

Slope stability verification (Bishop)Sum of active forces : $F_a = 216.01 \text{ kN/m}$ Sum of passive forces : $F_p = 425.85 \text{ kN/m}$ Sliding moment : $M_a = 3888.10 \text{ kNm/m}$ Resisting moment : $M_p = 7665.38 \text{ kNm/m}$ Factor of safety = $1.97 > 1.50$ **Slope stability ACCEPTABLE**

Name : Stage - analysis : 1 - 1



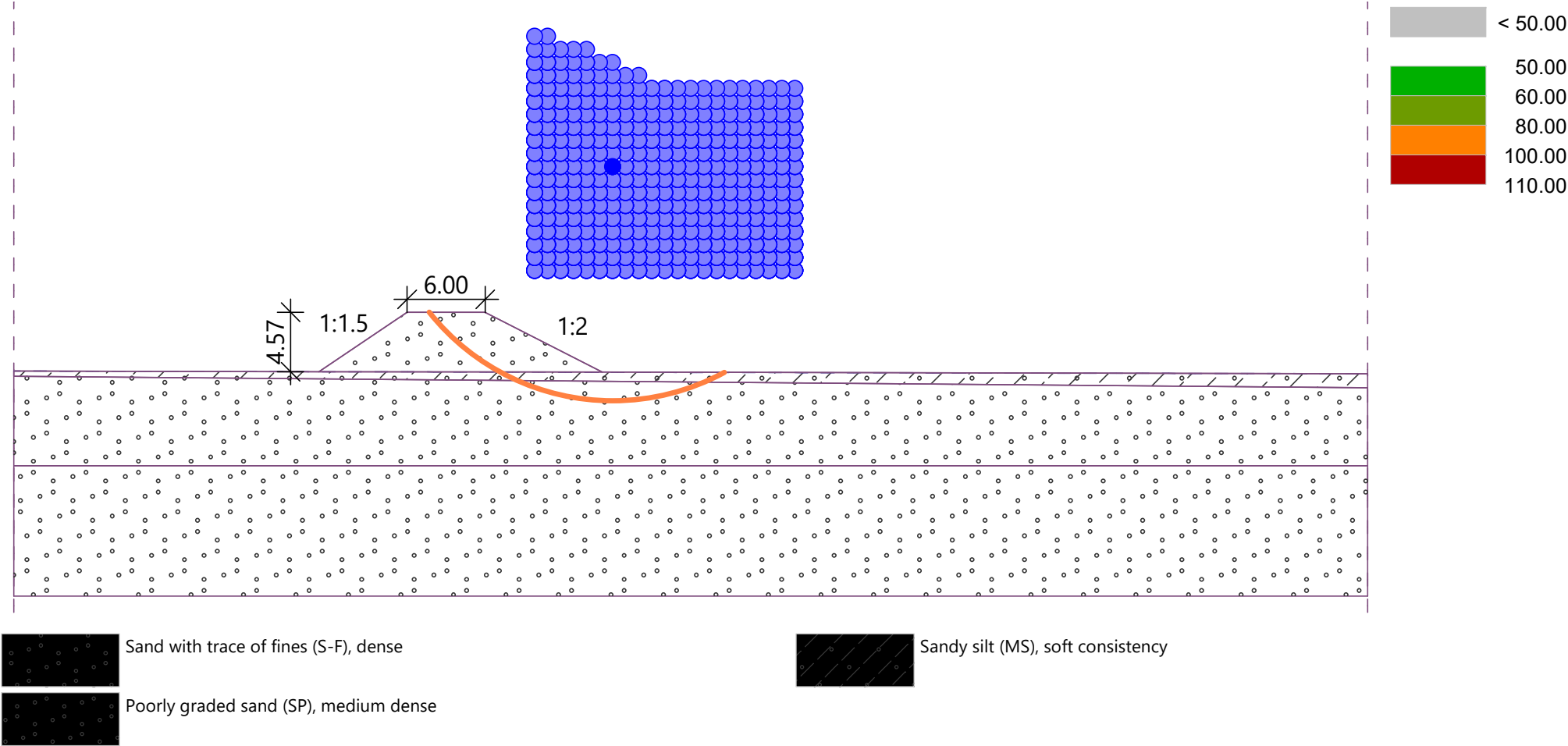
Slip surface after grid search.

Slope stability verification (Spencer)

Factor of safety = 1.98 > 1.50

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



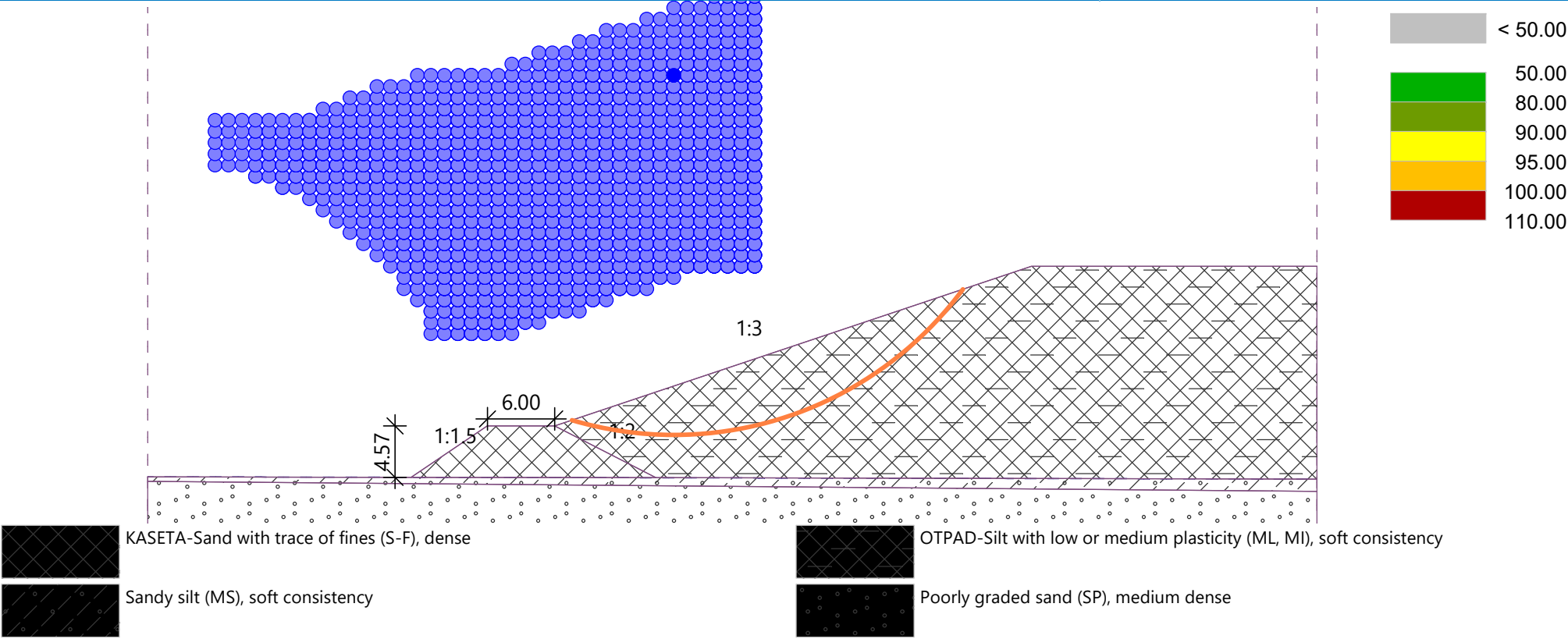
Slip surface after grid search.

Slope stability verification (Morgenstern-Price)

Factor of safety = 1.99 > 1.50

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



Slip surface after grid search.

Slope stability verification (Bishop)

Sum of active forces : $F_a = 732.29$ kN/m

Sum of passive forces : $F_p = 1134.35$ kN/m

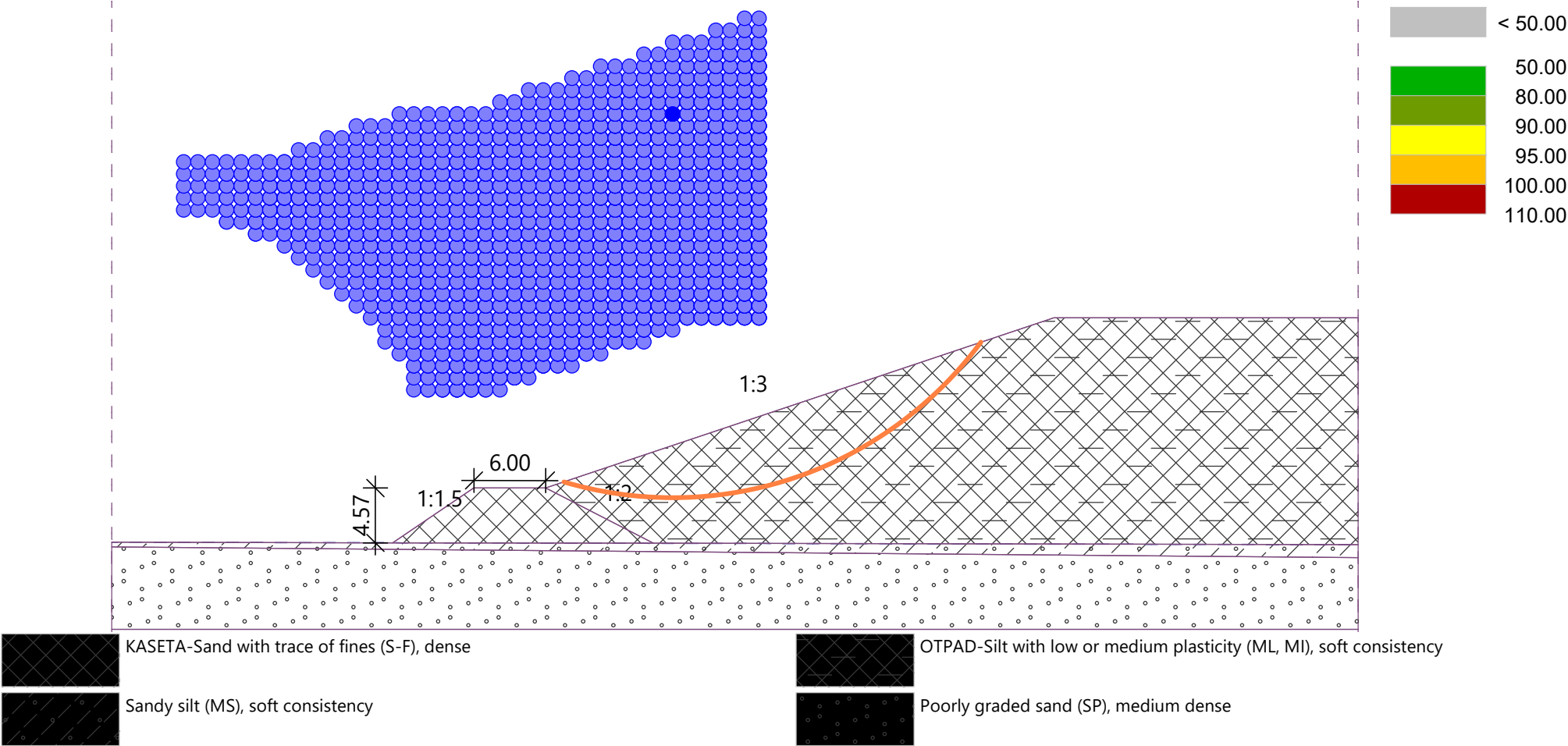
Sliding moment : $M_a = 23433.20$ kNm/m

Resisting moment : $M_p = 36299.18$ kNm/m

Factor of safety = $1.55 > 1.50$

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



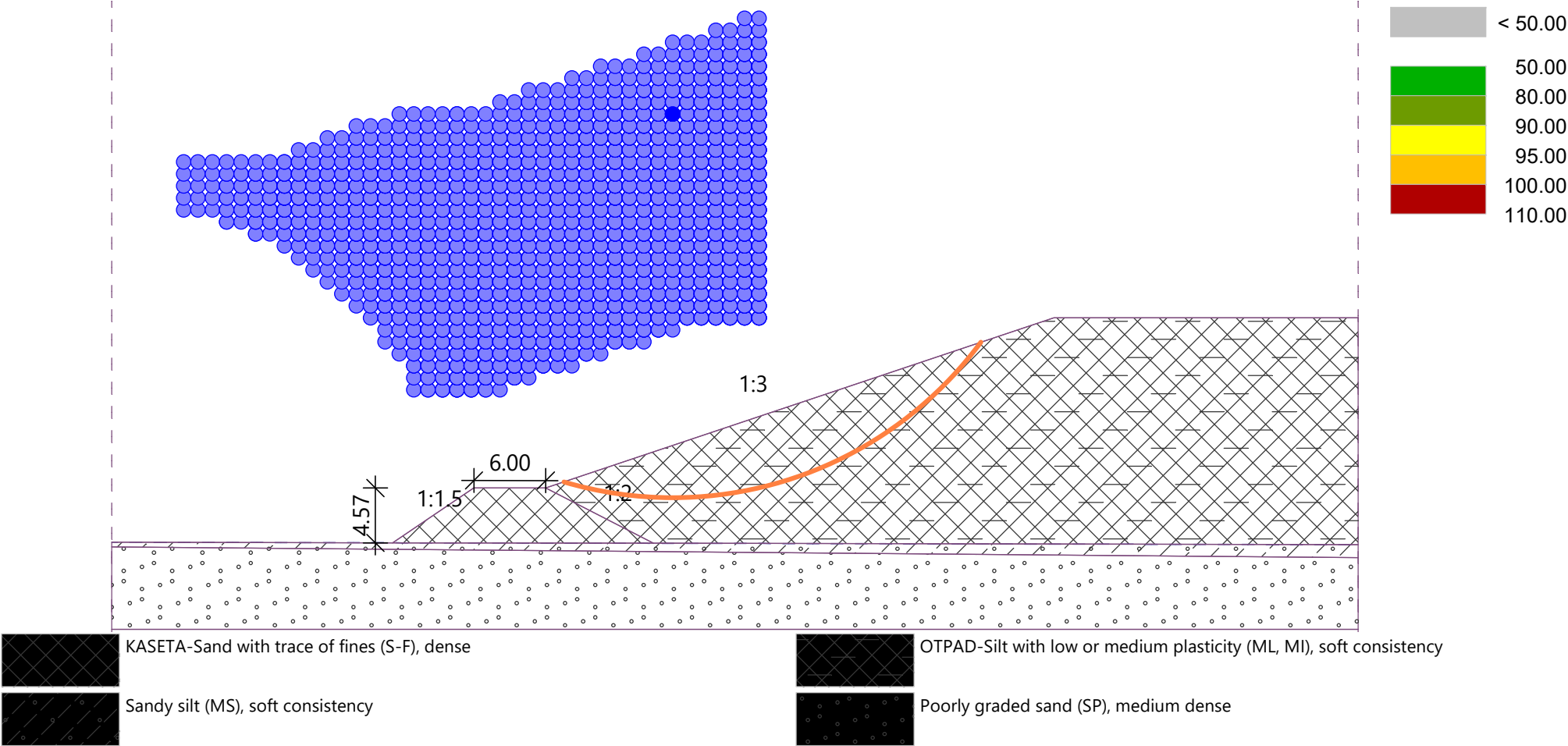
Slip surface after grid search.

Slope stability verification (Spencer)

Factor of safety = 1.55 > 1.50

Slope stability ACCEPTABLE

Name : Stage - analysis : 1 - 1



Slip surface after grid search.

Slope stability verification (Morgenstern-Price)

Factor of safety = 1.55 > 1.50

Slope stability ACCEPTABLE