The pipeline construction on the Ljubljana marshland – influence of hydrogeological characteristics

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Abstract: In perspective the drinking water supply will be from Ljubljana Marshland in efficaciously 500 l/s. Because of unsuitability and damages on old pipeline, the construction of new pipeline has been started. In the past the construction on the weak supporting ground had used the piles, but now the new approach is used.

Key words: pipeline construction, Ljubljana Marshland, hydrogeological characteristics

Introduction

Ljubljana marshland is known as an area where the house, road or communal construction presents the technical problem because of frequently overflows and permanent swampy. The construction on marshland has always caused the troubles, so it should be carefully planned and the soil should be preliminary investigated.

In the past Romans had a special unite that took care for keeping the road connection over the marshland. In the years between 1850 and 1856, before the construction of the railway Ljubljana-Trst, 14 boreholes were drilled between Notranje Gorice and Preserje with the intention to find out the soil geotechnical characteristics. Every time when the new construction is planed, the boreholes are drilled to investigate the feasibility founded the buildings and roads.

Below the layer of humus the lacustrine silt, called "polžarica", is situated. This is an unconsolidated soil, the primary source of buildings on the marshland. In the year 1936, when the road Ljubljana-Sušak was constructed, the experimental pyramid rose near the Iščica river and it sank for more than 1 m in very short time. The difficulties and problems that were observed during the railway construction between Preserje and Borovnica are well known - the dam plunged into the "polžarica" for 8 m (Grimšičar & Ocepek, 1967).

So far the investigations and researches were orientated towards a single location, the location where the construction was planned. However, the experiences point out that before each new construction the bigger area should be investigated.

Scientific paper

RESULTS AND DISCUSSION

The Ljubljana marshland is a plain area with a surface layer of very low water permeability. The typical marsh soils are in general up to 15 m deep and consist of very humid clayey-silty viscous to lightly kneading, normally consolidated, coherent soil. Deeper the soil consists of more solid layers – clayey gravel and sand that are inserted between clay, silt and peat layers.

The upper 15 m of weakly supported ground could be classified into two characteristic layers:

- the first layer called "polžarica" is viscous to lightly kneading plastic/clayey silt (MH, MH-CH) with humidity 80 - 120 %, volume weight 14 - 15 kN/m^3 and cohesion c_u=10 kPa and with internal friction angle φ = 26° - 29°.
- the second layer is medium to high plastic silty clay (classified from Cl –MI to CH – Mh) with natural humidity 30 – 70 %, volume weight 15 - 17 kN/m^2 and cohesion c_u=20 kPa (GABERC, 2003).

The surface of the marshland is overgrown with grass that covers a thin humus layer. In some places 2 m thick peat layers could be found below the humus. Somewhere the 2 m thick layer of organic clay is deposited over the "polžarica".

For safety public drinking water supply the city of Ljubljana needs an efficacious drinking water source outside the Ljubljana Field, where four water works with efficacious of about 2300 l/s are situated. Since 1974 the hydrogeological investigations have taken place on the Ljubljana Marshland. These investigations confirm that there is enough groundwater that could be the perspective drinking water source. In perspective about 500 l/s will be exploited from the Brest water work. Because the old pipeline is unsuitable to transport this quantity of water in 2001 the construction of the new pipeline began (ŽLEBNIK & MENCEJ, 1985).

The new pipeline is 9040 m long; 5340 m of it goes through the typical marshy ground. The terrestrial works have been executed in the clay, loam, silt and peat layers. All listed layers significantly change the geotechnical characteristics depending on precipitation. The pipes diameter is DN 700 mm and they are made from ductile iron.

In the past the piles were used for the construction on the weak supported ground. They were sunk into the supported ground. This is the solution, when the objects volume weight is greater than the soil volume weight.

The piles were not used for the new pipeline construction. The pipes were placed in the supporting cover veiled in geo-textile. The thickness and width of the supporting cover changed through sections regarding the carrying capacity of supporting ground. The entire complex – carrying cover and cover material - is veiled in geo-textile. For the carrying

cover and cover material the 8 - 16 mm quarry stone granulation was used. With this material the suitable specific weight for entire complex was achieved. The cover material specific weight was 15 - 16 kN/m^2 and the entire complex (pipeline + cover material) floated into the weak supporting ground. To achieve the uniformity the pipes and cover material were veiled in geo-textile (Železnik, 1997).

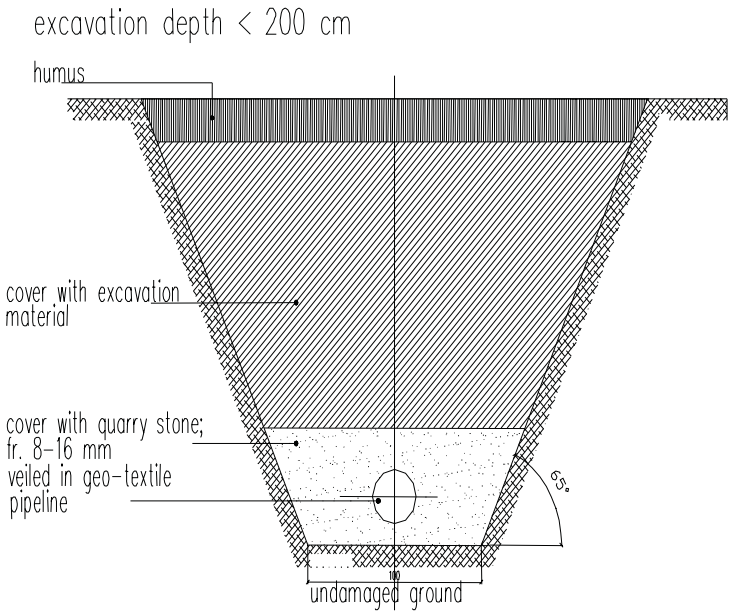

Figure 1. Detail of the pipeline built-in

The pipeline construction was executed in daily sections. That way of construction was selected because the soil geotechnical characteristics change when the water is present. Therefore, the influence of bad weather on construction was reduced. In spite of the pipeline dimension and the pipeline length, only the part of building pit, needed for the next pipeline section, was visible. After the pipeline built-in the original ground conditions were restored.

The bottom of the building pit was under the groundwater and hinterland water level (Iška river, reclamation ditches), but the excavation was mostly in the dry soil. In the time of precipitation only the water that dropped directly was in the excavation pit. The impermeability of the fundamental ground made possible to excavate more than it was forecasted, so for most of pipelines the panelled and disunite dike was unnecessary (Železnik, 1997).

CONCLUSIONS

Experiences from the building field indicate that if the excavation in typical marshland doesn't perforate impermeably layers of the aquifer, there is no artesian and subartesian groundwater and the soil technical characteristics don't change so dramatically as it was forecasted. The investigations demonstrate that if we tend to achieve the same or smaller specific weight from the excavation one, the subsiding of build material should be avoided.

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