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How many drillings are necessary? A case study

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ABSTRACT: In Zell am See, Austria, an 8 m deep two floor underground parking was built next to the Grand Hotel. For the site-investigation the first plan was to carry out ten drillings. The study of existing geologic data show that the construction-site lies at the end of an alluvial delta, where homogeneous sand/gravel-sediments were expected. Based on this knowledge the geologic investigation could be reduced to only two CPT's. The excavation pit was stabilized with jet-grouting walls and due to the high groundwater-level and the high permeability of the soil the bottom was sealed with a jet-grouting-plate. The soil conditions turned out as predicted, situated in the loose, homogeneous sand-gravel-ground the technically challenging jet-grouting work could be carried out without any problems.

1 INTRODUCTION

The Grand Hotel in Zell am See, Austria, is situated on the alluvial delta of the Schmittenbach right next to the lake of Zell am See. Due to the shortage of space in the dense covered area and the lack of parking places, a two-floor underground was planned. Because of the high groundwater-table near the lake and the high permeability of the soil, a dense excavation pit was necessary. A drawdown of the groundwater was not allowed.

A preliminary geologic analysis including mapping and the study of existing papers made it possible to reduce the costs of the site-investigation to a minimum.

2 LOCATION

Zell am See is a small but famous ski resort in Salzburg, Austria (Fig. 1)



Figure 1. Topographic map of Austria with location of the project

The small town is situated between the western bank of the lake and the rising mountains in the west. The topographic surface is formed by an alluvial delta and falls like a gentle slope to the lake (Fig. 2).



Figure 2. Location Zeller See

3 PROJECT

On the area of the Grand Hotel in the gap between the buildings, a two-floor underground parking should solve the local parking problems. A construction with a length of 30 m, a width of 20 m and a depth of 8 m below the surface was planned (Fig. 3). The east side of the building reaches to the lakeshore and the north and south sides touch the basement of existing buildings.



Figure 3. Position of lower basement

4 GEOLOGY

As this project includes a geotechnical very deep and difficult excavation the first idea for the geologic investigation was to carry out ten drilling – a quit costly plan.

The alternative concept for the site-investigation was to make at first a geologic mapping including all existing papers and data and then decide in a second step the range of the soil exploration.

4.1 Geologic overview

Zell am See lies in a valley, which was deeply eroded in the ice-age and postglacial filled with sediments up to the present-day surface level. The valley-trough reaches down to a depth of about 500 m. The lake of Zell am See is a relict of this glacial basin.

4.2 Local geologic situation

The deposits of the alluvial delta of the Schmittenbach are the youngest sediments, which lies on the postglacial basin-sediments. The delta has its origin at the bottom of the mountains on the west side and continues with a uniform, small surface gradient down to the lake. The delta exists of sand-gravel material including stones and boulders. The permeability is generally very high.

On the project area the groundwater table is just below the surface and is corresponding with the water level of the lake.

5 GEOLOGICAL INVESTIGATION

The first step was to carry out a geological mapping and search for all existing investigation-points and data. According to the long history of Zell am See with the first settlements 3000 years ago, we found a

lot of data including many drillings which are shown in Fig. 4.



Figure 4. Alluvial delta with existing investigation

The analysis of this basic data gave an interesting composition of the delta-sediments. These sediments are very inhomogeneous at the beginning of the delta with a matrix of sand and gravel and lots of stones and boulders (torrent-debris) up to a size of 10 meters. With an increasing haulage distance the material becomes more and more homogeneous resulting in a uniform sand-gravel-mixture. At the end of the delta there are no more stones or blocks; the energy of the river is too low and cannot transport these big parts, that's why they are deposited at the origin of the delta.

We knew from the first study that the soil at the construction site is homogeneous and can be penetrated with the CPT-equipment, that's why we decided to bring down just two CPT-sounding. The two outcrops showed pretty much the same CPT-profiles and confirmed the assumption of the geologic situation. In Fig. 5 the documentation of the CPT shows loose gravelly sand with a high permeability.

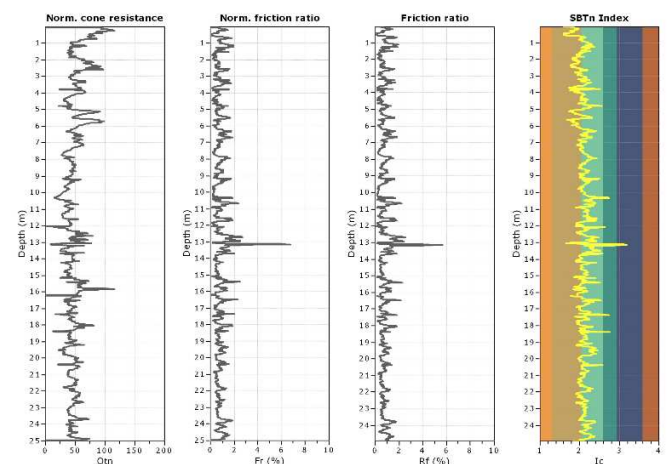


Figure 5. CPT Profile interpretation

6 EXCAVATION PIT

According to the results of the soil-investigation the fully sealing of the excavation-pit, with the jet-grouting system, was decided. At the front side, situated near the lake, sheet-piles were built in order to protect the lake from cement. This was a necessity, because the lake water has drinking water quality (Fig. 6 and 7).

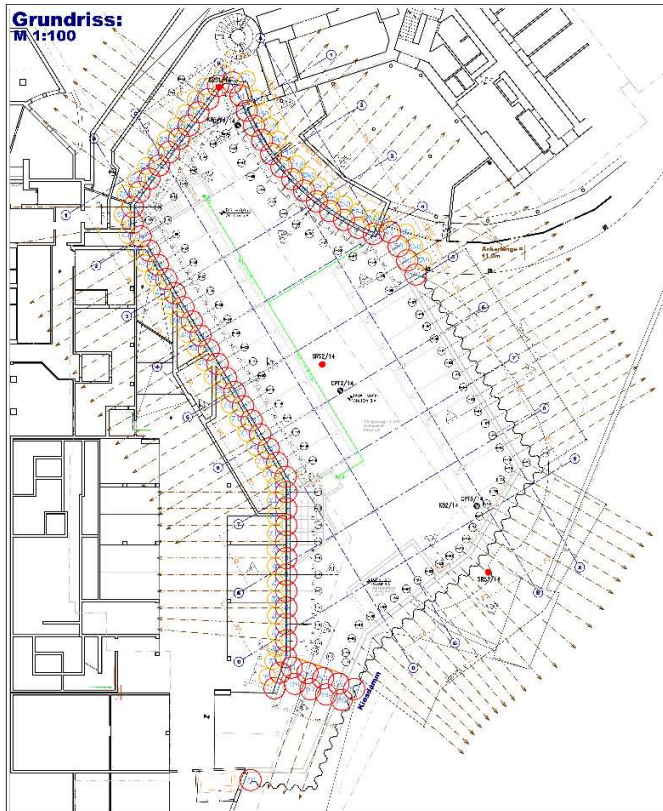


Figure 6. Layout of Jet-Grouting and Pile Wall

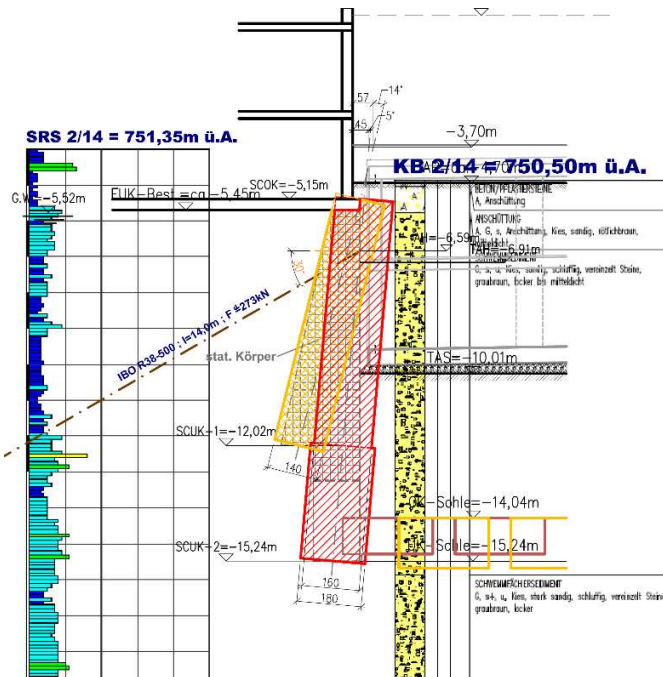


Figure 7. Sectional drawing of Jet-Grouting Columns

With the jet-grouting system the basements of the existing buildings on the north and south side could be underpinned and the jet-grouting walls stabilized the side bands.

To seal the bottom a jet-grouting-plate was injected, which had to be fixed in the ground with soil-nails due to the high water pressure.

The high-tech jet-grouting work was carried out according to the plan. For the bottom jet-grouting-plate, the direction of every drilling-point was measured by an inclinometer, in this way the deviation could be detected and the water tightness of the plate was guaranteed. Due to the short construction-time it was not possible to test the reseal the pit. The geologic conditions turned out as predicted and the grouting-work was carried out with no problems. Pictures of the jet-grouting-works and excavation near the lake are shown in Fig. 8 and 9.



Figure 8. Picture of Jet-Grouting-Works



Figure 9. Picture of excavation and soilcrete columns

7 CONCLUSION

This case study shows that even for a very difficult ground-operation a site-investigation with only two

CPT's was enough. The base for this low-budget program was an intensive preliminary geologic study with the understanding of the soil-genesis and the geotechnical interpretation. The mentioned example above shows that even a very complex underground-work does not automatically require a cost intensive site-investigation.

8 REFERENCES

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