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Sisimiut Airport – Project Investigations, Construction and Stability and Settlements of Runway Founded on Soft Marine Clay

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Motivation

Sisimiut Airport is located 4 km northwest of the town and designed with a runway (799 by 30 m) for Short Take Off and Landing aircrafts Dash-7 and to-day used by Dash-8. The Sisimiut airport and runway embankment was constructed in the coastal area characterized by small rock outcrops intersected with erosional valleys in bedrock filled with soft marine clays over sand and till. It may be considered a type locality for infrastructures founded on soft marine clay. The project investigations were carried out between 1991 and 1995 and consisted of open exploration excavations above sea level and geophysical surveys and boreholes and soundings below sea level to find the rock surface and the geotechnical properties of the overlying marine clays, meltwater sand and till. Especially, the local basins of 4 to 15 m of marine clay with low shear strength ($c_v \approx 30$ to 50 kPa) and high water contents ($w_{nat} \approx 25$ to 48% ≥ liquid limit w_L) called for advanced geotechnical laboratory tests. They consist of oedometer tests and triaxial compression tests in order to establish a safe design profile for the construction of the runway embankment. The valley at the eastern end of the runway with 15 m of marine clay was avoided due to stability cautions and evaluated large long-term settlements. The runway embankment was moved closer to the coast and with the runway west of the deep marine basin as seen in Figure 1. The airport and runway were constructed in the period 1996 to 1999 using compacted local rock fill from blasting rock obstacles and from the quarry at the present Terminal area. Regular traffic started in 2000. Maintenance of the safety zone and the asphaltic concrete paved runway has been very limited due to high quality construction and control methods applied.

Approach

The present case has been used as background for ARTEK courses in geotechnical engineering, road construction and surveying courses in the period from 1999 until today. Site inspections, construction drawings with surveying results from 1998 and 1999 and available geotechnical reports are integrated in our education and research. We have supplied field and laboratory investigations for a possible extension of the runway towards east. Focus has been on refining the consolidation properties in oedometer testing as the soil conditions may call for staged preload of the soft clay deposits in order to refine the stability calculations. Especially, a better determination of the consolidation coefficient c_k as function of stress level

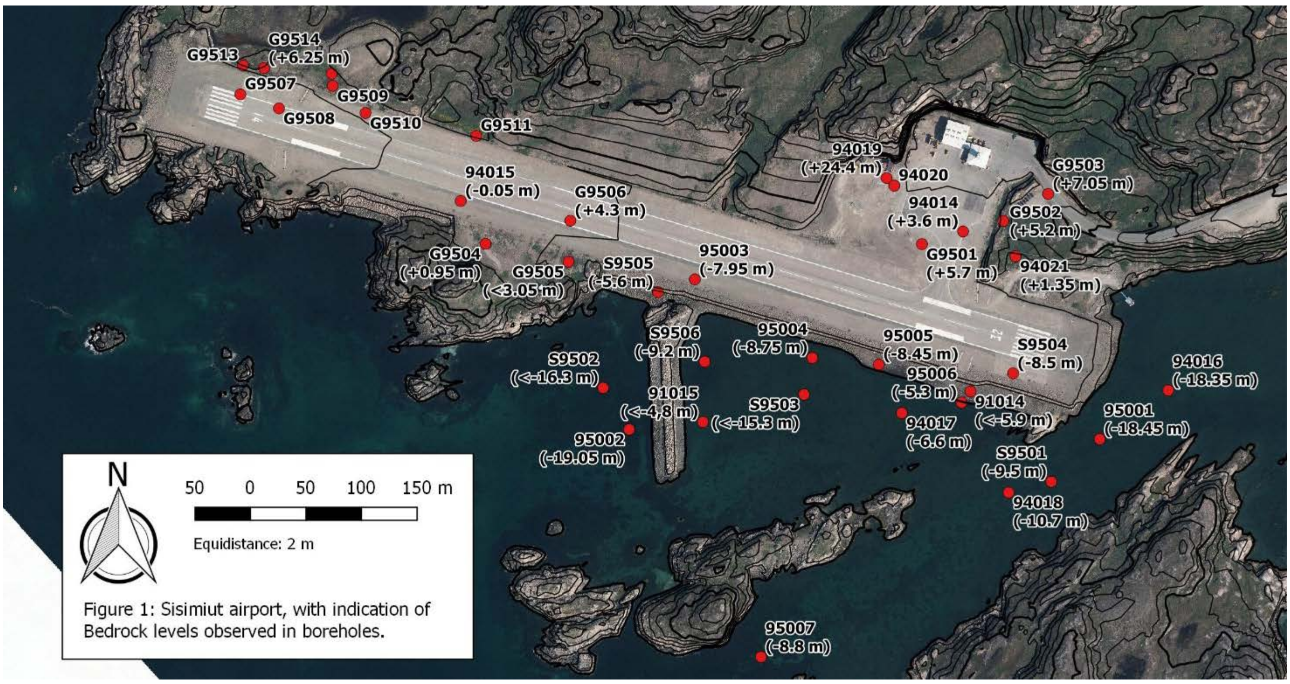

Figure 1: Sisimiut airport, with indication of Bedrock levels observed in boreholes.

has been studied. Actually, this parameter may vary from 2 to $20 \cdot 10^{-8}$ m^2/sec which could lead to a time interval of 1 to >10 years for final consolidation and need for long duration preload duration. In order to verify the consolidation properties we initiated from 1999 systematic surveying of well defined levelling points along the Runway and the Safety Zone and on the Breakwater. In total 8 sets of levelling have been done using available levelling tools and RTK GNSS and eventually a total station investigation in 2016. Some representative results of these measurements are shown in Fig. 2 along the white painted southern boundary of the runway from St. 1255 to St. 1700. In this area the runway and safety zone may rest on up to 5 m of soft marine clay. The differential settlements are 10 to 20 cm of which 5 to 15 cm takes place in the period of 1998 to 2005. This confirms calculations of primary settlements based on the oedometer tests being ~15 cm for rock fill load of 150 kPa on 3 to 5 m soft clay. Additional settlements achieved after the primary consolidation from 2005 to 2016 are caused by relative high values of creep found at preconsolidation stress of 120 to 200 kPa. The largest measured settlement (~50 cm) was found on the breakwater around borehole 95002 where the thickness of marine clay rises to 15m. However, the positions of the large rock boulders may have been changed due to wave and ice actions. The settlements in the western part of runway and safety zone boundaries with very limited amount of rock fill are less than 5 cm.

Conclusions

The project investigations and construction for the Sisimiut Airport may be a type locality for infrastructures founded on soft marine clay. As such it has been a perfect case study for ARTEK education of Arctic Engineers with engineering geological variability, use of geophysical methods and all geotechnical field and laboratory studies. In combination with the systematic surveying it has been very motivating for the students who learned a lot on the practical use and consequence of engineering studies for infrastructures.

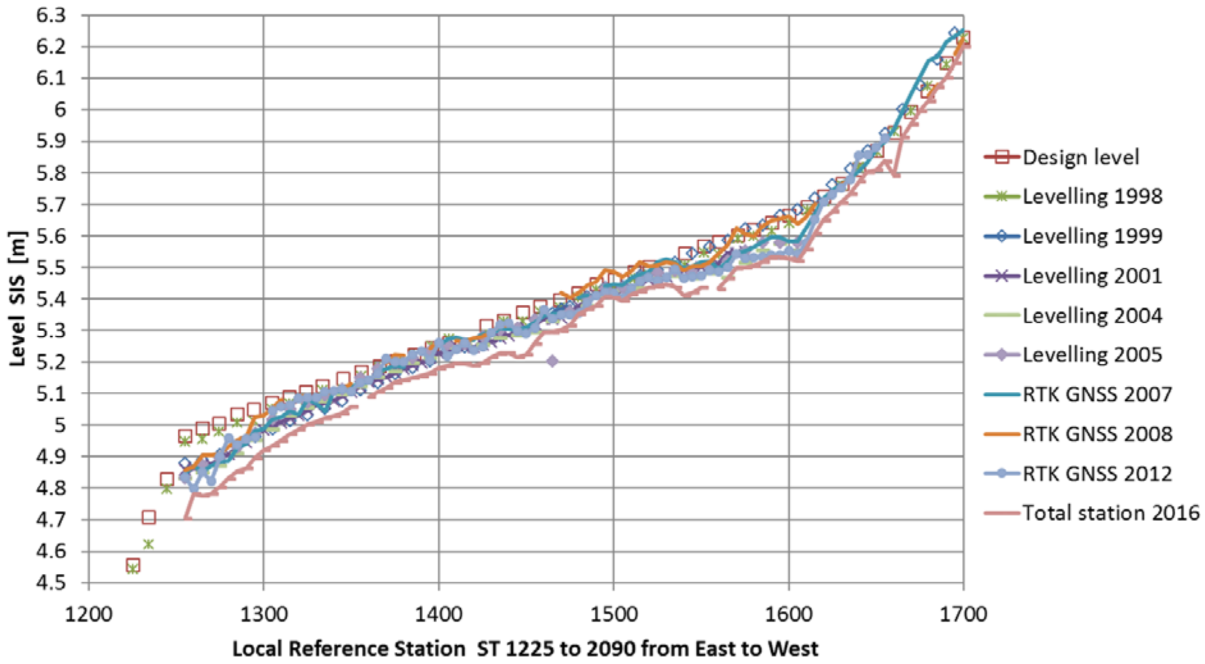

Figure 2: Levelling of southern boundary of runway. Station 1255 m is eastern end of runway.

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