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Kangerlussuaaq Airport: Deformations and construction failures in Arctic Permafrost areas

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Background

Infrastructure development is on the hottest topics these days in Greenland, especially for the airports of the country, raising political and media debate about the future of Kangerlussuaq international airport. Kangerlussuaq aerodrome is the main hub and the largest airport in the country. The current technical failures at the pavement, the cost of maintenance and the permafrost conditions are crucial parameters which may play a vitally important role for the future fate of the aerodrome.

Permafrost conditions and Settlements at Western Threshold

The climate at the airport area is stable dry sub-arctic and between 2004 and 2014 the mean annual temperature has been recorded at -3.3ºC. The minimum temperature in the Winter period can reach even -45ºC, while in the Summer up to 25ºC (Menne, 2012). The local area is characterized by continuous permafrost with an estimated thickness at 130m. The Active layer thickness (ALT) is equal to 2m under natural surfaces, whereas at below the paved surfaces it is estimated approximately at 4m (Jørgensen & Ingeman-Nielsen, 2007). The dark asphalt has the ability to absorb the sun radiation resulting in higher temperature below the asphalt and consequently higher ALT values.

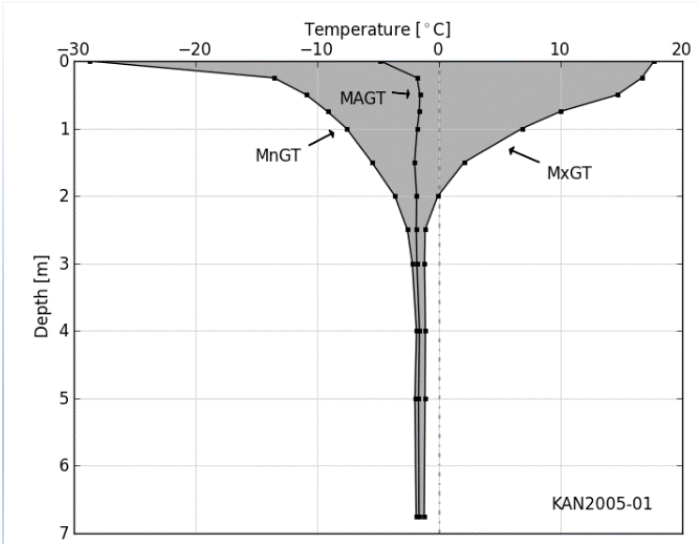

Figure 1: Trumpet curve documenting the thermal regime in natural clay and sandy deposits close to the airport area

In 1973, 15 years after the construction of the runway extension, USAF blueprints document the development of large settlements up to 30 cm of the runway pavement at the western threshold. Local repairs were performed in spring 1973, and during runway repavement in 1988-89, the entire section was excavated and replaced. In 2006, 17 years after reconstructions in the western part (1988-1989), new measurements document additional settlements in the same area. The settlements continue to develop, as documented by repeated measurements in 2011 (Asiaq, 2011). The embankment is about 15 m thick at this location and was constructed in two stages (6 m and 9 m) in an attempt to avoid trapping heat in the embankment construction. The cause of the settlements are presently unknown, but could be related to either constructional issues or the flowing of water through the embankment, causing thawing of the ice rich permafrost below. Restrictions presently apply to this part of the runway, banning usage until damages have been investigated and repaired

Six years later, a group of MSc students carried out an analytical survey making a grid of measurements 10x10m in western part of the runway and 50x50m at the rest of the runway. The results indicated severe

settlements equal to 52cm at the western threshold. Figure 2 depicts the progress of the settlements from every measurement that has carried out since the reconstruction of the runway in 1988/89, which is used as a reference considering no settlements that year.

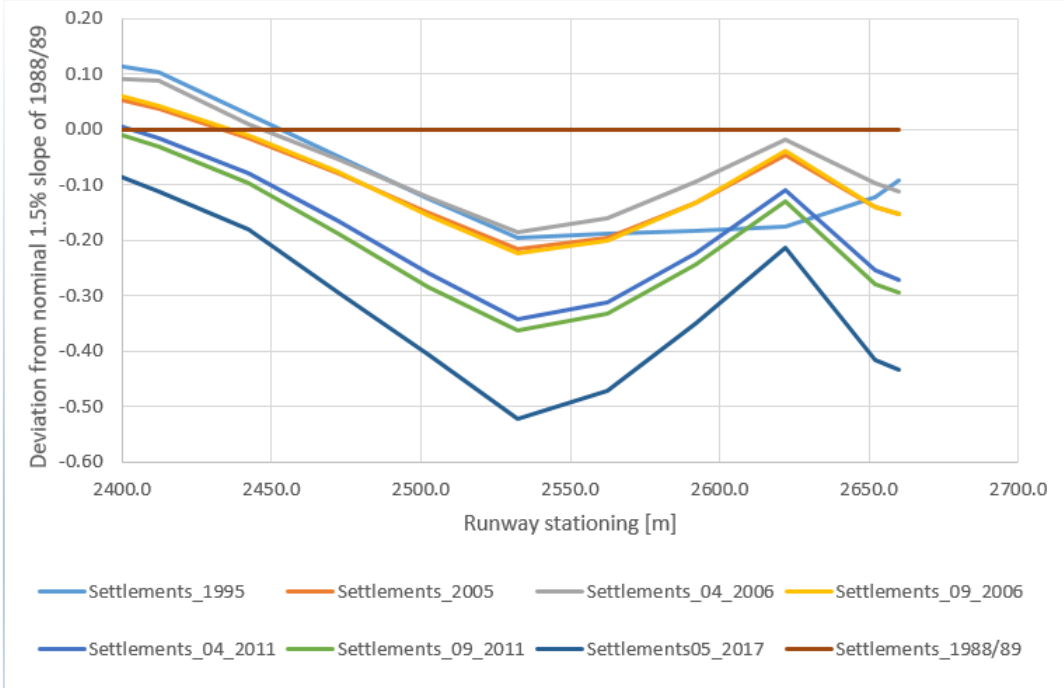

Figure 2: Settlements in the runway center line from 1988/89 to 2017 at the western threshold of Kangerlusuaq airport

Conclusions

The western part of the runway suffers from continuous severe settlements, caused probably by ice rich deposits and non-frost susceptible material used for the construction of the embankment. Another defect observed at the runway pavement is the inadequate and temporary repair of the joints filling with additional concrete. The cracks at the joints are caused probably due to the large thermal variance in the area. The surveying data analysis shows that the maximum annual settlement rate accurs at st. +2532m of the western threshold with an average value of 2.66 cm/year (from 1988/89 to 2017). The increase of settlements the following years could possibly lead to the shortening of the operational area for the airplanes.

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