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Development of Construction Properties of Warming Permafrost in Western Greenland Town Areas – A Preliminary Study

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In the light of projected industrial facilities and a general increase of inhabitants in the towns in Western Greenland, the utilisation of previously unused areas underlain by permafrost have become required as suitable bedrock outcrops in the town areas are running short. This study aims to describe the development of the construction properties of warming fine grained permafrost soils in two such urban areas.

The bearing capacity of permafrost soils that are maintained in the frozen state are usually high compared to non-frozen soils of the same composition. Especially for fine grained permafrost soils the transition from frozen to unfrozen state is known to entail a loss of bearing capacity as well as an increase of soil creep activity. With projected climate amelioration this pose a challenge to the desired service life time and foundation design of new constructions.

Permafrost soil cores of representative soil types have been sampled from the top of the permafrost zone in the townships of Sisimiut and Ilulissat situated at 66° to 69° northern latitude. Present soil temperatures vary from -3.5°C to 0°C. The preliminary classification testing classifies the soils as silty to very silty clays at both locations. Salinity as measured by concentration of Cl- ions is seen to be virtually 0 mg/L.

For each location three samples have been subjected to triaxial compression testing to determine the strength properties and another three samples have been subjected to oedometer testing to determine the deformation properties. For both tests samples have been tested at near-thawing temperatures of -3°C, -2°C and -1°C respectively.

Based on the triaxial tests the bearing capacity is evaluated based on Terzaghi's theory of soil bearing capacity and a bearing capacity-temperature curve is established. A temperature-strain rate-stress level diagram is established from the oedometer data. These curves could provide an efficient design tool for new construction designs in these areas if used in combination with a regional climate model capable of delineating the development of soil temperature. In this way the development of soil temperatures within the service life time of the construction can be predicted and the foundations designed based on the resulting corresponding bearing capacity available.

This approach is believed to contribute to a sustainable adaption of the new building mass to the projected climate changes and generally decrease maintenance costs of new constructions built on fine grained warm permafrost and subsequently prolong the effective service life time.