An Experimental Study of the Soil in the Terra Nova Bay, Antarctica

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1. INTRODUCTION
Korean government has decided to build the second antarctic research base at Terra Nova Bay in East Antarctic. There is permafrost where the sub-zero temperature lasts for more than 11 months throughout the year. The buildings such as the scientific research station may cause the support to be weakened by heating due to the energy-led ground behavior or cause a freezing-thawing cycle which might result in frost heave or thaw settlement, thereby eventually damaging the structure. For such reason, the evaluation of the soil freezing characteristic of the soils is very critical (e.g., Hong, 2007). Soil samples taken at Terra Nova Bay in the East Antarctica were transported to a laboratory in Korea, and tests were carried for soil freezing characteristics such as thermal conductivity, unfrozen water content, and unconfined compression strength.

2. SITE FOR CONSTRUCTION OF ANTARCTIC BASE
Terra Nova Bay, where the second antarctic research base will be built, comprises two peninsulas in the northwest-southeast and two bays. The peninsulas and bays are gently sloped and the two have similar features of glacial deposits and bedrock. The main ridge in the southwest is 600 m wide and 1.2 km long and the other ridge in the northeast is 300 m wide and 1.5 km long. A small bay is situated between the ridges. The site is adjacent to Campbell glacier in the east and glacier tongue is well developed to the ocean, while a cliff is formed by escarpment in the west (Korea Polar Research Institute, 2010).

3. GEOTECHNICAL AND FROST PROPERTY
3.1 Sample characteristics
The exposed land of Terra Nova Bay is mostly weathered rock bed, and the surface layer is covered with sand and gravel (glacial deposits) transported from a neighboring region during volcanic or glacial activities. The soil samples were taken from the surface at the proposed site and transported to the laboratory in Korea for testing. The key properties of the samples are outlined in Table 1.

3.2 Frost properties
The frost properties of soil samples from the Terra Nova Bay were investigated in a freezing chamber in KICT. The test results for the frost properties are summarized in Table 2.

3.3 Disscusion
The effect of unfrozen water content on the thermal characteristics of frozen soil is defined in Fig. 2. Thermal conductivity increases as unfrozen water content decreases, which is consistent with previous finding (Johansen 1975). The thermal conductivity was significantly reduced until the unfrozen water content was 15%. The thermal conductivity began converging after 15% unfrozen water content, and then it was slightly affected by unfrozen water content. Interestingly, the thermal conductivity can be estimated with following equation,

\[ \text{K} = 0.004\text{W}_0^2 - 0.187\text{W}_0 + 3.8 \]  

Mean values of measured unconfined compressive strengths are correlated with the results of unfrozen water content tests as shown in Fig. 3. Even though tested specimens were different, correlation between measured unconfined compressive strength and unfrozen water content can provide some information to estimate soil strength as a function of unfrozen water content. Fig. 3. shows that the correlation can be expressed with reasonable accuracy as

\[ q_u = -7.9\text{W}_0 + 1.91 \text{(kg/cm}^2\text{)} \]  

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