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On the compressibility and temperature boundary of warm frozen soils

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A silty-clay obtained along the Qinghai-Tibetan railway and a standard Chinese sand were taken as study objects. Saturated frozen soil samples were prepared for testing. Step-load was used and confined compression was carried out on the soils under different temperatures. Compression index and pseudo-preconsolidation pressure (PPC) were obtained. Unlike unfrozen soils, PPC is not associated with stress history. However, it is still the boundary of elastic and plastic deformations. Different compression indexes can be obtained from an individual compression curve under pressures before and after PPC. The parameters at different thermal and stress conditions were analyzed. It is found that temperature plays a critical role in mechanical behaviours of frozen soils. Efforts were then made on the silty-clay in order to suggest a convincing temperature boundary in defining warm frozen soil. Three groups of ice-rich samples with different ice contents were prepared and tested under confined compression. The samples were compressed under a constant load and with 5 stepped temperatures. Strain rates at different temperatures were examined. It was found that the strain rate at around -0.6°C increased abruptly. Analysis of compression index was performed on the data both from our own testing program and from the literature, which showed that at about -1°C was a turning point in the curves for compression index against temperature. Based on both our work and taking into account the unfrozen water content vs. temperature, the range of -1°C to -0.5°C seems to be the temperature where the mechanical properties change greatly. For convenience, -1.0°C can be defined as the boundary for warm frozen soils.