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Load Transfer of Steel Pipe Piles in Warming Permafrost

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Abstract : As the permafrost continues to melt in the northern regions due to global warming, a soil-water mixture is left behind with drastically lower strength; a phenomenon that directly impacts the resilience of existing structures and infrastructure systems. The frozen soil-structure interaction, which in ice-poor soils is controlled by both interface shear and ice-bonding, changes its nature into a sole frictional state. Adfreeze, the controlling mechanism in frozen soil-structure interaction, diminishes as the ground temperature approaches zero. The main purpose of this paper is to capture the altered behaviour of frozen interface with respect to rising temperature, especially near melting states. A series of pull-out tests are conducted on model piles inside a cold room to study how the strength parameters are influenced by the phase change in ice-poor soils. Steel model piles, embedded in artificially frozen cohesionless soil, are subjected to both sustained pull-out forces and constant rates of displacement to observe the creep behaviour and acquire load-deformation curves, respectively. Temperature, as the main variable of interest, is increased from a lower limit of -10°C up to the point of melting. During different stages of the temperature rise, both skin deformations and temperatures are recorded at various depths along the pile shaft. Significant reduction of pullout capacity and accelerated creep behaviour is found to be the primary consequences of rising temperature. By investigating the different pull-out capacities and deformations measured during step-wise temperature change, characteristics of the transition from frozen to unfrozen soil-structure interaction are studied.

Keywords : Adfreeze, frozen soil-structure interface, ice-poor soils, pull-out capacity, warming permafrost
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