Soil-Pile Interface Shear Strength Under Thermal Loading

1. Introduction

Energy piles are defined as dual-purpose structural elements. They utilise the required ground-concrete contact element to transfer the superstructure loads to the ground as well as acting as a heat exchanger unit. Several studies have highlighted the importance of gaining better understanding of coupled loading conditions and temperature effects on the soil-pile interaction mechanism. In particular, the effect of temperature cycles on side friction as it has been postulated that contraction during cooling and/or cycles of heating and cooling may lead to a decrease in side friction or shaft friction degradation.

2. Shearbox Test

A modified shearbox is used to study soil-pile interface shear strength under different temperatures. The modified shear box has a heating element placed at the bottom. The lower half of the box was reproduced with PTFE material to reduce lateral heat transfer and heat loss from the bottom side.

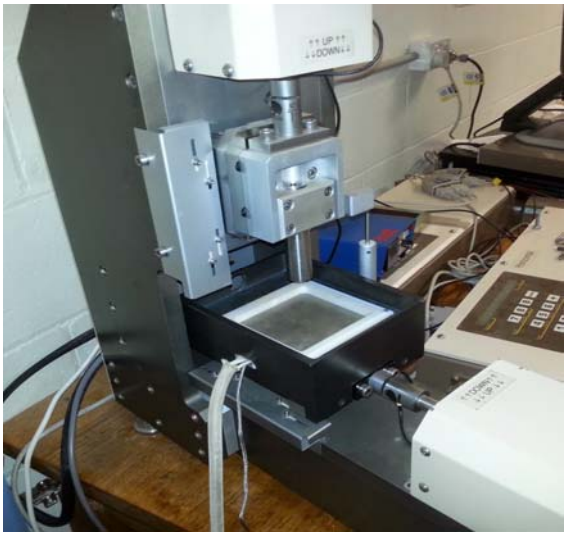

Figure 1 Modified shear box

Figure 2 Thermal conductivity test apparatus

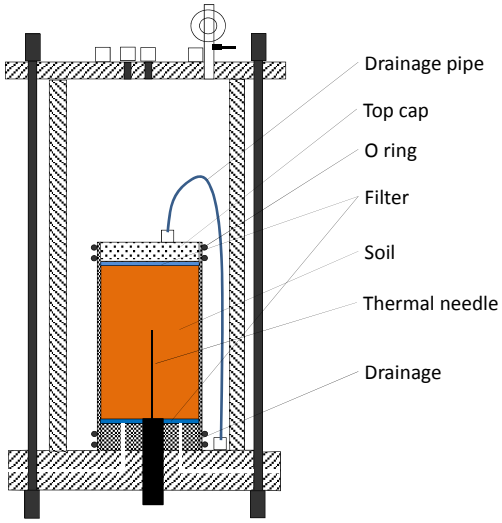

Figure 3 Schematic diagram of thermal conductivity test

3. Triaxial Cell Thermal Conductivity Test

Soil samples are placed in a triaxial cell to investigate the effect of confining pressure on thermal conductivity. During the test, different confining pressures are applied and a thermal needle sitting at the centre of soil samples is used to measure thermal conductivity.

The following equations are used to calculate the thermal conductivity:

$$\Delta T = \frac{Q}{4\pi\lambda}\ln(t) \qquad 0 < t \le t_1$$

$$\Delta T = \frac{Q}{4\pi\lambda}\ln\left(\frac{t}{t-t_1}\right) \qquad t > t_1$$

4. Computer Modeling

Numerically simulated shearbox test will be compared with experimental work. PFC (Particle Flow Code) will be used for the modelling work.

5. Conclusions

Interface shear strength under thermal loading is a complex problem. A range of variables other than temperature such as roughness, constant normal stiffness and shearing rate need to be investigated to gain a better understanding of the mechanisms governing soil-pile interface behaviour under thermal loads.

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