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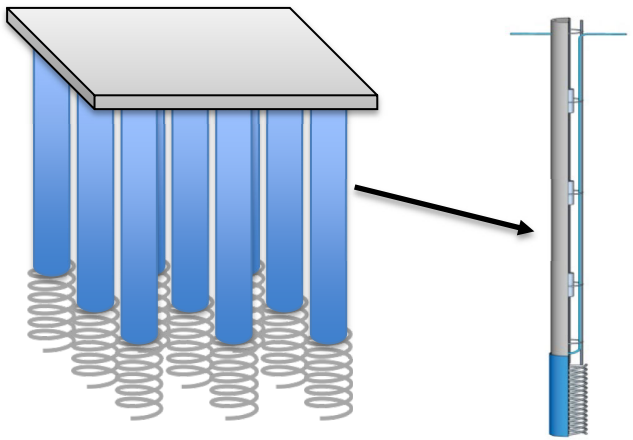
Thermo-mechanical behaviour of floating energy pile groups in sand

Key words:

Energy pile; Floating pile;

Pile group; Nonuniform thermal;

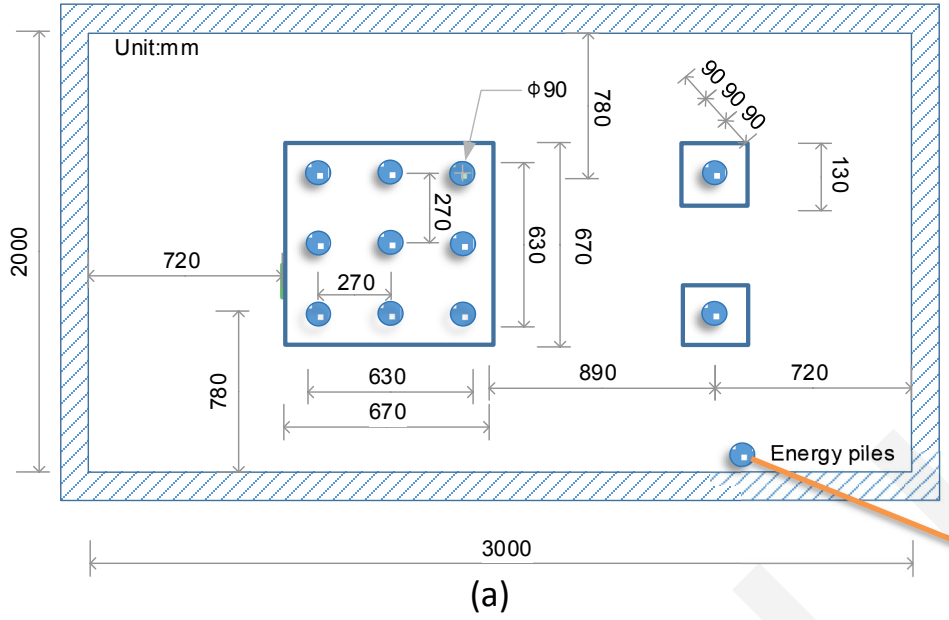
Nonuniform displacement



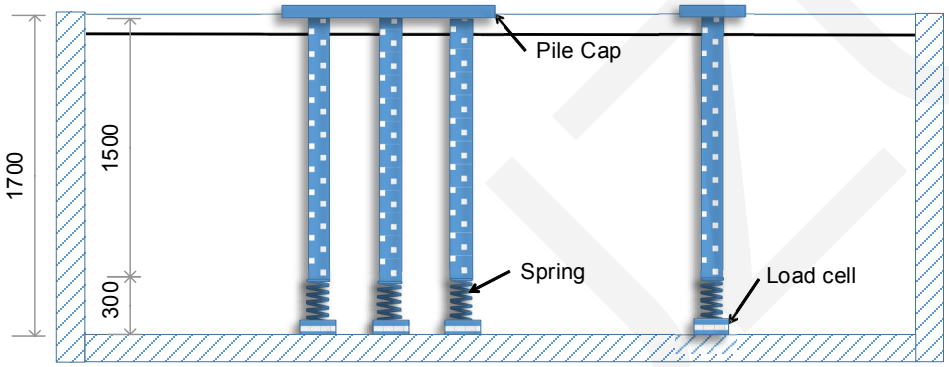
能源岩土国际合作联合研究中心

International Joint Research Center for Energy Geotechnics

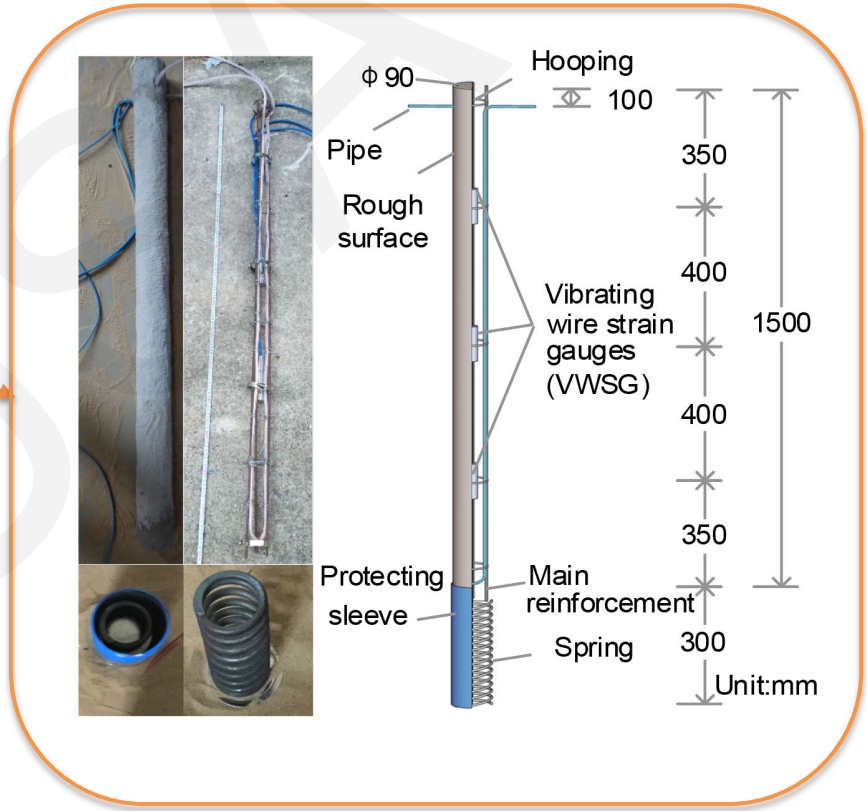
LAYOUT OF MODEL TEST



(a)

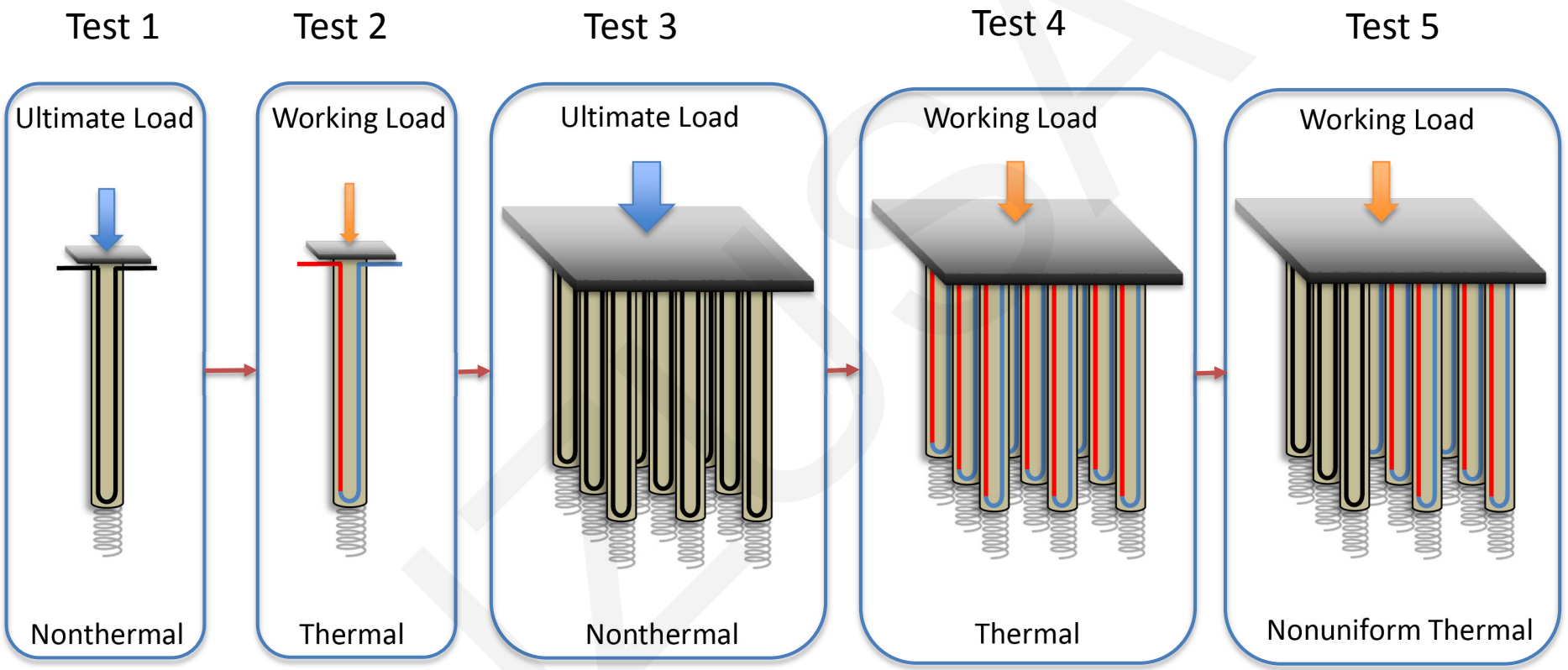


(b)



Layout of model test and the energy piles with sensor:
(a) cross section; (b) vertical section

METHOD


Test 1
Ultimate Load
Nonthermal
Test 2
Working Load
Thermal
Test 3
Ultimate Load
Nonthermal
Test 4
Working Load
Thermal
Test 5
Working Load
Nonuniform Thermal

RESULTS AND CONLUSIONS

- For long term heat exchange analysis of an energy pile group, the results of this study suggest that the energy pile group could be represented as a block heat exchanger unit with a surface temperature equal to the average temperature of the energy pile surface. The heat exchanger block has a cross sectional area equal to the gross area of the pile group, and its length is equal to the pile length.
- For the single energy floating pile, under the heating condition the pile top displacement was larger than the pile tip displacement as the restrained boundary condition (lateral confining pressure) was stronger in the lower half of the pile.
- Under the cooling condition, the single floating pile showed a downward soil-pile slippage due to a cooling-induced volume contraction effect that reduced the lateral confining pressure on the pile and consequently reduced the pile skin friction resistance.
- The thermal displacement of an energy floating pile group cap under the heating condition is a function of the restrained boundary condition of the top half of the pile group. As the small-scale tests conducted in this study had low confining pressure on the top half of the pile, the thermal displacement of the cap of the pile group was equal to the value of the free thermal condition.

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RESULTS AND CONLUSIONS

- Under the cooling condition, the pile-slippage magnitude of pile group was larger than that of the single pile, as the pile group interaction effect reduced the pile skin friction resistance.
- The pile tip thermal displacement of the inner pile in the group showed more downward movement under the cooling condition since this pile had a higher pile interaction effect.
- For the case where not all the piles in the group were thermally active, nonuniform displacement could occur. However, under the heating condition, this behaviour is a function of the pull-out resistance of the nonthermal pile, whereas under the cooling condition, it is controlled by the re-duction in the skin friction of the thermal pile due to the cooling-induced volume contraction behaviour.
- The thermally induced axial pile stress change is a function of the restrained boundary condition of the pile, which is determined mainly by the lateral confining pressure on the floating pile. Therefore, as pile interaction could reduce the restrained condition of the pile group, the thermally induced axial stress was larger for the single pile than for a pile in a group.

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