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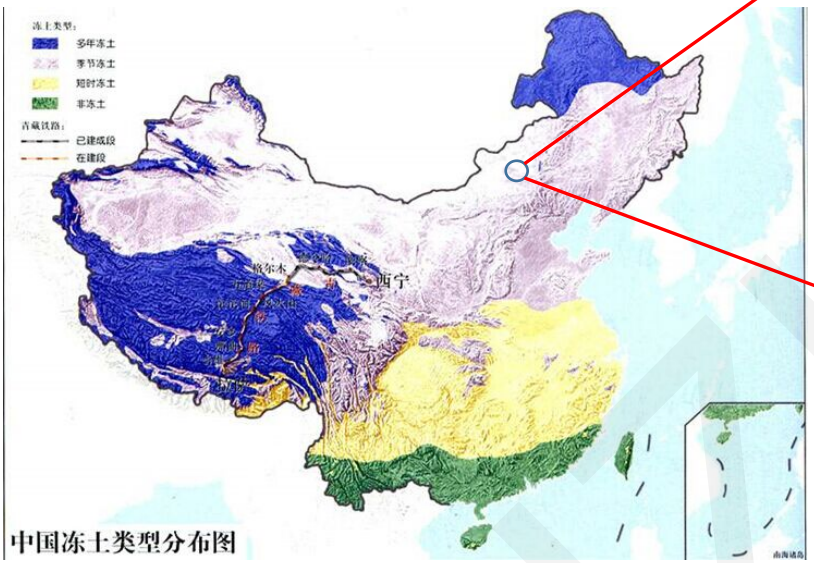
Experimental study on the anti-jacking-up performance of a screw pile for photovoltaic stents in a seasonal frozen region

Keywords:
Seasonal frozen region, Screw pile, Frost heave, Similarity principle, Jacking-up

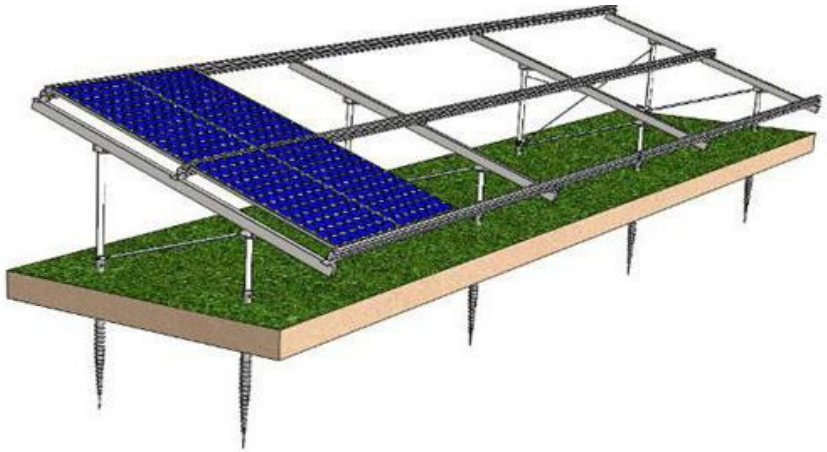
Engineering Background



Seasonal frozen soil distribution

Photovoltaic stents

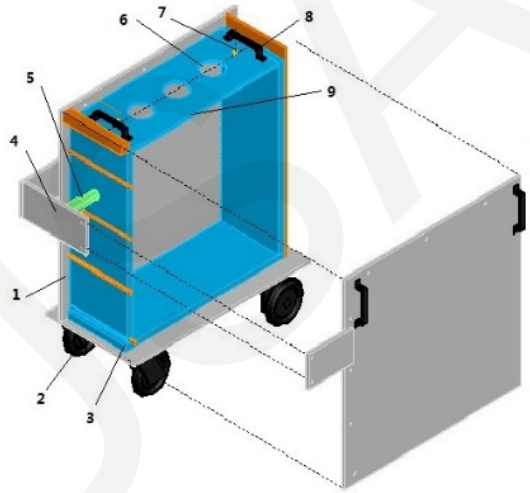
Screw piles are adopted to control uneven frost heave



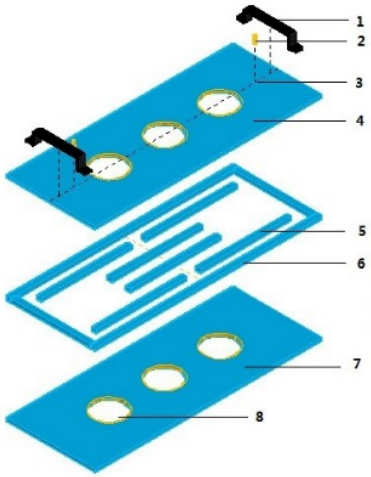
Test Method

Test box

(1000*mm* ×1000*mm*×400*mm*)



1 steel box
2 road wheel
3 shaft
4 jack base
5 screw jack
6 screw pile hole
7 water inlet
8 handle
9 upper cool bath board



1 handle
2 water inlet&outlet junction
3 water inlet
4 upper steel board
5 stiffener
6 frame
7 subjacent steel board
8 screw pile hole

Model piles in test *Length: 700mm, (scale:1:3)*

All-bladed pile

Small-double-blade pile

Large-double-blade pile

Small-half-bladed pile

Large-half-bladed pile

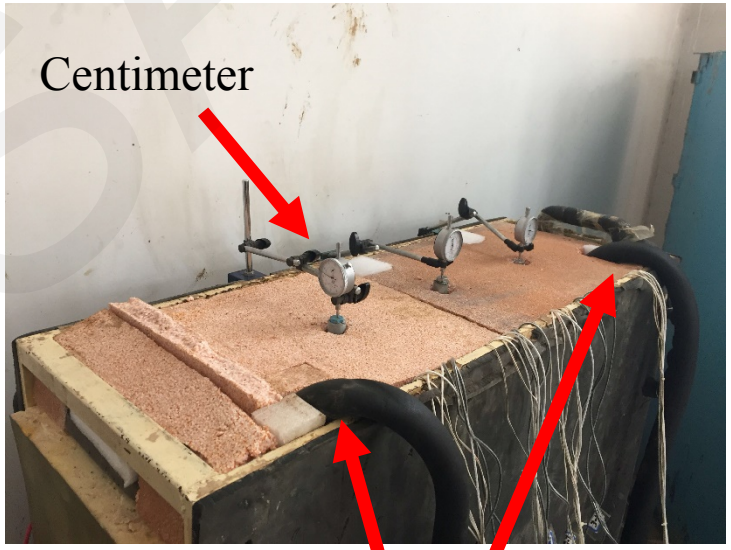
Smooth pile

Temperature sensors in *PVC tubes*

Screw piles

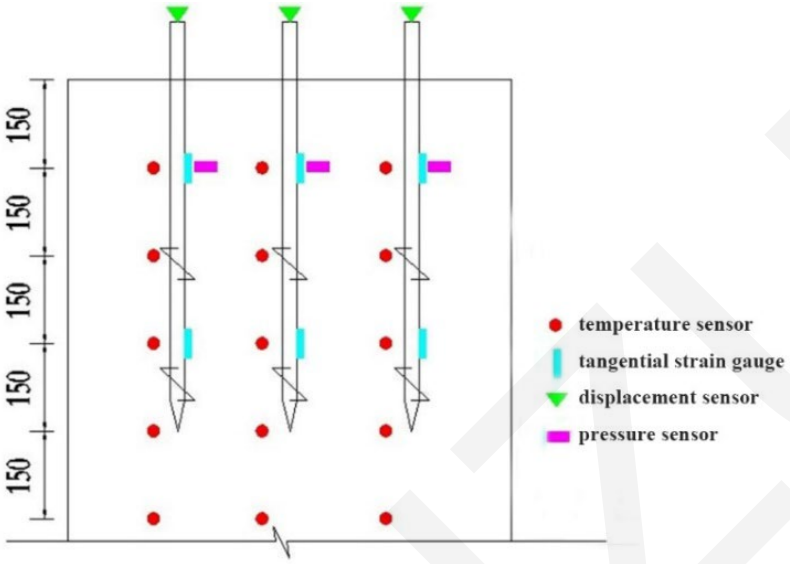
Hammer

Compaction

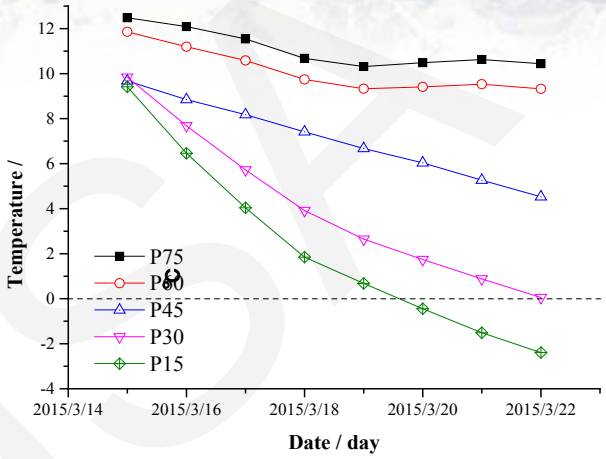


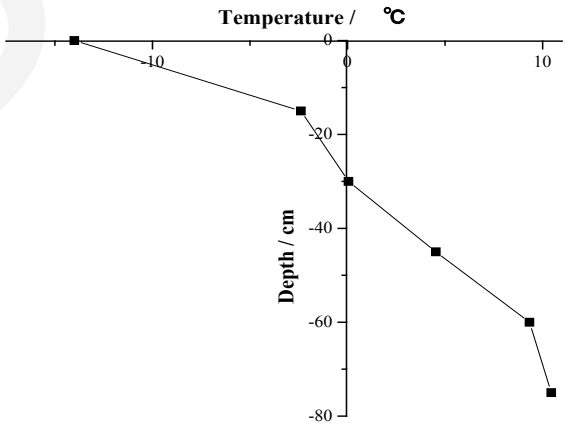
Inlet and outlet of cooling bath

Results Analysis

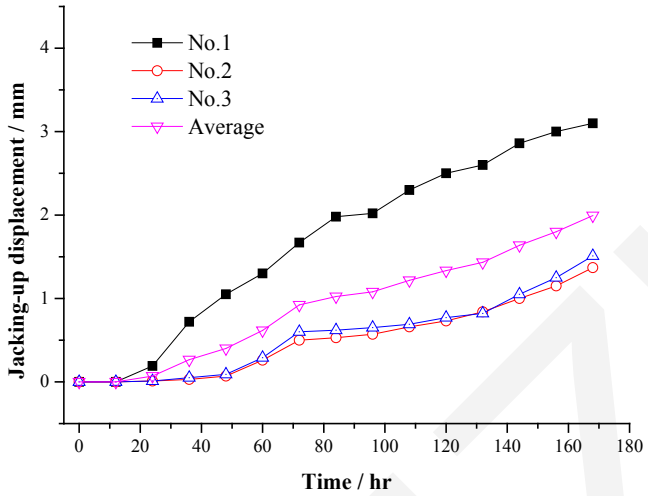


Layout of sensors

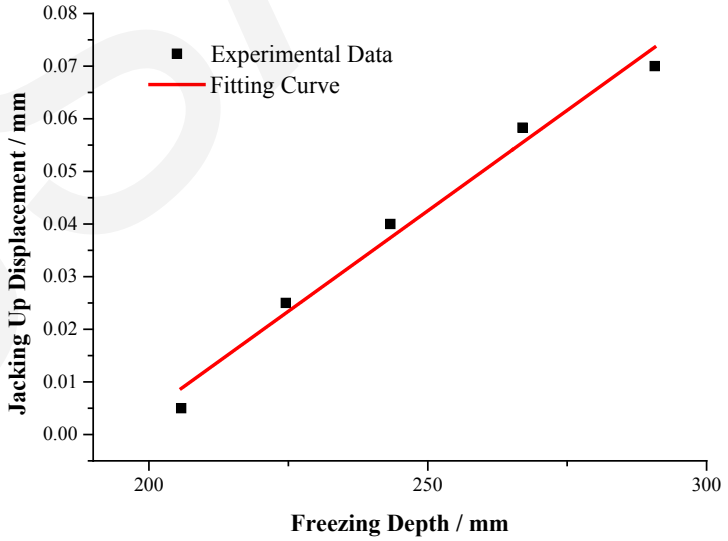




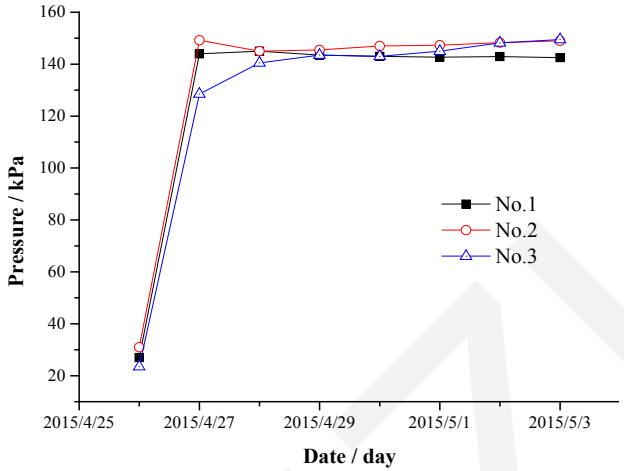
Temperature distribution of small-double-blade pile



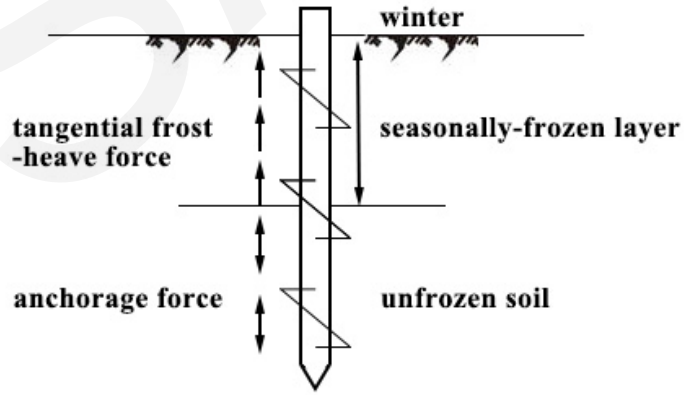
Jacking-up displacement of all-bladed pile



Jacking-up displacement varying with freezing depth



Soil Pressure varying with time



Schematic diagram of the screw pile

Conclusions

1. In the jacking-up test of piles, the displacement of the screw piles was generally smaller than that of the smooth pile, which proved the effectiveness of screw piles in seasonal frozen regions. It should be noted that the same patterns occurred in sample A and B.

2. The results showed that large-double-blade piles could inhibit jacking-up most effectively in seasonal frozen regions where the freezing depth reaches 0.9m in winter. Screw blades were also recommended to be deployed in unfrozen regions. According to the results, the jacking-up displacement increasing order is: large-double-blade pile < large-half-bladed pile < small-half-bladed pile < small-double-blade pile<all-bladed pile<smooth pile.

3. For each pile, the linear relationship between the jacking-up displacement and freezing depth was obtained respectively. The slope of the fitting line ranged from 6.83×10^{-4} to 1.47×10^{-2}.This could be applied for prediction when the freezing depth is clear.

4. Soil pressure increased greatly when the water in the pore began to freeze, but changed little when the ice content became stable. It indicated that the soil pressure remained stable in the frozen zone during the freezing process.