



***Evening talk titled “Applications of Centrifuge Modeling for the Study of Soft Soil Problems” by Prof. Leung Chun Fai***

*By Ir. Chua Chai Guan*

The talk took place on 08 April 2010 at the Tan Sri Professor Chin Fung Kee auditorium. It commenced at 5.30 p.m. and was attended by 30 participants. Professor Leung Chun Fai is a professor in the Department of Civil Engineering, National University of Singapore. His research interests include offshore geotechnics, soil-structure interaction, water front structures and centrifuge modeling.

Centrifuge modelling is now established as a versatile and reliable technique to study geotechnical problems. The stress conditions of a full-scale prototype can be recreated in a centrifuge model with a scale factor  $N$  (i.e. all the linear dimensions in the model reduced  $N$  times) where  $N$  times  $g$  (acceleration due to Earth's gravity) is the acceleration field of the centrifuge. Based on scaling law, the time for consolidation in the model can be shortened by  $1/N^2$  as well. The talk highlighted the findings of centrifuge model studies conducted at NUS on piles subject to negative skin friction, piles subject to soil movement due to excavation and tunneling and offshore jack-up spudcan foundation problems.

Different load distribution patterns developed along a single pile shaft were presented for different scenarios of the pile in consolidating clays, re-consolidating of remoulded clays, ground water drawdown and new fill. The centrifuge model clearly demonstrated that after sufficient axial load on pile, the lock-in negative skin friction (NSF) disappeared if there was no further soil settlement and the phenomenon of negative skin friction and axial load transfer appeared to be independent. The model on the pile group revealed that (a) Corner piles experienced the largest NSF drag load followed by side piles. Inner piles experienced the least NSF. (b) There was a clear trend of decreasing dragload, and thus increasing group reduction factor with increase in the size of a pile group. (c) With larger surcharge and hence larger ground settlement, there was a larger mobilisation of NSF drag load on the pile group and correspondingly much smaller group reduction factors.

The second problem presented was piles subject to lateral movement resulted from slope cut and excavation.

The findings from the centrifuge model were (a) Excavation resulted in soil stress relief in front of excavation and there was a reduction in soil strength after excavation. (b) Conventional theory (limiting soil pressure =  $9c_u$ ) would over-predict the induced pile bending moment (BM). (c) Conventional theory could predict the pile BM if post-excavation reduced soil strength was used. (d) If limiting soil pressure on the pile was taken as  $6c_u$ , conventional theory could also predict the pile BM using pre-excavation original soil strength profile for the given test configuration.

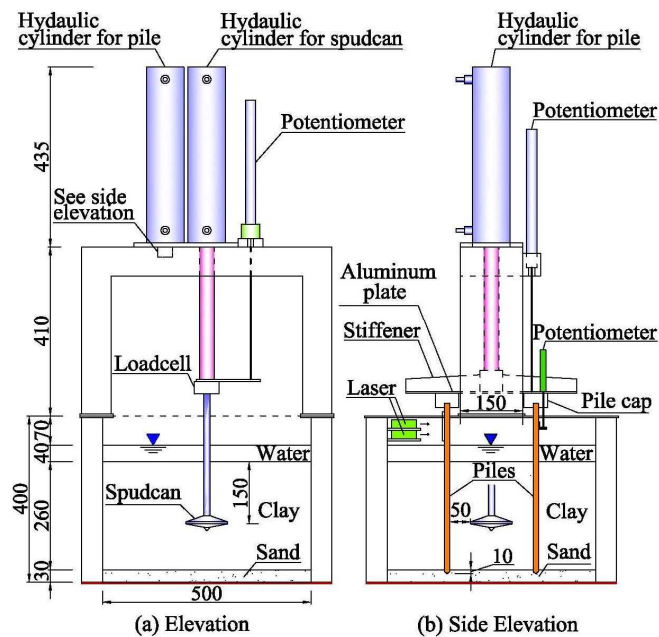


Figure 1: Centrifuge model set-up for Spudcan-pile interaction study

The third centrifuge model demonstrated that how a pile foundation interacted with tunneling activities. The soil displacement trajectory caused by tunnelling was derived using particle image velocimetry (PIV) technology. Besides that, the model captured how negative skin friction developed due to settling soil around the pile shaft and the direction of pile bending due to tunnel deformation.

The last presented application of centrifuge modeling was offshore jack-up spudcan foundation problem. The punch-through failure mechanism by a spudcan in stiff over soft clays was clearly captured using PIV technique. The analysed soil movement patterns at different clearance distances between the spudcan foundation and adjacent permanent jacket piled foundation were then used to study the interaction between spudcan and pile. It was found that the adjacent free head pile would experience bending stress at different directions at different spudcan penetration depths, as well as tension loads due to upward soil movement.

The talk ended at 7.00 p.m. with a round of applause from the audience for Prof. Leung's well delivered presentation.