Workshop titled "Advance Topics in Pile Foundation Design" by Prof. Leung Chun Fai

By: Ir. Chua Chai Guan

The workshop was held on 8 and 9 April 2010 at the Tan Sri Professor Chin Fung Kee auditorium and was attended by 90 participants. Presented by Prof. Leung Chun Fai, the workshop also featured three guest speakers from the industry. They were Ir. Tan Yean Chin, Ir. Liew Shaw Shang and Ir. Au Yong Yoke Lin.

Professor Leung is a professor in the Department of Civil Engineering, National University of Singapore. He is a chartered civil engineer of UK and a professional engineer (Geotechnical specialist) in Singapore. He has served as geotechnical consultant for many marine and onshore projects for government organisations and private companies in Singapore and overseas.

He highlighted that civil engineers were familiar with design of axially loaded piles. However, they may need to design piles for widely different scenarios. The workshop was designed to equip participants with advance topics covering the capacity and deflection of laterally loaded piles in soils & rocks, lateral pile load test, raked piles and piles subject to soil movement (embankment, excavation, tunnelling, negative skin friction and pile driving).

Prof. Leung introduced that the capacity of laterally loaded pile could be deduced from the method proposed by Broms (1964(a) & 1964(b)) for the cases of long & short piles with the unrestrained and restrained pile head conditions in clays and sands, respectively (see Figure 1). He further pointed out that the group efficiency was expected to be below one if the ratio of pile spacing/pile diameter was less than 8 for laterally loaded pile group.

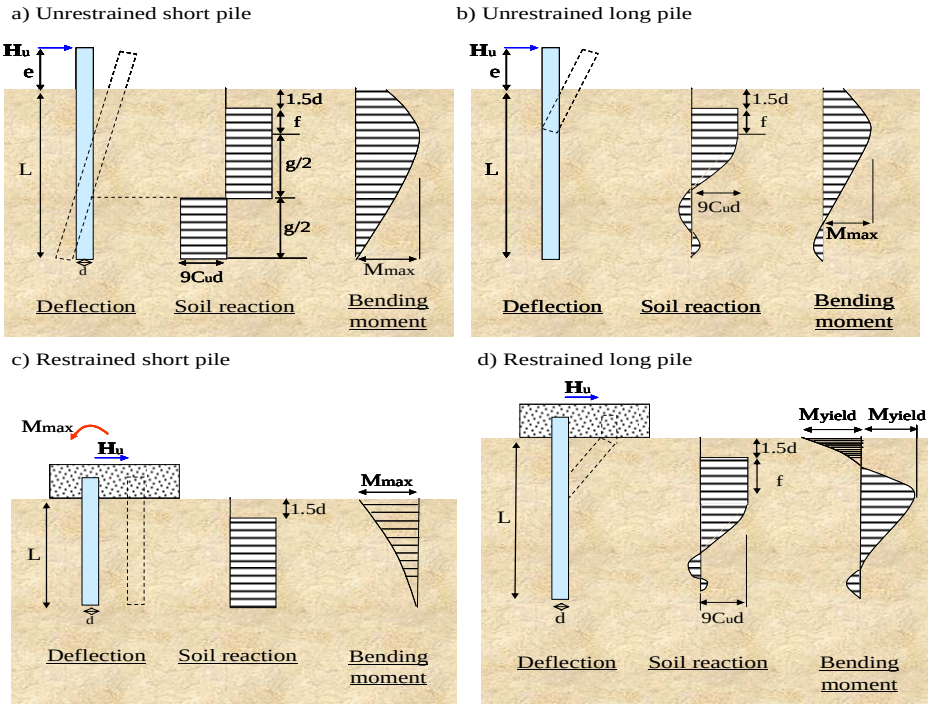

Figure 1: Pile deflection, soil reaction & bending moment in clays

Prof. Leung revealed that the deflection of laterally loaded pile can be estimated using elasticity theory or subgrade reaction model. He also introduced various correlations between subgrade modulus, young modulus, undrained shear strength and SPT 'N'. The method for estimating capacity and deflection of laterally loaded rock-socketed piles proposed by Randolph (1981), Poulos & Davis (1980), Carter & Kulhawy (1992) and Reese (1997) were demonstrated. He went on to share with participants some interesting findings from lateral pile load tests. The top 5 pile diameter governed the performance of a laterally loaded socketed pile and the contribution of a rock socket was relatively insignificant if it was located 5 pile diameters below the ground. Thus it is usually sufficient to design the pile against top soil.

The workshop continued with the design of raked piles by referring to Poulos Method (2006). Prof. Leung pointed out that raked piles are generally good for no soil movement cases. However, raked piles may NOT be good in certain cases of ground movement (caused by settling soil or lateral soil motion due to earthquake, construction activities etc). Engineers need to exercise good judgment on whether to use raked piles or NOT!

Another thing highlighted was the subtle differences between the behaviour of laterally loaded piles and that of piles subject to lateral soil movement. The conventional design methodology on laterally loaded piles cannot be applied to the latter mainly due to

a) Lateral displacement of each pile element is related to pile bending stiffness and horizontal pile-soil interaction stresses.
b) Lateral displacement of the corresponding soil element is related to soil stiffness, pile-soil interaction stresses, and free-field lateral soil movement (instead of applying lateral load H and bending moment M as for conventional lateral load case).
c) A limiting lateral pile-soil stress can be specified so that local soil failure can be allowed, thus permitting a non-linear response to be obtained (e.g. limiting pressure = 9 times undrained shear strength of clay).

A few case studies related to the design of piles subject to soil movement were presented:-

a) Piles in slope stability cases e.g. piles supporting embankment and piles located within excavation sites
b) Piles located behind an unsupported or a supported excavation work
c) Long piles adjacent to tunnels and short piles adjacent or on top of tunnels
d) Behaviour of piles subject to negative skin friction from centrifuge model tests
e) Soil movement caused by a large number of large diameter precast spun piles installed at a site with deep deposits of soft clay and 30m away

Each presented case was deliberated with an analytical methodology coupled with a parametric study. This followed by discussions and examples of calculations. In between the lectures, the three guest speakers also shared their practical experiences in piling works. The workshop ended with a round of applause from the participants.