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Title of presentation: Centrifuge modelling of piled foundations in swelling clays

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Geotechnical area: Piled foundations in swelling clays

Background

- The appropriate procedure for obtaining conservative estimates of pile shaft capacity in expansive unsaturated clays is currently uncertain.
- Pile shaft capacity (Qs) is governed by:
  - Lateral stress against pile shaft and
  - Soil shear strength

  …both of which vary significantly during swell.
- Conflicting literature has reported:
  - Increases in shaft capacity due to an increase in lateral pressure (Blight, 1984)
  - Reductions in shaft capacity due to soil softening (Elsharief *et al.*, 2007)

Experimental approach

- The clay tested in this study was a highly expansive South African clay with the following basic properties:
  - Liquid limit = 92%
  - Plasticity index = 55%
  - BS classification: clay of extremely high plasticity (CE)
- Centrifuge modelling of a pile embedded in a clay profile was conducted to monitor:
  - Changes in lateral pressure against the pile shaft during swell and
  - The penetration resistance at the clay's natural moisture content, and after allowing a targeted amount of swell to occur

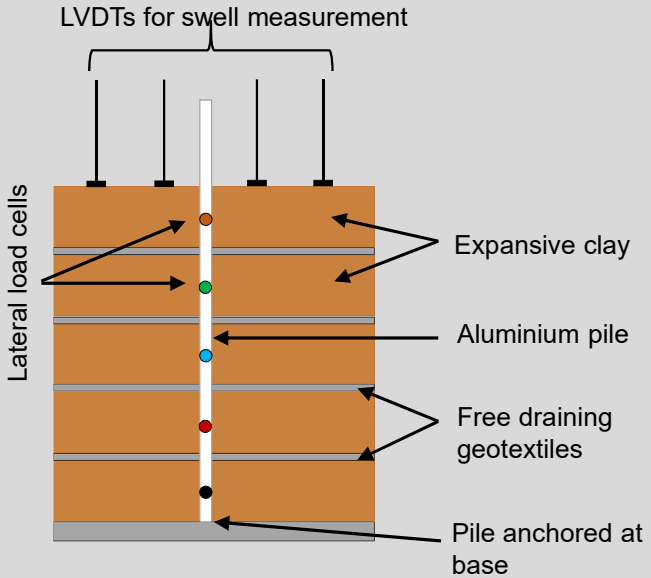

Figure 1: Simplified schematic of model setup

In-flight cone penetration testing (CPT)

- CPTs were performed:
  - At the clay's natural water content and
  - After allowing a targeted value of swell to be achieved (≈ 2.2% average surface swell)

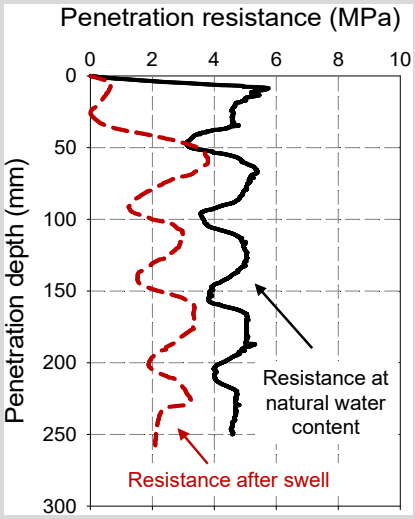

Figure 2: In-flight measurements of penetration resistance

Variation in lateral pressure during swell

- The centrifuge test results illustrated:
  - Initial increases in lateral pressure can increase the shaft capacity at small magnitudes of swell
  - At greater magnitudes of swell, soil softening becomes the dominant mechanism and can result in significant reductions in shaft capacity

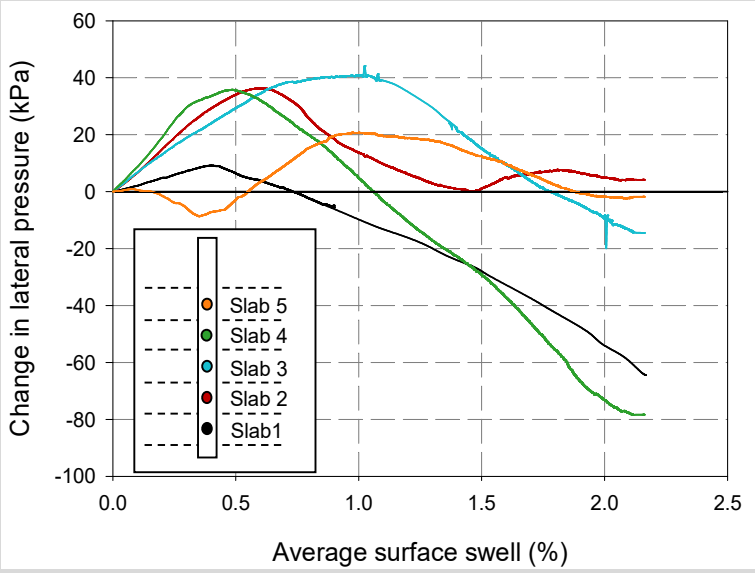

Figure 3: Variation in lateral stress against pile shaft during swell

Conclusion

- Pile shaft capacity in a swelling clay varies with time as it depends on the amount of swell which has occured.
  - At relatively small magnitudes, increases in lateral pressure can increase shaft capacity.
  - At higher magnitudes of swell, clay softening can act to reduce pile shaft capacity.

References

- Blight, G. E. (1984). Power Station Foundations in Deep Expansive Soil. *First International Conference on Case Histories in Geotechnical Engineering*, Missouri, pp. 77-86.
- Elsharief, A. M. Ahmed, E. O. & Mohamedzein, Y. E. A. (2007). Guidelines for the Design of Bored Piles in Expansive Soils in Sudan. *Graduate School Conference on Basic Science and Engineering*, University of Khartoum.