Design of suction foundations

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Design of Suction Foundations

Keynote paper summary:

- The keynote paper focuses on the more complex design issues and some pitfalls related to suction foundation design, in addition to summarising design practices and recommendations for basic understanding
- When technically feasible, suction foundations are often cheaper than pile foundations, their installation is relatively noise-free and, by applying overpressure, they can be fully removed during decommissioning
- Suction foundations have been deployed in the last three decades in a growing number of offshore developments, for bottom-fixed and floating structures, in shallow and deep waters, many of them successfully

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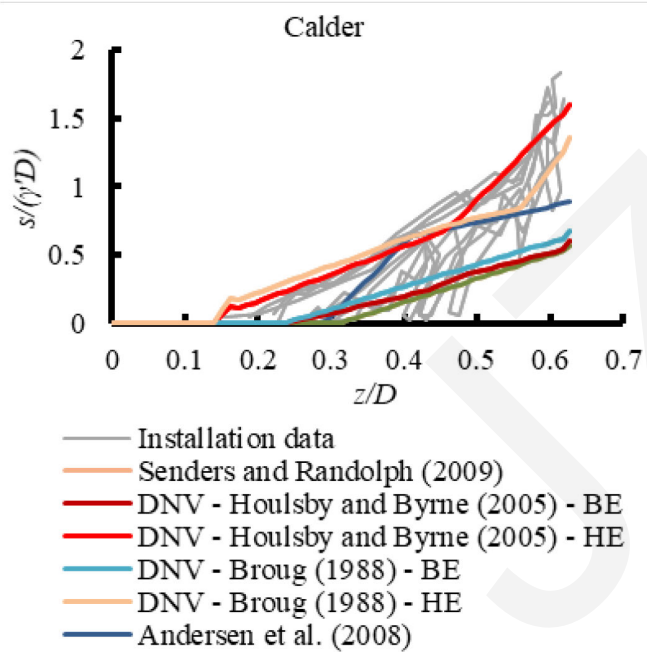
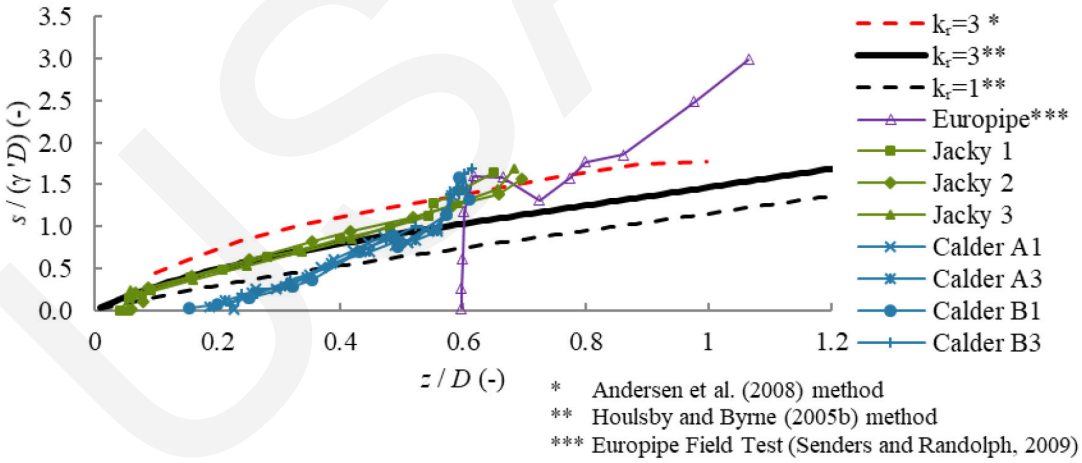
Design of Suction Foundations

Suction foundation installation feasibility:

- In dense sand, the theoretical suction pressure can be exceeded, due to soil arching





- There are significant differences between measured data and prediction methods in sand; no method provides consistently good predictions
- Installation in layered soils is feasible, but can be complicated especially for a clay over sand profile

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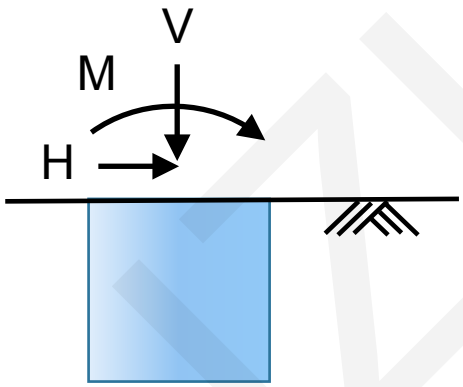
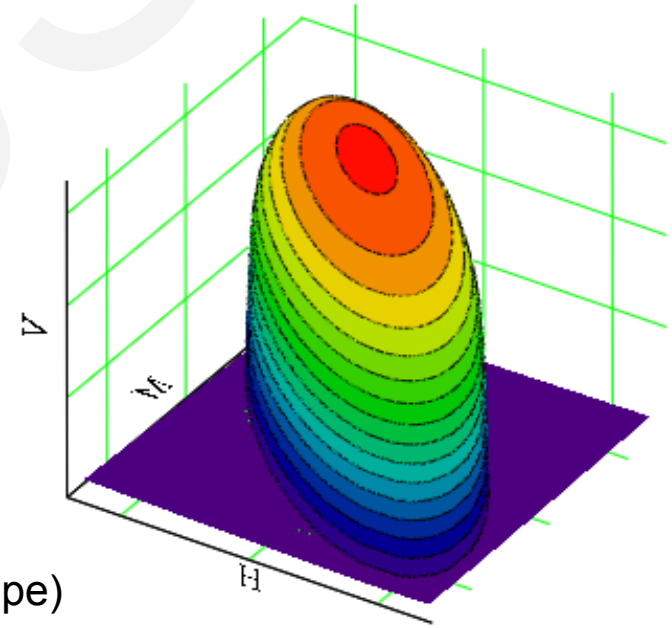
Suction foundation resistance:

- Suction caissons can resist VHM loads
- Usually the M resistance is high
- Optimized caisson design: VH resistance only (i.e. no M)





Resistance (VHM envelope)

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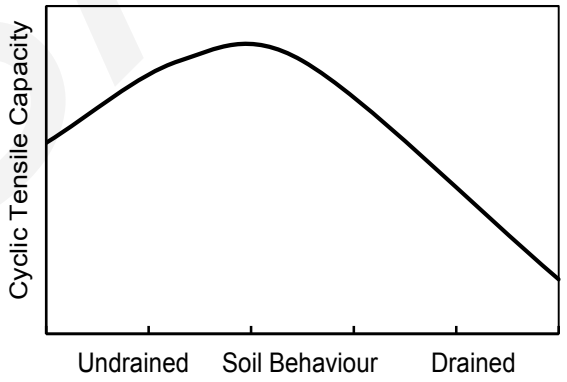
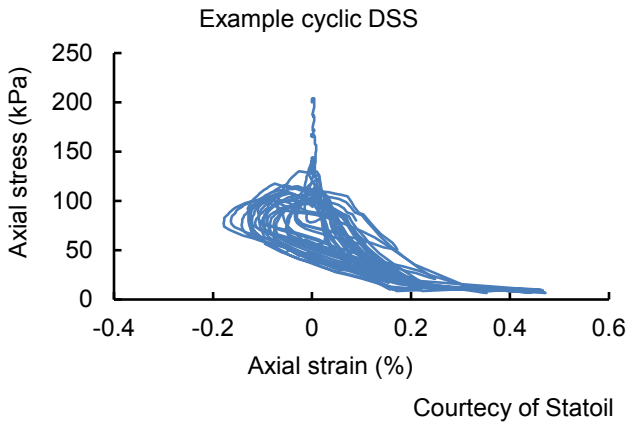
Suction foundation resistance:

- Soil response can be drained, partially drained and undrained
- Partially drained conditions can result in high soil resistance; resistance depends on soil permeability, which is difficult to assess
- Cyclic loading degrades soil strength
- Inadequate strain control in undrained cyclic DSS laboratory control can lead to incorrect interpretation of pore pressure, which may be difficult for dense sand; this may lead to overprediction of capacity





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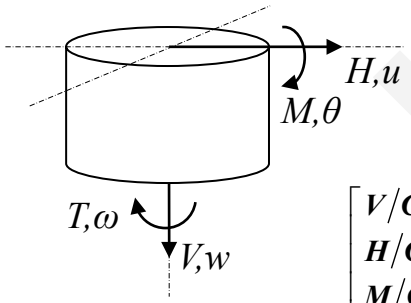
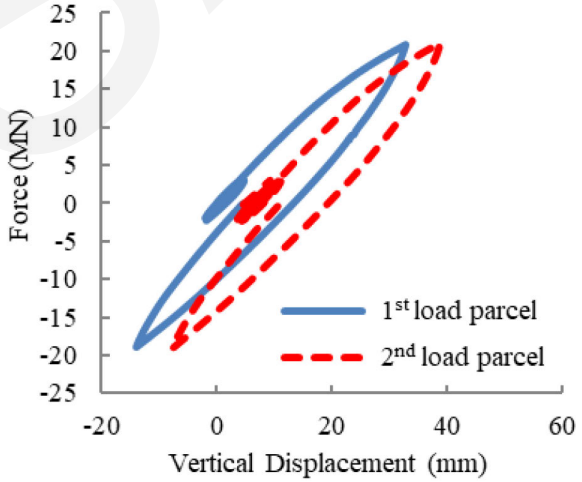
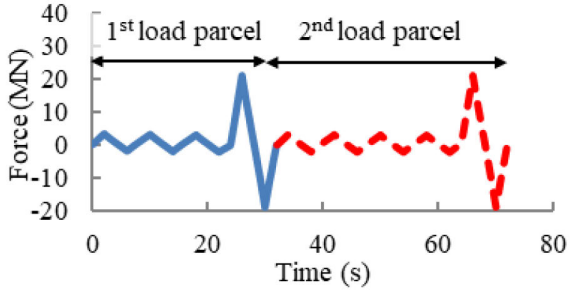
Suction foundation serviceability:

- Structural analysis typically requires linear stiffness matrices, soil shear modulus typically varies with shear strain and loading conditions (e.g. monotonic or cyclic)
- Additional foundation settlements can occur due to consolidation and post cyclic reconsolidation settlements
- Ratcheting in sand can occur due to cyclic non-recoverable plastic deformation; ratcheting depends on loading rate and soil permeability



$$\begin{bmatrix} V/GR^2 \\ H/GR^2 \\ M/GR^3 \\ T/GR^3 \end{bmatrix} = \begin{bmatrix} K_V & 0 & 0 & 0 \\ 0 & K_H & K_{HM} & 0 \\ 0 & K_{MH} & K_M & 0 \\ 0 & 0 & 0 & K_T \end{bmatrix} \begin{bmatrix} w/R \\ u/R \\ \theta \\ \omega \end{bmatrix}$$





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