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Moment loading of caissons installed in saturated sand

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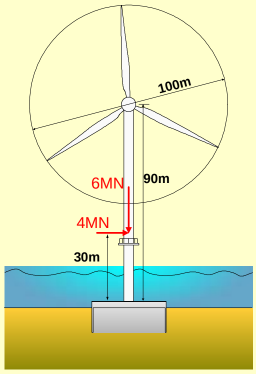
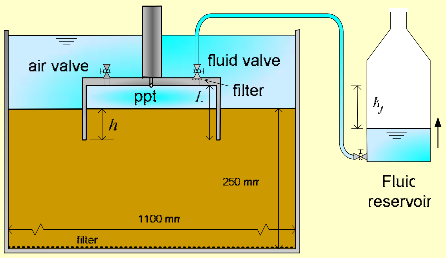
Proposed Foundation

Suction caissons are being considered as foundations for offshore wind turbines. A monopod caisson must be designed to support a typical 3MW turbine against environmental loads. The predominant loading involves very low vertical load in comparison with the horizontal and moment loads at the caisson level.

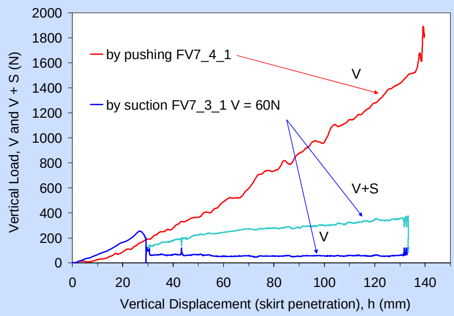


Experimental Approach

- Laboratory testing was performed in a dense, saturated sand to study how the moment capacity of a caisson is affected by the method of installation.
- Two caissons with similar aspect ratios *L/2R* = 0.5 and different thickness ratios *2R/t* = 86, 200 were used.

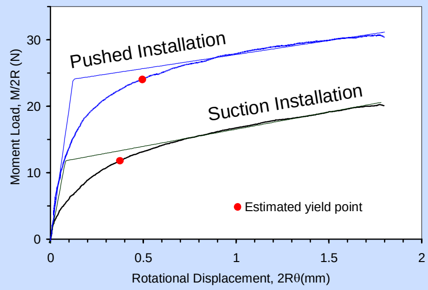


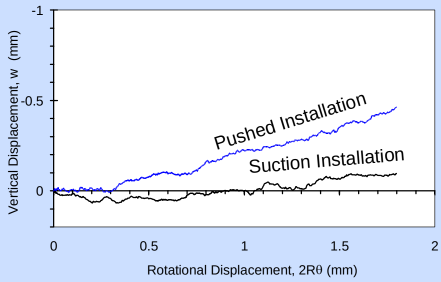
Caisson Installation Tests



- The use of suction reduces the net vertical load required to install a caisson.
- This is possible due to the hydraulic gradients caused by the suction.

Moment Capacity Tests

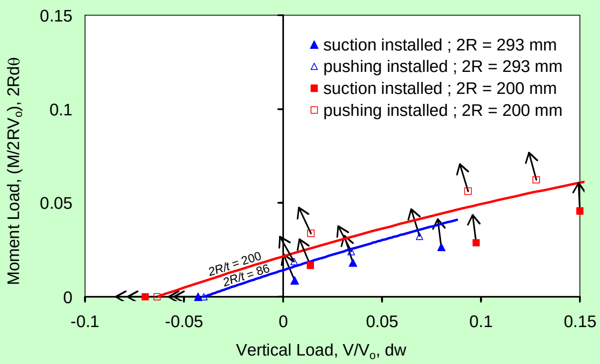




- Caissons were rotated under the same conditions: *V* = 40N, *M/2RH* = 1, *Rd* = 75%
- A significant difference in the moment responses of caissons installed by suction and by pushing was observed.
- Suction gives a lower moment capacity, but heave is reduced.

Yield Surfaces and Velocity Vectors

- A set of experimentally determined yield points scaled by V_o were plotted, *i.e.* $((M/2R)_y/V_o,\ V/V_o)$.
- Dimensionless yield surfaces were mapped out for two geometrically different caissons.



- Velocity vectors (dw, $2Rd\theta$) were determined as the increment of displacements when yield occurred.
- A theoretical function gives a good representation of a yield surface.
- The dimensionless parameters h_o, m_o, a, β_1, β_2 and t_o define the yield surface shape and V_o the yield surface size.

$$y=\left(\frac{H}{h_o V_o}\right)^2+\left(\frac{M}{2Rm_o V_o}\right)^2-2a\left(\frac{H}{h_o V_o}\right)\left(\frac{M}{2Rm_o V_o}\right)-\beta_{12}^2\left(\frac{V}{V_o}+t_o\right)^{2\beta_1}\left(1-\frac{V}{V_o}\right)^{2\beta_2}=0$$

- The above yield surface can not only be applied successfully to caissons with different sizes and aspect ratios, but can also account for the effect caused by the method of installation.

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See also www-civil.eng.ox.ac.uk