

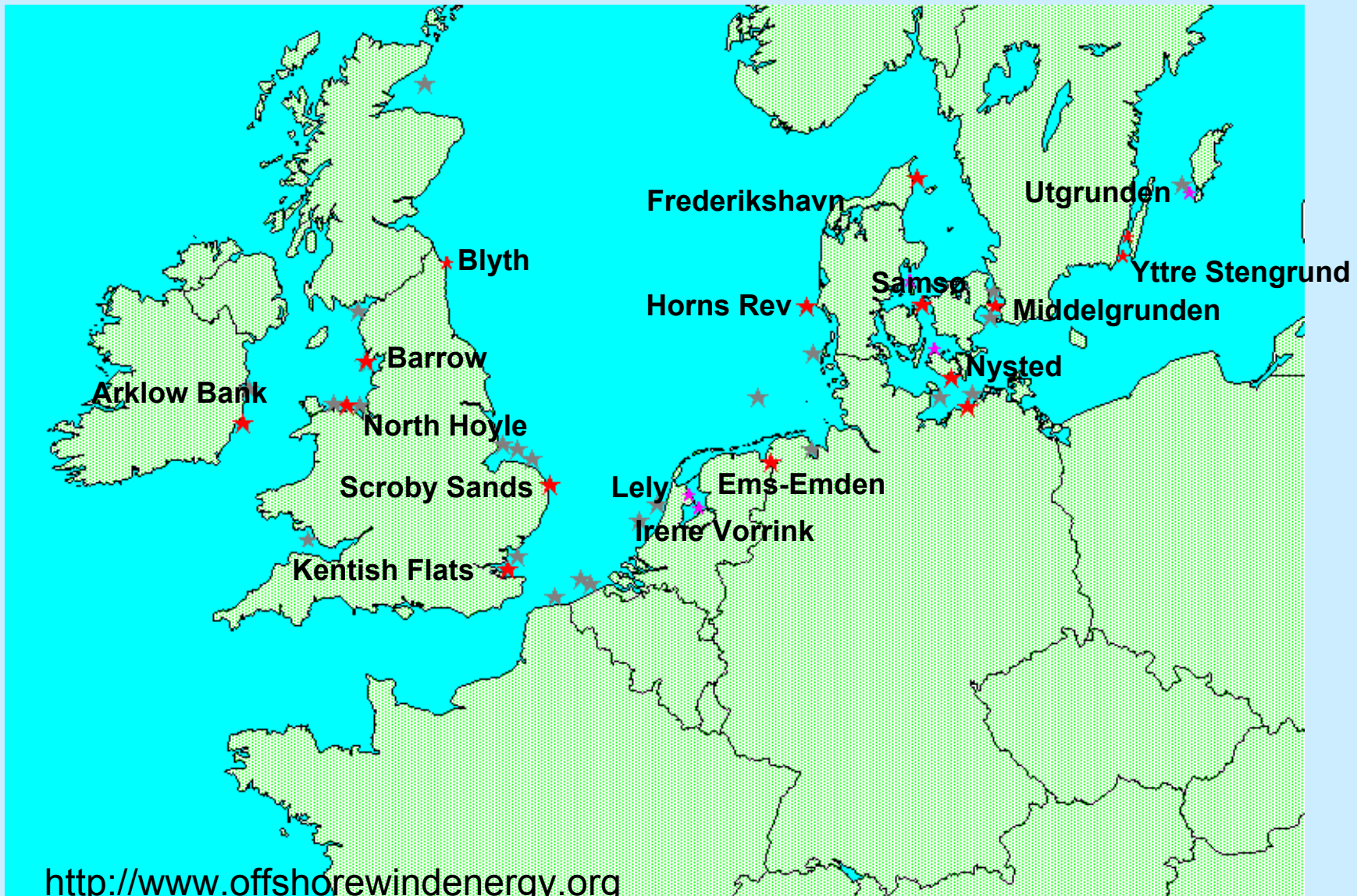
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FOUNDATIONS FOR OFFSHORE WIND TURBINES



Offshore wind energy in Europe



The foundation problem



Environmental Forces:

Waves + Wind + Currents

Gravity



Gravity base and pile foundations

Limited by sea depth (< 10 m) and turbine size (< 3 MW)



Gravity base foundation being floated out to Tunoe Knob Photograph © 1996 by Flemming Hagensen



Gravity base foundations at Nysted



Monopile foundation at Kentish Flats

For larger turbines (> 4 MW) foundation sizes and time increase considerably



Ems Emden 4.5 MW turbine

Suction caissons



valve

3 m diameter suction caisson

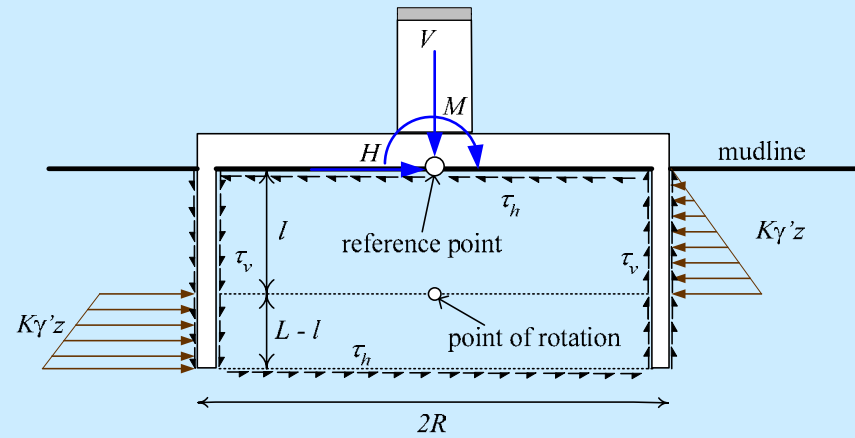


12 m diameter suction caisson

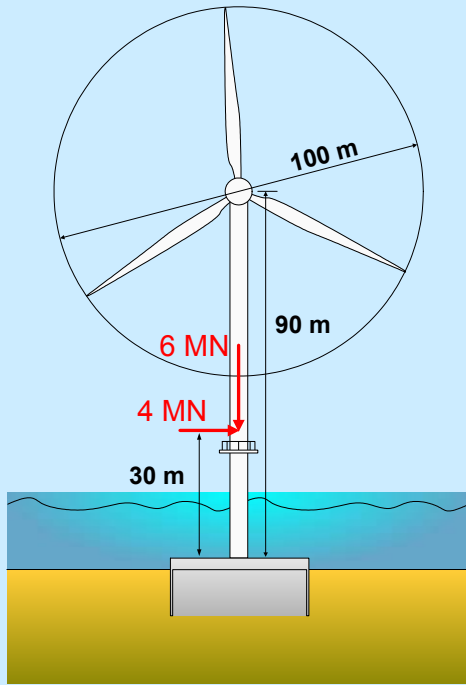


**ROV pump
(remote
operated
vehicles)**

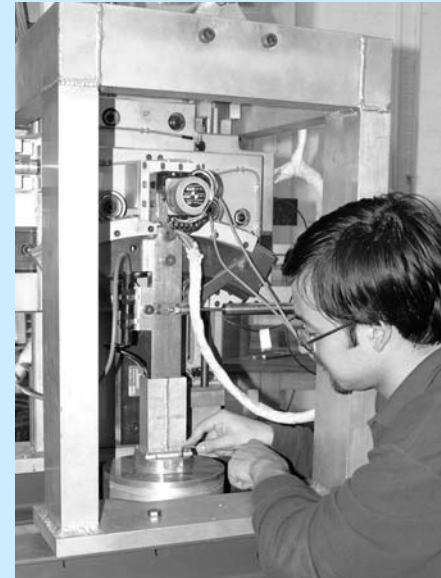
Research programme



Theoretical analyses



Trials and monitoring offshore

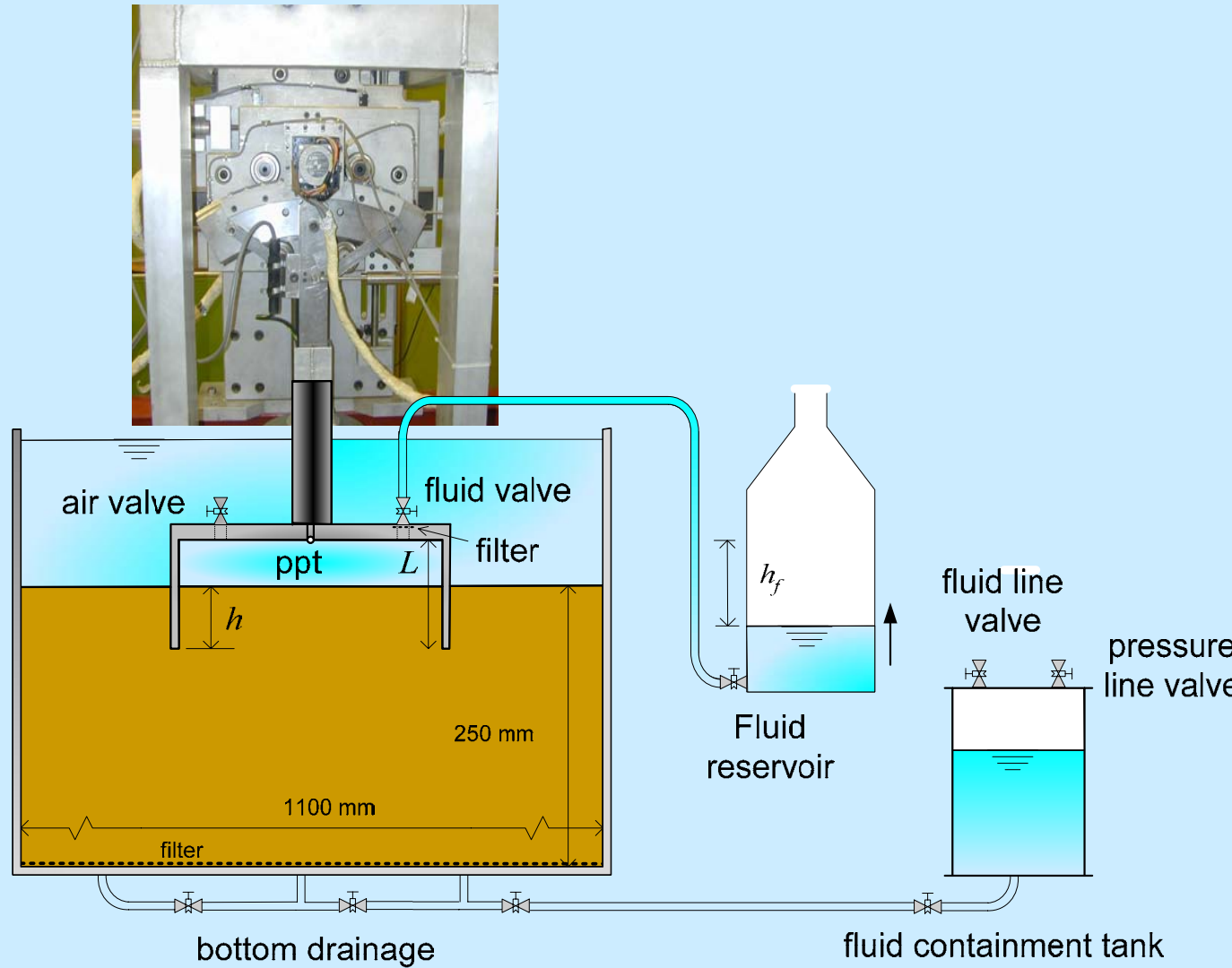


Laboratory model tests

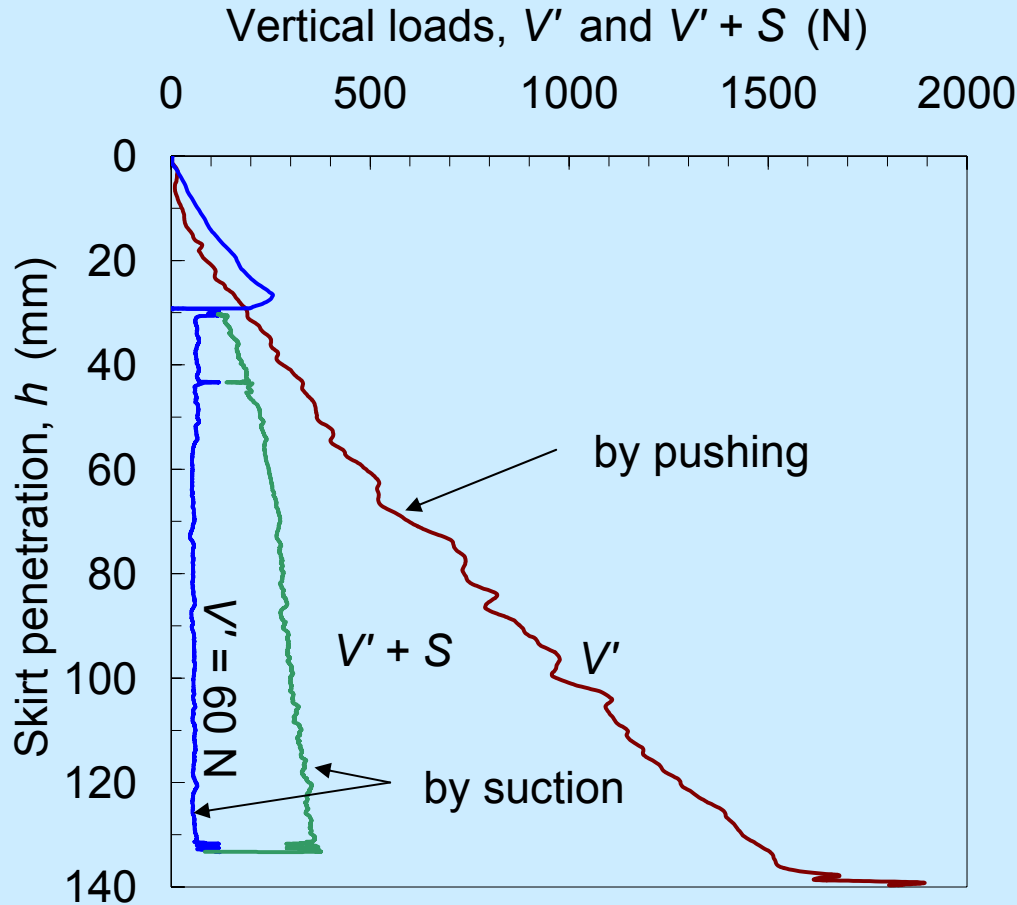


Field trials

Experimental procedures



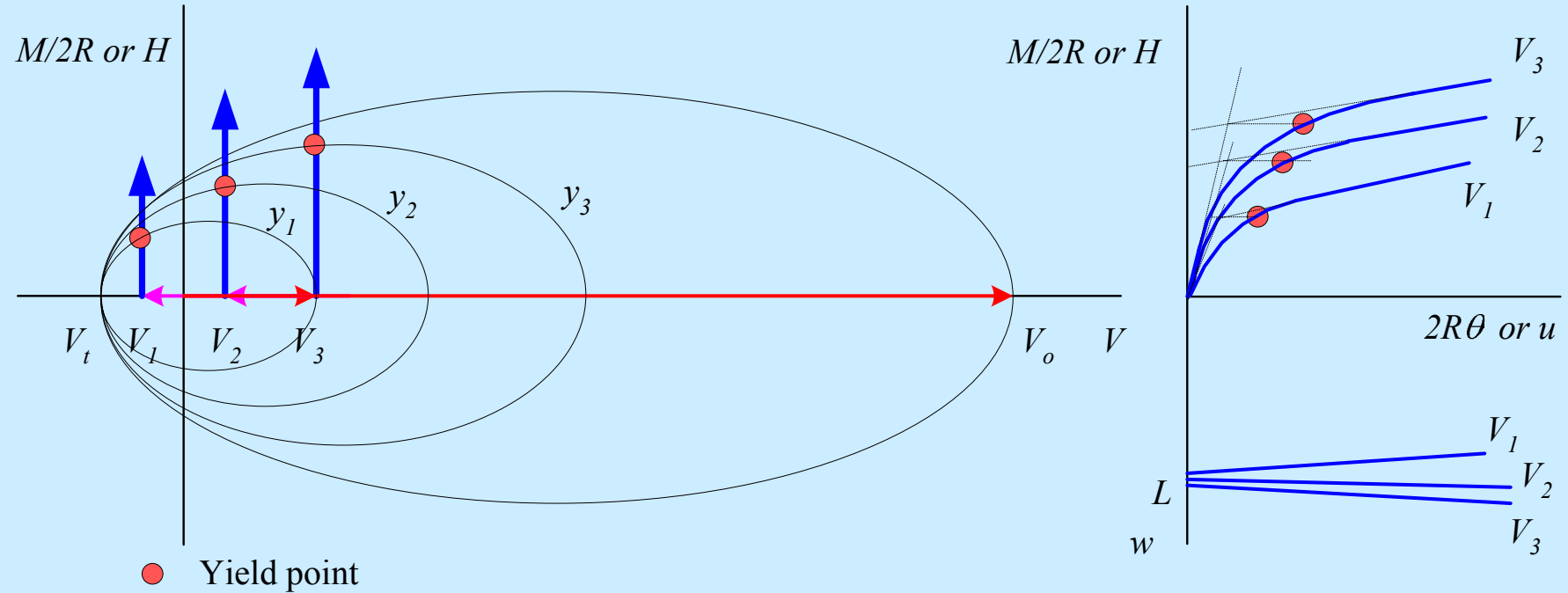
Installation results



-The use of suction reduces the net vertical load required to install a caisson

-This is possible due to the hydraulic gradients created by the application of suction

Yield surface from load-displacement response



Final Comments

- The foundation design is governed by the harsher and cyclic nature of loading conditions offshore
- Suction caisson foundations might become an option, in particular for large wind turbines
- Beneficial effect in the monotonic and cyclic response of the caisson when the vertical load increases
- Results to be used in the construction of a hyperplasticity model

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