Recent experimental wave load study on bottom fixed vertical cylinder study at the Kelvin Hydrodynamics Laboratory

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Background

Monopile wind turbines are typically anchored to the seabed using a large steel tube, when subjected to extreme wave loading, the monopile foundation can experience high stresses and strains that can lead to fatigue and failure, particularly when the higher-order components of the wave loading match the structural natural frequency.

Therefore, a better understanding of extreme wave loading on a monopile structure is critical for engineers.

The Kelvin Hydrodynamics Laboratory of the University of Strathclyde has been involved in extreme wave loading on bottom fixed cylinders since 2018, including utilising methods like four-phase decomposition and conducting research on various factors.

Kelvin Hydrodynamics Laboratory

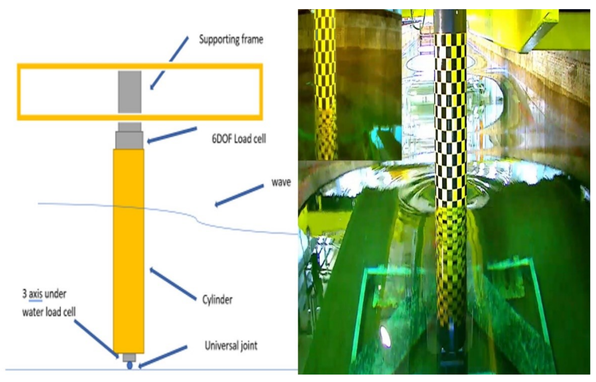


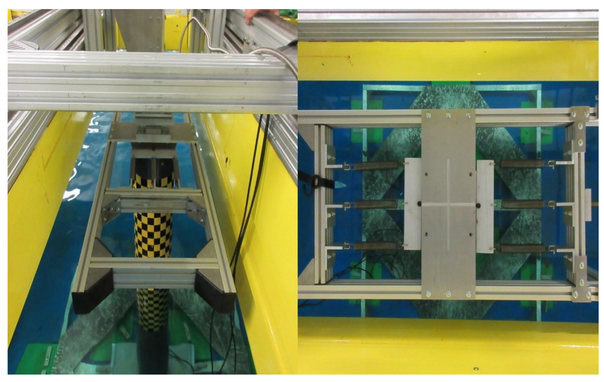
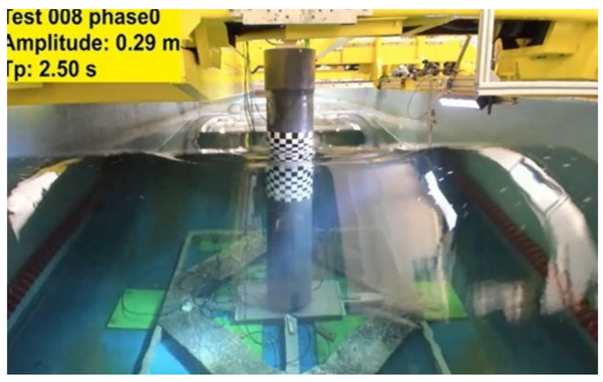
Towing tank dimensions: 76m length, 4.6m width, 2.3m max water depth.

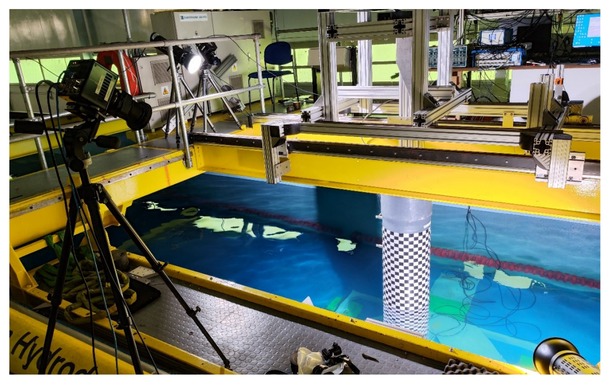
Wavemaker: force feedback dry back flap-type.

Wave beach: 14 m slope-type covered by porous media.

Progress of the wave load experiment



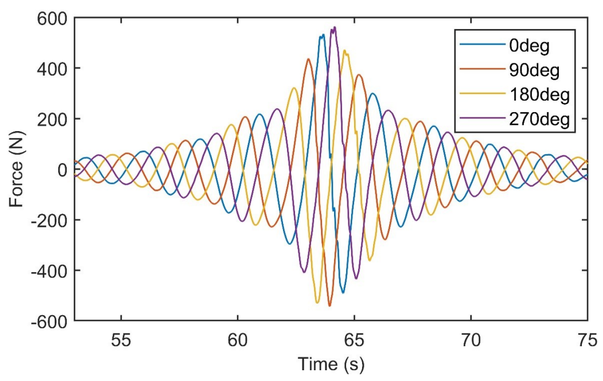


2018 — Diameter:0.315m; Top fixed

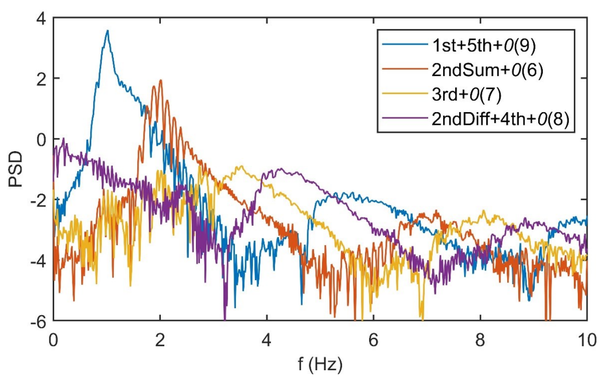
2020 — Diameter:0.315m; Compliance at the top

2022 — Diameter:0.400m; Wider range of test condition

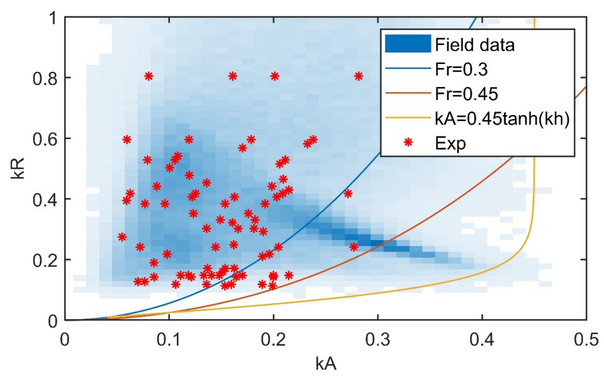
2023 — Diameter:0.400m; Breaking wave research



4 phases results



High order decomposition



Test condition

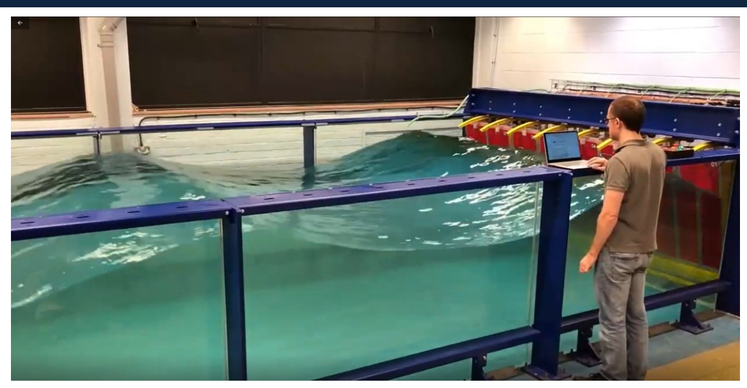
Breaking waves

Conclusion

Our recent experimental studies at the Kelvin Hydrodynamics Laboratory have provided valuable insights into wave loading on bottom fixed vertical cylinders. By utilizing the four-phase separation method, we were able to extract higher-order components in focus wave loading, allowing for a more comprehensive analysis. Additionally, the generation of 100k waves allowed us to delve deeper into understanding the response of the cylinders to different wave loadings. More recent experiments focus on secondary load cycle, breaking wave impact and wider design loading space.

These findings contribute to the existing knowledge of wave-cylinder interactions and provide a foundation for further research in this field.

Future



3D compact wave tank

Our future plan involves studying the influence of scale factor on extreme wave load in the 3D compact wave tank. The tank measures 9m in length, 3.15m in width, and has a fixed water depth of 1m. Wave generation is accomplished using 8 force feedback paddles as the wavemaker.

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University of Bath
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