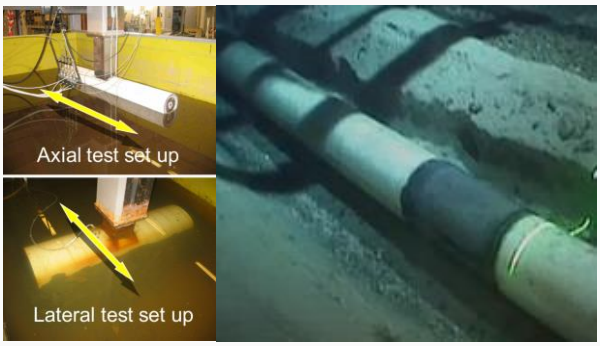
Specialist Analysis: Pipe-Soil Interaction



Pipe-Soil Interaction

During production shut down and restart operations, subsea pipelines can move either laterally or axially over the seabed and this movement is resisted by the seabed soil. The response is non-linear, depending on the interaction between load and resistance as the pipe displaces and deforms the soil.

Pipe-soil interaction is the most significant uncertainty associated with subsea pipeline design and is critical to the characterisation of forces that will act on the pipeline as it responds to the loads caused by changes in temperature, pressure and hydrodynamics.

The major challenges for the design of pipelines laid on the seabed are the control of lateral global buckling, pipe walking and route curve instability. Design and mitigation require a good understanding of pipe-soil interaction.

Axial and Lateral response:

Axial pipe-soil resistance defines end expansion and axial feed-in to each buckle, the rate of pipe walking and the shape of the global compressive and tensile force profiles along the pipeline. The lateral resistance is defined by:

Lateral Breakout response defines the buckling reliability and susceptibility to route-curve pullout

Lateral Residual response defines the highest load in the lateral buckle (higher lateral resistance causes higher levels of bending in the pipe) this load may also be influenced by breakout resistance.

Lateral Cyclic response defines the fatigue loading in the buckles and the potential for buckles to reduce or increase in size, which is often an important influence on the walking response and cumulative end expansion.

The pipe displacement to reach breakout or residual also has a significant influence on the structural response.

Benefits and value adding

Crondall Energy's engineers initiated much of the renowned pipe-soil interaction research carried out over the last decade at Cambridge University, the Norwegian Geotechnical Institute and at the University of Western Australia.

Crondall Energy continues to promote such research and is closely involved in the evaluation of operational survey data to improve understanding in pipe-soil interaction responses.

Crondall Energy has developed software to evaluate pipe-soil responses and probabilistic methods to ensure that when lateral resistance are high enough to prevent buckling they are eliminated from the design to avoid over-conservative design solutions.

Crondall Energy is also an advocate of conditional performance monitoring to evaluate the global response during field life, where the design uncertainty can lead to a rationalised approach to mitigation, based on observational methods.

"I don't know anyone, anywhere that has made such a significant contribution to bridge the gap between geotechnical and pipeline engineers"