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THESIS TITLE: Studies on surface gravity wave interaction with a subsea pipeline buried in seabed

ABSTRACT

Subsea pipelines transport hydrocarbons from oil fields to shore facilities traversing long distances along the seabed. These structures encounter severe environmental conditions and hence trenching and backfilling is in general recommended to safeguard them from environmental loads. Despite burying the pipelines they can be subjected to seepage forces caused due to hydrodynamic seabed pressures. The thesis work broadly discusses the consequences of waves propagating perpendicular to the pipe axis and along the pipe axis for pipes buried in the seabed. The following studies are carried out using numerical modelling.

- An integrated Finite element model is established for wave seabed and structure interaction within the framework of the frequency domain. The wave modelling is based on linear wave assumptions and soil modelling following Biot's consolidation equations. The sensitivity of wave and soil parameters for a range of wave frequencies is studied. Further, the integrated model is used to study the soil response around a buried pipe in the presence of a floating structure.
- Soil response around the buried pipe for waves incident in nearshore regions is studied using higher-order wave theories. Stokes, cnoidal and Solitary wave theories are used and the influence of wave nonlinearity on the pore pressures and stresses around the pipe are realized.
- Wave incidence along a buried pipe is investigated in the context of upheaval buckling. The buckling of a buried pipe due to combined wave-induced seepage forces and temperature of the pipe fluid is investigated using simple beam theory. The influence of seepage forces on the buckling of pipes is evident in low burial depth ratios and high sea states for pipes buried in intermediate water depth regions.
- The Prediction of the wave-induced seepage forces on buried pipes is made using Machine learning algorithms by training the models using the results obtained from Finite element simulations.

Keywords: Ocean waves, Biot's Equations, Buried pipe, Upheaval buckling, Finite element method