Breakout of Half-Buried Submarine Pipeline from Sea Bed

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BREAKOUT OF A HALF-BURIED PIPELINE FROM A SANDY SEA BED

by

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Abstract

This study investigates the breakout of a half-buried pipeline in a sandy sea bed subject to water currents and surface waves. Theory is presented, with numerical calculations. These are compared with the results of experiments conducted in a wave flume 180 feet long, 8 feet wide and 4 feet deep designed to study the breakout of a half-buried pipeline due to continuous monochromatic waves.

Analytical and numerical analysis were performed to predict movement of the pipeline during the breakout. The sandy sea bed was assumed to be porous and rigid. Lubrication theory was used to simulate the fluid flow at the gap between the pipe and soil. Relationships were derived to describe the breakout of pipelines under current, waves and their combination. An implicit numerical scheme was developed to solve the governing equations.

The breakout of the half-buried pipeline was related to the fluxes of water into the pipe-soil gap. The initial flux was due to the pore water inflow and this is

supplemented by the growing water flux through the gap opening, the balance between these two fluxes depend on the characteristics of the pipeline and soil. The total flux was initially small due to the typical low permeability of the sandy sea bed and the small initial gap opening. When the gap opening expanded, the flux through the gap opening grew and eventually led to the rapid release of the pipeline from the sea bed.

The gap configuration, in particular the width of the gap opening, was found to be critical to the breakout processes. The analysis, which assumes a rigid and porous sea bed, predicts the breakout times in the proper range, but underestimates the initial rate of rise and breakout displacement. The reason was attributed to the plastic soil deformation and passive soil failure near the gap opening which was observed during the experiments. This soil deformation and failure control the gap opening width during the initial stage, assists in retaining the pipeline in the trench and enhances the rapid release of the pipeline near the breakout time.

Prof. Mostafa A. Foda
Thesis Committee Chair

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