Experimental and numerical study of wave-induced backfilling beneath submarine pipelines
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This paper presents results of complementary experimental and numerical studies involving wave-induced backfilling of current-generated scour holes beneath submarine pipelines. The laboratory experiments are conducted in a wave-plus-current flume, utilizing Laser Doppler Anemometry to measure velocities, synchronized flow visualizations using digital image technology, along with live-bed scour and backfilling measurements. Each experiment is based on a two-stage process: (1) initial scour induced by a pure current, followed by: (2) backfilling induced by pure waves (either regular or irregular). The time series of scour depths are closely monitored through video recordings. Systematic analysis of these has resulted in a closed form expression for the backfilling time scale, which is demonstrated to be a full order of magnitude greater than the well-known time scale of scour (with both governed primarily by the Shields parameter). The developed expression is strictly valid for the current-to-wave backfilling scenarios considered, while likely serving as an upper limit for more general wave-induced backfilling circumstances. The experiments are complemented by similar backfilling simulations utilizing a fully-coupled hydrodynamic and morphodynamic CFD model. The numerical simulations demonstrate the ability of the model to predict backfilling towards expected equilibrium scour depths based on the new wave climate, with time scales reasonably inline with experimental expectations.

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