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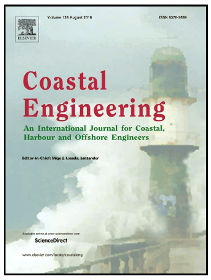

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Wave-induced dynamics of marine pipelines in liquefiable seabed

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Abstract: This paper presents a simple but workable modeling method to simulate the wave-induced liquefaction scenarios around a marine pipeline within the framework of the Biot's theory, incorporating the main features such as relation for the consolidation describing the pore-volume reduction, hysteretic stress-strain behavior of soil skeleton and soil-pipe contact effect. In this context, special attention is paid to the implementation of a well-calibrated cyclic soil model for hysteretic and nonlinear stress-strain behavior (i.e. strain softening and cyclic degradation), associated with a semi-empirical shear-volume coupling equation for capturing the accumulative volumetric change, which links the increment of volumetric strain per cycle of wave with the shear strain occurring during that particular cycle. The proposed modeling framework is then incorporated into an explicit time matching finite difference analysis procedure, allowing a full non-linear dynamic analysis of the intensive interactions between the pipeline and the seabed undergoing buildup of pore pressure and residual liquefaction. Retrospective simulation of the wave flume test performed by Sumer et al. (2006c) using the proposed model shows good agreement, calibrating the reliability of the modeling method for the prediction of wave-induced liquefaction of sandy seabed and failure process of the buried pipelines. Finally, the liquefaction mechanism around a buried pipeline under a nonlinear wave loading is investigated by numerical examples. The obtained results interpret the cause of liquefaction and the resulting consequence for pipeline stability in wave environment.

Keywords: Wave-induced liquefaction; Submarine pipelines; Strain softening; Cyclic degradation; Pipeline-seabed interaction.

List of symbols

A	Davidenkov model parameter
B	Davidenkov model parameter
C_1	constant of shear-volume coupling model
C_2	constant of shear-volume coupling model
$CSSR$	cyclic shear stress ratio
D	pipeline diameter
d	water depth
d_{50}	grain size
e	distance from the center of the pipe to the mudline
g	body force acceleration
G	shear modulus