Ain Shams University
Faculty of Engineering
Irrigation and Hydraulics Department

INVESTIGATING THE SCOUR BELOW SUBMARINE PIPELINES

A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of
DOCTOR OF PHILOSOPHY IN CIVIL ENGINEERING
(Irrigation and Hydraulics Engineering)

By

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STATEMENT

This thesis is submitted to the Irrigation and Hydraulics Department, Faculty of Engineering, Ain Shams University in the partial fulfillment of the requirements for the Degree of Doctor of Philosophy in Civil Engineering.

The work in this thesis was carried out in the Irrigation and Hydraulics Department, Faculty of Engineering, Ain Shams University from September 2010 to January 2013.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

Scour below submarine pipelines in currents or waves or combined current and wave is an important problem because it may lead to eventual rupture of the pipelines.

An experimental work was carried out in constructed wave and current flume to investigate the onset of scour below submarine pipelines. The main studied parameters were the pipeline diameter, burial depth, water depth, Shields parameter, Keulegan-Carpenter number and the angle of attack relative to pipeline longitudinal axis.

A number of 96 runs were executed in case of currents alone; the results indicated that scour is governed by the pipeline burial depth, Froude number, Shields parameter and angle of attack. The results indicated that scour decreases by increasing the burial depth and decreasing Froude number. The maximum scour depth occurred at angle of attack of 45^o. No scour was noticed if angle of attack is 0^o. Equations showing the relationship between scour depth and main affecting parameters were developed.

A number of 288 runs were executed in case of waves alone; the results gave the same indication as in the case of currents alone. It is also found that scour increases by increasing the Keulegan-Carpenter number (*KC*) for pipes 3, 6 and11.5 cm in diameter. The angle of attack of 90^o gives the maximum magnitude of the scour depth. Also, no scour occurred if angle of attack is 0^o. The results include the relationships between the scour depth and main affecting parameters for the different angles of attack.

A number of 288 runs were executed in case of combined current and wave; the results gave also the same indication as in the previous cases of currents and

waves. The maximum scour depth occurred at angle of attack of 45^o. And also, no scour occurred if angle of attack is 0^o. However, by investigating the three cases of flow it was found that the maximum magnitude of the scour depth occurred in case of current alone. All curves and equations showing the relationship between scour depth and main affecting parameters for the different angles of attack were developed.

Finally, a guide charts has been developed for designing offshore pipelines, based on the results of an experimental work in a wave flume and the relations between the main parameters. This charts aimed to help designers in the alignment stage to minimize scour around the pipeline.

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