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Seabed Scour Around a Vertical Pile

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ABSTRACT

Some of the foundations of structures located in soft clay deposits along the coast are prone for scouring. A review of the literature reveals that little information is available for scour in silty clay soil. Hence, the present study is oriented towards understanding the behaviour of foundations in clayey soil subjected to scouring. A series of scour tests are conducted in a 30m long and 2m wide flume using unidirectional currents with model piles embedded in clayey soil. Scour measurements due to steady streaming are monitored by using special instrumentation. This study indicates that the equilibrium scour depth is controlled by current velocity, flow depth to diameter of obstruction, shear velocity, model Reynolds number , Froude number, and soil characteristics.

Key words: Scour, piles, steady current, silty clay.

Nomenclature

S_e	Equilibrium scour depth
D	Diameter of obstruction
d	Flow depth
h	Depth of the soil bed
U	Current velocity
R_e	Reynolds number
F_r	Froude number
F_c	Critical Froude number
U_*	Shear velocity
τ_c	Critical shear stress
C_u	Shear strength of the soil.
ν	Kinematic viscosity of water
U_{*c}	Critical shear velocity
ρ	Density of water
k	Von Karman constant (0.4)

INTRODUCTION

There are several marine structures with pile foundations resting on erodible sea bed and the presence of these pile supported structures changes the primary flow field. The increased velocities of significant secondary flow at the obstruction and its associated additional turbulence cause scour around these structures. The depth of scour is important as the exact position of the mud line must be known for the computation of minimum penetration depth of piles for fixed structures. The erosive action of oscillatory waves and unidirectional water currents in the coastal zone has long plagued engineers designing marine structures such as offshore navigational towers and offshore petroleum drilling platforms. Due to installation of these structures, flow field changes and results in removal of sediments around the foundations of these structures. Further, these are carried away by the currents creating scour hole around the structure, thus, reducing considerably the designed lateral capacity and cause higher stresses in the structure itself. This situation results ultimately in undermining the integrity of the overall structure. Though, the fluid mechanics of the scour process are better understood the mechanics of sediment behaviour is not clearly understood. The key element in the scour process is the formation of vortex, which is due to meeting of incoming velocity profile with the obstruction, and is able to erode a significant amount of sediment away from the neighbourhood of the pile.

The scour depth corresponding to the fully-developed stage of scour process has been studied in coarse grained sediments extensively by several researchers [Breusers et al. (1977), Hjorth(1975) , Shen(1969), Jain and Fischer (1979) and Sumer et al. (1992)]. The scour development around the pile is governed by a number of empirically defined independent parameters. General parameters, which describe the boundary conditions for the local scour process are average velocity, pile diameter, water depth. In sands, Shield's entrainment function is used. Similarly such relations have been developed to obtain scour depth as a function of a number of independent parameters in silty clay soil. Although these relations may be confirmed by a series of model scour measurements, no physical understanding of the scour process has been provided.