On a Horizontal Cylinder Resting on a Sand Bed Under Waves and Currents

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ABSTRACT

Experiments have been made in laboratory flumes to investigate the interaction of a mobile sand bed with a cylinder under currents and under waves. The cylinder is free to move vertically under its own weight. The presence of a cylinder always caused incipient bed motion and ripple formation to occur at lower Shields numbers. The cylinder axis always dropped and forces were always reduced, sometimes substantially, as a result of bed motion. Hydrodynamic force was measured through the surface pressures by a novel device.

NOMENCLATURE

- $C_D$: drag coefficient
- $C_F$: force coefficient
- $d$: grain diameter
- $D$: cylinder diameter
- $g$: gravitational acceleration
- $h$: water depth
- $H$: wave height
- $KC$: Keulegan-Carpenter number
- $R_w$: bed Reynolds number in waves
- $R_c$: roughness Reynolds number
- $T$: wave period
- $u_0$: amplitude of velocity on a flat bed in waves
- $\bar{u}$: mean current velocity
- $\beta$: Stokes parameter for oscillatory flow around a cylinder
- $\xi$: amplitude of particle motion on a flat bed in waves
- $\lambda$: wave length
- $\mu$: dynamic viscosity
- $\nu$: kinematic viscosity
- $\psi$: Shields parameter
- $\psi_c$: critical Shields parameter for incipient motion
- $\rho$: density of water
- $\rho_s$: density of sand
- $\tau_0$: bed shear stress

INTRODUCTION

The stability of pipelines on the seabed when exposed to waves and currents has been the subject of much investigation. To assess instability, hydrodynamic forces are derived from wave/current kinematics with appropriate force coefficients and Coulomb friction has been assumed, again with an appropriate coefficient. However penetration of the pipeline into the bed is now considered to enhance stability. There has been considerable investigation of the lateral cylinder movement produced by wave loading causing the pipeline to dig itself in under its self weight, and currents has been the subject of much investigation. To

APPARATUS

The experiments were undertaken mainly in the 0.5-m-wide wave/current flume which is 20 m long and 0.4 m high in the Manchester Hydrodynamics Laboratory. The water depth was usually 0.25 m; wave heights up to 0.1 m and current velocities up...