LOCAL SCOUR AT BRIDGE SITES

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ABSTRACT.

The problem of local scouring at a circular cylinder in sandy material under threshold conditions was investigated experimentally. The aim of the study was to obtain a better understanding of the mechanism causing scour. Three fixed-bed scour models were constructed: the initial flat-bed model, an intermediate scour model and the final equilibrium scour hole model.

The experimental results have shown that although scour is initiated by the high local shear stresses which result from flow acceleration about the cylinder, the subsequent development of the scour hole is due to the establishment of a strong downflow ahead of the cylinder. The scour hole grows in the form of a frustrum of an inverted cone at a slope angle equal to the dynamic angle of repose of the bed material. Erosion occurs in the bottom part of the scour hole. Bed particles from the upper part of the hole slide down into the erosion area as the slope angle is increased by erosion of material from below. The equilibrium depth of scour is attained when the downflow becomes incapable of further erosion. For a particular bed material the downflow should be primarily a function of the mean approach flow velocity and cylinder diameter. Hence the study has shown that the equilibrium depth of scour should also be a function of these two parameters.

Additional measurements have shown that the horseshoe vortex, which is initially small, roughly circular in cross-section, and comparatively weak, increases dramatically in size and strength as the scour hole forms. During the development of the scour hole, the horseshoe vortex expands and moves down into the hole, increasing its circulation throughout the scour process, but at a diminishing rate. The shape of the vortex follows that of the scour hole-cylinder combination.

Measurements in the wake have added to existing information concerning the shedding and convection of wake vortices in shear flow. The results obtained are consistent with the occurence of span-wise cells of constant shedding frequency, separated at the discontinuities by longitudinal vortices. The vortices accelerate away from the cylinder at speeds initially less than the free stream but becoming constant and approximately equal to the free stream velocity at about 8 cylinder diameters downstream.

Based upon a survey of existing material, a design recommendation for the estimation of local scour depths at bridge piers is also presented.

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