Summary of Final Report, BB473
September 2003

LARGE SCALE AND LIVE BED LOCAL PIER SCOUR EXPERIMENTS (2 VOLUMES)

PROBLEM STATEMENT

The accurate prediction of sediment scour depths near bridge piers under design storm conditions is very important in bridge design. Under-prediction can result in costly bridge failure and possibly in the loss of lives, while over-prediction can result in millions of dollars wasted on the construction of a single bridge. The physical processes involved are very complex and difficult to analyze, and, thus, most design scour depth predictive equations are based on laboratory scale experimental results. An ongoing bridge scour research program at the University of Florida is directed at increasing the understanding of scour processes and improving the accuracy of design scour depth predictions.

In spite of significant research efforts over the last four decades, at a number of institutions around the world, there is still disagreement among researchers regarding such fundamental aspects of the problem as the most appropriate way to normalize the parameters required to characterize the scour processes. Even the variable used to normalize the equilibrium scour depth differs among researchers. Some use the local (unscoured) water depth, while others use the diameter/width of the structure.

OBJECTIVES

This research is designed to obtain local pier scour data for (1) large structures (up to 3 ft diameter) in the clearwater scour range and (2) smaller structures (0.5 ft diameter) in the high velocity, live bed scour range. The objectives include extending clearwater local scour data to large, prototype scale structures; adding to the live bed scour data base in the high velocity range; and providing data to test Sheppard's equation, the mathematical scour model proposed by the principal investigator.

FINDINGS AND CONCLUSIONS

The clearwater scour tests were performed at the Conte USGS-BRD Laboratory in Turners Falls Massachusetts, while the live bed scour tests were performed in the Hydraulics Laboratory at the University of Auckland in Auckland, New Zealand. All of the tests were performed by the author and his students with help from staff and students from the respective laboratories.

<u>Volume 1: Large Scale, Clearwater Scour Experiments</u>

The clearwater scour tests reported on in this document were performed in a 20 ft wide 21 ft deep 126 ft long flow-through flume with three different circular cylinders. Three different, near uniform diameter, cohesionless sediments (median diameters of 0.22 mm, 0.80 mm and 2.9 mm) were used in these tests. A range of water depths and flow velocities (in the clearwater scour range) were investigated. The reduced data from each experiment is presented in this report along with the values of pertinent dimensionless parameters. Comparisons of predicted scour depths using the mathematical model and the measured values are presented along with conclusions regarding the validity of the model.

The coefficients in Sheppard's equations have been slightly modified to accommodate the conservative equilibrium scour depths obtained by extrapolating the measured depths to infinite flow durations. The revised equations do a good job of fitting the data in the clearwater scour range.

Volume 2: Live Bed Experiments

The live bed scour tests were performed in a 5 ft wide 4 ft deep 148 ft long (flow and sediment) recirculating flume with a 0.5 ft diameter circular cylinder. Two different, near uniform diameter, cohesionless sediments (median diameters of 0.27 mm and 0.84 mm) were used in the tests. A range of water depths and flow velocities (from clearwater to six times the sediment critical velocity) were investigated. The reduced data from each experiment is presented in this report along with the values of pertinent dimensionless parameters. Comparisons of predicted scour depths using the mathematical model and the measured values are presented along with conclusions regarding the validity of the model.

The tests conducted in this study extended the live bed data to structure diameters three times that of the earlier work. High velocity live bed tests with larger prototype scale structures are needed. But until such time as facilities where such tests can be conducted are available, the equations provided in this report represent that best available method for local scour depth prediction in both clearwater and live bed scour ranges.

BENEFITS

This project establishes and verifies the Florida pier scour equation, which improves prediction of pier scour for bridges. The use of this equation reduces the current over-prediction that occurs when designers use the HEC-18 pier scour equation, and it is saving millions of dollars annually in the design of substructures for new bridges and the evaluation of scour for existing bridges in Florida.

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