Florida Department of Transportation Research

Investigation of Erosion Rates of Field Samples Using FDOT's Enhanced Sediment Erosion Rate Flume (SERF)

BDK75-977-53

The most common cause of bridge failure in the United States is the scouring of sediments, which are broadly classified as cohesionless (sand and gravel) and cohesive (rock, clay, sand-clay mixtures). For cohesionless sediments, predicting scour depth and erosion rates has been well studied and is fairly well understood. However, much less is known about cohesive sediments, which still require site-specific measurements to determine the relationship between erosion rate and shear stress.

In this project, University of Florida researchers used the Sediment Erosion Rate Flume (SERF) to measure erosion rates of cohesive sediments. The researchers made significant improvements to SERF, including pump repairs, laser system enhancements, installation of a digital video camera, updated graphical user interface, a rebuilt pump drive, and an increased capacity filter. The new laser system permitted accurate sample leveling; the previous ultrasonic system tended to penetrate cohesive sediments and give a "false bottom reading." The enhanced SERF led to a number of important findings.

A bird's eye view of SERF. The test chamber is on the right; support devices, such as pumps and filters, are on the left.

One of the advantages of SERF is that it allows erosion rate to be measured in terms of shear stresses rather than flow velocity. Shear forces have typically been determined from pressure differences upstream and downstream from the sample. Findings in this project indicated that this assumption may not be correct, and further study of shear stress estimation offers an opportunity for greater accuracy in erosion rate studies.

Because SERF is the only instrument that measures real-time erosion data, it revealed an interesting behavior of the sand-clay samples. They appeared to erode stepwise, with periods of rapid erosion interspersed with periods of slow erosion. Researchers believed this might be due to the method of compacting the samples during preparation. However, this behavior might correspond to that of real sediments, which are often deposited and compacted in cycles. Field trials are needed to determine if natural samples display this intriguing behavior. If so, a testing procedure would have to be developed for the SERF to ensure sufficiently conservative test results.

The researchers also encountered limitations of the enhanced SERF when used with cohesive materials. The amount of suspended material created by the testing tended to overwhelm the filtration system. The amount of suspended material could be a factor in erosion rates that is not easily accounted for at the present time. A sand injector intended to regulate the amount upstream from the sample could not be installed or calibrated due to the suspended materials problem. Also, the harsh conditions in the SERF damaged the laser system and its photoelectric sensors. Additional design work will be required to ensure that the laser system and its components are adequately protected.

Finally, a dataset from the Rotating Erosion Testing Apparatus (RETA) was reanalyzed. Results appear to show a preliminary correlation between erosion rate and rock cohesion. Lastly, a new operating manual was written for the SERF device.

Investigating the use of SERF for measuring scour rates continues to shed new light on mechanisms of scour and promises to give new tools for more secure design of bridges.

Project Manager: Rick Renna, FDOT Roadway Design Office
Principal Investigator: David Bloomquist, University of Florida
For more information, visit http://www.dot.state.fl.us/research-center