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HYDRAULICS/SEDIMENT TRANSPORT FLUME FEASIBILITY STUDY

PROBLEM STATEMENT

The flume in the Hydraulics Laboratory at the University of Florida has been used almost continuously for the past ten years for FDOT projects. These projects range from the conduct of basic research to the measurement of local sediment scour at existing and proposed bridge piers on Florida bridges. The results of these tests have saved millions of dollars in construction costs and have provided the information required to develop scour prediction equations and methods that will be used to save even more in the future. In spite of its usefulness the UF flume was limited in its capabilities and was at the end of its useful life when the building in which it was housed was up for renovation. Even though much has been learned about scour at bridge foundations over the last ten years, there are areas that still need to be researched. This is particularly true for higher velocity flow situations (the so-called live bed scour regime) and cases in which surface waves play a significant role in the scour process. Much work is also needed in the areas of abutment and contraction scour. The current state-of-the-art in predicting abutment and contraction scour is such that the predictions must be very conservative and, thus, costly to the taxpayer. Significant advances in these areas can be made if funding for facilities and research is available.

A hydraulics flume with live bed scour and wave generation capabilities would be fundamental to conduct this work. The flume should be tilting, large enough to minimize scale effects, able to recirculate sediment and water, and able to generate waves and currents simultaneously. Such a facility, with state-of-the-art controls and instrumentation, would be useful for a wide range of hydraulics/fluid mechanics and sediment transport problems confronted by FDOT. With its vast coastline and coastal waters, Florida has many hydraulics and sediment transport problems. The magnitude of these problems increases with the rapidly increasing population, the vast majority of which is concentrated in the coastal areas of the state.

OBJECTIVES

The objectives of this study were to determine the economic feasibility of constructing in Florida a large flume (as that described in the problem statement). The study would also investigate the potential location, size, capabilities, ownership, maintenance, operation, use scheduling, and other related issues.

FINDINGS AND CONCLUSIONS

Researchers conducted a survey of flumes at government laboratories and universities to determine whether a flume with the capabilities of the proposed facility exists. It was determined that such a flume does not currently exist. A workshop was then held to present for discussion a preliminary flume facility design: representatives of all FDOT districts and the Central Office, the U.S. Army Corps of Engineers, the Florida Department of Environmental Protection, and the University of Florida were in attendance. Many aspects regarding the feasibility of the proposed facility were

discussed, including (1) whether a flume with the proposed capabilities is needed to address FDOT's existing and anticipated hydraulics/sediment transport problems, 2) the proper size and capabilities required for such a facility, 3) potential locations for the facility, 4) issues regarding ownership and maintenance of the facility, and 5) approaches to funding the design and construction of the facility. The following are among the points of agreement reached at the workshop:

1. There is a need for a flume with the approximate capabilities of the proposed facility. With its vast coastline and elaborate roadway and bridge system in areas subject to storm surge inundation, and its active research programs in coastal engineering, coastal hydraulics, and bridge scour, Florida is a logical site for such a facility.

2. Regarding the size and capabilities of the flume, attendees recommended that the width of the flume be expanded from the proposed 12 ft to 20 ft, with an adjustable wall that could reduce the width to 12 ft when very high flow velocities are required. It was further agreed that the flume should be designed for a wave maker, but that it could be added at a later date to minimize initial cost.

3. A cost-benefit analysis should be performed to determine if the cost savings to FDOT resulting from the research would justify the cost of the facility. However, since such a wide range of research could be conducted in the proposed facility, it is difficult to anticipate many of the benefits and cost savings. For this reason, one of the main areas of research should be analyzed and the results extrapolated to provide a sense of potential benefit.

4. FDOT felt that it should not take ownership of the facility.

5. If the facility is constructed, FDOT would consider funding the operation and maintenance for some limited period of time (on the order of 5 years), after which the University would cover these costs with overhead from externally funded research contracts and grants.

Following the workshop, Henry Bollmann (FDOT) performed a cost-benefit analysis based on potential scour depth reductions resulting from flume research provided by the University of Florida. The analysis determined cost savings for several actual bridges constructed in Florida over the last few years. The results were extrapolated and applied to bridges that will be constructed in Florida over the next five years. This effort suggested that substantial savings would result from this single line of research.

BENEFITS

In considering all of the potential research that might be conducted at the proposed facility, it is reasonable to expect that the total cost savings and improvements in roadway and bridge design would be many times the value of the single subject evaluated in the cost-benefit analysis performed for this study.

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