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Pagán-Ortiz, Jorge E.

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Impact of the Federal Highway Administration's Scour Evaluation Program in the United States of North America's Highway Bridges

By

Jorge E. Pagán-Ortiz¹

ABSTRACT

Since the establishment of the scour evaluation program by the Federal Highway Administration (FHWA) in 1988, over 368,000 of the 484,264 bridges reported by State departments of transportation (DOTs) over riverine or tidal waterways have been evaluated for scour vulnerability as of April 2002. As a result of this program and the diligent work of professionals from the transportation community, including DOTs, Federal agencies, consultants and researchers, more than 26,100 bridges have been identified as scour critical.

This paper will highlight the accomplishments of this program and the partnership within the transportation community to ensure that bridges are designed, evaluated and protected, for the potential or observed scour condition, for the safety of the public users in the United States of North America.

¹ Senior Hydraulics Engineer, Federal Highway Administration, Office of Bridge Technology, HIBT-20, Washington, D.C. 20590, USA.

INTRODUCTION

The scour evaluation program was established by the FHWA of the United States Department of Transportation in September 1988 as the result of the catastrophic failure of the New York Thruway Authority bridge over Schoharie Creek in the State of New York in April 1987, caused by the effect of local scour around the foundation of Pier 3. Two years after this failure, another catastrophic failure occur as a result of the combination of lateral channel migration and local scour, the Northbound U.S. Route 51 Bridge over the Hatchie River in the State of Tennessee. These failures claimed the lives of 18 persons, and raised questions about the scour vulnerability of the Nation's highway bridge infrastructure. The FHWA was identified as the responsible agency, by the United States of North America's National Transportation Safety Board, to develop and disseminate guidance on scour for the State departments of transportation (DOTs) on the design of new bridges and the evaluation of existing bridges.

GUIDELINES

The FHWA conducted a survey in 1988 to establish a baseline of guidance used by the DOTs to design new bridges and evaluate existing bridges for scour. The survey showed that there was a need to develop design guidelines on stream stability and scour and guidelines for conducting evaluation of bridges susceptible to scour. In addition, the survey showed that there was a need to train engineers and inspectors on both stream stability and scour.

FHWA provided leadership by developing scour guidelines. Initially, guidance on scour was disseminated through technical advisory (TA) T 5140.20 titled "Scour at Bridges" dated September 1988. This TA focused on designing bridges for scour, prioritizing bridges for scour evaluations, and developing an plan of action for bridges, determined by the engineer, to be scour critical. The TA disseminated a document titled "Interim Procedures for Estimating Scour at Bridges." The Interim Procedures contained detailed guidance for designing new bridges and evaluating existing bridges for scour. Also, it contained guidance for bridge inspectors to aid them during their inspection of the channel condition in the vicinity of the bridge as well as indications of scour problems around the bridge foundations. As technology continued to evolve through research and experience gained by the transportation community on scour and stream stability, the TA was revised and issued as technical advisory T 5140.23 titled "Evaluating Scour at Bridges" dated October 1991. The interim procedures were updated to an FHWA Hydraulic Engineering Circular (HEC), No. 18 titled "Evaluating Scour at Bridges." The need to expand the knowledge on stream stability problems in the river environment and to address stream instability problems in the vicinity of bridges led FHWA to develop another publication, HEC-20 titled "Stream Stability at Highway Structures."

The guidance provided in the HECs has helped DOTs to structure their scour

evaluation programs. Another FHWA Publication, Hydraulics Design Series 6 titled “River Engineering for Highway Encroachments” (formerly know as “Highways in the River Environment,” provided guidance on stream stability and scour. DOTs have now virtually completed the screening of all bridges over waterways for scour using the following scour categories, as recommended by FHWA: *Low Risk*; *Scour Susceptible*; *Unknown Foundations*; *Tidal*; and *Scour Critical*.

The *Low Risk* category identifies bridges with low risk of failure or low vulnerability to scour as determined by the engineer. *Scour Susceptible* identifies bridges susceptible to scour, which need an evaluation, by an engineer, to determine their scour vulnerability. *Unknown Foundation* identifies bridges whose foundation type is unknown and/or the pile tip elevation is unknown. *Tidal* identifies bridges over tidal waterways, which need to be evaluated by an engineer. The last category, *Scour Critical*, identifies bridges determined to be unstable, by an engineer or an inspector, for the calculated or observed scour condition. As State DOTs continued to make progress in this program, the population of bridges in the low risk and scour critical categories increased while the population of scour susceptible population decreased. FHWA developed HEC No. 23 titled “Bridge Scour and Stream Instability Countermeasures,” to assist State DOTs develop a plan of action and to assist in the selection of countermeasures to protect bridges identified as scour critical. HEC-23 presents managerial and inspection strategies for developing a plan of action. Also, it presents state-of-the-practice guidance on a large variety of bridge scour and stream instability countermeasures.

TRAINING ON STREAM STABILITY AND SCOUR

DOTs have been reporting their progress on the scour evaluation program since 1990. While reporting on their scour status and conducting scour evaluations, DOTs have identified the need to provide technical training to bridge inspectors and engineers who are responsible for bridge inspection and for the scour evaluation of existing bridges and the design of new bridges, respectively. To respond to the State DOT training needs in stream stability and scour, FHWA developed a training course through the FHWA’s National Highway Institute (NHI) for engineers performing scour evaluation on existing bridges and/or new bridge design, “Stream Stability and Scour at Highway Bridges.” Currently, several DOTs require that, in order for a private consultant to do bridge scour evaluations and/or new bridge design work for that DOT, the engineering staff must attend this NHI training course. Another NHI training course, “Stream Stability and Scour at Highway Bridges-Bridge Inspectors Module,” is available for bridge inspectors responsible for reporting and coding the condition of bridges. These courses have been presented in 45 of the 52 DOTs in the United States of North America. A new NHI training course, “Countermeasure Design for Bridge Scour and Stream Instability” has been developed, which present guidelines for developing a plan of action for scour critical bridges, including managerial and inspection strategies, a countermeasure matrix with selection and design criteria, State DOTs installation experience and design references, and scour monitoring and instrumentation techniques.

STATUS OF THE SCOUR EVALUATION PROGRAM

Thanks to the partnership between the FHWA and DOTs in the scour evaluation program, most of the bridges over waterways have been evaluated and categorized following the guidelines provided by FHWA. The following status report, as of April 2002, serves to quantify the impact of this program on a nationwide basis:

- Most DOTs exceeded the FHWA major milestone of 90 percent of the bridge scour evaluations completed for bridges requiring an evaluation (42 DOTs with 90 percent or more).
- A detailed analysis of the April 2002 status report showed the following percentages by category:
 - 1) 70.6 percent of the reported 484,264 bridges over waterways -- *Low Risk*
 - 2) 18.3 percent, *Unknown Foundations*
 - 3) 5.5 percent, *Scour Susceptible*
 - 4) 5.4 percent, *Scour Critical*
 - 5) 0.2 percent, *Tidal*

Figure 1 presents the status of the scour evaluation program, reported by State DOTs, as of April 15, 2002.

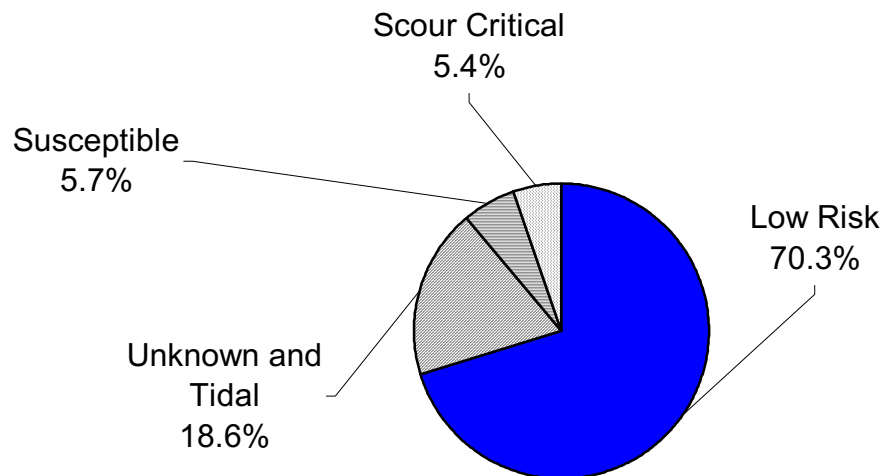


Figure 1. Status of Scour Evaluation Program (As of April 15, 2001)

CURRENT ACTIVITIES

The scour evaluation program has served to identify other areas where technology should be developed and/or enhanced in order to continue to provide state-of-the-art guidance to DOTs. Two major areas are how to evaluate and how to identify unknown foundations. Technology for identifying unknown foundations is now available for some foundation types, thanks to the results obtained from the National Cooperative Highway Research Program (NCHRP) Project 21-5(1). Another NCHRP project, 21-5(2), will investigate other devices for potential use in this area.

Technology on tidal hydrology and hydraulics has been enhanced through advancements made through a pooled-fund project on tidal hydraulics, led by the South Carolina DOT in partnership with several coastal States in the United States of North America and the FHWA. Currently, FHWA is developing a new Hydraulic Engineering Circular (HEC) publication, HEC-25, which would present guidance for estimating the hydrology and hydraulic parameters needed to estimate scour at bridges over of tidal waterways. A new training course on Tidal Hydraulics is under consideration by FHWA to disseminate the guidance contained in the new HEC-25.

The scour evaluation program has also served to identify needs to develop specifications for pier and abutment scour countermeasures, methods to assess channel migration, and portable devices for monitoring scour. Research activities, sponsored by NCHRP are currently underway to address these technology needs. In addition, the scour program has served to identify the need to update microcomputer software for scour modeling in a continuous basis. As such, FHWA has been actively enhancing microcomputer software for bridge hydraulics and scour calculations. The microcomputer software WSPRO, a one-dimensional bridge hydraulics, has been updated to include bridge scour modeling. This software is available through the Office of Bridge Technology website at www.fhwa.dot.gov/bridge. The microcomputer FESWMS, a two-dimensional bridge hydraulics, has been updated to include bridge scour and sediment transport modeling. A program interface, Surface-Water Modeling System, provides enhanced input/output data management and graphics for FESWMS.

SUMMARY

Since the initiation of the scour evaluation program, State and local DOTs have been able to identify and prioritize scour critical bridges in need of corrective actions due to the impact of stream instability and/or scour upon the bridge foundation. Some DOTs have developed plans of action that include specific instructions for bridge inspectors and other actions such as corrective measures to be designed and implemented on these bridges. FHWA developed a generic plan of action (GPOA) based on the guidance presented in HEC-23 to assist State DOTs. The GPOA has been distributed to all the State DOTs and is posted as part of a presentation titled "Approach to Developing a Plan of Action" in the Office of Bridge Technology Website at <http://www.fhwa.dot.gov/bridge/sctrb.htm>. FHWA plans to promote the implementation of the GPOA through its FHWA field offices.

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