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MAGNITUDE OF THE SCOUR EVALUATION PROGRAM

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Abstract

Tens of millions of dollars have been spent over the years on Federal-aid highway system bridges damaged by floods. Nearly 500,000 of the 577,000 existing bridges within the National Bridge Inventory are over waterways. The screening of these bridges over waterways for scour susceptibility will be completed, for the most part, by October 1992. The Federal Highway Administration has established January 1997 as the completion date for the scour evaluations of all existing bridges identified as scour susceptible. A cost-effective means of determining the specifics of bridges with unknown foundations is not currently available. Pending the development of technology to determine unknown foundations, these structures must be monitored during routine National Bridge Inspection Standards inspections and following significant flood events. The only exception to this course of action is for unknown foundation bridges on the Interstate system, which must be evaluated for scour before the January 1997 target date. This paper presents the existing bridge scour evaluation requirements, the magnitude of the overall scour evaluation program and the status of progress to date.

Introduction

The scouring of bridge foundations is the most common cause of bridge failures. Of the 577,000 bridges within the National Bridge Inventory, nearly 84 percent are over waterways. The Federal Highway Administration (FHWA) has assisted State highway agencies over the years in the restoration of flood damaged highway facilities through the Emergency Relief Program. It is estimated that nearly a billion dollars has been spent for this purpose. While the actual Emergency Relief Program costs associated with the restoration of bridges is not known, it is estimated at over a quarter of a billion dollars. The Intermodal Surface Transportation Efficiency Act of 1991 has authorized

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100 million dollars per year for the Emergency Relief Program. The failure of the New York Thruway/Schoharie Creek bridge due to scour in April 1987 with a loss of 10 lives served as the impetus for establishing the National Bridge Inspection Standards (NBIS) scour evaluations of all bridges over waterways within the National Bridge Inventory.

Bridge Scour Evaluation Requirements

With the Schoharie Creek failure, the FHWA reviewed its bridge scour guidance with care. In September 1988, Technical Advisory 5140.20, "Scour at Bridges," was issued by the FHWA. This Technical Advisory was very comprehensive and focused on the development and implementation of a program for evaluating scour vulnerability of existing bridges, using scour countermeasures and improving the state-of-knowledge for estimating scour at bridges. Technical Advisory 5140.20 provided a four-step procedure to follow for scour evaluations: 1) an interdisciplinary team of hydraulic, geotechnical and structural engineers should conduct scour evaluations; 2) all existing bridges over waterways with scourable beds should be evaluated for the risk of scour failures for a superflood; 3) a plan of action should be developed for all bridges that are determined to be scour critical; and 4) all bridges should be inspected for scour during the routine two-year NBIS inspection cycle. The initial direction for scour evaluations was contained in the document "Interim Procedures for the Evaluation of Scour at Bridges," which was an attachment to Technical Advisory 5140.20.

Step 2, evaluation of the risk of scour failures for a superflood, involves screening all existing bridges based on scour susceptibility to prioritize their order of evaluation and analyzing the structures for scour. If the scour analysis of a bridge indicates that its structural integrity would be threatened, it is termed as "scour critical" and Step 3, plan of action, must be initiated.

In September 1988, the FHWA also issued Technical Advisory 5140.21, "Revisions to the NBIS." While this Technical Advisory added underwater inspections among other changes to the NBIS, scour evaluations were formally initiated. Prior to this time, State highway agencies conducted NBIS bridge inspections without specific reference to scour. As a result of the 1988 NBIS revisions, the December 1988 FHWA publication "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges" (Coding Guide) established Item 113, Scour Critical Bridges, for reporting scour evaluations.

The Coding Guide requires coding more than 100 separate items for each bridge based, for the most part, on routine inspections. The coding items relevant to bridge scour and stream stability are: Item 60, Substructure; Item 61, Channel and Channel Protection; Item 71, Waterway Adequacy; Items 92 and 93, Critical Feature (Underwater) Inspection; and Item 113, Scour Critical Bridges. Items 60, 61 and 71 have been part of the routine bridge inspection program since its

inception in 1970. The 1988 Coding Guide did set more definitive coding criteria for Items 60, 61 and 71. Because of the special nature of underwater inspections, these inspections are typically accomplished at a different time than the routine inspections. In turn, Item 113 information is based on scour evaluations which are conducted independently of routine inspections.

The "Interim Procedures for Evaluating Scour at Bridges," the attachment to Technical Advisory 5140.20, was replaced by FHWA publication Hydraulic Engineering Circular (HEC) 18, "Evaluating Scour at Bridges," dated February 1991. Technical Advisory 5041.23, "Evaluating Scour at Bridges," dated October 28, 1991, supersedes Technical Advisory 5140.20. Inasmuch as a bridge waterway may be affected by changes that occur in the contiguous reach of natural channel, it is essential to consider the impact of such changes on bridge scour. For this purpose, the FHWA published HEC 20, "Stream Stability at Highway Bridges," dated February 1991. Implementation of the engineering technology contained in HECs 18 and 20 is being supported by the FHWA's National Highway Institute training course "Stream Stability and Scour at Highway Bridges." This course has been well received by the engineering community and is available to State highway agencies upon request to the FHWA.

Magnitude of the Bridge Scour Evaluation Program

In February 1990, the FHWA initiated biannual status reports from State highway agencies on the status of scour evaluations. It was emphasized at that time that a well developed screening process could lessen the number of subsequent scour analyses, thus minimizing the overall expenditure of resources. Within the screening process, it was documented that bridges identified with reasonably risk-free or low-risk foundations need no further evaluation. Recognizing the multitude of bridges within the National Bridge Inventory that lack foundation information, it was recommended that the scour evaluation of such structures be deferred, for the most part, until technology is developed to determine foundation information. Until technology is developed, unknown foundation bridges should be monitored during routine bridge inspections and after significant flood events.

There are 484,736 existing bridges over waterways within the National Bridge Inventory as reported by State highway agencies on November 15, 1991. A total of 239,501 bridges have been identified by State highway agencies as needing further scour evaluations, possibly scour analyses. As documented in HEC 18, a scour analysis is based on a hydraulic analysis which establishes the hydraulic characteristics needed in the scour determination. The use of sound engineering judgment is foundational to both hydraulics and scour determinations. With the large number of bridges that must be analyzed and recognizing that the current scour prediction algorithms need refinement, a bridge owner may be tempted to consider "shortcuts" in the overall analysis. As long as the "shortcuts" are reflective of sound engineering judgment, there should be no problem justifying a given scour determination.

The FHWA and State highway agencies are conducting numerous scour research studies and are planning others. These studies are being and will be pursued in a coordinated program by the highway community to determine scour technology and instrumentation that is currently lacking.

Status of Scour Evaluations

Through November 15, 1991, State highway agencies reported that 92 percent or 447,364 of the 484,736 bridges over waterways have been screened for scour susceptibility. Culverts constituted 80,428 of these structures, 18 percent of the population. There were 96,443 bridges with unknown foundations, 22 percent of the screened total. There were 30,322 bridges or 7 percent of the screened total that had been assessed as safe, needing no further scour evaluation. State highway agencies reported the completion of scour analyses for 6,332 bridges throughout the Nation. Of these 6,332 bridges, 670 or 11 percent have been determined to be scour critical. The State highway agencies have been developing a plan of action for each scour critical bridge.

The costs of the scour analyses have varied considerably, ranging from less than $1,000 to over $20,000 per bridge site. The necessary expenditure of resources to evaluate/analyze the 239,501 structures currently identified as needing further scour consideration is significant.

Summary

While the screening of existing bridges is nearly complete, scour evaluations are just getting under way. Scour evaluations will require additional training of hydraulic engineers and may well require the training of additional hydraulic engineers. Scour critical bridges will have to be identified and a plan of action developed for each one. The completion of scour evaluations by January 1997 will require a substantial commitment of resources by State highway agencies. The FHWA will work actively with the State highway agencies in the accomplishment of this overall endeavor.

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