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United States Geological Survey
Bridge Scour Evaluation Program
in Texas

David D. Dunn, A.M., ASCE and Henry R. Hejl, Jr., P.E.¹

Abstract

The Federal Highway Administration has mandated that all bridges in the Federal Aid System crossing over water be evaluated for scour susceptibility. The United States Geological Survey and the Texas Department of Transportation (TXDOT) have initiated a multi-year, multi-phase program to develop scour evaluation and analysis procedures that will allow TXDOT to quickly and efficiently evaluate some 11,000 bridges crossing over water in the state.

Introduction

In 1988, Federal Highway Administration (FHWA) released Technical Advisory 5140.20 (FHWA, 1988 and 1991) requiring that all bridges in the Federal Aid System crossing over water (excluding bridge class culverts) be evaluated for scour susceptibility. State departments of transportation not complying with this mandate risk losing federal funds. The technical advisory provided guidelines for these scour evaluations but left the development of actual procedures to the discretion of the states. FHWA published Hydraulic Engineering Circulars (HEC) 18 and 20 (Lagasse and others, 1990; Richardson and others, 1991) to provide the states with state-of-the-art methods for calculating scour and performing the scour evaluations.

The procedures described in HEC-18 and HEC-20 indicate three levels of analyses. A Level I analysis consists of a qualitative geomorphic survey to evaluate channel and bank stability in the vicinity of the bridge. A Level I analysis is envisioned as providing a screening to identify bridges which are candidates for higher-level analysis. A Level II analysis is a detailed engineering hydraulic analysis of the bridge site for specified design flows and calculation of the ultimate potential scour resulting from the design flows. A Level III analysis is a comprehensive fluvial model study of the stream upstream and downstream of the bridge crossing to

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predict channel migration, aggradation, or degradation. A Level III analysis is used when the Level I and Level II analyses are determined to be inadequate for evaluating complex conditions at a site.

To begin evaluating the large number of bridges crossing water in Texas, TXDOT has implemented a screening process to identify bridges where scour problems are likely to occur and to prioritize these bridges for scour evaluations. The initial screening process by TXDOT has identified about 8,000 bridges in need of further evaluation. Typical costs for a Level II or Level III analysis of a bridge following the HEC-18 and HEC-20 guidelines range from \$2,000 to \$20,000 or more. Thus, total cost to evaluate the bridges indicated in the initial screening process as needing further evaluation with Level II or Level III analyses ranges from \$16 million to \$160 million or higher. The cost and large numbers of bridges requiring evaluation prompted TXDOT to develop an effective scour evaluation program to 1) further screen bridges and identify bridges with low scour susceptibility 2) provide further prioritization of bridges for analysis and 3) provide a standardized analysis approach and a uniform presentation of results for effective management of the program. The United States Geological Survey (USGS), in cooperation with TXDOT, initiated a multi-phase study of scour at Texas bridges in March 1991.

Description of Program

USGS is providing several components to the TXDOT scour-analysis program. USGS will 1) evaluate a method of Level I analysis based upon procedures used in other states, 2) complete several Level II analyses in order to evaluate the HEC-18 and HEC-20 guidelines and develop standardized procedures for TXDOT to use in future evaluations, and 3) complete several Level III analyses with state-of-the-art fluvial simulation models to assist TXDOT in evaluating bridge crossings with complex fluvial characteristics.

Phase 1 of the study, due to be completed June 1, 1992, consists of 140 Level I analyses, development of a data base in which to store the Level I data, Level II analyses at twelve of the 140 sites, and one Level III analysis at a bridge where it is necessary to determine the possible effects of an upstream gravel mining operation. Record flooding in central Texas during December 1991 and January 1992 provided the opportunity to take real-time scour measurements at two bridge sites for comparison to computed scour. The objective of Phase 1 is to provide an initial data base with which to compare various alternative procedures and to increase familiarity with the HEC-18 and HEC-20 guidelines.

Phase 2 of the study consists of two parts. Part 1 of Phase 2 will be accomplished during June 1, 1992 to September 30, 1992. Five additional Level I and II analyses will be completed as well as one additional Level III analysis. An initial scour monitoring network will be established at the five sites to allow comparison of observed and computed scour. Additionally, the Level I and II analysis procedures will be evaluated and a sensitivity analysis will be performed to determine the

effects of varying levels of field work, a major cost of each evaluation. A preliminary standardized procedure will be developed for TXDOT to use for Level I and Level II analyses in its bridge-scour evaluation program. Part 2 of Phase 2 will consist of further evaluation of the procedures with emphasis on Level II and Level III analyses and the development of training documents. The training documents will provide a standardized procedure and reference to be used by TXDOT throughout the remainder of its in-house bridge-scour evaluation program.

Summary

The evaluation of the scour susceptibility of thousands of Texas bridges crossing water promises to be a time-consuming and expensive task. A technically sound, inexpensive method is being developed to enable TXDOT to screen candidate bridges for scour susceptibility and to make engineering determinations of the need for a more detailed analysis. The Level I analysis will hopefully prove to be a tool to fill that role. A standardized procedure for conducting the more detailed Level II and Level III analyses will allow TXDOT to conduct most of its bridge-scour evaluations in a uniform manner that provides for comparison and evaluation of results.

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