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Scour Evaluations of Existing Bridges

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Background

The collapse of the Schoharie Creek Bridge on April 5, 1987 was a catastrophic instantaneous failure caused by scour of the bridge foundation. This particular collapse received wide media attention due to a home video of part of the collapse, the location on the New York State Thruway and the tragic loss of life. This particular collapse was not the first major interstate highway bridge failure attributed to scour of foundations. It is fair to say, however, that this was the event that finally brought stream stability and bridge scour issues to the attention of highway administrators and bridge engineers throughout the nation.

Federal Policy Guidelines

On September 16, 1988, the U. S. Department of Transportation, Federal Highway Administration (FHWA) issued Technical Advisory (TA) T 5140.20, Scour at Bridges. Also issued on September 16, 1988 was Technical Advisory T 5140.21, Revisions to the National Bridge Inspection Standards (NBIS) which coincided with the issuance of a new Recording and Coding Guide for the Structural Inventory and Appraisal of the Nation's Bridges. It was the addition of coding requirements for scour vulnerability of bridges in the new coding guide which provided the regulatory muscle needed for nationwide implementation of the policies and procedures included in T 5140.20 Scour at Bridges.

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Design Guidelines and Aids

Soon after the issuance of the TA Scour at Bridges I began development of the HY-9 computer program as a tool for solving the numerous scour equations and documenting the results. The program went through several early revisions to accommodate changes reflected in the final procedures published as FHWA Hydraulic Engineering Circular No 18 Scour at Bridges [2]. This program has received wide distribution through the McTRANS Center for Microcomputers in Transportation at the University of Florida.

In addition to the Hy-9 computer program and the HEC-18 publication, FHWA has completed work on FHWA Highway Engineering Circular No. 20 Stream Stability at Highway Structures [3] and development of a 3 1/2 day National Highway Institute (NHI) training course based on these publications. In Region 6 the workshop has been held in Arkansas, Louisiana, and Texas.

Scour Screening Program

The primary focus of the FHWA, since the issuance of the technical advisories, has been toward completion of an initial scour screening of all waterway bridges in the nations inventory. The purpose of the screening was to categorize bridges as either highly susceptible to collapse due to scour or as low risk. To provide as much uniformity as possible to this nationwide effort the draft of HEC-18 was released with T 5140.20 in 1988 as interim procedures for evaluating scour at bridges. The final guidelines were issued October 28, 1991 as Technical Advisory T 5240.23. This now serves as the blueprint for completing the engineering evaluation necessary to complete the coding requirements of the NBIS Item 113.

To further focus efforts in Region 6 the Office of Structures recommended to the States that only bridges with as built plans and average daily traffic in excess of 100 vehicles per day be considered for the highly susceptible category. This approach was necessary

[2]. Richardson, E. V.,Harrison, L. J., Davis, S.R. 1991 Hydraulic Engineering Circular No. 18 Evaluating Scour at Bridges.USDOT, FHWA Publication No. FHWA-IP-90-017.

[3]. Lagasse, P.F., Schall, J.D., Johnson, F.L., Richardson, E.V., Richardson, J.r. and Chang, F.F.M, Stream Stability at Highway Structures. Publication No. FHWA-IP-90-014. U.S. Department of Transportation. Federal Highway Administration.

because of the very large number of local rural bridges. Review of the as built plans during the initial screening was considered essential to identifying susceptibility. The foundation type, depth and material and comparison of current channel cross section to as built section are all necessary for assigning a degree of susceptibility to the bridge.

The status of the screening effort in Region 6, as of November 1991, is presented in Table 1. The Federal Highway Administration has established January 1, 1997, as a target date for completing the engineering evaluation of all scour susceptible and low risk bridges.

Table 1. Scour Screening Results
Federal Highway Region 6

STATE	BRIDGE OVER WATER	LOW RISK	SCOUR SUSCEP TIBLE	UNKNOWN FOUNDAT ION	SCOUR CRITIC AL
ARKANSAS	12,018	4,403	1,468	6,135	0
LOUISIANA	10,432	618	8,580	1,226	8
NEW MEXICO	2,846	2,207	65	420	15
OKLAHOMA	21,097	14,355	117	2,384	53
TEXAS	39,252	26,456	5,972	177	0
REGION 6	85,643	48,039	16,202	10,342	76

We are concerned about the ability of the States to provide a full engineering evaluation for the over 54,000 bridges in the Region which have known foundations. In discussing this matter with the State's we find that they share our concern. Some doubt their ability to complete evaluations for all of the susceptible bridges in five years.

Evaluation Program

As presented in the NHI 3 1/2 day training course, Bridge Scour Analysis, is only one step in a three level evaluation process. The different levels are designed to further screen bridges for potential problems due to stream instability. Level I qualitative measures can be evaluated to determine if further Level II analyses are warranted. At Level II, basic engineering analyses are

applied, to evaluate bridge stability for calculated scour. In extremely complicated cases for important major bridges additional Level III analysis may be warranted. This would involve sophisticated computer and/or flume modeling.

Level II involves hydrologic, hydraulic, scour, structural and geotechnical computations to support the evaluation and recommendations. Because this will require a sizable investment in engineering resources, a good screening process is essential.

The following summaries describe the overall approach to stream stability evaluations being taken by the States in Region 6.

Arkansas

In Arkansas the responsibility for scour screening was assigned to a task group consisting of one member from each of four bridge design squads. They assigned summer aids to the task of locating and reprinting, from micro fiche, the plan sheets needed for scour screening. This resulted in books for each highway district. A copy was provided to each District Bridge Inspector and a copy was retained in the Central Office.

Using the inspection data and plan sheets, which included as built channel cross sections, some hydraulic information and the foundation type and material, the group screened all bridges with known foundations.

There are 2,618 bridges with known foundations to be evaluated. Of these, 1,468 are rated highly susceptible for scour. These evaluations will be performed in the Central Office by State personnel.

Louisiana

For many years the State has conducted hydrographic surveys of bridges with known or suspected scour or stream stability problems. Approximately 120 bridges are sounded with recording fathometers on a regular basis which varies from 6 months to 2 years depending on particular circumstances.

The Hydraulics section developed the State's Assessment and Analysis Plan dated March 30, 1990. The scour

screening procedures in this plan depend heavily on computerized data in the Master Structure File Data Base. For some years the State has maintained data in addition to the minimum requirements of the NBIS. One such item is a bridge scour rating. Only visible evidence of stream stability, as described in the Louisiana Bridge Inspectors Training Program Work Booklet, is covered. A rating of 4 or less places a bridge in the scour susceptible category.

All bridges greater than 200 feet in length have also been shown as scour susceptible. This limited degree of screening effort accounts for the relatively high percentage of bridges in the scour susceptible category. The State does include further screening steps in it's plan. At this point the state plans to hire consultant firms to perform the second level screening and subsequent analysis.

New Mexico

The bridge scour evaluation effort is being handled in the Bridge Design Section of the State Highway and Transportation Department. Due to the more manageable number of bridges, they were able to review their bridges in considerable detail during the screening effort.

Plans were reviewed as well as the NBIS ratings. For most bridges they have been able to make a scour calculation for main channel contraction scour and local pier scour using the 50-year flood frequency data shown on the plans. Based on these scour depths, inspection files, and review of the as built plans most of the State's bridges have been placed in the low risk category. The only question remaining is the possible effects of 100year floods and catastrophic floods.

Oklahoma

The State developed an initial screening process that considered a limited amount of data accessible through their computerized bridge inventory. Their first screening identified approximately 340 bridges to be fully evaluated. One Bridge Design Engineer was assigned to full time to perform these evaluations. These consisted of State owned bridges crossing one of 20 major waterways.

Data has been added to the computerized data base to

allow further screening and prioritization of 2064 bridges and 3004 culverts now shown as low risk. The local bridges are being evaluated by the consultants hired to perform NBIS inspections.

The in-depth evaluations have identified 51 scour critical bridges. Countermeasures have been installed at 12 and monitoring is planned for the remaining 41.

Texas

The Texas Department of Transportation has one of the largest bridge inventories in the nation. Although it took some time to mobilize, they have managed to perform a detailed screening of 32,428 bridges for which plans are available. One engineer in the central office has organized a comprehensive program for screening and evaluation.

The prioritization of the nearly 6000 scour susceptible bridges will be done by computer and a list will be provided to each district. In many districts the lists will be further divided among the various residencies.

During the period of October 1991 through January 1992 over 100 engineers were provided a minimum of 16 hours training for bridge scour computations. Additional training is planned for bridge hydraulic computations using the WSPRO water surface profile computer program.

The Texas screening effort emphasized the gathering of data, field review, and comparison of today's channel conditions with as built cross sections for every screened bridge. The data including partial bridge plans containing hydraulic, channel and foundation data has been pulled together and added to the bridge inventory hard copy file.