SP-20

Log H-470

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: June 17, 1986
In reply refer to: H-86-01 and -02

Mr. John R. Tabb
Director
Mississippi State Highway Department
Woolfolk State Office Building, Rm. 1004
P.O. Box 1850
Jackson, Mississippi 39215-1850

Mr. Ray D. Bass
Director
State of Alabama Highway Department
1409 Coliseum Boulevard
Montgomery, Alabama 36130

Mr. Dale R. Kelley
Commissioner
Tennessee Department of Transportation
James K. Polk Building
50 Deadwick Street
Nashville, Tennessee

About 2:01 p.m. central standard time, on April 24, 1985, two 34-foot-long twin spans at the south end of the Chickasawbogue Bridge on U.S. 43 about 2 miles north of Mobile, Alabama fell into water ranging from 10 to 30 feet deep after a steel H-pile bent 1/ collapsed. Two of the three southbound vehicles on the bridge at the time stopped before reaching the edge of the bridge void. However, one vehicle, a 1979 Ford van, became airborne, struck one of the falling bridge spans, and entered the water. The lone occupant exited the van, swam to shore before the van sank in 20 feet of water, and sustained minor injuries in the accident.

In a postaccident examination of the bridge, divers for the State of Alabama reported that the exposed steel H-piles were severely corroded near the mud line of the creek. The State of Alabama last inspected the Chickasawbogue Bridge on April 3, 1985. However, none of the underwater bridge elements was examined during that inspection. The underwater elements of the bridge had not been inspected by the State since November 1969.

The Chickasawbogue Bridge was designed in accordance with the State Highway Department of Alabama Standard Specifications for Highways, Bridges, and Materials, dated 1950, and in accordance with the American Association of State Highway Officials

1/ For more details, read Highway Accident Report "Collapse of the U.S. 43 Chickasawbogue Bridge Spans near Mobile, Alabama, April 24, 1985 (NTSB/HAR-86/01).

(AASHO) 2/ Standard Specifications for Highway Bridges, dated 1953. 3/ Design on the bridge started in 1952, and the bridge was opened for vehicles in 1958. Initially, the bridge had an estimated design life of 75 years.

In the Gulf States, 4/ steel pile was widely used in the construction of bridge substructures during the 1950s because it was economical and accommodated the rapid construction of bridges. The 1953 AASHO standard specifications for highway bridges suggested the following precaution to compensate for corrosion of exposed steel piles: "1/16 inch depth of thickness shall be deducted from all exposed surfaces when computing the area of steel in piles or shells." This particular requirement was not used in the design of the Chickasawbogue Bridge, nor was it a requirement in the Alabama Standard Specifications for Highways, Bridges, and Materials.

After the collapse, Safety Board investigators inspected the remaining bridge structure for horizontal and vertical misalignment. Span misalignment varied up to 3/8 inch in the horizontal direction and 1/4 inch in the vertical direction. Expansion joint openings varied from 1/32 inch at pile bent 5 to 1 1/2 inches at pile bent 6. At the time of the inspection, new steel H-piles were being installed to accommodate the reopening of the southbound lane for vehicle traffic.

The State of Alabama Highway Department (AHD) does not routinely record measurements for span misalignment or expansion joint openings on the bridge inspection report. On some occasions, bridge inspectors will note on the report obvious problems with misalignment. Misalignment is given a subjective rating by the inspector as part of the structural appraisal for bridges. Although AASHTO and Federal Highway Administration (FHWA) guidelines for bridge inspection suggest that measurements should be recorded, they do not provide any criteria for determining what the acceptable tolerance ranges should be for span misalignment or expansion joint openings.

At the time of the bridge collapse, the AHD inspected all bridges at 2-year intervals in accordance with the National Bridge Inspection Standards (NBIS) 5/ and inspected the underwater elements of "major" bridges at 5-year intervals. Although there is no universally accepted definition for a major bridge, the State of Alabama generally defines major bridges as those over rivers and those that include complex design, substructures, or foundations in deep water. The last inspection was made on April 3, 1985, 21 days before the collapse. Since the bridge was not classified as a major bridge, none of the underwater bridge elements were examined during these inspections. The Chickasawbogue Bridge had been inspected at the required 2-year intervals. The last reported inspection of the underwater elements was conducted in November 1969 after the FHWA Regional Office notified the State of the collapse of the Anclote Bridge in Florida due to the corrosion of exposed steel H-piles. At that time, the State examined the underwater elements of several bridges, including the Chickasawbogue Bridge. State highway officials did not uncover any apparent corrosion problems in the substructural elements of the Chickasawbogue Bridge after 11 years of service; as a result, no further underwater examinations were made.

2/ Now the American Association of State Highway and Transportation Officials (AASHTO).
3/ The American Association of State Highway Officials, Standard Specifications for Bridges (The Association, Washington, D.C.) 1953, p. 204.
4/ The five States with coastlines on the Gulf of Mexico are Florida, Alabama, Mississippi, Louisiana, and Texas.
5/ Reference 23 CFR 650.301 to 650.311, "National Bridge Inspection Standards," for details.

As a result of the inspections prompted by the Anclote Bridge collapse, the AHD discovered underwater corrosion problems on three other bridges located closer to Mobile Bay. The AHD continued to monitor the condition of these bridges and in 1974, discovered that the bridge spans had begun to misalign both in the transverse and longitudinal directions. The AHD reinforced the bridges with additional H-piles, but the condition became worse. In 1977, inspection of these bridges uncovered extensive corrosion of the substructural elements, which should have triggered the AHD to reinspect the Chickasawbogue Bridge. The AHD resolved the problems by encasing the steel piles in concrete from the water line to below the mud line on one bridge, and by replacing steel piles with concrete piles on the two other bridges. These three bridges and the bridge over the Chickasawbogue are over brackish water. 6/

Safety Board investigators contacted the FHWA's Division Administrator and Division Structural Engineer in Alabama and the FHWA Regional Structural Engineer in Atlanta, Georgia. These officials are responsible for ensuring compliance with the NBIS. FHWA conducts an annual review of the State bridge inspection programs, renders technical assistance, and assists in training in bridge inspection. None of the FHWA officials were aware that Alabama had not been inspecting the underwater elements of non-major bridges. Safety Board investigators examined the Structure Inventory and Appraisal Sheet (SI&A) that the FHWA requires each State to complete for all bridges and the bridge inspection report form used by the AHD. Each document provides for a rating of the substructure of the bridge. Neither document provides for reporting that underwater elements are examined when each bridge is inspected.

As a result of the collapse of the bridge spans over Chickasawbogue Creek, the AHD launched an intensive inspection and repair program. The State inspected the underwater elements of 655 bridges and bridge culverts. These bridges were constructed with either steel or concrete piles. Twenty of the bridges inspected, ten on Interstate routes and ten on State routes, exhibited varying stages of corrosion of the steel piles. Corrosion was found on exposed steel piles in both fresh and brackish water. In addition, one county-owned and one city-owned bridge, each over brackish water, were inspected and were found to have extensive corrosion. These bridges were closed because of imminent danger of collapse. As a result of this intensive inspection program, the AHD indicated that it will continue to inspect the underwater elements of these bridges every 2 years.

Of the seven State highway departments in FHWA Region 4, representatives from four--Florida, Mississippi, North Carolina, and Tennessee--testified on the underwater bridge inspection programs within their respective States. 7/ Except for Tennessee, all of the States have bridges over brackish waters. Representatives from two of the four States said that they have existing programs for inspecting the underwater elements of bridges. Florida and North Carolina perform underwater inspections on every bridge over water every 2 years; Tennessee and Mississippi inspect the underwater elements of their bridges only when problems are suspected (i.e., scour caused by weather conditions or damage caused by collision with ships).

At this time, many States do not comply with either the 2-year inspection cycle specified in the NBIS or the 5-year inspection cycle suggested in the AASHTO manual for underwater inspections. A 1980 study prepared by the Transportation Research Board indicated that 35 States do not routinely inspect bridge substructures below the waterline. Out of the 15 States that do conduct routine underwater inspections, 14

6/ Contains some salt.
7/ State Highway officials in Kentucky, South Carolina, and Georgia did not participate.

perform these inspections every 5 years or less. Because of the apparent lack of uniform policy on the underwater inspection of bridge elements, most States perform these inspections only when problems are suspected.

In addition to the lack of underwater inspection criteria, the FHWA and AASHTO do not provide effective criteria for determining acceptable tolerances for bridge span misalignment or expansion joint openings. The AASHTO manual suggests that measurements be recorded, but does not provide the methodology for recording measurements or for identifying potential causes of span misalignment or abnormal expansion of joint openings or closures. The FHWA Bridge Inspector's Training Manual, on the other hand, does stress that excessive misalignment should raise questions regarding the condition of the bridge. However, the manual does not provide written, objective, dimensional standards for measuring the alignment of bridge structural members. If alignment measurements are recorded routinely during the normal above water bridge inspection, the bridge inspector may determine if a substructural member has shifted, and may request a detailed underwater inspection to identify the cause(s) of shifting. The Safety Board believes that objective criteria should be developed to assist States in these areas.

At the time of the collapse, the AHD thought its existing underwater inspection program was adequate and met the requirements of the NBIS since few detailed criteria and little guidance were available. The underwater inspection program in Alabama covered about 110 of the 655 bridges statewide requiring underwater inspection. The underwater elements of the remaining bridges were inspected only when a problem was suspected and at the discretion of the AHD. However, the changing water conditions to which many of the bridges were subject should have prompted the AHD to inspect the underwater bridge elements more frequently. Neither the FHWA divisional nor regional reviews were thorough enough to detect the inadequacies of the State's underwater bridge inspection program.

Because of constantly changing environmental and loading conditions, most bridge designers cannot predict the life of bridges. Periodic inspections are necessary to make certain that all potential problems are detected early to minimize the potential for catastrophic failures. Design allowances and corrosion control methods will delay the corrosion process for steel piles, but will not prevent it completely. No foundation type (i.e., steel, concrete, or timber) is immune to corrosion or the loss of section integrity.

Effective, timely inspections are key to accident prevention. This accident could have been prevented had the State periodically inspected the underwater elements of its "nonmajor" bridges. Continued inspections of underwater bridge elements are required to ensure that the structural integrity of bridges is maintained, and that the maximum operating rating is appropriate. Spot checks should also be done to identify damage resulting from adverse weather and environmental situations.

As a result of its investigation of this accident, the National Transportation Safety Board recommended that the States of Alabama, Mississippi, and Tennessee:

> Revise the State bridge inspection report form to include a specific entry that denotes if the underwater substructural elements have been inspected, and specifies the date when the last underwater inspection was conducted. (Class II, Priority Action) (H-86-1)

Revise the State bridge inspection report form to include measurements for bridge span misalignment and abnormal expansion joint openings or closures. (Class II, Priority Action) (H-86-2)

GOLDMAN, Acting Chairman, and BURNETT, LAUBER, and NALL, Members, concurred in these recommendations.

By: Patricia A. Goldman
Acting Chairman