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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: June 17, 1986
In reply refer to: H-86-03 through -06

Honorable Ray A. Barnhart
Administrator
Federal Highway Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

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 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 (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/ 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).
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.

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"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.

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 until the collapse occurred.

The AHD officials were aware of varying water conditions in the vicinity of the Mobile Bay and Mobile River. However, based on the 1969 examination of the bridge underwater elements, the AHD officials thought that the water conditions near the U.S. 43 bridge site were not as corrosive as the water downstream. AHD officials measured the pH and chloride ion concentration of 746 and 278 part per million.

The bridge is located in estuarial waters where a brackish condition exists. Sea water from the Mobile Bay enters the creek and causes variations in the levels of salinity, dissolved oxygen, pH, and water velocity. In addition, tidal influence from the Mobile Bay and the Gulf of Mexico causes a salt water wedge to penetrate the Mobile River and its tributary streams. A report by a consultant for the American Iron and Steel Institute (AISI) on the Chickasawbogue Bridge collapse 6/ stated that a dense salt wedge exists at the bottom of the creek due to incoming tides. Since salt diffuses upward, the presence of the dissolved salts at the bottom of the creek significantly reduced the electrical resistivity of the entire body of water.

In addition to salinity levels of the water, the Chickasawbogue had a long history of pollution problems. The AISI report on the inspection of the collapsed bridge stated that two previous water quality studies had detected the presence of anaerobic bacteria at the mud line of the creek as early as 1958. The report also states that the creek was the receiving stream for various industrial wastes that apparently were high in sulfate content. Because of the tidal influence, effluents from industrial plants discharged either upstream or downstream could have affected the water quality at the bridge site, encouraging the growth of corrosive anaerobic bacteria.

5/ Reference 23 CFR 650.301 to 650.311, "National Bridge Inspection Standards," for details.

6/ Coburn, S.K. Report of Inspection of US-43 Bridge Collapse in Chickasaw, Alabama, August 15, 1985 (unpublished).

The FHWA's report on the 1984 annual bridge inspection program review for Alabama 7/ states that the AHD and all counties reviewed were not meeting the NBIS requirements for posting load limits at bridges. All bridges should be load posted if the operating rating is less than the legal load limit under the State and Federal law. At the time of the collapse, the AHD did not have a formal policy on posting bridges. The FHWA report also suggested that the State consider the following recommendations concerning load posting:

> Recommendations - (1) Design bridges capable of carrying legal loads. (2) Rerate all bridges using truck types and configurations which are compatible with the State legal loads for comparison with the operating rating and, if necessary for compliance, use special rating techniques to give the highest rated capacity of a bridge using acceptable methods. (3) Develop a formal policy on posting and encourage the counties to adopt it.

The Safety Board held a public hearing on this investigation in Atlanta in July 1985. Exhibits and testimony were entered into the record to assemble a comprehensive, factual docket of information on this accident and the bridge inspection programs within various States. Officials of the AHD, FHWA, AASHTO, AISI, U.S. Army Corps of Engineers (COE), and the National Bureau of Standards (NBS) provided testimony on the construction, maintenance, and inspection of the Chickasawbogue Bridge, and on the National Bridge Inspection Program, Federal oversight responsibilities, factors influencing the corrosion of exposed steel piles in marine environments, and appropriate countermeasures to retard corrosion.

FHWA officials who testified at the public hearing stated that the 5-year cycle for underwater inspection, suggested in the AASHTO manual, was not based on research but on the best engineering judgment available at the time the AASHTO manual was written. FHWA officials stated that they did not question the State's bridge inspection program or determination of "major" bridges because they felt the professional engineer in charge of the program was knowledgeable about the bridges within the State and was able to determine which bridges should and should not be subjected to underwater inspections. The FHWA officials stated also that in retrospect they probably should have asked more questions during the annual review process to clarify Alabama's policy on inspecting nonmajor bridges.

FHWA officials also stated that after the collapse of the Anclote River Bridge, only the States within the same FHWA region were notified of the circumstances and causes of the collapse. However, the results of the followup inspection program by the State of Florida were not disseminated. After the collapse of the Chickasawbogue Bridge spans, all 10 FHWA regions were notified and requested to take appropriate steps to make certain that all States had well-founded underwater inspection programs that identified the criteria, procedures, frequency, and followup methods necessary to comply with the requirements of the NBIS. Again, the results of the followup inspection program by the State of Alabama were not disseminated.

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

7/ FHWA 1984 Alabama Bridge Maintenance and Inspection Report, October 1984.

the waterline. Out of the 15 States that do conduct routine underwater inspections, 14 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.

The detail, type, and frequency of the underwater inspections are left to the discretion of the State highway officials. Both FHWA and AASHTO provide only suggested guidelines on underwater inspections, guidelines that do not identify specific details for inspecting the underwater elements of bridges based on the foundation type, substructure complexity, and water conditions the bridge is subject to. The Safety Board believes effective criteria are needed to assist the States in developing programs for the underwater inspection of bridges.

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.

In the 1984 annual review of the bridge inspection program in Alabama, the FHWA noted that the State did not meet the NBIS requirements for load-posting bridges, nor did the State have a formal policy on load posting. As a result of the bridge span collapse, Alabama recently completed an intensive bridge underwater inspection program to determine section losses for steel and concrete piles. The Safety Board suggests that the compiled data will be used to develop a statewide load posting program that accurately reflects the true operating rating for its bridges. The condition of the underwater elements is an important part in determining the safe load capacity of bridges. The Safety Board encourages other States to accurately assess the safe load capacity for bridges over water before establishing or updating existing statewide load-posting programs.

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 Federal Highway Administration:

> Establish criteria for inspecting the underwater elements of bridges which consider the following factors as they relate to bridge design and maintenance:
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> Complexity of structure and materials used,
> Marine environment surrounding the underwater elements of the bridges, and
> Frequency and magnitude of loads on the bridge.
> (Class II, Priority Action) (H-86-3)
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> Until research has been conducted to establish the appropriate inspection cycle, require all States to inspect the underwater elements of bridges on a 5-year cycle as suggested in the 1983 American Association of State Highway and Transportation Officials Manual for Maintenance Inspections of Bridges, unless more frequent inspections are performed. (Class II, Priority Action) (H-86-4)
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> Require State highway officials to determine the safe load capacity for all bridges. Ensure that the underwater elements of all bridges over water have been recently examined before the safe load capacity is determined. (Class II, Priority Action) (H-86-5)
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> Work with the American Association of State Highway and Transportation Officials to develop procedures for examining the substructural elements below water, considering the size, type, complexity of the bridge design, and the marine environment; develop effective criteria for determining acceptable tolerances for bridge span misalignment and expansion joint openings or closures which identify dimensional standards for the alignment of bridge spans. (Class II, Priority Action) (H-86-6)

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

Patricia A. Goldman

By: Patricia A. Goldman
Acting Chairman