

Log 4-411

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: July 19, 1984

Forwarded to:

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SAFETY RECOMMENDATION(S)

H-84-57

At 1:30 a.m., e.d.t., on June 28, 1983, a 100-foot-long suspended span between piers 20 and 21 of the eastbound traffic lanes of the Interstate Route 95 highway bridge over the Mianus River in Greenwich, Connecticut, collapsed and fell 70 feet into the river below. Two tractor-semitrailers and two automobiles plunged into the void in the bridge and were destroyed by impact from the fall. Three vehicle occupants died, and the other three received serious injuries. 1/

The suspended span which collapsed was attached to the bridge structure at each of its four corners. To support the weight of the northeast and southeast corners of the suspended span, each corner was attached to the girders of the cantilever arm of an adjacent anchor span by a pin and hanger assembly. The pin and hanger assembly includes an upper pin attached through the 2 1/2-inch-thick web of the girder of the cantilever arm and a lower pin attached through the 2 1/2-inch-thick web of the girder of the suspended span. One and one half-inch-thick steel hangers connect the upper and lower pins—one on the inner side and one on the outer side of the web.

Sometime before the collapse of the suspended span, the inner hanger in the southeast corner of the span came off of the inner end of the lower pin. This action shifted the entire weight of the southeast corner of the span onto the outer hanger. Over a period of time, the added weight initiated a fatigue crack in the top outer end of the upper pin. The outer hanger gradually worked its way farther outward on the pin, and when it reached the fatigue crack, the shoulder of the pin fractured off and the assembly failed. The span briefly balanced on its connections at the other three corners and then collapsed, southeast corner first, into the river 70 feet below.

1/ For more detailed information read Highway Accident Report—"Collapse of a Section of Interstate Route 95 Highway Bridge Over the Mianus River, Greenwich, Connecticut, June 28, 1983" (NTSB/HAR-84/03).

The National Transportation Safety Board determined that the probable cause of the collapse of the Mianus River Bridge span was the undetected lateral displacement of the hangers of the pin and hanger suspension assembly in the southeast corner of the span by corrosion-induced forces due to deficiencies in the State of Connecticut's bridge safety inspection and bridge maintenance program.

Article 3.6.42.-Pins and Pin Nuts of the 1953 American Association of State Highway Officials (AASHTO) specifications states that members joined by pins "... shall be held against lateral movement on the pins." The article does not define the movements or the forces which might cause movement. The designer did not consider any lateral force or movement in the design of the pin and hanger assembly. The bridge designer's chief engineer testified that "... the retainer plate [pin cap] is to act as a guide, like a washer--all it is is an oversized washer. In this case it was not designed to take any lateral load, because there are no design forces that the code specifies concerning it, nor would you expect it to." The detail was adapted from a standard type in common use at the time. The engineer said that the washer was added to provide an additional plane for rotation should one side of the hanger freeze up.

The pin cap thickness set forth in the bridge design was 5/16 inch. The pin cap thickness recommended in the Manual of Steel Construction published by the American Institute of Steel Construction (AISC) is 12/16 inch. There is no documentation as to why a thinner plate was chosen by the designer. Tests are planned to determine what loads the 5/16-inch-thick pin cap is capable of withstanding. The pin cap detail has been carried virtually unchanged in the AISC Manual of Steel Construction since the first edition was published in 1934. The details do not state the reasoning for selecting 12/16 inch as the recommended thickness of the pin cap. The AISC pin cap detail does not identify the members it is designed to connect.

The AASHTO specifications used in the design of this bridge required that members joined by pins be held against lateral movement. However, there were no design provisions made to "hold" the hangers against lateral movement on the pins of the suspended spans. The only element that resembled a retainer was the pin cap, but it was not designed to take any lateral load. Obviously, there were lateral forces and movement of the hanger on the pin leading to pressure on the pin cap, but these forces were primarily due to corrosion which the designer did not consider. Neither did the designer consider torsional forces which might cause out-of-plane movement. Testimony at the Safety Board's public hearing indicated that the foregoing corrosion and torsional forces and resulting movements normally would not have been considered in 1955 in designing a pin and hanger suspension, nor would they normally be considered today.

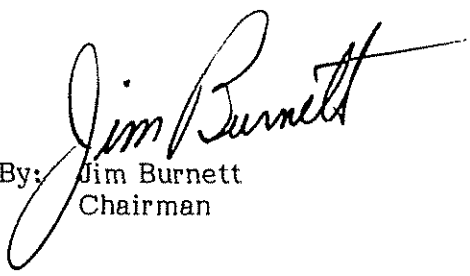
In view of the large corrosion pressures which were present in the assemblies, it is doubtful that the choice of a thicker pin cap would have prevented the failure. If anything, the thinner plate could have served to give an early warning of a problem, if the bridge inspectors had been able to see and had correctly interpreted the concave dishing or the paint cracking on some of the pin caps. The pin cap effectively hid the joint and much of the deterioration from view. Connections that are not hidden and are easily accessible are more likely to be inspected carefully and frequently maintained. The pin cap detail used in this design appeared in the AISC Manual as an approved design but there were superior pin connections described, i.e., the turned bolt and nut, which could have been used and which would not have involved the problem of hiding a critical element of the connection. The pin cap detail in the AISC manual was an accepted detailing practice; however, it should be accompanied by a warning about the difficulties in detecting corrosion and deterioration and in maintaining the connection or should be deleted from the manual.

Therefore the National Transportation Safety Board recommends that American Institute of Steel Construction:

Review the pin cap detail shown in the AISC Manual of Steel Construction to determine if it should be deleted from the manual or if qualifying conditions should be attached to its use. (Class II, Priority Action) (H-84-57)

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility ". . . to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and BURSLEY and GROSE, Members, concurred in this recommendation.

By:  Jim Burnett
Chairman

