U.S. Department
of Transportation
Federal Highway
Administration

1200 New Jersey Ave., SE
Washington, DC 20590

January 10, 2024

Mr. Dennis J. Collins
Investigator-in-Charge, Accident HWY22MH003
National Transportation Safety Board
Office of Highway Safety (HS-22)
490 L'Enfant Plaza, SW.
Washington, DC 20594

RE: Pittsburgh – Party Submissions (email from November 30, 2022)

Dear Mr. Collins,

In followup to your email, please accept the following submission from the Federal Highway Administration (FHWA) regarding our interpretation of the facts leading to the collapse, and efforts we plan to undertake to address the programmatic issues discovered during the investigation of the collapse and that will improve the state of practice in bridge inspection and evaluation nationwide.

Sincerely yours,

JOSEPH LAWRENCE HARTMANN

Digitally signed by JOSEPH LAWRENCE HARTMANN
Date: 2024.01.10 11:33:21 -05'00'

Joseph L. Hartmann, Ph.D., P.E.
Director, Office of Bridges and Structures

Enclosure

cc: Joey Hartmann (FHWA Director Office of Bridges and Structures)
Derek Soden (FHWA HQ Principal Structural Engineer)
Samantha Lubkin (FHWA Lead Structural Engineer)
Dennis O'Shea (FHWA HQ Bridge Safety Engineer – North)
Justin Ocel (FHWA Senior Structural Engineer)
Richard Runyen (PennDOT Assistant Chief Bridge Engineer)
Eric Setzler (City of Pittsburgh Chief Engineer)
Shawn Hudzinski (Port Authority of Allegheny County Deputy Chief)

FHWA Findings from Factual Evidence

Understanding that the NTSB has the Federal authority to make findings and identify the probable cause of the accident from the information developed in the investigation record, the FHWA is providing commentary herein on possible findings and derivative recommendations that could be directed at the Agency. Based on the evidence reviewed by the FHWA, detailed in our "*Assessment of Bridge Inspection and Load Rating*" report, we believe the sudden collapse of the Fern Hollow Bridge, while open to public traffic, to have resulted from a confluence of programmatic failures in bridge inspection, evaluation, and management.

The bridge was fabricated using uncoated weathering steel and, while corrosion certainly played into the collapse, the material should not be impugned since actions to mitigate the effects of that corrosion could have been deployed[1]. The evolving deterioration of the bridge was apparent, with multiple maintenance and repair recommendations made by bridge inspectors to address the effects of the corrosion identified in the biennial (and later annual) inspections[2]. Despite this, there was no evidence of action taken by the Owner to address corrosion by painting or by repairing section loss or through holes, the exception being an effort to supplement the deteriorated (and later failed) leg cross-braces with cables.

While inspectors continued to note growth in through holes in the frame leg webs and stiffeners, they failed to document remaining section data to the required fidelity needed for a proper load rating.[3] The Inspectors also failed to recognize tension zones in the frame legs, clearly noted on the design plans[4], which would have classified the legs as fracture critical members (FCM)[5] requiring hand-on inspection. Similarly, there is no indication that the tension tie plate, whose failure initiated the collapse, was recognized as a critical tension element that maintained the stability of the leg shoe[6]. Had the frame legs (including the tension tie plate) been appropriately classified they would have been subjected to increased inspection rigor and maintenance recommendations that addressed capacity issues and would have been assigned higher priority (as indicated in PennDOT's inspection guidance) thus requiring prompt action by the Owner and oversight by PennDOT.

Inspectors relied on the 2014 load rating calculations to assess the effect that the deterioration they identified had on bridge capacity, believing that the assumptions made in that load rating were more conservative than the current conditions they were observing in the frame

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[1] FHWA Technical Advisory 5140.22 issued on October 3, 1989 provides uncoated weathering steel recommendations for inspection and maintenance actions (such as routine washing, control of drainage, and controlling sources of moisture such as vegetation).
[2] Pg. 36 of FHWA's Assessment of Bridge Inspection and Load Rating Report.
[3] Appendix A of FHWA's Assessment of Bridge Inspection and Load Rating Report.
[4] Pg. 22 of FHWA's Assessment of Bridge Inspection and Load Rating Report.
[5] 23 CFR 650.305. In 2022, the term *Fracture Critical Member* was replaced in regulation with the term *Nonredundant Steel Tension Member*.
[6] Pg. 23 of FHWA's Assessment of Bridge Inspection and Load Rating Report.

legs.[7] However, that load rating made several errors in the calculation of loads and member capacities that made that assumption unreliable. One of those errors was an underestimation of the asphalt overlay thickness and its contribution to the dead load weight of the structure. There was no evidence of coordination between the City of Pittsburgh's paving operations and bridge inspection groups to ensure that repaving projects did not add more load to the bridge than assumed in design, nor was there evidence that inspectors made efforts to quantify the thickness of the asphalt wearing surface during their inspections.[8] As a result, the thickness of the asphalt wearing surface was nearly double what was shown on the design plans, adding a significant amount of dead load to the bridge that was unaccounted for in the load ratings.

The 2014 load rating made key assumptions that were in error based on the condition of the frame legs observed in inspections. The load rater appears to have prescriptively followed the articles in the 2002 AASHTO *Specifications for Highway Bridges* regarding effective length factors of "welded" members[9]. In doing so, they assumed a much lower effective length factor (k-factor) than appropriate[10] for the frame legs, resulting in an overestimation of the legs capacity to resist axial compression loads. This error led the load rater to believe the capacity of the legs to be controlled by shear near their mid-length, when it should have shown capacity controlled by global buckling at a significantly lower load.[11] In reality, the leg failed due to tension in the deteriorated tension tie plate, a mode not even considered in the load rating analysis.[12] These incorrect load rating assumptions led to an unconservative rating factor, which was then repeatedly used by inspectors to surmise that current conditions were better than those assumed in the load rating. Correct calculation of the dead load and the axial capacity of the frame legs would have led to a load rating value that more accurately characterized the unsafe condition of the bridge and prompted more urgent action by the City of Pittsburgh to guard public safety.

Based on the findings detailed in our "*Assessment of Bridge Inspection and Load Rating Report*", we have identified several efforts we plan to undertake to address the programmatic issues discovered during the investigation of the collapse and that will improve the state of practice in bridge inspection and evaluation nationwide. Those actions are provided below as proposed recommendations to FHWA.

FHWA Proposed Recommendations for NTSB's Consideration:

To the Federal Highway Administration (FHWA)

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[7] Tim Pintar interview on August 23, 2022.
[8] NTSB Bridge Collapse Specialist's Factual Report.
[9] Pg. 48 of FHWA's Assessment of Bridge Inspection and Load Rating Report.
[10] Pg. 49 of FHWA's Assessment of Bridge Inspection and Load Rating Report.
[11] Pg. 49 of FHWA's Assessment of Bridge Inspection and Load Rating Report.
[12] Pg. 53 of FHWA's Assessment of Bridge Inspection and Load Rating Report.

1. Update your *National Bridge Inspection Program Compliance Review Manual* to include regular data-driven evaluation of bridge owners' determination of the need to re-load rate bridges with advancing deterioration.
2. Issue your *Bridge Inspector's Reference Manual* as binding guidance and, if appropriate, incorporate it by reference into the NBIS regulation such that it can be relied upon by State DOTs in the development of their bridge inspection programs.
3. Update your *Bridge Inspector's Reference Manual* and bridge inspection training courses to include:
    a. Guidance on the identification of tension zones or elements that may be located in a perceived compression zone of a nonredundant steel member which would make the member a nonredundant steel tension member (NSTM); and
    b. Additional emphasis on the importance during bridge inspections of bridge inspectors measuring and recording the thickness of;
        i. Remaining section of significantly deteriorated steel components in enough detail to support a valid load rating; and
        ii. Asphalt wearing surfaces during routine inspections to support a valid load rating.
4. Work with the American Association of State and Highway Transportation Officials (AASHTO) to:
    a. Conduct research to advance nondestructive techniques for determination of the deck and wearing surface thicknesses on bridges;
    b. Develop and issue load rating guidance on the determination of an appropriate effective length factor for compression member instability;
    c. Develop and issue guidance on the need for bridge owners to assess whether the level of deterioration of a bridge component is likely to impair its ability to behave as assumed during design, necessitating a different analysis approach to support a valid load rating; and
    d. Update the *Manual for Bridge Evaluation* to provide:
        i. Guidance on the use of structural analysis to identify tension zones or elements that maybe located in a perceived compression zone of a nonredundant steel member which would make the member a nonredundant steel tension member (NSTM);
        ii. Guidance on valid and effective approaches to load rating members with advanced deterioration, including those with through holes;
        iii. Additional emphasis on the importance of measuring and recording the thickness of asphalt wearing surfaces to support a valid load rating and to describe physical means of measuring wearing surface thickness during routine inspections; and
        iv. Guidance for the proper consideration of global and local stability effects in the structural evaluation and load rating of bridge elements, including the effects of deterioration.