HIGHWAY GROUP CHAIRMAN'S FACTUAL REPORT

RAILROAD INTERSECTION AT GRADE COLLISION INVOLVING UNION PACIFIC RAILROAD TRAIN (UPRR) 2ASMAR-2 AND BURLINGTON NORTHERN SANTA FE TRAIN (BNSF) UKCKHKMO-05T FOLLOWED BY DERAILMENT AND IMPACT INTO AND PARTIAL COLLAPSE OF THE MISSOURI HIGHWAY BRIDGE A4376 SPANNING MISSOURI STATE ROUTE M

NEAR CHAFFEE, MISSOURI

MAY 25, 2013 ABOUT 2:30 A.M.

DCA-13-MR-004

(15) Pages

NATIONAL TRANSPORTATION SAFETY BOARD

OFFICE OF HIGHWAY SAFETY

WASHINGTON, D.C. 20594

HIGHWAY GROUP CHAIRMAN'S FACTUAL REPORT

A. ACCIDENT

Type:	Train Collision at Grade (Diamond Interlock Interchange)
Date and Time:	2:30 AM (CDT)
Location:	BNSF Railroad Mile 131
Vehicle #1:	BNSF Train UKCKHKMO-05T
Carrier #1:	Burlington Northern Santa Fe Railroad
Vehicle #2	UPRR Train 2ASMAR-2
Carrier #2	Union Pacific Railroad
Vehicle #3	2010 Nissan Versa
Carrier #3	Private Operation
Vehicle #4	2000 Chevrolet Malibu
Carrier #4	Private Operation
NTSB #:	DCA-13MR-004

B. Synopsis

On May 25, 2013 at approximately 2:30 a.m., central daylight time, near Chaffee, Missouri, Union Pacific (UP) southbound freight train, 2ASMAR-2 collided with BNSF southbound freight train U-KCKHKMO-O5T, where UP and BNSF tracks cross at Rockview interlocking. The BNSF train was occupying the interlocking when the UP train struck the 12th

car behind the locomotives of the BNSF train. As a result of the collision, 13 cars of the BNSF train were derailed. Two locomotives and 11 cars on the UP train were derailed. Spilled diesel fuel from the derailed UP locomotives caught fire. Missouri State Highway M bridge is above the Rockview interlocking and collision forces resulted in the collapse of portions of the highway bridge. The engineer and conductor on the UP train were the only crew members that were injured and they were transported to a local hospital. Subsequent to the bridge collapse, two motor vehicles struck damaged highway elements and were involved in fires. Five occupants of the motor vehicles were transported to a local hospital. It was clear and 48° F at the time of the accident. (See Photograph 1 below)

B. Highway Factors Group

David S. Rayburn	NTSB [redacted]	Group Chairman
Edward J. Hess	MODOT [redacted]	Member
Steve Krause	FRA [redacted]	Member
David L. Wyman	MODOT [redacted]	Member

C. Introduction and Details of Investigation

The highway group examines the design and maintenance of the highway and bridge environment to determine documented facts that may have contributed to the cause of the accident or contributed to the severity of the accident's outcome.

Details of Investigation

The wreckage was photographed by the group members and survey dimensions along with aerial photos were taken the the BNSF and the UPRR. Roadway and bridge design plans were provided by the Missouri Department of Transportation. The group examined roadway dimensions and curvature along with traffic flow and general geometric design guidelines. Plans were examined to provide a general description of the approach geometry to the bridge, the bridge deck, the bridge superstructure, and accompanying support bents on the railroad right of way. Bi-ennial bridge inspection records were examined to determine the present day condition of the bridge. American Association of State Highway Transportation Officials (AASHTO), American Railway Engineering Association (AREA) and American Railway Engineering and Maintenance-of- Way Association (AREMA) design giudelines were examined to determine when

crash walls or bridge pier protection is recommended to protect bridges against impacts by railroad equipment.

1.0 General Highway Information

Missouri State Route M travels through western Scott County Missouri from Interstate Highway 55 west to the western county line near the communities of Rockview and Chaffee. The highway is generally oriented east and west in the accident area. Route M has a posted speed limit of 55 mph and the Average Daily Traffic (ADT) in 2011 was 3,514 vehicles a day. The roadway is functionally classified as a major rural collector, and it has a design speed of 60 mph. Design plans indicated that heavy truck traffic comprised approximately 6 percent of the total ADT.

In the accident area, the roadway had two 12-foot-wide travel lanes, one in each direction. On the approach to the bridge the pavement had a double yellow pavement stripe designating it as a no passing zone. The approach roadway had 10-foot wide shoulders that narrowed to three-feet-wide on the bridge. On the westbound approach the roadway was tangent or straight. On the eastbound approach the bridge was proceeded by a 955-foot-long, 5-degree or 1146-foot radius curve that had a superelevation of .08 ft/foot. Both east and westbound approaches had vertical sag curves of 460 feet long and 450 feet long respectively. Then the vertical grade changed to 6 percent to form a 1060-foot-long crest vertical curve in the center of the bridge that had a design stopping sight distance of 350 feet in 1988, the design year. The calculation procedures changed for stopping sight distances in more recent versions of the AASHTO Policy on Geometric Deisgn of Highways and Streets. The current stopping sight distance for a curve of these

dimensions is 440 feet.[1] The approach guard rails were 27-inch-high blocked-out W-beam guard rails with turned down end-treatments.[2] The bridge had 32-inch high, NCHRP 350 test-level 4 concrete railings. See diagram below for sight distance diagram.

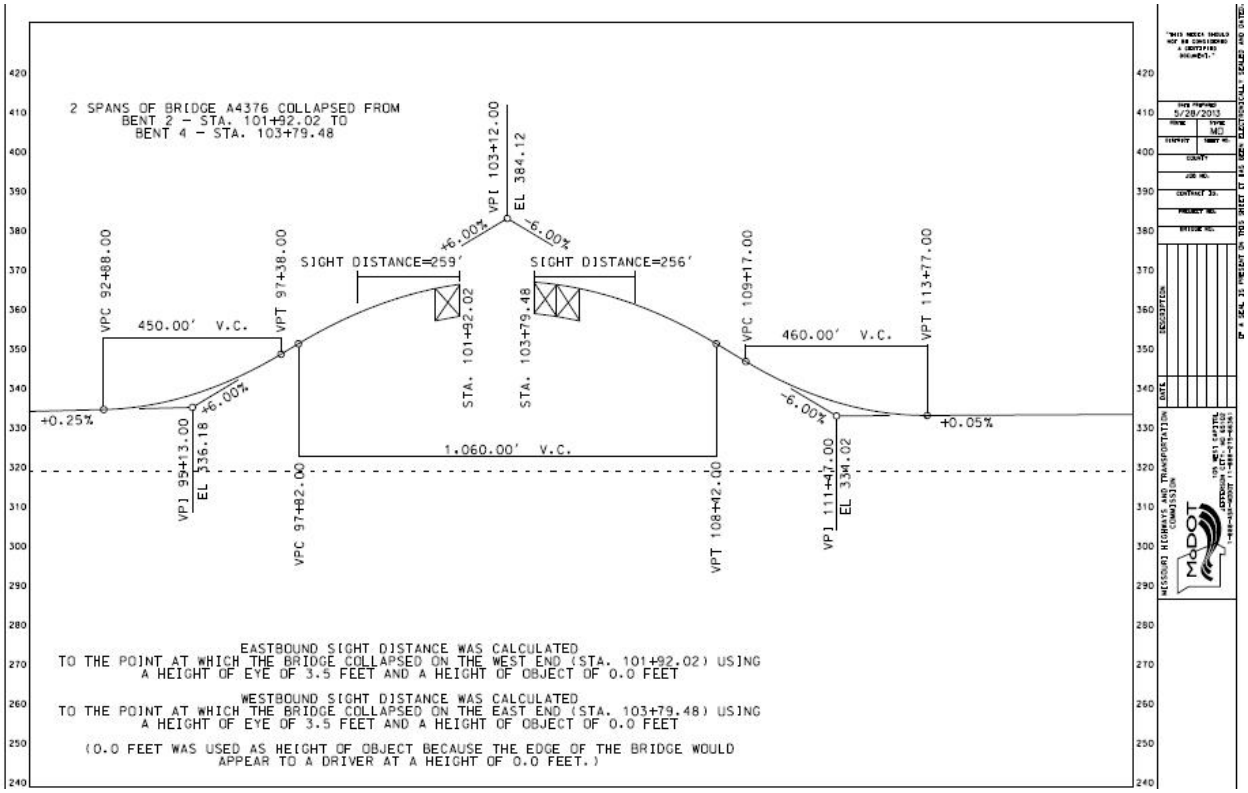


Figure 1

1.1 Bridge Design and Inspection Information

The Route M highway bridge over the BNSF/UPPR Diamond at grade crossing was designed and constructed in 1988. The structure was listed in MODOT's records as

[1] See Missouri Highway Commission Project Plans RRS-RS-11-36-3
[2] Currently the end treatments are substandard

structure No: A4376 and had Federal No: 3576 in the National Bridge Inventory. It was located at highway Station No: 102+29.48. The structure had five spans supported by two abutments and 4 intermediate column bent assemblies. The approach spans were pre-stressed concrete, pre-cast 4-beam girders that were 62 feet long each on the west side of the bridge and 58 foot-long each on the east side of the bridge. The main span had 66-inch deep rolled steel 4-beam girders that were 125 feet long. The bent caps had concrete diaphragms which the girders were connected to. Both bents next to each abutment were steel pipes filled with concrete. Each was 60 feet long with 30 foot embedment depth. Both were comprised of six steel columns. There were three concrete columns at bents 3 and 4. Each coulmn was 36-inches in diameter and embedded to a depth of 41 feet below the footings. For more bridge details see(Highway Attachment 1 – Highway Plans)

Bent No.3 was sheared off at the base of the footing by the train impact after the derailment. This loss of structure allowed spans 2 and 3 to collapse. The downward vertical movement of these spans was stopped by the wreckage of the derailed train cars underneath the structure. Photographs showed there were several UPRR Auto-rack carrier cars that came to rest against the fractured cloumns of bent No.3. Also, oval shaped impact damage was found on BN Car No. 30230 that was 42-inches wide and 39 inches deep. The shape of the damage was consistent with impact into one of the bent columns. This car number was car 22 in the consist or 10 cars behind the impact area, which occurred at 12 cars behind the engine. The vertical clearance between the track elevation and the botton of the girders was approximately 24.5 feet. The horizonal

clearance from the center of the rails to bent No. 3 was 21 feet 9 ¾ inches. There was not a crash protection wall shielding the bents from impact with railroad equipment.

2.0 Inspection Information

Bridge No: AA4376 was subject to the FHWA required bridge inspection standards. It was last inspected on February 25, 2013. The deck and substructure were rated as satisfactory and the superstructure was rated as good. A special inspection was performed on the bridge on January 30, 2013 in response to a BNSF derailment that occurred on the evening of January 29th, 2013. The inspector noted that bent No. 3 had been struck in that derailment as well. The inspector noted the impact only caused light scraping and paint marks on the concrete bent with no structural damage.

2.1 Impact Protection and Proposed Improvements

The American Railway Engineering and Maintenance-of-Way Association (AREMA) had the following 2005 design guidelines in their 2012 edition. Crash walls or piers of heavy construction are recommended for piers if the horizontal clearance from the centerline of the rails to the piers is less than 25 feet.

2.1.5 PIER PROTECTION (2005) AREMA

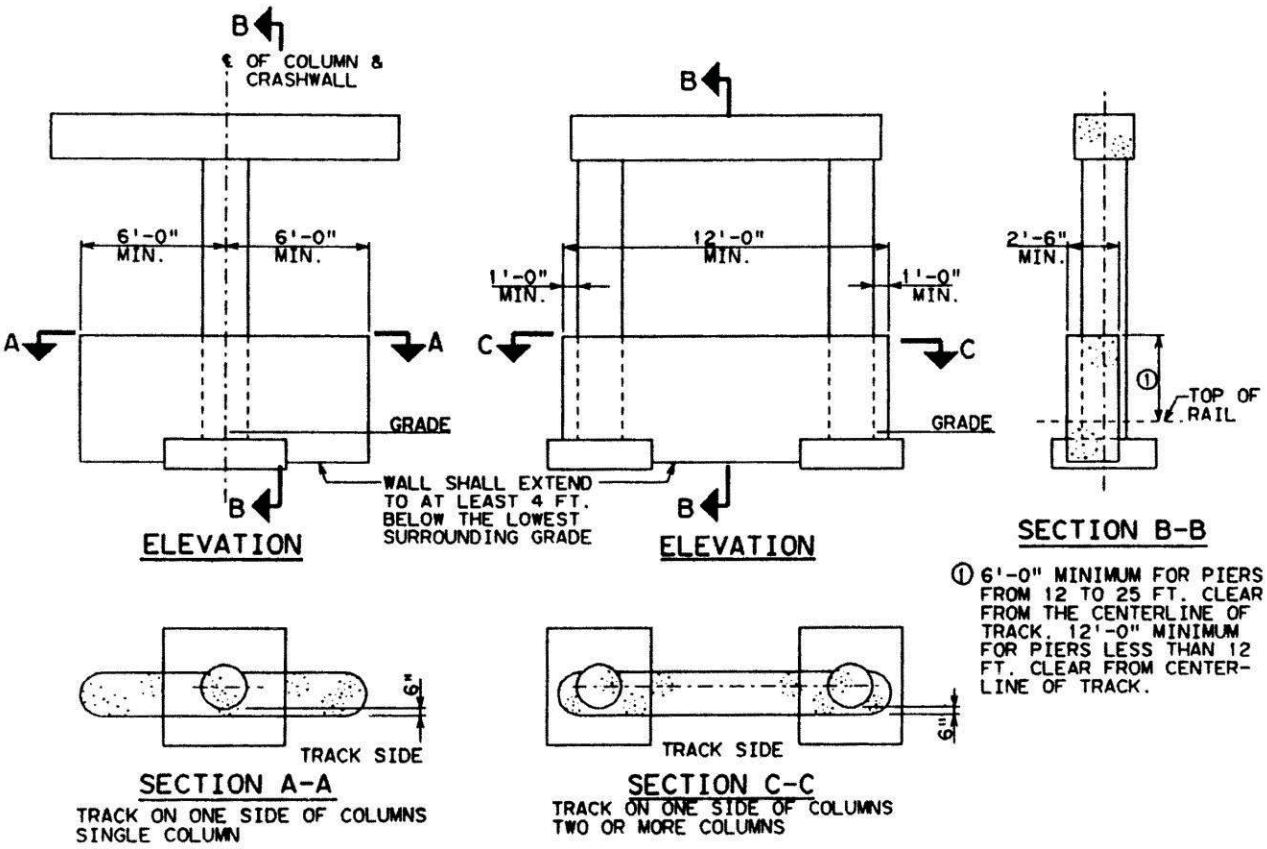
2.1.5.1 Adjacent to Railroad Tracks[1]

a. To limit damage by the redirection and deflection of railroad equipment, piers supporting bridges over railways and with a clear distance of 25 feet (7600 mm) or less from the centerline of a railroad track shall be of heavy construction (defined below) or shall be protected by a reinforced concrete crash wall. Crash walls for piers from 12 to 25 feet (3600 to 7600 mm) clear from the centerline of track shall have a minimum height of 6 feet (1800 mm) above the top of rail. Piers less than 12 feet (3600 mm) clear from the centerline of track shall have a minimum crash wall height of 12 feet (3600 mm) above the top of rail.

b. The crash wall shall be at least 2′ -6″ (760 mm) thick and at least 12 feet (3600 mm) long. When two or more columns compose a pier, the crash wall shall connect the columns and extend at least 1 foot (300 mm) beyond the outermost columns parallel to the track. The crash wall shall be anchored to the footings and columns, if applicable, with adequate reinforcing steel and shall extend to at least 4 feet (1200 mm) below the lowest surrounding grade.

c. Piers shall be considered of heavy construction if they have a cross-sectional area equal to or greater than that required for the crash wall and the larger of its dimensions is parallel to the track.

d. Consideration may be given to providing protection for bridge piers over 25 feet (7600 mm) from the centerline of track as conditions warrant. In making this determination, account shall be taken of such factors as horizontal and vertical alignment of the track, embankment height, and an assessment of the consequences of serious damage in the case of a collision.



21.0
22.0

Figure 2

The concrete column bents at the accident location were 36 inches in diameter and would not qualify as heavy construction under theses guidelines, since their cross sectional area was only 21 square feet and the minimum required crash wall is 2.5 feet X 12 feet or 30 square feet. American Railway Engineering Association (AREA) guidelines in their 1986 edition were in place when this bridge was designed and constructed. AREA guideline 2.1.5 for Concrete Pier Protection Construction did not define heavy construction in the 1986 edition that applied to this bridge . AREA is the predecessor organization to AREMA. Missouri DOT (MODOT) documents related to pier protection were also examined. MODOT bridge design and construction

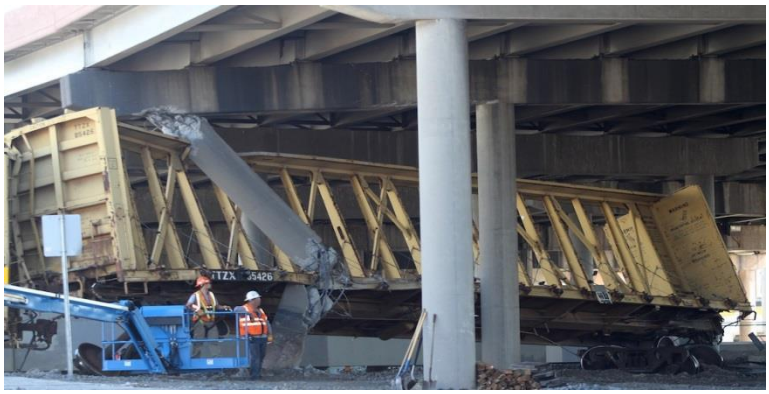
spcifications had detailing construction for pier protection walls but no warrants on when they were to be used. The Federal Highway Administration (FHWA) was also contacted regarding pier protection requirements for highway bridges over railroads. FHWA indicated that since these public structures were being constructed on private railroad property under the authority of easements granted by the railroad that warrants and specifications specified by the railroad or AREMA would be the governing documents. The American Association of State and Highway Transportation Officials (AASHTO) 2012 Load Resistance Factor Design Manual advises engineers to contact AREMA for specifications and warrants for pier crash protection near railroads.

Since this was the second rail equipment impact into the supporting bridge structure in the past six months, the Missouri Department of Transportation is taking the added step of incorporating crash walls in the new design for this bridge that provides approximately 600 kips of resistance to impact forces. The equivalent 600 kip static load is based on information obtained from crash testing an 80,000-pound truck into a concrete structure at 50 mph. (For more information see Highway Attachment 2 excerpts from AASHTO 2012 LRFD Manual.) See Photo 2 below depicting new bridge spanning Route M.

Photograph 2

2.2 U.S. Bridge Information

Approximately 4% of U.S. Highway bridges or 24, 103 bridges span railroad tracks. BNSF provided the NTSB with information on their system indicating that they had seven other diamond interlocking at grade intersections underneath or in close proximity to highway bridges. On the UPRR system they had 27 at grade crossings within .125 miles of a highway bridge. The FRA provided a computerized list of Railroad incidents with damage from February through May of 2013. Only one other incident with a highway bridge was found and it resulted in only minor damage. For more information see (Highway Attachment 3 FRA Incident Reports). Additionally, one other railroad accident occurred in October 2013, near El Paso, Texas where a bridge pier was substantially damaged, resulting in the closure of Interstate Highway 10 until repairs could be performed. See photo below.



3.0 Automobile Accidents Following the Bridge Collapse

Two separate westbound automobiles on Route M drove off into the void created by the collapse of span 2 and 3. Both vehicles left pre-impact tire friction marks on the pavement characteristic of braking heavily. The first accident involved a 2010 Nissan Versa which was occupied by a 30 year-old male driver and a 38 ear-old female passenger. Both were wearing seat belts and received minor injuries. The second vehicle accident involved a 2000 Chevrolet Malibu that was driven by 22-year-old male and occupied by 19-year-old female seated in the right front and an unrestrained 19-year-old female seated in the rear. Four of the five injured car passengers received minor injuries. The right front passenger in the Malibu received serious injuries that consisted of lower leg fractures. The first passenger car accident occurred 3 minutes and 52 seconds after the derailment and the second passenger car accident occurred 1 minute after the first passenger car accident or 4 minutes 52 seconds after the derailment.

3.1 Factual Data for Collision Force Analysis

Recorded Train speed at Impact:

BNSF – 22 mph

UPRR – 43 mph

BNSF Approach angle – 0 degrees

UPRR – approach angle – 67 degrees

BNSF Weight - 9478 tons or 18,956,000 pounds – Average weight per car 118 tons

UPRR Weight - 5,200 tons or 10,400,000 pounds – Average weight per car 80 tons

//End of Report//