Bridge No. 17.44 Milwaukee Sub
Accident of July 4, 2012
Inspection of Bridge Spans

Introduction

Following the July 4, 2012 derailment at Bridge No. 17.44, Milwaukee Sub, The Union Pacific Railroad requested that Modjeski and Masters, Inc. provide an examination of salvaged bridge spans and an expert opinion as to the role of the spans in the derailment.

Incident

Various accounts state that on the afternoon of July 4, 2012, a loaded unit coal train heading by three locomotive engines and approximately 138 coal cars proceeding north derailed at the site of Bridge No. 17.44 causing numerous coal cars to be displaced, dumping a large amount of coal at the bridge and on the embankments. Photographs of the site indicate that the bridge beam spans were displaced from their original position and remained intact within the large debris field. Reports indicate that the engines and a number of loaded coal cars successfully crossed the bridge and remained on track before the incident occurred.

Site and Bridge Description

Bridge No. 17.44 Milwaukee Sub is located in Glenview, Illinois just north of Chicago. The Union Pacific Railroad crosses Shermer Road with an open deck, beam span type bridge forming an underpass for vehicular traffic having a 14 ft. clearance. On either side of the bridge are massive concrete abutments which form the end supports for the bridge as well as retain high earthen embankments. A single central pier equally distant between abutments separates the two lanes of traffic. The bridge is skewed to the roadway and is for the purposes of this Report, designated North-South and the roadway East-West. The bridge carries two tracks on 13 ft. centers, has wooden ties, and walkways to the outside of each track and between tracks.

The bridge has two beam spans per track; from the south abutment to the center pier and from the center pier to the north abutment. Each beam span is composed of four rolled beams rigidly separated by multiple diaphragms which “unitize” the beams. Each diaphragm consisted of a flat vertical plate bolted to a connection angle which in turn is bolted to each beam. There were up to seven diaphragms between each pair of girders depending on beam positions within the group of beams. Each span is skewed approximately 35 degrees resulting in equal length beams being staggered by a uniform spacing. The beams are spaced such that a pair of beams supports each rail. Because of the skew, at the abutments for each set of beams there is a 9 ft. long beam, separate from the unitized set of beams, used to “square” the spans such that ties can be supported by beams up to the abutment backwall before being supported by ballast on the backside of the backwall. These short beam spans, also called “jump spans”, are supported on bolsters attached to a thick base plate anchored to the abutment by anchor bolts.

The Bridge was originally built in 1911 and has had modifications over the years. The last repairs were in 2010 which included concrete repairs and replacement of grillages and bolsters.

The bridge is routinely inspected by the Union Pacific Railroad.

Site Conditions of July 9, 2012

The site inspection for the beam spans was performed on July 9, 2012 by Donald F. Sorgenfrei, P.E., Senior Vice President of Modjeski and Masters, Inc.

At that time of the inspection, rail traffic had been re-established for multiple days as the Railroad completely "filled" the underpass with stone for temporary support of the two tracks. The fill negated inspection of the abutments and center pier. Photographs furnished by the Union Pacific of both abutments prior to placement of fill showed that the massive concrete abutments remained in good condition with only minor damage. Located to the west of the bridge, at the toe of the fill on Shermer Road was the center pier cap which was of reinforced concrete. The pier cap was cracked, but remained intact. H-pile supports for the cap were not observed.

Steel components of the bridge had been moved to alongside the embankment and road, east of the railroad embankment and north of Shermer Road. All bridge components had been marked with white spray paint to identify the components as bridge parts to be salvaged. The inspection progressed from south to north viewing the various spans and other components both for general conditions and any specific findings.

Of the four sets of rolled beam spans, two sets had older style beams called "S" beams which are narrower and have tapered flanges, and two sets of newer WF (wide flange) beams that are wider and have constant thickness flanges. Within each set, all beams were of the same type (not mixed). The ends of the beams were atop sole plates skewed parallel to the abutment and central pier face. The sole plate "unitize" the ends of two beams with the beams fillet welded to the plate and the plate anchored to the grillages.

Inspection Notes

General Observations

- Any steel bending, scraping from objects, tears, and gouges were readily noted by the yellowish coloration representing very recent oxidation (rusting) of steel.
- Throughout, the beams were without any loss of metalwork from corrosion. Less than a handful of locations had some localized pitting, characterized as minor pitting.
- No beams showed a downward deflection of stretch marks from overloading.
- No beams showed prior cracks
- Diaphragms remained connected between beams except one location where the beam was separated from the set of beams. One full length diaphragm connection angle was severed and one partially severed.

- In older beam sets, a field of blank holes were noted near diaphragms which had prior attachments of some sort.
- Fillet welds between sole plates and beam ends generally remained in place. Where welds were broken there had been good weld fusion.
- Other than a concrete cap of the center pier, no metalwork of that pier was observed.

Beam Span Set No. 1

- A set of four “S” type beams remained diaphragmed together as a unit and generally straight with wavy top flanges at one end
- Prior position location within bridge not known at this time
- Significant accident damage from objects sufficient to bend thick flanges
- Beams in full section, no loss of metal from corrosion
- One full depth severed diaphragm connection angle remaining in place and one partially severed connection angle
- One fresh tear in a top flange of several inches in length
- Beam bearing areas in good condition
- No indications of beam span failure

Beam Span Set No. 2

- A set of three wide flange type beams diaphragmed together as a unit with fourth beam not attached to extended diaphragms (beam found elsewhere on site)
- Prior position location within bridge not known at this time
- Localized bends in flanges from objects, beams generally straight
- Beams in full section, no loss of metal from corrosion
- Beam bearing areas in good condition
- No indications of beam span failure

Beam Span Set No. 3

- A set of four “S” type beams diaphragmed together as a unit
- Prior position within bridge not known at this time
- Major lateral sweep in set of beams
- Beam set in the field is positioned upside down
- Beams in full section, no loss of metal from corrosion
- Beam bearing areas in good condition
- No indication of beam span failure

Beam Span Set No. 4

- A set of four wide flange type beams diaphragmed together as a unit
- Prior position within bridge not known at this time
- Beams generally straight with flange bends from object impacts
- Beams in full section, no loss of metal from corrosion

- Beam bearing areas in good condition
- Extra holes in beams from prior attachments
- No indication of beam span failure

9 ft. Beam Units (Jump Spans)

- The beam units consisted of a single beam of same depth as the main beam span units.
- Beams were in full section
- Beam ends were fillet welded to sole plates which in turn are bolted to bolsters
- Bolsters were of new construction being weldments and in full section
- Bolsters were anchored to a thick base plate with anchor bolts.
- No deficiencies were noted in these units and no indications of a failure mode

Grillages

- Grillages were welded beams having a 12 x1.25 top flanges, 1" thick web and an 18 x 1.5 bottom flange sitting on a base plate
- Multiple grillages were present without bridge location identity
- Grillages were installed in recent past and in good condition having full section
- No indications of failure

Possible Causes for Bridge Beam Span Failures

Failure of beam span bridges can be caused by one or more of the following situations:

1. Overload causing beams to yield and sag
2. Deteriorated metalwork from corrosion causing a crippling of a beam or resulting in an overload condition or cracks emanating from holes within a beam.
3. Metal fatigue
4. Beams displacement by an accident

1. Overload

The beam spans were independently checked for load capacity and rated in excess of the capacity needed for carrying both locomotives and cars authorized for this Line. In fact the locomotives and a number of loaded coal cars did transit the bridge before the incident occurred.

Despite the large pile-up of debris from the accident and the numerous "dings," bends and scratches on the beams, no visible deformations in the beam spans were noted to indicate having had an overload condition. Such indications would be found in bottom flange stretch marks and/or sagging of the beams.

2. Deteriorated Metalwork

This open deck bridge was absent of any metalwork deterioration that would cause a reduction in carrying capacity or lead to stress risers. Often there will be corrosion on underpass beam spans from salt spray from vehicles or metalwork losses in dark moist areas where the metalwork rests on the abutment. These conditions did not exist on this bridge. The only corrosion noted was a local spot which when the corrosion product was readily removed, minor pitting over about an 8" circle having approximately 1/32" pitting depth. One girder end also had pitting between a bearing stiffener and the end of beam of about 1/32" depth. Some beams still had remnants of paint particularly Beam Span Set 4 which still had some coal tar epoxy present.

There were no corrosion holes and no cracks in the metalwork.

Additionally, the beam span end supports at the abutments and the abutments themselves were recently refurbished.

3. Metal Fatigue

There were no indications of metal fatigue. In fact the beam spans are redundant having two beams per rail. Also rolled beams have the safest fatigue category of all fatigue categories.

4. Beams Displaced by Accident

Bridge failures are most commonly caused by disturbance/displacement of bridge components and/or spans. Such accidents might be caused by an over height loaded truck striking a bridge beam and bending the beams such that the beams cannot take a load or by a moving load striking the side of the bridge sufficient to misalign the rails.

There were no indications on the beam span sets indicative of either of the cited cases. Additionally, the locomotives and a number of loaded coal cars did successfully transited the bridge before the incident.

Opinion

It is this investigator's opinion that after viewing the remnants of the steel removed from Bridge 17.44, Milwaukee Sub, as positioned along the Railroad R/W along with other recovered materials, that the bridge spans did not play a role in the derailment of the subject train. The structural condition of the remnants does not support a bridge span failure mode from overload, deterioration or fatigue, but suggests that the accident displaced the spans.

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