Erik Dickson - RE: Maclay Bridge load rating

From: "Jackson, Amanda" <amjackson@mt.gov>
To: Erik Dickson <edickson@co.missoula.mt.us>
Date: 12/16/2011 3:02 PM
Subject: RE: Maclay Bridge load rating
CC: "Barnes, Kent" <kbarnes@mt.gov>, "Murphy, Mike" <mikmurphy@mt.gov>, "Sta...

Erik:

I apologize for taking so long to get back to you on this. I discovered a couple mistakes in my rating when I was reviewing it to answer your questions.

The first thing I should note is that the rating changed after I discovered my first mistake. The rating went down. The bridge requires posting at 11 tons. Once my rating has been fully checked, Missoula County will receive a letter from MDT requesting that the bridge be posted for the proper weight. Another thing to note is that all fire trucks except the E-312 now have an operating rating less than 1. When I removed the impact load in my calculations, I got an operating factor above one for all of the fire trucks. This means that all of the fire trucks should only use the bridge in an emergency situation, and when crossing, all except for the E-312 need to cross the bridge at less than 5 mph, keep the vehicle centered on the bridge deck, avoid changing gears, accelerating, and braking while crossing the bridge, and ensure that no other vehicles occupy the bridge while the fire truck is crossing.

The rating factors for the Parker truss changed after I discovered my second mistake, but it does not affect the overall rating of the bridge. The updated rating factors are included in the rating I have posted to our ftp site (see the link below).

ftp://ftp.mdt.mt.gov/download/l32101000+01001_rating.pdf

Answers to your questions are as follows.

1. On page one of the attached file, I've summarized Muth's and MDT's results in order to see the Rating Factors and Load Ratings together. While the final Load Ratings are comparable for the Pony Truss, the Rating Factors vary significantly for the truss and the stringers and produce different controlling factors. Likewise for the Parker Truss, the Rating Factors for the truss vary. I believe that MDT should have received a copy of Muth's calculations for review, so would you be able to discuss the differences between the Rating Factors?

I agree that the Rating Factors vary significantly. I do not, however, have a copy of Muth's calculations for the trusses. The only thing we received in the packet you sent to us was a summary sheet giving the Rating Factors for each truss. No truss calculations were included, so I am unable to find out why our ratings are so different. At this point, however, the differences are irrelevant. As you will see there are enough discrepancies to make further review of Muth's calculations unnecessary.

The main difference in Rating Factors for the floorbeams is due to a difference in steel strength used in our calculations. Because this bridge was constructed in 1935, I used the Unknown Steel 1905 to 1936 strength listed in the *AASHTO Manual for Bridge Evaluation, Second Edition, 2011*, which is 30 ksi. Muth assumed 36 ksi steel in his calculations. ASTM A 36 was not issued as a standard until 1960; therefore, using 36 ksi steel to rate this bridge is incorrect. A 7 (33 ksi steel) might have been around for buildings at the time this bridge was built, but it was not consolidated with the bridge standard until 1939. MDT's 1935 edition of "Design Specifications for Highway Structures uses 18,000 psi allowable stress in tension, and max allowable in bending

which is equal to $0.6F_y$. F_y would therefore equal 30,000 psi. Using 30 ksi steel is appropriate for rating this bridge. Also, Muth used Allowable Stress Rating in his calculations while I used Load Factor Rating. This will contribute to some small differences in Inventory Rating Factors. One might expect that using Allowable Stress could give a smaller rating factor than Load Factor, however, so the primary reason for MDT's lower rating factor is that Muth used too high a grade of steel in his rating analysis.

A look at Muth's rating for the stringers on the pony truss revealed that he forgot to add the Impact Factor when calculating live load moments. If I add the Impact Factor to Muth's calculations, I get the following comparison of Rating Factors. The differences here can again be explained by the difference in steel strength used in our rating calculations. Another difference in our stringer ratings is that Muth used the S 8x18.4 shape for all of the interior stringers and an even spacing of 2.5 ft. I have some measurements taken by our inspectors in 1980 that show the third stringer in on each side as being that size (I used the similar W 8x18 shape), but the rest of the stringers are measured as smaller. I used the W 8x15 shape for these stringers. I also had a spacing for each individual stringer bay that I used in my analysis instead of assuming even spacing.

Truck	MDT RFi	Muth RFi
Type 3	0.650	0.833
Type 3S2	0.705	0.914
Type 3-3	0.780	1.012

2. On page two of the attached file, the highlighted Inventory Load Rating of 14.4 tons for an HS20-44 is based on the Inventory Rating Factor of 0.4 for member L4U5. The Rating of 13.11 tons for a Type 3 is lower, but the Inventory Rating Factor is higher at 0.524, so it appears that the Inventory Load Rating is actually controlled by the Rating Factor?

The load rating is calculated by multiplying the Rating Factor and the truck weight. The HS 20-44 truck weighs 36 tons, so 0.4*36 = 14.4. The Type 3 truck weighs 25 tons, so 0.524*25 = 13.1. A list with each truck and its full weight is below.

HS 20-44	36 tons
Type 3	25 tons
Type 3S2	36 tons
Type 3-3	40 tons

3. On pages 4, 5 and 7 of the attached file, why were analyses run for 10 stringer lines? Were they simply as a comparison to the actual condition of 8 stringer lines?

When I first rated the truss, I wasn't sure how many stringer lines were under the pony truss. I had Muth's plans that showed 8 stringer lines – 2 exterior channels and 6 interior I shapes. I had a photo of the underside of the truss that clearly showed 8 I shapes and what I thought were 2 exterior channel shapes. I also had some old measurements that noted 8 stringer lines, but gave me spacings for 9 stringer bays (which would mean 10 stringers). I asked our inspectors to take a look for me and find out what the actual condition was, but they said the water was too high for them to get under the bridge at that time. I rated both conditions because 8 stringers was more conservative for the stringer rating and 10 stringers was more conservative for the truss rating. I was able to visit the bridge this summer after I completed the rating. There are 8 I shapes under the pony truss, and what I thought were exterior channels that I saw in the photo were actually the lower chord. So, there are 8 stringer lines, but they are all I shapes. I was then able to determine that two of the spacings in the measurements I had were for the deck overhangs. I revised my final rating for this condition, which is reflected in the attached results.

4. Did MDT's analysis look at the stringers and floorbeams on the Parker Truss?

Yes, my analysis did look at the stringers and floorbeams of the Parker Truss. I forgot to include those results when I put together the final rating packet. They are also included in the file on the ftp site. I apologize for the omission.

5. Why weren't the Inventory Ratings and Operating Ratings for the emergency response vehicles included in the Final Load Ratings Results table on page 8 of the attached file?

The Rating Factors were more important to my analysis of the fire trucks than ratings in tons. The Rating Factors told me if the trucks could safely cross the bridge or not. The fire truck ratings in actual tons were fairly meaningless to me, so I did not calculate them. The only reason they are calculated in the summaries for the stringers and floorbeams of the Parker truss and all of the ratings for the Pony truss is because the software I used automatically calculates them. They were not calculated in my hand-rating of the Parker truss.

6. The final and possibly most basic yet important question (or maybe just a confirmation of my assumptions) since this analysis was requested for emergency response vehicles. Is it reasonable to say that a Rating Factor, either Inventory or Operating, that is greater than 1.0 indicates that no weight restrictions are required for that design vehicle?

When you say “no weight restrictions” I believe what you’re alluding to is the fact that we may not require load posting a particular bridge when it rates 1 or higher for legal loads. Weight restrictions still exist, however. Take, for example, the case of the fire truck configurations that I analyzed. Say the analysis gives a rating factor of 1.1 for a particular configuration. What that means is that the weight restriction is 10% higher than the weights we were given for that configuration. Beyond that the bridge’s capacity does not meet axle weights at those spacings.

To explain the difference between Inventory and Operating: an Inventory Rating factor of 1 or greater means that the bridge has the capacity to carry that vehicle (for the axle spacings and weights given) on a frequent basis over an indefinite period of time. An Operating Rating of greater than 1 means the vehicle can cross the bridge occasionally, on a permit basis. Conversely, an Inventory Rating of less than 1 means the vehicle could, and likely will, damage the bridge with frequent crossings, and an Operating Rating of less than 1 means the vehicle is too heavy for the bridge.

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From: Erik Dickson [mailto:edickson@co.missoula.mt.us]
Sent: Thursday, December 01, 2011 11:48 AM
To: Jackson, Amanda
Subject: Maclay Bridge load rating

Amanda -

I'll be the representative for County Public Works working on the Pre-NEPA feasibility study for the potential replacement of Maclay Bridge. As I am not in the regular practice of all things structural and probably know just enough to be dangerous, I was hoping to verify a few things to avoid speaking out of turn. I'm not sure if you're aware of the how things are going over here, but the Maclay Bridge Alliance is in favor of dropping any plans for replacement and have been very critical of the County's past efforts or future plans for rehabilitation instead of replacement. They're very thorough in their review of available information and have been through the analysis that Frank Muth completed in 2003, so I'm sure that they will go through MDT's analysis and will have some questions or concerns. There are a few questions that I have or can anticipate will be asked, and I was hoping you could address them before local discussions start after we make the latest information available.

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I'd appreciate any comments that you'd be able to send my way. Thanks for your time.

Erik

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