ATTACHMENT 31 – Mn/DOT TRANSMITTAL OF REPORT TO NTSB ENTITLED LOAD RATING OF BRIDGE 9340 WITH CONSTRUCTION LOADS

(4 pages)

Load Rating of Bridge 9340 with Construction Loads.

This study is based on the loading diagram supplied by David Rayburn on October 18. 2007. This diagram consisted of 184 k rock, 199 k sand, plus 194 k other construction equipment, for a total of 577 k. This loading is in the inner two south bound lanes, south half of the main span.

Had this proposal been forwarded to us from the contractor at the start of the overlay contract, we would likely have rejected it, before doing any analysis for the loads. We would have questioned if there were alternate locations for stockpiling the materials. This loading is immediately seen to be much larger than design loads. For example, the HS 20 design lane load is 0.64 k / ft. The rock and sand piles weigh about four times as much as this, spread over a width of 14 ft, just slightly more than a design lane.

Never-the-less, as requested, we have continued to further check these loads using more rigorous methods.

This load rating was done under the governing AASHTO Bridge Design Specification, Seventeenth Edition and the Manual for Condition Evaluation of Bridges, Second Edition. The load factors used for dead load and live load were 1.30, the operating level.

An overall comparison was made of all the loads included in the 577 kips. On a square foot basis, the rock and sand piles were almost twice as heavy as the next highest loads, D16, B16, or B15. On a linear foot basis, the rock and sand were more than twice as heavy as D16, B16, or B15. The three trucks are of legal highway weight (as close as we can tell without axle spacings and loads). The side by side trucks are 15 feet apart, more than the lane width of 12 ft. There is a 20 foot overlap between the D16 truck and the sand pile. This is not significant to the stringers, since D16's weight would fall mainly on the 3rd and 4th stringers from the median and the sand actually produces uplift on the 3rd stringer (and a very small downward force on the 4$^{th)}$. (According to the STAAD analysis)

Overall, the rock and sand piles are the heaviest loads, present the most concentrated loading effects, and warrant the most scrutiny.

To facilitate the calculations, the rock and sand piles were converted to "ridges" or "prisms". The rock became a triangular prism load, 14 ft wide x 60 ft long at 3.07 k / ft. The sand became a triangular prism load, 14 x 55 ft at 3.61 k / ft.

To determine the load distribution of the rock and sand to the structure, STAAD was used. The deck was modeled as a continuous structural member over the stringers. The results of this showed that 29.0 % of the load went to the stringer closest to the median. The stringer next to it (the first interior from the median) received 74.4 % of the load.

At this point, the stringers were checked using the Bridge Analysis and Rating System (BARS). This program is based on the load factor method and the specifications mentioned above. BARS does not have the capability for user input of uniform loads. Two methods were used:

First the rock and sand piles were converted to a model multi-axle truck. Our model consisted of 19 axles at about 6 ft spacing. For the spans under consideration the controlling rating factor was 0.96, negative moment at 2.0 (truss panel point 9) and adjusted to zero impact.

In the second method the stringers were checked by applying the rock and sand piles to the BARS influence lines. The method used alternate span loading to the maximum detriment of the stringer, and the STAAD lateral distribution. The controlling rating factor was 1.11 at point 3.0, negative moment. A rating factor of 1.0 or greater is acceptable. This method would be considered a more accurate representation of the loading than in the paragraph above where a moving load was applied.

The floor trusses were checked with the influence lines from the original calculations. Two members of the floor truss were selected for checking. Under the dead load member U5-U6 has the most compression force and member L4-L7 has the most tension force. The load case under consideration was the construction loads plus HS 20 trucks in three adjacent traffic lanes (3 lanes govern). The trucks, D16, B16, or B15, were modeled as uniform loads over their lengths. HS 20 loads in adjacent lanes were positioned to produce maximum effect on the floor trusses. It showed that the floor truss at U11 received the most reaction from the construction loads. The operating rating factor for the construction loads is 2.1 for tension member L4-L7 and 1.4 for compression member U5-U6.

The main trusses were checked with the influence lines from the original calculations. Nine members were selected based on their locations and original design forces. The load case under consideration was the construction loads plus HS 20 lane loads with concentrate load in adjacent traffic lanes. The trucks on the bridge were assumed as uniform loads over their lengths. Article 3.11.3 Lane Loads on Continuous Spans was followed for HS 20 lane loads to produce maximum effects on trusses. The capacity of each member was based on original calculations that are shown on the original plan. The operating rating factors for the main truss members are shown in the table.

Member	L13-L13'	U8-U10	U6-U8	L11-L13	U10-L11	U8-L9	L9-U10	L8-L9	U10-U12
RF Oper.	4.5	11.6	3.3	2.7	3.0	2.0	2.2	3.8	2.0

In conclusion the most direct response to your question is we would have likely denied the contractors request based on a quick and fairly simple review. However a more rigorous analysis shows all rating factors to be above one.

Notes:

The BARS rating uses a dead load distribution that was standard practice at MnDOT up to the mid 1990s. Interior stringers were designed for their self weight, the contributory deck weight and 33 % of the railing weight. This is a conservative method in this and almost all cases.

The dead load increases had previously been entered in BARS. For the analysis of the floor trusses and the main trusses, a dead load increase of 19.5 % over the original design was used.

These calculations have not considered that on August 1 the bridge was lighter by the amount of the 2 inches of concrete that had been removed from the two lanes.

No impact was added to the construction loads.