

BRIDGE ADVISORY NUMBER: BA-2023-02

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SUBJECT: Guidance for the use of “Field Evaluation and Documented Engineering Judgment” Ratings

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Note: This Bridge Advisory replaces BA-2012-02, issued on October 16, 2012.

This reference shall serve as additional guidance for the use and documentation of judgment ratings in the state of Michigan.

For bridges where necessary details are not available from plans, design calculations, or shop drawings, an approximate load rating based on a physical inspection, field measurements, and rational criteria may be produced by a qualified engineer. Every effort should be made to locate the structure plans or obtain field data required to perform the analysis and load rating. Applicability is limited to reinforced and prestressed concrete structures or other structures under special circumstances as determined by the engineer and approved by MDOT and FHWA.

The appropriate rating(s) shall be determined by the engineer upon careful consideration of all available information including, but not limited to:

- Comparable structures with era-appropriate designs may be used to conservatively approximate the capacity of a structure with unknown components. The date of the comparable structure’s plan should pre-date the structure in question. The factors considered to determine the structures are comparable shall be documented.
- Material properties may be estimated using the year built and an appropriate reference, such as the MDOT Bridge Analysis Guide (BAG) Tables 10.25-10.29. The reference used and the assumed material properties shall be documented.
- The design vehicle and/or loading may be assumed from the year built. A history of Michigan design loads is included in Chapter 2 of the MDOT BAG.
 - The observed performance of the structure under traffic shall be noted. Based on field observations and route ADTT information, consider the likelihood that the bridge has been subjected to full legal loads. For example, if a bridge is on a low volume rural roadway with little or no truck traffic, it may not have been designed for, nor ever subjected to, full legal loads. In such cases, posting may be necessary to prevent overload of the structure even if it does not show signs of distress.
- Condition of load carrying components shall be documented in detail and any observed conditions that could affect structural capacity shall be noted and accounted for in all judgment ratings. For example, the presence of vertical cracks near the middle of the span, or diagonal cracks near the supports may indicate overstress of a concrete member, and posting may be necessary.

- In the absence of measurable loss that would require a detailed section loss calculation, the capacity of structures may be adjusted in accordance with the condition factors set forth in the AASHTO Manual for Bridge Evaluation (MBE) Table 6A.4.2.3-1.
- Modifications to the structure since the original construction can increase or decrease member capacities. Any observed modifications shall be documented and effects to the structure noted.
- The capacity of structures with limited redundancy may be adjusted in accordance with the system factors set forth in AASHTO MBE Table 6A.4.2.4-1.

COMMON JUDGMENT RATING METHODS

1. Field measured values, assumed material properties, and reinforcing and/or prestressing details may be used to complete a load rating using a rational method of analysis. All assumptions used in the analysis must be justified.
 - a. For example: “Plans for structure XYZ, which is a similar structure type and was built around the same time as the structure in question, shows #N bars at S-in spacing. Therefore, #N bars at S-in spacing is assumed in the analysis of this structure.”
2. Moment and shear tables for various vehicles/spans from Chapter 10 of the MDOT BAG may be used to complete a judgment rating analysis.
 - a. Compare the live load moments and shears between the design vehicle (assumed from year built) and the AASHTO HS-20 or HL-93 loading (as applicable based on the rating method) and the Michigan legal and overload vehicles.
 - b. The structure may be assumed to have a remaining capacity equal to an inventory rating of 1.0 for the design vehicle at critical locations. Since the remaining capacity can be assumed to be constant, the ratio of the load effects (moment/shear) between the assumed design vehicle and the rating vehicle will be the rating vehicle's rating factor, adjusting for live load factors and impact between different specifications.
 - c. Example: Given a structure in good condition, using LFR, and considering moment effects for a 30-ft span and the Michigan 1-unit trucks (similar for other vehicles and load effects):

Vehicles	Moments for a 30-ft span from BAG Tables 10.8, 10.9, and 10.4 (ft*k)	LFR Load Factors (A ₂) (MBE 6B.4.3)	Judgment Rating Factors*	Rating Level
Assumed Design Vehicle - H20 **	247	2.17	1.00	Inventory
AASHTO HS-20 or HL-93 loading	282	2.17	0.88	Inventory
AASHTO HS-20 or HL-93 loading	282	1.3	1.46	Operating
Truck #1	186	1.3	2.22	Operating
Truck #2	259	1.3	1.59	Operating
Truck #3	272	1.3	1.52	Operating
Truck #4	319	1.3	1.29	Operating
Truck #5	276	1.3	1.49	Operating
* (inventory level load factor * assumed design vehicle moment) / (desired rating level load factor (A ₂) * rating vehicle moment)				
** A rating of 1.0 for the Assumed Design Vehicle is indicative of a structure with no deterioration (structure condition is as designed)				

3. AASHTOWare Bridge Rating (BrR) may be used to aid in determining assumed reinforcing and/or prestressing details and complete a judgment rating analysis.
 - a. Model the structure in BrR and adjust the reinforcing and/or prestressing details until the design vehicle (assumed from year built) produces an inventory rating of 1.0.
 - b. Assume this reinforcing for the member and re-run the model using the AASHTO HS-20 or HL-93 loading (as applicable based on the rating method) and the Michigan legal and overload vehicles to determine the appropriate federal inventory and operating rating factors, Michigan operating rating factors and posted loads, if required.

- c. Clearly identify the model as a “judgment rating” in the AASHTOWare Bridge Rating (BrR) description field and summarize all assumptions made on the load rating assumptions form.
4. Additional methods may be applicable. For example, axial/moment/shear interaction may be used for arch/frame structures.

If the strength of concrete or reinforcement is in question, material samples may be taken from the structure and tested. Material sampling shall be performed in accordance with Section 5 of the AASHTO MBE.

Alternatively, the structure may be load tested to determine the safe load carrying capacity, however load testing shall be redone if the structure experiences a change in condition. Load testing shall be performed in accordance with Section 8 of the AASHTO MBE.

DOCUMENTATION FOR JUDGMENT RATINGS

All applicable items shall be documented and placed in the bridge file along with the judgment rating results.

- Statement of efforts to obtain design documents
- Field evaluation notes
- Description of load path, redundancy, traffic, evidence of damage
- Justification of method used to determine load rating
- Statement that “Load rating is based on field evaluation and engineering”
- Design calculations as needed to support the judgment rating

REFERENCES:

2020, The Manual for Bridge Evaluation (MBE), 3rd Ed, 2018 with 2020 Interim Revisions, American Association of State Highway and Transportation Officials (AASHTO) Washington DC.

Michigan Bridge Analysis Guide 2005 Edition with 2009 Interim Update, Michigan Department of Transportation (MDOT)

2002, Michigan Structure Inventory and Appraisal Coding Guide, Michigan Department of Transportation (MDOT)