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Load rating is the determination of the live-load carrying capacity of an existing bridge. Load ratings are based on data from the design plans, shop drawings, as built plans, field inspections, and field measuring and testing. The load rating is also used to support posting, maintenance, rehabilitation, and replacement decisions.

A Consultant Load rating may be required as part of the design process for new bridges. The engineer responsible for the design check shall perform a load rating analysis. The load rating should be conducted after the superstructure design check process is complete, but prior to preparation of the final plans.

For precast items, a load rating must be completed by the precast fabricator.

1.1.1 Reference Material

The National Bridge Inspection Standards (NBIS) as found in the Code of Federal Regulations 23 CFR 650 Subpart C


FWHA technical documents as listed on the FHWA Load rating Website
https://www.fhwa.dot.gov/bridge/loadrating/

North Dakota Vehicle Size and Weight Guide

North Dakota Weight Limitations Chart

Multiple Vehicle Combinations Regulations
1.1.2 Definitions
The following definitions are consistent with the definitions provided by the MBE.

Inventory Rating (LFR)
Load ratings based on the inventory level allow comparisons with the capacity for new structures and therefore, results in a live load, which can safely utilize an existing structure for an indefinite period of time.

Operating Rating (LFR)
Load ratings based on the operating rating level generally describe the maximum permissible live load to which the structure may be subjected. Allowing unlimited numbers of vehicles to use the bridge at operating level may shorten the life of the bridge.

Design Inventory Level Rating (LRFR)
Generally corresponds to the rating at the design level of reliability for new bridges in the AASHTO LRFD Bridge Design Specifications.

Design Operating Level Rating (LRFR)
Maximum load level to which a structure may be subjected. Generally corresponds to the rating at the operating level of reliability in past load rating practice.

Legal Level Load Rating (LRFR)
This rating level provides a single safe load capacity (for a given truck configuration) applicable to AASHTO and state legal loads.
# 1.2 Qualifications and Responsibilities

The Structure Management Section is responsible for the North Dakota Bridge Inspection program in compliance with 23 CFR §650 Subpart C. Load rating is part of the Bridge Inspection Program.

## 1.2.1 Program Manager

The Program Manager oversees compliance the National Bridge Inspection Standards (NBIS).

### 1.2.1.1 Program Manager Qualifications
- Registered PE
- Completed the FHWA approved National Highway Institute (NHI) comprehensive bridge inspection training course. (Course number 130056)

### 1.2.1.2 Program Manager Responsibilities
- Administer the bridge load rating program
- Ensure compliance with federal load rating directives (CFR & MBE)
- Ensure compliance with North Dakota load rating policies and procedures (This Manual)
- Coordinate and conduct load rating training
- Perform quality assurance audits on load rating reports

## 1.2.2 Load Rating Engineer

### 1.2.2.1 Load Rating Engineer Qualifications
- Registered PE
- Completed the FHWA approved National Highway Institute (NHI) load rating course number 130092. (Preferred but not required.)

### 1.2.2.2 Load Rating Engineer Responsibilities
- Develop and maintain load rating manuals and standards
- Load rate structures in accordance with the MBE and this manual
- Review load ratings prepared by consultants
- Prepare and/or verify load rating reports for in house load ratings
- Review load rating reports prepared by consultants
- Provide oversite of consultant load rating engineers
1.2.3 Consultant Load Rating Engineer

1.2.3.1 Consultant Load Rating Engineer Qualifications

- Registered PE
- Completed the FHWA approved National Highway Institute (NHI) load rating course number 130092. (Preferred but not required.)
- During the selection process, preference will be given to engineers with 5 or more years of load rating experience

1.2.3.2 Consultant Load Rating Requirements

The load rating shall be completed using the AASHTOWare Bridge Rating Software (BrR) as indicated in Section 3.0 of this manual. The superstructure must be completely defined in BrR using the schedule-based input.

The load ratings shall be reported to the Department using the Load Rating Report Summary and a Load Rating Detailed Report as described in Section 3.2 and Section 3.3.

Following completion of the load ratings, the electronic model will be submitted to and become the property of the Department. The Department reserves the right to use the model for future load ratings.

All Load ratings must independently reviewed prior to submission to the Department. Provide routine and consistent checks for data integrity, correctness and completeness. Identify and address errors and omissions.
1.3 Load Rating Requirements

Federal law (23 CFR 650 Subpart C) requires that all bridges, defined as structures over 20 feet in length, be inspected and subsequently be load rated in accordance with procedures specified in the MBE. The National Bridge Inspection Standards (NBIS) requires that the individual charged with overall responsibility for the load rating of bridges must be a registered professional engineer. The federal requirements for bridge inspection, load rating, and bridge management are further elaborated on in the Metrics for the Oversight of the National Bridge Inspection Program (FHWA, 2013). Specifically, Metric #4 – Load Rating Engineer, Metric #13 – Load Rating, and Metric #14 – Post or Restrict, provide guidance for selected elements of bridge load rating.

1.3.1 Load Rating Intervals

Load ratings shall be completed at the following intervals:

1. Load ratings for new bridges shall be completed prior to bid according to the provisions of this manual.

   For load ratings calculated during the design phase, the Inventory Rating must be greater than 1.0. If the Inventory Rating is less than 1.0, the design must be revised to increase the capacity until the Inventory Rating is 1.0 or greater.

2. Load ratings shall be verified by the Load Rating Engineer after construction of the bridge to incorporate any changes in the design details as noted on as-built plans, change orders, construction inspection, and initial inspection reports.

3. Load ratings shall be updated by the Load Rating Engineer when a meaningful change in condition of the structure occurs as defined below:

   o Bridge rehabilitation that affects structural components
   o A significant change in the live load of the bridge due to a change in the use of the bridge
   o Increase in dead load on the bridge
   o A change in state or federal laws regulating truck weights
   o Structural damage resulting from a bridge hit, ice damage, flood damage, fire damage, or other cause
   o Deterioration that affects structural capacity of the superstructure, such as:
      ▪ Rotated or displaced beams
      ▪ Steel section loss or cracking
      ▪ Broken welds or missing bolts
      ▪ Exposed rebar in concrete
      ▪ Splitting, cracking, or rot of timber members
The load rating shall also be reviewed when the NBI ratings decline to the values listed in the Table below. After review, the Load Rating Engineer will determine if the bridge needs to be re-rated:

<table>
<thead>
<tr>
<th>Component</th>
<th>NBI rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deck</td>
<td>4</td>
</tr>
<tr>
<td>Super</td>
<td>5</td>
</tr>
<tr>
<td>Sub</td>
<td>4</td>
</tr>
<tr>
<td>Culvert</td>
<td>4</td>
</tr>
</tbody>
</table>

### 1.3.2 Software

An electronic model of the superstructure must be developed. The model must be created using the AASHTOWare Bridge Rating (BrR) Software Version 6.8.2 or newer.

For bridge types that are incompatible with BrR, an alternate software may be used with approval by the Load Rating Engineer.

### 1.3.3 Load Rating Procedures

For bridges designed or rehabilitated prior to October 1st, 2010; rate the structures using the LFD and LRFR method.

For bridges designed or rehabilitated after October 1st, 2010; rate the structures using the Load & Resistance Factor Rating (LRFR) method.

For bridges constructed of timber, rate the structures using the Allowable Stress Design (ASD) method.

The identification information for the structure must match the identification information in the NDDOT Bridge Management System (BMS).

The bridge reference line should be placed at the centerline of the bridge.

Model the unique girder elements of the structure. Rate at tenth points of all spans, at 0.45 times the span length for simple span bridges, and at 0.25 and 0.75 times the span length for continuous bridges.

Rate both interior and exterior girders. Select an interior girder that is most likely to control, due either to condition or geometry, to exemplify the interior girders. Select an exterior girder with the largest overhang. For bridges with a curved edge of deck and chorded girders, set one overhang to the maximum overhang within the span.

Other features that must be load rated include:
- Fracture critical members or components with fatigue prone details
- Gusset plates and connection elements for nonredundant steel truss bridges
- Other connections of nonredundant systems (e.g., nonredundant floor beam, connections, pin and hanger assemblies)

Refer to the Appendices for structure type specific information.
1.3.4 Concrete Box Culverts

Single-span culverts with depth of fill more than 8 ft do not be load rated for live loads as the live load effects are negligible.

Multiple-span culverts with a depth of fill that exceeds the distance between faces of end walls do not need to be load rated for live loads as the live load effects are negligible.

Distribution of wheel loads for culverts with less than 2.0 ft of fill shall be taken as specified in LRFD Design Article 4.6.2.10.

Distribution of wheel loads to culverts with 2.0 ft or more of cover shall be as specified in LRFD Design Article 3.6.1.2.6.

For concrete box culverts, use the default soil material values as indicated below.

<table>
<thead>
<tr>
<th>Name:</th>
<th>Standard Soil 1</th>
<th>Description: Standard Soil 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil unit load =</td>
<td>120,000 pcf</td>
<td>Saturated soil unit load =</td>
</tr>
<tr>
<td>At-rest lateral earth pressure coefficient (LRFD/LRFR) =</td>
<td>0.50</td>
<td>Active lateral earth pressure coefficient (LRFD/LRFR) =</td>
</tr>
<tr>
<td>Maximum lateral soil pressure (LFD) =</td>
<td>60,000 pcf</td>
<td>Minimum lateral soil pressure (LFD) =</td>
</tr>
</tbody>
</table>

Optional Live Load Factor for EV’s on Box Culverts

For EV’s on box culverts, if the EV rating is less than 1, override the Live Load Factor per FHWA 2016 Memorandum to 1.3. To navigate to the override window, click on “Advanced Options” in the “Analysis Settings” window.
1.3.5 **Bridges Without Plans**

Plans may not exist for some bridges.

For steel structures without plans, detailed field measurements are required. Load rate using the detailed field measurements and ignore composite action between the steel girders and the deck when load rating steel bridges with concrete decks without plans.

For concrete structures without plans or reinforcement details, follow these steps:

1. Gather all available information about the bridge from the state bridge file and database.
2. Perform a detailed bridge inspection and field measure any structural components when possible.
3. Search for plans for any structures that were built of a similar design and time period.
4. Search for any common items or reinforcement details.
5. Use the collected information to complete the load rating.
1.3.6 Load Rating Vehicles

The vehicles included in this section are the vehicles that are required to be rated per the MBE along with State specific vehicles. The level of analysis is different for the LFR method and the LRFR method. Schematics and Axle Loads for the State Specific vehicles are located in Appendix A.

The design vehicle for the LFR method is the HS-20 vehicle. This vehicle must be rated at both the inventory and operating level. All other vehicle types must be rated at the operating level.

The design vehicle for the LRFD method is the HL-93 vehicle. This vehicle must be rated at design inventory and design operating level. All other vehicle types must be rated at the legal level.

<table>
<thead>
<tr>
<th>LFR Method</th>
<th>LRFR Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inventory Level</strong></td>
<td><strong>Design Inventory Level</strong></td>
</tr>
<tr>
<td>• HS-20</td>
<td>• HL-93</td>
</tr>
<tr>
<td><strong>Operating Level</strong></td>
<td><strong>Design Operating Level</strong></td>
</tr>
<tr>
<td>• HS-20</td>
<td>• HL-93</td>
</tr>
<tr>
<td>• AASHTO Type 3</td>
<td>• HS-20</td>
</tr>
<tr>
<td>• AASHTO Type 3S2</td>
<td>• AASHTO Type 3</td>
</tr>
<tr>
<td>• AASHTO Type 3-3</td>
<td>• AASHTO Type 3S2</td>
</tr>
<tr>
<td>• Notional SHV</td>
<td>• AASHTO Type 3-3</td>
</tr>
<tr>
<td>• SHV 4</td>
<td>• Notional SHV</td>
</tr>
<tr>
<td>• SHV 5</td>
<td>• SHV 4</td>
</tr>
<tr>
<td>• SHV 6</td>
<td>• SHV 5</td>
</tr>
<tr>
<td>• SHV 7</td>
<td>• SHV 6</td>
</tr>
<tr>
<td>• ND 1</td>
<td>• SHV 7</td>
</tr>
<tr>
<td>• AG 1</td>
<td>• ND 1</td>
</tr>
<tr>
<td>• Permit Level</td>
<td>• AG 1</td>
</tr>
<tr>
<td></td>
<td>• Reserved for Future Use</td>
</tr>
</tbody>
</table>

The lowest rating for the HS-20 vehicle and the HL-93 vehicle for the respective method shall be coded in NBI Item 66 Inventory Rating and Item 64 Operating Rating in the Bridge Management System (BMS). Note: The controlling rating for bridge posting may not always be the HS-20 or HL 93 design vehicle.

1.3.7 Submittal of Load Rating Transfer of Structure Model

At the conclusion of the rating, the structure model shall be transferred to the Department for future use, a Load Rating Report Summary shall be generated, and a Load Rating Detailed Report shall be sent to the Bridge Division. If the size of the documents exceed the capacity of email, then the NDDOT MFT site should be used to complete the transfer. For guidance on using the MFT site see: http://mydot.nd.gov/divdist/itd/docs/UsingMFT.pdf
1.3.7.1 Transfer of the BrR Structure Model
To export the bridge in BrR, select the bridge and go to File>Batch Export>Export. BrR will ask for a target directory to store the bridge as an XML file.

1.3.7.2 Load Rating Report Summary
The load rating report summary shall include the following information:
- Bridge ID
- Name of Engineer(s) responsible for the rating, and individual responsible for review
- Rating date
- Software version used
- Superstructure type
- Year built
- Length
- No. of spans
- Span lengths
- Wearing surface type and thickness
- Depth of cover
- Facility carried
- ADTT
- NBI location
- Rating factor and tons for each vehicle listed in section 3.1
- Method used
- Analysis level
- Limit state
- Controlling member & location

A sample load rating report summary sheet is included in Appendix B

1.3.7.3 Load Rating Detailed Report
A load rating detailed report shall accompany the load ratings. The load rating detailed report must contain any field measurements and assumptions made by the consultant. The report must include enough detail that a new model and analysis can be re-created from information contained within the report, when supplemented with information from the design plans and shop drawings.

1.4 Posting Requirements
Notify the structure management engineer immediately if a structure requires posting, as identified below.

LRFR Method
For bridges evaluated with the LRFR method, with a legal rating less than 1.00, the bridge must be posted. The safe posting load shall be determined by Eq. 6A.8.3-1 in the MBE

\[
\text{Safe Posting Load} = \frac{W}{0.7 \left[ (RF) - 0.3 \right]}
\]  
(MBE 6A.8.3-1)
Where:

\[ RF = \text{Legal Load Factor} \]

\[ W = \text{Weight of rating vehicle (Tons)} \]

Bridges that are not capable of carrying a minimum gross weight of 3 tons must be closed. If a rating of less than 3 tons, the Program Manager and the Load Rating Engineer shall be notified immediately.

**LFD Method**

For bridges evaluated with the LFD method, with an operating rating of less than 1.00, the bridge must be posted. The bridge must be posted at tonnage equal to the operating rating or less. A posting lower than the operating rating may be selected at the discretion of the bridge owner.

Bridges that are not capable of carrying a minimum gross weight of 3 tons must be closed. If a rating of less than 3 tons, the Program Manager and the Load Rating Engineer shall be notified immediately.

**Concrete Bridges Without Plans**

A concrete bridge with unknown reinforcement need not be posted for restricted loading when it has been carrying normal traffic for an appreciable length of time and shows no distress.
1.4.1 Signing Requirements
Regulatory signs must conform to the requirements of the MUTCD manual.

All bridges should be posted using R12-1 or R12-4 as shown below.

![R12-1 Sign](image1)

To calculate the axle limits, use the following equation:

\[ 0.444 \times \text{Max Gross Weight} = \text{Max Axle Weight}. \]

1.5 Permit Load rating

For Permit Load Rating, the LFR method will be used for the automated routing system. For loads larger than 300,000 lbs or vehicles with a non-standard gauge, the LRFR method will be used for permit analysis.

The automated routing system uses the BrR Load Rating Tool for routine permit vehicle analysis. The load rating tool uses pre-computed data for each structure. As part of the load rating submittal, the precomputed data must be generated and sent to the department for future use with the automated routing system.

For P/s Concrete bridges, report the results of the Service 1 check.
Appendix A: ND Defined Trucks

ND 1 – Agricultural Products Seasonal 10% Load Limit Increase

Axle 1 13,200 lbs
Axle 2 17,600 lbs
Axle 3 17,600 lbs
Axle 4 17,600 lbs
Axle 5 17,600 lbs
Axle 6 17,600 lbs
Axle 7 17,600 lbs
GVW 118,800

AG 1 – Grain Cart

TBD
### Appendix B: Sample Load Rating Summary Sheet

<table>
<thead>
<tr>
<th>Vehicle Name</th>
<th>Current Load (tons)</th>
<th>Load (Factor)</th>
<th>Method</th>
<th>Analysis</th>
<th>Limit State</th>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS-20 Inventory</td>
<td>F</td>
<td>0.77</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>HS-20 Operating</td>
<td>F</td>
<td>2.71</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>Type 3-3</td>
<td>F</td>
<td>2.92</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>NRB SHV</td>
<td>F</td>
<td>2.00</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>SHV-5</td>
<td>F</td>
<td>2.00</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>SHV-6</td>
<td>F</td>
<td>2.00</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>SHV-7</td>
<td>F</td>
<td>2.00</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>EV-2</td>
<td>F</td>
<td>2.69</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>EV-3</td>
<td>F</td>
<td>1.78</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>HS-20 Inventory</td>
<td>F</td>
<td>6.03</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>HS-20 Operating</td>
<td>F</td>
<td>83.38</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>Type 3-3</td>
<td>F</td>
<td>105.22</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>NRB SHV</td>
<td>F</td>
<td>129.46</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>SHV-5</td>
<td>F</td>
<td>80.08</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>SHV-6</td>
<td>F</td>
<td>77.72</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>SHV-7</td>
<td>F</td>
<td>77.72</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>EV-2</td>
<td>F</td>
<td>81.00</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
<tr>
<td>EV-3</td>
<td>F</td>
<td>76.58</td>
<td>F</td>
<td>Tension</td>
<td>Legal</td>
<td>G1 Mid Span-Concrete</td>
<td></td>
</tr>
</tbody>
</table>