

**STATE OF RHODE ISLAND
DEPARTMENT OF TRANSPORTATION**



BRIDGE LOAD RATING GUIDELINES

September 2022

Contents

LIST OF FIGURES	1
LIST OF TABLES	1
DEFINITIONS.....	2
ABBREVIATIONS	3
SUMMARY OF REVISIONS (June 2022).....	4
SUMMARY OF REVISIONS (NOVEMBER 2019).....	4
SUMMARY OF REVISIONS (AUGUST 2017)	5
SUMMARY OF DRAFT REVISIONS (MARCH 2017).....	6
1. GENERAL.....	7
1.1 Introduction.....	7
1.2 Purpose of this Document.....	7
1.3 NBI vs. Non-NBI Bridges.....	7
1.4 System of Units.....	7
1.5 Load Rating Methodology	8
1.6 Requirements to Perform a Load Rating Analysis.....	8
1.6.1 New, Rehabilitated, or Repaired Bridges.....	8
1.6.2 Bridges Under Staged Construction.....	8
1.6.3 Reevaluation of Existing Bridges	8
1.6.4 Temporary Bridges	9
1.6.5 Design Check Load Ratings.....	9
1.6.6 Other	9
1.7 Elements to be Load Rated	9
1.7.1 Decks.....	9
1.7.2 Superstructure	10
1.7.3 Substructure	10
1.8 Software	10
1.8.1 AASHTOWARE BrR.....	10
1.8.2 Other Approved Structural Software	11
1.9 Load Rating Team Qualifications and Responsibilities.....	11
1.9.1 Load Rating Team Qualifications	11
1.9.2 Load Rater of Record Responsibilities	12
1.10 Data Collection for Load Rating.....	12
1.10.1 Review of Existing Bridge Plans and Documents	12
1.10.2 Beam & Span Orientation.....	13
1.10.3 Bridge Inspection for Load Rating.....	13

1.10.4	Assessment of Truck Traffic Conditions at Bridge Site	13
1.10.5	Selection of Surface Roughness Rating	14
1.10.6	Materials	15
1.11	Bridges with Unknown Structural Components	16
2.	LOADS FOR EVALUATION.....	16
2.1	Dead Loads	16
2.1.1	General	16
2.1.2	Distribution	16
2.1.3	Wearing Surface.....	17
2.1.4	Utilities.....	17
2.2	Transient Loads.....	18
2.2.1	Longitudinal Braking Forces	18
2.2.2	Pedestrian Live Loads (PL).....	18
2.2.3	Application of Vehicular Live Loads.....	18
2.2.4	Wind Loads, WL and WS	18
2.2.5	Temperature Effects, TG and TU.....	18
2.2.6	Creep and Shrinkage, CR and SH.....	18
2.2.7	Dynamic Load Allowance (IM).....	18
3.	STRUCTURAL ANALYSIS.....	19
3.1	Approximate Methods of Structural Analysis.....	19
3.2	Refined Methods of Analysis.....	19
3.3	Field Load Tests.....	19
4.	LOAD RATING PROCEDURES	20
4.1	General Load Rating Equation.....	20
4.2	Resistance Factors and Resistance Modifiers for the Strength Limit States.....	20
4.2.1	Resistance Factor: ϕ	20
4.2.2	Condition Factor: ϕ_c	21
4.2.3	System Factor: ϕ_s	22
4.3	Resistance Factors and Resistance Modifiers for the Service Limit States	22
4.4	Live Loads and Load Factors	22
4.4.1	General LRFR Live Load Rating Vehicle Rating Process.....	22
4.4.1.1	Strength Design Load Rating (HL-93).....	23
4.4.1.2	Strength Legal Load Rating (AASHTO Legal Loads).....	23
4.4.1.3	Strength Rating for Permit Loads	26
4.4.1.4	Service and Fatigue Live Load Ratings	28
4.5	Bridges with Low Rating Factors (Below Statutory).....	28

5.	CONCRETE STRUCTURES	29
5.1	Materials	29
5.2	Assumptions for Load Rating	29
5.3	Shear	29
5.4	Unknown Structural Components	30
5.5	Prestressed Concrete Structures	30
5.6	Continuity Diaphragms	30
5.7	NEXT Beams	30
6.	STEEL STRUCTURES	31
6.1	Analysis.....	31
6.2	Materials	31
6.3	Deteriorated Members.....	31
6.4	Beam End Deterioration.....	31
6.4.1	Beam End Deterioration Cases	31
6.4.1.1	Analysis Criteria	32
6.4.1.2	Reporting Criteria	33
6.5	I-Sections	33
6.5.1	General	33
6.5.2	Non-composite Sections/Partially Composite Sections/Sections with Unknown or No Shear Connectors	33
6.5.3	Longitudinal Deck Reinforcement.....	34
6.5.4	Connections.....	34
7.	TIMBER STRUCTURES	34
7.1	Materials	34
7.2	Resistance Factors.....	34
7.2.1	Wet Service Factor, C_M	34
8.	PRE-ENGINEERED ARCHES OR FRAMES	34
9.	MASONRY ARCHES	35
10.	BURIED STRUCTURES	35
10.1	Structural Analysis.....	35
11.	POSTING OF BRIDGES.....	35
11.1	Potential Bridges Requiring Posting	35
11.2	Bridges Requiring Posting	36
12.	QUALITY CONTROL AND QUALITY ASSURANCE REVIEW OF LOAD RATINGS AND POSTINGS	36
12.1	Quality Control of Load Ratings.....	36
12.2	Quality Assurance of Load Ratings	36

12.3	Quality Control/Quality Assurance of Load Postings.....	36
13.	LOAD RATING DELIVERABLES.....	37
13.1	Load Rating Report.....	37
13.1.1	Report Cover.....	37
13.1.2	Index	37
13.1.3	Summary of Bridge Rating	37
13.1.4	Breakdown of Bridge Rating	37
13.1.5	Location Map.....	38
13.1.6	Description of Bridge.....	38
13.1.7	Rating Analysis Assumptions & Criteria.....	38
13.1.8	Evaluation & Recommendations.....	39
13.1.9	References & Available Plans.....	39
13.1.9.1	Orientation Plan / Orientation Section View	39
13.1.9.2	Applicable Existing Plans	39
13.1.10	Truck Loadings	39
13.1.11	Agreement of Independent Reviewer.....	39
13.1.12	Appendix A (Inspection Report).....	39
13.1.13	Appendix B (Photographs).....	39
13.1.14	Appendix C (Computations)	40
13.1.15	Appendix D (Computer Input & Output).....	40
13.2	Electronic File Submission	40
13.2.1	Bridge Folder	41
13.2.2	Rating Folder	41
13.2.3	Rating Subfolders.....	41
13.2.3.1	Inspection Report	41
13.2.3.2	Existing Plans.....	41
13.2.3.3	Calculations.....	41
13.2.3.4	Sketches	42
13.2.3.5	Output	42
13.2.3.6	Report.....	42
13.2.3.7	Other Documents	42
13.3	Consultant QA Checklist	42
14.	AASHTOWare BrR GUIDELINES FOR RATINGS	42
14.1	BrR Updates.....	43
14.2	File Naming	43
14.3	General Modeling	43

14.4	Dead Load Distribution Methods.....	43
14.4.1	Option 1	43
14.4.2	Option 2	43
14.5	Bridge Description.....	44
14.6	Materials	44
14.7	Beam Shapes.....	44
14.8	Appurtenances.....	44
14.9	Superstructure Definition.....	44
14.9.1	Load Case Description	45
14.9.2	Framing Plan Detail	45
14.9.3	Structure Typical Section.....	45
14.9.4	Shear Connector Definitions.....	45
14.10	Member Loads	45
14.11	Member Alternatives.....	45
14.11.1	General.....	45
14.11.2	Control Options.....	45
14.11.3	Live Load Distribution.....	46
14.12	BrR Tolerance Settings	46
APPENDIX.....		47

APPENDIX A- SAMPLE REPORT

APPENDIX B-DESIGN CHECK LOAD RATING GUIDANCE

LIST OF FIGURES

<i>Figure 1-Poor Surface Roughness (Rating=1; IM=33%).....</i>	<i>14</i>
<i>Figure 2-Average Surface Roughness (Rating=2; IM=20%).....</i>	<i>15</i>
<i>Figure 3-Smooth Surface Roughness (Rating=3; IM=10%).....</i>	<i>15</i>
<i>Figure 4 - Determination of Average Web Thickness for Deteriorated Web Bottom.....</i>	<i>33</i>

LIST OF TABLES

<i>Table 1-Load Rating Team Requirements</i>	<i>12</i>
<i>Table 2-Surface Roughness Rating.....</i>	<i>14</i>
<i>Table 3-Dynamic Load Allowance for Rating</i>	<i>18</i>
<i>Table 4-Condition Factors.....</i>	<i>21</i>
<i>Table 5-Limit States for Load Ratings</i>	<i>22</i>

DEFINITIONS

Condition Rating: The numerical assessment of the physical condition of the bridge components.

Fatigue Serviceability Index: Dimensionless relative measure of the performance of a structural detail, at a particular location in the structure, with respect to the overall resistance of the member. The values vary between 1.0 and 0.

Force Effect: The response (axial force, shear force, bending moment) in a member or element due to the loading.

Legal Loads: Rating vehicles considered Federal and State maximum vehicular loads that do not require an oversize permit due to load effects. These vehicles are included in the load rating analysis and are used to establish a bridge posting if required.

Limit State: A condition for which the bridge component ceases to satisfy the criteria for which it was designed.

National Bridge Inspection Standards (NBIS): Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of bridge inventory records.

National Bridge Inventory (NBI): A repository (or database) of information for bridges that are subject to the NBIS. The bridge data reported to the NBI conforms to FHWA's coding requirements.

NBI Bridges: Bridge subject to the NBIS. These bridges carry vehicular traffic and have clear spans equal to or greater than 20'.

Non-NBI Bridges: Bridge not subject to the NBIS. This includes bridges with less than 20' clear span; do not carry vehicular loads; or not on public roads.

Posting: Signing a bridge for load (weight) restriction for the AASHTO/State legal loads. It is noted the AASHTO legal loads are considered the State legal loads.

Rating Factor: The ratio of the available capacity to the load produced by the live load vehicle under consideration.

Reliability Index: A computed quantity defining the relative safety of a structural element or structure expressed as the number of standard deviations that the mean of the margin of safety falls on the safe side.

Service Limit State: Limit state for limiting stress, deformations, and cracking.

Strength Limit State: Safety limit state for strength and stability.

Specialized Hauling Vehicles: Short but heavy vehicles that may or may not meet the provisions of Federal Bridge Formula B but induce load effects greater than Routine Commercial Vehicles, especially on short spans.

ABBREVIATIONS

AASHTO: American Association of State Highway and Transportation Officials
ADTT: Average Daily Truck Traffic
ASR: Allowable Stress Rating
CFR: Code of Federal Regulations, 23 CFR 650, Subpart C (National Bridge Inspection Standards-NBIS)
CR: Force effects due to creep
DW: Dead load of wearing surface and utilities
FEA: Finite Element Analysis
FEM: Finite Element Model
FHWA: Federal Highway Administration
LFR: Load Factor Rating
LL: Live Load
LRFD: Load and Resistance Factor Design
LRFR: Load and Resistance Factor Rating
MBE: AASHTO Manual for Bridge Evaluation
NBI: National Bridge Inventory
NBIS: National Bridge Inspection Standards
PM Office: RIDOT Project Management Office
RF: Rating Factor
RIBIM: Rhode Island Bridge Inspection Manual
RIDOT: Rhode Island Department of Transportation
SH: Force effects due to shrinkage
SNBI: Specifications for the National Bridge Inventory
TG: Force effect due to temperature gradient
TU: Force effect due to uniform temperature
WL: Wind on live load
WS: Wind load on structure

SUMMARY OF REVISIONS (September 2022)

The following is a summary of revisions from the *Bridge Load Rating Guidelines dated November 2019*. Minor grammatical corrections were made throughout the document which are not noted below.

- Section 1.2: Added reference to the CFR.
- Section 1.6.2: Added new section for bridges under phased construction.
- Section 1.6.5: Added new section for design check load ratings.
- Section 1.6.: Added new section for temporary bridges
- Section 1.7.2: Removed last sentence of 4th paragraph as it is no longer applicable.
- Section 1.8: Added note about load rater responsibility with software.
- Section 1.8.2: Added CANDE.
- Section 1.10.4: Added guidance for ADTT initial, present, and limit.
- Section 1.10.5: Minor clarification
- Section 2.1.3: Minor clarification for exposed deck depth of effective slab.
- Section 2.1.4: Minor clarification.
- Section 4.4.1.4.1: Clarified to exclude C' details.
- Section 4.5: Added statement pertaining to special analysis for permit trucks.
- Section 5.3: Revised first bullet.
- Section 6.4.1: Clarification.
- Section 6.4.1.1: Correction to have language match sketch.
- Section 6.4.1.2: Clarification.
- Section 6.5.2: Clarification.
- Section 6.5.3: Clarification.
- Section 11: Clarification
- Section 13: Minor clarifications and updates throughout this section. Removed all references to hard copies.
- Section 13.1.4: Minor correction.
- Section 13.1.9.1: Minor clarification
- Section 13.1.15: Added a bullet for traffic data.
- Section 13.3: New section for Consultant QA Checklist.
- Section 14.11.1: Removed requirement that prohibits linking of beams in BrR.
- Section 14.11.2: Minor clarification for “plastic analysis”.
- Section 14.5: Added note for description text box.
- Appendix A Sample Report-Summary Sheet: Revised.
- Appendix B: Added new section for Design Check Load Rating guidance.

SUMMARY OF REVISIONS (NOVEMBER 2019)

The following is a summary of revisions from the *Bridge Load Rating Guidelines dated August 2017*. Minor grammatical corrections were made throughout the document which are not noted below.

- Section 1.1: Added another bullet.
- Section 1.2: Revised MBE version.
- Section 1.3: Minor clarification.
- Section 1.4: Corrected system of units.
- Section 1.6.2: Revised title and clarified last paragraph.
- Section 1.7.2: Added reference to MBE for curved structures.

- Section 1.7.3: Added 1st sentence.
- Section 1.9: Clarified requirements for the load rater and load rating team. Added new Table.
- Section 1.10.1: Minor clarifications.
- Section 1.10.6: Revised last paragraph.
- Section 2.1.3-4: Minor clarifications.
- Section 2.2.1-6: Minor clarifications, corrections to MBE references.
- Section 2.2.7: Removed 1st paragraph and inserted new paragraph to reference MBE. Minor clarification of last paragraph.
- Sections 3.2-3: Minor corrections.
- Section 4.2: Removed 1st paragraph.
- Section 4.2.2: Added clarification to 1st paragraph, updated Table 3, added clarification to 1st, updated 2nd and 3rd paragraphs.
- Section 4.4.1: Minor correction in bullet no. 2, minor update to Table 4.
- Section 4.4.1.2: Revised Fast Act information to reflect latest FHWA Guidance.
- Section 4.4.1.3.1: Corrected terminology to “annual permits” to reflect RI General Laws, added new RI 5b truck.
- Section 4.4.1.3.2: Corrected terminology to “special trip” to reflect RI General Laws; minor clarifications in each paragraph, added new RI-OP4 & RI-OP5 trucks.
- Section 4.4.1.4.1: Minor correction.
- Section 4.5: Minor correction.
- Sections 5.2, 5.3, 5.4, 5.5, 5.6, 6.2, 6.3: Minor clarifications and AASHTO reference updates.
- Section 6.4: Re-organized section, added clarifications throughout, inserted new sections 6.4.1.1 and 6.4.1.2. Inserted new Figure 4. Technical content remained the same but re-organized for clarification purposes.
- Section 6.5.2: Minor corrections.
- Section 10.1: Removed 1st paragraph and inserted new sentence referencing the MBE.
- Section 11: Deleted 6th sentence in 1st paragraph, deleted last two paragraphs. Other minor corrections.
- Section 11.1: Revised 1st paragraph.
- Section 12.3: Updated title of section to include “Quality Assurance.”
- Section 13.1.2: Title Sheet deleted; rest of sections renumbered.
- Section 13.1.5, now 13.1.4: Added last sentence to 1st paragraph.
- Section 13.1.8, now 13.1.7: Added several items to the list of assumptions.
- Section 13.1.16, now 13.1.15: Added several “screenshots.”
- Section 13.2.3.3: Inserted new image for folder structure. Added “Beam End.”
- Section 14.2, 14.3, 14.4, 14.6, 14.7, 14.8, 14.9.1, 14.10, 14.11: Minor clarifications
- Appendix A Sample Report-Report Cover: Revised.
- Appendix A Sample Report-Summary Sheet: Revised
- Appendix A Sample Report-Breakdown Tables: Revised
- Appendix A Sample Report-Description of Bridge: Revised

SUMMARY OF REVISIONS (AUGUST 2017)

The following is a brief summary of revisions from the “Draft” *Bridge Load Rating Guidelines* dated March 2017. These guidelines have been renamed *Bridge Load Rating Guidelines*, August 2017.

- Section 1.3: Minor clarification.
- Section 1.6.2: Clarified first bullet. Clarified last paragraph.
- Section 1.7.1: Added bullets.

- Section 1.7.3: Added bullet.
- Section 1.9.2: Clarification and updated references.
- Section 2.2.1: Minor clarification.
- Section 2.2.2: Revised paragraph.
- Section 2.2.3: Added last sentence.
- Section 2.2.5: Added clarification.
- Section 3.2: Added last sentence.
- Section 4.4.1: Clarified 2nd bullet. Minor clarification to note for Table.
- Section 4.4.1.2 Clarified EV Vehicles.
- Section 5.3: Clarified section.
- Section 5.4: Minor clarification.
- Section 5.5: Added clarification to strand loss.
- Revised Section 6.3 to separate out beam end deterioration.
- Added Section 6.4 for beam end deterioration.
- Section 11: Clarified section.
- Section 11.1: Removed third bullet.
- Section 11.2: Clarified 2nd bullet.
- Section 13.1.5: Clarified reporting requirements.

SUMMARY OF DRAFT REVISIONS (MARCH 2017)

The RIDOT Guidelines for Load and Resistance Factor Rating (LRFR) of Highway Bridges, Revision No. 1, January 2011, has been updated to a Revision No. 2 in January 2017. This revision contained many updates to include current FHWA requirements but is officially considered a “Draft” per FHWA. These updates include, but are not limited to, the following general changes from the 2011 guidelines:

- Revised and reorganized all previous sections in their entirety and reorganized the format. Content from the previous version is generally the same however more information has been added to supplement the previous version:
- The major changes are as follows:
 - Removed all references to BRASS and replaced/added new sections for AASHTOWare BrR.
 - Updated names to the RIDOT Standard vehicle live loads.
 - Added section for approved software (Section 1.8)
 - Clarified load rater qualifications and responsibilities (Section 1.9)
 - Clarified information pertaining to dead loads and distribution (Section 2.1)
 - Added new section for bridges with low rating factors (Section 4.5)
 - Added new sections pertaining to concrete, steel, timber, pre-engineered arches or frames, masonry arches, and buried structures (Sections 5,6,7,8,9,10)
 - Complete update to load rating report deliverables (Section 13)
 - Added new section pertaining to AASHTOWare BrR (Section 14)
 - Updating of report templates (Section 0)

1. GENERAL

1.1 Introduction

A bridge load rating is the determination of the safe live load carrying capacity of a newly designed or existing bridge structure. Load ratings are typically determined by analytical methods based on information obtained from bridge plans and supplemented by information gathered from field inspections or field testing. Knowledge of the capacity of each bridge to carry loads is critical for several reasons, including, but not limited to, the following:

- To determine which structures have substandard load capacities that may require posting or other remedial action.
- To determine the safe posting limits for those structures with substandard load capacities.
- To assist in the most effective use of available resources for rehabilitation or replacement.
- To assist in the overload permit review process.
- FHWA requires bridge load ratings be submitted to them annually. The NBIS (Title 23, Code of Federal Regulations, Section 650.313 (c)), requires that load ratings be in accordance with the latest AASHTO Manual.

1.2 Purpose of this Document

The purpose of this document is to provide guidance to load rating engineers for performing and submitting load rating reports to RIDOT. These guidelines are intended to supplement the Code of Federal Regulations, 23 CFR 650, Subpart C (National Bridge Inspection Standards-NBIS). All load ratings shall be in accordance with the NBIS. This document was developed using the American Association of State Highway Transportation Officials (AASHTO) *Manual for Bridge Evaluation*, 3rd Edition, 2018 with the latest interims, hereinafter referred to as the MBE. The procedures in this document are to provide guidelines that will result in consistent and reproducible load rating inputs and deliverables. Please note that this document serves as a supplement to the MBE and deals primarily with RIDOT specific load rating requirements, interpretations, and policy decisions. The requirements set forth in these guidelines apply to all RIDOT personnel as well as consultants performing load ratings for RIDOT. ***While these guidelines are intended to provide bridge load rating policy, it does not preclude reasonable and practical exemptions subject to the approval of RIDOT.***

These guidelines are intended to be a living document such that changes will be issued as required due to changes in policy, loadings, code changes, etc.

1.3 NBI vs. Non-NBI Bridges

It is noted this document was developed for bridges classified as NBI bridges (structure length equal to or greater than 20'). However, the relevant provisions of these guidelines may be applied to non-NBI structures (structure length less than 20').

1.4 System of Units

The U.S. Customary System of Units is the default system of units for all RIDOT load ratings.

1.5 Load Rating Methodology

All bridges designed by Load and Resistance Factor Design (LRFD) after October 1, 2010, shall be load rated using Load and Resistance Factor Rating (LRFR). Bridges designed by LRFD prior to October 1, 2010, may be load rated using LRFR or LFR/ASR and reported to the NBI. It is noted that LRFR is the primary method for the load rating of bridges in Rhode Island. However, in some cases, an alternative method such as ASR or LFR is permissible subject to the approval of RIDOT.

1.6 Requirements to Perform a Load Rating Analysis

1.6.1 New, Rehabilitated, or Repaired Bridges

Any new, rehabilitated, or repaired bridge shall have a new or updated load rating. The new or updated load rating calculations shall reflect the bridge as-built/as-rehabilitated condition. When load ratings are performed in conjunction with bridge construction, the load rating results shall be submitted at the substantial completion phase of construction unless otherwise approved by RIDOT.

1.6.2 Bridges Under Staged Construction

For bridges under staged construction, it is the responsibility of the RIDOT PM Office to provide the Bridge Ratings Section with interim load ratings for each construction phase. Interim load ratings shall analyze any portion of a structure, whether new or old, that will be open to traffic and shall account for changes to live load distribution, dead loads, and any other relevant information specific to each construction phase. Interim load ratings must be submitted at the time of opening of each construction phase to traffic. Exceptions to the above will be granted on a case-by-case basis.

1.6.3 Reevaluation of Existing Bridges

The bridge inspection team in conjunction with a load rater shall review the bridge file after each inspection to see if a re-analysis is required. If so, the applicable documentation shall be submitted to the RIDOT Bridge Rating Section. In general, a revised load rating may be necessary if any of the following conditions have occurred since the previous inspection or load rating:

- The primary member condition at critical locations has changed such that re-analysis is warranted (i.e., section properties at critical locations have changed due to increased deterioration that may affect the overall capacity of the structure). Before sending the appropriate documentation to RIDOT, the inspection team shall have reviewed the load rating on file and decided that a re-rating is required based on preliminary calculations.
- Dead loads have changed due to resurfacing or other non-structural alterations (i.e., utilities, barrier placement, protective fencing, etc.)
- Section properties have changed due to rehabilitation, re-decking, or other alterations.
- Damage due to vehicular or vessel hits.
- Increased cracking in primary members.
- Increased section losses at critical connections.
- Significant changes in traffic loadings or traffic volumes that could change the load factor(s) used in the previous load rating.

Load ratings for existing bridges should be calculated using the as-inspected member properties. Any questions on this shall be directed to the RIDOT Bridge Rating Section.

1.6.4 Temporary Bridges

It is the responsibility of the RIDOT PM Office to provide the Bridge Ratings Section with a load rating report for any temporary bridge that will be open to traffic as part of a bridge rehabilitation or replacement project. Load rating reports for temporary bridges must be submitted prior to opening the structure to traffic.

1.6.5 Design Check Load Ratings

As part of the bridge design process and RIDOT/FHWA QA/QV/QC Plan with the RIDOT PM Office, design check load ratings shall be performed at the 90% design phase.

For design build contracts, or projects where a design check load rating is required as part of the construction contract, design check load ratings shall be submitted to the Bridge Ratings Section in accordance with the applicable portions of these guidelines.

Design check load ratings shall include gusset plates and connections for all primary members regardless of redundancy.

Refer to Appendix B for further guidance.

1.6.6 Other

Other factors that could trigger a new load rating are as follows:

- Permit analysis
- No previous load rating on file (i.e., newly discovered bridge or culvert).

1.7 Elements to be Load Rated

The load rating shall include analysis of the following elements:

1.7.1 Decks

- Open and concrete filled steel grid decks
- Reinforced concrete decks (only at RIDOT discretion, see below)
- Concrete decks with longitudinal post tensioning
- Timber decks
- Metal decks
- Transversely post-tensioned decks
- Decks with girder spacing equal to 10' or more
- Decks with significant overhangs

Reinforced concrete bridge decks are not typically evaluated as part of the load rating unless significant deterioration warrants at RIDOT's discretion. It is noted that reinforced concrete bridge decks may be susceptible to punching shear failure, especially where heavy permit trucks are known to cross the bridge.

1.7.2 Superstructure

- All elements defined as “primary members” as well as stringer-floorbeam connections, girder-floorbeam connections, and truss connections.
- Capacity of gusset plates and connection elements for non-redundant steel truss bridges.
- Diaphragms, cross frames, and primary connections for curved structures. Refer to MBE 6A.6.9.7 for more information about the rating of cross frames and diaphragms.
- Other connections of non-redundant systems.

Both the interior and exterior girders shall be checked to establish which governs the load rating.

Capacity of connections in redundant structures shall be checked only if condition warrants.

FHWA Technical Advisory T5140.29, dated January 15, 2008, recommends that during future recalculations of load capacity on existing non-load path redundant steel bridges, the capacity of gusset plates be checked to reflect changes in condition of dead load, to make permit or posting decisions, or to account for structural modifications or other alterations that result in significant changes in stress levels. Previous load ratings should be reviewed for bridges which have been subjected to significant changes in stress levels, either temporary or permanent, to ensure that the capacities of gusset plates were adequately considered.

1.7.3 Substructure

The following shall only be evaluated at RIDOT’s discretion if the structural and/or loading condition warrants:

- Timber and metal pier elements.
- Concrete pier caps and bent caps.
- Pier caps or other substructure components with special or unique geometric characteristics.

1.8 Software

Standard analysis tools can maximize efficiency, provide consistency, and facilitate future revisions of load ratings. It is important with any software program that the load rater setup and enter data in such a way that will be easily understood and editable in the future by another person. This requires the use of notes or other documentation to reference and explain the backup for any information entered in the program so that all assumptions and inputs are unambiguous. ***Furthermore, all raw data files used to perform the load rating are required to be submitted to enable future revisions.***

It is noted that load raters are responsible for the accuracy of the analysis for any software program. Therefore, when performing an analysis, load raters must account for existing software bugs by regularly reviewing bug reports from software vendors. If new software bugs are discovered, it must be brought to the attention of the Bridge Ratings Section.

1.8.1 AASHTOWARE BrR

AASHTOWare BrR is the primary software application for RIDOT load ratings. The latest AASHTOWare BrR shall be used for the following bridge types:

- Steel or concrete multistringers/multigirder

- Reinforced concrete girders
- Reinforced concrete slabs (and/or other approved software if necessary)
- Prestressed precast concrete I-girders or box beams
- Cast in-place box girders (and/or other approved software if necessary)
- Girder/floor beam/stringer systems (and/or other approved software if necessary)
- Curved girders (and/or other approved software if necessary)
- Culverts (and/or other approved software if necessary)
- Trusses (and/or other approved software if necessary)
- Timber (and/or other approved software if necessary)

For cases where AASHTOWare BrR is not applicable, please refer to Section 1.8.2.

To obtain a discounted license to perform load ratings for the Department, the consultant shall contact RIDOT prior to purchasing the program from AASHTO.

For specific RIDOT requirements with AASHTOWare BrR, refer to Section 14.

1.8.2 Other Approved Structural Software

The use of load rating software from independent software vendors is subject to the approval of RIDOT. The following software programs are generally considered acceptable to RIDOT *only* when AASHTOWare BrR is not applicable or needs to be supplemented. Please note this list is subject to change:

- BRASS
- CANDE
- CSI Bridge
- Descus
- LARSA
- Mathcad
- MDX
- MIDAS
- SAP
- SlabRate
- STAAD

It shall be noted that use of MIDAS is preferred considering the Department has a license for this software.

1.9 Load Rating Team Qualifications and Responsibilities

1.9.1 Load Rating Team Qualifications

The load rating team shall consist of multiple individuals meeting the requirements of *Table 1-Load Rating Team Requirements*. It is noted each individual listed in this table is designated on the Summary Sheet of the load rating report in the QA/QC Box (refer to Section 13.1.3-Summary of Bridge Rating). The load rater of record shall be considered the load rater as defined in the *Code of Federal Regulations*, Title 23, Part 650, Subpart C, Section 650.309 (23 *CFR* 650.309) which is defined as follows:

- (d) Load ratings must be performed by, or under the direct supervision of, a registered professional engineer.

Table 1-Load Rating Team Requirements

Individual	Requirements
Individual Performing Analysis ^{1,2} “Analysis By”	<ul style="list-style-type: none"> • Bachelor’s Degree in Civil or Structural Engineering Or <ul style="list-style-type: none"> • Registered Professional Engineer
Independent Reviewer ^{2,3}	<ul style="list-style-type: none"> • Bachelor’s Degree in Civil or Structural Engineering Or <ul style="list-style-type: none"> • Registered Professional Engineer
QA	<ul style="list-style-type: none"> • Registered Professional Engineer And <ul style="list-style-type: none"> • Separate individual from the Independent Reviewer
Load Rater of Record ⁴ (Individual that stamps and sign the cover sheet of the load rating report)	<ul style="list-style-type: none"> • Either the Individual Performing Analysis, Independent Reviewer, or QA person And <ul style="list-style-type: none"> • Registered Professional Engineer in Rhode Island And <ul style="list-style-type: none"> • Required to Stamp & Sign the Cover Sheet of the Load Rating Report

Notes:

1. This is the individual(s) that shall be listed as the “Analysis By” person in the report Summary Sheet QA/QC Box (refer to Section 13.1.3).
2. At a minimum, either the Individual Performing Analysis or the Independent Reviewer must be a Registered Professional Engineer.
3. The individual responsible to independently verify the load rating analysis and sign the Agreement of Independent Reviewer (refer to Section 13.1.11).
4. The individual charged with the overall responsibility for the load rating as defined in 23 CFR 650.309 and herein.

1.9.2 Load Rater of Record Responsibilities

The load rater of record is responsible for determining the load-carrying capacity of the bridge in its current condition according to various live loads (design, legal, and permit trucks). Refer to the *Code of Federal Regulations* (CFR), Title 23, Part 650, Subpart C, Section 650.313 (23 CFR 650.313) for load rater responsibilities.

The load rater of record is ultimately responsible to rate each bridge as to its safe load-capacity in accordance with the MBE. RIDOT is the responsible authority for appropriate load posting or restriction of a bridge in accordance with 23 CFR 650.313.

1.10 Data Collection for Load Rating

1.10.1 Review of Existing Bridge Plans and Documents

The load rater is responsible to review all available plans and documents for the bridge including the previous load rating report. In general, bid plans are available for most bridges. As-built drawings are not typically available for bridges constructed in the past. Shop drawings are also useful sources of information about the bridge, if available. In the cases where as-built or bid plans may not exist, complete field measurements of the structure will be required to perform the load rating. Any plan information, if available, can be obtained from the RIDOT Plan Room or the RIDOT Bridge Engineering Unit. Previous load rating reports can be obtained from the RIDOT Bridge Rating Section. Other appropriate bridge records, testing reports, repair or rehabilitation plans should be reviewed to determine their impact on the load carrying capacity of the structure if they are available. The load rater shall review any existing plans

as the first source of information for material strengths and stresses. If the material strengths are not explicitly stated on the plans, RIDOT construction and material specifications applicable at the time of the bridge construction shall be reviewed. This may require investigations into old ASTM, AASHTO Material Specifications, or RIDOT Standards at the time of construction. Hard copies of old RI Standard Specifications are available for review at RIDOT. In the absence of any information and as a last resort, the MBE provides guidance and data on older bridge types and materials that allows the evaluation of existing bridges. Refer to Section 1.10.6 for further information pertaining to materials.

1.10.2 Beam & Span Orientation

The layout and labeling of the beams, piers, and spans shall follow the labeling system of the latest bridge inspection report. This allows for consistency when comparing the current load rating report to the latest inspection report. Whenever there is a conflict between the previous load rating and the latest inspection report, we recommend following the beam and span labeling of the latest inspection report.

1.10.3 Bridge Inspection for Load Rating

Bridges being investigated for load capacity must be inspected for condition as per the latest edition of the MBE and the FHWA *Bridge Inspector's Reference Manual*. Bridge inspections are conducted to determine the physical and functional condition of the bridge; to form the basis for the evaluation and load rating of the bridge, as well as analysis of overload permit applications. The inspector must verify the accuracy of existing plans or sketches with field measurements. It is especially important to measure and document items that may affect the load capacity, such as dead loads, section deterioration, and damage. Only sound material should be considered in determining the nominal resistance of the deteriorated section. Where present, utilities, attachments, depth of fill, and thickness of wearing surface should be field verified at the time of inspection. Wearing surface thicknesses are also highly variable. Multiple measurements at curbs and roadway centerline should be used to determine an average wearing surface thickness. It shall be noted that bridge inspections performed as part of the NBIS satisfy this requirement. However, it is expected that a field visit be performed when necessary to verify the condition of the structure and/or section losses.

1.10.4 Assessment of Truck Traffic Conditions at Bridge Site

In general, ADTT can be estimated from Average Daily Traffic (ADT) data for the site. It is reasonable to assume 10% truck traffic in the absence of any information. If current traffic volumes are unavailable from the bridge file, the RIDOT Traffic Research Section may be contacted via email at dot.trafficdata@dot.ri.gov for the most current ADTT information for the route carried by the bridge or routes with a similar functional classification.

If fatigue is a concern in the load rating evaluation, then site specific ADTT counts may be considered upon approval of the Department. When estimating finite fatigue life per section 7.2.5 of the MBE, the following method may be used to determine the values for $(ADTT_{SL})_0$, $(ADTT_{SL})_{PRESENT}$, and $(ADTT_{SL})_{LIMIT}$ in the absence of more precise information:

- $(ADTT_{SL})_{PRESENT}$: Calculate using latest known ADTT at given time and increase the ADTT by 1% for each future year up the present year.
- $(ADTT_{SL})_0$: Calculate by using latest known ADTT and decrease the ADTT by 1% for each year past until the year built/year reconstructed.
- $(ADTT_{SL})_{LIMIT}$: Calculate using latest known ADTT and increase the ADTT 1% for each future year until the end of the design life year.

Live load factors prescribed in the MBE shall be used and need not be modified.

1.10.5 Selection of Surface Roughness Rating

LRFD dynamic load allowance of 33% reflects conservative conditions that may prevail under certain distressed approach and bridge deck conditions. For the load rating of legal and permit vehicles for bridges with less severe approach and deck surface conditions, the dynamic load allowance (IM) may be decreased based on field observations in accordance with MBE Table C6A.4.4.3-1 (See LRFD Article 3.6.2). The inspector and/or load rater shall carefully note these and other surface discontinuities to benefit from a reduced dynamic load allowance. Dynamic load allowance need not be applied to timber bridge components.

To ensure proper and consistent selection of dynamic load allowance values in all load ratings, the load rater shall assign a rating for the surface roughness of the bridge riding surface based on a field review or inspection report. This rating value shall be documented in the load rating report. Surface Roughness is defined as follows:

Table 2-Surface Roughness Rating

Surface Roughness Rating	Description
3 = Smooth	Smooth riding surface at approaches, bridge deck, and expansion joints
2 = Average	Minor surface deviations or depressions
1 = Poor	Significant deviations in riding surface at approaches, bridge deck, and expansion joints



Figure 1-Poor Surface Roughness (Rating=1; IM=33%)



Figure 2-Average Surface Roughness (Rating=2; IM=20%)



Figure 3-Smooth Surface Roughness (Rating=3; IM=10%)

1.10.6 Materials

In the absence of any material data or when any AASHTO legal load rating factor for a bridge is below 1.0, consideration shall be given to performing steel and/or concrete material sampling and testing to obtain a

more realistic evaluation of the bridge. Please note that no material sampling and testing shall be performed unless approved by the Department.

The engineer shall use sound judgement based on experience with similar types of bridges to determine if material testing would be beneficial to the overall rating of the bridge. The engineer shall perform a trial test to see if material testing is practical and cost effective by changing the material properties used in the analysis to see what the reasonable impacts could be if material testing was performed. The results will be helpful to determine if material testing is feasible.

For concrete structures, material testing shall be in accordance with MBE 6A.5.2.1 unless otherwise approved.

For general material testing, refer to MBE Section 5.

1.11 Bridges with Unknown Structural Components

There are bridges where common analytical methods are not adequate to determine the load rating. For bridges where details such as reinforcing in a concrete bridge are not available from existing plans or field evaluation, knowledge of the live load used in the original design, the current condition of the structure, and live load history may be used to provide a basis for determining a safe load capacity.

Consideration may be given to non-destructive testing (NDT) and material testing to help determine the characteristics of the bridge. Such testing will sometimes provide enough information to produce a reliable load rating for the bridge. This shall only be done with approval from the Department.

Per the MBE Section 6.1.4, a concrete bridge with unknown details need not be posted for restricted loading if it has been carrying normal traffic and shows no visible distress. Nondestructive load tests can also be helpful in establishing the safe load capacity for such structures if desired. Section 8 of the MBE provides guidance on the use of load tests, the interpretation of load test results, and the types of bridges that are suitable candidates for load tests. Proposed load tests, if required, shall be reviewed and approved by RIDOT.

2. LOADS FOR EVALUATION

2.1 Dead Loads

2.1.1 General

Dead loads shall be calculated based on plan dimensions unless otherwise measured. The dead load of any structural plates (i.e., stiffeners, connection, etc.) shall be computed and not assumed as a “miscellaneous” connection percentage.

The minimum unit weights of materials used in computing dead loads shall be in accordance with LRFD Table 3.5.1-1 in the absence of more precise information.

2.1.2 Distribution

For bridges designed by LRFD, the sidewalk, safety walk, barrier/railing superimposed dead load shall be distributed 60 percent to the fascia beams and 40 percent evenly to all interior beams (60/40). If the sidewalk spans over more than one beam, then 60 percent of the above superimposed dead loads shall be

distributed evenly among the beams carrying the sidewalk and 40 percent among the remaining interior beams. This criteria is based on the RI LRFD Bridge Design Manual (2007) and is considered appropriate for the rating of bridges constructed after 2007.

For bridges not designed by LRFD, the distribution of the superimposed dead loads shall be investigated using equal distribution, 50/50, or 60/40. In general, the distribution method which provides the higher overall rating factors for the bridge shall govern. However, this is subject to the discretion of the engineer based on the bridge condition and performance.

For adjacent precast deck and box beam sections without a composite concrete slab and with failed shear keys as evidenced by visual inspection, the dead loads shall be distributed consistent with the way the bridge is performing, assuming no transfer of load across the failed keys. However, this assumption shall be discussed with RIDOT prior to finalizing the load rating.

For utility loads, distribution shall be in a manner that best represents the force effects on individual members as determined by the load rater.

2.1.3 Wearing Surface

The load factor for DW at the strength limit state may be taken as 1.25 where the thickness has been field measured from either a bridge inspection or site visit. It is important to note that all average curb reveals documented within AASHTOWare BrM are based on field measurements; in such cases, the reduced DW load factor may be utilized. In the absence of plans to confirm the original curb reveal, pavement cores can be considered if this load is expected to produce low rating factors. Otherwise, the load rater will have to use judgement based on the age of the bridge, surrounding bridges curb reveals, etc. to determine a reasonable thickness.

The weight of a future wearing surface should not be included as a dead load because it is not part of the existing or as-built condition.

For exposed concrete bridge decks, the effective depth of the deck slab shall consider the top ½" as sacrificial for structural analysis purposes.

The wearing surface shall be distributed equally to all beams regardless of the dead load distribution method utilized in Section 2.1.2.

2.1.4 Utilities

The weight of utility pipes and utility supports shall be included under the DW load case. A separate DW load case specifically for these utilities is acceptable when the load factor is different from the wearing surface.

Every effort shall be made to compute the dead weight of utilities based on existing plans, shop drawings, photographs, etc. Where no information is available, we suggest using a load of 250 pounds per foot for a pipe size greater than or equal to a 6-in diameter and 125 pounds per foot for a pipe size less than a 6-in. diameter. These values are only to be used in the absence of any information and shall be specifically documented in the load rating report.

2.2 Transient Loads

2.2.1 Longitudinal Braking Forces

The effects of longitudinal braking forces shall not be considered except for load rating of substructure or as requested by the Department.

2.2.2 Pedestrian Live Loads (PL)

Pedestrian live loads shall be analyzed in accordance with MBE 6A.2.3.4.

2.2.3 Application of Vehicular Live Loads

Average bridge curb reveal less than 6" is considered mountable and live load shall be considered on the sidewalk without restriction from the curb. For any average curb reveal greater than or equal to 6", live load shall not be considered on the sidewalk.

Striped lanes per MBE 6A.2.3.2 are permitted per RIDOT approval.

2.2.4 Wind Loads, WL and WS

Wind loads shall not be considered unless requested by the Department.

2.2.5 Temperature Effects, TG and TU

Refer to MBE 6A.2.3.6.

2.2.6 Creep and Shrinkage, CR and SH

Refer to MBE 6A.2.3.8.

2.2.7 Dynamic Load Allowance (IM)

The dynamic load allowance shall be applied in accordance with MBE 6A.4.3.3 (Design Load), 6A.4.4.3 (Legal Loads), and 6A.4.5.5 (Permit Loads). Refer to Table 3 below for selection of the appropriate dynamic load allowance.

Table 3-Dynamic Load Allowance for Rating

Riding Surface Rating	IM
3	10%
2	20%
1	33%

For concrete arches, rigid frames or slab bridges that have cover greater than 12 inches, the dynamic load allowance shall be calculated in accordance with AASHTO LRFD Article 3.6.2.2.

3. STRUCTURAL ANALYSIS

3.1 Approximate Methods of Structural Analysis

The default method of analysis for any load rating shall be the single line girder or line girder system analysis consistent with AASHTOWare BrR.

3.2 Refined Methods of Analysis

Bridges subject to low ratings or complex structures may require the use of refined methods of analysis such as 3-D finite element models. Typically, 3-D finite element models will more accurately distribute loads and possibly improve the overall rating factor for a bridge. Refined methods of analysis are justified to avoid posting of a bridge subject to the approval of the Department. The following are cases where a refined method of analysis is considered appropriate:

- Bridges analyzed using approximate methods with rating factors for any legal load less than 1.0
- Concrete slab bridges not designed by LRFD methods and the previous rating factors are low
- Varying skews at supports
- Curved bridges
- Girder spacing and span lengths outside the range of LRFD distribution formulas
- Bridges previously analyzed using a refined method of analysis

It is noted that no load rating report using an approximate method of analysis which satisfies the above criteria shall be submitted to the Department unless a refined method of analysis has been considered. Please note the use of refined methods is subject to the approval of the Department.

If by engineering judgement a refined method of analysis appears beneficial to the overall rating based on experience or the previous load rating for the bridge, the load rater shall then perform the refined method of analysis upon approval from the Department. Also, material testing and non-destructive testing (NDT) may be considered in conjunction with the refined analysis to determine any rebar information or concrete strengths for more accurate results. This shall be considered on a case-by-case basis with the Department considering access requirements, traffic, costs, etc.

Some of the newer more complex structures such as segmental bridges, curved-girders, integral bridges, cable-stayed, etc. were designed using sophisticated analysis methods. Therefore, a sophisticated level of analysis will be required to rate these structures.

For any refined analysis, a table of distribution factors shall be provided in the load rating report. Refer to MBE C6A.3.3.

3.3 Field Load Tests

The actual performance of most bridges is more favorable than conventional theory dictates. If directed by RIDOT, the safe load capacity for a structure can be determined from full scale non-destructive field load tests, which may be desirable to establish a higher safe load carrying capacity than calculated by analysis. Refer to the MBE Section 8 for information on the types of load tests, conducting field load tests, and using the results to establish a new or updated load rating. Some of the benefits of a load test are as follows:

- Evaluate performance of unknown structural or low rated bridge components

- Confirm load distribution
- Behavior of deteriorated or damaged members
- Measure stresses for fatigue evaluation
- Measure dynamic load allowance

The following conditions are situations where a load test would not be considered practical:

- The cost of testing exceeds the estimated cost of repairs or strengthening.
- Based on engineering judgement and experience with load tests, the load test is unlikely to show an improvement in the load carrying capacity.
- Difficult access or on-site traffic conditions.

4. LOAD RATING PROCEDURES

4.1 General Load Rating Equation

The general rating equation in LRFR (MBE Eq. 6A.4.2.1-1) is given as:

$$RF = \frac{\phi_c \phi_s \phi R_n - (\gamma_{DC})(DC) - (\gamma_{DW})(DW) \pm (\gamma_P)(P)}{(\gamma_L)(LL + IM)}$$

In the LRFR Rating Factor equation:

RF	= Rating Factor
R _n	= Nominal member resistance (as inspected)
φ _c	= Condition Factor (refer to Section 4.2.2)
φ _s	= System Factor (refer to Section 4.2.3)
φ	= LRFD Resistance Factor
DC	= Dead load effect due to structural components and attachments
DW	= Dead load effect due to wearing surface and utilities
P	= Permanent loads other than dead loads (secondary prestressing effects, etc.)
LL	= Live load effect of the rating vehicle
IM	= Dynamic load allowance (refer to Section 2.2.7)
γ _{DC}	= LRFD load factor for structural components and attachments
γ _{DW}	= LRFD load factor for wearing surfaces and utilities
γ _P	= LRFD load factor for permanent loads other than dead loads
γ _L	= Evaluation live load factor for the rating vehicle (refer to Section 4.4)

The load and resistance factors for evaluation are as provided in MBE Section 6 and Section 4.2 of this document.

4.2 Resistance Factors and Resistance Modifiers for the Strength Limit States

4.2.1 Resistance Factor: φ

For the Strength Limit States, the member capacity is given as:

$$C = \phi_c \phi_s \phi R_n$$

Where:

- ϕ_c = Condition Factor (MBE Table 6A.4.2.3-1)
- ϕ_s = System Factor (MBE Table 6A.4.2.4-1)
- ϕ = LRFD Resistance Factor

Where, the following lower limit shall apply:

$$\phi_c \phi_s \geq 0.85$$

Resistance factor ϕ has the same value for new design and for load rating. Resistance factors, ϕ , shall be taken as specified in the LRFD Specifications for new construction. A reduction factor based on member condition, Condition Factor ϕ_c , is applied to the resistance of degraded members. An increased reliability index is maintained for deteriorated and non-redundant bridges by using condition and system factors in the load rating equation.

4.2.2 Condition Factor: ϕ_c

The condition factor provides a reduction to account for the increased uncertainty in the resistance of deteriorated members and the likely increased future deterioration of these members during the period between inspection cycles. Per the MBE 6A.4.2.3, the condition factor may be considered optional based on an agency's load rating practice. However, RIDOT requires application of the condition factor. The load rater shall use Table 4-Condition Factors below to determine the appropriate condition factor in conjunction with engineering judgement.

Table 4-Condition Factors

Element Condition State of Member at Location Being Analyzed*	NBI Superstructure Rating*	ϕ_c (Estimated Loss)	ϕ_c (Field Measured)
CS 1 or 2	6 or higher	1.00	1.00
CS 3	5	0.95	1.00
CS 4	4 or lower	0.85	0.90

*Application of the condition factor is at the final discretion of the load rater. These values are intended for general guidance and may be modified based on reasonable assumptions. All assumptions shall be stated in the narrative of the load rating report.

The Condition Factor ϕ_c does not account for section loss but is used in addition to section loss. For instance, a concrete member may receive a low condition rating due to heavy cracking and spalling or due to the deterioration of the concrete matrix. Such deterioration of concrete components may not necessarily reduce their calculated flexural resistance. But it is appropriate to apply the reduced condition factor in the LRFR load rating analysis. If there are also losses in the reinforcing steel of this member, they should be measured and accounted for in the load rating. It is appropriate to also apply the reduced condition factor in the LRFR load rating analysis even when the as-inspected section properties are used in the load rating as this reduction by itself does not fully account for the impaired resistance of the concrete component.

If section properties are obtained accurately, by actual field measurement of losses using a D-meter or calipers rather than by an estimated percentage of losses, the values specified for ϕ_c in MBE Table 6A.4.2.3-1 shall be increased by 0.05 ($\phi_c \leq 1.0$). RIDOT requires inspection teams to measure and document section losses for critical areas. Therefore, in most cases it is appropriate to use the value in the ϕ_c (Field Measured)

column of the above table. The load rater is responsible to determine the appropriate condition factor at each controlling location as needed based on the deterioration for each member. The overall controlling condition factor shall be reported on the Summary Sheet in the Load Rating Report.

4.2.3 System Factor: ϕ_s

System factors in MBE Section 6A.4.2.4 and MBE Table 6A.4.2.4-1 shall apply for all RIDOT load ratings.

4.3 Resistance Factors and Resistance Modifiers for the Service Limit States

For all non-strength limit states, $\phi = 1.0$, $\phi_c = 1.0$, $\phi_s = 1.0$

4.4 Live Loads and Load Factors

4.4.1 General LRFR Live Load Rating Vehicle Rating Process

Live load models outlined below shall be evaluated for the Strength, Service and Fatigue limit states in accordance with Table 5-Limit States for Load Ratings. Refer to the subsequent sections for further detailed information of each step below. Below is the general live load rating process:

1. Rate the design load using the HL-93 loading at the Inventory (Design) and Operating levels.
2. Rate the AASHTO Legal trucks (Type 3, Type 3S2, Type 3-3, H20, SU4, SU5, SU6, SU7, EV2 and EV3) and the RIPTA Bus. The RIPTA Bus shall be considered an AASHTO Legal Load for the purposes of the load rating. However, it is noted the RIPTA Bus is not considered an actual legal load nor shall govern a bridge posting but rather will be restricted from crossing the bridge if inadequate to support the bus. Lane-Type Legal Load Models are to be used for spans greater than 200 feet and for negative moment areas as given in MBE Figures D6A-4 and D6A-5 respectively.
3. Rate for the permit vehicles as given in Section 4.4 of this document. Other overweight permit vehicles that deviate significantly from the standard permit vehicles are to be evaluated on a case-by-case basis per direction of RIDOT. These standard permit vehicles assist RIDOT in the review of overweight permits and additional vehicles may be added in the future.

Table 5-Limit States for Load Ratings

Bridge Type	Limit State	HL-93 Load	AASHTO Legal Loads	Permit Loads
Steel	Strength I	●	●	
	Strength II			●
	Service II	●	●	●
	Fatigue	●		
Reinforced Concrete	Strength I	●	●	
	Strength II			●
	Service I			●
Prestressed Concrete	Strength I	●	●	
	Strength II			●
	Service III	●	See Note 1	
	Service I			●
Timber	Strength I	●	●	
	Strength II			●

Notes:

1. Refer to MBE C6A.5.4.2.2a. This is an optional check per the MBE except for segmental concrete bridges. However, for newly constructed bridges designed by LRFD this limit state shall be included in the analysis, but the bridge will not be posted for this limit state as it is optional except for segmental concrete bridges. When this limit state is included, the values shall be reported in the Breakdown Tables but not the Summary Sheet.

4.4.1.1 Strength Design Load Rating (HL-93)

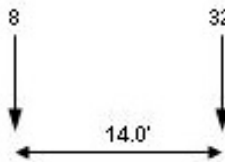
The design-load rating (or HL-93 rating) assesses the performance of existing bridges utilizing the LRFD HL-93 design loading and design standards with dimensions and properties for the bridge in its present as-inspected condition. It is a measure of the performance of existing bridges to new bridge design standards contained in the LRFD Specifications. The design-load rating produces Inventory and Operating level rating factors for the HL-93 loading. The design load live-load factors for the Strength I limit state shall be taken as given in MBE Table 6A.4.3.2.2-1.

The dynamic load allowance specified in the LRFD Specifications for new bridge design (LRFD Article 3.6.2) shall apply. For the design load rating, regardless of the riding surface condition or the span length, always use 33% for the dynamic load allowance (IM).

The results of the HL-93 rating are to be reported as a Rating Factor.

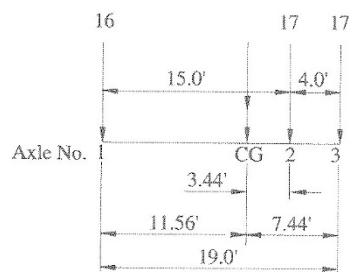
4.4.1.2 Strength Legal Load Rating (AASHTO Legal Loads)

Per the MBE, the following legal loads shall apply for all span lengths and load effects:



H20

Unit Weight = 40 kips (20 tons).

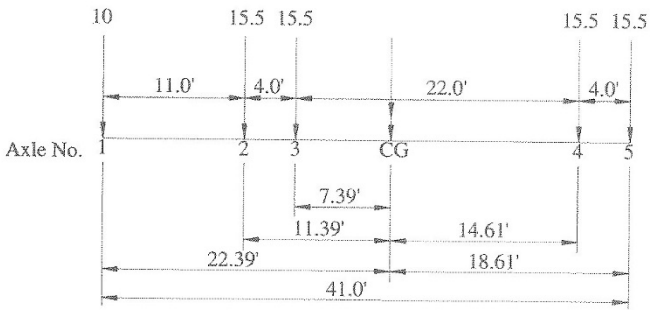


INDICATED CONCENTRATIONS ARE
AXLE LOADS IN kips

C.G. = CENTER OF GRAVITY

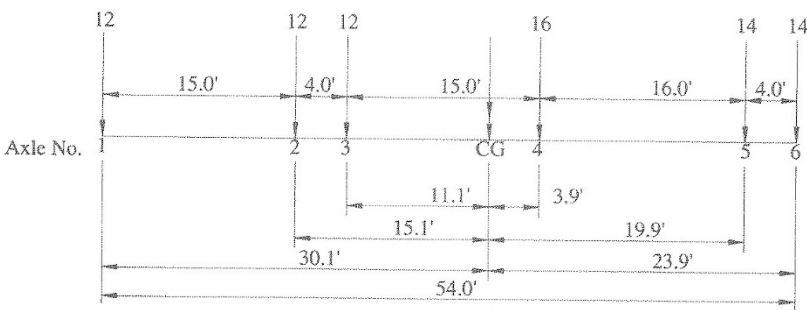
Type 3 (MBE Figure D6A-1)

Unit Weight = 50 kips (25 tons).



Type 3S2 (MBE Figure D6A-2)

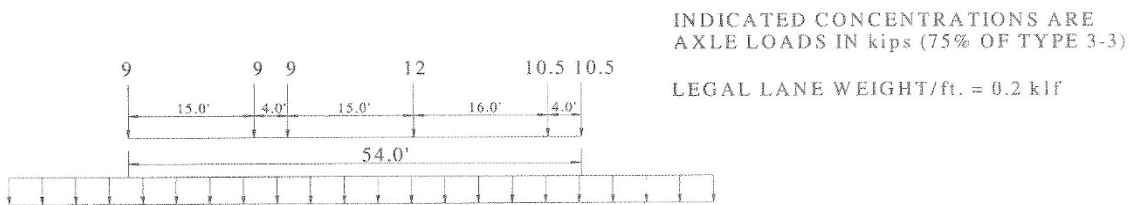
Unit Weight = 72 kips (36 tons).



Type 3-3 (MBE Figure D6A-3)

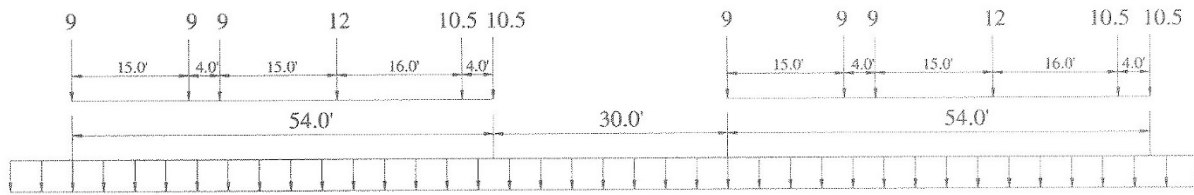
Unit Weight = 80 kips (40 tons).

For the following lane-type legal load model, apply for all span lengths greater than 200 feet and all load effects:

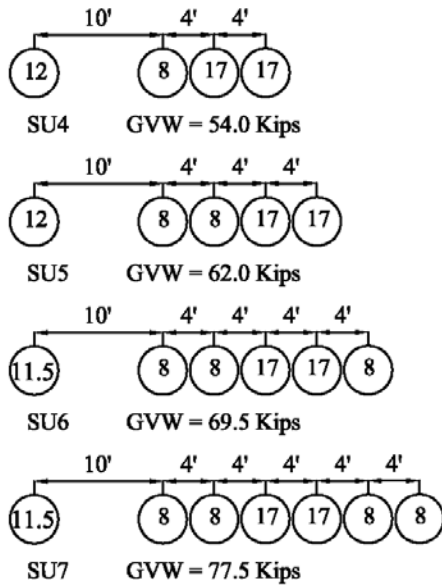


Lane-Type Loading for Spans Greater than 200 feet (MBE Figure D6A-4)

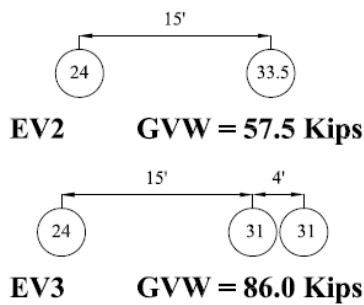
For the following lane-type legal load model, apply for negative moment and interior reaction for all span lengths:



Lane-Type Loading for Negative Moment and Interior Reaction (MBE Figure D6A-5)



Single-Unit SHV's that Meet Federal Bridge Formula B (MBE Figure D6A-7)

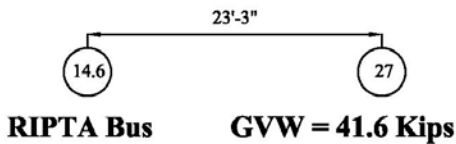


FAST Act Emergency Vehicles

For guidance on how to apply these loads please refer to the Questions and Answers-Load Rating for the FAST Act's Emergency Vehicles, Revision R01, dated March 16, 2018, which can be obtained from the FHWA website. FHWA acknowledged the research results from NCHRP 20-07, Task 410 on August 16, 2019. Therefore, use of the calibrated live load factors from that NCHRP research is acceptable upon RIDOT approval.

RIPTA Bus

The following load shall be analyzed as an AASHTO Legal Load for the purposes of the load rating:



For the RIPTA Bus analysis, should the rating factor be less than 1.0, RIDOT requires the load rater to investigate options (i.e., other travel lanes or areas of the bridge) to determine where, if possible, the bus may drive within the travel way without restriction. Options should be considered and discussed within the “Evaluation & Recommendations” section of the load rating report. The intent of this investigation is to look further into the analysis to find alternate paths, if possible, to allow the RIPTA bus over the bridge.

4.4.1.3 Strength Rating for Permit Loads

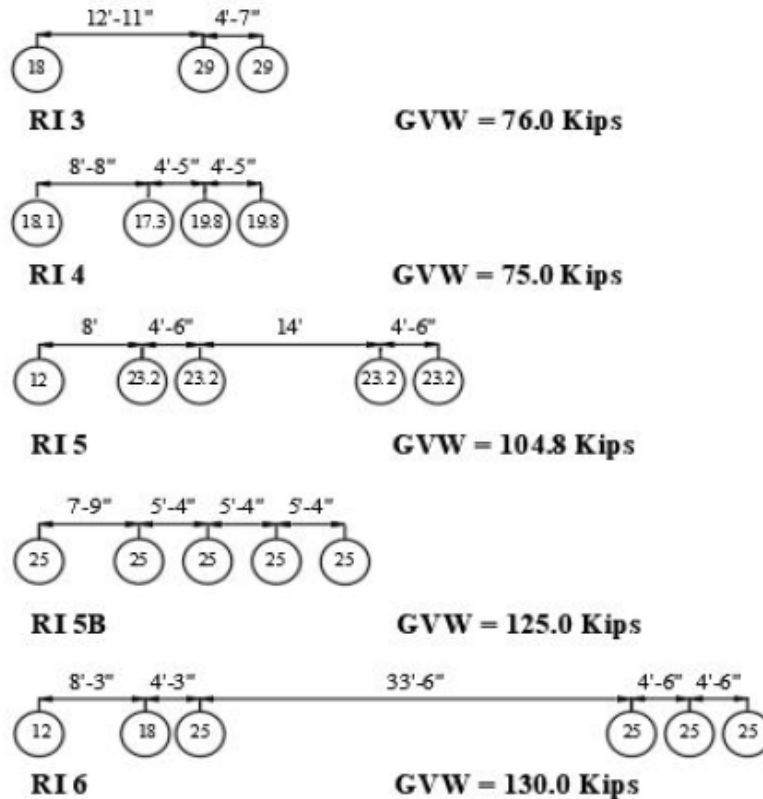
Permit loads shall be evaluated per the subsequent sections:

4.4.1.3.1 Annual Permits

Annual permits are issued for the movement of specific vehicles per the RI General Laws. Annual permits are usually valid for unlimited trips over a period not to exceed one year. The permit vehicle may mix in the traffic stream and move at normal speeds without any restrictions.

The permit load factors shall be in accordance with MBE Table 6A.4.5.4.2a-1.

The following routine permit loads shall be analyzed for each bridge:



4.4.1.3.2 Special Trip Permits

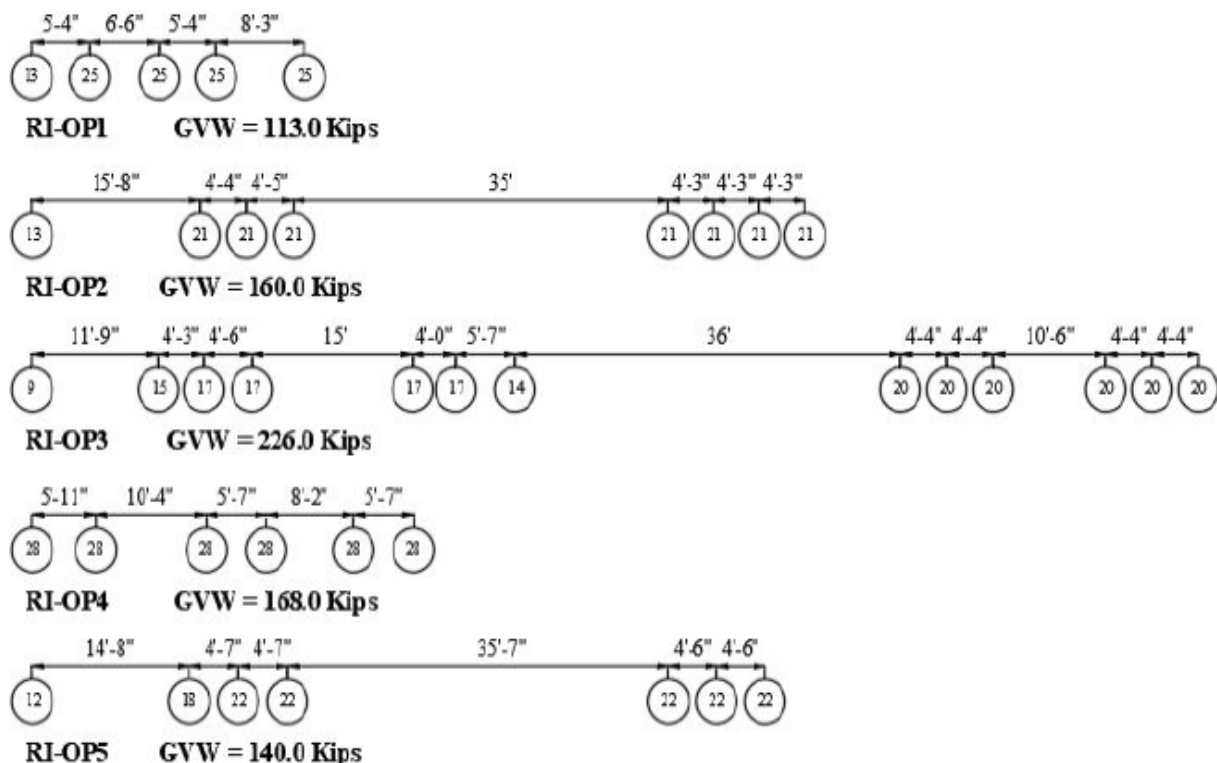
Permits for special or limited crossings are for one-way or round-trip movement of overweight vehicles. These permits are valid only for the specific date, time, vehicle, and route designated in the permit. Special trip permit analysis shall be performed for a single lane loading. This is used because these permit loads are infrequent and are likely the only heavy loads on the structure during the crossing. When one-lane LRFD distribution factor is used, the built-in 1.2 multiple-presence factor should be divided out by dividing the computed one-lane distribution factor by 1.2 before using in the permit load rating. The permit vehicle shall be placed laterally on the bridge, within the striped lanes, to produce maximum stresses in the critical member under consideration. In special cases the dynamic load allowance may be neglected provided that the maximum vehicle speed can be reduced to 5 MPH prior to crossing the bridge. The permit load factors shall be in accordance with MBE Table 6A.4.5.4.2a-1. It is noted that unless otherwise requested or justified, the special or limited crossing factors to be used are for the single trip, mixed with traffic.

The special trip vehicles shown below represent the classes of overweight trucks most frequently used to carry loads requiring a single trip permit. These configurations were chosen by reviewing past overweight permit applications received by RIDOT and by comparing the load effects induced by the various truck configurations in each permit class to extract a small number of representative vehicles as standard permits.

For specific special trip permit applications where the truck may not fit the standard permit configurations, the actual truck configuration described in the permit shall be the live load used to analyze all pertinent structures and may be requested by RIDOT. In the future, RIDOT may define additional special trip permit vehicles based upon the frequency of such permits and their potential to induce load effects outside the envelope of the other standard permit vehicles.

Special trip permit load analysis assumes only one permit load on the bridge, which allows the use of the single-lane distribution. For special trip permit vehicles, it is important to note that the vehicle could traverse the bridge in any lane, making it necessary to investigate whether the exterior or interior girder controls the load rating.

The following special trip permit vehicles shall be analyzed for each bridge:



4.4.1.4 Service and Fatigue Live Load Ratings

Strength is the primary basis for evaluation. The focus of serviceability checks is to identify and control live load effects that could potentially damage the bridge structure and impair its serviceability and service life. Evaluation of service and fatigue limit states shall be included per the guidelines herein.

The service and fatigue limit states and load factors shall be in accordance with MBE Table 6A.4.2.2-1 and the following:

4.4.1.4.1 Steel Bridges

In situations where fatigue-prone details are present (category C or lower, excluding C'), fatigue shall be computed. Fatigue is not required for shear connectors. The fatigue serviceability index or infinite life shall be documented on the Summary of Bridge Rating Sheet in the Load Rating Report.

4.5 Bridges with Low Rating Factors (Below Statutory)

As previously stated, load ratings are performed to ensure bridge safety, to comply with federal regulations, to assist with determining needs for bridge replacement or rehabilitation, to determine needs for posting,

and to assist with the processing of overload permits. For these reasons, it is very important that accurate load rating results are reported. The safety of the public is of paramount importance, but overly conservative assumptions and methods can also adversely impact the public, emergency vehicles, businesses, etc. The intent of this provision is to make sure we have the most accurate load rating possible for a bridge.

In cases where any rating factor for the AASHTO legal loads is below 1.0, the load rater shall thoroughly review the assumptions used in the rating to ensure that assumptions have not led to overly conservative ratings. Bridges with low rating factors will always require further review and possible refinements to arrive at the most accurate rating factors for a bridge. Bridges that exhibit insufficient capacity when analyzed by approximate methods may be analyzed by refined methods of analysis as described in LRFD Article 4.6.3. Furthermore, bridges may be evaluated for load testing if the evaluator believes that analytical procedures do not accurately represent the true behavior and load distribution of the structure. Please note that no refined analysis or load test shall be performed without prior approval from the Department.

For structures that carry primary permit routes, a special analysis shall be conducted for any permit load model that does not pass the LRFR load rating analysis. The special analysis shall investigate various options that may allow permit loads to safely cross the bridge, such as reducing speed, restricting travel to a specific lane, etc. The load rater shall coordinate with the Bridge Ratings Section for these cases.

No final load rating report shall be submitted to the Department until all assumptions and analysis methods have been thoroughly evaluated and reviewed with RIDOT. Therefore, before submitting a load rating report with low rating factors, the load rater shall contact the RIDOT Bridge Rating Section to discuss all assumptions and methods prior to submitting the official report.

5. CONCRETE STRUCTURES

5.1 Materials

- MBE Table 6A.5.2.2-1, Yield Strength of Reinforcing Steel, shall only be used when the yield strength is not available from bridge construction or design records. Every effort shall be made to obtain the bridge records and design information first before using the MBE Table.

5.2 Assumptions for Load Rating

- For any concrete slab or T-Beam superstructure not designed by LRFD, the rating method shall be a refined method of analysis. However, if the existing load rating report on file has been completed using traditional methods and there is no reduction in capacity when compared to the previous load rating, it is permissible to use the traditional method of analysis.

5.3 Shear

- Per the MBE 6A.5.8, “In-service concrete bridges that show no visible signs of shear distress need not be checked for shear when rating for the design or legal loads.” However, any visible signs of shear distress require shear analysis per the MBE. It is noted that while shear does not need to be checked per the MBE when there is no sign of shear distress, the load rater shall include the shear results in the Appendix of the load rating report for informational purposes only.
- For non-prestressed members, the Simplified Procedure as described in LRFD Article 5.7.3.4.1 may be used. However, if the rating factors are below previous values or less than 1.0 for AASHTO legal loads, then the General Procedure in LRFD Article 5.7.3.4.2 shall be evaluated.

5.4 Unknown Structural Components

As stated in section MBE 6.1.4-Bridges with Unknown Structural Components, the following shall be considered:

“For bridges where necessary details, such as reinforcement in a concrete bridge, are not available from plans and field measurements, a physical inspection of the bridge by a qualified inspector and evaluation by a qualified engineer may be sufficient to establish an approximate load rating based on rational criteria. Load tests may be helpful in establishing the safe load capacity for such structures.”

“A concrete bridge or concrete bridge length culvert with unknown details need not be posted for restricted loading if it has been carrying normal traffic for an appreciable period and shows no distress. The bridge shall be inspected regularly to verify satisfactory performance.”

The design year, bridge condition, and knowledge of the live load can be useful to provide a basis for assigning a safe load capacity. In some cases, RIDOT will request material sampling and testing and/or load test for such structures.

5.5 Prestressed Concrete Structures

- Prestress losses shall be computed using the AASHTO Approximate method for composite structures. If any rating factor for the AASHTO Legal Loads is below 1.0 using this method, then the AASHTO Refined Method shall be used as applicable. Assume the following values if actual values cannot be obtained:
 - Service life: 75 years
 - Transfer time: 24 hours
 - Age at time of deck placement: 28 days
 - Humidity: 80%
- Any exposed prestressing strands shall be considered effective if only minor surface rust is present.
- Any exposed prestressing strand with deterioration and section loss, separation, or fracture shall be discounted from the analysis as appropriate. It is noted there are several typical methods for determining strand loss due to deterioration and the load rater shall fully document the assumptions in the analysis.

5.6 Continuity Diaphragms

- Any concrete structure which meets the requirements of LRFD Article 5.12.3.3 to make simple span precast members act as continuous can be analyzed as such. If the age of the girder when continuity was established is not clearly specified but the structure was clearly designed to be made continuous, that girder shall still be analyzed as continuous for live load.

5.7 NEXT Beams

- Distribution factors for NEXT beams should follow the guidance provided on PCI Northeast website.

6. STEEL STRUCTURES

6.1 Analysis

- Plastic analysis for bridges not designed by LRFD is permitted based on the judgement of the load rater. This option can be toggled within the control options of BrR.

6.2 Materials

- MBE Table 6A.6.2.1-1, “The Minimum Mechanical Properties of Structural Steel by Year”, shall only be used when the minimum yield and tensile strength is not available from bridge construction or design records. Every effort shall be made to obtain the bridge records and design information first before using the MBE Table. In some cases, material sampling such as coupon tests, may be required with approval from the Department.

6.3 Deteriorated Members

- The guidelines in MBE Section C6A.6.5 shall be followed when evaluating deteriorated members. It is important to note that sound engineering judgement shall be used when evaluating such members in addition to the MBE guidelines. The method of analysis for the reduced section and the amount of deterioration shall be clearly documented. The deterioration shall be based on actual field measurements from either the latest inspection report or site visit. Consult with the RIDOT Bridge Ratings Section for further clarification if needed.

6.4 Beam End Deterioration

The following guidelines shall be followed when analyzing localized beam end deterioration. Please note the shear capacity of the web in the beam end shall always be rated. These are general guidelines only and the presence of localized holes may require local analysis of stresses. The load rater shall make the appropriate determination of the required level of analysis based on the condition.

Definition of section losses below are included in the RIBIM Section 6.4.

6.4.1 Beam End Deterioration Cases

- **Case I – Stiffened or Unstiffened with Minor Section Losses:** This case applies to full height stiffeners or plates with no section loss, or minor section losses. This case also applies to unstiffened webs with no section loss or minor section losses:
 - No analysis is required. However, the axial resistance of the stiffener may be performed based on the discretion of the load rater.
- **Case II – Stiffened or Unstiffened with Moderate or Significant Section Losses:** This case applies to full height stiffeners or partial height plates with moderate to significant section losses (i.e. full width deterioration across stiffener/plate):
 - If the height of the intact stiffener or plate extends a minimum of $0.75 \times$ depth of the web per guidance in AISC Engineering Journal, Volume 52, No. 4 article titled *Crippling of Webs with Partial-Depth Stiffeners under Patch Loading*, the web is considered stiffened and the following shall be performed:

- For a full height plate, check the axial resistance of this plate. If all legal and permit load models pass, no further action is required. If any legal or permit rating factor is less than 1.0, refer to the next bullet.
 - Web is susceptible to yielding and web yielding shall be checked at the Strength Limit State.
- If the height of the stiffener/plate does not meet the condition above for a stiffened web, the web is considered unstiffened and the following shall be performed:
 - Check web crippling and web yielding at the Strength Limit State.
- **Case III – Unstiffened with Moderate or Significant Section Losses:** This case applies to webs that have no stiffeners or plates and exhibit moderate to significant section losses.
 - Check web crippling and web yielding the Strength Limit State.

6.4.1.1 Analysis Criteria

- For web yielding analysis, evaluate based on the following:
 - The distance of “k”, as referenced in LRFD D6.5.2-3, shall be taken as the thickness of the bottom flange when the bottom of the web exhibits significant deterioration.
 - The web thickness shall be the average web thickness along the base of the web within the zone of $N+2*2.5k$, but this zone shall not exceed the distance from the back face of the bearing to the end of the beam (beam overhang). Documentation of the average web thickness for web yielding calculations shall be provided. Refer to *Figure 4 - Determination of Average Web Thickness for Deteriorated Web Bottom*
- For web crippling analysis, evaluate based on the following:
 - The web thickness shall be the average web thickness along the thinnest portion of web within the “N” portion of the web above the bearing as shown in *Figure 4 - Determination of Average Web Thickness for Deteriorated Web Bottom*. Typically, this will be along the base of the web. Documentation of the average web thickness for web crippling calculations shall be provided.
- For axial resistance of bearing stiffeners, the resistance of the column section shall be based on the effective section per LRFD 6.10.11.2.4b.
- Axial resistance of the stiffener, bearing resistance, web crippling, and web yielding shall be evaluated for the design, AASHTO, and permit load vehicles. To save analysis time, if the HL-93 (Design Load) rating factor at the Inventory level is above 1.0 then no rating factors are required to be calculated for the AASHTO legal vehicles. However, the permit vehicles shall still be evaluated.

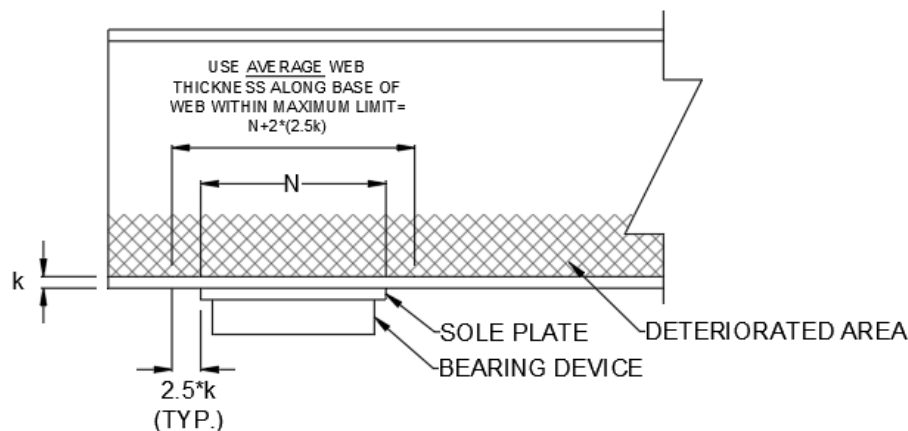


Figure 4 - Determination of Average Web Thickness for Deteriorated Web Bottom

6.4.1.2 Reporting Criteria

- If the bridge contains deteriorated bearing stiffeners or connection plates modeled as bearing stiffeners, the higher resistance of either the axial resistance of the stiffener, web yielding, or web crippling shall be the beam end capacity. Please note that web crippling can be excluded if the conditions in Section 6.4.1 (Case II-1st bullet) are satisfied.
- The results of the bearing (axial resistance of the stiffener), web crippling, and web yielding analysis shall be tabularized and included within the *Breakdown of Bridge Rating* of the report. However, only the results of the permit vehicles shall be reported as the governing rating factor in the *Summary Sheet*.
- In the report *Summary Sheet*, the checkbox for the flag for bearing, web crippling, and web yielding shall be checked if any AASHTO legal vehicle rating factor is <1.0. However, this shall not be reported as the governing rating factor. Any flagged bridge will be monitored at a reduced inspection frequency as determined by RIDOT and/or repaired but will only be posted at the discretion of the RIDOT on a case-by-case basis.

6.5 I-Sections

6.5.1 General

- The provisions of LRFD Appendix A6 shall apply for flexural resistance of straight composite I-sections in negative flexure and straight non-composite I-sections with compact or non-compact webs so long as the requirements set forth in LRFD Article A6.1 are satisfied. This option can be toggled within BrR.
- The provisions of LRFD Appendix B6 shall apply for moment redistribution from interior-pier I sections in straight continuous span bridges so long as the requirements of LRFD Article B6.2 are satisfied. This option can be toggled within BrR.

6.5.2 Non-composite Sections/Partially Composite Sections/Sections with Unknown or No Shear Connectors

- The compression flanges of sections where the deck is not connected to the steel section by shear connectors shall be considered adequately braced by the concrete deck in positive flexure where the

girder is in full contact with the deck and there are no signs of cracking, heavy rust, or separation along the top flange/concrete deck interface.

- For bridges with no shear connectors, partial composite action shall be considered based on the guidelines below.
- Determine if composite action exists based on the guidelines from *NCHRP Research Results Digest, November 1998-Number 234, Manual for Bridge Rating Through Load Testing*.
 - For girders where there is an observed break in the bond between the top flange and the concrete deck, the capacity shall be determined as though it is non-composite.
 - For steel I-sections in flexure with concrete decks and unknown composite action, the I-section shall initially be assumed to be non-composite. If any rating factor for the AASHTO Legal Loads is below 1.0, then the section shall be evaluated as a composite section without shear connectors if there are no signs of distress along the top flange/concrete deck slab interface that would indicate a lack of composite action. If the top flange is not partially or fully encased in concrete, use a maximum interface shear stress across the top steel flange of 70 psi. If the top flange is at least partially embedded in concrete use 100 psi.

6.5.3 Longitudinal Deck Reinforcement

- Longitudinal reinforcement in the deck slab may be neglected in the negative moment capacity analysis over the pier. However, if any rating factor is below 1.0, the longitudinal reinforcement shall be included.

6.5.4 Connections

- Field splices shall be rated if the splice is part of a fracture critical member, if section loss is present, or if any slip is observed in the connection.
- Connection plates of any floor system superstructure primary members shall only be load rated if section loss is present.
- Gusset plates shall be analyzed in accordance with MBE Article 6A.6.12.6.

7. TIMBER STRUCTURES

7.1 Materials

- If the species and/or grade of lumber cannot be determined from the existing plans or field assessment, assume Southern Pine No. 1.

7.2 Resistance Factors

7.2.1 Wet Service Factor, C_M

Wet conditions shall be used in the analysis.

8. PRE-ENGINEERED ARCHES OR FRAMES

When load rating pre-engineered arches or frames, the load rater shall be aware that the design may have incorporated the soil/arch interaction to reduce the forces in the arch. The soil/arch interaction shall be considered in the analysis.

The load rater shall consider the design load of the system when performing an evaluation. If the rating factors appear low based on the design load, further investigation and validation of assumptions shall be carefully examined prior to submitting a report to RIDOT.

9. MASONRY ARCHES

Masonry arches shall be load rated in ASR, in accordance with MBE Article 6A.9.1 unless dictated otherwise by RIDOT.

10. BURIED STRUCTURES

10.1 Structural Analysis

Refer to MBE 6A.5.12.10.3a for analysis of buried structures.

11. POSTING OF BRIDGES

NBIS regulations (23 CFR Part 650) require each bridge to be rated as to its safe load-carrying capacity in accordance with the MBE (incorporated by reference, see §650.317). Posting or restricting the bridge shall be in accordance with the MBE or in accordance with State law, whenever the maximum unrestricted legal loads or State routine permit loads exceed that allowed under the operating rating or equivalent rating factor. Load Raters/Load Rating Engineers will make load posting recommendations to RIDOT based on the load rating analysis. RIDOT is the responsible authority to make the posting decision and holds the responsibility for implementing the load posting decision in accordance with State law and the NBIS. The FHWA Division Office will be consulted, if required, in this decision-making process. Bridge postings are tracked within the RIDOT load rating tracking database and FHWA will be informed of bridge postings as required. The load rating tracking database is the primary RIDOT tool to track the status and dates of all load rating reports, pending posting sign actions, and posting sign field installations. Posting sign actions are reviewed and followed-up weekly. The timeline for completed posting sign actions will be in accordance with 23 CFR § 650.317(l) *Load posting*. Bridge closure shall be in accordance with 23 CFR § 650.317(m) *Closed bridges*.

All posting decisions must be based on the results of a current field inspection and load rating. Authority to post or close a bridge is maintained by the bridge owner, conforming to local regulations or policy, within the limits established by the MBE.

The fatigue and service III limit state (except concrete segmental bridges) will not dictate a bridge posting.

11.1 Potential Bridges Requiring Posting

Prior to submitting a load rating report with a recommendation for posting, the following shall be investigated:

- The load rater shall explore all assumptions used in the analysis and analysis methods in accordance with Section 4.5 of these guidelines. No final load rating report shall be submitted until this is completed.
- The load rater shall evaluate the bridge to see if a traffic restriction (i.e., barrier) can be reasonably implemented to restrict traffic and eliminate the need for a bridge posting. If it is not feasible, the bridge will have to be posted in accordance with Section 11.2. For bridges with a traffic restriction, the

rating factors in the “Summary of Bridge Rating” of the report shall be based on the portion of the bridge that is open to traffic.

- A concrete bridge with unknown details need not be posted for restricted loading if it has been carrying normal traffic and shows no distress. Refer to Section 1.11.

11.2 Bridges Requiring Posting

For any bridge that requires a posting after investigating Section 11.1, the following shall apply:

- Any strength or applicable service limit legal load rating factors below statutory will require a bridge posting for the appropriate values. The appropriate values will be determined by the owner in consideration of the load rating, bridge condition, etc. While the safe posting load formula in MBE Section 6A.8.3 can be a useful tool to aid the bridge owner, this formula will not be used to compute the bridge posting values in RI.
- Bridges not capable of carrying 3 tons for any AASHTO Legal Load as specified in Section 4.4.1.2 will be closed.

12. QUALITY CONTROL AND QUALITY ASSURANCE REVIEW OF LOAD RATINGS AND POSTINGS

The load rater shall refer to MBE Section 1.4, the applicable portions of RI Bridge Inspection Manual Chapter 5, and the guidelines below:

12.1 Quality Control of Load Ratings

Quality control procedures are intended to maintain the quality of the bridge load ratings and are usually performed continuously within organizations. The consultant shall have quality control procedures in place to assure the accuracy and completeness of all load ratings in addition to these guidelines. As part of the quality control process, all load rating calculations shall be independently checked as detailed in Section 1.9.

When software programs are used, the load rater shall perform independent spot checks to validate the accuracy of the load rating results generated by the software. The reviewer shall verify all input data, verify that the summary of load capacity information accurately reflects the analysis, and be satisfied with the accuracy and suitability of the software.

12.2 Quality Assurance of Load Ratings

Quality assurance procedures are used to verify the adequacy of the quality control procedures to meet or exceed the standards established by the agency or the consultant performing the load ratings. Quality assurance procedures are usually performed independent of the load rating teams on a sample of their work. Guidance on quality measures for load rating may be found in MBE Section 1.4.

12.3 Quality Control/Quality Assurance of Load Postings

Verification of the posting (or non-posting) shall be confirmed during bridge inspections. Bridge inspection teams shall verify the load posting signs during any routine, special, or fracture critical inspection.

13. LOAD RATING DELIVERABLES

13.1 Load Rating Report

The load rating report shall be a comprehensive report that facilitates the review and ease of updating in the future. The load rating report deliverables shall consist of an Adobe PDF Version (PDF), as detailed in the subsequent sections. All load ratings shall be submitted electronically using the RIDOT Bridge Ratings Section SharePoint site.

The RIDOT logo shall be used on all report narrative sheets.

The load rating report shall be composed of the following sections and ordered as outlined below.

13.1.1 Report Cover

The report cover contains all pertinent bridge information and shall be stamped by the load rater of record per Section 1.9.1.

Report Covers shall be color coded in the following manner:

Red Cover: Any AASHTO legal load rating (H-20, Type 3, Type 3S2, Type 3-3, SU4, SU5, SU6, SU7, EV2, and EV3) is 10 tons or less. Please note the RIPTA bus shall not affect the color of the cover.

Yellow Cover: Any AASHTO legal load rating of more than 10 tons but less than statutory

Green Cover: All AASHTO legal load ratings are above statutory.

Refer to Appendix A for sample.

13.1.2 Index

The index shall list all major sections within the report with page numbers. Description of what documents are included within each section should be provided.

13.1.3 Summary of Bridge Rating

The Summary of Bridge Rating shall contain a tabular listing of all controlling load rating values, condition factor, system factor, surface roughness, ADTT, QA/QC, and other specific criteria. For each truck, only the governing rating factor for the controlling limit state shall be provided with the appropriate tonnage. The template for this sheet is available from RIDOT in Microsoft Excel.

For the QA/QC box on this sheet, the requirements for the load rating team are detailed in Section 1.9.

Refer to Appendix A for sample.

13.1.4 Breakdown of Bridge Rating

The Breakdown of Bridge Rating shall contain tabular listings of ratings of applicable bridge elements at all critical locations. Separate sheets are required for the Legal and Permit loads. At a minimum, if all legal load rating factors are above 1.0 then the controlling interior and exterior beam for moment and shear for the controlling limit state shall be included within the breakdown. Should any legal load rating factor be less than 1.0, in addition to the above, all locations with a rating factor below 1.0 shall be reported in this

breakdown. This is important as exact locations with rating factors below 1.0 are needed to program future repairs or rehabilitation. In addition to the rating factors, the tonnage values shall be included within this table. For BrR ratings, the output files shall contain the breakdown for all limit states.

Any questions regarding the above shall be directed to the RIDOT Bridge Rating Section.

Refer to Appendix A for sample.

13.1.5 Location Map

A color location map showing sufficient landmarks and roadway information to allow user to easily locate and identify the structure. A callout with the bridge number, route carried, crossing, and municipality shall be provided on this map.

13.1.6 Description of Bridge

A tabular listing of all pertinent bridge information shall be provided.

Refer to Appendix A for sample.

13.1.7 Rating Analysis Assumptions & Criteria

A narrative description of the methods, assumptions, material properties, and standards used in the analysis. The following elements shall be included within this section:

- Listing of applicable Standards.
- Brief scope of work for the load rating.
- Reference to the software used in the analysis and the applicable version.
- Pertinent assumptions such as, but not limited to:
 - Limit states analyzed
 - Summary of superstructure configuration
 - Material properties used in the analysis with appropriate backup as applicable.
 - Depth of fill / wearing surface thickness
 - Surface Roughness / Dynamic Load Allowance
 - Method of live load distribution factors (i.e., computed by BrR, hand computations, etc.)
 - Resistance factors and load modifiers
 - Factors used in rating equation
 - Superstructure modeling method
 - “Control Options” toggled in BrR.
 - Method of superimposed dead load distribution for each component
 - Discussion of how each dead load was applied in the analysis and breakdown of which dead loads constitute DC1, DC2, etc. This discussion shall clearly explain how the dead loads were computed and where they are located within the output.
 - List of all beam ends analyzed and beam ends not analyzed with reason for not analyzing.
 - Table of fatigue prone details that are C or lower (excluding C’).
 - Pedestrian live load (if applicable)
 - Live loads used in the analysis

13.1.8 Evaluation & Recommendations

A summary of the controlling elements of the structure and recommendations to either improve or maintain the condition of the structure. Also, include a discussion of fatigue life for steel structures, and a comparison of the current results to the previous load rating.

13.1.9 References & Available Plans

A list of all references used for the load rating of the structure such as plans, shop drawings, design calculations, specifications, manuals, previous load rating, computer software/version, etc. shall be provided. In addition, the following shall be included:

13.1.9.1 Orientation Plan / Orientation Section View

The bridge orientation plan and section view showing appropriate beam labels/orientation shall be included. The orientation shall match the orientation in the inspection report rather than the design plans. For bridges where there is inconsistent orientation between previous inspection and/or load rating reports, use the orientation in the current inspection report but provide cross reference to the other labeling system for ease of review and comparison.

13.1.9.2 Applicable Existing Plans

Provide copies of only the cover sheet and relevant plan sheets used for the analysis within this section as reference. A complete set of plans does not need to be included within the body of the report. The intent of this provision is to have the relevant sheets used in the analysis on-hand for review and/or future revisions. Sheets such as the general plan, framing plan, cross section, beam details, connection details, etc. are considered the relevant sheets. It is not necessary to include the complete plan set within the load rating report. Only include the complete set of plans as a backup file with the report.

13.1.10 Truck Loadings

A graphical configuration of all truck loadings used in the analysis shall be provided.

13.1.11 Agreement of Independent Reviewer

An independent review is required for all RIDOT load ratings as part of the QA/QC process. Provide a signed/dated statement such as “I hereby state that all assumptions, hand calculations, and software inputs have been verified for accuracy for the load rating of Bridge No. XXX”.

Refer to Appendix A for sample.

13.1.12 Appendix A (Inspection Report)

Provide a blue divider for this section.

The narrative portion of the bridge inspection report which the load rating is based upon shall be provided.

13.1.13 Appendix B (Photographs)

Provide a blue divider for this section.

The appropriate number of color photographs of the bridge, two photos per sheet, including at a minimum the elevation and approach views, framing views (if it varies, one of each type) and sufficient photos to document the condition of the critical members that govern the load rating to substantiate the assumptions in the calculations shall be provided. The complete set of photos does not need to be included within this section. It is acceptable to provide a statement that “Only applicable inspection photos relevant to this load rating are included within this report. A complete set of photos are included with the bridge inspection report which is separate from this report.”

13.1.14 Appendix C (Computations)

Provide a blue divider for this section.

Provide all backup hand computations, spreadsheets, section loss sheets, sketches, beam end analyses, fatigue evaluation, if necessary, etc. that support the assumptions and inputs used in the analysis. It is noted all raw electronic files used for the analysis shall be submitted with the load rating report. These files are needed to edit/update future load ratings.

13.1.15 Appendix D (Computer Input & Output)

Provide a blue divider for this section.

The following shall be provided:

- Screenshot of the framing plan.
- Screenshot of the typical section.
- Screenshot of beam(s) configuration.
- Screenshot of analysis results for controlling members.
- Screenshot of dead load moment and shear summary for each controlling member.
- Screenshot of any important parameters used in the analysis (i.e., stress limits of concrete, etc.).
- Screenshot of material properties.
- Screenshot of vehicle library template.
- Screenshot of control options.
- Screenshot of traffic data
- Last page of this section to have statement indicating that input and output files are provided in the PDF version of the report.
- BWS Report for controlling members. At a minimum, the typical interior and exterior member shall be included.
- LRFR Output for controlling members. At a minimum, the typical interior and exterior member shall be included.
- Specification check for load induced fatigue and fatigue serviceability index at the controlling location.
- All other detailed input and output files including specification checks at the controlling location.

13.2 Electronic File Submission

The information below provides the content, layout, and file naming convention of the electronic bridge load rating deliverable. All submissions shall be submitted to the Department’s SharePoint site.

The file structure shall be as follows:

13.2.1 Bridge Folder

The parent folder shall be labeled with the 6-digit bridge number.

13.2.2 Rating Folder

The rating folder shall be the subfolder to the Bridge Folder and be labeled as the MM.DD.YYYY of the rating.



13.2.3 Rating Subfolders

The subfolders to the Rating Folder shall consist of the following:

-
- 1.Inspection Report
 - 2.Existing Plans
 - 3.Calculations
 - 4.Sketches
 - 5.Output
 - 6.Report
 - 7.Other Documents

13.2.3.1 Inspection Report

The PDF version of the inspection report, including photos used in the analysis, shall be included within this folder.

13.2.3.2 Existing Plans

The PDF version of the existing plans shall be included within this folder. If file is too large, include only relevant sheets. If the existing plans are on file for a previous rating, please omit from this submittal but provide a document within this folder referencing the load rating report which contains the existing plans.

13.2.3.3 Calculations

The calculations folder shall consist of the following subfolders and contain all raw (original) data files for future editing:

- Beam End Analysis
- Dead Loads
- Distribution Factors
- Section Loss Calculations
- Section Properties
- z_Other

13.2.3.4 Sketches

All raw data files for sketches, as well as PDF, shall be included.


13.2.3.5 Output

The output folder shall consist of the following subfolders and contain the applicable output files. If using other software programs, it is acceptable to modify the contents and names of the folders below. The AASHTOWare BrR output file can be placed in the “Model Files” subfolder.

- BrR-BWS Reports
- BrR-LRFR Reports
- BrR-Specification Checks
- Model Files
- Other

13.2.3.6 Report

A PDF version of the report shall be included in this folder. The report shall be labeled using the format LRR_YYYY_MM_DD_Six-digit-Bridge-Number. Refer to example below:

 LRR_2021_01_22_030751

13.2.3.7 Other Documents

Any other supporting documents not included elsewhere in this folder shall be included.

13.3 Consultant QA Checklist

The consultant shall prepare and submit the *Consultant Load Rating QA Checklist* with the load rating report. This checklist can be obtained from RIDOT and shall be placed in the parent electronic load rating folder.

14. AASHTOWare BrR GUIDELINES FOR RATINGS

This section is intended to provide useful general program notes specific to RIDOT to develop consistent and reproducible files for future updating. The following sections are organized in a similar manner to the BrR tree layout. For sections of BrR not covered below, the parameters are left to the discretion of the load rater.

14.1 BrR Updates

Load raters are responsible to check the BrR website for software updates, support, and frequently asked questions to ensure accuracy of results prior to submitting a Load Rating Report

14.2 File Naming

All BrR files require two unique identifiers, a Bridge ID and a NBI Structure ID. The Bridge ID shall be the six-digit bridge number and the NBI Structure ID shall be the six-digit bridge number with nine (9) zeros placed in front as follows:

- Six-digit bridge number: 030701
- NBI Structure ID: 000000000030701

The BrR .xml file name shall be the six-digit bridge number.

14.3 General Modeling

- In general, GIRDER SYSTEM is preferred. For large bridges or bridge with complicated framing, it is acceptable to use GIRDER LINE for the appropriate girders. Regardless, all detailed backup dead load calculations used in the model load shall be provided in their original data file format.

14.4 Dead Load Distribution Methods

There are two options to apply superimposed dead load to the structure. Either method is acceptable but for consistency with load ratings please follow one of the two methods below:

14.4.1 Option 1

- Set the SUPERSTRUCTURE LOADS / DL DISTRIBUTION / STAGE 2 to user-defined. The user can input the appropriate dead load values for each member within the MEMBER ALTERNATIVE using the MEMBER LOADS window. Note that for cases where the wearing surface is inputted using the STRUCTURE TYPICAL SECTION / WEARING SURFACE tab, setting the DL distribution to USER DEFINED will cause BrR to ignore any wearing surface dead load information. Therefore, the user must manually compute the wearing surface dead load per member and input the appropriate values in the MEMBER LOADS window. All backup calculations for these member loads must be provided as part of the load rating deliverables.

14.4.2 Option 2

- Maintain the default setting in BrR of SUPERSTRUCTURE LOADS / DL DISTRIBUTION / STAGE 2 DL DISTRIBUTION / UNIFORMLY TO ALL GIRDERS. This will allow the wearing surface to be computed using the input provided in the STRUCTURE TYPICAL SECTION / WEARING SURFACE tab. However, the user must change the unit weight for any APPURTENANCES to 0.00, and manually compute these values and input using the MEMBER LOADS for each member. This allows the APPURTENANCES to be assigned in the STRUCTURE TYPICAL SECTION and to display in the TYPICAL SECTION SCHEMATIC view. It is suggested the actual geometric values for the APPURTENANCES be input to allow for the correct display in the SCHEMATIC view. This

will help visually confirm the correct cross section. All backup calculations for these member loads must be provided as part of the load rating deliverables.

14.5 Bridge Description

- All tabs shall be completed based on the information from the latest inspection report. RIDOT does not use the Custom Agency Fields.
- In the bridge description text box, include the date of the load rating, consultant name and load rater, and any special instructions that would be helpful to future load raters who will update the analysis.
- The Global Reference Point shall be 0.00 for the X and Y coordinates.
- The ADT information shall be from the latest inspection report and the load rater shall assume a 50% directional PCT unless more precise traffic information is available. In cases where fatigue in steel bridges may be a concern more accurate traffic data may be available from RIDOT.
- For fatigue calculations to perform properly, the estimated annual traffic growth rate must be entered. By default, this value shall be 1.00% (0.01) in the absence of more precise information.

14.6 Materials

- The material properties shall match the design data shown on the existing plans. If material properties are not available in the BrR standard library, the load rater shall enter the appropriate information for each material based the properties obtained from the design plans or other design information for the bridge. The name and description in BrR shall match the design information for consistency.

14.7 Beam Shapes

- Member shapes can often be selected from the BrR library of shapes; however, the load rater should review the member dimensions and properties to ensure they match the bridge plans or previous rating calculations. Older shapes may require manual input of the member properties. Should that be the case, the appropriate backup calculations and raw electronic file (if applicable) shall be provided as part of the load rating deliverables.

14.8 Appurtenances

- The use of appurtenances is permitted as it allows the correct display in the schematic window to help visually confirm the cross section. It is noted that appurtenances will not always be appropriate for all bridges, but its use can be helpful when applicable.

14.9 Superstructure Definition

- The superstructure definition name at a minimum shall contain the bridge number and span number. For example, “XXX-Span 1.”
- Spans shall be labeled in accordance with the bridge inspection report, not the design plans. Cross referencing of the inspection label vs the design plan label using parenthesis after the member name is useful for referencing purposes. For example, in the Member Alternative, “Beam A (Beam No. 10).”
- The Description tab shall contain any useful notes helpful to future load raters such as the date of the load rating; name of individual who prepared the BrR file; any unique assumptions or workarounds used in BrR to help future load raters update the analysis; any other pertinent information the load rater believes is useful to future load raters.

14.9.1 Load Case Description

The default load cases of DC1, DC2, and DW shall be used to describe the dead loads. Please note the backup calculations for these loads shall be provided within the load rating deliverables.

14.9.2 Framing Plan Detail

- Diaphragm dead load shall be computed by the load rater and entered within the FRAMING PLAN DETAIL.

14.9.3 Structure Typical Section

- The wearing surface thickness field measured box shall be checked when the curb reveal is measured and the original curb reveal is known from the existing plans. Also, the load case shall be DW.

14.9.4 Shear Connector Definitions

- It is not necessary to enter the shear connectors into BrR for the purposes of a load rating. However, the presence of shear connectors must be acknowledged (under MEMBER ALTERNATIVE /DECK PROFILE / SHEAR CONNECTORS) for composite action to be considered by BrR.

14.10 Member Loads

- Additional dead loads (transverse stiffeners, longitudinal stiffeners, utilities, etc.) shall be input as a MEMBER LOAD for a uniform load. It is noted BrR does not compute stiffener dead loads even when they are user-defined within BrR.

14.11 Member Alternatives

14.11.1 General

- Members shall be labeled in accordance with the bridge inspection report, not the design plans. Cross referencing using parenthesis after the member name is useful for referencing purposes. Also note as-built or as-inspected in the name.
- For all LRFR load ratings, the load rater shall select the most current “Spec Version” unless otherwise directed by RIDOT.
- When incorporating section losses into the BrR model, a separate MEMBER ALTERNATIVE for the member that exhibits section loss shall be created for any new inspection. The as-built or previous model shall be maintained. The as-inspected MEMBER ALTERNATIVE shall be set to EXISTING / CURRENT (E) (C) to ensure that any analysis runs from the BRIDGE WORKSPACE or BRIDGE EXPLORER utilizes the as-inspected MEMBER ALTERNATIVE.

14.11.2 Control Options

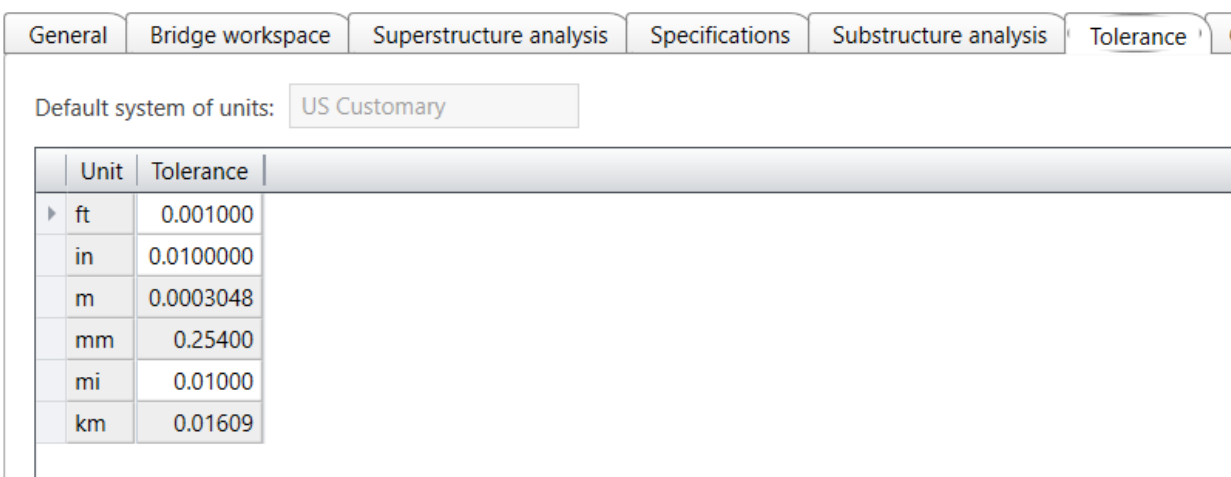
- In CONTROL OPTIONS, load rater shall toggle “Allow Plastic Analysis” when applicable.
- In CONTROL OPTIONS, it is recommended for continuous steel structures exhibiting low rating factors to enable “Use Appendix A6 for Flexural Resistance”. This option will first initiate the specification checks to determine if use of Appendix A6 is permissible as per the specifications.

14.11.3 Live Load Distribution

- Live load distribution factors shall be computed using the “Compute from Typical Section” feature within BrR. If the load rater must manually compute distribution factors, then caution shall be exercised. Any changes to member spacing, beam shape, specifications, or other parameters to compute the live load distribution factors will not allow the program to compute the new live load distribution factors automatically during an analysis event. If the live load distribution factors are manually computed, the load rater must verify the values inputted in BrR prior to running the final analysis.

14.12 BrR Tolerance Settings

- Tolerance settings can be viewed by clicking on the CONFIGURATION BROWSER icon / SYSTEM DEFAULTS / TOLERANCE. The BrR default settings shall be applied. If the load rater is unable to reproduce previous ratings computed using BrR, the tolerance settings should be reviewed.



Unit	Tolerance
ft	0.001000
in	0.0100000
m	0.0003048
mm	0.25400
mi	0.01000
km	0.01609

-

APPENDIX

APPENDIX A-SAMPLE REPORT

Bridge Load Rating

Prepared for

**Rhode Island
Department of Transportation**

[CITY OR TOWN]
[ROUTE CARRIED]
OVER
[CROSSING]

**Bridge No. [BRIDGE NUMBER]
Bridge Name: [BRIDGE NAME]**



Date of Inspection: [DATE]
Date of Rating: [DATE]

LOAD RATER OF RECORD:

[INSERT P.E. STAMP]

Prepared By:
[FIRM OR AGENCY NAME]

Report Cover

SUMMARY OF BRIDGE RATING

Municipality:
Route Carried:
Owner: State
Maintained By: State

Bridge No.:
Crossing:
Year Built:
Year(s) Rebuilt/Rehab:

VEHICLE TYPE		Strength RF	Service RF	Tons
HL-93	INV			
	OPER			
H20				
TYPE 3				
TYPE 3S2				
TYPE 3-3				
LTLLM				
SU 4				
SU 5				
SU 6				
SU 7				
EV 2				
EV 3				
RI 3				
RI 4				
RI 5				
RI 5B				
RI 6				
RI-OP1				
RI-OP2				
RI-OP3				
RI-OP4				
RI-OP5				
Fatigue*				
RIPTA				

Grey shaded vehicle types are considered legal loads.

*Controlling fatigue location only. Other locations not reported in this load rating.

LRFR Evaluation Factors
Surface Roughness Rating: _____
Gov. Condition Factor, Φ_c : _____
System Factor, Φ_s : _____
ADTT (One-Way): _____

Posting Analysis
Posting Recommendation : _____
Gov. Legal Rating Factor: _____
Gov. Legal Load Model: _____

QA/QC
Analysis By: _____
Independent Reviewer: _____
QA By: _____
LR Date: _____

LR = Load Rating ; Gov.=Governing

Please check the following items that apply:

- ☐ Bridge load rating is not governed by deck rating
- ☐ Bridge load rating is not governed by substructure rating
- ☐ Connections do not control the load rating
- ☐ Exterior girder controls the load rating
- ☐ Bridge plans do not exist
- ☐ Load rating based on Inventory Inspection (baseline load rating)
- ☐ Load test performed
- ☐ Refined analysis performed
- ☐ Material testing performed
- ☐ Bridge has infinite fatigue life
- ☐ Bridge has finite fatigue life; Fatigue Serviceability Index is [x]
- ☐ Beam end analysis was performed (bearing, web yielding, and/or web crippling)
- ☐ Flag for bearing / web crippling / web yielding check per RIBLRG Section 6.4.1.2
- ☐ Traffic restriction; reported rating factors for unrestricted portion

Summary of Bridge Rating


BREAKDOWN OF BRIDGE RATING


Town/City:
Route Carried:
Owner:
Maintained By:

Bridge No.:
Crosses:
Year Built:
Year(s) Rebuilt/Rehab:

RATING LOAD (LEGAL LOADS)

BRIDGE COMPONENT	DESIGN LOAD (HL-93)		LEGAL LOAD (TONS / RATING FACTOR)											
	HL-93 INV	HL-93 OPR	The values below are for the controlling limit state force effect and location. Refer to Appendix D for a detailed breakdown of other limits states and force effects.											
			H 20	TYPE 3	TYPE 3S2	TYPE 3-3	L1LLM	SU 4	SU 5	SU 6	SU 7	EV2	EV3	RIPTA
[Element] [Limit State/Force Effect] [Analyzed Location]														
[Element] [Limit State/Force Effect] [Analyzed Location]														
[Element] [Limit State/Force Effect] [Analyzed Location]														
[Element] [Limit State/Force Effect] [Analyzed Location]														
[Element] [Limit State/Force Effect] [Analyzed Location]														

 = Controlling Rating Factor

 = Below Statutory Rating Factor

* Unless Otherwise Noted

Breakdown (Legal Loads)



BREAKDOWN OF BRIDGE RATING

Town/City:
Route Carried:
Owner:
Maintained By:

Bridge No.:
Crosses:
Year Built:
Year(s) Rebuilt/Rehab:

RATING LOAD (PERMIT LOADS)

BRIDGE COMPONENT	PERMIT LOAD (TONS / RATING FACTOR) <i>The values below are for the controlling limit state force effect and location. Refer to Appendix D for a detailed breakdown of other limits states and force effects.</i>									
	RI 3	RI 4	RI 5	RI 5B	RI 6	RI-OP1	RI-OP2	RI-OP3	RI-OP4	RI-OP5
[Element] [Limit State/Force Effect] [Analyzed Location]										
[Element] [Limit State/Force Effect] [Analyzed Location]										
[Element] [Limit State/Force Effect] [Analyzed Location]										
[Element] [Limit State/Force Effect] [Analyzed Location]										

 = Controlling Rating Factor
 = Below Statutory Rating Factor
 * Unless Otherwise Noted

Breakdown (Permit Loads)

DESCRIPTION OF BRIDGE

Bridge Number:
Owner:
Maintained By:
Location:
Route Carried:
Feature Intersected:

YEAR BUILT & INSPECTION DATES

Latest NBI Inspection Date:
Field Verification Date (if applicable):
Date of Construction:
Date(s) of Rebuild/Rehab:
Description of Rebuild/Rehab:

DESIGN:

Original Design Loading:
Bridge Type:
Superstructure:
Substructure:
Bearings:
Bridge Spans: [Total length; Total number of spans; Length of each span]
Bridge Skew:
Bridge Width: [Out-to-out]
Roadway Width: [Curb-to-curb]
Roadway Surface:
Curb Reveal:
Wearing Surface Thickness:
Sidewalk/Walkway/Median:
Utilities:
Bridge Railing:

CONDITION:

Deck NBI Condition Rating: [Provide condition rating and reference Inspection Report]
Superstructure NBI Condition Rating: [Provide condition rating and reference Inspection Report]
Substructure NBI Condition Rating: [Provide condition rating and reference Inspection Report]
Culvert NBI Condition Rating: [Provide condition rating and reference Inspection Report]

Description of Bridge

LOAD RATING REPORT
Bridge No. XXXXXX Route Carried, Town



AGREEMENT OF INDEPENDENT REVIEWER

I hereby state that all assumptions, hand calculations, and software inputs have been verified for accuracy for the load rating of Bridge No. XXXXX.

Date:

XXXXXX

Agreement of Independent Reviewer

APPENDIX B-DESIGN CHECK LOAD RATING GUIDANCE

The guidelines herein are intended to be specific for design check load ratings and supplement the RI Bridge Load Rating Guidelines. For any questions, please contact the RI Bridge Ratings Section.

Objectives:

- Perform a load rating at the 90% design phase of a project as a “design check” for all minor rehabilitation, major rehabilitation, and replacement bridge projects. All trucks identified in Section 4 of the *RI Bridge Load Rating Guidelines* shall have $RFs > 1.0$. This includes separate load ratings for any interim phased portion(s) (new and old) and the completed bridge structure.
- Identify any possible structural concerns affecting capacity discovered through the load rating process.

General:

- All load ratings shall be performed in the latest version of AASHTOWare BrR/BrDr unless it is not suitable for the applicable analysis. It is understood that some bridges may have been designed with refined methods or other software and therefore other programs may be necessary to analyze the bridge. However, BrR/BrDr is our preferred analysis tool and the use of other software shall be approved by the RIDOT Bridge Ratings Section.
- For bridges under phased construction, each traffic phase that is open to traffic shall be analyzed for all AASHTO legal loads and RI permit trucks. This includes both the old and the new portions of superstructures open to traffic for any phase. A separate Summary Sheet shall be included for each phase.

Loads & Factors:

- ADT shall be based on the design plans.
- Dynamic Allowance shall be based on the anticipated wearing surface conditions.
- The condition factor shall be determined based on the anticipated condition.
- The DL distribution for the exterior/interior beams shall be based on the method used in the design calculations.
- The DW factor shall be 1.5 for conservatism.
- The utilities dead loads shall be calculated based on actual loads and not assumed.
- Pedestrian live load application shall be consistent with the design assumptions.

Decks:

- Traditional concrete bridge decks do not need to be analyzed. Other bridge decks shall be discussed with the RIDOT Bridge Ratings Section to determine if analysis is warranted.
- Longitudinal steel in the deck slab shall be included if the design relies upon this steel. If not, it shall be omitted.

Superstructure:

General:

- For composite bridges, the actual size and spacing of shear connectors shall be entered in BrR instead of toggling “composite” for the beam length.

Steel Bridges:

- Perform a beam end analysis on any beam end with 1/16" or greater section loss. For any beam end with a $RF \leq 1.5$ for any AASHTO legal load or RI permit load, the beam end shall be repaired.
- Perform a fatigue analysis and provide the serviceability index for any fatigue prone detail that exhibits inadequate service life for the remaining life of the rehabilitated bridge. Furthermore, a fatigue analysis of the shear connectors shall be included for new superstructures. A tabular summary of all locations that may need to be retrofitted shall be provided within the Conclusions & Recommendations Section of the report.
- Plastic analysis is permitted if the bridge is designed based on plastic analysis.

Concrete Bridges:

- For new prestressed superstructures, Service III shall be included.
- For new RC bridges, shear must be included and not "ignored".
- For prestressed bridges, prestress losses shall be determined based on the design information (if available).

Substructure:

- For any RC pier cap that will remain as part of a superstructure replacement, it shall be analyzed for both legal and permit loads. The intent is to ensure the pier cap is adequate for all AASHTO and RI permit vehicles as specified in Sections 4.4.1.2 and 4.4.1.3.

Report:

- The *Cover Sheet* shall be labelled "DESIGN CHECK LOAD RATING" at the top of the sheet. Below this line, the project name, RIC number, and design submission level shall be listed (i.e. 90% Submission, PS&E Submission).
- The *Appendices* for the inspection report and photos can be omitted considering this is a design check and not an actual load rating report for an in-service bridge.
- The XML file shall be submitted with the report.

[END OF DOCUMENT]