STATE OF RHODE ISLAND
DEPARTMENT OF TRANSPORTATION

BRIDGE LOAD RATING GUIDELINES

August 2017

Contents

LIST OF FIGURES

LIST OF TABLES

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.

Non-NBI: Bridge not subject to the NBIS. This includes bridges with less than 20’ clear span

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

Posting: Signing a bridge for load (weight) restriction for the AASHTO legal loads.

Rating Factor: The ratio of the available capacity to the load produced by the particular 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 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 Transportation Officials
ADTT: Average Daily Truck Traffic
ASR: Allowable Stress Rating
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
RF: Rating Factor
RIBIM: Rhode Island Bridge Inspection Manual
RIDOT: Rhode Island Department of Transportation
SH: Force effects due to shrinkage
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 (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: Clarified 2nd to last paragraph.
- 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 <u>all</u> 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 15)

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 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. This document was developed using the American Association of State Highway Transportation Officials (AASHTO) *Manual for Bridge Evaluation*, 2nd Edition, 2011 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 will apply for Non-NBI structures as well (structure length less than 20').

For non-NBI culverts load ratings are not typically required unless specifically requested by RIDOT. Culverts consist of single cell box culverts, multiple cell box culverts, and three-sided culverts. Other Non-NBI structures will only be load rated on a case by case basis.

1.4 System of Units

The English 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 of construction unless otherwise approved by RIDOT.

1.6.2 Re-rating 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 made a determination 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 both the as-built and as-inspected member properties to serve as a baseline for comparison when feasible. Any questions on this shall be directed to the RIDOT Bridge Rating Section. The as-built capacities shall be summarized in a similar format for as-inspected conditions when reported in the load rating report.

1.6.3 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.
- 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 re-calculations 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. It is noted the most current procedure to evaluate gusset plate ratings from FHWA shall be used. The latest technical guidance can be obtained from FHWA's website.

1.7.3 Substructure

- Timber and metal pier elements.
- Concrete pier caps and bent caps only if condition (deterioration) warrants, at RIDOT's discretion.
- Pier caps or other substructure components with special or unique geometric characteristics.

1.8 Software

Standard analysis tools can maximize efficiency, provide consistency, and also 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***.

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 multistringer/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
- 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 Rater Qualifications and Responsibilities

1.9.1 Qualifications

The load rater is the individual who determines the live-load-carrying capacity of an existing bridge using information contained in the existing bridge plans supplemented by information gathered from the most recent bridge inspection. The load rater is sometimes referred to as a load rating engineer. Consultants and RIDOT are both required to have a load rater meeting the minimum qualifications established in the *Code of Federal Regulations*, Title 23, Part 650, Subpart C, Section 650.309 (23 *CFR* 650.309) and are listed below:

> (c) The individual charged with the overall responsibility for load rating bridges must be a registered Professional Engineer.

Alternatively, the load rating may be performed by an unlicensed engineer and then checked by a registered Professional Engineer meeting the qualifications of the load rater. The qualifications for an unlicensed engineer include a degree in civil or structural engineering and to perform the load rating under the supervision of a registered Professional Engineer. In these cases, the load rater shall sign the Agreement of the Independent Review in the load rating report (refer to Section 13.1.12).

1.9.2 Responsibilities

The load rater 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). The following procedures have been established within the *Code of Federal Regulations*, Title 23, Part 650, Subpart C, Section 650.313 (23 *CFR* 650.313) regarding load rating and are listed below:

> (c) Rate each bridge as to its safe load-carrying capacity in accordance with the AASHTO *Manual for Bridge Evaluation* (incorporated by reference, see §650.317). Post or restrict the bridge in accordance with the AASHTO *Manual for Bridge Evaluation* or in accordance with State law, when the maximum unrestricted legal loads or State routine permit loads exceed that allowed under the operating rating or equivalent rating factor.

The consultant load rater is 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 (refer to Section 11).

The load rating engineer is responsible to provide quality control of all load ratings by having the load rating independently reviewed prior to submittal to the Department (refer to Section 12).

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 Inspection 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. Old construction and material specifications are available for review at RIDOT upon request. 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 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.

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 in order 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 his field review and notes. This rating value shall be documented in the load rating report. Surface Roughness is defined as follows:

Table 1-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 particular 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 past 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.

Material testing shall be in accordance with MBE 6A.5.2.1 unless otherwise approved. Refer to MBE Section 5.3 for detailed information pertaining to material sampling and testing.

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" connections 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 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 value 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 be 7 ½” and any thickness above this amount shall be considered a sacrificial wearing surface unless indicated otherwise on the design plans

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

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 and every effort has been made to determine the utility weight 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 as a last resort.

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.

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 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 MBE6.8.2.3.2 are permitted.

2.2.4 Wind Loads (WL / WS)

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

2.2.5 Temperature Effects, TG and TU

Temperature effects shall not be considered for typical or non-segmental bridges.

2.2.6 Creep and Shrinkage, CR and SH

Creep and shrinkage shall not be considered for typical bridges. For any complex structure, creep and shrinkage effects will be at the discretion of RIDOT.

2.2.7 Dynamic Load Allowance (IM)

For legal and permit vehicle ratings of longitudinal members, having spans greater than 40 ft. with less severe approach and deck surface conditions, the Dynamic Load Allowance (IM) may be decreased from the LRFD design value of 33%, as given below in Table 2-Dynamic Load Allowance for Rating for the Strength and Service limit states. Dynamic load allowance shall be applied to the load rating vehicle models and not to the lane loads. Regardless of riding surface condition, always use 33% for spans 40 ft. or less and for transverse members. Selection of IM shall be in accordance with the requirements of Section 1.10.5. The dynamic load allowance shall not exceed 20% for permit loads above 150,000 lbs., and eliminated entirely for slow moving permit loads (< 5 mph).

Table 2-Dynamic Load Allowance for Rating

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

For concrete arches, rigid frames or slabs 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 model. Typically, 3-D finite element models will more accurately distribute loads and possibly improve the overall rating factor for a particular 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 past 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 past experience with load tests, the load test is unlikely to show an improvement in the load carrying capacity.
- Access difficulties 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

Strength is the primary limit state for load ratings; service and fatigue are selectively applied in accordance with these guidelines and the MBE.

4.2.1 Resistance Factor: ϕ

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

$$C = \phi_c \ \phi_s \ \phi \ Rn$$

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 as follows:

Table 3-Condition Factors

Element Condition State of Member under Consideration	ϕ_c (Estimated Loss)	ϕ_c (Field Measured)
CS 1 or 2	1.00	1.00
CS 3	0.95	1.00
CS 4	0.85	0.90

The Condition Factor ϕ_c does not account for section loss, but is used in addition to section loss. 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 ($\phi_c \leq 1.0$). 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.

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. Also, the condition factors above are based on the element level Condition Rating of the member under consideration rather than the overall bridge NBI Condition Rating. This provision means the poor condition of one member will not reduce the capacity of a similar member that may be in better condition. The load rater is responsible to determine the appropriate condition factor 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: ϕs

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, φ =1.0, φ_c = 1.0, φ_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 4-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. Legal lane loads 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 4-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 (non-segmental)	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.

4.4.1.1 Strength Design Load Rating (HL-93)

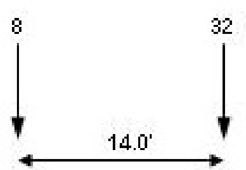
The design-load rating (or HL-93 rating) assesses the performance of existing bridges utilizing the LRFD HL-93 design loading and design standards with dimensions and properties for the bridge in its present as-inspected condition. It is a measure of the performance of existing bridges to new bridge 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).

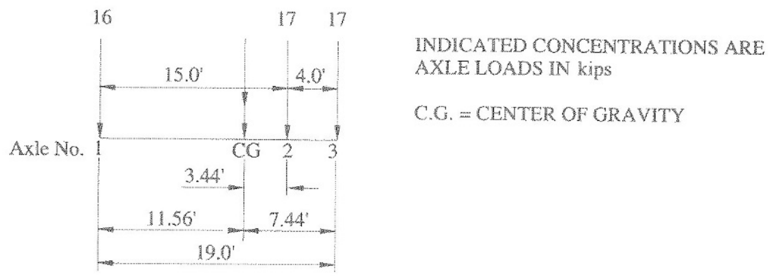
The results of the HL-93 rating are to be reported as a Rating Factor.

4.4.1.2 Strength Legal Load Rating (AASHTO Legal Loads)

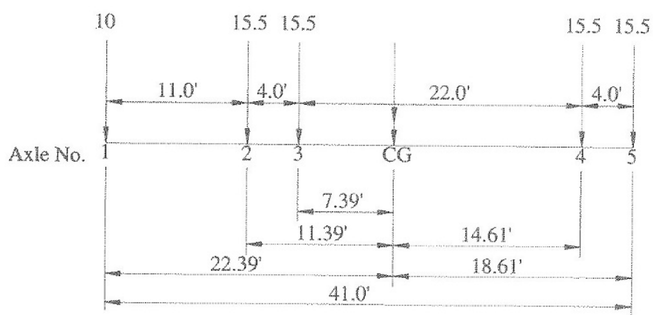
Per the MBE, the following legal loads shall apply for all span lengths and load effects:



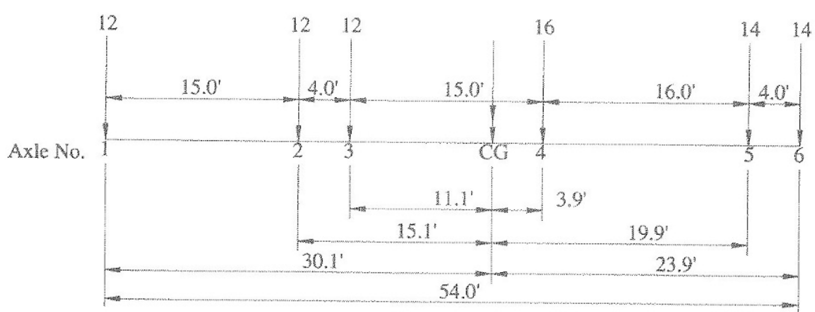
H20
Unit Weight = 40 kips (20 tons).



Type 3 (MBE Figure D6A-1)
Unit Weight = 50 kips (25 tons).

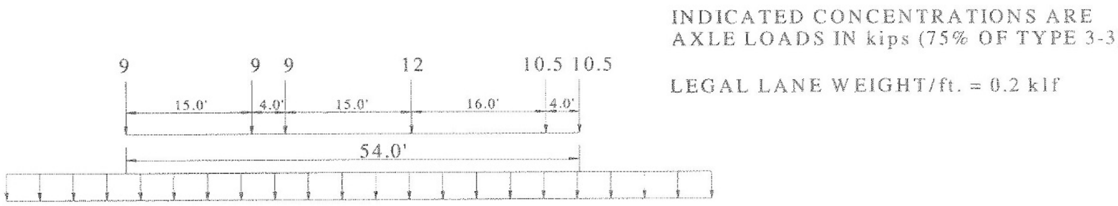


Type 3S2 (MBE Figure D6A-2)
Unit Weight = 72 kips (36 tons).



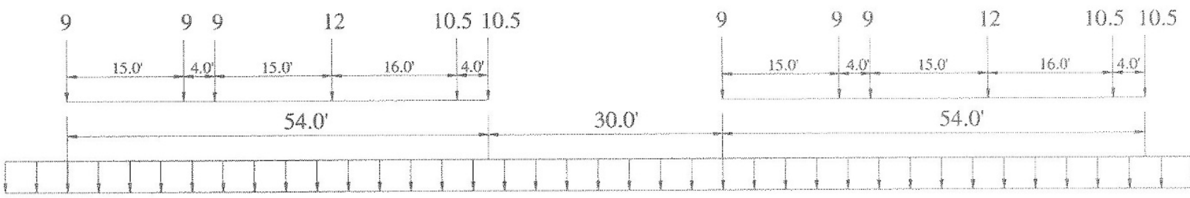
Type 3-3 (MBE Figure D6A-3)
Unit Weight = 80 kips (40 tons).

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

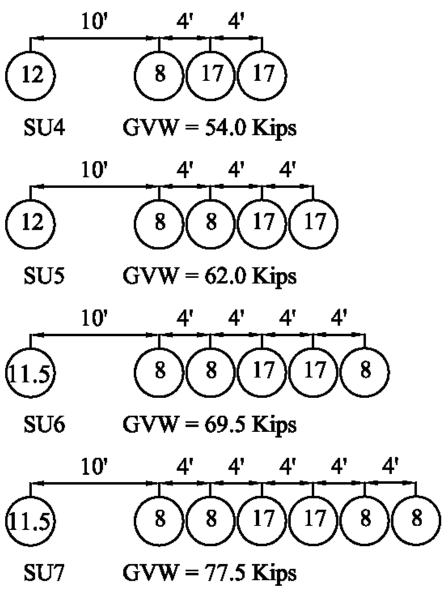


Lane-Type Loading for Spans Greater than 200 feet (MBE Figure D6A-4)

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

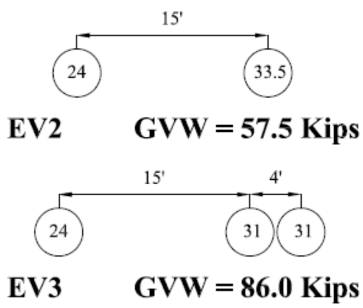


Lane-Type Loading for Negative Moment and Interior Reaction (MBE Figure D6A-5)



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

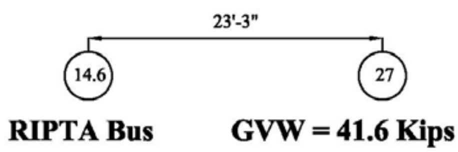
The Fast Act Emergency Vehicles below shall be included in the load rating for all Interstate bridges as well as on/off ramp bridges to/from these highways within reasonable access to the Interstate (approximately one road mile). Interstate bridges within RI include all bridges carrying I-95, I-295, and I-195. For guidance on how to apply these loads please refer to the Questions and Answers-Load Rating for the FAST Act's Emergency Vehicles, March 2017 which can be obtained from FHWA at https://www.fhwa.dot.gov/bridge/loadrating/fast1410_qa.pdf.



FAST Act Emergency Vehicles

<u>RIPTA Bus</u>

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

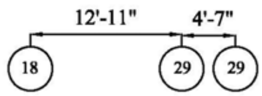
Permit loads shall be evaluated per the subsequent sections:

4.4.1.3.1 Routine or Annual Permits

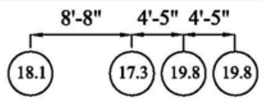
Routine permits are issued by the Rhode Island Department of Motor Vehicles for the movement of specific vehicles per the RI General Laws. Routine permits are usually valid for unlimited trips over a period not to exceed one year. The permit vehicle may mix in the traffic stream and move at normal speeds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

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

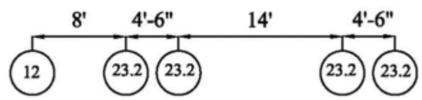
The following routine permit loads shall be analyzed for each bridge:



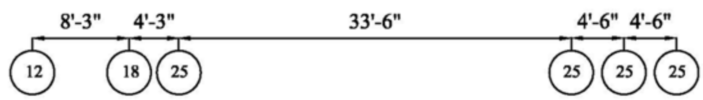
RI 3 (Formerly RI-BP1) GVW = 76.0 Kips



RI 4 (Formerly RI-BP2) GVW = 75.0 Kips



RI 5 (Formerly RI-BP3) GVW = 104.8 Kips



RI 6 (Formerly RI-BP4) GVW = 130.0 Kips

4.4.1.3.2 Special or Limited Crossing 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.

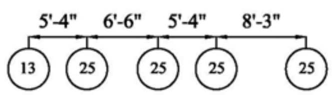
Special or limited crossing permit analysis shall be performed for a single lane loading. This is used because these permit loads are infrequent and are likely the only heavy loads on the structure during the crossing. When one-lane LRFD distribution factor is used, the built-in 1.2 multiple-presence factor should be divided out (That is, divide 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 standard special or limited crossing permit 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 most future permit load investigations, the results of the standard special or limited crossing permit vehicles will provide a sound basis for screening the load for bridge safety without the need for a re-analysis. For specific single 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 standard special or limited crossing 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.

Single trip permit load analysis assumes only one permit load on the bridge, which allows the use of the single-lane distribution. For single 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 standard special or limited crossing permit vehicles shall be analyzed for each bridge:



RI-OP1 **GVW = 113.0 Kips**

RI-OP2 **GVW = 160.0 Kips**

RI-OP3 **GVW = 226.0 Kips**

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) then 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 general public, emergency vehicles, businesses, etc. The intent of this provision is to make sure we have the most accurate load rating possible for a particular 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 particular 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.

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 3-D Finite Element Analysis. However, if the existing load rating report on file has been completed using traditional methods and contains satisfactory rating factors, 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.
- For non-prestressed members, the Simplified Procedure as described in LRFD Article 5.8.3.4.1 may be used. However, if the rating factors are low then the General Procedure in LRFD Article 5.8.3.4.2 shall be evaluated.

5.4 Unknown Reinforcement

As stated in MBE 6.1.4:

"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 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 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." These bridges must be inspected in accordance with NBIS and the RIBIM.

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. It is noted there are several typical methods for determining strand loss due to deterioration and the load rater shall fully document the methodology used in the analysis.

5.6 Continuity Diaphragms

- Any concrete structure which meets the requirements of LRFD Article 5.14.1.4 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, with approval from the Department, material sampling (coupon tests) may be required.

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 RIDOT for further clarification if needed.

6.4 Beam End Deterioration

The following procedures shall be followed when analyzing localized beam end deterioration. The beam end shall be considered the end panel of the web above the bearing. Please note the shear capacity of the web in the beam end shall always be rated.

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

<u>Beam End Deterioration Cases:</u>

- Case I - For full height stiffeners or plates with no section loss, or minor section losses, and for unstiffened webs (no stiffeners) with up to minor section losses all with no signs of distress over the bearing location:
  - o Bearing, web crippling, and web yielding shall not be checked. However, axial resistance of the stiffener may be performed based on the discretion of the engineer.
- Case II - For full height stiffeners with moderate to significant deterioration or partial height plates:
  - o If full height plates are significantly deteriorated (i.e. full width deterioration across stiffener/plate) or partial height plates are present, web crippling need not be checked if the height of the intact stiffener or plate extends a minimum of 0.75 * 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*. However, the web is still susceptible to yielding and web yielding shall be checked at the Strength Limit State.
- Case III - For unstiffened webs (no stiffeners or plates) with moderate to significant section losses, the effects of web local yielding and web local crippling shall be evaluated at the Strength Limit State considering the following:
  - o The length of the beam beyond the bearing may be relied upon for support up to a distance equal to 2.5*k, but not to exceed the distance from the back face of the bearing to the end of the beam (beam overhang).

<u>Analysis and Reporting Criteria:</u>

- For web yielding analysis, evaluate based on the following:
  - o 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.
  - o The web thickness shall be the <u>average</u> web thickness along the base of the web within the zone of N+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.
- For web crippling analysis, evaluate based on the following:

- The web thickness shall be the average web thickness over the height 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.
- Bearing, web crippling, and web yielding shall be evaluated for the design, AASHTO, and permit vehicles. To save analysis time, if the HL-93 rating factor is above 1.0 then no rating factors are required to be calculated for the AASHTO vehicles.
- The results of the bearing, 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*. This will restrict the permit vehicles from crossing the bridge.
- The flag for bearing, web crippling, and web yielding shall be checked if any AASHTO vehicle rating factor is <1.0. However, this shall not be reported as the governing rating factor on the *Summary Sheet*. Any flagged bridge will be monitored at a reduced inspection frequency and/or repaired, but will only be posted at the discretion of the Department 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 and Sections with Unknown Shear Connectors

- The compression flange shall be considered 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 or heavy rust separation along the top flange/concrete deck interface.
- Determine if composite action exists based on the guidelines from *NCHRP Research Results Digest, November 1998-Number 234, Manual for Bridge Rating Though Load Testing*.
  - 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, use a maximum interface shear stress across the top steel flange of 70psi. If the top flange is at least partially embedded in concrete use 100psi.
  - 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 partially braced non-composite.

6.5.3 Longitudinal Deck Reinforcement

- Longitudinal reinforcement in the deck slab shall be included in the negative moment capacity analysis over the pier.

6.5.4 Connections

- Field splices shall be rated if the splice is part of a fracture critical member, or 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

In accordance with MBE 6A.5.12.10.3a, for single span culverts, the effects of live load may be neglected where the depth of fill is more than 8 feet and exceeds the span length; for multiple span culverts, the effects may be neglected where the depth of fill exceeds the distance between the inside faces of end walls. However, culverts with deep fills shall be evaluated for the effects of permanent loads only.

11. POSTING OF BRIDGES

NBIS regulations (23 CFR Part 650) require to rate each bridge as to its safe load-carrying capacity in accordance with the MBE (incorporated by reference, see §650.317). Post or restrict the bridge in accordance with the MBE or in accordance with State law, when 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. Bridges with an initial load rating report recommending posting that are based on traditional methods but are recommended for a refined analysis will be coordinated with FHWA. Bridge postings are tracked within the Department load rating tracking database and FHWA will be informed of bridge postings as required. The load rating tracking database is the primary Department tool to track the current status and dates of all load rating reports, pending posting sign actions, and posting sign field installations. Posting sign actions are reviewed and follow-up weekly. The timeline for completed posting sign actions will be in accordance with FHWA policies.

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 strength limit state is used for checking the ultimate capacity of structural members and is the primary limit state utilized by RIDOT for determining posting needs. The fatigue limit state will not dictate a bridge posting.

The following guidelines shall be used for posting of bridges in RI:

11.1 Potential Bridges Requiring Posting

For any bridge with a legal load rating factor less than 1.0, the following shall be investigated prior to posting a bridge in Section 11.2:

- 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 not satisfying the criteria in 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 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 checked by an independent engineer other than the load rating engineer 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 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 updating of the information in the future. The load rating report deliverables shall consist of a hard copy, Adobe PDF Version (PDF), and CD as detailed in the subsequent sections.

The hard copy of the rating report shall be printed on 8½"x11" sheets and be GBC bound with clear front and back covers. Fold-out pages shall not be included. The CD shall be attached to the inside of the back cover.

The load rating report shall be composed of the following sections and ordered as outlined below. Please note the information detailed below is required for both the hard copy and PDF version of the report unless indicated otherwise.

13.1.1 Report Cover

The report cover contains all pertinent bridge information and shall be stamped by a Registered Professional Engineer in the State of RI.

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: All AASHTO legal load ratings 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 Title Sheet

The title shall be a stamped white copy of the report cover.

13.1.3 Index

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

13.1.4 Summary of Bridge Rating

Tabular listing of all controlling load rating values, condition factor, system factor, surface roughness, ADTT, QA/QC, and other specific criteria. The template for this sheet is available from RIDOT in Microsoft Excel.

For the QA/QC box on this sheet, please note the following:
- The “Load Rating Engineer” shall be the load rater as defined in Section 1.9.1.
- The “Load Rating Done/Checked By” shall be a separate individual and the person signing the “Agreement of Independent Reviewer” (Section 13.1.12).
- The “Quality Assurance By” is the person responsible for quality assurance within the organization. It is preferred that this individual be a separate individual.

Refer to Appendix A for sample.

13.1.5 Breakdown of Bridge Rating

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 typical controlling interior and exterior beam for moment and shear for all limit states shall be included within the breakdown. Should any legal load rating factor be less than 1.0, in addition to the above, all locations regardless of the limit state 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.

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

Refer to Appendix A for sample.

13.1.6 Location Map

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.

13.1.7 Description of Bridge

Tabular listing of all pertinent bridge information.

Refer to Appendix A for sample.

13.1.8 Rating Analysis Assumptions & Criteria

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.
    - 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.
    - Pedestrian live load (if applicable)
    - Live loads used in the analysis

13.1.9 Evaluation & Recommendations

Summary of the controlling elements of the structure and recommendations to either improve or maintain the condition of the structure. Include discussion of fatigue life for steel structures.

13.1.10 References & Available Plans

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. In addition, the following shall be included:

13.1.10.1 Orientation Plan / Orientation Section View

The bridge orientation plan and 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 or review and comparison.

13.1.10.2 Applicable Existing Plans

Provide 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/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 on the CD submitted with the report.

13.1.11 Truck Loadings

Graphical configuration of all truck loadings used in the analysis.

13.1.12 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.

13.1.13 Appendix A (Inspection Report)

Provide a blue divider for this section.

Include the narrative bridge inspection report which the load rating is based upon.

13.1.14 Appendix B (Photographs)

Provide a blue divider for this section.

Include 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. 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.”

13.1.15 Appendix C (Computations)

Provide a blue divider for this section.

Provide all backup hand computations, spreadsheets, section loss sheets, sketches, 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 on the CD that accompanies the load rating report. These files are needed to edit/update future load ratings.

13.1.16 Appendix D (Computer Input & Output)

Provide a blue divider for this section.

For the hard copy of the report (not PDF version), 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.).
- Last page of this section to have statement indicating that input and output files are provided in the PDF version of the report.

For the PDF version of the report, the following shall be provided:
- All of the above criteria for the hard copy.
- 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.

For the PDF version of the report, all detailed and comprehensive input and output files shall be provided. However, these documents do not need not be included within the hard copy that is submitted to the Department.

13.1.17 Report CD

The inside back cover of the hard copy of the report shall contain a CD containing the following. Refer to Section 13.2 for the file organization and naming structure of the electronic files to be included on the CD:
- PDF version of the load rating report. See requirements in Section 13.1
- BrR/Software input files
- Raw (original) electronic data files for all supplemental calculations (i.e. dead loads, distribution factors, section loss, section properties, etc.)
- Existing plans
- Shop drawings
- Design calculations
- Other support information (i.e. material test data, etc.)

13.2 Electronic Files on CD

The information below provides the content, layout, and file naming definitions of the electronic bridge load rating deliverable.

The file structure for the CD shall be as follows:

13.2.1 Bridge Folder

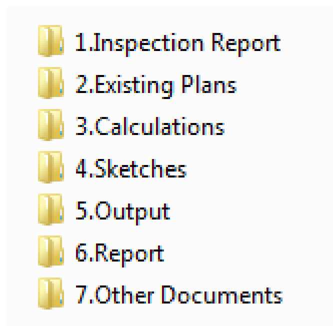
The parent folder on the CD shall be labeled with the 6-digit bridge number.

13.2.2 Rating Folder

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

13.2.3 Rating Subfolders

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



13.2.3.1 Inspection Report

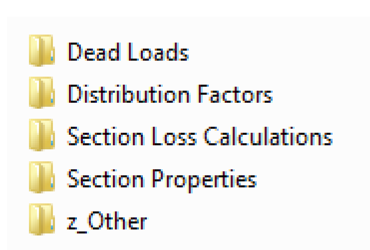
PDF version of the inspection report used in the analysis. Photos shall be included within this file.

13.2.3.2 Existing Plans

PDF version of the existing plans. If file is large just include the 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

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

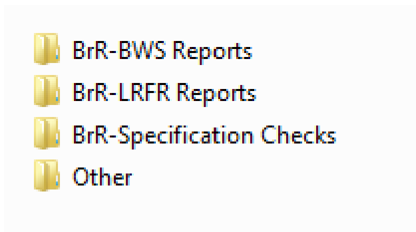


13.2.3.4 Sketches

Include all raw (original) data files for sketches as well as PDF.

13.2.3.5 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 this directory.



13.2.3.6 Report

PDF version of the report. The report file shall be named with the six-digit bridge number.

13.2.3.7 Other Documents

Include any other supporting documents not included elsewhere in this folder.

14. AASHTOWare BrR GUIDELINES FOR RATINGS

This section will be utilized to provide specific BrR load rating guidance and is based on BrR Version 6.8. This section is intended to provide useful general program notes specific to RIDOT in an effort to develop consistent and reproducible files for future editing. 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

At least one person from each consultant firm performing load ratings shall subscribe to the AASHTOWare BrDR mailing list. This insures that proper notifications will be received when program updates are available, critical errors have been uncovered or corrected, or general BrR information must be distributed. The website is as follows:

https://aashto.mbakercorp.com/Pages/eNotification.aspx

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 format.
- It is preferred to use separate superstructure definitions for the as-built and as-inspected conditions. This allows the user to perform an analysis from the explorer.

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 the 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 APPERTUNANCES 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 SHEMATIC 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 at this time.
- 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% in the absence of more precise information.

14.6 Materials

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

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 and 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.
- Spans 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.
- The description shall contain any useful notes helpful 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 a part of 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) in order 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. BrR does not compute the dead load of transverse or longitudinal stiffeners.

14.11 Member Alternatives

14.11.1 General

- Do not link member alternatives within BrR. Reasons for this pertain to the ability to apply future section losses to specific members.
- 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. The as-built model shall be maintained in the model. 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 utilize the as-inspected MEMBER ALTERNATIVE.
- If there are no section losses and the as-built is the same as the as-inspected then only one MEMBER ALTERNATIVE shall be created under the as-built name. This will help reduce file size for large bridges.

14.11.2 Control Options

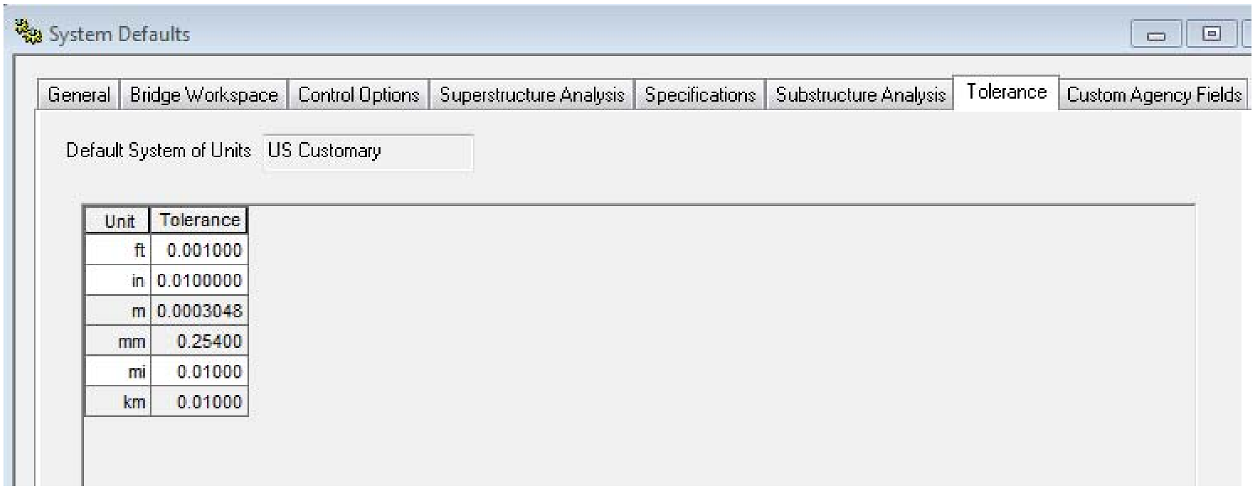
- In CONTROL OPTIONS, select “Allow Plastic Analysis” for all steel bridges with the exception of built-up steel members.
- In CONTROL OPTIONS, it is recommend for continuous steel structures exhibiting low rating factors to enable “Use Appendix A6 for Flexural Resistance”. BrR will automatically check several criteria prior to use based on checking this box.

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 as if there are any changes to member spacing, beam shape, specifications, or other parameters to compute the live load distribution factors then the program will not 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.



15. APPENDIX A-SAMPLE LOAD RATING REPORT

Bridge Load Rating

Prepared for

Rhode Island
Department of Transportation

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

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

Date of Inspection: [LATEST INSPECTION DATE]
Date of Rating: [DATE RATING SUBMITTED]

Prepared By:
[CONSULTANT NAME & ADDRESS]

[INSERT P.E. STAMP]

Report Cover

SUMMARY OF BRIDGE RATING

Municipality:		Bridge No.:	
Route Carried:		Crossing:	
Owner:		Year Built:	
Maintained By:		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				
EV2				
EV3				
RI 3				
RI 4				
RI 5				
RI 6				
RI-OP1				
RI-OP2				
RI-OP3				
Fatigue				
RIPTA				

Grey shaded vehicle types are considered legal loads.

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	
LR Engineer Name:	
LR Engineer License #:	
LR Engineer Signature:	
LR Checked By:	
Quality Assurance 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
- As-built load rating (from construction plans / baseline load rating)
- As-inspected load rating (based on inspection report and/or field verification)
- Load test performed
- Refined analysis performed
- Material testing performed
- Bridge has infinite fatigue life
- Bridge has finite fatigue life; Fatigue Serviceability Index is [x]
- Flag for web buckling / web crippling / web yielding check (if performed)
- Traffic restriction; reported rating factors for unrestricted portion
- EV2/EV3 applies as bridge carries Interstate or on/off ramp for I-95, I-295, I-195
- Bridge is located on RIPTA Bus Route

Summary of Bridge Rating

BREAKDOWN OF BRIDGE RATING

Town/City:	Bridge No.:
Route Carried:	Crosses:
Owner:	Year Built:
Maintained By:	Year(s) Rebuilt/Rehab:

RATING LOAD (LEGAL LOADS)

BRIDGE COMPONENT	DESIGN LOAD (HL-93)		LEGAL LOAD (TONS)										
	INV	OPER	H20	TYPE 3	TYPE 3S2	TYPE 3-3	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]													

Breakdown (Legal Loads)

BREAKDOWN OF BRIDGE RATING

Town/City:	[INSERT LOCATION]	Bridge No.:	[INSERT NO.]
Route Carried:	[INSERT ROUTE]	Crosses:	[INSERT]
Owner:	[STATE/TOWN]	Year Built:	[INSERT YEAR]
Maintained By:	[STATE/TOWN]	Year(s) Rebuilt/Rehab:	[INSERT YEAR(s)]

RATING LOAD (RI PERMIT LOADS)

BRIDGE COMPONENT	RI PERMIT TRUCKS (TONS)						
	RI 3	RI 4	RI 5	RI 6	RI-OP 1	RI-OP 2	RI-OP 3
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]

Note: Breakdown shall include all limit states for each location analyzed.

Breakdown (Permit Loads)

DESCRIPTION OF BRIDGE

Bridge Number:	[BRIDGE NO.]
Owner:	[OWNER]
Maintained By:	[MAINTAINER]
Location:	[TOWN/CITY]
Route Carried:	[STREET]
Feature Intersected:	[FEATURED INTERSECTED]

Year Built & Inspection Dates:

Latest NBI Inspection Date:	[DATE]
Field Verification Date (if applicable):	[DATE]
Date of Construction:	[YEAR]
Bridge Type:	[TYPE]
Original Design Loading:	[TYPE]
Date(s) of Rebuild/Rehab:	[YEAR]
Description of Rebuild/Rehab:	[TYPE]
Posting:	[TYPE]

Design:

Superstructure:	[X]
Substructure:	[X]
Bearings:	[X]
Bridge Spans:	[TOTAL LENGTH & AMOUNT OF SPANS, LENGTH PER SPAN]
Bridge Skew:	[x°-xx'-x"]
Bridge Width:	[X'-XX"] out-to-out
Roadway Width:	[X'-XX"] curb-to-curb
Roadway Surface:	[X]
Curb Reveal:	[X]
Sidewalk/Walkway/Median:	[X]
Utilities:	[X]
Bridge Railing:	[X]
Approach Railing:	[X]

Condition:

Wearing Surface Condition:	[X]
Bridge Railing Condition:	[X]
Deck Condition:	[X]
Beam Condition:	[X]
Bearing Condition:	[X]
Abutment Condition:	[X]
Pier Condition:	[X]

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. XXXX.

Date:

XXXXXX

Agreement of Independent Reviewer

[END OF DOCUMENT]