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CHAPTER 1: INTRODUCTION

1.1 PURPOSE

This manual describes the West Virginia Division of Highways WVDOT policies and procedures for load rating and posting of in-service public road bridges. This manual serves as a standard and provides uniformity in the policy and procedures for determining the load capacity of bridges under the jurisdiction of the West Virginia Division of Highways. Design load ratings for bridges being designed in West Virginia should follow Structure Directive 2150 Load Rating of New Bridge Design.

1.2 SCOPE

The provisions of this manual are intended to serve as a guide to the West Virginia Division of Highways personnel involved in the load rating and posting of in-service highway bridges. Those involved in the load rating and posting of in-service highway bridges includes, but is not limited to: district bridge engineers, district evaluation engineers, district evaluation staff, central office evaluation staff, and any consultant or contractor performing load rating analysis on a bridge owned by the West Virginia Division of Highways for legal load evaluation.

1.3 DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

1.3.1 Definitions and Terminology

- *Bridge* – A structure including supports erected over a depression or an obstruction such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between under copings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; It includes multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.
- *Live Load Distribution Factor* – The fraction of a rating truck or lane load assumed to be carried by a structural component. The American Association of State Highway and Transportation Officials Standard Specifications for Highway Bridges use wheel line distribution factors whereas the American Association of State Highway and Transportation Officials Load and Resistance Factor Bridge Design Specifications use axle/lane distribution factors.
- *Load Rating* – The analysis to determine the safe vehicular live load carrying capacity of a bridge using bridge plans and supplemented by measurements and other information gathered from an inspection.



- *Load Factor* – A load multiplier accounting for the variability of loads, the lack of accuracy in analysis, and the probability of simultaneous occurrence of different loads.
- *Program Manager* – The individual in charge of the program, that has been assigned the duties and responsibilities for bridge inspection, reporting, and inventory. The program manager provides overall leadership and is available to inspection team leaders to provide guidance. The program manager for West Virginia is also the Assistant Director (Bridge) of Operations Division.
- *Rating Factor* – The ratio of the available capacity in excess of dead load to the live load demand.

1.3.2 Abbreviations and Acronyms

AASHTO – American Association of State Highway and Transportation Officials

ADT – Average Daily Traffic

ADTT – Average Daily Truck Traffic

ASD – Allowable Stress Design

ASR – Allowable Stress Rating

BMD – WV Bridge Maintenance Directive

BrR – AASHTOWare Bridge Rating Software

CO – Commissioner's Order

CRTS – Coal Resource Transportation System

DBE – District Bridge Engineer

FHWA – Federal Highway Administration

GVW – Gross Vehicle Weight

HO – WVDOH Deputy State Highway Engineer – Operations

LFD – Load Factor Design

LFR – Load Factor Rating

LRE – Load Rating Engineer

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

NCHRP – National Cooperative Highway Research Program

NSTM – Nonredundant Steel Tension Member

OM – Operations Division

QA – Quality Assurance

QC – Quality Control

SI&A – Structure Inventory and Appraisal



UBI – Under Bridge Inspection

WVDOH – West Virginia Division of Highways

1.4 REFERENCES

WVDOH bridge evaluations shall adhere to the requirements of the NBIS. Users of this manual are encouraged to use the following reference manuals.

- AASHTO Publications
 - MBE, most current edition with applicable revisions/interims
 - LRFD Bridge Design Specifications, most current edition with applicable revisions/interims
 - Standard Specifications for Highway Bridges, 17th Edition
- WVDOH Publications
 - WVDOH Structural Directives
 - Bridge Inspection Manual
 - Modern Timber Bridge Manual
- Other
 - NCHRP Report 725 Guidelines for Analysis Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges

1.5 COORDINATION

Users should direct questions concerning the applicability or requirements of the referenced documents to the Evaluation Section of OM.

1.6 REVISIONS

Revisions may be the result of changes in WVDOH, FHWA, or AASHTO requirements.

Users are invited to send suggestions to the Evaluation Section of OM.

Approved policy and editorial revisions will be included in interim revisions to this manual or a new edition containing all updates.



CHAPTER 2: LOAD RATING PROCESS

2.1 GENERAL

The WVDOH aims to provide a safe, effective, and efficient highway system. Load ratings shall be governed by the NBIS and as modified by this manual. Consultant load rating is subject to the terms of contract and scope of work.

2.2 RESPONSIBILITY

Load ratings must be performed under the supervision of a professional engineer licensed by the state of West Virginia. Both in-house and consultant structure load rating results should be checked for accuracy as part of the QC & QA process. It is the responsibility of the LRE and the DBE to verify acceptability of all load rating results and safe load capacities.

2.2.1 Computer Program Verification

Whenever possible, longhand verifications shall be performed for a portion of the computer analysis to satisfy the LRE or Verifying Engineer that the computer program is accurate and performing as intended.

2.2.2 Independent Verification

An independent verification of the rating should be performed when possible. When computer programs are used, the verifier should ensure: the accuracy of all input data; the accuracy and suitability of the computer program; and the final load capacities match the analysis results.

2.3 INSPECTION DATA USED FOR LOAD RATING

A load rating is based on existing structural conditions of a bridge as stated in MBE 6.1.1 and 6.1.2. For information on inspection information used in load rating, refer to the MBE, CHAPTER 4 of this manual, and the WVDOH Inspection Manual.

2.4 CONCEPTS AND LOAD RATING METHODOLOGIES

1. Members of substructures need not be routinely rated for live load except for steel caps and columns, which shall be load rated in most cases. Substructure elements should be rated in situations where the engineer has reason to believe their capacity may govern the load capacity of the entire bridge. See CHAPTER 11 for further guidance.



2. All superstructure spans and their respective live load carrying components shall be load rated for all applicable load effects including, but not limited to: moment, shear, axial, combined moment and shear, combined bending plus axial, and torsion. If the LRE using engineering judgment, determines certain components will not control the rating, a full investigation of the non-controlling elements is not required.
3. For most structures, the governing rating shall be the lesser of the safe load determined by shear or moment of the critical component. For more complex structures, other force effects or limit states may control the rating.
4. The load rating and posting of bridges shall be based on satisfying the requirements for the strength and service limit states, guided by the considerations discussed this manual. For LRFR, limit states shall be considered in accordance with MBE Table 6A.4.2.2-1.
5. WVDOT typically uses BrR for routine, production use bridge load rating; however, the LRE should use other software, spreadsheets, and hand calculations, as necessary, to obtain accurate load ratings.
6. When consultants perform load ratings, they will follow the requirements outlined in their contract which will require adherence to this manual and the current MBE. Contract requirements take precedence over the requirements of this manual. Consultant load ratings shall be signed and sealed by a professional engineer registered in the State of West Virginia. The consultant shall have QC procedures in place. If a consultant has a question about load rating, they should contact the Evaluation Section of OM.

2.5 NEW BRIDGES

Load ratings shall be obtained and documented no later than the time of the inventory inspection. Ratings may be obtained before bridge construction as part of the plan review process. Load ratings performed during the design phase shall conform to the requirements of this manual and the MBE.

Bridges load rated during the design process shall have the load ratings and other supporting data submitted on the plan sheets in accordance with the applicable structural directives.

Load ratings reported on the DS-25 at the inventory inspection should be from a district load rating file/model, not from assigned load ratings based on the design plans. If the structure type prevents accurate modeling with available software, assigned ratings will be allowed.

2.5.1 Phased Construction

If a bridge project utilizes phased construction, the safe load capacity of the structure carrying traffic shall be rated in its current condition. Phased construction may lead to structural configurations containing Priority 1 members, as defined later in Chapter 14 of this manual, and are to be evaluated as such in accordance with the posting policy outlined in Chapter 14. Bridge



inventory updates and load ratings to determine safe load capacity of phased construction must take place within applicable timeframes outlined by WVDOH and FHWA.

2.6 EXISTING BRIDGES

Existing bridges shall be evaluated at every inspection. If the LRE determines the existing load ratings are still valid, such as when no changes to the bridge affecting load ratings, a new load rating is not required. If possible, any computer analysis should be verified to check any software updates. At each in-depth inspection, the bridge load rating analysis should be thoroughly checked for accuracy.

Items requiring an update to an existing load rating include, but are not limited to:

1. A change in member capacity
 - a. Section loss, broken rebar or strands, spalled concrete, broken diaphragm/cross-frame, etc.
2. A change in dead load
 - a. New or altered wearing surface, rehabilitated deck, new attachments, etc.
3. A change in live load
 - a. New rating trucks
 - b. Change in usage: more truck traffic, change in lane striping
 - c. Overweight permits
4. A change in load rating methodology

Refer to CHAPTER 4 through CHAPTER 13 of this manual for WVDOH's policies on rating methods to use for various structural types.

2.7 REHABILITATED BRIDGES

Rehabilitated bridges shall be load rated as necessary to update SI&A information. At the time of the next inspection, the rehabilitated bridge shall be treated as an existing bridge (see Section 2.6).

2.8 USE OF COMPUTER SOFTWARE

The use of in-house and/or commercial computer software and spreadsheets is encouraged to aid in the load rating calculations. The LRE and Verifying Engineer are responsible for using the software and/or spreadsheets appropriately, interpreting the results appropriately, and performing the independent checks as required.

Internally, DOH utilizes the following programs and spreadsheets to load rate structures:



- Commercial Software

BrR – Can be used for most bridge structures and is the preferred software for the WVDOH.

LARS Bridge – Used to maintain the current Superload permit evaluation system until a new hauling permit system is in place that interfaces directly with BrR's Load Rating Tool for permit live load analysis.

MDX – May be used to load rate curved and straight steel bridges as a secondary check to BrR.

Midas – Used for complex structure load rating for structure configurations and types not easily handled by BrR.

Other commercial software purchased after this time

- Spreadsheets

There are several in-house spreadsheets that aid in load rating available on the DBE Google Drive resource site.

2.9 QC & QA

2.9.1 QC Review

In accordance with BMD I300-1, some bridge inspection reports submitted to central office for review shall have the load rating summary reviewed to ensure compliance with this manual.

2.9.2 Specific Requirements

2.9.2.1 WVDOH Load Ratings QC Review

BMD-I300-1 outlines “District Statewide Quality Control – Evaluation” as the Evaluation Section’s requirement to perform periodic quality control checks and reviews of load ratings performed by district load rating and evaluation staff. For information on these reviews, please reference BMD-I300-1. District LRE’s are expected to review the findings and make any necessary changes to specific bridge load ratings and load rating procedures in future load ratings.

The Evaluation Section of OM, with approval from the Program Manager or the Evaluation Section Manager, may independently verify the load ratings performed by district staff to validate the accuracy and completeness of any bridge evaluation as part of the overall QC & QA program.



2.9.2.2 Consultant Load Ratings

Consultants are responsible for the QC & QA of their work, checking both accuracy and completeness. WVDOH reserves the right to review consultant assumptions, methodology, and accuracy before accepting load rating results from consultants.



CHAPTER 3: DATA COLLECTION

3.1 GENERAL

The collection of relevant and pertinent existing data regarding the structure is required to perform the load rating. The available information for a specific bridge may be assembled from many different sources or may rely exclusively on inspection and field measurements when other information does not exist. It is the LRE's responsibility to determine the reliability and applicability of available information used to obtain the load rating.

3.2 EXISTING PLANS

Existing plans are often necessary to perform a load rating. The DBE and evaluation engineer will be able to provide plans for most bridges when they are available. As-built plans show the bridge dimensions and properties as it was constructed, thus, they are the preferred plan documentation. Construction plans may be used if the LRE judges them to accurately represent the as-built structure. Construction plans should be used in conjunction with the inventory report to establish basic bridge layout and geometry for load rating. Occasionally bridge plan sets (mainly newer bridges) will have design stress and/or load rating information that may assist with load rating.

3.3 INSPECTION REPORTS

The inventory report details many necessary properties of the bridge. The inventory report should indicate if plans are available or not. When plans are not available, the inventory report should provide all necessary information pertaining to bridge layout and geometry.

The most recent inspection report is required to perform a load rating. It should have documentation of condition defects affecting the load rating. It is the responsibility of the LRE to include all appropriate deficiencies documented in the latest inspection reports in the load rating analysis. The latest in-depth inspection report and all the subsequent reports should contain all deterioration documentation necessary for load rating. Some deficiencies to look for include but are not limited to: structural steel section loss, reinforcing steel section loss, broken prestressing strands, and heavily deteriorated concrete.



3.4 OTHER RECORDS

Shop drawings are occasionally available, and commonly required for prestressed concrete beams. Shop drawings may be useful for detailed connection information, particularly gusset plate dimensions. Typically, the shop drawings supersede the contract plans where differences arise.

Other structure history records may exist that will provide additional information pertinent to the load rating. These records may override specifications or measurements reported in the construction plans or repair plans. Examples include:

- Correspondence
- Field Testing Reports
- Maintenance History
- Mill Reports
- Posting History



CHAPTER 4: GENERAL REQUIREMENTS

4.1 CONDITION OF BRIDGE MEMBERS

The condition and extent of deterioration, cracking, bending, or other deficiencies of structural components shall be considered in the load rating. The load rating shall be representative of the structure as it exists in the field; future wearing surfaces accounted for in the design, but not present on the bridge, should not be included.

4.2 DEAD LOADS

The dead load unit weights given in the current AASHTO LRFD Bridge Design Specifications Section 3.5 shall be used in the absence of more precise information.

4.2.1 Distribution of Dead Loads Applied Along Lines (Line Girder Analysis)

Dead loads applied along lines would include parapets, railings, barriers, sidewalks, curbs, and any other superimposed dead load localized along one “line” of the bridge. If these superimposed loads are added to a concrete deck after the deck has hardened, specifications note the load may be distributed uniformly to all beam (or girder) lines. While this method may work well for narrower cross-sections with fewer beams, the proper load distribution diminishes as the bridge width and number of beam lines increases. For this reason, a conservative approach for application of dead loads along lines is outlined below.

For 3-line beam systems, line loads should be distributed equally to all beam lines. For systems with 4 or more lines of beams, the line loads should be distributed as follows: for line loads along the outside of the bridge deck (parapets, railings, curbs, etc.), 60% of that load should be applied to the exterior beam line. The maximum of 40% of the weight in question, or the total line load weight equally distributed to all beam lines (including all line loads traversing the bridge deck), should be applied to the first interior beam. The remainder of the interior beams, if the cross-section has more than 4 lines, should have the equally distributed weight applied to them.

Line loads applied away from the outside edge of decks (median barriers, sidewalks, etc.) should be distributed using engineering judgement. These loads may be uniformly distributed to all beam lines if deemed acceptable by the LRE.



4.3 SIDEWALK LOADING OR PEDESTRIAN LOADING

4.3.1 Pedestrian Live Loading Using the LRFR Method

Follow MBE Article 6A.2.3.4.

4.3.2 Sidewalk Loading Using the LFR or ASR Method

Follow MBE Article 6B.6.2.4.

For bridges closed to vehicular traffic but opened to pedestrian traffic, see Section 15.2.1 of this manual.

4.4 LIVE LOADS

4.4.1 LRFR Method

The following live loads shall be used when rating a structure using the LRFR method (CRTS loads are only required for bridges on the CRTS):

- Design Live Load
 - HL-93 (See MBE Figure C6A-1)
- Legal Live Load (See Figure 4-1 through 4-3)
 - T3
 - SU4
 - SU5
 - SU6
 - SU7
 - WV-2S2
 - 3S2
 - Lane-Type Legal Load
 - See MBE Article 6A.4.4.2.1a
 - The lane-type load models shown in MBE Figures D6A-4 and D6A-5 shall be used (no combination with other state legal loads is required)
 - Emergency Vehicles (See Section 4.6.2.1 and 4.11.1.3)
 - EV2
 - EV3
 - CRTS Trucks
 - SU-40
 - SU-45



- 3S-55
- 3S-60
- WP-47 (See Section 4.9.1)

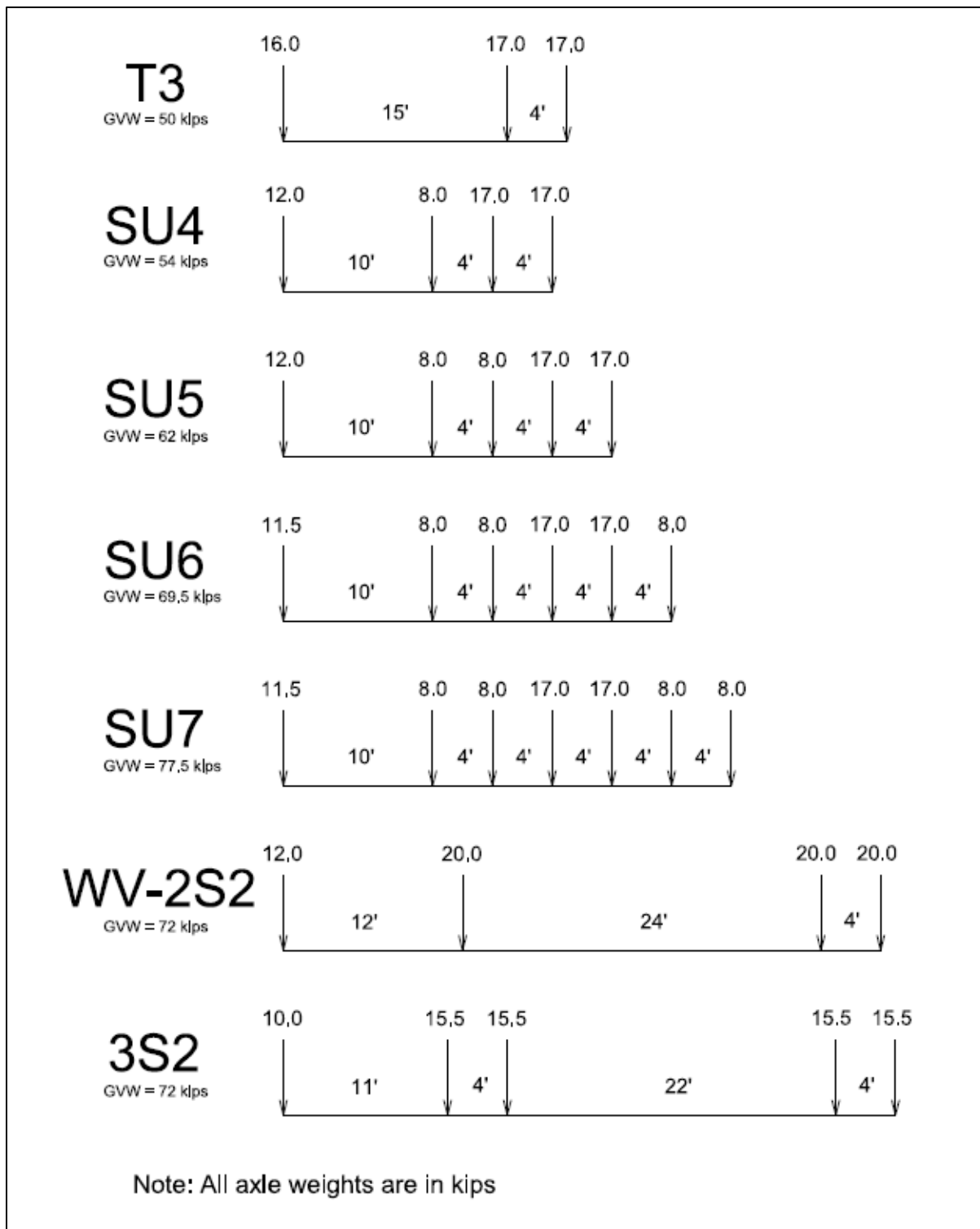
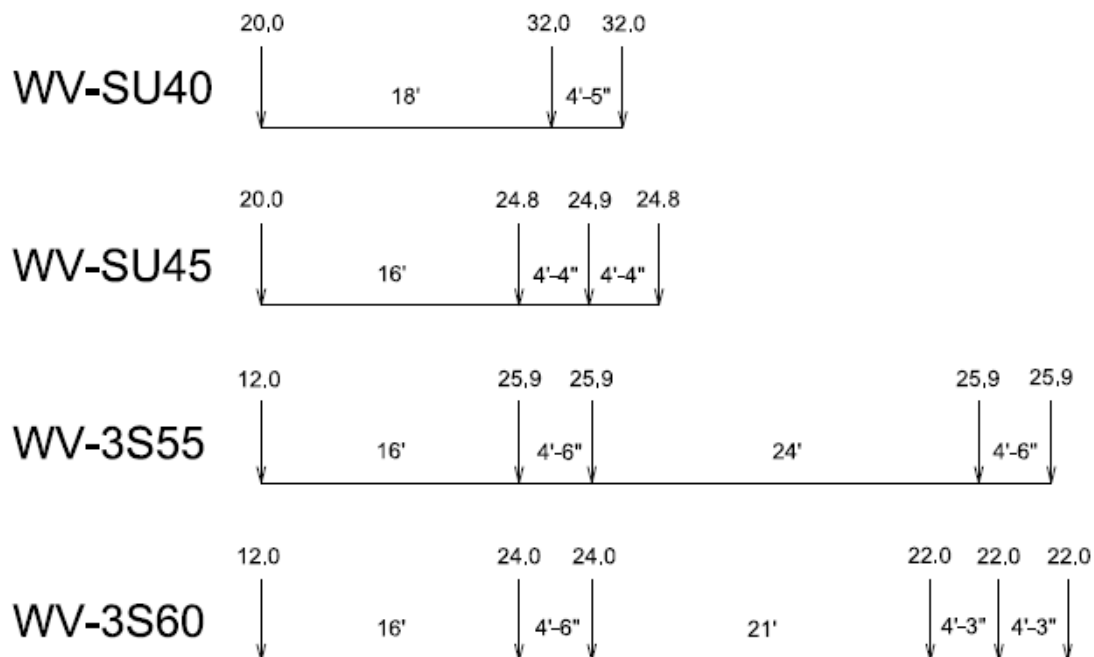


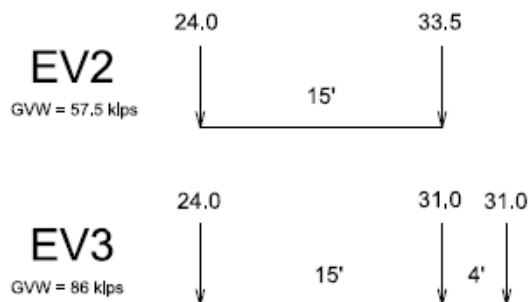
Figure 4-1 Legal Live Load Vehicles



CRTS VEHICLE LIVE LOADS



EMERGENCY VEHICLE LIVE LOADS



Note: All axle weights are in kips

Figure 4-2 CRTS and Emergency Vehicle Live Loads



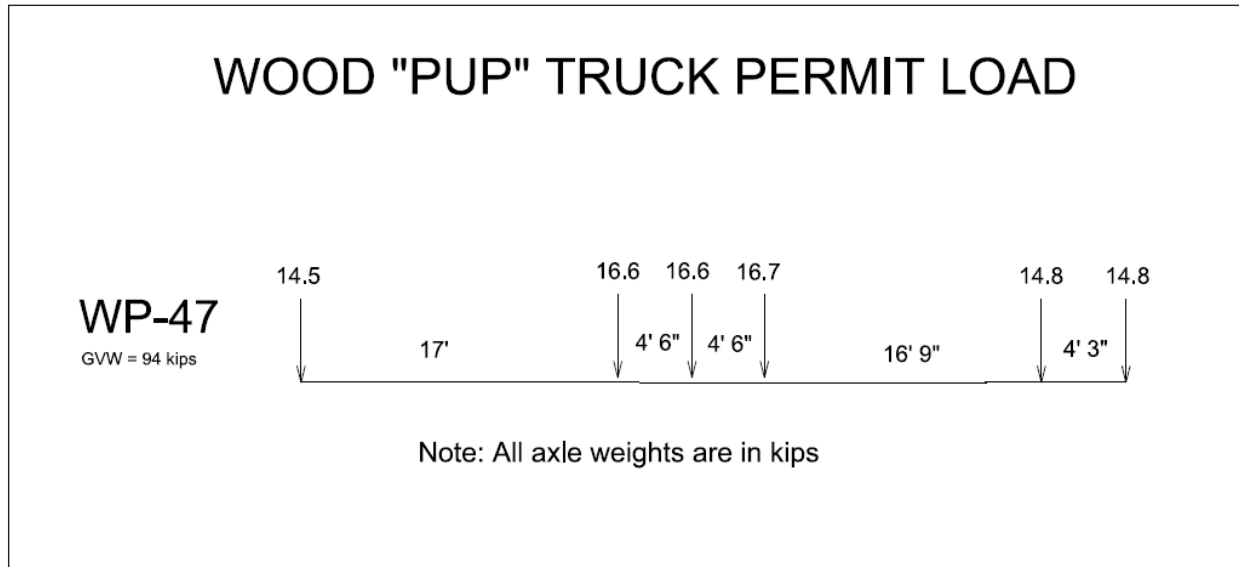


Figure 4-3 Wood "Pup" Truck Live Load

4.4.2 LFR or ASR Method

The following live loads shall be used when rating a structure using the LFR or ASR method (CRTS loads are only required for bridges on the CRTS):

- Design Live Load
 - HS20-44 (See MBE, Figures 6B.6.2-1 and 6B.6.2-2)
- Legal Live Load (See Figure 4-1 through 4-3)
 - T3
 - SU4
 - SU5
 - SU6
 - SU7
 - WV-2S2
 - 3S2
 - Emergency Vehicles (See Section 4.6.2.1 and 4.11.1.3)
 - EV2
 - EV3
 - CRTS Trucks
 - SU-40
 - SU-45
 - 3S-55
 - 3S-60
 - WP-47 (See Section 4.9.1)



4.5 WIND LOADS

Wind loads are not normally considered in load rating. However, the effects of wind on special structures such as movable bridges, long-span bridges, and other high-level bridges should be considered in accordance with applicable standards.

4.6 IMPACT AND TRANSVERSE LIVE LOAD DISTRIBUTION

4.6.1 Impact

The live load impact used for design and legal rating shall be as specified in the MBE. WVDOH does not permit reducing the impact of legal loads as in MBE Table C6A4.4.3-1.

Live load impact for single-trip overweight permit trucks may be reduced and is discussed in Section 4.9.2.

4.6.2 Transverse Live Load Distribution

The transverse live load distribution used for rating shall be as specified in the MBE, Section 6, “Part A” for the LRFR method and Section 6, “Part B” for the ASR and LRFR methods.

When a refined method of analysis is used for the transverse distribution of live load (for example, methods other than the approximate method), the truck and lane load shall be positioned to maximize the force effect being analyzed. Positioning of the truck and uniform lane load within a design lane or adjacent lane shall be determined following MBE 6A.2.3.2 for LRFR and 6B.6.2.2 for LFR/ASR. WVDOH recommends using a 10-foot-wide design lane for wheel placement, resulting in 4 feet between wheel lines of adjacent lanes. WVDOH recommends using the design lanes instead of the actual striped lanes; that is, wheel loads should be placed 2 feet from the curb regardless of the location of striped lanes. Instances may warrant using striped lanes when more feasible, such as a roadway cross-section that includes mountable barriers or sidewalks with no indication of vehicular encroachment. In cases where the roadway width is less than 10 feet wide, the load should be centered in the roadway so that the distance to the wheel load from the barrier would be less than 2 feet. The 6 feet gage distance between wheels should be maintained.

4.6.2.1 Emergency Vehicles

If necessary, when combined with other unrestricted legal loads for rating purposes, the emergency vehicle needs only to be considered in a single lane of one direction of a bridge.



4.7 MATERIAL PROPERTIES FOR LOAD RATING

The material properties used for the ratings of all structures shall be based on the material grade or design stresses specified in the plans. In the absence of plans, or if the plans do not specify the material grades or design stresses, the LRE must use other means to determine the appropriate material properties based on the information available. Typically, this information is based on the year the bridge was constructed and can be found in the MBE, Section 6. If the plans designate the AASHTO specification or WVDOT specification, it may be possible to find historical specifications on material properties. Material testing may be used to determine material properties which may be prudent when higher load ratings are desired.

4.7.1 Structural Steel

Material properties for structural steel of unknown grade shall be obtained from MBE Table 6A.6.2.1-1. Material properties for pins of unknown grade shall be obtained from MBE Table 6A.6.2.2-1.

4.7.2 Steel Rivets

Material properties for steel rivets of unknown grade shall be obtained from MBE Table 6A.6.12.5.1-1.

4.7.3 Reinforcing Steel

Material properties for reinforcing steel of unknown grade shall be obtained from MBE Table 6A.5.2.2-1.

4.7.4 Prestressing Steel

Material properties for prestressing steel of unknown grade shall be obtained from MBE Table 6A.5.2.3-1.

4.7.5 Timber

If documented material properties are not available, the type and grade of wood may be used to find material properties in the AASHTO Standard Specifications or AASHTO LRFD.



4.8 RATING METHODS

4.8.1 When to Use LRFR, LFR, or ASR

LRFR is the most current methodology for rating bridges. It is based on the latest bridge research and technology. LRFR methodology uses load and resistance factors calibrated based on structural reliability theory to achieve a minimum target reliability for the strength limit state.

Any bridge may be rated using LRFR. All bridges designed using LRFD shall be rated using LRFR.

Bridges not designed by LRFD may be rated using LFR. Certain structure types such as timber and masonry, which cannot be rated by LFR, shall be rated using ASR or LRFR.

4.8.2 When to Use Field Evaluation and Documented Engineering Judgment

Field evaluation and documented engineering judgment may be used when one of the following criteria is satisfied:

- Plans are not available for reinforced concrete or prestressed concrete structures.
- A structure type is not able to be analyzed by district personnel such as arches, frames, culverts, etc. Using judgment ratings for these structure types is not ideal; however, for bridges with little to no deterioration a judgment load rating is acceptable.

For assistance on rating concrete structures such as arches, beams, girders, slab bridges, etc., which are in good or fair condition and for which little or no design load information is available, or for culverts where an analysis cannot be performed, see Appendix A.

Field evaluation and documented engineering judgment maybe used for load rating when severe deterioration is found in reinforced/prestressed concrete, steel or timber superstructures or substructures. In this case, the superstructure/substructure condition rating shall not be higher than three.

4.8.3 Original Design Loading/Assigned Ratings

If a load rating analysis is not possible, it may be possible to assign load ratings based on the design load/design load ratings. To assign ratings, the current condition of the bridge should not have changed from the original design in a manner affecting the load rating, per FHWA Memorandum dated September 29, 2011.



4.9 PERMIT LOAD ANALYSIS

4.9.1 Annual (Blanket) Permit Trucks

The WV oversize and overweight annual (blanket) permit allows carriers using a truck tractor, semi-trailer combination with five or more axles to be in excess of legal weight limits up to the following limits:

Table 4-1 Annual Overweight Permit Limits

	Interstate and Other Divided Routes	US and Selected Routes*	All Other Routes
GVWT (lbs)	110,000	90,000	Legal
	All Routes		
Single Axle (lbs)	28,000		
Tandem Axle (lbs)	45,000		
Tridem Axle (lbs)	50,000		

*The list of selected routes is kept and maintained by the Permits Section of OM located in the central office.

Users of the annual permit are required to obey posted weight limits. Most bridges not satisfying overweight permit limits will also not satisfy legal weight limits; annual permit holders are currently only prevented from crossing bridges by restricting the bridge with a weight posting by CO. It should be noted annual permits can be evaluated at 100% of the operating/legal rating level. OM will periodically screen bridges using inspection report queries to determine if any structures require special restrictions for annual overweight permit trucks.

In addition to the annual (blanket) permits mentioned above, WV offers two additional specialty annual permits (aside from CRTS)— the commodity permit and the wood-truck permit. The commodity permit allows industry to apply for permits to allow weights up to a GVW of 120,000 pounds designated for interstate commerce typically considered divisible and not allowed under other legal load provisions. The applicant must demonstrate through engineering analysis the vehicle permitted under this permit does not adversely affect the designated routes. For a list of current permits and routes that need to be load rated for each commodity permit, please see Appendix D.



The wood-truck permit allows special permits for applicants who transport any wood product (forest, craft, or manufacturing), allowing up to a GVW of 94,000 pounds without tolerance. See Figure 4-3 under Section 4.4 for the truck configuration including axle weights and spacings. Please note this configuration, the Wood “Pup” Truck, WP47, was typically found to be the controlling truck configuration considering the two legal wood truck permit configurations allowed by state statute. For this reason, the other 6-axle combination wood truck, WT47, previously included will not be routinely evaluated. For routine load rating of this permit truck using LRFR methodology, consider this configuration at the legal load rating level with all other legal truck configurations. This will simplify the load rating process and add some potential conservatism to the ratings. If a bridge is found to require posting using LRFR for this truck only, the analysis should be performed with this wood truck as a routine/annual permit evaluation with the revised live load factor to determine if the posting is warranted.

4.9.2 Single Trip Oversize and Overweight Permit Trucks

Single trip oversize and overweight permit trucks are analyzed during the permit application process using the Superload analysis system hosted at the GotPermits website. Superload uses LARS Bridge Modeler file data to load rate structures for overweight loads.

Currently, Superload cannot perform an LRFR analysis; therefore, all permit analyses are either LFR or ASR. For structures rated using the LRFR method, it is recommended an LFR version of the LARS file be created for Superload.

For bridges load rated using engineering judgment, or in cases where an accurate LARS Bridge file cannot be produced, a capacity table should be used. For the information and spreadsheet needed to create capacity tables, WVDOT personnel may go to the DBE Google Drive resource site or contact the Evaluation Section of OM.

Currently, BrR models should have a capacity table developed for inclusion in the permitting system. This capacity table should be conservatively based, as any permit that fails analysis and is sent for technical review can be further evaluated inside of BrR for more accurate permit load ratings.

If a permit truck fails a standard rating analysis, the load may be considered for crossing a structure at reduced impact. Superload yields results of rating factors for the truck at various levels of impact. Permit trucks may be analyzed using a minimum reduced impact factor of 10%. Permit trucks approved to traverse a structure at low impact do so by reducing speed. These loads will be monitored to ensure compliance with speed restrictions.

In addition to low impact provisions, permit evaluators may utilize LRFR permit evaluation for a bridge failing LFR permit review from Superload. LRFR permit evaluation uses lower live load factors, especially for single trip permits.



4.10 LIMIT STATES

4.10.1 LRFR

MBE Table 6A.4.2.2-1 shall be followed. For prestressed concrete members, the Service III limit state should be satisfied for design checks, but bridges should not be posted based on the Service III limit state.

4.10.2 LFR or ASR

For legal load rating and posting, the strength limit state shall be utilized. In addition, for steel beams and girders the service ratings based on the overload provision in Standard Specification Article 10.57 should be routinely considered when establishing safe load capacity, per MBE Section 6B.5.3.1. Under unique circumstances, and when the bridge's safe load capacity has not previously considered the overload provision, a DBE may waive the requirement of load rating for the Overload provision. This waiver should be used judiciously. Common causes for waiver may include, but are not limited to: near future replacement, or minimal commercial traffic/low ADT routes, on bridges not previously rated for this provision. For causes outside of those listed, the DBE should seek concurrence from the Evaluation Section of OM. If the waiver is utilized, the reasoning must be described in detail on the DS-25.

4.11 LOAD FACTORS, CONDITION FACTORS, AND SYSTEM FACTORS

4.11.1 Load Factors

4.11.1.1 *LRFR Method*

For the LRFR method, the load factors shown in the MBE shall be used per MBE Section 6A.4.2.2 and Appendix B6A which has been updated in the 2013, 2014, and 2016 interim revisions).

In determining the ADTT used to select live load factors, use the data from SI&A. The ADTT used to determine live load factors should be for one direction. Therefore, to convert a bidirectional ADTT to one direction, it should be assumed 55 percent of the total traffic is unidirectional, unless known otherwise. The 55 percent assumption is taken from the AASHTO LRFD Bridge Design Specifications Article C3.6.1.4.2. For fatigue rating, the calculated ADTT must be converted to a single lane value by use of the appropriate factor from AASHTO LRFD Bridge Design Specifications Table 3.6.1.4.2-1.

For structures with an unknown ADTT, the most conservative live load factor should be used.



LARS Bridge internally determines the appropriate load factor based on the input ADTT. LARS Bridge linearly interpolates the live load factor in accordance with the MBE.

4.11.1.2 *LFR and ASR Methods*

For the LFR method, the load factors specified in the MBE should be used. For the ASR method, there are no load factors.

4.11.1.3 *Emergency Vehicles*

A live load factor of 1.3 may be utilized in the LRFR or LFR method per previous FHWA guidance. The revised emergency vehicle live load factors presented in NCHRP 20-07 Task 410, as acknowledged by FHWA Acting Director Shay Burrows by email dated August 16, 2019, may be used as an alternative to previous FHWA guidance stating a live load factor of 1.3 should be used. A copy of this report's information and revised live load factors for the EVs is located on the DBE Google Drive resource site.

4.11.2 Condition Factor

4.11.2.1 *LRFR Method*

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. The condition factor is not intended to be a substitute for using accurately measured section properties of bridge members.

The condition factors presented in MBE Table 6A.4.2.3-1 shall be used. As noted in MBE Section C6A.4.2.3, if section properties are obtained accurately, by field measurement of losses, rather than by an estimated percentage of losses, the condition factor values in MBE Table 6A.4.2.3-1 may be increased by 0.05 to a maximum of 1.0.

4.11.3 System Factor

4.11.3.1 *LRFR Method*

System factors should be used in accordance with MBE Table 6A.4.2.4-1. The system factors listed in the MBE are more conservative than the LRFD design values and may be modified with approval from the Evaluation Section of OM.



4.12 LOAD TESTING

Load testing should be considered when certain conditions exist resulting in less reliable conventional methods of analysis. Specific situations allowing for load testing are as follows:

1. Deterioration is difficult to quantify.
2. Conventional analysis methods are difficult to apply to a unique structural configuration.
3. There is a public need to allow heavy vehicles to traverse a bridge where conventional analysis will not allow (i.e. to avoid, remove, or raise a posting).

4.13 LOAD RATING FOR UBI TRUCKS

UBI inspection trucks are utilized statewide to perform bridge safety inspections. Once the safe load capacity of a bridge reaches the point where load posting/restriction is warranted, the weight and utilization of these inspection vehicles becomes a concern. For this reason, all load posted structures across the state shall be evaluated for all UBI vehicles operating within the state.

Once a bridge is to be posted, or if a bridge is currently posted, the current UBI truck configurations shall be load rated for the bridge, in addition to the standard legal loads currently rated. If a bridge is to be inspected by use of a UBI truck, that bridge and all bridges along the travel route to and from the bridge must rate satisfactorily for the UBI truck in question. UBI trucks can be considered at 100% of operating stress level for ASR/LFR. For LRFR, the UBI trucks may be considered a single trip permit, allowing a lower live load factor to be applied in the rating calculation. Low impact may be used for the bridge being inspected if the UBI truck will traverse the bridge at slow speed. For bridges along the travel route to and from the bridge, low impact evaluation will typically not be allowed.

For the current and typical UBI truck configurations in WV, please refer to Figure 4-4 (below). Most rental UBI truck configurations are similar to those shown in Figure 4-4. If an evaluation notes borderline unsatisfactory ratings for the rental vehicle, the rental company should be contacted for correct axle weight and configuration.

It should be noted the overall weight of the UBI truck, when in the extended position, can place up to 76% of the overall axle weight on the loaded side tires. Each applicable truck configuration's loading is included in Figure 4-4 below. This should be considered during calculation and application and distribution of the truck's live load.



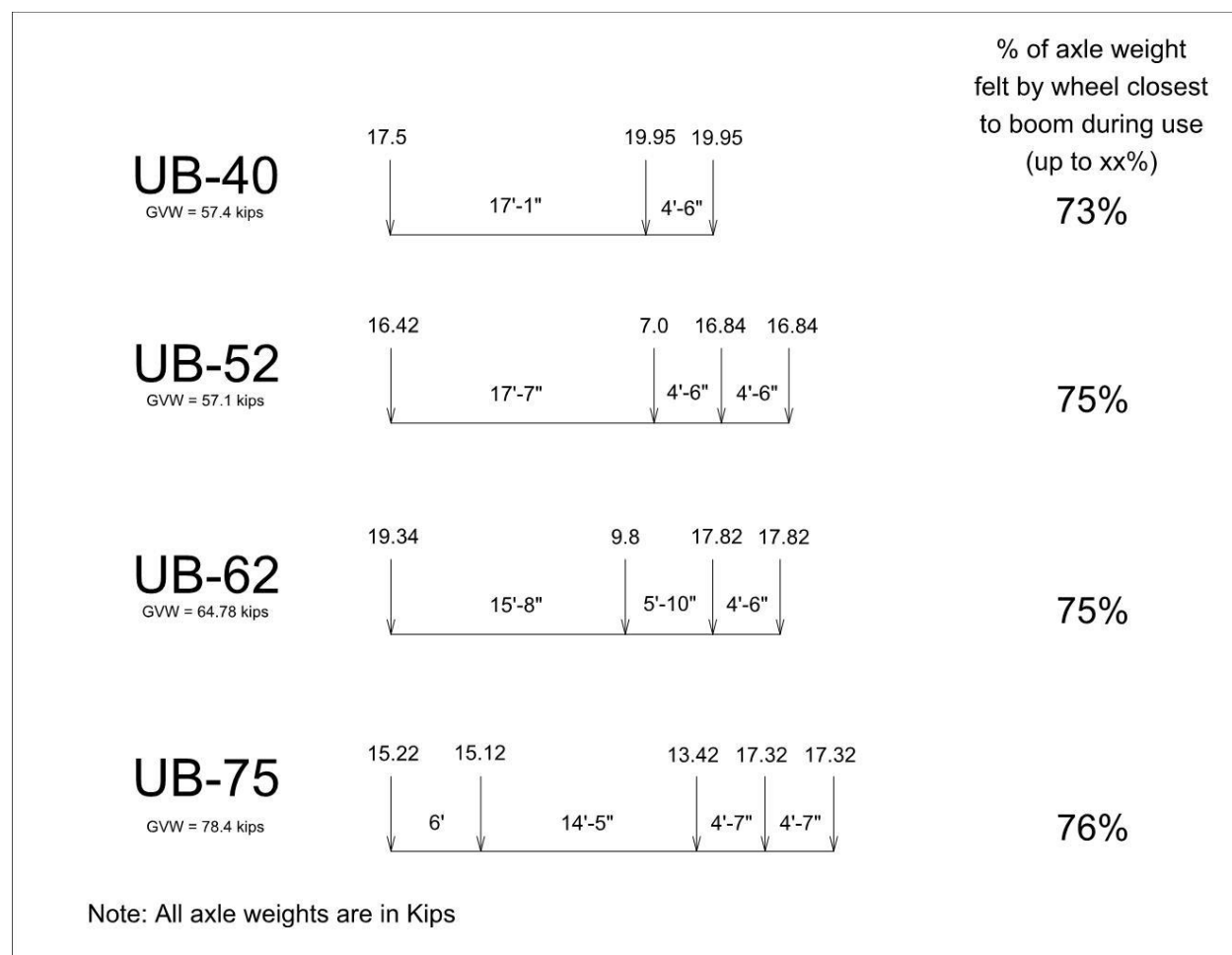


Figure 4-4 UBI Truck Live Loads



CHAPTER 5: DECKS

5.1 INTRODUCTION

This section covers decks of all materials supported by girders, stringers, or other floor systems.

5.2 POLICIES AND GUIDELINES

Beam-supported concrete deck slabs and metal decks satisfactorily carrying normal traffic need not be routinely evaluated for load capacity. If, due to deterioration, the LRE believes the deck will govern the safe load capacity of the structure, the deck may need to be load rated and/or load posted.

Timber decks exhibiting excessive deformations or deflections under normal traffic loads are considered suitable candidates for further evaluation and often control the rating.

When design plans are available, the applicable concrete strength and reinforcing steel yield strength should be used. If plans or material information is not available, use values found in MBE Sections 6A.5.2.1 6A.5.2.2.



CHAPTER 6: REINFORCED CONCRETE SUPERSTRUCTURES

6.1 INTRODUCTION

This section covers the rating of reinforced concrete girders and longitudinally reinforced concrete slabs. This section does not cover prestressed concrete members. All reinforced concrete girders and slabs shall be rated.

6.2 POLICIES AND GUIDELINES

When design plans are available, the applicable concrete strength and reinforcing steel strength should be used. If plans or material information is not available, use values in MBE Section 6A.5.2.1 and 6A.5.2.2. The general preference setting template(s) to be used in BrR are available in the AASHTOWareBr central database. They are available for download from the Google Drive resource site, as found in Appendix B, and are shown for reference in Appendix C.

For reinforced concrete bridges in which plans are not available and the details needed for a load rating stress analysis cannot be found, the use of engineering judgment is permitted, as discussed in Appendix A. In some instances, exposed rebar may reveal the size and spacing of reinforcement, allowing for a load rating analysis. This method of analysis is encouraged.

A concrete bridge with unknown reinforcement need not be posted for restricted loading when it has been carrying normal traffic for an appreciable length of time and shows no distress. In other cases, a concrete bridge with no visible signs of distress, but whose calculated load rating indicates the bridge needs to be posted, can be alternately evaluated through load testing per MBE Section 6A.8.1.

6.2.1 Analysis and Rating

6.2.1.1 *Special Considerations*

The following items shall be considered:

- For reinforced concrete slab bridges, it is advised to use the method described in Standard Specifications 3.24.3, and LRFD 4.6.2.3 is advised.
- Integral/Sacrificial wearing surfaces present on decks exposed to traffic shall not be considered in strength calculations. If the thickness of the integral wearing surface is not specified, at least ¼" shall be assumed to be an integral wearing surface and not included in strength calculations. This difference in full thickness and effective thickness shall be assumed for any concrete deck exposed to traffic.



6.2.2 LRFR Method

No exceptions to the MBE should be made.

6.2.3 LFR or ASR Method

No exceptions to the MBE should be made.



CHAPTER 7: PRESTRESSED CONCRETE SUPERSTRUCTURES

7.1 INTRODUCTION

This section describes the rating of prestressed concrete girders. All prestressed concrete bridges are to be rated.

7.2 POLICIES AND GUIDELINES

When design plans are available, the applicable concrete strength and prestressing steel strength should be used. Shop drawings often have more specific and accurate material properties than construction plans. If plans or material information is not available, use values found in MBE Sections 6A.5.2.1, 6A.5.2.2, and 6A.5.2.3.

Stress-relieved strands should be assumed when the strand type is unknown.

7.2.1 Analysis and Rating

7.2.1.1 *Special Considerations*

The following items shall be considered:

- Integral/Sacrificial wearing surfaces present on decks exposed to traffic shall not be considered in strength calculations. If the thickness of the integral wearing surface is not specified, at least ¼" shall be assumed to be an integral wearing surface and not included in strength calculations. This difference in full thickness and effective thickness shall be assumed for any concrete deck or top flange of prestressed beam exposed to traffic.

7.2.2 Software-Specific WVDOR Policy

7.2.2.1 *BrR*

WVDOR policy specific to BrR is as follows:

1. The general preference setting template(s) to be used in BrR are available in the AASHTOWareBr central database and are available for download from the Google Drive resource site per see Appendix B, and are shown for reference in Appendix C.
2. For continuous superstructures with continuity diaphragms providing continuous behavior for live loads and any other loads applied to the composite section over



interior supports, most WVDOT structures of this type include extended strands from the beam ends spliced and bent upwards into the continuity diaphragm to resist positive moment effects related to creep. BrR's input cannot currently accept prestress strands as reinforcement in the continuity diaphragm. For this reason, it is prudent to set an area of mild reinforcement equal to the area of strands provided in the diaphragm, while setting the modulus of elasticity, yield strength, and ultimate strength equal to that of the prestressing strands. Any additional mild reinforcement in the longitudinal direction of the beams included in the continuity diaphragm should be included to calculate the resistance at this location.

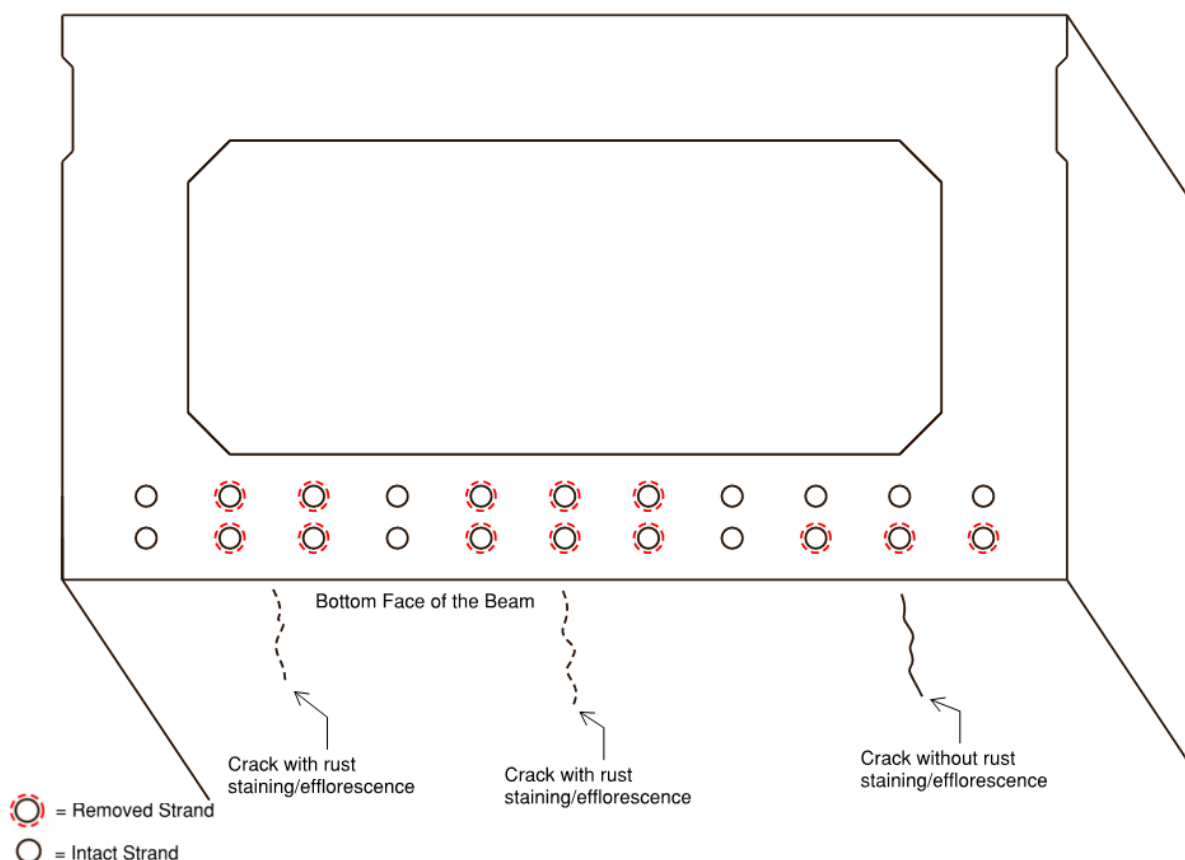
7.2.3 Deteriorated PSC Member Guidelines

Previous condition ratings or bridge performance should not be used to determine the prestressed beam capacity. If a prestressed member shows signs of deterioration, including exposed/severed prestressing strands, cracking, rust staining, efflorescence, spalling, etc., the following guidelines should be followed by using engineering judgment. Concurrence with the Evaluation Section of OM should be obtained when safe load capacity ratings are produced by means or methods outside of the guidance below.

Longitudinal cracking with/without rust or efflorescence:

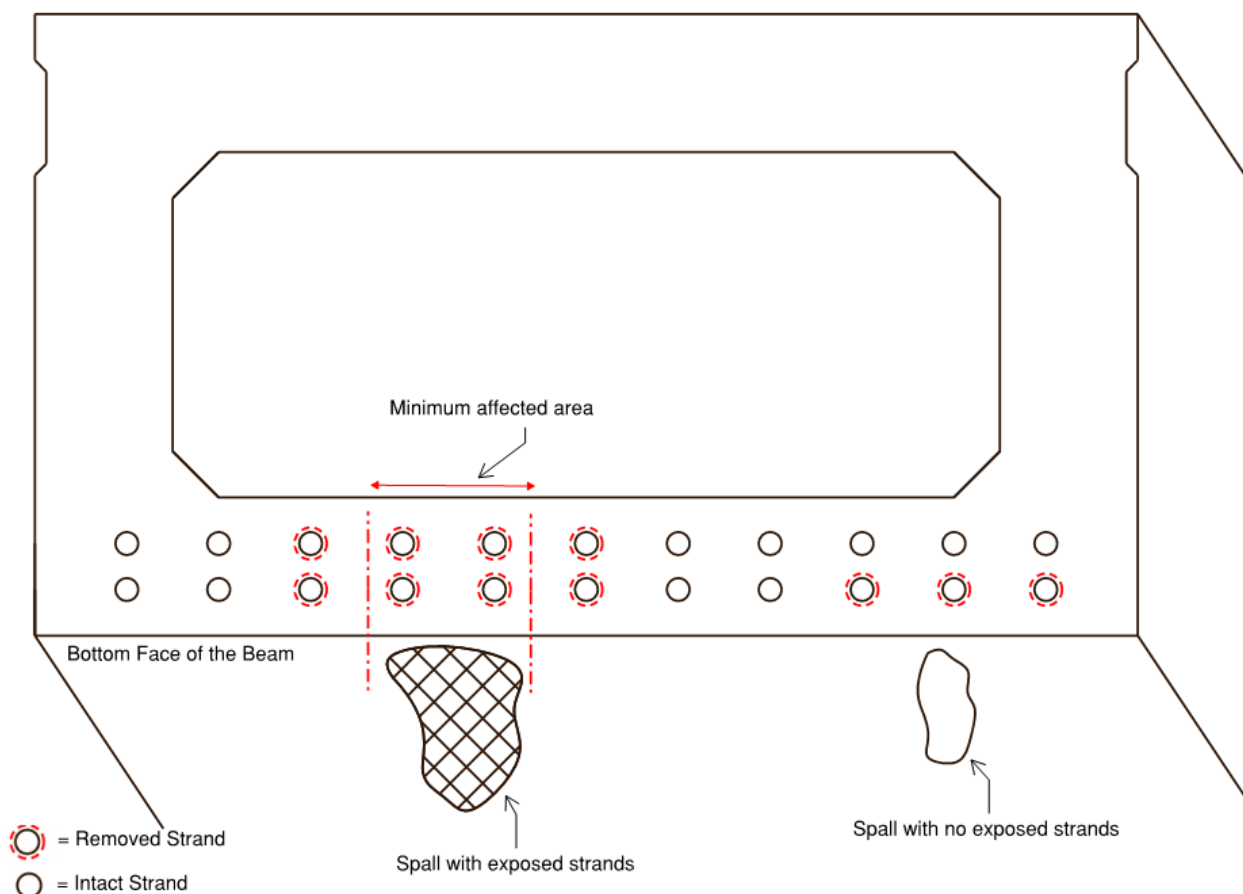
- If a longitudinal crack is present in the concrete beam element, remove one (1) strand above or next to the crack, including adjacent strands. Hairline and narrow cracks, as defined by the 2014 WVDOT Bridge Inspection Manual (Appendix C) for prestressed members, may be ignored for this guideline.
- If a longitudinal crack with rust staining and/or efflorescence is present in the concrete beam element, remove at least two (2) rows/columns of strands, including adjacent strands.
- If full length longitudinal cracking is observed in the wearing surface of an adjacent beam superstructure (adjacent box beams, channel beams, slabs, etc.), the current load rating analysis should consider a live load distribution of one wheel line per beam to account for independent action of adjacent beams. This independent action should be confirmed with camber differential measurements taken by inspection teams. Additionally, load testing and/or monitoring may be used to verify or negate independent beam action and loss of load sharing within the superstructure.





Spalling, exposed strands, and/or severed strands:

- If a spall is present and strands are not exposed, assume strands within the minimum affected area of the spall and strands adjacent to the affected area are not functioning, only for the closest row/column of strands to the spall.
- If a spall is present with exposed strands, assume strands within the minimum affected area of the spall and strands adjacent to the affected area are not functioning, for the closest two (2) rows/columns of strands to the spall.
- If a spall is present and exposed strands are severed, assume strands within the minimum affected area of the spall and strands adjacent to the affected area are not functioning, for the closest two (2) rows/columns of strands to the spall. Depending on the severity and area of the spall, consider taking twice the depth of the spall as the minimum affected area where strands are not functioning (e.g. If a spall has a depth of 5 inches, consider all the strands within 10 inches of the original beam cross-section as not functioning, including adjacent strands).



If the location of the deficiencies described above is localized, engineering judgment should be used to determine the extent and application of the guidelines. There may be instances when removal of strands from the entire beam is overly-conservative; however, decisions on the extent of strand removal or strand inclusion should be made judiciously.

If transverse cracks, particularly on the bottom flange or bottom portions of the web, are noted in the inspection report in areas of high positive bending moment, extreme caution should be exercised when load rating the prestressed member. These cracks could imply flexural cracking of the member, which may indicate a previous overloading or a loss of capacity of the member.

For post-tensioned, segmental concrete channel beams, a loss of post-tensioning cables can greatly reduce the capacity of the bridge and pose an immediate threat to public safety. In accordance with BMD-I185, post-tensioned, segmental beams should be considered for load posting once the beams have reached a condition similar to those shown in the group 1 photographs (of BMD-I185). If the condition of the segmental channel beams is worse than that shown by the group 1 photographs, including failed wires or cables of the post-tensioning, the Evaluation Section of OM should be contacted immediately for further direction and assistance.



CHAPTER 8: STEEL SUPERSTRUCTURES

8.1 INTRODUCTION

This section covers the rating of steel girders. All steel superstructure bridges shall be rated.

8.2 POLICIES AND GUIDELINES

The plastic capacity of a girder can be used for determining the load capacity. All required checks must be satisfied in the AASHTO specifications before the plastic capacity is allowed.

Girders with shear studs or anchors are considered composite sections.

8.2.1 Analysis and Rating

8.2.1.1 *Special Considerations*

The following items shall be considered:

- Top flanges of through-girder bridges shall be considered unbraced unless shown otherwise by acceptable analysis methods and permitted by the Evaluation Section of OM.
- Steel stringers and girders supporting a timber deck connected through metal deck clips shall not be considered laterally braced by the deck or deck clips.
- Webs shall be considered stiffened when a full depth transverse stiffener is present, but not when a partial depth cross-frame/diaphragm connection plate is present (web panels still need to meet provisions in specification, e.g., spacing requirements, to allow the web to be considered a stiffened panel).
- Cross-frames and diaphragms resisting primary loads shall be rated. Cross-frames and diaphragms in horizontally curved structures are typically primary members (see section 8.2.1.2 below for additional information). Cross-frames and diaphragms in straight, skewed bridges with skew angles exceeding 20 degrees from normal shall be considered primary load resisting members.
- Rating for Service II limit state is required when using the LRFR Design and Legal Load ratings, but optional for permit rating.
- Integral/Sacrificial wearing surfaces present on decks exposed to traffic shall not be considered in strength calculations. If the thickness of the integral wearing surface is not specified, at least $\frac{1}{4}$ " shall be assumed to be an integral wearing surface and not included in strength calculations. This difference in full thickness and effective thickness shall be assumed for any concrete deck exposed to traffic.



8.2.1.2 Curved Girders

Analysis and rating of curved girders should be performed as follows; refer to NCHRP Report 725, Guidelines for Analysis Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges:

- Use one of the following analysis methods:
 - 3D analysis
 - Grid
 - Line girder with V-Load method
- Rate curved girders as follows:
 - Incorporate lateral flange bending effects
 - Rate for bending and shear at controlling locations
 - Rate cross-frames
 - When curved girders meet the conditions listed in LRFD 4.6.1.2.4b and 4c, the effects of curvature may be ignored in the analysis for determining the major-axis bending moments and bending shears.
- BrR is the software of preference for any curved girder superstructure. Curved superstructures should be modeled as such in BrR, even if curvature effects can be ignored. This provides the best representation of the as-built structure and will give the most accurate ratings for safe load capacity.
 - If the superstructure meets the provisions listed in AASHTO LRFD 4.6.1.2.4b and 4c to ignore the effects of curvature, WVDOH will consider the cross-frames and/or diaphragms as secondary members not requiring load rating.
- Load ratings reported on the DS-25 and for NBI purposes should be obtained from BrR, and a capacity table for inclusion in Superload for OS/OW permits shall be generated.

8.2.2 Software-Specific WVDOH Policy

8.2.2.1 BrR

WVDOH policy specific to BrR is as follows:

1. The general preference setting template(s) to be used in BrR are available in the AASHTOWareBr central database. They are available for download from the Google Drive resource site (see Appendix B) and are shown for reference in Appendix C.
2. When a rolled shape is converted to a plate girder for input in BrR, the plate chosen should result in a section modulus as near as practical to the actual section modulus of the rolled shape. Additionally, the web height should be adjusted to maintain the section height; however, the web thickness used in the equivalent section shall be the actual web thickness.



3. The length of cover plates should be input reducing the total length of the plate by the development length at each end of the plate. WVDOT policy is to assume the development length is equal to 1.5 times the width of the cover plate.
4. For composite decks, $\frac{1}{4}$ inch thickness shall be removed for the effective deck thickness unless known otherwise. The dead load from the sacrificial wearing surface must be considered in the rating.
5. Slab reinforcing steel is not required to be modeled for simple span composite decks.

8.2.3 LRFR Method

No exceptions to the MBE should be made other than noted above.

8.2.4 ASR or LFR Method

No exceptions to the MBE should be made other than noted above.



CHAPTER 9: STEEL TRUSS SUPERSTRUCTURE

9.1 INTRODUCTION

This section pertains to the rating of steel truss superstructures. All steel trusses shall be rated.

9.2 POLICIES AND GUIDELINES

The WVDOT uses the following policies and guidelines:

1. **Truss Members** – A rating is required for all members in the main truss line. A rating is required only for members carrying live load (typically a rating is not required for portal or sway bracing members; however, cross-frames of deck trusses supporting stringers are required).
2. **Interior Floor Beams** – A rating is required for the critical interior floor beam. To determine the critical floor beam, more than one interior floor beam may require investigation due to variations in cross-sectional size, grade of material, loads, or any other determining factor.
3. **End Floor Beams** – A rating is required for an end floor beam when its capacity is different from the interior floor beams or when member deterioration or loading could result in a lower rating factor than an interior floor beam.
4. **Interior Stringers** – A rating is required for the critical interior stringer. To determine the critical stringer, more than one interior stringer may require analysis due to variations in cross-sectional size, grade of material, span length, loads, or any other determining factor.
5. **Exterior Stringers** – A rating is required for an exterior stringer when its cross-sectional size is different from that used for the interior stringers or when member deterioration or loading could result in a lower rating factor than an interior stringer.
6. **Gusset Plates** – A rating is required for all gusset plates carrying live load. Gusset plate ratings shall be performed in accordance with the MBE. All effort should be made to model and rate the gusset plates within BrR – this will allow each gusset plate to be rated automatically during any rerating or for automated permit analysis. For assistance in rating, in-house personnel should refer to the spreadsheet “WVDOT Gusset Plate LFR v2.9.xlsx” (or latest version) available on the Google Drive resource site. Gusset plates can vary greatly, so every type of gusset is not easily rated by one spreadsheet.
7. **Main Chord Splices** – A rating is required for all splices in the truss members. If chord splices provide a controlling capacity for any given member, the BrR model should reflect the controlling capacity for the chord member in the model for automated inclusion in permit analysis.



8. Main Chord Pins – A rating is required for all pin hanger connections and pin bearing connections present in the truss. If pin and/or hanger ratings control a given member in the truss, the BrR model should reflect the controlling capacity for the pin/hanger in the model for automated inclusion in permit analysis.



CHAPTER 10: TIMBER SUPERSTRUCTURES

10.1 INTRODUCTION

This section pertains to the rating of timber superstructures. All timber bridges shall be rated.

10.2 POLICIES AND GUIDELINES

The LRFR or ASR method shall be used for timber bridges as there is no LFR method for this type of bridge.

Many timber bridges in the WV inventory can be load rated using BrR or the WVDOH Modern Timber Bridge Manual created by WVU-CFC. The manual can be found on the Google Drive resource site. WVDOH uses the following:

1. Impact from live load shall not be applied to timber structures per AASHTO LRFD Section 3.6.2.3, or Standard Specifications Section 3.8.1)
2. Bending stress can be affected by imperfections in the members and should be accounted for in the rating calculations.



CHAPTER 11: SUBSTRUCTURES

11.1 INTRODUCTION

Members of substructures need not be routinely rated for live load. Substructure elements such as pier caps and columns should be rated in situations where the engineer has reason to believe the capacity may govern the load capacity of the entire bridge.

11.2 POLICIES AND GUIDELINES

WVDOH uses the following criteria to determine when the substructure should be load rated:

1. Substructure units potentially controlling the overall ratings for the bridge shall be load rated. This may include concrete, masonry, or timber substructures with deterioration, tipping, or damage present determined to be detrimental to the substructure's load carrying capabilities.
2. Steel bent/pier caps, abutment caps, and columns shall be load rated routinely.
3. Piles should be load rated when significant soil erosion has occurred in the vicinity of the pile. This typically occurs when scour of the pile leads to the susceptibility of buckling or when the pile cannot be supported in friction.



CHAPTER 12: BOX CULVERTS

12.1 INTRODUCTION

This section pertains to the rating of bridge-length concrete box culverts. Bridge-length box culverts have a length of 20 feet or greater between inside faces of outside walls measured along the centerline of the roadway.

12.2 POLICIES AND GUIDELINES

Culverts should be rated according to the guidelines provided in the MBE. If the plans or original design calculations do not exist, or severe deterioration exists, engineering judgment can be used. Engineering judgment must be based on a field evaluation. Field evaluation and engineering judgment ratings must be documented.

AASHTO MBE 6A.5.12.10.3a outlines when live load effects become negligible. If a bridge meets the provisions of MBE 6A.5.12.10.3a and live load is neglected, the DS-25 should be left blank (see section 15.2.1).

12.3 SOFTWARE

BrR should be utilized to load rate box culverts with known details, with a capacity table generated for use in Superload for OS/OW permits.



CHAPTER 13: NON-TYPICAL BRIDGE TYPES

13.1 INTRODUCTION

This section pertains to bridge types not covered in other sections of this manual, such as steel arch bridges, concrete arch bridges, cable stayed bridges, suspension bridges, and other uncommon bridge types.

13.2 POLICIES AND GUIDELINES

At this time, no policy guidelines exist for the rating of non-typical bridge types with the exception listed below. The LRE should discuss different options with the DBE and with the Evaluation Section of OM, particularly if contract work is an option.

13.3 STEEL BEAMS RESISTING GRAVITY LOADS ON WEAK AXIS

This section pertains to bridges constructed of steel beams whose weak axis resists gravity loads. These beams are placed directly flange to flange with concrete poured onto the beams. To rate these bridges using LFR, use the spreadsheet named “LFR Weak Axis Beam 2.4.xlsx” (or latest version) located on the DBE Google Drive resource site. Some of these structures have attachments providing composite action. Engineering judgement should be used to determine if composite action is present.



CHAPTER 14: BRIDGE POSTING

14.1 GENERAL

Bridge owners shall post all bridges as required. Before weight limit posting is recommended, a complete and accurate analysis should be performed and approved by the WVDOH supervisor or contracting authority.

Posting bridges for load limits is critical to the safety of the traveling public but may create hardship on the motoring public and industry using the bridge. Bridges rating low using ASR may benefit by being rated using LFR or LRFR to determine if the bridge can accommodate higher loads based on currently accepted codes. Similarly, bridges rating low using LFR method may benefit by being rated using LRFR prior to posting. If a bridge was designed using ASD, ASR ratings may be used to justify load postings and safe load capacity even if LFR was performed and reported to the NBI. It is acceptable to rate any bridge type using the LRFR method.

The Program Manager can authorize deviations from the following policy if in their opinion such deviation is in the best interest of the traveling public and does not compromise public safety.

14.2 POSTING FOR LEGAL TRUCK LOADS

Bridges shall be load rated according to the provisions of this manual using the legal trucks set forth in Section 4.4. The legal weight limits for each legal truck on each route type are shown in Table 14-1.

Table 14-1 Legal Weight Limits (for posting) in Tons

ROUTE	T3	SU4	SU5	SU6	SU7	2S2	3S2	LANE	EV2	EV3	SU-40	SU-45	3S-55	3S-60
Interstate	25	27	31	34.75	38.75	-	40	40	28.75	43	-	-	-	-
65,000	33	35.75	35.75	35.75	35.75	35.75	35.75	40	28.75	43	-	-	-	-
80,000	33	38.5	40.15	40.15	40.15	36	44	40	28.75	43	-	-	-	-
120,000	33	38.5	40.15	40.15	40.15	36	44	40	28.75	43	42	47.25	57.75	63



14.3 POSTING REQUIREMENTS

For the purpose of the posting requirements, please note the two following bridge element classifications:

Priority 1 – All NSTMs and their connections apart from floorbeams in good or fair conditions and their connections.

- When considering the safe load capacity of connections, including gusset plates, if any NSTMs frame into the connection, that connection in its entirety shall be considered Priority 1 for evaluation purposes. If, in the opinion of the engineer, any one failure mode being checked should be evaluated at the higher priority 2 rating level for safe load capacity, concurrence with the Evaluation Section of OM must be obtained.

Priority 2 – All other members and connections not qualifying as Priority 1.

The following conditions and maximum rating levels are the maximum posting limits.

- Bridges load rated based on a calculated LRFR analysis must be limited to a load limit not to exceed the legal rating level.
- Bridges load rated based on a calculated LFR or ASR analysis or by engineering judgment must be limited to a load limit not to exceed the following limits:
 - All bridges must be limited to a load limit not to exceed 70% of the operating rating of Priority 1 members and 85% of the operating rating of Priority 2 members with the following exceptions:
 - If the bridge has an ADTT (one-direction) less than or equal to 1,000 and the member has a condition of fair (5) or better, the bridge must be limited to a load limit not to exceed 85% of the operating rating of Priority 1 members and 100% of the operating rating of Priority 2 members.
 - For emergency vehicles and UBI trucks, bridges must be limited to a load limit not to exceed 100% of the operating rating of all members.
- Any bridge not load rated by the LRFR method containing Priority 1 members limited to a load limit exceeding 70% of the operating ratings and any bridge containing Priority 2 members limited to a load limit exceeding 85% of the operating rating must be subjected to more frequent competent inspections (i.e. must be inspected at an interval less than 24 months).
- For all simple spans greater than 200' and all continuous spans of any length, the force effects generated by multiple trucks in a single lane becomes a concern. In certain instances, the bridge shall be restricted by posting a sign requiring trucks to maintain a set distance apart when crossing the structure. The MBE specified lane-type load models should be used to decide whether to restrict bridges for multiple trucks in a single lane; however, if those live load effects cannot be generated, use the following procedure to determine whether to restrict the distance of consecutive trucks:



- For bridges load rated based on a calculated LRFR analysis, the HL-93 design operating rating factor will be used as a screening tool. For all simple spans greater than 200' and all continuous spans of any length, if the HL-93 operating rating factor is less than 1.0, please contact the Evaluation Section of OM for guidance.
- For bridges load rated based on a calculated LFR or ASR analysis, the HS20 lane load model should be used as a screening tool. For all simple spans greater than 200' and all continuous spans of any length, if the HS20 operating rating is less than 36 tons, please contact central office for guidance.
- Bridge type structures, box culverts, pipes, and other miscellaneous structures not meeting the definition of a bridge due to span length may be limited to legal (operating) rating levels if deemed prudent in the opinion of the DBE.

The above written posting requirements are also described in the following tables. Table 14-2 indicates the maximum weight limits displayed as percentages of the operating rating.

Table 14-2 Maximum Weight Limits as Percentages of the Operating Rating

Rating Method	Vehicle	Criteria	Priority 1	Priority 2
LFR, ASR, or Judgment	Standard and CRTS	ADTT ≤ 1,000 AND Member Condition Rating ≥ 5	85%	100%
		ADTT > 1,000 OR Member Condition Rating < 5	70%	85%
	Emergency/UBI Trucks		100%	
LRFR			100% (of legal)	

When a bridge has a weight limit exceeding the values in Table 14-3 (expressed as percentages of the operating rating), more frequent inspections are required (interval <24 months).



Table 14-3 Percentages of the Operating Rating Representing Weight Limits Requiring More Frequent Inspections

Rating Method	Vehicle	Priority 1	Priority 2
LFR, ASR, or Judgment	Standard and CRTS	70%	85%

For convenience during legal load evaluations, safe load capacity weight limit tables have been provided in Appendix E.

14.3.1 Required Timeframes for Bridge Postings

Bridge postings should be expeditiously reviewed and processed to ensure timely erection of weight limit signs once the determination of bridge posting need has been made. FHWA mandated a maximum of 30 days to erect bridge posting signs, per NBIS. For non-emergency bridge postings, WVDOT policy requires signs to be erected in the field within 30 days from the date of the CO. Additionally, under no circumstances shall the timeframe from the load rating date to the CO date exceed 15 days. Any deviation from this ruling should be considered a rare circumstance and must be documented in the Engineer's Comments section of the state's database collection software and in the Posting Submittal Log located in the DBE Google Drive.

For city-owned bridges falling outside of the jurisdiction of WVDOT for bridge posting, the recommendation made to the city for a bridge posting shall occur within 15 days of the load rating date, on the DS-25 Form, determining the need for the posting.

If the bridge evaluation deems a posting would be necessary by policy, but repairs can be made within 45 days, the open inspection report can be submitted through normal processing with proper notes and documentation on the DS-25 Form and in the Engineer's Comments of the report. Prior to or during the next scheduled inspection, the bridge's inventory report and DS-25 Form will be updated to reflect the repairs made. If the repairs cannot be completed within 45 days, a temporary safe load capacity and bridge posting must be issued until repairs can be made. At no time can temporary safe load capacity exceed the full operating (ASR/LFR/Judgment) or legal (LRFR) rating level.

All dates required to be tracked along the process of a bridge posting are on the "Posting Submittal Log, C.O. Tracking" spreadsheet housed on the DBE Google Drive. If these timeframes for bridge posting cannot be met, proper notes should be documented on the tracking spreadsheet to explain the specific reason for the delay.



14.3.2 Emergency Bridge Posting

Damage and loss of structural capacity can occur from vehicular or vessel impact strikes, flood damage, overloads, or other conditions. These situations can lead to the necessity to immediately post a bridge, prior to proper evaluation and review procedures outlined in the routine posting process in Section 14.5. This immediate response may be realized during a routine inspection, or it may be driven by factors outside of the inspection cycle.

If a bridge is determined to be unsafe at the current legal or posted level and requires emergency bridge posting, the DBE, District Evaluation Engineer, or other qualified bridge engineer shall immediately act as outlined in the steps below. If the bridge requires immediate closure, refer to BMD-P57 for guidance.

Emergency Bridge Posting Procedure:

- Immediate issuance of an emergency bridge posting work order to the District Sign Shop.
 - Erection of a gross load posting (R12-1) sign by district forces using available sign stock and numbering as soon as possible. (If deemed an emergency, a gross load posting should be used in lieu of a silhouette sign until such time that a complete evaluation can be performed.)
 - If advanced posting is warranted, the advanced signs with applicable mileage placards should be installed as soon as possible, but sign installation at the bridge should not be postponed.
 - If detour signage is needed, prompt erection of detour signs to allow truck traffic alternate routes.
- Prompt notification (within 24 hours of determination) to the District Engineer/Manager, NBIS Program Manager, Evaluation Section of OM, and any other appropriate organizations. If the temporary posting level is below 18 tons gross load, local school officials and public transits need notified (if applicable).
- Submission of a DS-25 Form requesting an Emergency CO within 24 hours of determination of the emergency posting.
 - The ratings on this DS-25 should be assigned by judgment based on the level of posting requested for the emergency restriction.
 - The tracking spreadsheet on the DBE Google Drive resource site should include a note designating an Emergency Posting.
- An updated load rating and evaluation reflecting the condition of the bridge/element in question performed within 15 days of temporary posting.
 - If the emergency posting need was determined outside of a regular bridge inspection, this updated load rating should be coupled with a Special Bridge Inspection documenting what occurred to cause the emergency.



- If this completed evaluation determines a permanent weight restriction differing from the emergency posting value is warranted without immediate repairs, a new DS-25 Form shall be submitted for processing to Evaluation Section of OM as outlined in the routine posting process (section 14.5 below), subject to the timeframes listed in section 14.3.1.
- If the updated evaluation leads to repairs or retrofits that can be accomplished within 45 days, the emergency posting can remain in place until such time that the repairs are performed. After repairs are performed, a new DS-25 Form shall be submitted for processing to Evaluation Section of OM to modify the bridge's safe load capacity (either complete removal of the emergency posting or higher posting level).
 - If this results in a modified safe load capacity and posting level, an updated CO shall be requested through normal procedures.

14.4 WEIGHT LIMIT SIGNAGE

In the event a posting is required, the decision to use a gross load or silhouette posting is left to the discretion of the DBE; however, if the posted load limit cannot meet the following minimum posting requirements, a gross load posting is required.

- T3 – 9 Tons, SU4 – 11 Tons, 3S2 – 13 Tons
- SU40 – 12 Tons, SU45 – 14 Tons, 3S55 – 17 Tons, 3S60 – 18 Tons

The minimum load posting weight is 3 tons. Bridges not capable of carrying a minimum gross load weight of 3 tons shall be closed.

For any type of weight limit posting sign, whole numbers shall be used.

Advanced posting signage should be recommended when it is expected drivers will not be able to stop and turn around without much disruption to traffic. The advanced posting scheme should be coordinated with district traffic engineering staff. If a bridge is determined to warrant advanced posting, it should be indicated on the DS-25 (checkbox on the group IV sheet). Records of which bridge postings include advanced warning signs should be kept and maintained by the district.

When a bridge is silhouette posted on a non-CRTS route, the posted values shall not exceed the values shown in Figure 14-1. When a bridge is silhouette posted on a CRTS, the posted values shall not exceed the posted values shown in Figure 14-2. The values for each truck arranged from top to bottom of the silhouette shall be equal to or greater than the preceding truck.

On CRTS routes, the silhouette posting (either the 4-line CRTS silhouette or 5-line CRTS silhouette including the 2-axle configuration) must be compared to and evaluated with the standard legal truck configurations. If a standard legal truck configuration (T3, SU4, etc.) needs restricted



by policy in addition to the CRTS configurations, the load rating must evaluate the lowest safe load capacity for each silhouette line on the sign (i.e., the T3 should be evaluated with the SU40, the SU4-SU7 trucks should be evaluated with the SU45, and the 3S2 should be evaluated with the 3S55).

Maximum Posted Values				
	<u>Interstate</u>	<u>65,000</u>	<u>80,000</u>	
	<u>20</u>	<u>20</u>	<u>20</u>	T
	<u>25</u>	<u>30</u>	<u>30</u>	T
	<u>27</u>	<u>33</u>	<u>35</u>	T
	<u>37</u>	<u>33</u>	<u>36</u>	T
	<u>40</u>	<u>33</u>	<u>40</u>	T

Figure 14-1 Maximum Posted Values for non-CRTS Silhouette Weight Limit Sign

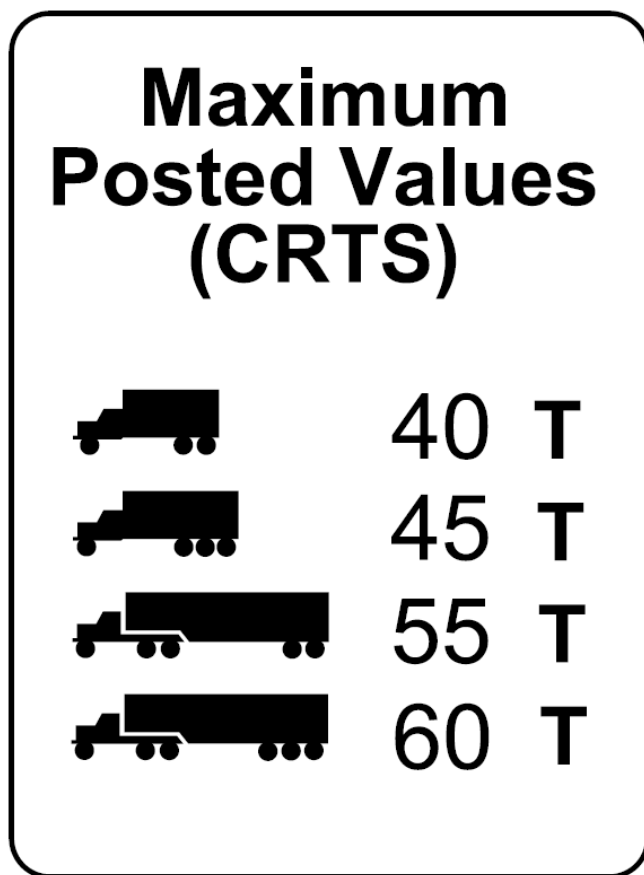


Figure 14-2 Maximum Posted Values for CRTS Weight Limit Sign

14.5 CHANGE IN POSTING PROCESS

The posting process described in this section pertains to any change in posting status for the structure or the location as referenced by the county-route-milepost (CO-RT-MP). Once a structure is determined to be posted, per Section 14.3, the following steps shall occur to limit weight on the structure within timeframes outlined in Section 14.3.1.

1. The DBE decides to modify allowable truck weights on a bridge.
2. The LRE shall complete the DS-25 on the current open inspection report. If a change in posting recommendation occurs outside of a normal inspection report, either a Special Inspection report may be generated or a DS-25 external to AssetWise may be developed.
3. If the DBE decides to utilize a silhouette type posting sign, the LRE shall generate a draft mockup of the posting sign silhouette.
4. If the structure did not previously have a posting restriction, the LRE shall update SI&A Sheet 8: Item 16 (NBI 41) to be coded "B".
5. The District Engineer/Manager shall review and sign the DS-25.



6. The DBE shall initiate a new line on the “Posting Submittal Log, C.O. Tracking” spreadsheet housed on the DBE Google Drive resource site.
7. The LRE shall send, via email to DOHBridgePostingRequests@wv.gov, the completed DS-25, previous CO, if applicable, silhouette sign mockup, if applicable, location map of the structure, and change in posting explanation, if applicable, to the Evaluation Section of OM.
8. The Evaluation Section of OM shall review the DS-25 for completeness and compliance with this manual, specifically Section 14.3, and apply their initials adjacent to the controlling load rating values.
9. OM shall generate an unsigned CO then distribute the CO to various entities including, but not limited to, the appropriate offices of the District Engineer/Manager and DBE.
10. The Director of OM shall approve and sign the DS-25.
11. OM shall send the completed DS-25, previous CO, if applicable, silhouette sign mockup, if applicable, location map of the structure, and change in posting explanation, if applicable, to the HO.
12. The HO and the Commissioner shall review, approve, and sign the CO, then distribute it to various entities including, but not limited to, the appropriate offices of the District Engineer/Manager and DBE.
13. The DBE shall ensure weight limit signs are installed at the bridge, typically performed in coordination with the district sign shop.
14. The DBE shall update the SI&A and Google Drive DBE document tracking spreadsheet accordingly.
 - a. The fields to be updated are on Sheet 8: Item 16 (NBI 41) and on Sheet 9: posting values and date of posting.
 - b. Update the values of the open inspection report or if it has been finalized, the asset values shall be updated.
 - c. Ensure all data fields on the Google Drive DBE “Posting Submittal Log, C.O. Tracking” spreadsheet have been populated.
 - d. Ensure the signed CO is attached in AssetWise in the Manager Files location and, if applicable, previous invalid COs are removed.

14.5.1 Rescinding Bridge Postings based on New or Rehabilitated Structure

Typically, a request to rescind a restriction placed on a particular county-route-milepost associated with a bridge is completed with the inventory inspection of the new or rehabilitated structure as updated or new bridge load ratings are performed during the inventory inspection. This also holds true for bridge projects using phased construction. If inventory update efforts are performed correctly, when traffic is switched to the new bridge, or portion thereof, this method of rescinding works and is consistent.



Note the restriction is in reference to the CO-RT-MP, not the structure itself. For this reason, it is acceptable to attach a copy of the rescind CC Order to the current in-service bridge asset in AssetWise – this shows there is no current restriction along that CO-RT-MP.

If a rescind request is issued for a location with traffic being maintained by a temporary structure after the low-rating bridge is demolished/removed, the safe load capacity ratings for the temporary structure must ensure all legal loads are safe and meet the provisions of this manual.



CHAPTER 15: LOAD RATING DOCUMENTATION

15.1 INTRODUCTION

All load ratings analyses shall be documented in accordance with this manual. The purpose of good documentation is to clearly present: the safe load carrying capacity of the structure and supporting documentation used to obtain these results.

15.2 DS-25 AND WV SI&A

15.2.1 DS-25

The DS-25, Safe Load Capacity Analysis and Justification Report, details and justifies the safe load capacity of the bridge and any current or recommended weight restrictions related to the bridge's capacity. The DS-25 should always be updated when new load ratings are obtained; therefore, every structure shall have an up-to-date DS-25 reflecting the current known condition of the structure. Ratings shall be recorded for the legal trucks set forth in Section 4.4.

Each truck configuration should have a controlling rating reported on the DS-25, Group II page. Typically, only the controlling ratings should be reported on this page; however, if both Priority 1 and Priority 2 members are present for an LFR or ASR analysis, the controlling member ratings for each priority level should be reported. An example would be an LFR truss with several NSTMs. The controlling NSTM ratings would be reported under the Priority 1 line, while the controlling non-NSTM ratings would be reported under the Priority 2 line.

Once the controlling ratings are reported on the DS-25, each line shall be evaluated against the thresholds defined in Appendix E - Safe Load Capacity Weight Limit Tables to determine if posting is warranted (see Chapter 14 – Bridge Posting for more information).

On the DS-25 Group III sheet, under item 27, if the ratings are controlled by the deteriorated condition of a member, an explanation under the same item 27 shall be provided for the member and deteriorated component controlling the ratings. For item 28 on the same sheet, the safe load capacity is defined as one of three options: Legal Loads, Present Restrictions, or Recommended Restrictions. If a posting is in place or being recommended, the safe load capacity cannot be set to legal loads.

There are certain instances when the DS-25 form should be left blank and is not needed. This would include under record inspection reports (DS-33), instances when depth of fill negates live load effects on the bridge (NBI 64 and NBI 66 codes of 99), or structures with no loading applied, such as bridges closed to all traffic.



Bridges closed to vehicular traffic but accessible by pedestrians should be load rated and evaluated accordingly, with a maximum gross weight for pedestrian use reported on the DS-25 under the notes box on the Group II page. There may be instances when the bridge is lightly loaded with pedestrian traffic; likewise, some bridges may be loaded with large volumes of pedestrian traffic. For this reason, the DBE should decide on a case-by-case basis the level of load rating and evaluation required to determine the safe load capacity of the bridge. The DBE may use engineering judgment to determine the anticipated pedestrian loading of the bridge. If the anticipated pedestrian loading exceeds the safe load capacity of the bridge, the bridge shall be closed to all traffic.

If a temporary bridge is in place and carrying traffic, the DS-25 shall reflect the safe load capacity of the temporary bridge. If this temporary bridge is part of a construction contract, where a contractor installed the temporary bridge to maintain traffic during demolition/construction of a new bridge, ratings may be based on design loading information found in the contract plans.

15.2.2 WV SI&A

The WV SI&A load rating data fields, housed in Sheet 8 and Sheet 9 of the SI&A form, include NBI items 63, 64, 65, and 66, all relating to the inventory and operating design ratings of the bridge. NBI items 64 and 66, on Sheet 8 of the SI&A, should be coded in English tons. NBI items 63 and 65, on Sheet 9 of the SI&A, should be picked from available options representing ratings coded in tons. This means a code of 6, 7, 8, D, E, or F should NOT be used for NBI 63 or NBI 65.

Any bridge with negligible live load effects due to fill depth, in accordance with applicable specifications, shall be coded “99” for the inventory and operating ratings on Sheet 8 (NBI 64 and NBI 66).

If a bridge rates at or above 98 tons for the inventory or operating stress level of the design vehicle, the tonnage rating reported on Sheet 8 will be limited to 98 tons, with 99 tons reserved for negligible live load effects discussed above.

15.2.3 LRFR

The HL-93 rating factors shall be reported on the DS-25. HL-93 ratings in tons shall be reported for NBI purposes. These tonnage ratings reported for HL-93 shall be obtained by multiplying the controlling rating factors by 36 tons. The “Method Used to Determine ... Rating” fields, NBI items 63 and 65, should be coded to “3” to correspond to LRFR ratings reported in tons. All other legal truck ratings shall be reported as discussed in Section 15.2.1.



15.3 ANALYSIS PACKET – LOAD RATING SUMMARY AND SUPPORTING DOCUMENTATION

While the DS-25 shows the controlling rating values governing the safe load capacity of the structure, a need exists to document a summary of all applicable load ratings for the bridge and all supporting documentation used to perform the bridge evaluation and load rating into an analysis packet. This load rating summary is best captured on a DS-35 Form. The DS-35 is a detailed summary of the load rating results for each limit state of each member of the structure. In addition to the load rating summary, all supporting documentation used during the bridge rating should be included in the analysis packet. This includes hand calculations, assumptions made, references used, etc.

The analysis packet in its entirety shall be attached to the bridge asset in AssetWise as an asset file under Manager Files (same location as inventory report attachments, DS-12's, etc.). There is no need to attach the analysis packet under each report separately.

15.4 HAND CALCULATIONS

Any hand calculations performed should be clearly documented and kept by the district, included in the analysis packet mentioned in Section 15.3.

15.5 COMPUTER MODELS

For in-house ratings, all BrR model files will be stored in the central server database, AASHTOWareBr. For access requests or information on this database, please contact Evaluation Section of OM. Other load rating software input files shall be kept by the district and submitted to OM. Consultants shall submit all computer model input files with final load rating reports.

15.5.1 Superload Model Files

The most recent LARS Bridge files and capacity table files submitted to OM for inclusion into Superload are kept by OM. See Section 4.9.2 for more information.



APPENDIX A: JUDGMENT LOAD RATING CONCRETE STRUCTURES

The purpose of this directive is to revise the statewide policy for assigning load ratings to those concrete structures rated by judgment due to the lack of sufficient information and/or plans to allow a structural analysis to be completed. This directive is intended to include concrete structures such as arches, beams, girders, slab bridges, etc., which are in good or fair condition and for which little or no design load information is available, or for concrete, steel, or aluminum culverts where an analysis cannot be performed by normal procedures.

These tables should not be used for material types other than the specific group of bridges described in this directive. However, the values in the tables may be useful as a guide in assigning rating values for other types of structures where an analysis cannot be completed by hand or available computer software. In this situation, the DBE should determine rating values based on judgment, but this policy should not be referenced as the basis for that judgment.

The current edition of the MBE allows concrete bridges with unknown details to be exempt from posting if it has been carrying normal traffic for an appreciable length of time and shows no distress; however, the bridge may need inspected at more frequent intervals than bridges with calculated load ratings or with load ratings determined from load testing. The MBE and NBIS limit the operating rating level as the maximum permissible live load to which the structure may be subjected. Any bridge assigned an operating rating lower than the legal load for a vehicle on that route system must be posted at levels that satisfy the WVDOT posting policy.

The rating tables contained herein represent reasonably accurate rating values for concrete bridges similar to those used for development of the tables. However, actual ratings for some specific bridges may be significantly different than what the tables predict, and the DBE may use judgment to assign values different from those shown in the tables. For example, our experience with concrete arches has shown those structures are capable of safely carrying loads much higher than their original design load. The DBE may use their judgment to assign rating values not requiring the bridge to be posted. Concrete beams, girders, and slabs have not performed as well as arches and may not be suitable structures for this exception.

The tables are to only be used for superstructures in good or fair condition and of WVDOT quality construction. Bridges coded poor or critical in the SI&A should be evaluated by the DBE, and the rating values should be reduced appropriately considering the degree of deterioration, excessive dead load, signs of distress, and other factors important in assigning the judgment ratings and justifying the safe load capacity. The condition rating of these bridges should be based on the condition of the main load carrying element and not secondary elements. For arch bridges this would normally be the arch ring and not the spandrel, parapet, or wing walls. It may be appropriate to review/revise condition codes for these structures rated poor or critical.



The rating tables were developed from design calculations of six arches, six through girders and eight tee beams with spans ranging from 25 to 80 feet. Operating ratings were approximated for each bridge and an inventory to operating ratio was calculated. For convenience, the concrete bridges were grouped into three span length ranges. The live load design vehicle was converted to equivalent vehicles and new values were projected for the various AASHTO or State legal vehicles shown in the tables.

To use the rating tables, first determine the rating vehicle as described below. Once the rating vehicle has been determined, select the appropriate table based on span length and use the corresponding ratings for reporting on form DS-25.

If one of the following design vehicles or design criteria is known, use the corresponding rating vehicle:

Design Vehicle/Criteria	Rating Vehicle
15 Ton Roller	H15
100 psf	H15
150 psf	H20

If the design load is unknown, use the following rating vehicles based on the date of construction or estimated date of construction:

Date Built	Rating Vehicle
Prior to 1921	H10
1921 thru 1943	H15 or H20*
1944 and Newer	HS15

* Routes which were a part of the mainline road system during this period should be assigned the higher value.



Various precast concrete beam structures produced through the late 1980 were designed for an HS20 live load. Structures produced after the late 1980s were designed for an HS25 live load. If the design loading is known to be a conventional H or HS AASHTO vehicle, use that as the rating vehicle. If the design loading is known to be HL-93, use HS25 as the rating vehicle.



APPENDIX A.1 – JUDGMENT TABLES

TABLE 1
Spans less than 41'

Rating Vehicle	OPERATING (Tons)														HS20 (Tons)	
	Standard							CRTS				Emergency		Permit	Inv	Oper
	T3	SU4	SU5	SU6	SU7	2S2	3S2	SU40	SU45	3S55	3S60	EV2	EV3	WP47		
H10	30	26	28	29	31	37	43	28	32	45	45	29	28	42	16	35
H15	45	43	43	43	46	55	65	43	48	67	67	44	43	62	24	52
H20	60	53	56	57	62	73	86	56	63	89	89	58	57	83	32	70
HS15	51	46	48	49	52	62	73	47	54	76	76	50	48	71	27	59
HS20	69	61	64	66	71	84	99	64	73	103	103	67	65	96	36	79
HS25	84	74	79	80	86	103	121	78	89	125	125	82	79	117	45	99

TABLE 2
Spans 41' through 60'

Rating Vehicle	OPERATING (Tons)														HS20 (Tons)	
	Standard							CRTS				Emergency		Permit	Inv	Oper
	T3	SU4	SU5	SU6	SU7	2S2	3S2	SU40	SU45	3S55	3S60	EV2	EV3	WP47		
H10	28	27	28	28	29	39	41	28	29	46	46	28	27	38	13	31
H15	42	43	43	43	43	59	61	43	43	69	69	42	43	57	19	46
H20	57	54	57	57	59	79	83	56	58	93	93	57	56	78	26	61
HS15	60	57	60	60	62	84	87	59	61	97	97	60	59	82	27	65
HS20	68	65	68	68	70	95	99	67	71	123	123	68	66	103	36	72
HS25	99	94	99	99	102	138	144	98	101	162	162	99	97	135	45	107



TABLE 3
Spans longer than 60'

Rating Vehicle	OPERATING (Tons)														HS20 (Tons)	
	Standard							CRTS				Emergency		Permit	Inv	Oper
	T3	SU4	SU5	SU6	SU7	2S2	3S2	SU40	SU45	3S55	3S60	EV2	EV3	WP47		
H10	29	28	29	29	30	36	35	29	29	40	40	29	29	34	12	31
H15	44	43	44	44	45	55	54	43	44	60	60	44	43	52	18	46
H20	58	56	58	58	59	72	71	57	59	80	80	58	57	69	24	61
HS15	67	65	67	67	68	83	82	66	68	92	92	67	66	80	27	70
HS20	89	86	89	89	91	111	109	89	91	125	125	89	88	108	36	94
HS25	111	108	111	111	113	138	136	109	112	153	153	111	110	132	45	117



APPENDIX B: LOAD RATING RESOURCES

- **AASHTO Manuals**

MBE, LRFD, and more.

WVDOH maintains a list of available AASHTO manuals on ProjectWise.

- **Load Rating Examples**

The appendices to the MBE has several good load rating examples.

- **Highways Operations DBE Document Library – Google Drive**

Previous BIC presentations, AASHTOWare BrR Resources, Load Rating Spreadsheets and Resources, WV Timber Bridge Manual, BMDs, etc.

<https://drive.google.com/drive/folders/1YEsUtvBmewBA6yPzU61p62mZ8iDM7z3S>

- **BrR**

Help can be obtained from pressing F1 while inside of the BrR program, for any input field. In addition, the help button on the top menu bar has a few helpful features, including the “Support” option, which includes several links to tutorials, training, and online help files.

- Google Drive (link above) BrR Resources folder
 - BrR Training and Self-Learn Resources
- www.aashtobr.org
 - BrDR User Group Home Page
 - “Presentations” link shows most previous RADBUG meeting presentations
- JIRA Access
 - BrDR support ticket center
 - Read-only access for viewing support issues
 - <https://bridgeware.atlassian.net/servicedesk/customer/portals>
 - Login email: brdr@promiles.com
 - Password: readaccess



- **LARS**

[C:\BKey\Docs](#) – On each user’s local computer. Contains the following:

LARS_LarsBridgeUserManual – Explains the software screen by screen and is quite helpful.

LARS Specification Manual – Explains calculations LARS uses in detail with code references and might be helpful for understanding the LARS detailed outputs such as capacities of beams, etc.

Release Notes - Summarizes changes in LARS for each version release.

[C:\BKey\Training](#) – Contains walkthrough examples

The 6 PDFs, an overview pdf, and 6 examples are helpful when first using LARS.



APPENDIX C: AASHTOWARE BRR PREFERENCES, TEMPLATES, AND BEST PRACTICES

General Preference Setting Templates currently available in AASHTOWareBr central DB and available for inclusion and use in any local DB in BrR:

- LFR steel A36 allow plastic
- LRFR steel A36 allow plastic
- LFR steel pre-A36 no plastic
- LRFR steel pre-A36 no plastic
- LFR steel no 10.57 allow plastic
- LFR concrete
- LRFR concrete – design
- LRFR concrete - legal

Template Name: LFR steel A36 allow plastic

Template Description: LFR - This template is to be used for steel bridges allowing plastic analysis per specification. A36 and newer steel is considered ductile; steel designations older than A36 are not ductile enough to consider plastic analysis.

LFD

 Points of interest

- ☒ Generate at tenth points
- ☒ Generate at section change points
- ☒ Generate at user-defined points
- ☐ Allow moment redistribution
- ☒ Allow plastic analysis of cover plates
- ☒ Include field splices in rating
- ☒ Include bearing stiffeners in rating
- ☒ Allow plastic analysis
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Ignore overload operating rating
- ☐ Ignore shear
- ☐ Consider tension-field action in stiffened web end panels

 Distribution factor application method

 - ☐ By axle
 - ☒ By POI



Template Name: LRFR steel A36 allow plastic

Template Description: LRFR - This template is to be used for steel bridges that should allow plastic analysis per spec. Also allows Appendix A6 when applicable. A36 and newer steel is considered ductile; steel designations older than A36 are not ductile enough to consider plastic analysis.

LRFR

-  Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
 - ☒ Generate at stiffeners
- ☐ Allow moment redistribution
- ☒ Use Appendix A6 for flexural resistance
- ☒ Allow plastic analysis
- ☐ Evaluate remaining fatigue life
- ☐ Ignore long. reinf. in negative moment capacity
- ☒ Include field splices in rating
- ☐ Consider tension-field action in stiffened web end panels
-  Distribution factor application method
 - ☐ By axle
 - ☒ By POI



Template Name: LFR steel pre-A36 no plastic

Template Description: LFR - This template is to be used for steel bridges that should NOT allow plastic analysis per spec.

LFD

-  Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
- ☐ Allow moment redistribution
- ☐ Allow plastic analysis of cover plates
- ☒ Include field splices in rating
- ☒ Include bearing stiffeners in rating
- ☐ Allow plastic analysis
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Ignore overload operating rating
- ☐ Ignore shear
- ☐ Consider tension-field action in stiffened web end panels
-  Distribution factor application method
 - ☐ By axle
 - ☒ By POI



Template Name: LRFR steel pre-A36 no plastic

Template Description: LRFR - This template is to be used for steel bridges that should NOT allow plastic analysis per spec.

LRFR

-  Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
 - ☒ Generate at stiffeners
- ☐ Allow moment redistribution
- ☐ Use Appendix A6 for flexural resistance
- ☐ Allow plastic analysis
- ☐ Evaluate remaining fatigue life
- ☐ Ignore long. reinf. in negative moment capacity
- ☒ Include field splices in rating
- ☐ Consider tension-field action in stiffened web end panels
-  Distribution factor application method
 - ☐ By axle
 - ☒ By POI



Template Name: LFR steel no 10.57 allow plastic

Template Description: LFR - This template is the same as "LFR steel A36 allow plastic", but it ignores the service ratings from std spec article 10.57

LFR

-  Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
- ☐ Allow moment redistribution
- ☒ Allow plastic analysis of cover plates
- ☒ Include field splices in rating
- ☒ Include bearing stiffeners in rating
- ☒ Allow plastic analysis
- ☐ Ignore long. reinf. in negative moment capacity
- ☒ Ignore overload operating rating
- ☐ Ignore shear
- ☐ Consider tension-field action in stiffened web end panels
-  Distribution factor application method
 - ☐ By axle
 - ☒ By POI



Template Name: LFR concrete

Template Description: This template includes default concrete settings (both R/C and P/S) for LFR analysis.

LFD

-  Points of interest
 - ☒ Generate at tenth points except supports
 - ☒ Generate at support points
 - ☒ Generate at support face & critical shear points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
-  Shear computation method
 - ☐ Ignore
 - ☐ Use AASHTO 1979 interim code
 - ☒ Use current AASHTO
-  Distribution factor application method
 - ☐ By axle
 - ☒ By POI
- ☐ Consider moment capacity reduction
- ☒ Consider deck reinf. development length



Template Name: LRFR concrete - design

Template Description: This template includes default concrete settings (both R/C and P/S) for LRFR analysis; includes service III for P/S design check.

LRFR

-  Points of interest
 - ☒ Generate at tenth points except supports
 - ☒ Generate at support points
 - ☒ Generate at support face & critical shear points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
-  Shear computation method
 - ☐ Ignore
 - ☒ General procedure
 - ☐ General procedure - Appendix B5
 - ☐ Simplified procedure
 - ☐ Simplified procedure - Vci, Vcw
-  Loss & stress calculations
 - ☒ Use gross section properties
 - ☐ Use transformed section properties
-  Multi-span analysis
 - ☒ Continuous
 - ☐ Continuous and simple
- ☐ Ignore design & legal load shear
- ☐ Ignore permit load shear
- ☒ Consider legal load tensile concrete stress
- ☒ Consider splitting resistance article
- ☐ Ignore tensile rating in top of beam
- ☒ Consider deck reinf. development length
- ☒ Consider permit load tensile steel stress
- ☐ Ignore long. reinf. in rating
-  Distribution factor application method
 - ☐ By axle
 - ☒ By POI
- ☐ Allow negative epsilon in general shear method



Template Name: LRFR concrete - legal

Template Description: This template includes default concrete settings (both R/C and P/S) for LRFR analysis; IGNORES service III for P/S legal load rating.

LRFR

-  Points of interest
 - ☒ Generate at tenth points except supports
 - ☒ Generate at support points
 - ☒ Generate at support face & critical shear points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
-  Shear computation method
 - ☐ Ignore
 - ☒ General procedure
 - ☐ General procedure - Appendix B5
 - ☐ Simplified procedure
 - ☐ Simplified procedure - Vci, Vcw
-  Loss & stress calculations
 - ☒ Use gross section properties
 - ☐ Use transformed section properties
-  Multi-span analysis
 - ☒ Continuous
 - ☐ Continuous and simple
- ☐ Ignore design & legal load shear
- ☐ Ignore permit load shear
- ☐ Consider legal load tensile concrete stress
- ☒ Consider splitting resistance article
- ☐ Ignore tensile rating in top of beam
- ☒ Consider deck reinf. development length
- ☒ Consider permit load tensile steel stress
- ☐ Ignore long. reinf. in rating
-  Distribution factor application method
 - ☐ By axle
 - ☒ By POI
- ☐ Allow negative epsilon in general shear method



Analysis Settings Templates currently available in the AASHTOWareBr central DB and available for inclusion and use in any local DB in BrR:

Templates	Description	Analysis	Public / Private	
HL 93 Design Review	HL 93 Design Review	LRFD	Public	
HS 20 Rating	HS 20 Rating	Member Alternative	Public	
LRFR Design Load Rating	LRFR Design Load Rating	LRFR	Public	
LRFR Legal Load Rating	LRFR Legal Load Rating	LRFR	Public	
WV LFR Standard w/ CRTS line	BrR new analysis event	LFD	Public	
WV LFR Standard line	BrR new analysis event	LFD	Public	
WV LFR Standard 3D FEM	BrR new analysis event	LFD	Public	
WV LFR Standard w/ CRTS 3D FEM	BrR new analysis event	LFD	Public	
WV LRFR Standard line	BrR new analysis event	LRFR	Public	
WV LRFR Standard w/ CRTS line	BrR new analysis event	LRFR	Public	
WV LRFR Standard 3D FEM	BrR new analysis event	LRFR	Public	
WV LRFR Standard w/ CRTS 3D FEM	BrR new analysis event	LRFR	Public	
WV LFR box culverts	BrR new analysis event	LFD	Public	
WV LFR box culverts w/ CRTS	BrR new analysis event	LFD	Public	

BrR Best Practices:

- Stage 2 superimposed DL application for line loads
By default, for line girder analysis, BrR will apply stage 2 dead loads uniformly to all girder lines. For 3D FEM models, load distribution is based on the overall system stiffness. To better capture line weights (ref. WV BLRM 4.2.1) in BrR:
 1. Develop the model “normally” with line loads, label it “xxxxx – 3D FEM”
 2. Copy that original, complete superstructure system definition and label the new one “xxxxx – line girder”
 3. Under the line girder definition, delete the line loads (parapet rails, sidewalk, median barrier, etc.)
 4. Calculate actual line load distribution outside of BrR, then apply as member loads
 5. Make sure all alternative settings are correct
 6. See slides in EE Meeting_10.27.2021.pptx file for more information



- Miscellaneous DL

It is good practice to consider some level of miscellaneous dead load, typically as a stage 1 structural component dead load, to account for anything that may be missed during normal load calculations and application within the model file. In prior application using LARS Bridge, the primary way of accomplishing this was to add a somewhat arbitrary dead load per unit length along the span(s). In BrR, miscellaneous DL can be added as a percentage of the member's self-weight or as additional load per unit length.



APPENDIX D: APPROVED COMMODITY PERMITS

Provided herein are approved commodity permits issued by WVDOT memorandum. Each memorandum shows the applicable truck configurations and associated routes they are permitted to travel on. Bridges along the listed routes and mileposts need to have all applicable permit truck configurations included on their routine load rating evaluations.





WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

Division of Highways

1900 Kanawha Boulevard East • Building Five • Room 110
Charleston, West Virginia 25305-0430 • (304) 558-3505

Jim Justice
Governor

Thomas J. Smith, P. E.
Secretary of Transportation/
Commissioner of Highways

October 10, 2017

MEMORANDUM

TO: All Law Enforcement Agencies

FROM: Gregory L. Bailey, P.E. *Gregory Bailey*
Deputy State Highway Engineer –
Operations/
Acting Maintenance Division Director

SUBJECT: TRAVEL ON WV-62, WV-869, AND US-35 IN PUTNAM AND MASON COUNTIES

Any truck operated by Challenger Freight while bearing this letter and a valid vehicle specific West Virginia overweight multi-trip hauling permit is authorized to haul engines above the established legal weight from the Toyota Plant located in Buffalo to the Ohio state line. These moves may be up to and including 120,000 lbs. (with no tolerance), GVW, over the routes listed with the designated vehicle configurations listed below.

	<u>Routes</u>
WV-62 Putnam County	MP 17.70 - 19.90
WV-869 Putnam County	MP 0.00 - 0.58
WV-35 Putnam County	MP 20.19 - 23.82
WV-35 Mason County	MP 0.00 - 18.24

Vehicle ConfigurationOption 1

Axle Weight(pounds)	<u>12,000</u>	<u>16,000</u>	<u>16,000</u>	<u>16,750</u>	<u>16,750</u>	<u>14,167</u>	<u>14,166</u>	<u>14,167</u>
Axle Spacings	<u>7'-5"</u>	<u>4'-6"</u>	<u>12'-10"</u>	<u>9'-1"</u>	<u>9'-1"</u>	<u>5'-0"</u>	<u>5'-0"</u>	<u>5'-0"</u>

Option 2

Axle Weight(pounds)	<u>12,000</u>	<u>16,000</u>	<u>16,000</u>	<u>18,000</u>	<u>18,000</u>	<u>13,333</u>	<u>13,334</u>	<u>13,333</u>
Axle Spacings	<u>17'-5"</u>	<u>4'-6"</u>	<u>12'-10"</u>	<u>9'-1"</u>	<u>9'-1"</u>	<u>5'-0"</u>	<u>5'-0"</u>	<u>5'-0"</u>

Option 3

Axle Weight(pounds)	<u>12,000</u>	<u>16,000</u>	<u>16,000</u>	<u>15,000</u>	<u>15,000</u>	<u>15,333</u>	<u>15,334</u>	<u>15,333</u>
Axle Spacings	<u>17'-5"</u>	<u>4'-6"</u>	<u>12'-10"</u>	<u>9'-1"</u>	<u>9'-1"</u>	<u>5'-0"</u>	<u>5'-0"</u>	<u>5'-0"</u>

This authority is granted under House Bill 3064.

GLB:Gj

E.E.O./AFFIRMATIVE ACTION EMPLOYER



APPENDIX E: SAFE LOAD CAPACITY WEIGHT LIMIT TABLES

Weight Limits

(Tons)

6/3/2020

Table 1 - Legal Weight Limits

100%	T3	SU4	SU5	SU6	SU7	2S2	3S2	Lane	EV2	EV3	SU-40	SU-45	3S-55	3S-60	WP47
Interstate	25	27	31	34.75	38.75	-	40	40	28.75	43	-	-	-	-	-
65,000	33	35.75	35.75	35.75	35.75	35.75	35.75	40	28.75	43	-	-	-	-	47
80,000	33	38.5	40.15	40.15	40.15	36	44	40	28.75	43	-	-	-	-	
120,000	33	38.5	40.15	40.15	40.15	36	44	40	28.75	43	42	47.25	57.75	63	

Table 2 - Legal Weight Limits divided by .7

70%	T3	SU4	SU5	SU6	SU7	2S2	3S2	Lane	EV2	EV3	SU-40	SU-45	3S-55	3S-60	WP47
Interstate	35.7	38.6	44.3	49.6	55.4	-	57.1	57.1	-	-	-	-	-	-	-
65,000	47.1	51.1	51.1	51.1	51.1	51.1	51.1	57.1	-	-	-	-	-	-	67.14
80,000	47.1	55.0	57.4	57.4	57.4	51.4	62.9	57.1	-	-	-	-	-	-	
120,000	47.1	55.0	57.4	57.4	57.4	51.4	62.9	57.1	-	-	60.0	67.5	82.5	90.0	

Table 3 - Legal Weight Limits divided by .85

85%	T3	SU4	SU5	SU6	SU7	2S2	3S2	Lane	EV2	EV3	SU-40	SU-45	3S-55	3S-60	WP47
Interstate	29.4	31.8	36.5	40.9	45.6	-	47.1	47.1	-	-	-	-	-	-	-
65,000	38.8	42.1	42.1	42.1	42.1	42.1	42.1	47.1	-	-	-	-	-	-	55.29
80,000	38.8	45.3	47.2	47.2	47.2	42.4	51.8	47.1	-	-	-	-	-	-	
120,000	38.8	45.3	47.2	47.2	47.2	42.4	51.8	47.1	-	-	49.4	55.6	67.9	74.1	

Priority 1 All fracture critical members and their connections with the exception of floorbeams that are in good or fair condition and their connections.

Priority 2 All other members and connections not qualifying as Priority 1

