

3.15 LOAD RATING OF NEW BRIDGE DESIGN

Bridges shall be load rated in accordance with the current versions of the WVDOT Bridge Load Rating Manual and the Manual for Bridge Evaluation (MBE). All applicable limit states per MBE Table 6A.4.2.2-1 will be satisfied, including those listed as optional checks.

The bridge load rating analysis using the LRFR method shall be performed concurrent with the final design to assure adequate load rating. The designer will perform the load rating and submit all required information, as detailed in this article, to Maintenance Division. Upon submission, the DOH (Maintenance Division or the District Office) will perform an independent load rating of the bridge. If the independent load rating check performed by the DOH indicates a rating less than any of the target values (shown below in Table 1), the Bridge Project Manager in coordination with the Evaluation Section of Maintenance Division shall be contacted immediately to determine what actions are to be taken before proceeding further with the final design and detailing.

The target ratings for new or replacement bridge designs are shown in Table 1.

Design- Inventory (Factor)	Legal (Tons)													
	Standard							Emergency		CRTS*				Permit
	Type 3	SU4	SU5	SU6	SU7	Type 3S2	Lane**	EV2	EV3	SU- 40	SU- 45	3S- 55	3S- 60	WT47
1.00	41	49	51	51	51	55	50	36	54	53	60	73	79	59

*Required for CRTS Routes Only

**Not required for single spans less than and equal to 200 feet

Table 3.15 – Target Ratings

Although the HL93 loading is known to envelope all AASHTO legal loads and EV's, it may not control over CRTS vehicle configurations. Accordingly, all new designs for bridges must satisfy all applicable target ratings shown in Table 1.

The Designer shall state in the plans when redistribution of negative moments is utilized, for use in the permit rating of the bridge (see AASHTO LRFD 4.6.4).

The request for an independent load rating check shall be submitted to Maintenance Division (OM) by the Bridge Project Manager prior to finalizing design plans. The request shall contain the following information:

- Load rating sheets containing tabulated section properties, live load distribution factors (and conversion factors, if needed), dead load moments and shears, and live load moments and shears at critical locations in each span and at all supports
- Controlling rating factors (design) and tonnages (legal loads) for all required configurations, as shown in Table 1
- A full set of current bridge design plans
- The PS&E date of the project

If requested, the Designer shall be required to submit to OM original rating computations included with the design calculations and shall clearly identify or include the following information:

- Design specifications
- Design live load
- Member capacities
- Method of analysis – line girder, grid, or finite element
- Method used for calculation of live load distribution factors
- Table of applicable load factors
- Controlling limit states
- Design, Legal, and Permit Ratings for all required loadings for consultant designed bridges if required by project scope
- Relevant computer input and output information for consultant designed bridges if required by project scope

LOAD RATING OF NEW OR REPLACEMENT FRAMES, ARCHES, THREE SIDED STRUCTURES, AND CULVERTS

The load rating analysis shall be performed by the designer in accordance with the Governing Specifications and the MBE using the live load models presented in this document.

If it is determined that the depth of fill is such that live load effects can be neglected then the structure would have an infinite safe load capacity for HL93, all legal trucks, and CRTS Trucks as long as the structure has residual capacity remaining after dead load effects have been considered.

A 3D Finite Element Analysis shall be performed for any structure that is constructed on a longitudinal slope to determine the out of plane load effects on the structure in the final condition.

Calculations shall be submitted to the Bridge Project Manager for approval prior to fabrication of any primary structural elements.

LOAD RATING OF REHABILITATED OR WIDENED STRUCTURES

Load rating of structures using combination specifications within the superstructure (e.g. a superstructure designed by LRFD for the new widened superstructure elements and the original superstructure elements designed by Load Factor Design) shall not be permitted.

Load rating of structures partially reconstructed resulting in the use of combination specifications between substructure and superstructure elements (e.g. a reconstructed superstructure designed by LRFD supported by the original substructure designed by Allowable Stress Design, Load Factor Design, or unknown specifications) is permitted. The method of analysis for a reconstructed superstructure shall be Load and Resistance Factor Rating.

CONVERSION FACTORS FOR REFINED ANALYSIS

When structures are designed using refined analyses, conversion factors shall be developed. The refined analyses methods include line girder analyses based on refined live load distribution factors, grid analyses and finite element analyses. The conversion factors indicate the relationship of live load design moments and shears, obtained from the refined analysis, to the live load moments and shears obtained from a standard line girder analysis with a live load distribution factor of 1.0 for a single lane (a single lane equals two wheels). Do not use AASHTO distribution factors for the line girder analysis.

The conversion factors for refined analyses shall be computed using the following equation:

$$CF = \frac{\text{Moment (refined analysis)}}{\text{Moment (line girder analysis)}}$$

Subsequent analyses of the structure may be completed using a standard line girder analysis with a live load distribution factor 1.0 for a single lane (a single lane equals two wheels). Do not use AASHTO distribution factors for the line girder analysis. For additional loadings, or re-evaluation of the design vehicle, the live load moments and shears obtained from the standard line girder analysis shall be multiplied by the conversion factors obtained from refined analysis at appropriate girder location under investigation. For example, for Girder 3 at mid-span of span 2, the equivalent refined moment can be calculated as follows:

Girder 3, Location: Span 2.5

$$CF = 1.026 \text{ (listed in the table on the original plans)}$$

$$M_{(LG)} = 3175.8 \text{ K-FT (live load moment from line girder analysis)}$$

$$M_{(refined)} = 3175.8 \text{ K-FT (1.026)}$$

$$= 3258.4 \text{ K-FT (equivalent refined live load moment)}$$

4.4.1.18 Load Rating Sheets

The Load Rating sheets shall contain the following information. Sample rating sheets are available from the WVDOH.

- Girder elevation showing critical rating locations
- Section properties for steel beam/girder bridges, including
 - Span number
 - Location in span
 - Yield strength for top flange, bottom flange and web
 - Top and bottom flange thickness or size of rolled beam
 - Web depth and thickness
 - Section modulus with respect to the top and bottom flanges for the
 - Non-composite section
 - Composite section for positive moment (steel girder plus deck concrete for both n and $3n$ modular ratios)
 - Negative flexure section (steel girder plus longitudinal deck reinforcing)
- Section properties for prestressed concrete beam bridges, including
 - Span number
 - Location in span
 - Concrete compressive strength f'_c , and allowable tension and compression
 - Girder cross-section area
 - Section modulus with respect to the top and bottom flanges for the
 - Non-composite section
 - Composite section
 - Section modulus with respect to the top and bottom rows of prestressing strands
 - Non-composite section
 - Composite section
 - Girder flexural strength and shear strength at all critical section locations
- Design service moment and shear for steel beam/girder bridges
 - Service load moment and shear due to non-composite dead load (DL1), composite dead load (DL2) and live load including impact for the design rating vehicle (HL93) and all other required legal load configurations (see section 3.15) at all critical section locations and flange transitions along the length of the girder
- Design service moment and shear for prestressed concrete beam bridges

- Service load moment and shear due to non-composite dead load (DL1), composite dead load (DL2) and live load including impact for the design rating vehicle (HL93) and all other required legal load configurations (see section 3.15) at all critical section locations
- Axial load and moment due to the effective prestress force after all losses at all critical section locations
- Secondary moments due to prestressing forces at all critical locations for post-tensioned concrete beams only
- For tangent structures designed using line girder analysis, provide live load distribution factors for moment and shear calculated based on the Governing Specifications.
- For curved structures and tangent structures designed using refined analysis, provide conversion factors for live load moment and shear.
 - Provide sample calculations on the plan sheet that demonstrate the derivation and use of the conversion factors provided. The example calculations shall be based on actual values provided for the design girder on the plans, such that the reader can follow the computations by comparing them to the original plans.
 - Identify the number of traffic lanes loaded in the refined analysis.
- Sample rating calculations should be performed at the location where the load rating is critical and included with the load rating sheets
- Load rating tables
 - Provide load tables as shown below
 - Rating values provided shall be given as a factor for the design load (HL93) and given in tons for all legal load configurations.

Design Load Ratings – HL93	
Design Level	Rating Factor
Inventory	
Operating	

Rating Level	Load Rating Table Safe Load Capacity (Tons)													
	Standard							Emergency		CRTS*				Permit
	Type 3	SU4	SU5	SU6	SU7	Type 3S2	Lane**	EV2	EV3	SU-40	SU-45	3S-55	3S-60	WT47
Legal														

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