Overview of WVDOT Highway Bridge Rating Protocols

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Short Span Steel Bridge Workshop

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Short Span Steel Bridge Alliance &

West Virginia Local Technical Assistance Program

Who Am I?

- Dr. Robert M. Tennant, Ph.D.
  - Please call me Robby
  - Operations Division – Evaluation Section
  - Transportation Trainee III (for now…)
  - Started working at the DOH in March 2022
  - Graduated from WVU in 2016 … and 2018 … and 2022

  - Huge Nerd … shocker
  - Avid Swifty … not a shocker

Outline

- Goals
- Background
- Purpose
- Assumptions
- **Load and Resistance Factor Rating**
- Q/A
- Contact Information

Goals

- Introduce myself to you
- Provide the history to why we load rate bridges
- Provide relevant load rating insights to assist in design

Background

Background (Cont'd)

Background (Cont'd)

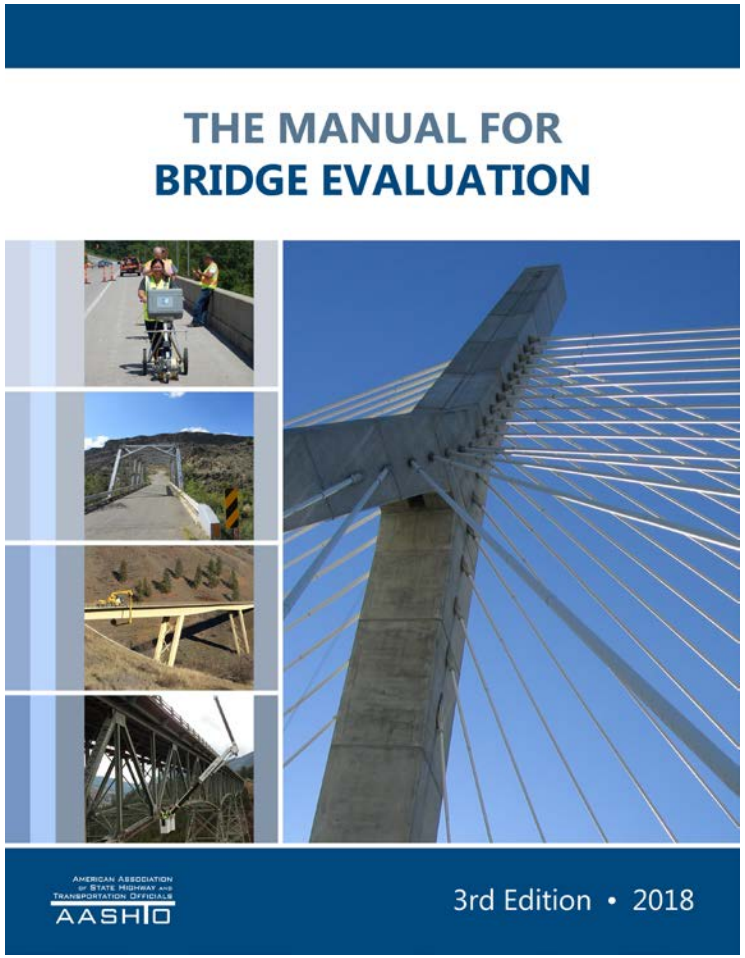
Background (Cont'd)

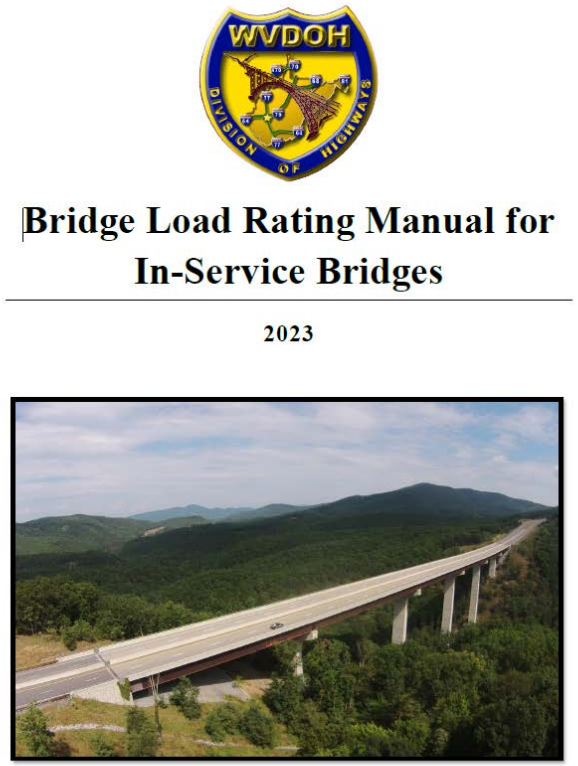
Purpose

- Existing highway bridges are rated to:
  - Provide safety for the traveling public
  - Facilitate the safe passage of goods
  - Prioritize the owners needs

- Bridges that cannot safely carry statutory loads, based on a load-rating evaluation, should be load posted, rehabilitated, or replaced

Assumptions





Rating Equation

Allowable Stress Rating (ASR)

- $RF = \frac{Available}{Demand} = \frac{C-DL}{(LL+IM)}$
  - The capacity is based on the rating level, limit state, and material property
  - The loads are not factored

Load Factor Rating (LFR)

- $RF = \frac{Available}{Demand} = \frac{C-A_1 DL}{A_2(LL+IM)}$
  - The capacity is specified in the load factor sections of the AASHTO Standard Specifications
  - A_1 = 1.3
  - A_2 = 2.17 (for inventory)
  - A_2 = 1.3 (for operating)

Rating Equation (cont'd)

Load and Resistance Factor Rating (LRFR)

- $RF = \frac{Available}{Demand} = \frac{\phi C - \gamma_{DL} DL}{\gamma_{LL}(LL+IM)}$

  - We factor everything

Rating Tonnages (for all methods)

- $RT = (RF)(W)$

  - W = weight of vehicle applying the live load

Shake It Off

LRFR – Evaluation Levels

- Design Load Rating
- Legal Load Rating
- Permit Load Rating

LRFR – Evaluation Levels (cont'd)

- Design Load Rating
  - See MBE Figure C6A-1 for layouts for:
    - Design Truck
    - Design Tandem
    - Design Lane
    - Additional Model for Negative Moment and Interior Reaction

LRFR – Evaluation Levels (cont'd)

- Legal Load Rating
  - T3
  - 3S2
  - Type 3-3 (soon)
  - Specialized Hauling Vehicles (SU4, SU5, SU6, SU7)
  - Emergency Vehicles (EV2, EV3)

Quick Note … WV Route Types

Interstate Highways

GVW	80,000
0 (steer)	20,000
0 (single)	20,000
00 (tandem)	34,000

-Federal Bridge Formula applies to all other combinations

TOLERANCE: None

Local Service Routes

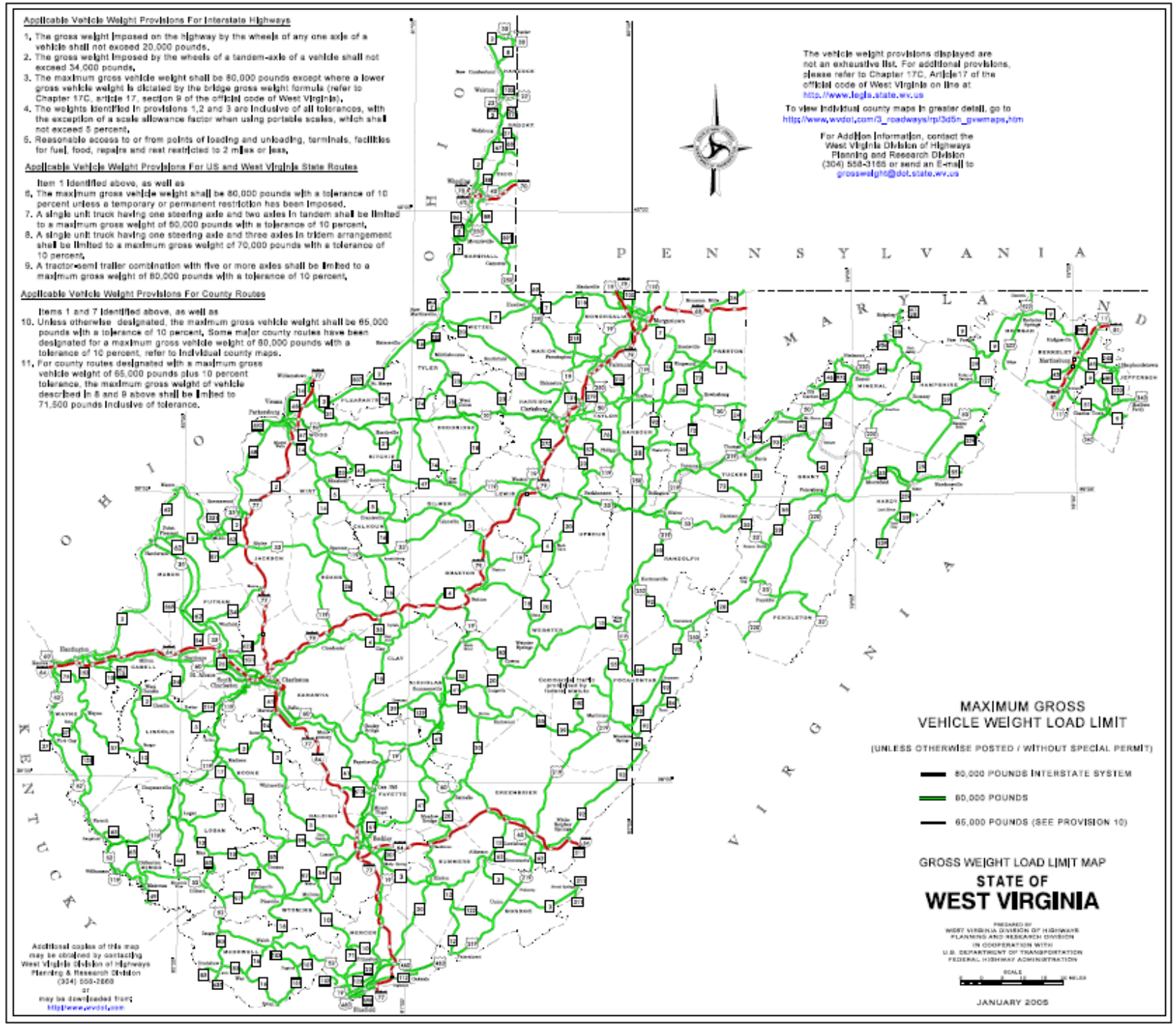
GVW	65,000
0 (steer)	20,000
0 (single)	20,000
00 (tandem)	34,000

TOLERANCE: 10%

US and WV Routes

GVW	80,000
Axle Limit	20,000
Single Unit Tandem (3 axles total)	60,000
Single Unit Tridem (4 axles total)	70,000
Single Unit Quadrum (5 axles total)	73,000
Tractor-Semi Trailer (5 axles total)	80,000
Tractor-Semi Trailer (6 axles total)	80,000
Combination Tandem w/2 axles Trailer (5 axles total)	80,000
Combination Tridem w/2 axles Trailer (6 axles total)	80,000

TOLERANCE: 10%


Applicable Vehicle Weight Provisions For Interstate Highways
1. The gross weight imposed on the highway by the wheels of any one axle of a vehicle shall not exceed 20,000 pounds.
2. The gross weight imposed by the wheels of a tandem-axle of a vehicle shall not exceed 34,000 pounds.
3. The maximum gross vehicle weight shall be 80,000 pounds except where a lower gross vehicle weight is dictated by the bridge gross weight formula (refer to Chapter 17C, article 17, section 9 of the official code of West Virginia).
4. The weights identified in provisions 1,2 and 3 are inclusive of all tolerances, with the exception of a scale allowance factor when using portable scales, which shall not exceed 5 percent.
5. Reasonable access to or from points of loading and unloading, terminals, facilities for fuel, food, repairs and rest restricted to 2 miles or less.
Applicable Vehicle Weight Provisions For US and West Virginia State Routes
Item 1 identified above, as well as
6. The maximum gross vehicle weight shall be 80,000 pounds with a tolerance of 10 percent unless a temporary or permanent restriction has been imposed.
7. A single unit truck having one steering axle and two axles in tandem shall be limited to a maximum gross weight of 50,000 pounds with a tolerance of 10 percent.
8. A single unit truck having one steering axle and three axles in tridem arrangement shall be limited to a maximum gross weight of 70,000 pounds with a tolerance of 10 percent.
9. A tractor-semi trailer combination with five or more axles shall be limited to a maximum gross weight of 80,000 pounds with a tolerance of 10 percent.
Applicable Vehicle Weight Provisions For County Routes
Items 1 and 7 identified above, as well as
10. Unless otherwise designated, the maximum gross vehicle weight shall be 65,000 pounds with a tolerance of 10 percent. Some major county routes have been designated for a maximum gross vehicle weight of 80,000 pounds with a tolerance of 10 percent, refer to individual county maps.
11. For county routes designated with a maximum gross vehicle weight of 65,000 pounds plus 10 percent tolerance, the maximum gross weight of vehicle described in 8 and 9 above shall be limited to 71,500 pounds inclusive of tolerance.
The vehicle weight provisions displayed are not an exhaustive list. For additional provisions, please refer to Chapter 17C, Article17 of the official code of West Virginia on line at https://www.legis.state.wv.us
To view individual county maps in greater detail, go to https://www.wvdot.com/3_roadways/rp/3d5n_gwvmaps.htm
For Addition Information, contact the West Virginia Division of Highways Planning and Research Division (304) 558-3165 or send an E-mail to grossweight@dot.state.wv.us
OHIO
PENNSYLVANIA
MARYLAND
VIRGINIA
KENTUCKY
MAXIMUM GROSS VEHICLE WEIGHT LOAD LIMIT
(UNLESS OTHERWISE POSTED / WITHOUT SPECIAL PERMIT)
80,000 POUNDS INTERSTATE SYSTEM
80,000 POUNDS
65,000 POUNDS (SEE PROVISION 10)
GROSS WEIGHT LOAD LIMIT MAP
STATE OF
WEST VIRGINIA
PREPARED BY
WEST VIRGINIA DIVISION OF HIGHWAYS
PLANNING AND RESEARCH DIVISION
IN COOPERATION WITH
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
JANUARY 2005
Additional copies of this map may be obtained by contacting West Virginia Division of Highways Planning & Research Division (304) 558-2885 or may be downloaded from; http://www.wvdot.com

Permit Load Rating

- Annual (Blanket) Permit Trucks
- Coal Resource Transportation System (CRTS) Trucks – analyzed as legal
- Commodity Permits – analyzed as legal
- Wood Truck – analyzed as legal
- All Others

Still With Me?

WVDOH Bridge Load Rating Manual

Bridge Load Rating Manual for In-Service Bridges

2023

CHAPTER 1: INTRODUCTION

1.1 Purpose

This manual describes the West Virginia Division of Highways WVDOH 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.

CHAPTER 2: LOAD RATING PROCESS

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.

Structure Directive 2150

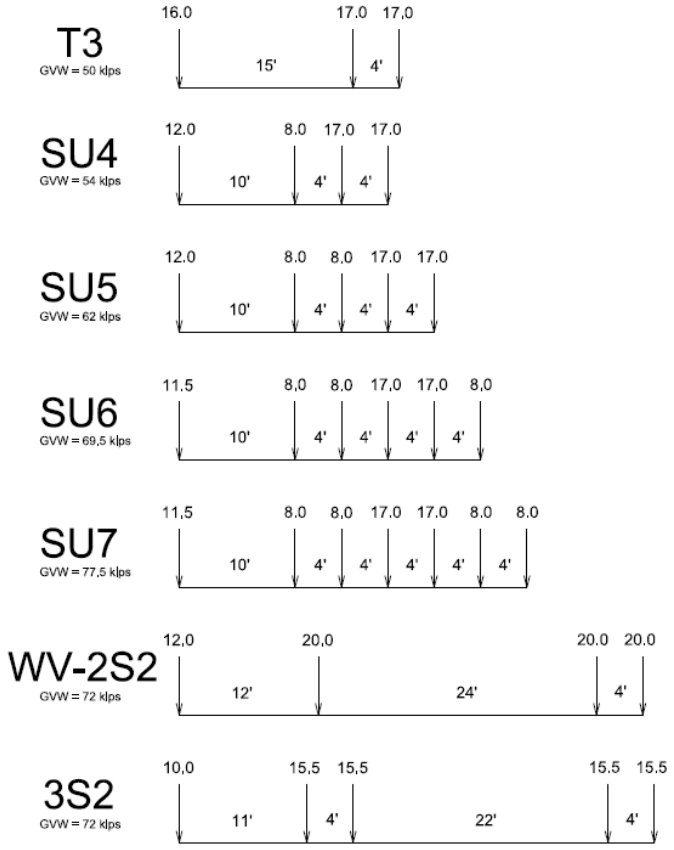
STRUCTURE DIRECTIVE 2150
LOAD RATING OF NEW BRIDGE DESIGN
January 4, 2023
Supersedes May 4, 2022

2150.1-LOAD RATING OF NEW AND REPLACEMENT BRIDGES

Load rating analysis shall be performed for all new or replacement bridges, including value engineering or value engineering change proposals submitted by the contractor, using the LRFR method found in the current edition of the AASHTO 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.

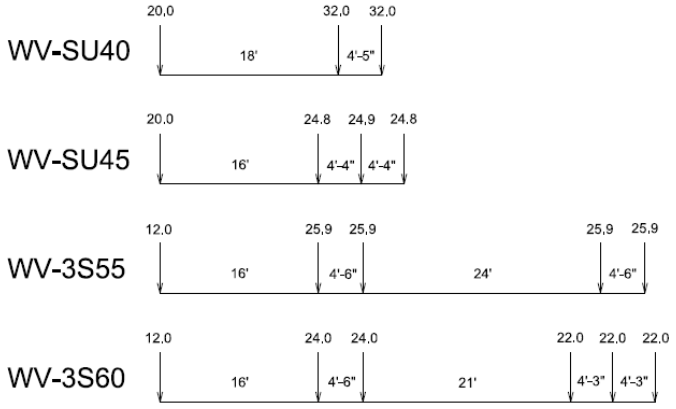
Each bridge shall be load rated at inventory and operating levels for AASHTO's HL93 loading as presented in the MBE on all routes. In addition, a legal load evaluation shall be completed for each West Virginia legal load on all routes. Bridges on a Coal Resource Transportation System (CRTS) route shall be load rated for four additional trucks (WV-SU40, WV-SU45, WV-3S55, and WV-3S60) during the legal load evaluation. The axle configurations and loads for the WV Legal Trucks are shown in Figure 2150.A, CRTS Trucks and Emergency Vehicle Live Loads are shown in Figure 2150.B, and Wood "Pup" Truck Live Loads are shown in Figure 2150.C.

Structure Directive 2150 (cont'd)

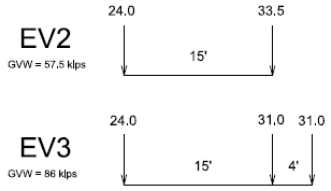


Note: All axle weights are in kips

CRTS VEHICLE LIVE LOADS

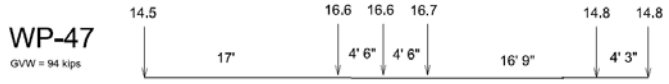


EMERGENCY VEHICLE LIVE LOADS



Note: All axle weights are in kips

WOOD "PUP" TRUCK PERMIT LOAD



Note: All axle weights are in kips

Structure Directive 2150 (cont'd)

Table 2150.D -Target Ratings

Design-Inventory (Factor)	Legal (Tons)													
	Standard							CRTS*				Emergency		Permit**
HL93	Type 3	SU4	SU5	SU6	SU7	Type 3S2	Lane***	SU-40	SU-45	3S-55	3S-60	EV2	EV3	WP47
1.00	41	49	51	51	51	55	50	53	60	73	79	36	54	59

* Required for CRTS (Coal Resource Transportation System) routes only, considered as legal load evaluation

** Although WP47 is a permitted truck, it shall be load rated as a legal load configuration

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

Structure Directive 2150 (cont'd)

The designer will perform the load rating and submit all required information, as detailed in this article, to the bridge project manager. A request for an independent load rating check shall be submitted to the Evaluation Section of Operations Division (OM) by the bridge project manager during the load rating submission. The request shall contain the following information:

A. 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.
B. Controlling rating factors (design) and tonnages (legal loads) for all required configurations, as shown in Table 2150.D.
C. A full set of current bridge design plans.
D. The CP/RW date of the project.

Structure Directive 3042

STRUCTURE DIRECTIVE 3042
GENERAL PLAN AND EVALUATION
May 4, 2022
First Edition

The following is a general format for detailing and may be modified depending on the complexity of the project. See the "Final Detail Bridge Plan Submission Certification" checklist in DD-202 for a complete listing

Structure Directive 3042 (cont'd)

- **3042.18 – 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: …
  - Section properties for prestressed concrete beam bridges, including: …
  - Design service force effects for steel beam/girder bridges, including: …
  - Design service force effects for prestressed concrete beam bridges, including : …
  - Live load distribution factors for service force effects for tangent structures designed using line girder analysis
  - Conversion factors for service force effects for curved structures designed using refined analysis
  - Sample rating calculations at the critical load rating location included with the load rating sheets
  - Load rating tables (Design Load Rating and Legal Load Rating)

Relevant(ish) Manual Updates

2.4 Concepts and Load Rating Methodologies

5. WVDOH 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.

Relevant(ish) Manual Updates (cont'd)

- Phased Construction – When to Rate?

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.

Questions?

Contact Information

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- Phone: (304) 290-7001