


# Indiana Bridge Load Rating And Posting

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# Modernization of Policy

## Bridge Inspection Manual Part 3

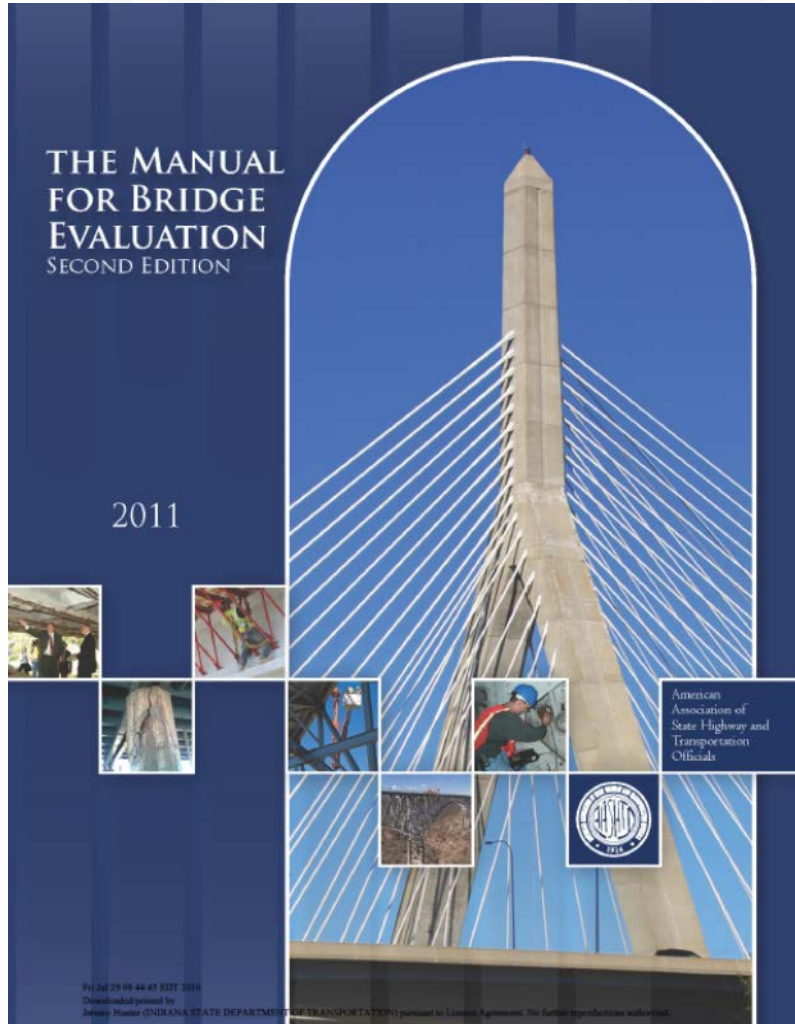
- Published 12/22/17

Number	Memo Date	Effective Date	Subject	Attachments
<u>17-</u> <u>06</u> 	12/22/17	Immediately	Revisions to the Part 3 of the INDOT Bridge Inspection Manual	

- Aligns Indiana Load Rating Practices with AASHTO Manual For Bridge Evaluation
- Changes Bridge Posting Evaluation and Requirements
  - Requires evaluation of all Indiana Legal Loads as defined in BrIM Part 3 Figure 3-4.2

# Indiana Bridge Load Rating Requirements

- AASHTO Manual For Bridge Evaluation 2<sup>nd</sup> Edition



- Defines requirements for:
  - Bridge Records
  - Bridge Management
  - Bridge Inspection
  - Bridge Material Testing
  - Bridge Load Rating

# Modernization of Policy

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## Definition of Terms (LFR vs LRFR)

- Load Factor Rating (LFR)
  - Inventory
  - Operating
- Load & Resistance Factor Rating (LRFR)
  - Design
    - Inventory
    - Operating
  - Legal
  - Permit

# Manual for Bridge Evaluation: Loads

- Load & Resistance Factor Rating (LRFR)

**Table 6A.4.2.2-1—Limit States and Load Factors for Load Rating**

Bridge Type	Limit State*	Dead Load $\gamma_{DC}$	Dead Load $\gamma_{DW}$	Design Load		Legal Load $\gamma_{LL}$	Permit Load $\gamma_{LL}$
				Inventory	Operating		
				$\gamma_{LL}$	$\gamma_{LL}$		
Steel	Strength I	1.25	1.50	1.75	1.35	Tables 6A.4.4.2.3a-1 and 6A.4.4.2.3b-1	—
	Strength II	1.25	1.50	—	—	—	Table 6A.4.5.4.2a-1
	Service II	1.00	1.00	1.30	1.00	1.30	1.00
	Fatigue	0.00	0.00	0.75	—	—	—
Reinforced Concrete	Strength I	1.25	1.50	1.75	1.35	Tables 6A.4.4.2.3a-1 and 6A.4.4.2.3b-1	—
	Strength II	1.25	1.50	—	—	—	Table 6A.4.5.4.2a-1
	Service I	1.00	1.00	—	—	—	1.00
Prestressed Concrete	Strength I	1.25	1.50	1.75	1.35	Tables 6A.4.4.2.3a-1 and 6A.4.4.2.3b-1	—
	Strength II	1.25	1.50	—	—	—	Table 6A.4.5.4.2a-1
	Service III	1.00	1.00	0.80 Table 6A.4.2.2-2	—	1.00	—
	Service I	1.00	1.00	—	—	—	1.00
Wood	Strength I	1.25	1.50	1.75	1.35	Tables 6A.4.4.2.3a-1 and 6A.4.4.2.3b-1	—
	Strength II	1.25	1.50	—	—	—	Table 6A.4.5.4.2a-1

\* Defined in the *AASHTO LRFD Bridge Design Specifications*.

# Manual for Bridge Evaluation: Loads

- Load & Resistance Factor Rating (LRFR): Legal Load Rating Factors

**Table 6A.4.4.2.3a-1—Generalized Live Load Factors,  $\gamma_L$  for Routine Commercial Traffic**

Traffic Volume (one direction)	Load Factor for Type 3, Type 3S2, Type 3-3, and Lane Loads
Unknown	<del>1.80</del> 1.45
$ADTT \geq 5,000$	<del>1.80</del> 1.45
$ADTT \leq 1,000$	<del>1.65</del> 1.30
$ADTT \leq 100$	1.40

Linear interpolation is permitted for  $ADTT$  values between 5,000 and 1,000.

**Table 6A.4.4.2.3b-1—Generalized Live Load Factors,  $\gamma_L$  for Specialized Hauling Vehicles**

Traffic Volume (One Direction)	Load Factor for NRL, <del>SU4, SU5, SU6, and</del> SU7
Unknown	<del>1.60</del> 1.45
$ADTT \geq 5000$	<del>1.60</del> 1.45
$ADTT \leq 1000$	<del>1.40</del> 1.30
$ADTT \leq 100$	<del>1.15</del>

Linear interpolation is permitted for  $ADTT$  values between 1,000 and 5,000.

# Manual for Bridge Evaluation: Loads

- Dynamic Load Allowance

## 6A.4.4.3—Dynamic Load Allowance: *IM*

The static effects of the truck loads shall be increased by 33 percent for strength and service limit states to account for the dynamic effects due to moving vehicles. The dynamic load allowance shall be applied only to the axle loads when the lane type loads given in Figures D6A-4 and D6A-5 are used for evaluation.

Dynamic load allowance need not be applied to wood components (LRFD Design Article 3.6.2.3).

Table C6A.4.4.3-1—Dynamic Load Allowance: *IM*

Riding Surface Conditions	<i>IM</i>
Smooth riding surface at approaches, bridge deck, and expansion joints	10%
Minor surface deviations or depressions	20%

# Manual for Bridge Evaluation: Resistance

- Condition Factor
  - Discretionary tool: allows for general NBI Condition linked strength reduction

**Table 6A.4.2.3-1—Condition Factor:  $\phi_c$**

Structural Condition of Member	$\phi_c$
Good or Satisfactory	1.00
Fair	0.95
Poor	0.85

# Manual for Bridge Evaluation: Resistance

- System Factor
  - Strength reduction to address reliability of system redundancy

**Table 6A.4.2.4-1—System Factor:  $\phi_s$  for Flexural and Axial Effects**

Superstructure Type	$\phi_s$
Welded Members in Two-Girder/Truss/Arch Bridges	0.85
Riveted Members in Two-Girder/Truss/Arch Bridges	0.90
Multiple Eyebars in Truss Bridges	0.90
Three-Girder Bridges with Girder Spacing 6 ft	0.85
Four-Girder Bridges with Girder Spacing $\leq 4$ ft	0.95
All Other Girder Bridges and Slab Bridges	1.00
Floorbeams with Spacing $> 12$ ft and Noncontinuous Stringers	0.85
Redundant Stringer Subsystems between Floorbeams	1.00

# Manual for Bridge Evaluation: Unknown Materials

- Reinforced Concrete

**Table 6A.5.2.1-1—Minimum Compressive Strength of Concrete by Year of Construction**

Year of Construction	Compressive Strength, $f'_c$ , ksi
Prior to 1959	2.5
1959 and Later	3.0

**Table 6A.5.2.2-1—Yield Strength of Reinforcing Steel**

Type of Reinforcing Steel	Yield Strength, $f_y$ , ksi
Unknown steel constructed prior to 1954	33.0
Structural grade	36.0
Billet or intermediate grade, Grade 40, and unknown steel constructed during or after 1954	40.0
Rail or hard grade, Grade 50	50.0
Grade 60	60.0

**Table 6A.5.2.3-1—Tensile Strength of Prestressing Strand**

Year of Construction	Tensile Strength, $f_{pu}$ , ksi
Prior to 1963	232.0
1963 and Later	250.0

# Manual for Bridge Evaluation: Unknown Materials

- Structural Steel and Rivets

**Table 6A.6.2.1-1—Minimum Mechanical Properties of Structural Steel by Year of Construction**

Year of Construction	Minimum Yield Point or Minimum Yield Strength, $F_y$ , ksi	Minimum Tensile Strength, $F_{ts}$ , ksi
Prior to 1905	26	52
1905 to 1936	30	60
1936 to 1963	33	66
After 1963	36	66

**Table 6A.6.12.5.1-1—Factored Shear Strength of Rivets:  $\phi F$**

Rivet Type or Year of Construction	$\phi F$ , ksi
Constructed prior to 1936 or of unknown origin	18
Constructed after 1936 but of unknown origin	21
ASTM A502 Grade I	25
ASTM A502 Grade II	30

# Manual for Bridge Evaluation: Bridge Posting

## 6A.8.3—Posting Analysis

The decision to load post a bridge should be made by the Bridge Owner based on the general procedures as set forth in this Manual and established practices of the Bridge Owner. The following guidelines may be of assistance to authorities responsible for establishing posting weight limits.

When the rating factor  $RF$  calculated for each legal truck (AASHTO vehicle) is greater than 1.0, the bridge need not be posted.

When for any legal truck the  $RF$  is between 0.3 and 1.0, the following equation should be used to establish the safe posting load for that vehicle type:

$$\text{Safe Posting Load} = \frac{W}{0.7} [(RF) - 0.3] \quad (6A.8.3-1)$$

# INDOT BrIM: Modernization of Policy

What are the required load rating vehicles?

## Design Vehicles

- New structures or rehabilitations
- Listed on the plans of the primary load carrying members

Truck Configuration
HL-93
Fatigue*
H-20
HS-20
HS-25
Alternate Military
Toll Road Loading No. 1
Toll Road Loading No. 2
Special Toll Road Truck
Michigan Train Truck #5
Michigan Train Truck #8

\* The Fatigue configuration shall be used for evaluating the Fatigue Limit State per MBE Table 6A.4.2.2-1 whenever HL-93 is specified on applicable plans

**Figure 3-4.1 Potential Design Vehicles**

# INDOT BrIM: Modernization of Policy

What are the required load rating vehicles?

## Legal Vehicles

- Required by state and/or federal law
- As a group represent typical “legal” truck configurations
- Use for determining the present day capacity of a bridge
- Use for determining load restrictions

Truck Configuration	LRFR Subcategory
H-20	Routine Commercial Traffic
HS-20	Routine Commercial Traffic
Alternate Military	Routine Commercial Traffic
AASHTO Type 3	Routine Commercial Traffic
AASHTO Type 3S2	Routine Commercial Traffic
AASHTO Type 3-3	Routine Commercial Traffic
Lane-Type*	Routine Commercial Traffic
EV2	Routine Commercial Traffic
EV3	Routine Commercial Traffic
NRL**	Specialized Hauling
SU4	Specialized Hauling
SU5	Specialized Hauling
SU6	Specialized Hauling
SU7	Specialized Hauling

\* Load and Resistance Factor Rating (LRFR) only

\*\* Not to be used for load posting

Figure 3-4.2 Required Legal Vehicles

# INDOT BrIM: Modernization of Policy

What are the required load rating vehicles?

## Permit Vehicles

- Use to consider passage for vehicles that exceed legal requirements
- Broken into two subcategories
  - Routine
    - Typically multi-trip annual permits
    - Use for determining the present day capacity of a bridge for applicable routes
    - Use for determining load restrictions for applicable routes
  - Special
    - Single trip or non-routine permit analysis

Routine	Special
Toll Road Loading No. 1	Superload – 11 Axles
Toll Road Loading No. 2	Superload – 13 Axles
Special Toll Road Truck	Superload – 14 Axles
Michigan Train Truck #5	Superload – 19 Axles (305K)
Michigan Train Truck #8	Superload – 19 Axles (480.09K)

**Figure 3-4.3 Potential Permit Vehicles**

# Load Rating Example

<u>DESIGN LOADS</u>		
<i>(future wearing surface ==&gt; 35 psf)</i>		
Applicable Design Vehicle	Vehicle Configuration	Inventory Rating Factors
<input checked="" type="checkbox"/>	HL-93	0.400
<input checked="" type="checkbox"/>	Fatigue	1.310
<input checked="" type="checkbox"/>	H-20	0.842
<input checked="" type="checkbox"/>	HS-20	0.842
<input type="checkbox"/>	<del>HS-25</del>	
<input type="checkbox"/>	<del>Alternate Military</del>	
<input type="checkbox"/>	<del>Toll Road Loading NO. 2</del>	
<input type="checkbox"/>	<del>Toll Road Loading NO. 1</del>	
<input type="checkbox"/>	<del>Special Toll Road Truck</del>	
<input type="checkbox"/>	<del>Michigan Train Truck NO. 5</del>	
<input type="checkbox"/>	<del>Michigan Train Truck NO. 8</del>	

# Load Rating Example

LEGAL & ROUTINE PERMIT LOADS (future wearing surface NOT included)					
	# of Axles	Vehicle Configuration	Rating Factors	Load Capacity (tons)	Safe Posting Load (tons)
	2	EV2	0.834	23.98	
	3	EV3	0.581	24.98	
				Single Axle	13.97
				Tandem	18.01
				Gross	23.98
Applicable Routine Permit	# of Axles	Vehicle Configuration	Rating Factors	Load Capacity (tons)	Safe Posting Load (tons)
	varies	NRL	0.945	<del>22.12</del>	<del>22.12</del>
	2	H20-44	1.106	22.12	22.12
	2	Alternate Military	0.982	23.57	23.38
	3	HS20-44	0.671	24.16	19.08
	3	AASHTO Type 3	1.510	37.75	37.75
	4	SU4	1.380	37.26	37.26
<input type="checkbox"/>	4	<i>Toll Road Loading NO. 2</i>			
	5	AASHTO Type 3S2	1.177	42.37	42.37
	5	SU5	1.215	37.67	37.67
<input type="checkbox"/>	5	<i>Toll Road Loading NO. 1</i>			
	6	AASHTO Type 3-3	1.150	46.00	46.00
	6	Lane-Type	0.763	30.52	26.46
	6	SU6	1.088	37.81	37.81
<input type="checkbox"/>	7	<i>Special Toll Road Truck</i>			
	7 / 8	SU7	0.982	38.05	37.75
<input checked="" type="checkbox"/>	8	Michigan Train Truck NO. 5	0.646	43.28	33.12
<input checked="" type="checkbox"/>	11	Michigan Train Truck NO. 8	0.627	42.07	31.35

# Documentation/Submittal Process

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- BRADIN is now active
  - Request Read Only Access
  - Bridge Inspection Memo will be issued once BRADIN is ready for Local Bridge Data
  - Write-Only access will be available to INDOT personnel, and Consultant Load Rating Engineers (LRE)

# Additional Resources

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- All recent load rating presentations are being added to the INDOT Bridge Design Website <http://www.in.gov/indot/3669.htm>
- Examples, Software, Guidance will be added to the website as well.

# Summary

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Questions?

