Workshop Agenda

I. Introductions
II. Load Rating Basics
III. General Equations
IV. Load Rating Procedure
V. Incorporating Member Distress
VI. Posting, SHV's and Permitting
VII. Load Rating Example #1
- Simple Span Non-composite Steel

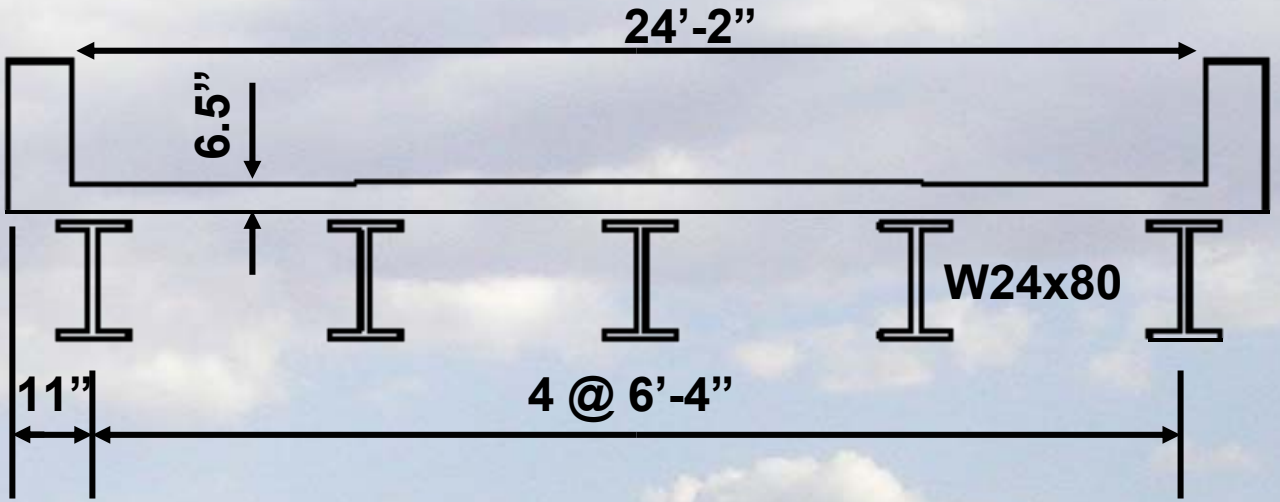
Load Rating Example #1

- **Simple Span Non-composite Steel**
  (Bridge Type 301)

Procedure

1. Calculate Member Capacity
2. Calculate Dead Load
   - Incorporate section loss
3. Calculate Live Load
   - HS20 / Posting / Permit trucks
4. Rating Equation
5. Check Posting if applicable
6. Check Permit Truck if applicable

Load Rating Example #1
Br 5905



- Non-composite
- 36’-0” simple span
- F_y = 33 ksi

Load Rating Example #1

- Calculate W24x80 moment capacity
  - $I_x = 2230\ in^4$
  - $S_x = \dfrac{I_x}{D/2} = \dfrac{2230\ in^4}{24\ in/2} = 186\ in^3$
  - $M_y = S_x \times F_y = 186\ in^3 \times 33\ ksi$

    $= 6138\ k\text{-}in = 512\ k\text{-}ft$

Load Rating Example #1

- **Calculate Dead Load Moment**
  - Beam - 80 lb/ft
  - Haunches, diaphragms and Misc - say 8 lb/ft
  - 2 - Railings - 320 lb/ft
  - Deck 6.5” with 6’- 4” tributary area

Load Rating Example #1

- **Calculate Dead Load Moment**
  - M = $wL^2/8$ (uniform load simple span max M)

$$M_{DL} = \frac{\left(80 + 8 + \frac{320 \times 2}{5} + \left(\frac{6.5}{12} \times 6.33 \times 150\right)\right) \times 36^2}{8}$$

$$M_{DL} = 118350 \text{ lb-ft} = 118.4 \text{ k-ft}$$

Load Rating Example #1

- **Calculate Live Loads**
  - Distribution Factor = Beam spacing/11
  - Assume Impact = 30%

$$DF = 6.333/11 = 0.576$$

$$HS20 = 379 \text{ k-ft}$$ **From AASHTO chart for span length**

$$M_{LL} = HS20 \times DF \times Impact$$

$$M_{LL} = 379 \times 0.576 \times 1.3 = 283.7 \text{ k-ft}$$

Load Rating Example #1

- **Calculate Inventory Rating**

$$\text{HS Rating} = \frac{\text{Capacity} - 1.3 \times \text{Dead Load}}{2.17 \times \text{Live Load}_{\text{HS20} + \text{Impact}}} \times 20$$

$$\text{HS Rating} = \frac{(512\ \text{k-ft}) - (1.3 \times 118.4\ \text{k-ft})}{2.17 \times 283.7\ \text{k-ft}} \times 20$$

$$\text{HS Rating} = \text{HS}11.6$$

Load Rating Example #1

- **Calculate Operating Rating**

$$\text{HS Rating} = \frac{\text{Capacity} - 1.3 \times \text{Dead Load}}{1.3 \times \text{Live Load}_{\text{HS20 + Impact}}} \times 20$$

$$\text{HS Rating} = \frac{(512\ \text{k-ft}) - (1.3 \times 118.4\ \text{k-ft})}{1.3 \times 283.7\ \text{k-ft}} \times 20$$

$$\text{HS Rating} = \text{HS19.4}$$

Load Rating Example #1

- **Scenario 1**
  - **Assume 2" deck overlay with ½" milled off**
    Calculate Dead Load Moment

$$M_{Overlay} = \frac{\left(80 + 8 + \frac{320 \times 2}{5} + \left(\frac{(6.5 + 2 - 0.5)}{12} \times 6.33 \times 150\right)\right) \times 36^2}{8}$$

$$M_{DL} = 137587 \text{ lb-ft} = 137.6 \text{ k-ft}$$

Load Rating Example #1

- **Calculate Updated Rating with overlay**

$$\text{Inv Rating} = \frac{(512\text{ k-ft}) - (1.3 \times 137.6\text{ k-ft})}{2.17 \times 283.7\text{ k-ft}} \times 20$$

$$\text{Inv Rating} = \text{HS}10.8$$

$$\text{Op Rating} = \frac{(512\text{ k-ft}) - (1.3 \times 137.6\text{ k-ft})}{1.3 \times 283.7\text{ k-ft}} \times 20$$

$$\text{Op Rating} = \text{HS}18.1$$

Load Rating Example #1

- **Scenario 2**
  - Assume 50% section loss to bottom flange at center span
  - $I_x = \sum(I_x + (A \times d^2))$– Parallel Axis Theorem
  - $I_x = 1670\ in^4$
  - $S_x = 123\ in^3$
  - $M_y = S_x \times F_y = 123 \times 33 = 4060$ k-in = 338 k-ft

Load Rating Example #1

- **Calculate Updated Rating with section loss**

$$\text{Inv Rating} = \frac{(338\,\text{k-ft}) - (1.3 \times 118.4\,\text{k-ft})}{2.17 \times 283.7\,\text{k-ft}} \times 20$$

$$\text{Inv Rating} = \text{HS}5.0$$

$$\text{Op Rating} = \frac{(338\,\text{k-ft}) - (1.3 \times 118.4\,\text{k-ft})}{1.3 \times 283.7\,\text{k-ft}} \times 20$$

$$\text{Op Rating} = \text{HS}10.0$$

Rating Summary

Rating	Original	2” Overlay	Section Loss
Inventory	HS11.6	HS10.8	HS5.0
Operating	HS19.4	HS18.1	HS10.0

Load Rating Example #1 (Cont.)

- **Check for posting on section loss example**
  - **Check Type M3, M3S2 and M3S3 at operating level**

$$\text{Rating Factor} = \frac{\text{Capacity} - 1.3 \times \text{Dead Load}}{1.3 \times \text{Live Load}_{\text{Posting Truck}} + \text{Impact}}$$

  - **To get posting weight take truck weight times rating factor**

Load Rating Example #1

- Find Posting Truck moments from chart
  - Type M3 (24 tons) = 410 k - ft
  - Type M3S2 (40 tons) = 379.4 k - ft
  - Type M3S3 (40 tons) = 388.6 k - ft

Truck	RF	Tons	Sign
Type M3	0.60	14.4	14
Type M3S2	0.65	25.9	24
Type M3S3	0.63	25.2	24

Load Rating Example #1 (Cont.)

- Other things to check by engineer
  - Plastic moment capacity, Z
  - Shear capacity (near supports)
  - Serviceability AASHTO 10.57.1
    - 0.8Fy noncomposite
    - 0.95Fy composite
  - Bearing Stiffeners
  - Exterior Beam
  - Compression Flange Bracing

Load Rating Example #1

- **Not usually checked**
  - Splices, diaphragms or connections
  - Fatigue
  - Concrete Deck
  - Local failure
  - Shear for slabs
  - Substructure (bearings, piles, movement)

REPORT FORM

EXAMPLE

FORM RC–CL Revised Feb. 2005	Mn/DOT BRIDGE RATING AND LOAD POSTING REPORT FOR COUNTY AND LOCAL AGENCIES

Bridge Location and Description

Hwy. No. 56 (over) under Upper Iowa River — Bridge No. 5905

Year Built 1940 — Year Remodeled ____ — Replaces Br. ____

Type 301 — County Mower — Ref. Pt. ____

Description 2 span 24'-2" Roadway width, 2 concrete railings, no sidewalk W24x80 at 6'-4" spacing

Location 2.6 miles West of Jct CSAH 8 near Tappi

Data for Basis of Report (Check all that apply)

- ☐ Bridge Inventory File
- ☐ Previous Bridge Rating and Load Posting Report
- ☒ Bridge Plans
  - ☒ New ☐ Overlay
  - ☐ Repair/Reconstruction ____
  - ☐ Other Dead Load Modifications ____
- ☒ Bridge Inspection Report, by ____, date ____
  - ☐ Damaged Component ____
  - ☒ Deteriorated Component Interior beam bottom flange det. 50% at midspan

Type of Analysis:

☒ Manual ☐ Computer* ☐ BARS ☐ Virtis, V.____ ☐ Other*

*____

Method of Rating (Check appropriate box)

- ☒ Load Factor (LF)
- ☐ Allowable Stress (AS) (Timber only)
- ☐ Load & Resistance Factor (LRFR)
- ☐ Load Testing
- ☐ No Rating Computations Performed

Design Load HS15

Design Method ASD

Summary of Rating and Load Posting Analysis

Load Posting Limits Posting: ☒ Required ☐ Not Required			Bridge Rating	
Vehicle Type M3	Semi-Trailer Type M3S2	Truck-Full Trailer Type M3-3	Inventory Rating	Operating Rating
14 Tons	24 Tons	24 Tons	5 HS	10 HS

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature: County Engr — Date: 3/5/05

Typed or Printed Name: County Engineer — Reg. No. 12345

BR3939.doc

REPORT FORM

FORM RD–CL Revised Feb. 2005	BRIDGE RATING DETAILS

Bridge Type 301 | Bridge No. 5905

Rating Method LFD | Design Load: HS15

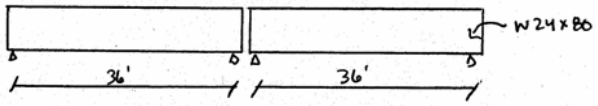
Roadway Width 24'-2" | Inventory Rating: HS - 5

☐ Curved ☐ Tapered | Operating Rating: HS - 10

Beam Spacing 6'-4" | Rated EAL Checked AAA

Live Load Distribution Lane Width | Date 3/7/05

Single 14' Multiple 11' | Sheet 2 of 2



BEAM ELEVATION ②

Show Span Lengths and Structure / Beam Depths

Truck	Rating Factor	Location	Limit State ①	Notes / Comments
HS 20 Inventory	0.25	50%	Ult. Moment	
HS 20 Operating	0.50	50%	Ult. Moment	
Post, M 3	0.60	50%	Ult. Moment	
Post, M 3S2	0.65	50%	Ult. Moment	
Post, M 3-3	0.63	50%	Ult. Moment	

① Choose from: service or ultimate; shear or moment.
② Elevation may be on back or another sheet if it won't fit here.

BR3942b.doc