Design Load Rating (DL) Process for Montana Department of Transportation's (MDT) Load Rating Manual

October 13, 2023

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Who We Are

Keely Matson, P.E.
Bridge Department Manager (Denver, CO)
15 Years Experience in Bridge Design and Load Ratings

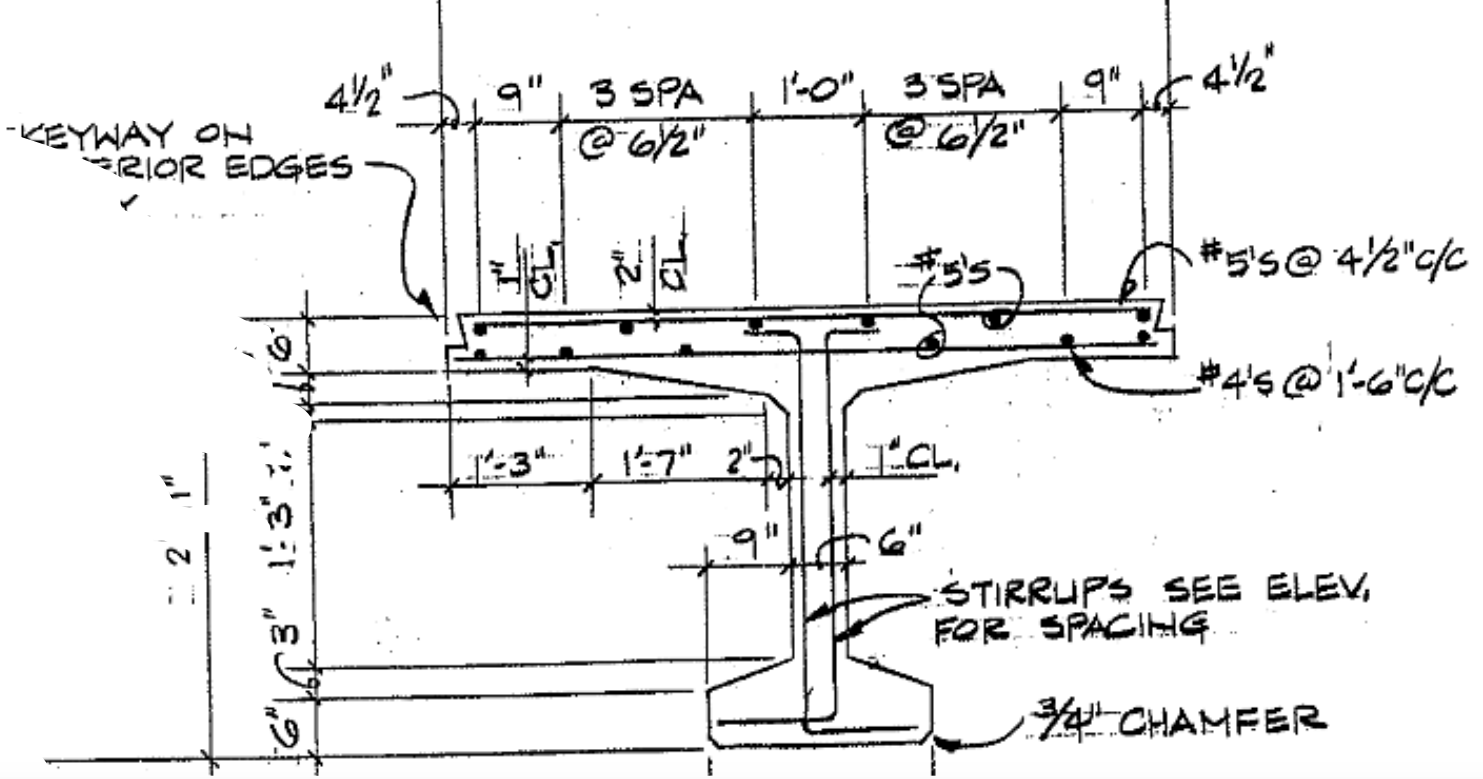
Luke Potthast, P.E.
Senior Structural Engineer (Denver, CO)
11 Years Experience in Bridge Design and Load Ratings

MBI and MDT Working Together

- Load Rating Contract 2021-2024
  - Throughout our Term Assignments we've load rated 545 bridges including:
    - Concrete
    - Prestressed Concrete
    - Steel (including curved)
    - Trusses
    - Timber
    - Culverts
- Load Rating Manual Update
- Inspection QA and Manual Update

Bridges Without Adequate Information

- Close to 400 bridges that can't be rated with information available
- 325 of those bridges are Concrete and Prestressed
- County Owned structures
- Low volume local roads



What is a Design Load Rating (DL) and Why is it Needed?

- A process to load rate concrete bridges without plans and/or shop drawings
- Better than the ‘old-school’ Rational Evaluation (Assigned Rating) method
- Develop a ‘design’ for the bridge with a design ratio close to 1.0
- More accurate ratings when including deterioration
- Cheaper than Load Testing and NDE

Condition Rating	LFR Design Load Rating Factors		Load Posting (Tons)
NBI Condition Rating *	Inventory	Operating	
7 to 9 (Good to Excellent Condition no sign of deterioration or distress)	1.00	1.66	No posting required
5 to 6 (Fair Condition with minor or initial signs of deterioration or distress)	0.75	1.25	No posting required
4 (Poor Condition structural deterioration or distress present)	0.60	1.00	No posting required
3 (Serious condition major deterioration or signs of distress. See Note 1)	0.39 0.21	0.65 0.35	15 8
2 (Critical condition may need to consider closure)	0.13	0.22	5
0 or 1 (Bridge Closed)	0.0	0.0	Bridge Closed

*NBI condition rating is either NBI #59 (Superstructure) or #62 (Culvert)

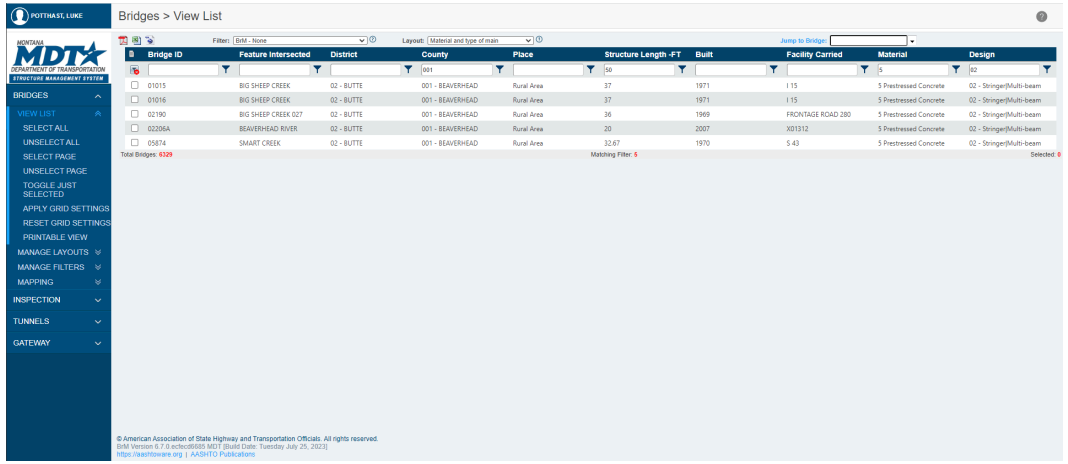
DL Case Study

- MBI worked with MDT to identify a small sample set
- The purpose of the sample set is to help develop a DL procedure and best practices
- Focused on county-owned prestressed structures
- Exhausted all other avenues to find shop drawings:
  - Contacted Counties, Engineers, Fabricators, etc

DL Case Study Process

1 Found an Example

- Use MDT's AASHTOWare BrM database
- Search based on:
  - Age
  - Proximity
  - Span
  - "Sister Bridges" vs "Similar (Cousin) Bridges"
- Limited precast fabricators used in MT within recent history
  - Beunher
  - Eagle Precast
  - Central Pre-Mix (Oldcastle)
  - Contech
  - United Prestress
  - Stanley Structures



DL Case Study Process

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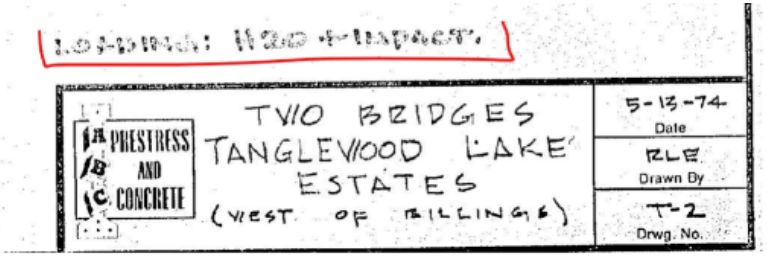
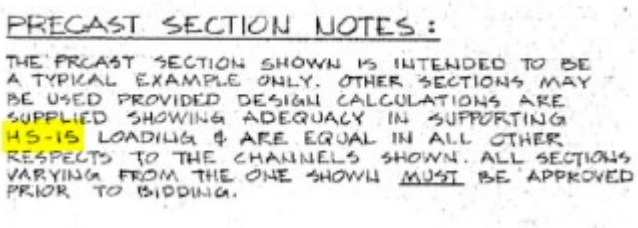
2 ‘Designed’ the Bridge

- All bridges were designed in LFR
- Some bridges used non-standard live loads for design: H20 or HS15 vs HS20-44
- Used a combination of AASHTOWare BrD and BrR
  - BrD only uses LRFD code provisions
  - BrR uses LFR
- Recreated design using example and tweaking as needed
  - Used material properties from either MBE or Standard Specifications
  - Used strand patterns similar to the example, including harped strands
  - Included shear checks in our designs

Year of Design	Facility Type	Design Truck Load
After 1970	Interstate	HS-20
1961 to 1970		HS-15
Before 1961		H-15
All	Other Primary Routes	H-15
All	Secondary Routes	H-15

Table 3.4.8.1.3-1 – Design Load, Year of Design & Facility Type Correlation





DL Case Study Process

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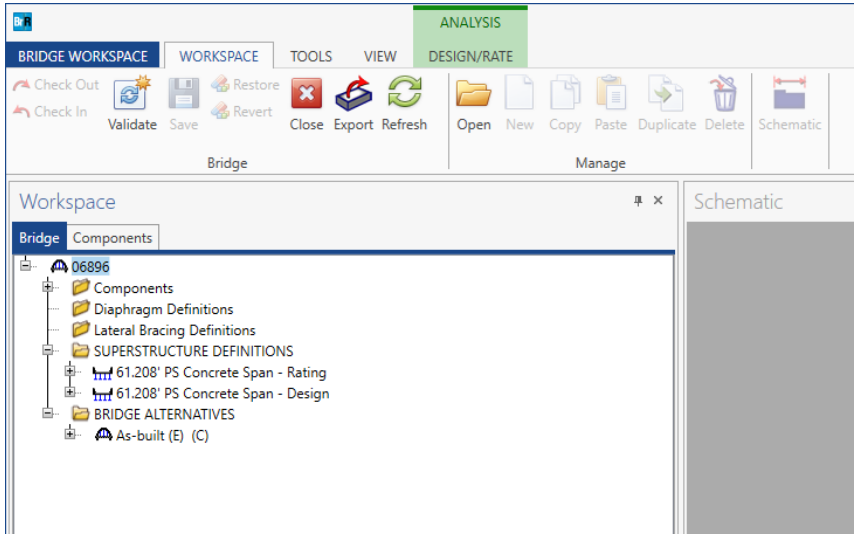
3 Load Rated the Bridge

- Separate Design and Rating models in BrR
- Load rated bridges in LRFR
- Rating Refinements:
  - Rate in LFR for bridges built before 2010
  - Remove Service III limit state for legal vehicles
  - Reduced EV live load effects per NCHRP 20-07



DL Case Study Process

1. Found an Example
2. ‘Designed’ the Bridge
3. Load Rated the Bridge

Identified Issues

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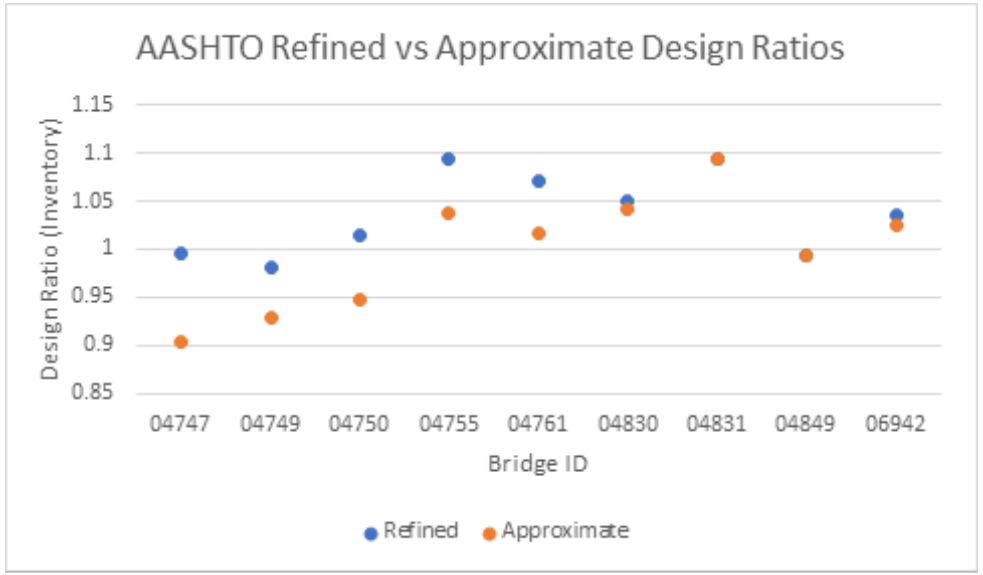
Key Issues

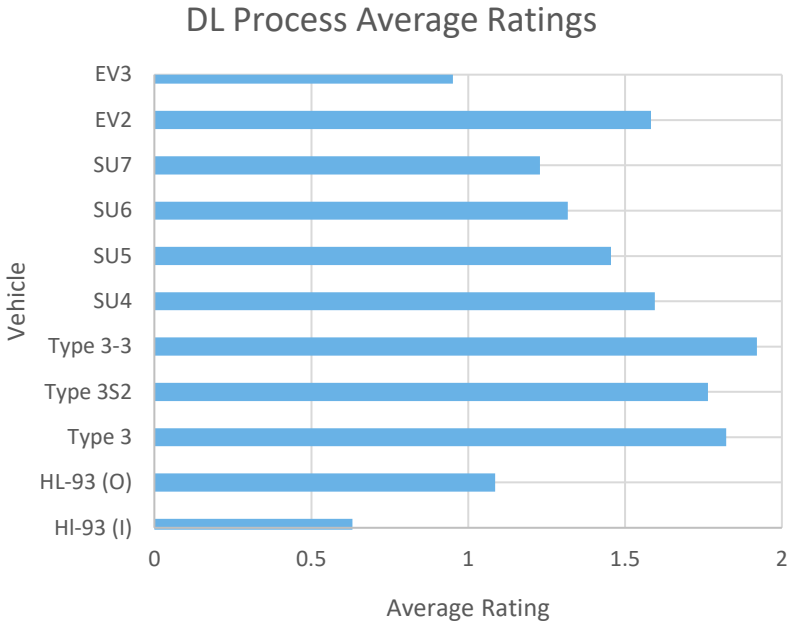
- Difficulty getting design ratio within target range (0.98-1.0)
- Finding a design program that uses LFD
- Using the applicable version of the design code

Happy Little Accident

- MDT uses AASHTO Refined analysis for PS losses including elastic gains in load ratings
- Older designs more likely to use Approximate method for PS losses
- Resulted in higher design ratios with fewer strands resulting in lower load ratings
- Still no postings required

Results





- Design ratios ranged from 0.982-1.095
- Approximate methods for PS losses reduced design ratio 4% on average
- No postings required

Things to Consider

Develop standards upfront

- Search DOT archives and work with local fabricators to find historical standards

Accuracy vs Efficiency

- To recreate the assumed design → use Strands in a Row method
- A ‘design’ ratio of 0.98-1.0 → use P&CGS strand input method

Applicable Code Checks

- Use the 1979 AASHTO Interim Shear Provisions?


Questions?

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A Big Thank You To:
Mary Smith, PE (MDT Load Rating Engineer)