2008
Bridge Load Rating Class 101

Workshop Agenda

VIII. Load Rating Example #2
- Simple Span Nail Laminated Timber Deck (without distress)

IX. Class Exercise
- Simple Span Nail Laminated Timber Deck (with distress)

X. Review of worked out examples

XI. Submittal to MN/DOT and Review of Process

XII. Common mistakes and questions

Common Mistakes / Questions

- **Live Loads**
  - 2 x Wheel loads = lane loads
- **Make sure posting sign is out on bridge**
  - Same from both directions
- **Lack of Enforcement**
  - May change posting/closing decision

Common Mistakes / Questions

- For shorter bridges, semi can't fit on bridge. Why do you post for semi then?
  - This is accounted for in calculations. The posting weight is ratioed to axles that can be on bridge
- Different code different answer
  - ASD could be higher for steel
  - LRFR generally lower
- What code is required
  - LRFR for new bridges after 2010
  - LFR acceptable beyond 2010 for existing bridges

Common Mistakes / Questions

- **Substructure rating is very subjective**
  - There is research into rules of thumb from different states. That should be coming next year.
- **Culverts with > 4’ fill**
  - Major load is not from live load.

Common Mistakes / Questions

- Truckers perspective: Bridge doesn't fall down when I drive a illegal heavy truck over it so it must be OK
  - There are conservatisms in assumptions and calculations. You are reducing your safety factor. There also could be unknown section losses.
  - Reduces service life of bridge

We would like to extend our thanks to:

- **Gary Peterson**
  - State Construction and Maintenance Bridge Engineer
- **Ed Lutgen**
  - Bridge Rating Engineer/North Region Bridge Construction Engineer
- **Dave Conkel**
  - State Aid Bridge Engineer
- **Brian Homan**
  - Asst State Aid Bridge Engineer (extraordinaire)
- **Rick Kjonaas**
  - State Aid

Thank you for coming to the:

2008 Bridge Load Rating Class 101

Questions/Comments?

Additional Considerations

- Structural steel
- Reinforced concrete
- Concrete culverts
- Prestressed concrete
- Timber
- Truss bridges

Structural Steel

Special Considerations

- Use the following table for yield strength:

Year of Construction	Yield Point F_y (ksi)
Before 1905	26
1905-1936	30
1937-1963	33
1964-1989	36
1989-present	50

Special Considerations (Cont.)

- For beams consider overload requirements of AASHTO Stnd. Spec. 10.57 (Serviceability)
- Can use plastic capacity per Std Spec. 10.50 (Z modulus)
- Operating rating of welds, bolts, and rivets use max strength from Table 10.56A AASHTO Stnd. Spec.
- For friction joint fasteners (A325 bolts) use a stress of 21 ksi and 1.0 for A_1 & A_2

Reinforced Concrete

Special Considerations

- Use the following table for reinforcement yield strength:

Reinforcing steel	Yield Point F_y (ksi)
Prior to 1940	30
Unknown Steel (prior to 1954)	33
Structural Grade	36
Billet or Intermediate Grade and unknown after 1954 (Grade 40)	40
Rail or Hard Grade (Grade 50)	50
Grade 60	60

Ref: Manual for Condition Evaluation of Bridges
Note some older bridges used square bars not round.

Culvert Considerations

- Culverts > 5’ fill have significantly lower live load component
  - By reducing rating/posting the safety not increased
- Watch for distress that could cause failure
  - Settlement
  - Soil pressures
- Hydraulic considerations
  - Higher Velocities
  - Debris buildup
  - Alternate scour paths

Prestressed Concrete

Prestressed Concrete

- **Inventory Level (HS-20 Truck)**
  - Concrete Tension
    - Almost always controls center beam
  - Concrete Compression (2 equations)
  - Prestress Steel Tension
  - Flexural Strength
  - Shear Strength

Prestressed Concrete

- **Operating Level (HS-20 Truck)**
  - Flexural Strength
  - Shear Strength (most likely control)
  - Prestressing Steel Tension

Prestressed Concrete

- **Inventory Level (HS-20 Truck)**

$$RF = \frac{6\sqrt{f'_c} - (F_d + F_p + F_s)}{F_l}$$

Concrete Tension

- **Operating Level (HS-20 Truck)**

$$RF = \frac{\phi R_n - (1.3D + S)}{1.3L(1+I)}$$

Flexural and Shear Strength

Timber Structures

Timber Structures

- Conduct load rating using ASR or LRFR methods
- ASR
  - Inventory unit stress = allowable stress for stress-grade lumber given in AASHTO Standard Specs.
  - Operating unit stress = 1.33 times allowable stress for stress-grade lumber, then reduced for grade and condition based on inspection

Timber Superstructures

- **During inspection:**
  - All corrosion/section loss should be recorded and subtracted from the gross cross-section area.
  - Tension Members
    - Find size, number, and location of all bolts/rivets (to determine net area)
    - Check condition of threaded rods at turnbuckles
  - Compression Members
    - Check for misalignments, bends, or kinks
    - Check connections for eccentricities

Timber Decks

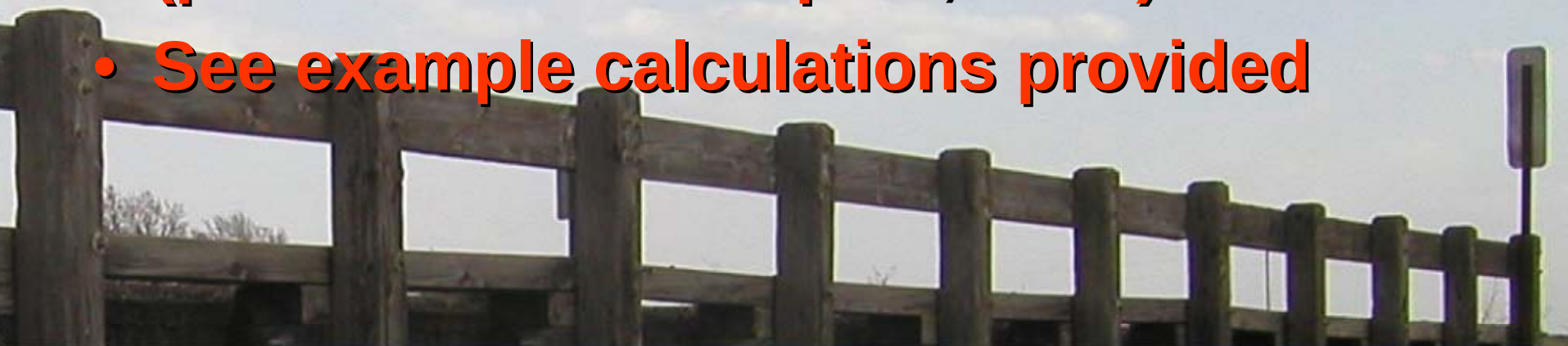
- Timber planking
  - Check for moment and shear
- Timber slabs
  - Check spreader beam
- See example calculations provided

Abutment Timber Piling Bent

- Section loss at groundline
- In addition to supporting dead and live loads, abutment piling brace approach backfill.
  - Behavior similar to beam column
- See example calculations provided

Pier Timber Piling Bent

- Section loss at waterline
- Estimate unbraced length
- Pier cap can be critical to carry sufficient load distribution
- Longitudinal and transverse loads (potential for ice impact, wind)
- See example calculations provided



When to Hire a Consultant

- Continuous spans
  - Moment distribution is a function of I
- Excessive distress
  - Possible repair plan
- Complex structures
  - Arches, trusses
- Beyond the comfort level of signing engineer