University of Cincinnati
College of Engineering
Spring Quarter 2009
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Transverse Beams

- Dead Load
  - Steel Deck and Beam – 490 lb/ft^3
  - Rails - 490 lb/ft^3
  - Ballast – 120 lb/ft^3
  - Ties – 60 lb/ft^3

Steel Deck and Beam

- Selected Beam W12x136
  - 136 lb/ft (AISC Code)
- Deck
  - 1/2 inch thickness minimum (AREMA Code)
    - ½ in x 1 ft / 12 in x 2 ft x 490 lb/ft^3 = 40.83 lb/ft

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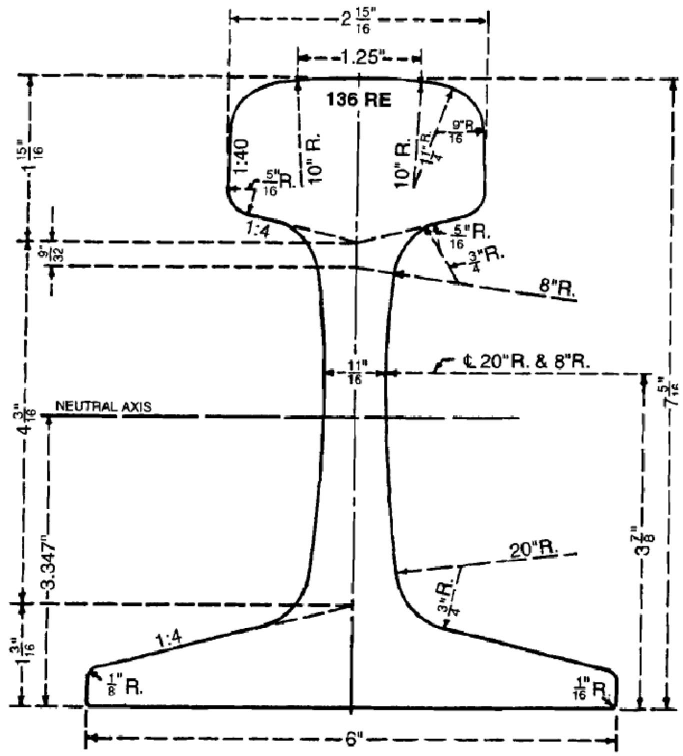
IDS Project: RAILROAD BRIDGE DESIGN

Rails

- Spacing (AREMA Code)
  - 56.5 in
- Locations of loads (centerline of tracks = centerline of bridge)
  - 18 ft – 56.5 in x 1 ft / 12 in = 13.29 ft
  - 13.29 ft / 2 = 6.65 ft (location of one track)
  - 6.65 ft + 56.5 in x 1 ft / 12 in = 11.35 ft (location of the other track)
- 136 lb/yd (AREMA Code)
  - 136 lb/yd x 1yd / 3 ft x 2 ft = 90.667 lb



1. Rail Area (square inch) Head Web Base Whole Rail	 4.8187 3.6375 4.8702 13.3263
2. Rail Weight (lb/yd) (based on specific gravity of rail steel = 7.84)	135.8826
3. Moment of Inertia about the neutral axis	94.20
4. Section modulus of the head Section modulus of the base	23.70 28.20
5. Height of neutral axis above base	3.34
6. Lateral moment of inertia	14.44
7. Lateral section modulus of the head Lateral section modulus of the base	9.83 4.82
8. Height of shear center above base	1.64
9. Torsional rigidity is 'KG' where G is the modulus of rigidity and K = (error for K greater than 10%)	6.24

Figure 4-1-5. 136 RE Rail Section[1]

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Ballast

- Minimum ballast depth = 6 inches below tie. (AREMA Code)
  - Minimum ballast cover of tie = 4 inches (AREMA Code)
    - Total of 10 inches ballast
  - Disregard the 1.75 ft^3 the tie takes up and the change in depth in the shoulders of ballast
    - 10 in x 1 ft / 12 in x 2 ft x 120 lb/ft = 200 lb/ft

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Ties

- Use largest tie – 9 ft x 7 in x 9 in
  - 7 in x 9 in x 1 ft^2 / 144 in^2 x 60 lb / ft^3 = 26.25 lb/ft
- Find location of loads
  - 18 ft – 9 ft = 9 ft
  - 9 ft / 2 = 4.5 ft (Starts at 4.5 ft)
  - 4.5 ft + 9 ft = 13.5 ft (Ends at 13.5 ft)

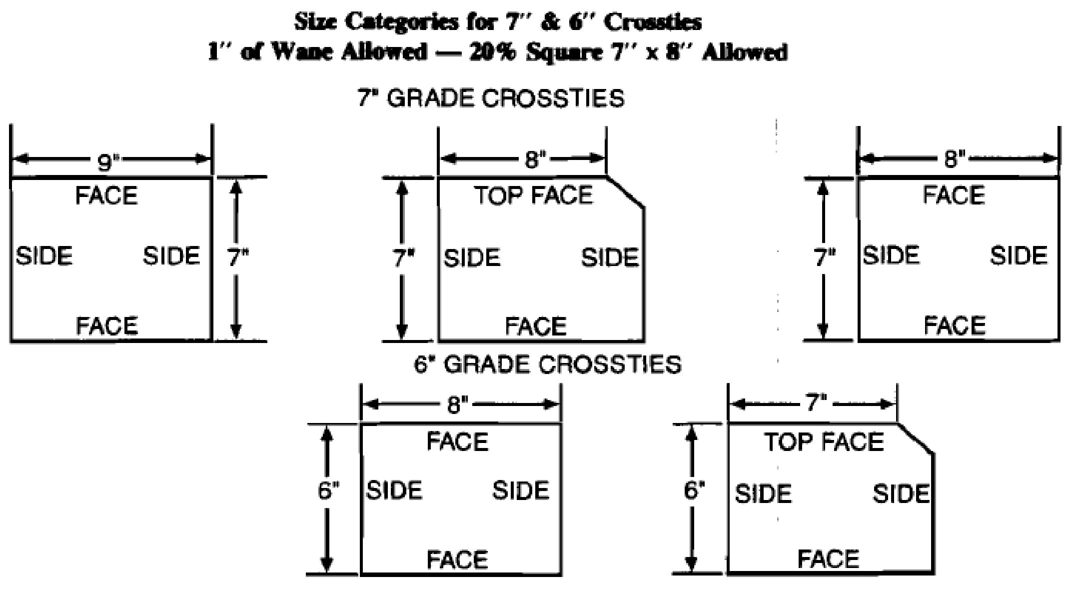

Figure 30-3-1. Dimensions of 7-inch and 6-inch Cross Ties

Live Loads

- Live load applied to transverse beams (AREMA Code)
  - Maximum axle weight = 80,000 lb
  - Minimum axle spacing = 5 ft
  - Transverse spacing = 2 ft
  - Total 1.15AD/S
    - 1.15 x 80,000 lb x 2 ft / 5 ft = 36,800 lb
  - Applied at the top of each rail
    - 36,800 lb / 2 = 18,400 lb
    - We know locations (6.65 ft and 11.35 ft)

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Impact Load

- Percentage of live load applied
  - Rocking, other forces
  - Length = 18 ft
  - Total 40 – $3L^2$ / 1600
    - 40 – 3 x 18^2 / 1600 = 39.39%
    - .3939 x 36,800 lb x .9 (ballast) = 13046 lb
  - Applied at the top of each rail
    - 13046 lb / 2 = 6522 lb
    - We know locations (6.65 ft and 11.35 ft)

Wind Load on Train

- 300 lb/ft at 8 ft height
  - 300 lb/ft x 2 ft = 600 lb
  - 600 lb x 8 ft = 4800 lb – ft
  - 4800 lb-ft / (56.5 in x 1 ft / 12 in) = 1020 lb (on one rail)
  - -1020 lb on the other rail

Total Loading

- Dead Load
  - Uniform Loads
    - 136 lb/ft + 41 lb/ft + 200 lb/ft + 26 lb/ft (from 4.5 ft to 13.5 ft) = 403 lb/ft
      - Close enough to 400 lb/ft
  - Point Loads
    - 90 lb at 6.65 ft and 11.35 ft
- Live Load
  - Point Loads
    - 18,400 lb + 6523 lb +/- 1020 lb = 25943 lb
      - Close enough to 25943 lb at 6.65 ft and 11.35 ft

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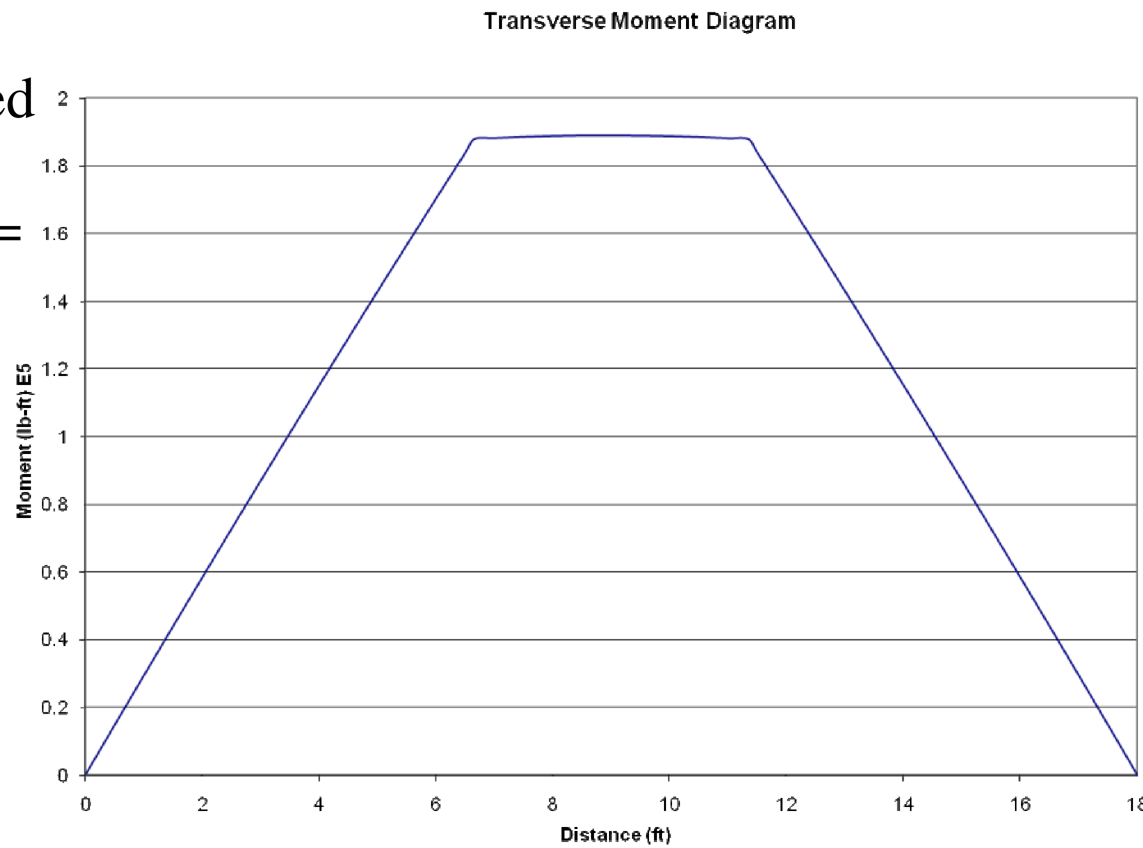
Sizing the Transverse Beam

- Find max moment based on load case
  - 188,000 lb-ft
- Choose strength of steel to be used
  - 70 ksi
  - FOS adjustment = 70 ksi x 0.55 = 38.5 ksi (AREMA Code)
- Calculate section modulus
  - 38.5 ksi = 188 k –ft / S
  - S = 58.6 in^3
- W12x136 has S = 64.2 in^3
- Check deflection
  - 0.2 in < 18 ft x 12 in/ft * 1/360



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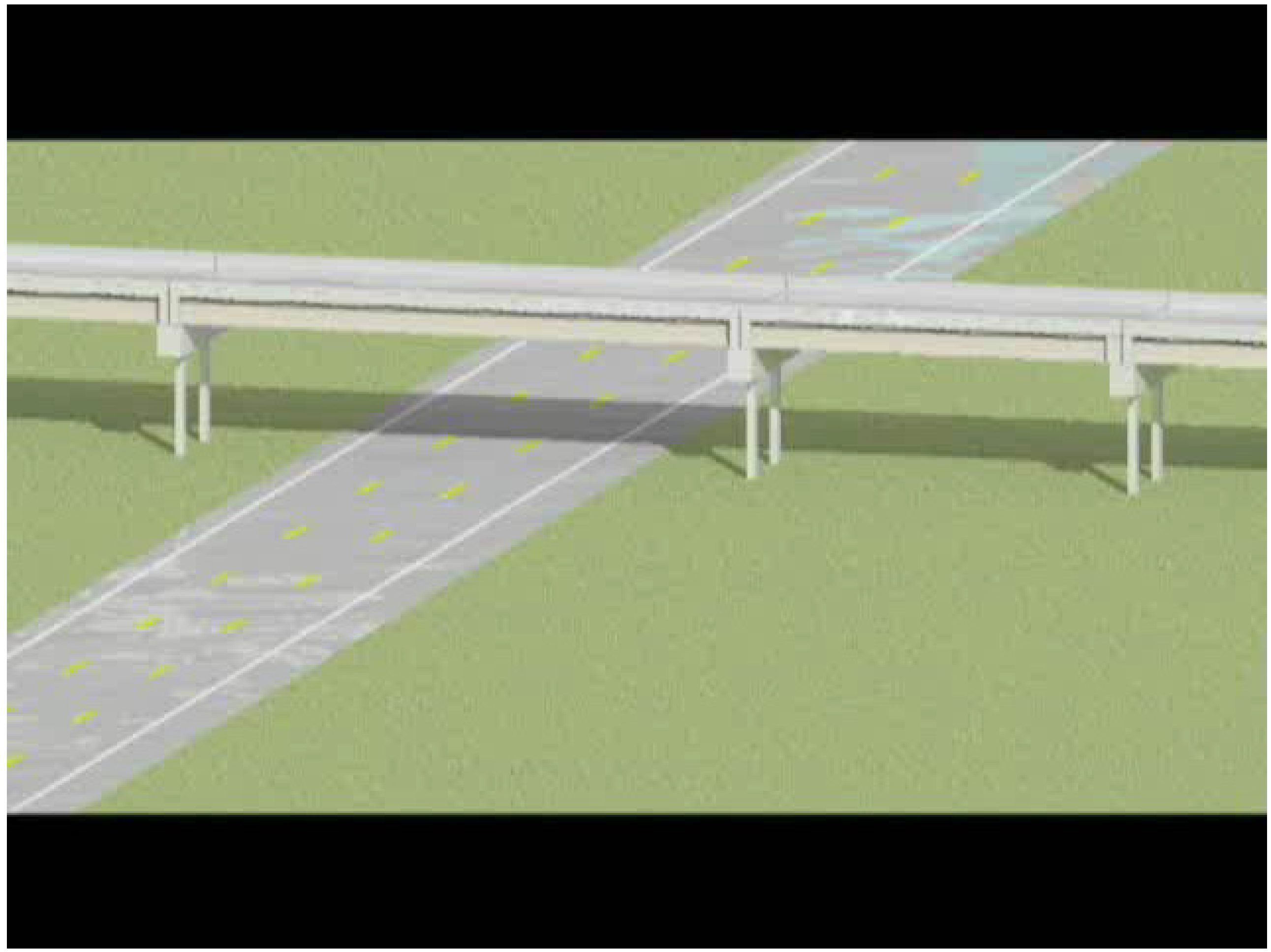
Replacement Technologies



Self-propelled modular transporters (SPMT's) could allow for the bridge to be replaced in one piece.

The bridge is assembled somewhere near the existing bridge. The existing bridge is lifted and set down somewhere for demolition. Finally, the new bridge is set in place.

The current method used in most bridge replacement projects is to have lane closures while work is done overhead. A bridge could take several months to construct.

The use of SPMT's allow for the bridge to be replaced with road closures lasting for only a few days.