AASHTOWare™ BRIDGE DESIGN AND RATING

# LFD Rating of Composite Steel Box Girders in AASHTOWare BrR

ITD Load Ratings

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2025 Rating and Design User Group Meeting

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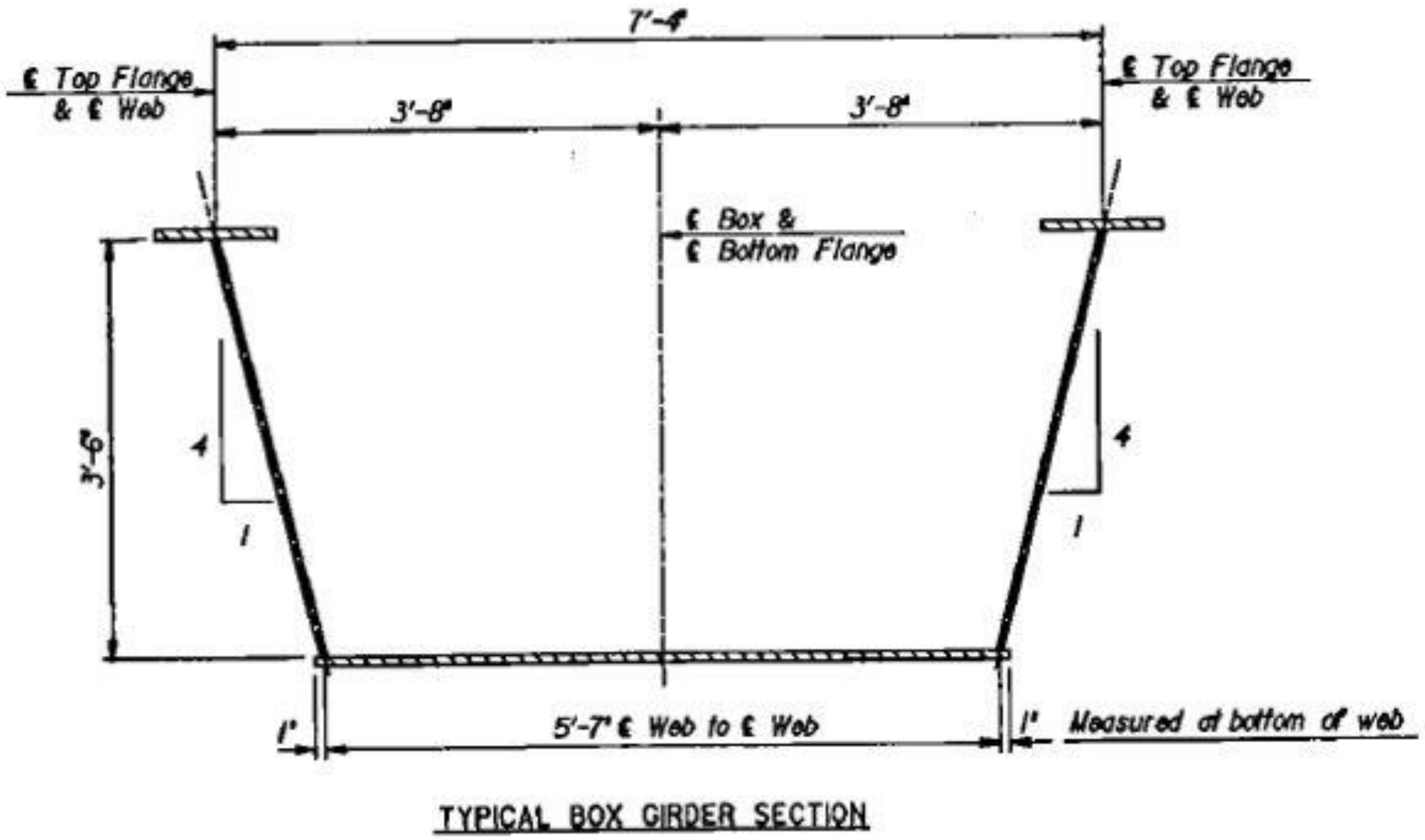


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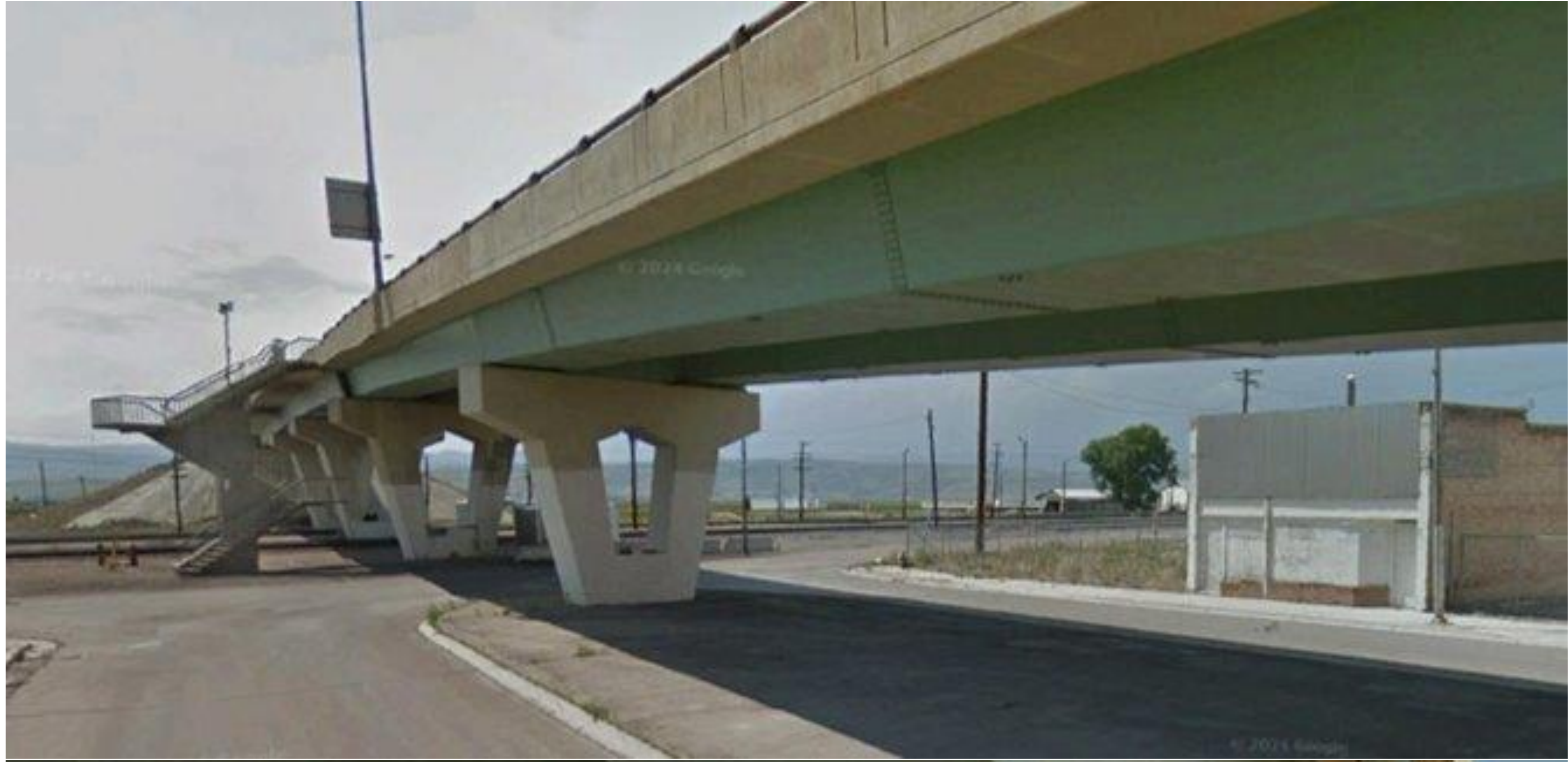
# ITD STEEL BOX GIRDER

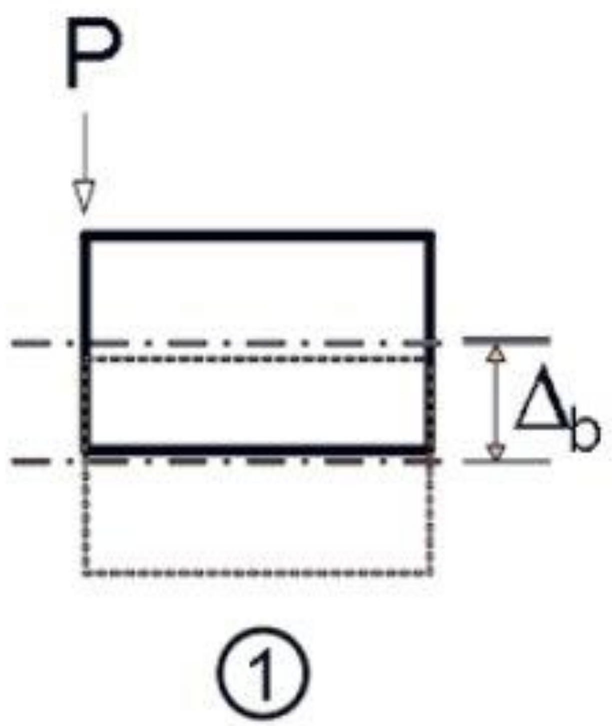
- **Straight and Skewed Steel Box Girder Bridges**
  - Box Girders as Line Girders
  - Equivalent I-Girder Method in AASHTOWare
  - Goal to get rating factors for shear and moment into one equivalent girder.





# BOX GIRDER VS. EQUIVALENT I-GIRDER

- Box Girder (Fully Composite)
  - Web Shear
  - Web-Bend Buckling
  - Flange Yield (Top and Bottom Flange)
  - Local Flange Buckling (Bottom Flange)
  - No lateral torsional buckling
    - Boxes are 100 to 1000 times more torsionally stiff than I-Girders.




**VS.**

- Equivalent I-Girder (Fully Composite)
  - Web Shear
  - Web-Bend Buckling
  - Flange Yield (Top and Bottom Flange)
  - Local Flange Buckling (Bottom Flange)
  - Lateral Torsional Buckling (Do not want in equivalent model)
    - "Dummy" bracing added at every 5 ft to simulate box girder torsional rigidity and ensure lateral torsional buckling in the equivalent I-Girder does not control

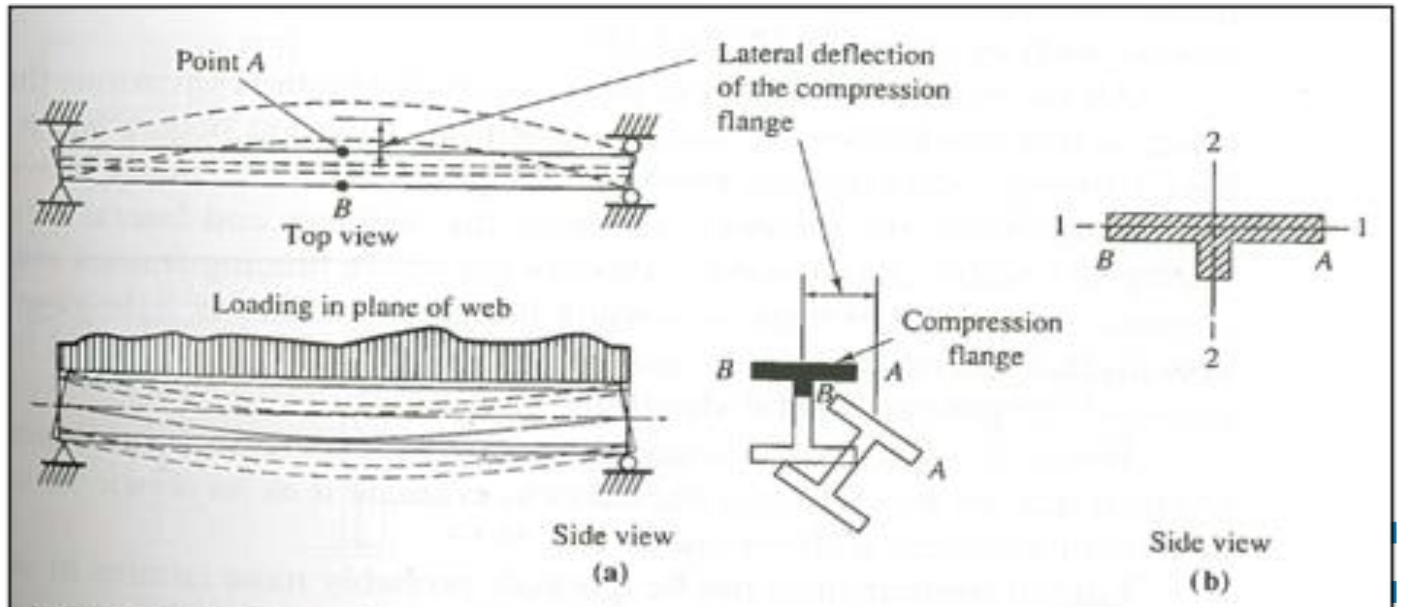
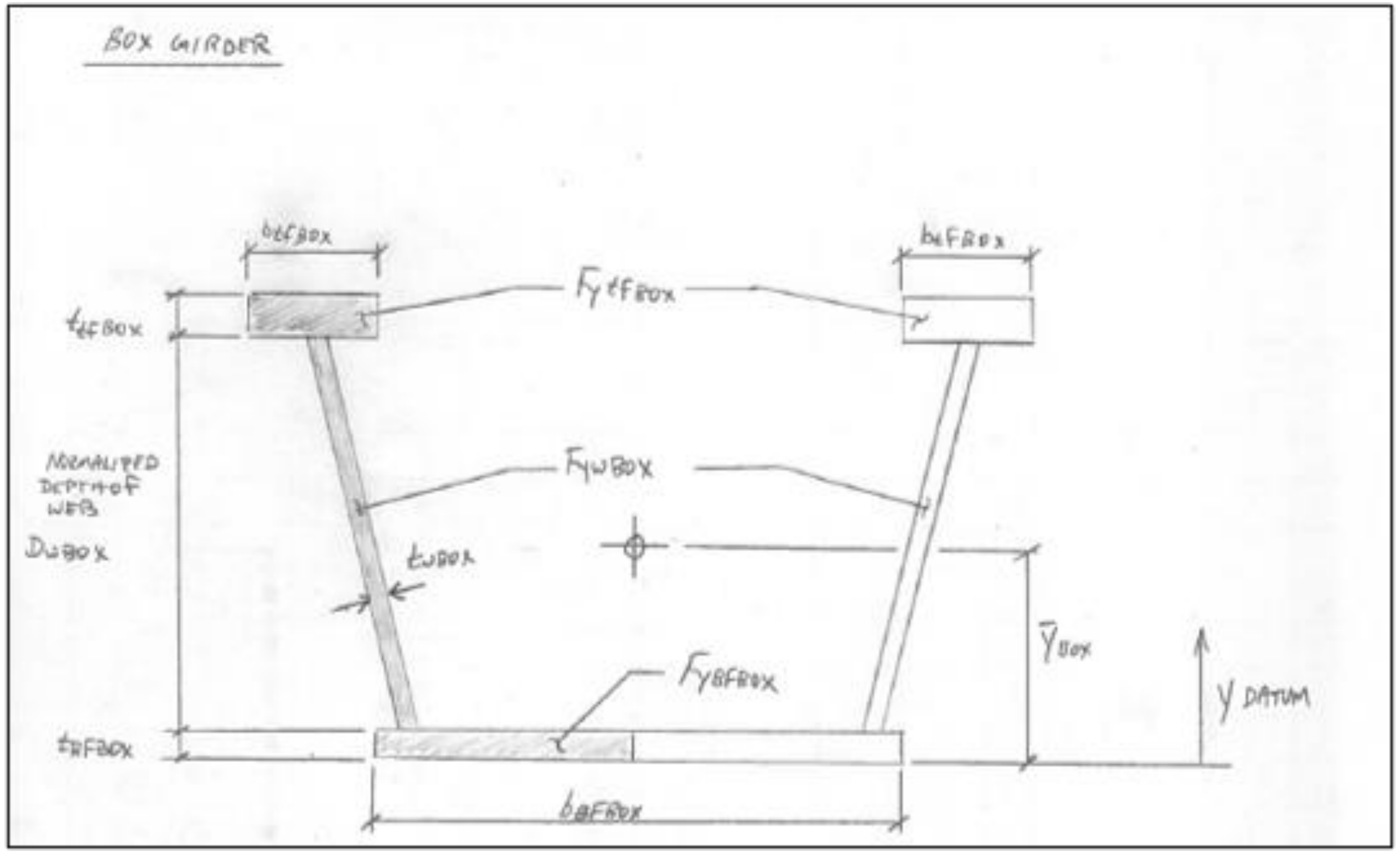



Figure 9.1.1 Beam laterally supported only at its ends.

# ACTUAL BOX GIRDER

# ½ I-GIRDER EQUIVALENT

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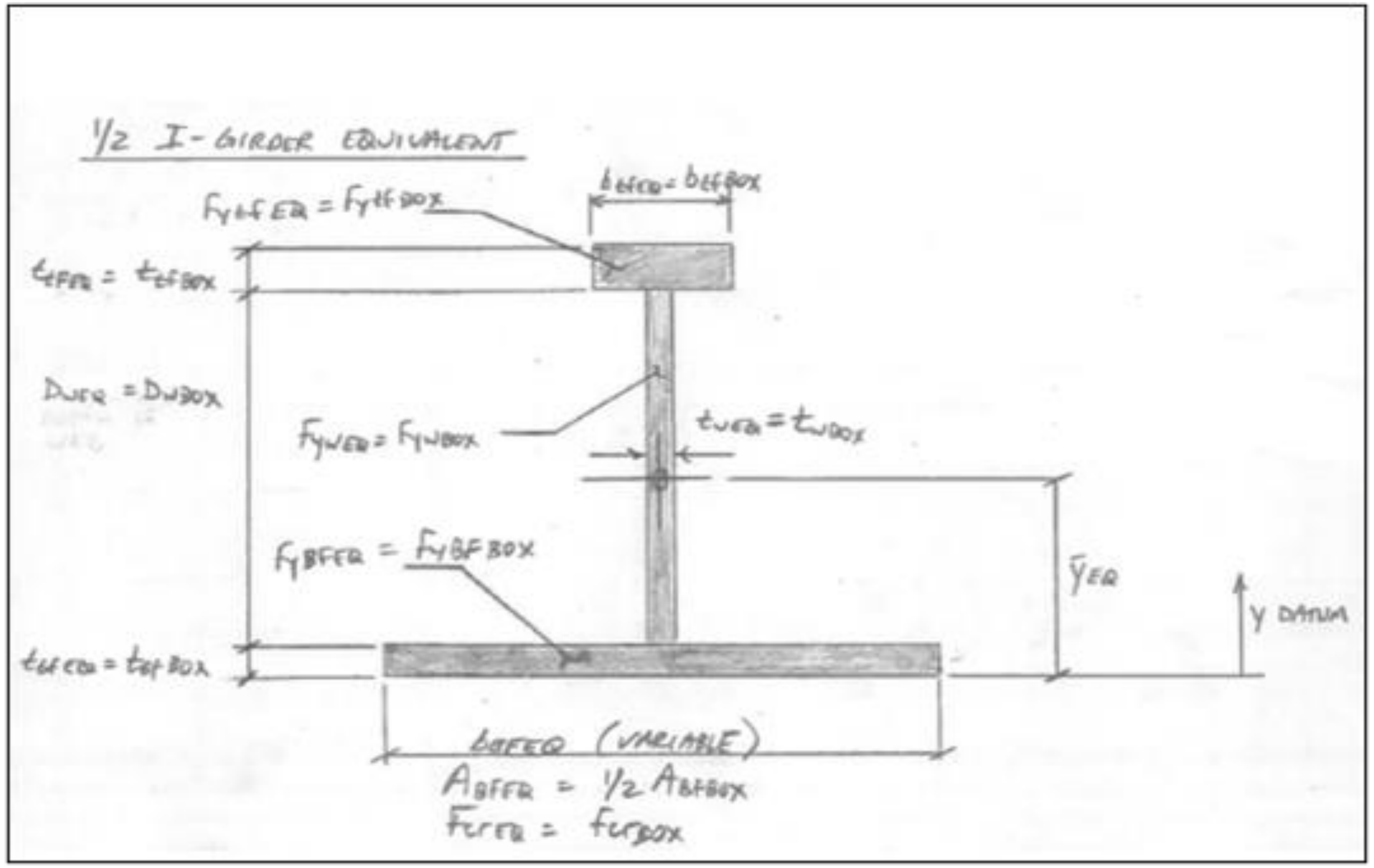


- Set $S_{EQ}$ = ½ $S_{BOX}$
- Set $DF_{LLEQ}$ = ½ $DF_{LLBOX}$
- Set $F_{crEQ}$ = $F_{crBOX}$ for bottom flange local buckling
- Set $Effwidth_{EQ}$ = ½ $Effwidth_{BOX}$
- $f_{EQ} = f_{BOX}$ ($f = Mc/I = M/S$)

# BOX GIRDER OBJECTIVES

- Captured:
  - Load Rating for Major Axis Bending – Positive and Negative Flexure, Top and Bottom Flanges
  - Load Rating for Major Axis Shear – Webs
  - LFR
- Not Captured:
  - St. Venant's Torsional Stresses
  - Cross-Sectional Distortion Stresses
  - System Effects (Line Girder Only)
  - Skew Effects (one bridge square, one 21° skew)
  - Curvature Effects (Bridges were straight)
  - LRFR


②　　③

- AASHTO Std. Spec. 17th Ed. 2002

**10.39.3.2 Secondary Bending Stresses**

*10.39.3.2.1* Web plates may be plumb (90° to bottom of flange) or inclined. If the inclination of the web plates to a plane normal to the bottom flange is no greater than 1 to 4, and the width of the bottom flange is no greater than 20% of the span, then the transverse bending stresses resulting from distortion of the span, and the transverse bending stresses resulting from distortion of the girder cross section and from vibrations of the bottom plate need not be considered. For structures in this category transverse bending stresses due to supplementary loadings, such as utilities, shall not exceed 5,000 psi.

*10.39.3.2.2* For structures exceeding these limits, a detailed evaluation of the transverse bending stresses due to all causes shall be made. These stresses shall be limited to a maximum stress or range of stress of 20,000 psi.

- AASHTO LRFD 10th Ed.

**6.11.1.1—Stress Determinations**

Box flanges in multiple and single box sections shall be considered fully effective in resisting flexure if the width of the flange does not exceed one-fifth of the effective span. For simple spans, the effective span shall be taken as the span length. For continuous spans, the effective span shall be taken equal to the distance between points of permanent load contraflexure, or between a simple support and a point of permanent load contraflexure, as applicable. If the flange width exceeds one-fifth of the effective span, only a width equal to one-fifth of the effective span shall be considered effective in resisting flexure.

For multiple box sections in straight bridges satisfying the requirements of Article 6.11.2.3, the live-load flexural moment in each box may be determined in accordance with the applicable provisions of Article 4.6.2.2.2b. Shear due to St. Venant torsion and transverse bending and longitudinal warping stresses due to cross-section distortion may also be neglected for sections within these bridges that have fully effective box flanges. The section of an exterior member assumed to resist horizontal factored wind loading within these bridges may be taken as the bottom box flange acting as a web and 12 times the thickness of the web acting as flanges.

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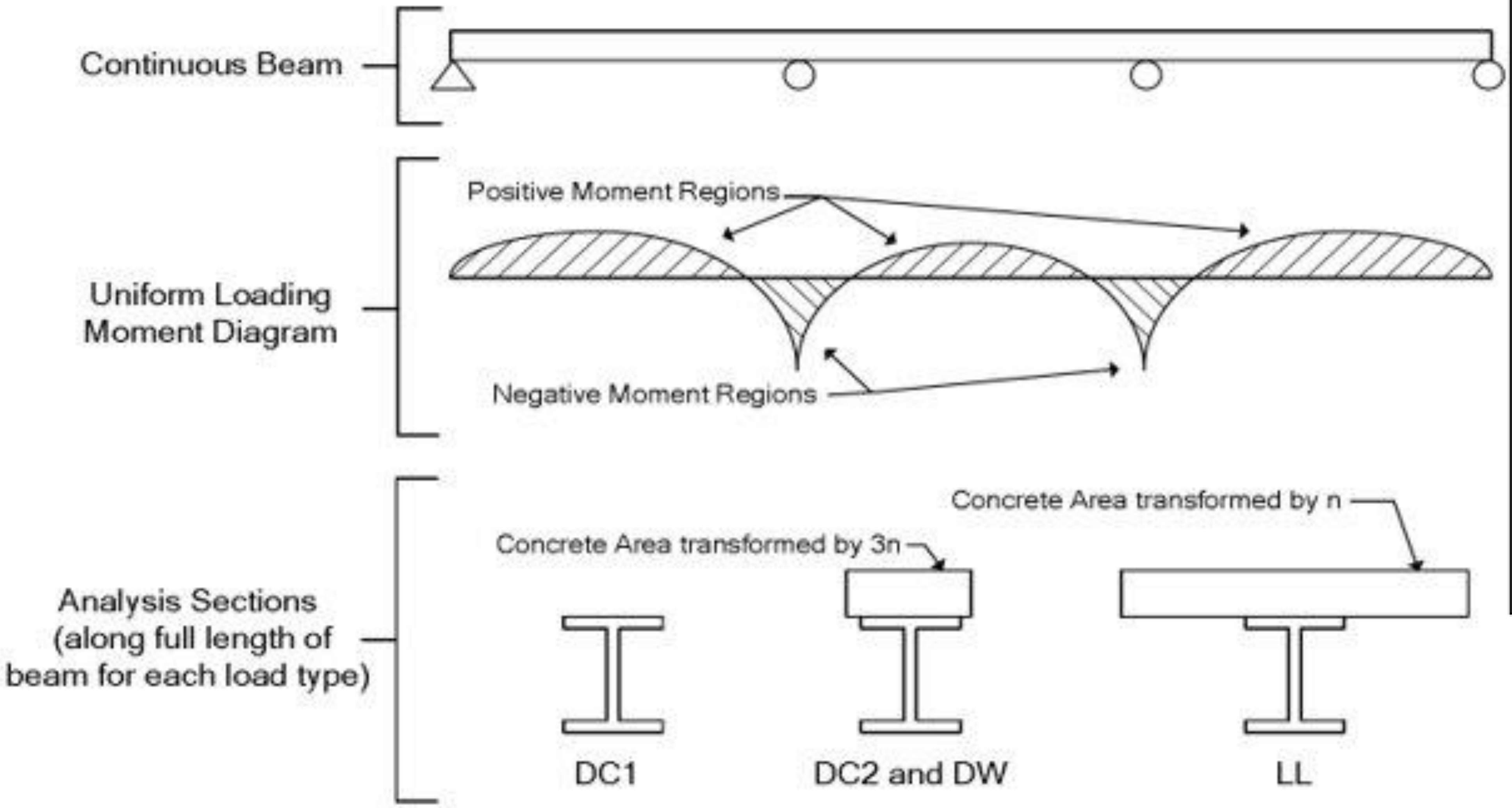
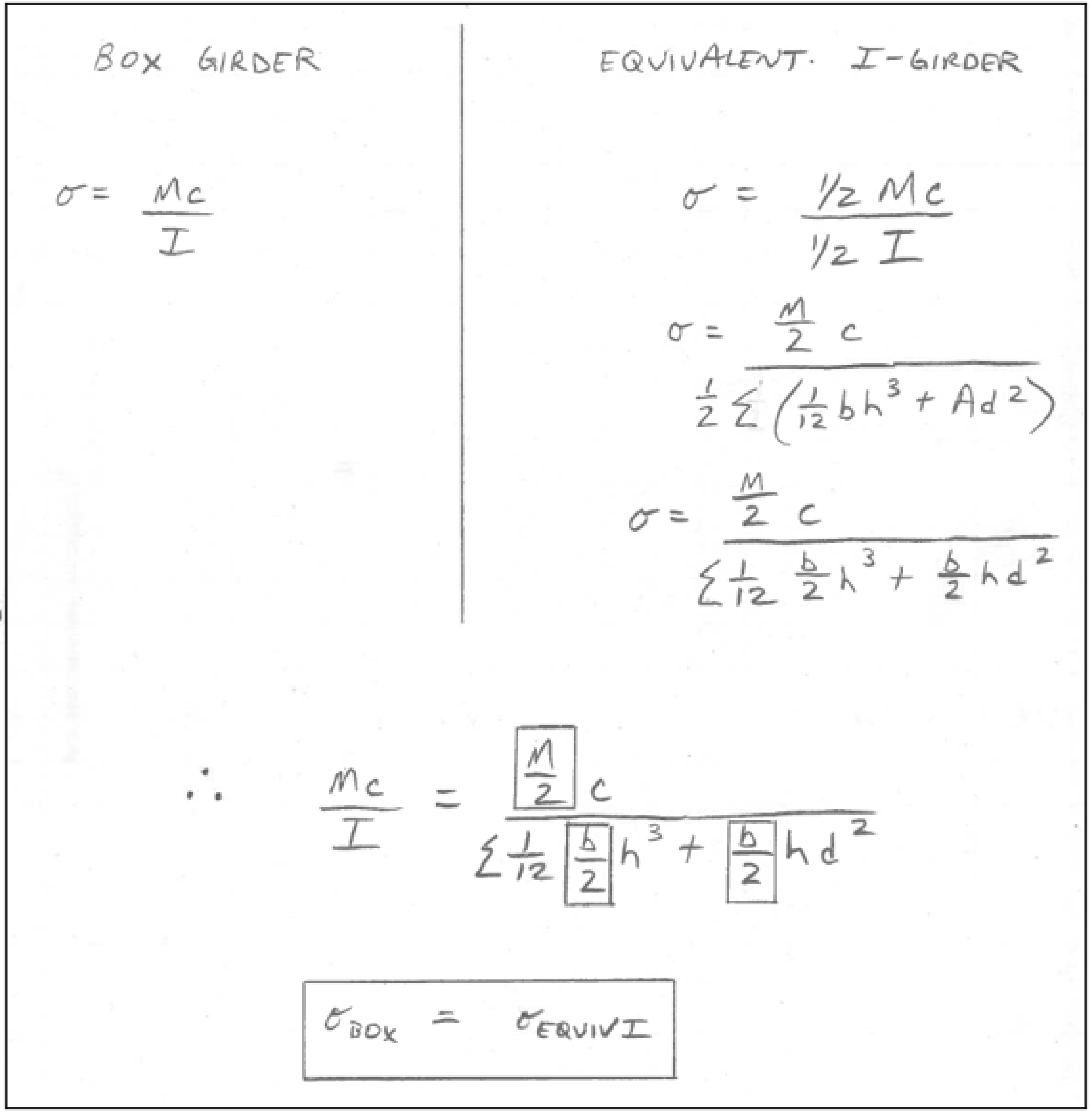
# EQUIVALENT STRESSES: BOX GIRDER VS. EQUIVALENT I-GIRDER

- ½ Girder Steel = ½ Steel Dead Load
- ½ Effective Deck Width = ½ Effective Deck Section for n and 3n
- ½ Tributary Deck Width = ½ Concrete Dead Load
- ½ Live Load Distribution Factor = ½ Live Load (Moment, Shear)

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# EQUIVALENT SHEAR FORCE: BOX GIRDER VS. EQUIVALENT I-GIRDER

- With C factor included in calculation, ~2% error or less in most cases with $d_0$ normalized over the difference in D of the web
  - AASHTO Std. Spec. 17th Ed. 2002

**10.48.8 Shear**

**10.48.8.1** The shear capacity of webs of rolled or fabricated flexural members shall be computed as follows:

For unstiffened webs, the shear capacity shall be limited to the plastic or buckling shear force as follows:

$$V_u = CV_p \qquad (10\text{-}113)$$

For stiffened web panels complying with the provisions of Article 10.48.8.3, the shear capacity shall be determined by including post-buckling resistance due to tension-field action as follows:

$$V_u = V_p\left[C + \frac{0.87(1-C)}{\sqrt{1+(d_o/D)^2}}\right] \qquad (10\text{-}114)$$

$V_p$ is equal to the plastic shear force and is determined as follows:

$$V_p = 0.58F_y D t_w \qquad (10\text{-}115)$$

The constant C is equal to the buckling shear stress divided by the shear yield stress, and is determined as follows:

for $\frac{D}{t_w} < \frac{6{,}000\sqrt{k}}{\sqrt{F_y}}$

$$C = 1.0$$

for $\frac{6{,}000\sqrt{k}}{\sqrt{F_y}} \le \frac{D}{t_w} \le \frac{7{,}500\sqrt{k}}{\sqrt{F_y}}$

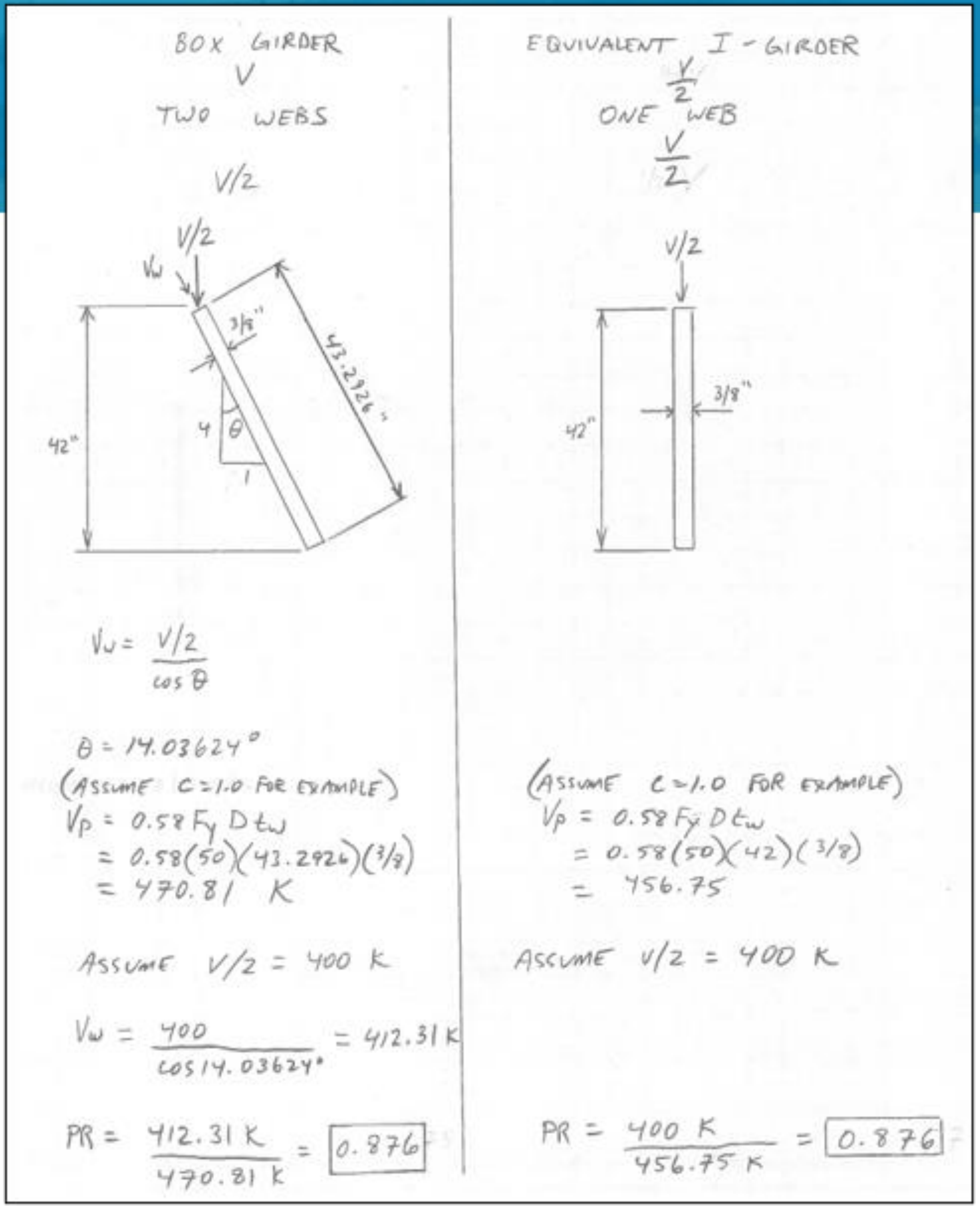
$$C = \frac{6{,}000\sqrt{k}}{\left(\frac{D}{t_w}\right)\sqrt{F_y}} \qquad (10\text{-}116)$$

for $\frac{D}{t_w} > \frac{7{,}500\sqrt{k}}{\sqrt{F_y}}$

$$C = \frac{4.5\times 10^7 k}{\left(\frac{D}{t_w}\right)^2 F_y} \qquad (10\text{-}117)$$

where the buckling coefficient, $k = 5 + [5 \div (d_o/D)^2]$, except k shall be taken as 5 for unstiffened beams and girders.

D = clear, unsupported distance between flange components;
$d_o$ = distance between transverse stiffeners;
$F_y$ = yield strength of the web plate.




AASHTOWare™ BRIDGE DESIGN AND RATING

# LIVE LOAD DISTRIBUTION – AASHTO LFD EQUATIONS

- AASHTO Std. Spec. 17th Ed. 2002

**10.39.2 Lateral Distribution of Loads for Bending Moment**

**10.39.2.1** The live load bending moment for each box girder shall be determined by applying to the girder, the fraction $W_L$ of a wheel load (both front and rear), determined by the following equation:

$$W_L = 0.1 + 1.7R + \frac{0.85}{N_w} \qquad (10\text{-}70)$$

where

$$R = \frac{N_w}{\text{Number of Box Girders}} \qquad (10\text{-}71)$$

$N_w$ = $W_c/12$ reduced to the nearest whole number;
$W_c$ = roadway width between curbs in feet, or barriers if curbs are not used. R shall not be less than 0.5 or greater than 1.5.

- Compute DF of actual box girder
- DF Equivalent I-Girder = ½ DF Actual Box Girder
- Lever Rule for Shear at Supports

# LIVE LOAD DISTRIBUTION- AASHTO LFD EQUATIONS

Live Load Distribution

Standard | LRFD

Distribution factor input method

- (selected) Use simplified method
- Use advanced method
- Use advanced method with 1994 guide specs

☑ Allow distribution factors to be used to compute effects of permit loads with routine traffic

| Lanes loaded | Distribution factor (wheels) | | | |
|---|---|---|---|---|
| | Shear | Shear at supports | Moment | Deflection |
| 1 Lane | 1.113 | 0.676 | 1.113 | 0.500 |
| Multi-lane | 1.113 | 0.812 | 1.113 | 1.000 |

# SETTING SECTION GEOMETRY – ACTUAL BOX

Longitudinal Location (Repeating Columns for Printing) | Actual Box Girder Steel Section Properties

Input | Iteration

| | | | | Top Flanges | | | | | | Webs | | | | | Bottom Flange | | | | Longitudinal Stiffeners | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel Section | Pier/Abut | Station | x location from CL Brg | Left $t_{tf}$ | Left $b_{tf}$ | Right $t_{tf}$ | Right $b_{tf}$ | Fy | Normalized Depth | Left $t_{web}$ | Left $D_{web}$ | Right $t_{web}$ | Right $D_{web}$ | Fy | $t_{bf}$ | $b_{bf}$ | b (btwn webs) | Fy | # | w (btwn stif | I | A | d | $\bar{y}$ |
| | | | ft | in | in | in | in | psi | in | in | in | in | in | psi | in | in | in | psi | | in | $in^4$ | $in^2$ | in | in |
| 1 | Abut 1 | 0 | 0 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 1 | | 1 | 35 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 2 | | 0 | 35 | 0.75 | 12 | 0.75 | 12 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 2 | Pier 1 | 1 | 45 | 0.75 | 12 | 0.75 | 12 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 2 | | 0 | 55 | 0.75 | 12 | 0.75 | 12 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 1 | | 1 | 55 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 1 | | 0 | 62.5 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 1 | End Stiff. | 1 | 62.5 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 0 | N/A | N/A | N/A | N/A | N/A |
| 1 | Begin Stiff. | 0 | 129.5 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 0 | N/A | N/A | N/A | N/A | N/A |
| 1 | | 1 | 129.5 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 1 | | 0 | 137 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 2 | | 1 | 137 | 0.75 | 12 | 0.75 | 12 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 2 | Pier 2 | 0 | 147 | 0.75 | 12 | 0.75 | 12 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 2 | | 1 | 147 | 0.75 | 12 | 0.75 | 12 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 1 | | 0 | 157 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |
| 1 | Abut 2 | 1 | 192 | 0.75 | 9 | 0.75 | 9 | 50000 | 39 | 0.375 | 40.25 | 0.375 | 40.25 | 50000 | 0.438 | 66 | 64.5 | 50000 | 2 | 21.5 | 23.3 | 5.58 | 7.05 | 1.54 |

- For every longitudinal section
  - Steel Only Section – DC1 Load
  - n Section – Transient Short-Term Live Load
  - 3n Section – Long-Term Dead Load (DC2, DW)

# SETTING SECTION GEOMETRY – ACTUAL BOX (CONTIN.)

Box Girder: Calculate Local Buckling Capacity of Bottom Flange of Actual Box girder at All Sections (AASHTO Std. Spec. 10.51.5)

| w/t < 3,070√k/√Fy ? | 6650√k/√Fy | 3,070√k/√Fy < w/t < 6650√k/√Fy ? | c | w/t > 6650√k/√Fy ? | Critical Buckling Stress of Bottom Flange Fcr psi |
|---|---|---|---|---|---|
| NO | 68.06 | YES | 0.52 | NO | 44340.7464 |
| NO | 68.06 | YES | 0.52 | NO | 44340.7464 |
| NO | 68.06 | YES | 0.52 | NO | 44340.7464 |
| NO | 68.06 | YES | 0.52 | NO | 44340.7464 |
| NO | 68.06 | YES | 0.52 | NO | 44342.6105 |
| NO | 67.70 | YES | 0.51 | NO | 44186.6532 |
| NO | 67.70 | YES | 0.51 | NO | 44186.6532 |
| N/A | N/A | N/A | N/A | N/A | N/A |
| N/A | N/A | N/A | N/A | N/A | N/A |
| NO | 67.70 | YES | 0.51 | NO | 44186.6532 |
| NO | 67.70 | YES | 0.51 | NO | 44186.6532 |
| NO | 68.06 | YES | 0.52 | NO | 44342.6105 |
| NO | 68.06 | YES | 0.52 | NO | 44340.7464 |
| NO | 68.06 | YES | 0.52 | NO | 44340.7464 |
| NO | 68.06 | YES | 0.52 | NO | 44340.7464 |
| NO | 68.06 | YES | 0.52 | NO | 44340.7464 |

**10.51.5.4** If longitudinal stiffeners are used, they shall be equally spaced across the flange width and shall be proportioned so that the moment of inertia of each stiffener about an axis parallel to the flange and at the base of the stiffener is at least equal to

$$I_s = \phi t^3 w \qquad (10\text{-}138)$$

where

$\phi = 0.07k^3n^4$ when n equals 2, 3, 4, or 5;
$\phi = 0.125k^3$ when n = 1;
w = width of flange between longitudinal stiffeners or distance from a web to the nearest longitudinal stiffener;
n = number of longitudinal stiffeners;
k = buckling coefficient which shall not exceed 4.

*10.51.5.4.1*

For a longitudinally stiffened flange designed for the yield stress $F_y$, the ratio w/t shall not exceed the value given by the formula

$$\frac{w}{t} = \frac{3{,}070\sqrt{k}}{\sqrt{F_y}} \qquad (10\text{-}139)$$

*10.51.5.4.2* For greater values of w/t

$$\frac{3{,}070\sqrt{k}}{\sqrt{F_y}} < \frac{w}{t} \le \frac{6{,}650\sqrt{k}}{\sqrt{F_y}} \qquad (10\text{-}140)$$

the buckling stress of the flange, including stiffeners, is given by Article 10.51.5.2 in which c shall be taken as

$$c = \frac{6{,}650\sqrt{k} - \frac{w}{t}\sqrt{F_y}}{3{,}580\sqrt{k}} \qquad (10\text{-}141)$$

*10.51.5.4.3* For values of

$$\frac{w}{t} > \frac{6{,}650\sqrt{k}}{\sqrt{F_y}} \qquad (10\text{-}142)$$

the buckling stress of the flange, including stiffeners, is given by the formula

$$F_{cr} = 26.2k(t/w)^2 \times 10^6 \qquad (10\text{-}143)$$

- For every longitudinal section transition
  - Calculate Actual Bottom Flange Buckling Capacity

# DOUBLE ITERATION OF BOTTOM FLANGE

| Longitudinal Location (Repeating Columns for Printing) | | | | | | Equivalent I-girder: Manipulate tbf and bbf of Bottom Flange to change Slenderness Ratio to meet Fcr and Sx | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Input | Iteration | | | Iteration | | | | | | | | | | | | |
| | | | | Bottom Flange | | Slenderness Ratio of Bottom Flange | | | Critical Buckling Stress | | | | | | | |
| Steel Section | Pier/Abut | Station | x location from CL Brg | $t_{bf}$ | $b_{bf}$ | t/b? | Goal to match Box= t/b = (sqrt(Fcr)/4400) | % difference (Box/I-Girder) | Fcr Box (Goal) | Fcr I-Girder Equiv | % difference (Box/I-girder) | Instruct | 1/2 *Abf Box | Abf I-Girder | % difference (Box/I-Girder) | Instruct |
| | | | ft | in | in | | | % | psi | psi | % | | in^2 | in^2 | % | |
| 1 | Abut 1 | 0 | 0 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.270 | 44340.746 | 44102.415 | 0.540 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 1 | | 1 | 35 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.270 | 44340.746 | 44102.415 | 0.540 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 2 | | 0 | 35 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.270 | 44340.746 | 44102.415 | 0.540 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 2 | Pier 1 | 1 | 45 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.270 | 44340.746 | 44102.415 | 0.540 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 2 | | 0 | 55 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.272 | 44342.611 | 44102.415 | 0.545 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 1 | | 1 | 55 | 0.83 | 17.39 | 0.047729 | 0.04777 | 0.095 | 44186.653 | 44102.415 | 0.191 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 1 | | 0 | 62.5 | 0.83 | 17.39 | 0.047729 | 0.04777 | 0.095 | 44186.653 | 44102.415 | 0.191 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 1 | End Stiff. | 1 | 62.5 | 0.48 | 30.3 | 0.015842 | 0.01580 | -0.285 | 4830.877 | 4858.504 | -0.569 | make more slender | 14.4375 | 14.544 | -0.732 | Subtract Ar |
| 1 | Begin Stiff. | 0 | 129.5 | 0.48 | 30.3 | 0.015842 | 0.01580 | -0.285 | 4830.877 | 4858.504 | -0.569 | make more slender | 14.4375 | 14.544 | -0.732 | Subtract Ar |
| 1 | | 1 | 129.5 | 0.83 | 17.39 | 0.047729 | 0.04777 | 0.095 | 44186.653 | 44102.415 | 0.191 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 1 | | 0 | 137 | 0.83 | 17.39 | 0.047729 | 0.04777 | 0.095 | 44186.653 | 44102.415 | 0.191 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 2 | | 1 | 137 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.272 | 44342.611 | 44102.415 | 0.545 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 2 | Pier 2 | 0 | 147 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.270 | 44340.746 | 44102.415 | 0.540 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 2 | | 1 | 147 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.270 | 44340.746 | 44102.415 | 0.540 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 1 | | 0 | 157 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.270 | 44340.746 | 44102.415 | 0.540 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |
| 1 | Abut 2 | 1 | 192 | 0.83 | 17.39 | 0.047729 | 0.04786 | 0.270 | 44340.746 | 44102.415 | 0.540 | make less slender | 14.4375 | 14.4337 | 0.026 | Add Area |

**10.48.2 Braced Noncompact Sections**

For sections of rolled or fabricated flexural members not meeting the requirements of Article 10.48.1.1 but meeting the requirements of Article 10.48.2.1 below, the maximum strength shall be computed as the lesser of

$$M_u = F_y S_{xt} \quad (10\text{-}98)$$

or

$$M_u = F_{cr} S_{xc} R_b \quad (10\text{-}99)$$

subject to the requirement of Article 10.48.2.1(c) where

$$F_{cr} = \left(4,400 \frac{t}{b}\right)^2 \leq F_y$$

$b$ = compression flange width
$t$ = compression flange thickness
$S_{xt}$ = section modulus with respect to tension flange (in.$^3$)
$S_{xc}$ = section modulus with respect to compression flange (in.$^3$)
$R_b$ = flange-stress reduction factor determined from the provisions of Article 10.48.4.1, with $f_b$ substituted for the term $M_r/S_{xc}$ when Equation (10-103b) applies

- All critical buckling stresses Box vs. Equivalent I-Girder within 1% or less
- All bottom flange areas ½ Box vs. Equivalent I-Girder within 1% or less
    - Contributes to section property comparison of section moduli (S, in^3)

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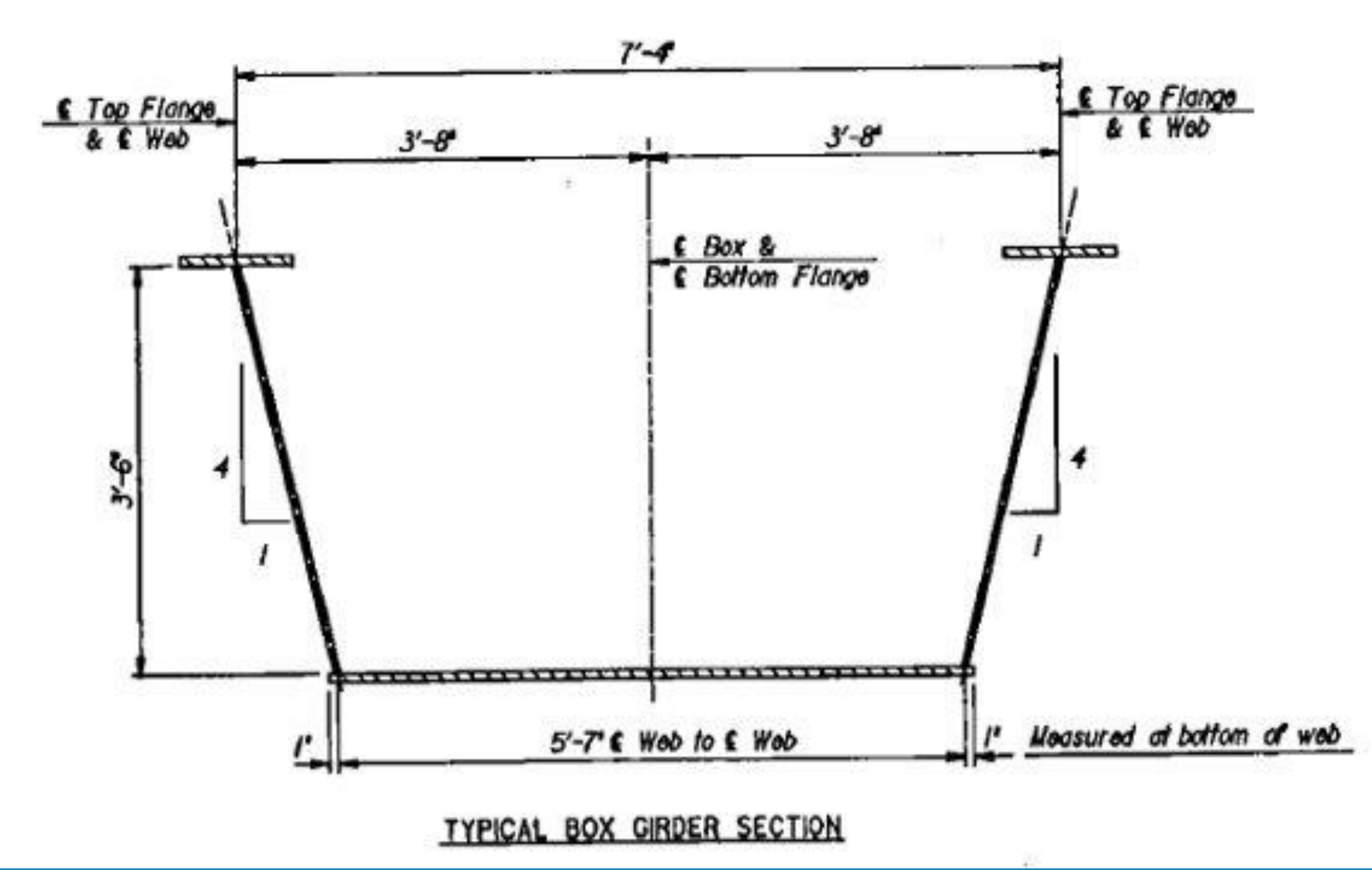
# SECTION PROPERTY COMPARISON: ACTUAL BOX VS. EQUIVALENT I-GIRDER

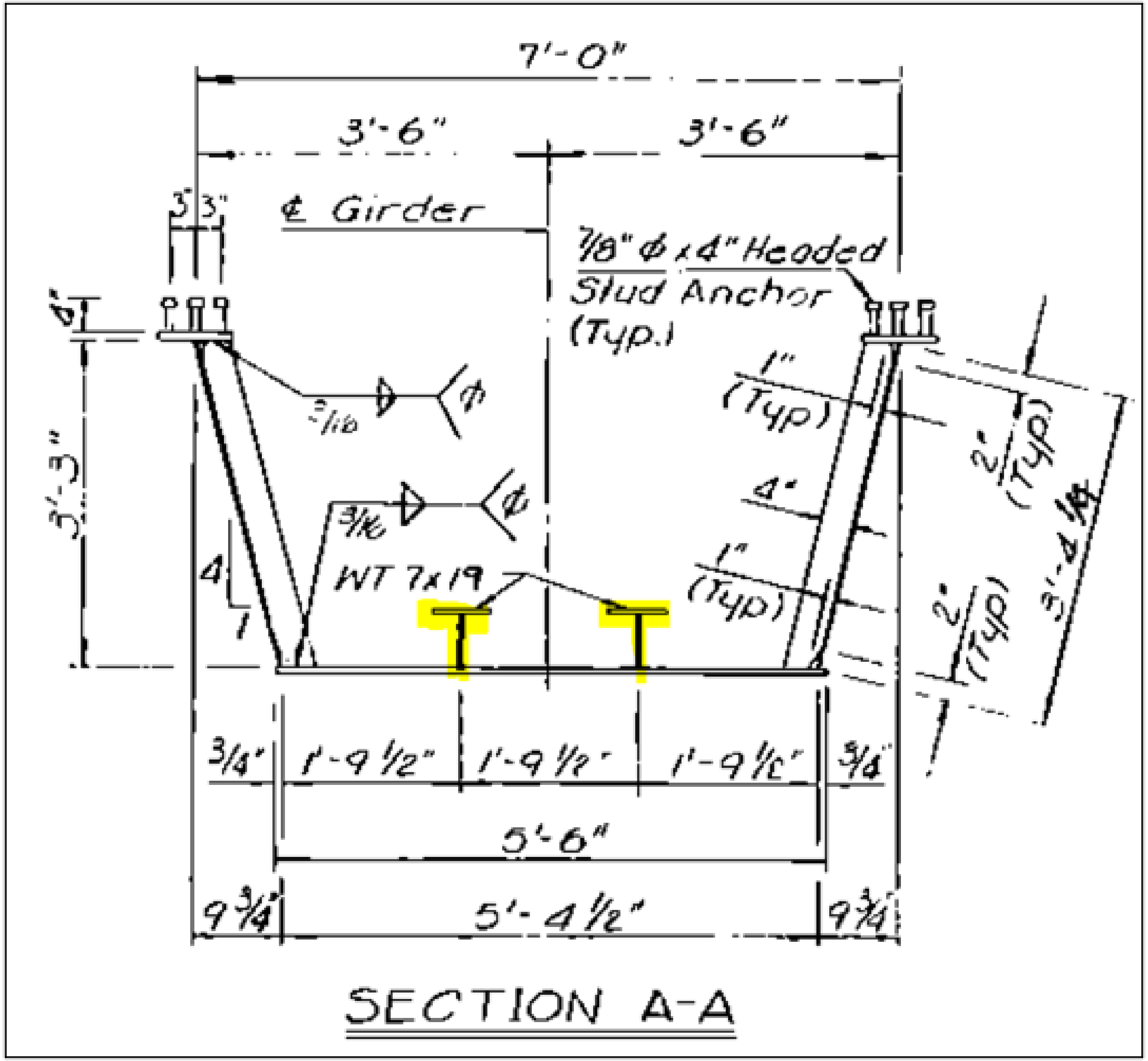
| Longitudinal Location (Repeating Columns for Printing) | | | | Final Comparison for Setting I-Equivalent vs. Actual Box | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Input | Iteration | | | | | | | | | | |
| | | | | W/O Deck and Fillet | | W/ Deck and Fillet (n transform) | | W/ Deck and Fillet (3n transform) | | W/ Rebar Only Cracked Section | |
| Steel Section | Pier/Abut | Station | x location from CL Brg | $S_{top}$ % Difference | $S_{bottom}$ % Difference | $S_{top}$ % Difference | $S_{bottom}$ % Difference | $S_{top}$ % Difference | $S_{bottom}$ % Difference | $S_{top}$ % Difference | $S_{bottom}$ % Difference |
| | | | ft | IF 100 < %, Conservative | IF 100 < %, Conservative | IF 100 < %, Conservative | IF 100 < %, Conservative | IF 100 < %, Conservative | IF 100 < %, Conservative | IF 100 < %, Conservative | IF 100 < %, Conservative |
| 1 | Abut 1 | 0 | 0 | 100.69 | 101.50 | 98.84 | 101.03 | 99.62 | 101.05 | 101.95 | 101.54 |
| 1 | | 1 | 35 | 100.69 | 101.50 | 97.68 | 101.03 | 99.62 | 101.05 | 101.95 | 101.54 |
| 2 | | 0 | 35 | 100.44 | 101.36 | 97.68 | 101.03 | 99.60 | 101.04 | 101.68 | 101.46 |
| 2 | Pier 1 | 1 | 45 | 100.44 | 101.36 | 97.68 | 101.03 | 99.60 | 101.04 | 101.68 | 101.46 |
| 2 | | 0 | 55 | 100.44 | 101.36 | 97.68 | 101.03 | 99.60 | 101.04 | 101.68 | 101.46 |
| 1 | | 1 | 55 | 100.69 | 101.50 | 97.68 | 101.03 | 99.62 | 101.05 | 101.95 | 101.54 |
| 1 | | 0 | 62.5 | 100.69 | 101.50 | 97.68 | 101.03 | 99.62 | 101.05 | 101.95 | 101.54 |
| 1 | End Stiff. | 1 | 62.5 | 100.68 | 99.51 | 98.55 | 100.16 | 99.94 | 100.04 | 102.87 | 100.37 |
| 1 | Begin Stiff. | 0 | 129.5 | 100.68 | 99.51 | 98.55 | 100.16 | 99.94 | 100.04 | 102.87 | 100.37 |
| 1 | | 1 | 129.5 | 100.69 | 101.50 | 97.68 | 101.03 | 99.62 | 101.05 | 101.95 | 101.54 |
| 1 | | 0 | 137 | 100.69 | 101.50 | 97.68 | 101.03 | 99.62 | 101.05 | 101.95 | 101.54 |
| 2 | | 1 | 137 | 100.44 | 101.36 | 97.68 | 101.03 | 99.60 | 101.04 | 101.68 | 101.46 |
| 2 | Pier 2 | 0 | 147 | 100.44 | 101.36 | 97.68 | 101.03 | 99.60 | 101.04 | 101.68 | 101.46 |
| 2 | | 1 | 147 | 100.44 | 101.36 | 97.68 | 101.03 | 99.60 | 101.04 | 101.68 | 101.46 |
| 1 | | 0 | 157 | 100.69 | 101.50 | 97.68 | 101.03 | 99.62 | 101.05 | 101.95 | 101.54 |
| 1 | Abut 2 | 1 | 192 | 100.69 | 101.50 | 97.68 | 101.03 | 99.62 | 101.05 | 101.95 | 101.54 |

- All Sections Section Moduli Within ~6% or less
- S=I/c

# BOX GIRDERS WITH OR WITHOUT LONGITUDINAL STIFFENERS




- b/t ratio of bottom flange of equivalent I-Girder can be iterated to match the local buckling capacity of the bottom flange of an actual box section with or without longitudinal stiffeners
- ITD Bridge had stiffeners that were not full length, so both scenarios applied



# SECTION GEOMETRY IN AASHTOWARE BRR

Type: Plate Girder

Web | Top flange | Bottom flange

**Web**

| Begin depth (in) | Depth vary | End depth (in) | Thickness (in) | Support number | Start distance (ft) | Length (ft) | End distance (ft) | Material | Weld at right |
|---|---|---|---|---|---|---|---|---|---|
| 42 | None | 42.0000 | 0.4375 | 1 | 0 | 276.00 | 276.00 | ASTM A36 | -- None -- |

Type: Plate Girder

Web | Top flange | Bottom flange

**Top flange**

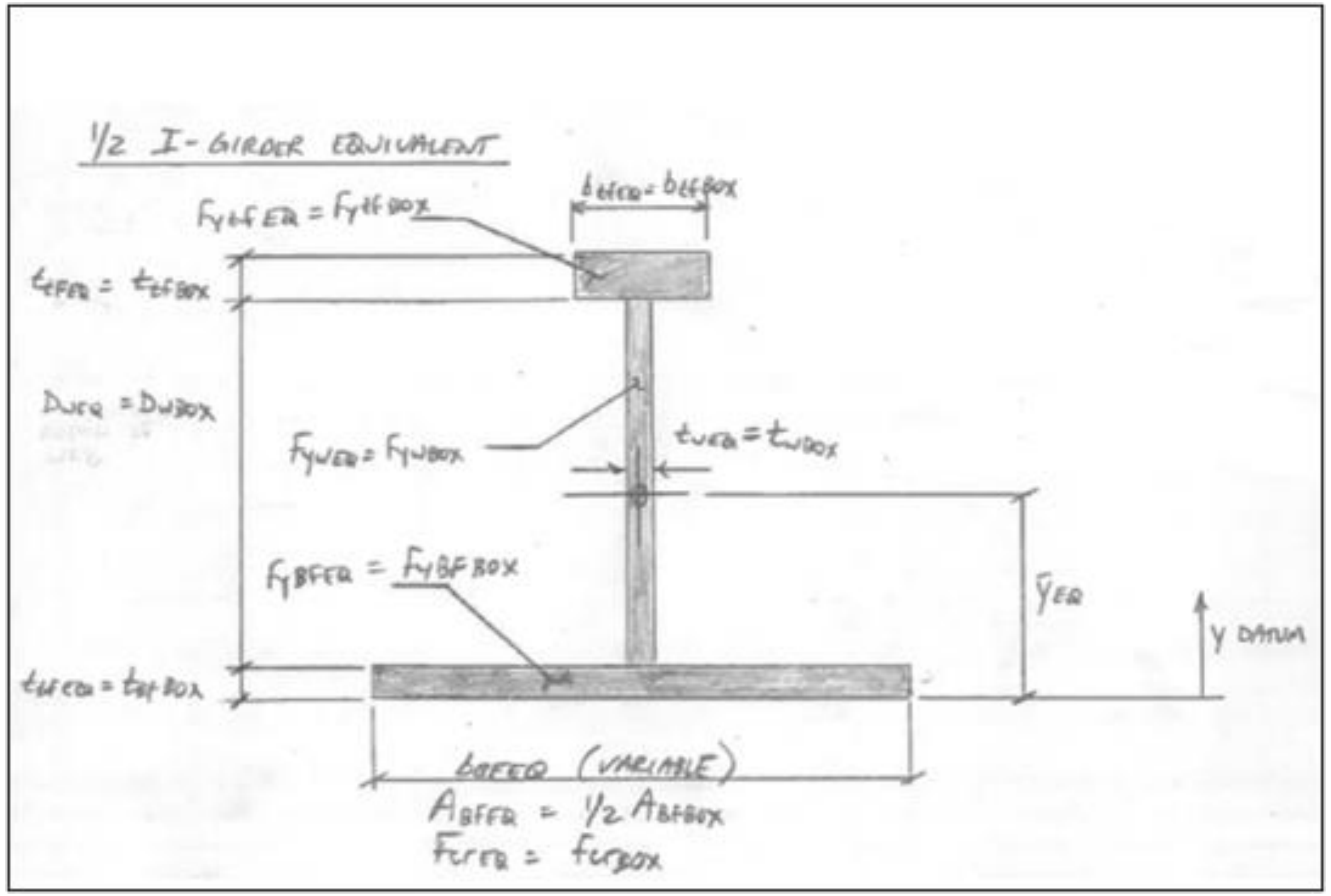
| Begin width (in) | End width (in) | Thickness (in) | Support number | Start distance (ft) | Length (ft) | End distance (ft) | Material | Weld | Weld right |
|---|---|---|---|---|---|---|---|---|---|
| 12 | 12.0000 | 0.7500 | 1 | 0.00 | 83.23 | 83.23 | ASTM A36 | -- None -- | -- None -- |
| 12.0000 | 12.0000 | 1.8750 | 1 | 83.23 | 19.54 | 102.77 | ASTM A36 | -- None -- | -- None -- |
| 12.0000 | 12.0000 | 0.7500 | 2 | 10.77 | 70.46 | 81.23 | ASTM A36 | -- None -- | -- None -- |
| 12.0000 | 12.0000 | 1.8750 | 2 | 81.23 | 19.54 | 100.77 | ASTM A36 | -- None -- | -- None -- |
| 12.0000 | 12.0000 | 0.7500 | 3 | 8.77 | 83.23 | 92.00 | ASTM A36 | -- None -- | -- None -- |

Type: Plate Girder

Web | Top flange | Bottom flange

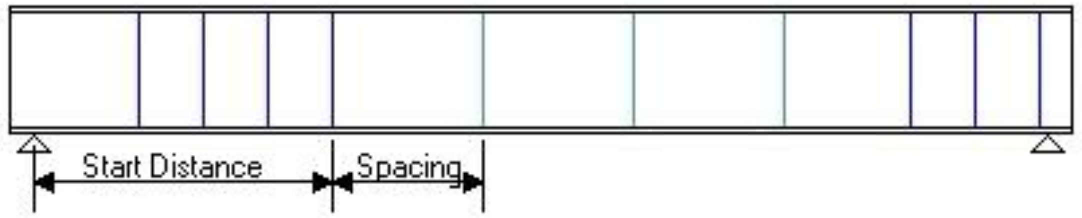
**Bottom flange**

| Begin width (in) | End width (in) | Thickness (in) | Support number | Start distance (ft) | Length (ft) | End distance (ft) | Material | Weld | Weld right |
|---|---|---|---|---|---|---|---|---|---|
| 25.73 | 25.7300 | 0.5730 | 1 | 0.00 | 19.91 | 19.91 | ASTM A36 | -- None -- | -- None -- |
| 25.7000 | 25.7000 | 0.7690 | 1 | 19.91 | 34.95 | 54.86 | ASTM A36 | -- None -- | -- None -- |
| 25.7300 | 25.7300 | 0.5730 | 1 | 54.86 | 11.03 | 65.89 | ASTM A36 | -- None -- | -- None -- |
| 19.1600 | 19.1600 | 0.7730 | 1 | 65.89 | 19.03 | 84.92 | ASTM A36 | -- None -- | -- None -- |
| 21.4900 | 21.4900 | 0.9210 | 1 | 84.92 | 11.45 | 96.37 | ASTM A36 | -- None -- | -- None -- |
| 19.1600 | 19.1600 | 0.7730 | 2 | 4.37 | 80.02 | 84.39 | ASTM A36 | -- None -- | -- None -- |
| 21.4900 | 21.4900 | 0.9210 | 2 | 84.39 | 11.45 | 95.84 | ASTM A36 | -- None -- | -- None -- |
| 19.1600 | 19.1600 | 0.7730 | 3 | 3.84 | 19.03 | 22.87 | ASTM A36 | -- None -- | -- None -- |
| 25.7300 | 25.7300 | 0.5730 | 3 | 22.87 | 11.03 | 33.90 | ASTM A36 | -- None -- | -- None -- |
| 25.7000 | 25.7000 | 0.7690 | 3 | 33.90 | 34.95 | 68.85 | ASTM A36 | -- None -- | -- None -- |
| 25.7300 | 25.7300 | 0.5730 | 3 | 68.85 | 23.15 | 92.00 | ASTM A36 | -- None -- | -- None -- |



# TRANSVERSE STIFFENERS & DIAPHRAGMS

- Transverse Stiffener Spacing and Geometry
  - Same as actual box girder web
- Fictional diaphragms every 5 to 6 ft – simulates box girder torsional rigidity, ensures lateral torsional buckling doesn't control rating




Transverse stiffener ranges | Longitudinal stiffener ranges

| Name | Support number | Start distance (ft) | Number of spaces | Spacing (in) | Length (ft) | End distance (ft) |
|---|---|---|---|---|---|---|
| PL 3 1/2 x 3/8" | 1 | 79.33 | 1 | 0.0000 | 0.00 | 79.33 |
| PL 3 1/2 x 3/8" | 1 | 79.33 | 3 | 38.0000 | 9.50 | 88.83 |
| PL 3 1/2 x 3/8" | 1 | 88.83 | 1 | 76.0000 | 6.33 | 95.17 |
| PL 3 1/2 x 3/8" | 2 | 3.17 | 2 | 38.0000 | 6.33 | 9.50 |
| PL 3 1/2 x 3/8" | 2 | 82.50 | 1 | 0.0000 | 0.00 | 82.50 |
| PL 3 1/2 x 3/8" | 2 | 82.50 | 2 | 38.0000 | 6.33 | 88.83 |
| PL 3 1/2 x 3/8" | 2 | 88.83 | 1 | 76.0000 | 6.33 | 95.17 |
| PL 3 1/2 x 3/8" | 3 | 3.17 | 3 | 38.0000 | 9.50 | 12.67 |

Number of spans: 3 Number of girders: 4

Layout | Diaphragms | Lateral bracing ranges

Girder bay: 1 | Copy bay to... | Diaphragm wizard...

| Support number | Start distance (ft) Left girder | Start distance (ft) Right girder | Diaphragm spacing (ft) | Number of spaces | Length (ft) | End distance (ft) Left girder | End distance (ft) Right girder | Load (kip) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.00 | -3.24 | 4.97 | 3 | 14.90 | 14.90 | 11.66 | |
| 1 | 14.90 | 11.66 | 4.97 | 1 | 4.97 | 19.87 | 16.63 | 0.1200 |
| 1 | 19.87 | 16.63 | 6.08 | 2 | 12.17 | 32.04 | 28.80 | |
| 1 | 32.04 | 28.80 | 6.08 | 1 | 6.08 | 38.12 | 34.88 | 0.1200 |
| 1 | 38.12 | 34.88 | 6.08 | 2 | 12.17 | 50.29 | 47.05 | |
| 1 | 50.29 | 47.05 | 6.08 | 1 | 6.08 | 56.37 | 53.13 | 0.1200 |
| 1 | 56.37 | 53.13 | 6.08 | 2 | 12.17 | 68.54 | 65.30 | |
| 1 | 68.54 | 65.30 | 6.08 | 1 | 6.08 | 74.62 | 71.38 | 0.1200 |
| 1 | 74.62 | 71.38 | 5.79 | 2 | 11.58 | 86.20 | 82.96 | |
| 2 | 0.00 | -3.24 | 6.68 | 2 | 13.36 | 13.36 | 10.12 | |
| 2 | 14.69 | 11.45 | 5.35 | 1 | 5.35 | 20.04 | 16.80 | 0.1200 |
| 2 | 20.04 | 16.80 | 6.14 | 2 | 12.28 | 32.32 | 29.08 | |
| 2 | 34.18 | 30.94 | 4.28 | 1 | 4.28 | 38.45 | 35.21 | 0.1200 |
| 2 | 38.45 | 35.21 | 6.11 | 2 | 12.22 | 50.68 | 47.44 | |
| 2 | 50.68 | 47.44 | 6.11 | 1 | 6.11 | 56.79 | 53.55 | 0.1200 |
| 2 | 56.79 | 53.55 | 6.14 | 2 | 12.28 | 69.07 | 65.83 | |
| 2 | 69.62 | 66.38 | 5.58 | 1 | 5.58 | 75.20 | 71.96 | 0.1200 |
| 2 | 75.20 | 71.96 | 5.60 | 2 | 11.20 | 86.40 | 83.16 | |
| 3 | 0.00 | -3.24 | 6.87 | 2 | 13.74 | 13.74 | 10.50 | |
| 3 | 15.27 | 12.04 | 5.35 | 1 | 5.35 | 20.62 | 17.38 | 0.1200 |
| 3 | 20.62 | 17.38 | 6.08 | 2 | 12.17 | 32.79 | 29.55 | |
| 3 | 32.79 | 29.55 | 6.08 | 1 | 6.08 | 38.87 | 35.63 | 0.1200 |
| 3 | 38.87 | 35.63 | 6.08 | 2 | 12.17 | 51.04 | 47.80 | |
| 3 | 51.04 | 47.80 | 6.08 | 1 | 6.08 | 57.12 | 53.88 | 0.1200 |
| 3 | 57.12 | 53.88 | 6.08 | 2 | 12.17 | 69.29 | 66.05 | |
| 3 | 69.29 | 66.05 | 6.08 | 1 | 6.08 | 75.37 | 72.13 | 0.1200 |
| 3 | 75.37 | 72.13 | 5.54 | 2 | 11.08 | 86.45 | 83.21 | |

# SPECIFICATION CHECKS

Specification Checks for Int. CSC Girder - 32 of 2798

Properties | Generate | Articles: All articles | Format: Bullet list

Specification filter | Report

- Span 1 - 82.96 ft.
- Span 1 - 83.23 ft.
- Span 1 - 84.92 ft.
- Span 1 - 87.48 ft.
- Span 1 - 92.00 ft.
- Span 2 - 1.72 ft.
- Span 2 - 3.44 ft.
- Span 2 - 4.37 ft.
- Span 2 - 6.78 ft.
- Span 2 - 9.20 ft.
- Span 2 - 10.12 ft.
- Span 2 - 10.77 ft.
- Span 2 - 12.00 ft.
- Span 2 - 13.46 ft.
- Span 2 - 16.80 ft.
- Span 2 - 18.00 ft.
- Span 2 - 18.40 ft.
- Span 2 - 19.87 ft.
- Span 2 - 22.94 ft.
- Span 2 - 26.01 ft.
- Span 2 - 27.60 ft.
- Span 2 - 29.08 ft.
- Span 2 - 32.15 ft.
- Span 2 - 35.21 ft.
- Span 2 - 36.80 ft.
- Span 2 - 38.27 ft.
- Span 2 - 41.33 ft.
- Span 2 - 44.38 ft.
- Span 2 - 46.00 ft.
- Span 2 - 47.44 ft.
- Span 2 - 50.49 ft.
- Span 2 - 53.55 ft.
- Span 2 - 55.20 ft.
- Span 2 - 56.62 ft.
- Span 2 - 59.69 ft.

| Specification reference | Limit State | Flex. Sense | Pass/Fail |
|---|---|---|---|
| NA 10.48.1 Noncomposite Compact Section | | N/A | Not Required |
| 10.48.1.1 Compact Section Requirements | | N/A | General Comp. |
| NA 10.48.2 Braced Noncompact Sections | | N/A | Not Required |
| 10.48.2.1 Cross-section requirements | | N/A | General Comp. |
| NA 10.48.3 Noncomposite Transition Section | | N/A | Not Required |
| ✓ 10.48.4 Noncomposite Noncompact Partially Braced Members | | N/A | Passed |
| NA 10.48.4.1.Cb Noncomposite Cb Calculation | | N/A | Not Required |
| ✗ 10.48.4.1.Mr Noncomposite Mr Calculation | | N/A | Failed |
| 10.48.4.1.Rb Noncomposite Rb Calculation | | N/A | General Comp. |
| ✓ 10.48.8 LFD Shear Calculations | | N/A | Passed |
| ✓ 10.50.1.1.2 Composite Compact Positive Moment Section | | N/A | Passed |
| ✓ 10.50.1.2 Noncompact Positive Moment Members | | N/A | Passed |
| 10.50.1.2.Rb Composite Rb Calculation | | N/A | General Comp. |
| ✗ 10.50.2.1 Composite Compact Negative Moment Section | | N/A | Failed |
| ✗ 10.50.2.2 Noncompact Negative Moment Members | | N/A | Failed |
| 10.50.2.2 Composite Cb Calculation | | N/A | General Comp. |
| NA 10.53.1.2 Braced Noncompact Hybrid Sections | | N/A | Not Required |
| ✗ 6B.4 Steel Combined Moment and Shear | | N/A | Failed |
| ✗ 6B.4 Steel Flexure Moment | | N/A | Failed |
| ✓ 6B.4 Steel Flexure Overload | | N/A | Passed |
| ✓ 6B.4 Steel Flexure Stress | | N/A | Passed |
| ✓ 6B.4 Steel Shear Stress | | N/A | Passed |
| 6B.4 Steel Shear Stress in End Panels | | N/A | General Comp. |
| Depth of web in compression in the Elastic Range (Dc) | | N/A | General Comp. |
| First Yield Moment (My) Calculations for All Sections | | N/A | General Comp. |
| ✗ LFD General Steel Flexural Results | | N/A | Failed |
| LFD Steel Elastic Section Properties | | N/A | General Comp. |
| Plastic Moment (Mp) for Composite Sections in Negative Moment | | N/A | General Comp. |
| Plastic Moment (Mp) for Composite Sections in Positive Moment | | N/A | General Comp. |
| NA Plastic Moment (Mp) for Noncomposite Sections | | N/A | Not Required |
| Steel Stresses for Sections in Positive Flexure | | N/A | General Comp. |
| Unbraced Length Calculations | | N/A | General Comp. |

Span 2 – 4.37 ft

Bottom Flange Transition Location

# SPECIFICATION CHECKS

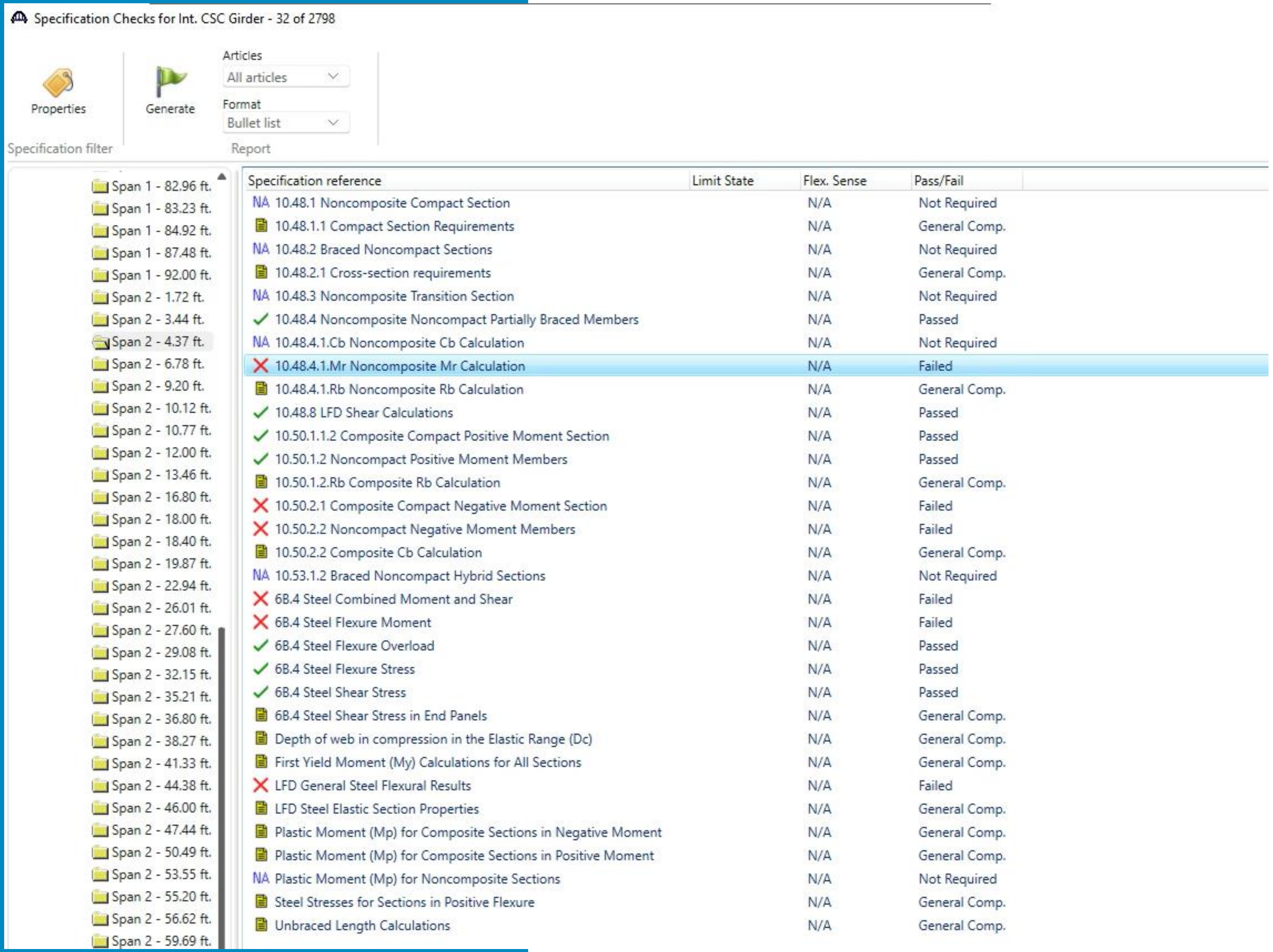
- Note: Even if Iyc/Iy falls outside of 0.1 and 0.9 limits, AASHTOWare still computes Mr

```
SUMMARY:

(a) Compression flange proportionality

              Iyc
     0.1 <= ----- <= 0.9
              Iy

Mu = Mr*Rb*R        (10-103a)

   where, Mr = partially braced resistance moment, 10.48.4.1
          Rb = web slenderness ratio, 10.48.4.1
          R  = hybrid reduction factor, 10.53.1.2


RESULTS:

   Top flange Iyt/Iy = 0.373  (Pass)
   Bot flange Iyb/Iy = 0.626  (Pass)
```

| Load Group | Load Comb | Flexure Type | (a) | Mr (kip-ft) | Rb | R | Mu (kip-ft) |
|---|---|---|---|---|---|---|---|
| Inventory | 1, INV, MAX | Neg | Pass | 2476.31 | 1.000 | 1.000 | 2476.31 |
| Inventory | 1, INV, MIN | Neg | Pass | 2476.31 | 1.000 | 1.000 | 2476.31 |
| Inventory | 2, INV, MAX | Neg | Pass | 2476.31 | 1.000 | 1.000 | 2476.31 |
| Inventory | 2, INV, MIN | Neg | Pass | 2476.31 | 1.000 | 1.000 | 2476.31 |

AASHTOWare™ BRIDGE DESIGN AND RATING

# SPECIFICATION CHECKS



# SPECIFICATION CHECKS

RESULTS:

Note - Bottom flange b/t is too large. Minimum capacity between 10.48.2 and 10.48.4.1 will be used.

| Load Group | Load Comb | Flexure Type | Cb | Dc (in) | My (kip-ft) | r' (in) | Lp (in) | Lr (in) | EQ | Mr (kip-ft) |
|---|---|---|---|---|---|---|---|---|---|---|
| Inventory | 1, INV, MAX | Neg | 1.1763 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 1, INV, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 2, INV, MAX | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 2, INV, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 3, INV, MAX | Neg | 1.1859 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 3, INV, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 4, INV, MAX | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 4, INV, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 5, INV, MAX | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 5, INV, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 6, INV, MAX | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 6, INV, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 7, INV, MAX | Neg | 1.1927 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Inventory | 7, INV, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 1, OPG, MAX | Neg | 1.1464 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 1, OPG, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 2, OPG, MAX | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 2, OPG, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 3, OPG, MAX | Neg | 1.1519 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 3, OPG, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 4, OPG, MAX | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 4, OPG, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 5, OPG, MAX | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 5, OPG, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 6, OPG, MAX | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 6, OPG, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 7, OPG, MAX | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |
| Operating | 7, OPG, MIN | Neg | 1.0000 | 27.5025 | 2476.31 | | | | 103c | 2476.31 |

**10.48.4 Partially Braced Members**

Members not meeting the lateral bracing requirement of Article 10.48.2.1(c) shall be braced at discrete locations spaced at a distance, $L_b$, such that the maximum strength of the section under consideration satisfies the requirements of Article 10.48.4.1. Bracing shall be provided such that lateral deflection of the compression flange is restrained and the entire section is restrained against twisting.

**10.48.4.1** If the lateral bracing requirement of Article 10.48.2.1(c) is not satisfied and the ratio of the moment of inertia of the compression flange to the moment of inertia of the member about the vertical axis of the web, $I_{yc}/I_y$, is within the limits of $0.1 \le I_{yc}/I_y \le 0.9$, the maximum strength for the limit state of lateral-torsional buckling shall be computed as

$$M_u = M_r R_b \qquad (10\text{-}103a)$$

**10.48.2 Braced Noncompact Sections**

For sections of rolled or fabricated flexural members not meeting the requirements of Article 10.48.1.1 but meeting the requirements of Article 10.48.2.1 below, the maximum strength shall be computed as the lesser of

$$M_u = F_y S_{xt} \qquad (10\text{-}98)$$

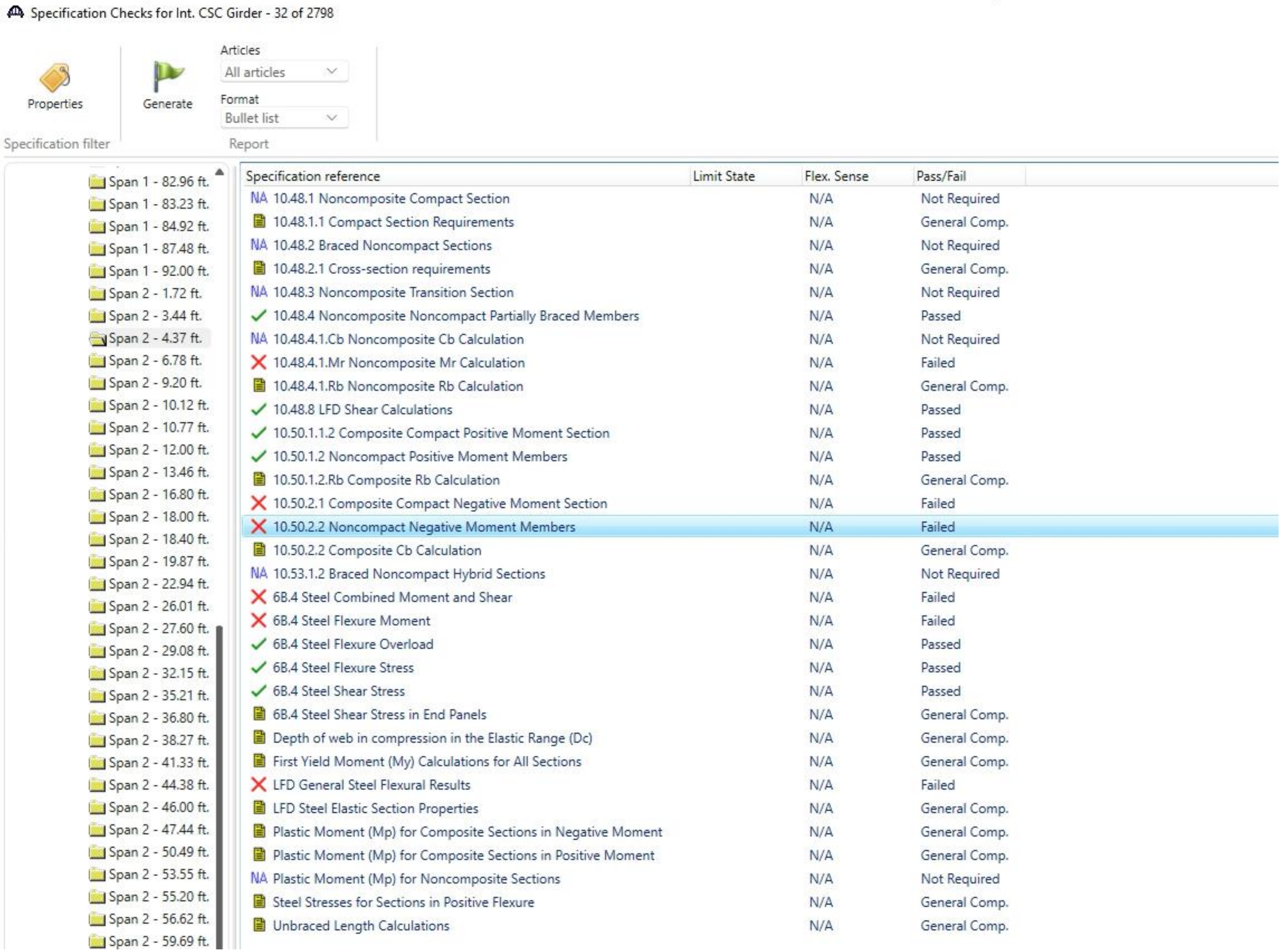
or

$$M_u = F_{cr} S_{xc} R_b \qquad (10\text{-}99)$$

subject to the requirement of Article 10.48.2.1(c) where

$$F_{cr} = \left(4{,}400\frac{t}{b}\right)^2 \le F_y$$

# SPECIFICATION CHECKS



# SPECIFICATION CHECKS

| Longitudinal Location (Repeating Columns for Printing) | | | | Equivalent I-girder: Manipulate tbf and bbf of Bottom Flange to change Slenderness Ratio to meet Fcr and Sx | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel Section | Pier/Abut | Station | x location from CL Brg | /b? | Goal to match Box= t/b = (sqrt(Fcr)/4400) | % difference (Box/I-Girder) | Fcr Box (Goal) | Fcr I-Girder Equiv | % difference (Box/I-girder) | Instruct | 1/2 *Abf Box | Abf I-Girder | % difference (Box/I-Girder) | Instruct |
| | | | ft | | includes hybrid reduction | % | psi | psi | % | | | | | |
| 1 | PIER 1 | 0 | 0.00 | 0.022 | 0.022 | 0.5 | 9689 | 9601 | 0.9 | | | | | |
| 1 | | | 11.88 | 0.022 | 0.022 | 0.5 | 9689 | 9601 | 0.9 | | | | | |
| 1 | back | | 19.91 | 0.022 | 0.022 | 0.5 | 9689 | 9601 | 0.9 | | | | | |
| 1 | ahead | | 19.91 | 0.030 | 0.030 | -0.3 | 17226 | 17334 | -0.6 | | | | | |
| 1 | | | 25.38 | 0.030 | 0.030 | -0.3 | 17226 | 17334 | -0.6 | | | | | |
| 1 | back | | 54.85 | 0.030 | 0.030 | -0.3 | 17226 | 17334 | -0.6 | | | | | |
| 1 | ahead | | 54.85 | 0.022 | 0.022 | 0.5 | 9689 | 9601 | 0.9 | | | | | |
| 1 | back | | 65.88 | 0.022 | 0.022 | 0.5 | 9689 | 9601 | 0.9 | | | | | |
| 1 | ahead | | 65.88 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | | | 79.33 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | | | 83.23 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | | | 83.23 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | back | | 84.91 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | ahead | | 84.91 | 0.043 | 0.043 | -0.2 | 35398 | 35559 | -0.5 | | | | | |
| 1 | PIER 2 | 92 | 0.00 | 0.043 | 0.043 | -0.2 | 35398 | 35559 | -0.5 | | | | | |
| 1 | back | | 4.35 | 0.043 | 0.043 | -0.2 | 35398 | 35559 | -0.5 | | | | | |
| 1 | ahead | | 4.35 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | | | 9.50 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | | | 10.77 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | | | 10.77 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | Splice | | 22.38 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | Splice | | 66.38 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | | | 81.23 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | | | 81.23 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | | | | | |
| 1 | | | 82.50 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | make more slender | 14.906 | 14.811 | 0.645 | Add Area |
| 1 | back | | 84.41 | 0.040 | 0.040 | -0.3 | 31327 | 31512 | -0.6 | make more slender | 14.906 | 14.811 | 0.645 | Add Area |

Spec Check Detail for 10.50.2.2 Noncompact Negative Moment Members

***** Compression Flange *****

| Limit State | Load Comb | Flexure Type | Component | (a) | (b) | Rb | R | Fcr 10.48.2 (ksi) | (c) | Mu/Sxc 10.48.2 (ksi) | Mu Comp (kip-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inventory | 1, INV, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 1, INV, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 2, INV, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 2, INV, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 3, INV, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 3, INV, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 4, INV, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 4, INV, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 5, INV, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 5, INV, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 6, INV, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 6, INV, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 7, INV, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Inventory | 7, INV, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 1, OPG, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 1, OPG, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 2, OPG, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 2, OPG, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 3, OPG, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 3, OPG, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 4, OPG, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 4, OPG, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 5, OPG, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 5, OPG, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 6, OPG, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 6, OPG, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 7, OPG, MAX | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |
| Operating | 7, OPG, MIN | Neg | Bot Flange | Fail | Pass | 1.000 | 1.000 | 31.51 | Pass | | 2249.83 | Fail |

# SPECIFICATION CHECKS

Specification Checks for Int. CSC Girder - 32 of 2798

Properties | Generate | Articles: All articles | Format: Bullet list

Specification filter | Report

- Span 1 - 82.96 ft.
- Span 1 - 83.23 ft.
- Span 1 - 84.92 ft.
- Span 1 - 87.48 ft.
- Span 1 - 92.00 ft.
- Span 2 - 1.72 ft.
- Span 2 - 3.44 ft.
- Span 2 - 4.37 ft.
- Span 2 - 6.78 ft.
- Span 2 - 9.20 ft.
- Span 2 - 10.12 ft.
- Span 2 - 10.77 ft.
- Span 2 - 12.00 ft.
- Span 2 - 13.46 ft.
- Span 2 - 16.80 ft.
- Span 2 - 18.00 ft.
- Span 2 - 18.40 ft.
- Span 2 - 19.87 ft.
- Span 2 - 22.94 ft.
- Span 2 - 26.01 ft.
- Span 2 - 27.60 ft.
- Span 2 - 29.08 ft.
- Span 2 - 32.15 ft.
- Span 2 - 35.21 ft.
- Span 2 - 36.80 ft.
- Span 2 - 38.27 ft.
- Span 2 - 41.33 ft.
- Span 2 - 44.38 ft.
- Span 2 - 46.00 ft.
- Span 2 - 47.44 ft.
- Span 2 - 50.49 ft.
- Span 2 - 53.55 ft.
- Span 2 - 55.20 ft.
- Span 2 - 56.62 ft.
- Span 2 - 59.69 ft.

| Specification reference | Limit State | Flex. Sense | Pass/Fail |
|---|---|---|---|
| NA 10.48.1 Noncomposite Compact Section | | N/A | Not Required |
| 10.48.1.1 Compact Section Requirements | | N/A | General Comp. |
| NA 10.48.2 Braced Noncompact Sections | | N/A | Not Required |
| 10.48.2.1 Cross-section requirements | | N/A | General Comp. |
| NA 10.48.3 Noncomposite Transition Section | | N/A | Not Required |
| ✓ 10.48.4 Noncomposite Noncompact Partially Braced Members | | N/A | Passed |
| NA 10.48.4.1.Cb Noncomposite Cb Calculation | | N/A | Not Required |
| ✗ 10.48.4.1.Mr Noncomposite Mr Calculation | | N/A | Failed |
| 10.48.4.1.Rb Noncomposite Rb Calculation | | N/A | General Comp. |
| ✓ 10.48.8 LFD Shear Calculations | | N/A | Passed |
| ✓ 10.50.1.1.2 Composite Compact Positive Moment Section | | N/A | Passed |
| ✓ 10.50.1.2 Noncompact Positive Moment Members | | N/A | Passed |
| 10.50.1.2.Rb Composite Rb Calculation | | N/A | General Comp. |
| ✗ 10.50.2.1 Composite Compact Negative Moment Section | | N/A | Failed |
| ✗ 10.50.2.2 Noncompact Negative Moment Members | | N/A | Failed |
| 10.50.2.2 Composite Cb Calculation | | N/A | General Comp. |
| NA 10.53.1.2 Braced Noncompact Hybrid Sections | | N/A | Not Required |
| ✗ 6B.4 Steel Combined Moment and Shear | | N/A | Failed |
| ✗ 6B.4 Steel Flexure Moment | | N/A | Failed |
| ✓ 6B.4 Steel Flexure Overload | | N/A | Passed |
| ✓ 6B.4 Steel Flexure Stress | | N/A | Passed |
| ✓ 6B.4 Steel Shear Stress | | N/A | Passed |
| 6B.4 Steel Shear Stress in End Panels | | N/A | General Comp. |
| Depth of web in compression in the Elastic Range (Dc) | | N/A | General Comp. |
| First Yield Moment (My) Calculations for All Sections | | N/A | General Comp. |
| ✗ LFD General Steel Flexural Results | | N/A | Failed |
| LFD Steel Elastic Section Properties | | N/A | General Comp. |
| Plastic Moment (Mp) for Composite Sections in Negative Moment | | N/A | General Comp. |
| Plastic Moment (Mp) for Composite Sections in Positive Moment | | N/A | General Comp. |
| NA Plastic Moment (Mp) for Noncomposite Sections | | N/A | Not Required |
| Steel Stresses for Sections in Positive Flexure | | N/A | General Comp. |
| Unbraced Length Calculations | | N/A | General Comp. |

# SPECIFICATION CHECKS

**10.50.2.2 Noncompact Sections**

When the steel section does not satisfy the compactness requirements of Article 10.50.2.1 but does satisfy all the requirements of Article 10.48.2.1, the sum of the bending stresses due to the appropriate loadings acting on the re-

- The girder does not satisfy noncompact criteria for compressive strength so AASHTOWare takes the minimum of the partially braced compressive capacity or the local flange buckling capacity.
- Since the partially braced capacity is Fy due to the fictional bracing input at every 5', local flange buckling controls
- Therefore, for the bottom flange, AASHTOWare checks capacity to Fy and Fcr only, mimicking the behavior of the actual box girder

- Fcr = 31.51 ksi
- S, negative moment = 856.76 in^3
- Mu=Fcr x S
- Mu=31.51 ksi x 856.76 in^3 x 1/12 in = 2249.85 k-ft (verified)

Spec Check Detail for LFD General Steel Flexural Results

```
Steel Plate - At Location = 96.3700 (ft) - Right     Stage 3

Section within Top Flange Continuous Bracing Region

INPUT:

Section Type                                : Composite
Top Flange Continuously Laterally Supported: Yes
Allow Plastic Analysis Control Option       : Yes
Moment Redistribution Occured               : No
Location is Adjacent to Pier                : No

SUMMARY:
```

| Limit State | Load Comb | Flexure Type | Capacity Type | Governing Resistance Article | Mu (kip-ft) | Code |
|---|---|---|---|---|---|---|
| Inventory | 1, INV, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 1, INV, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 1, OPG, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 1, OPG, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 2, INV, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 2, INV, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 2, OPG, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 2, OPG, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 3, INV, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 3, INV, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 3, OPG, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 3, OPG, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 4, INV, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 4, INV, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 4, OPG, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 4, OPG, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 5, INV, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 5, INV, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 5, OPG, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 5, OPG, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 6, INV, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 6, INV, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 6, OPG, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 6, OPG, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 7, INV, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Inventory | 7, INV, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 7, OPG, MAX | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |
| Operating | 7, OPG, MIN | Neg | Moment | 10.50.2.2 | -2249.83 | Fail |

# FINAL BOX GIRDER RATING SUMMARY

- BK 16705, US 89 over UPRR in Montpelier, ID- Spans 5-7

| Span 5,6,7 Controlling Load Ratings for MDX | | | | | | |
|---|---|---|---|---|---|---|
| | | | Inventory | | Operating | |
| Truck | Girder | Location | Inv. RF | Limit State | Op. RF | Limit State |
| HS 20 | 1 | 2.88 | 0.95 | Bending | 1.59 | Bending |
| Type 3 | 2 | 2.88 | 1.36 | Bending | 2.27 | Bending |
| Type 3S2 | 2 | 2.88 | 1.02 | Bending | 1.7 | Bending |
| Type 3-3 | 2 | 2.88 | 1 | Bending | 1.67 | Bending |
| Idaho 121 | 1 | 2.88 | 0.83 | Bending | 1.39 | Bending |

| INVENTORY RATINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rating Vehicle | Controlling Configuration | Weight (Tons) | Controlling Member | Controlling Location | Controlling Limit State | Rating Factor | Rating (Tons) |
| HS-20 | Lane | 36 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 0.85 | 30 |
| Idaho - Type 3 | Truck | 27 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 1.36 | 36 |
| Idaho - Type 3S2 | Truck | 39.5 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 1.05 | 41 |
| Idaho - Type 3-3 | Truck | 39.5 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 1.03 | 40 |
| Idaho - 121k | Truck | 60.5 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 0.85 | 51 |
| NRL | Truck | 40 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 0.94 | 37 |

| OPERATING RATINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rating Vehicle | Controlling Configuration | Weight (Tons) | Controlling Member | Controlling Location | Controlling Limit State | Rating Factor | Rating (Tons) |
| HS-20 | Lane | 36 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 1.41 | 50 |
| Idaho - Type 3 | Truck | 27 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 2.27 | 61 |
| Idaho - Type 3S2 | Truck | 39.5 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 1.76 | 69 |
| Idaho - Type 3-3 | Truck | 39.5 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 1.72 | 68 |
| Idaho - 121k | Truck | 60.5 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 1.42 | 85 |
| NRL | Truck | 40 | G2 - Int. Gir. | 6.05 | Design Flexure - Steel | 1.57 | 62 |

- Results:
  - Typically areas of high moment or areas with abrupt changes in capacities i.e. flange transitions or longitudinal stiffener termination locations controlled the rating
  - Skew impacts results, since flange and web transitions occur at different 10$^{th}$ points for each girder (not accounted for in box girder grillage analysis

# FINAL BOX GIRDER RATING SUMMARY

- BK 16705, US 89 over UPRR in Montpelier, ID- Spans 2-4

| Span 2,3,4 Controlling Load Ratings for MDX | | | | | | |
|---|---|---|---|---|---|---|
| | | | Inventory | | Operating | |
| Truck | Girder | Location | Inv. RF | Limit State | Op. RF | Limit State |
| HS 20 | 1 | 3.12 | 1.27 | Shear | 2.12 | Shear |
| Type 3 | 1 | 3.12 | 1.67 | Shear | 2.78 | Shear |
| Type 3S2 | 1 | 3.12 | 1.25 | Shear | 2.09 | Shear |
| Type 3-3 | 1 | 3.12 | 1.24 | Shear | 2.06 | Shear |
| Idaho 121 | 1 | 3.12 | 1.06 | Shear | 1.77 | Shear |

| INVENTORY RATINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rating Vehicle | Controlling Configuration | Weight (Tons) | Controlling Member | Controlling Location | Controlling Limit State | Rating Factor | Rating (Tons) |
| HS-20 | Lane | 36 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 0.80 | 28 |
| Idaho - Type 3 | Truck | 27 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 1.15 | 31 |
| Idaho - Type 3S2 | Truck | 39.5 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 0.89 | 35 |
| Idaho - Type 3-3 | Truck | 39.5 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 0.87 | 34 |
| Idaho - 121k | Truck | 60.5 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 0.72 | 43 |
| NRL | Truck | 40 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 0.79 | 31 |

| OPERATING RATINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rating Vehicle | Controlling Configuration | Weight (Tons) | Controlling Member | Controlling Location | Controlling Limit State | Rating Factor | Rating (Tons) |
| HS-20 | Lane | 36 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 1.34 | 48 |
| Idaho - Type 3 | Truck | 27 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 1.92 | 51 |
| Idaho - Type 3S2 | Truck | 39.5 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 1.48 | 58 |
| Idaho - Type 3-3 | Truck | 39.5 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 1.45 | 57 |
| Idaho - 121k | Truck | 60.5 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 1.20 | 72 |
| NRL | Truck | 40 | G4 - Ext. Gir. | 3.07 | Design Flexure - Steel | 1.32 | 52 |

- Results:
  - Different distribution of sidewalk load increased demands in BrR model
  - Skew impacts transition locations
  - BrR limits compression flange stress to Fcr (28.2 ksi at controlling location), MDX allows Fy

# BK 12185

MDX:

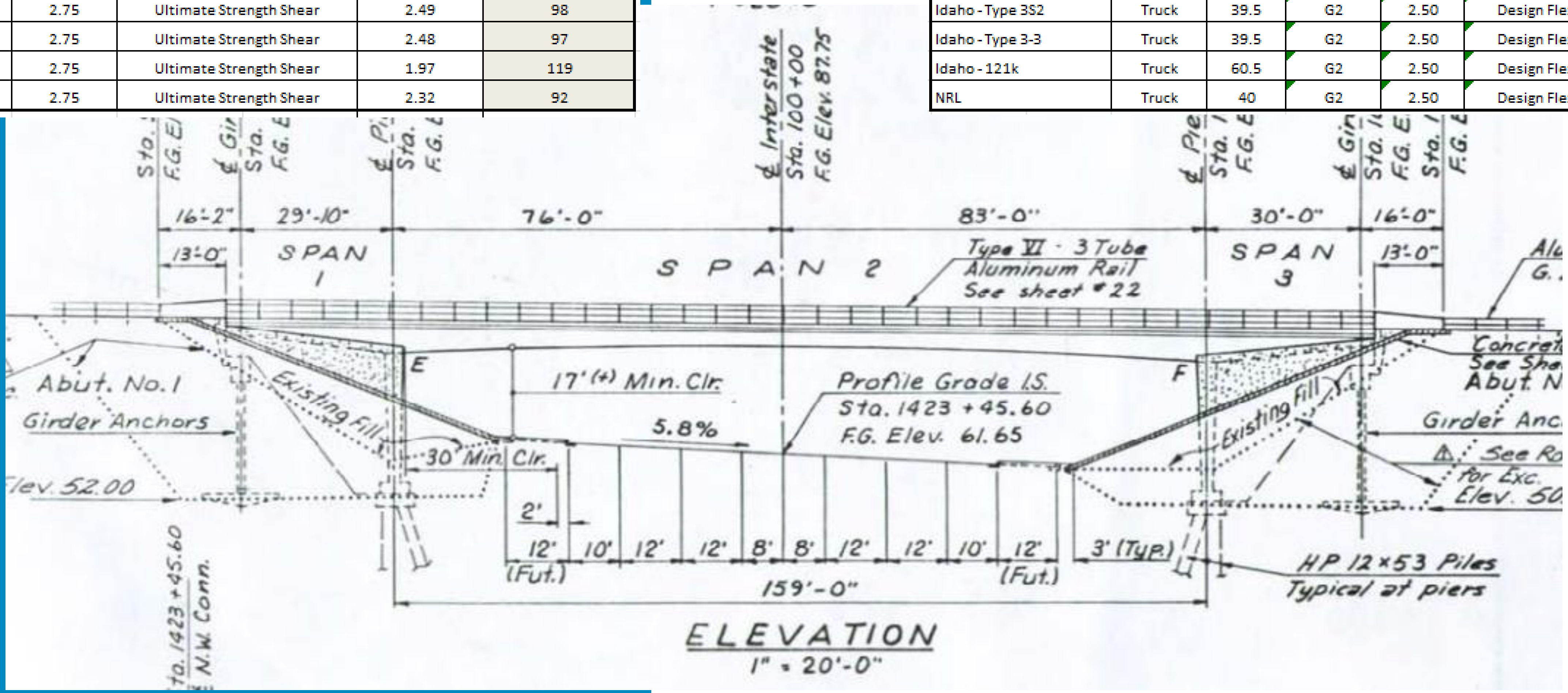
| INVENTORY RATINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rating Vehicle | Controlling Configuration | Weight (Tons) | Controlling Member | Controlling Location | Controlling Limit State | Rating Factor | Rating (Tons) |
| HS-20 | Truck | 36 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 1.58 | 56 |
| Idaho - Type 3 | Truck | 27 | G2 - Int. Gir. | 2.50 | Ultimate Strength Moment | 2.04 | 55 |
| Idaho - Type 3S2 | Truck | 39.5 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 1.49 | 58 |
| Idaho - Type 3-3 | Truck | 39.5 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 1.49 | 58 |
| Idaho - 121k | Truck | 60.5 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 1.18 | 71 |
| NRL | Truck | 40 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 1.39 | 55 |

| OPERATING RATINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rating Vehicle | Controlling Configuration | Weight (Tons) | Controlling Member | Controlling Location | Controlling Limit State | Rating Factor | Rating (Tons) |
| HS-20 | Truck | 36 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 2.65 | 95 |
| Idaho - Type 3 | Truck | 27 | G2 - Int. Gir. | 2.50 | Ultimate Strength Moment | 3.40 | 91 |
| Idaho - Type 3S2 | Truck | 39.5 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 2.49 | 98 |
| Idaho - Type 3-3 | Truck | 39.5 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 2.48 | 97 |
| Idaho - 121k | Truck | 60.5 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 1.97 | 119 |
| NRL | Truck | 40 | G2 - Int. Gir. | 2.75 | Ultimate Strength Shear | 2.32 | 92 |

BrR:

| INVENTORY RATINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rating Vehicle | Controlling Configuration | Weight (Tons) | Controlling Member | Controlling Location | Controlling Limit State | Rating Factor | Rating (Tons) |
| HS-20 | Truck | 36 | G2 | 2.50 | Design Flexure - Steel | 1.37 | 49 |
| Idaho - Type 3 | Truck | 27 | G2 | 2.50 | Design Flexure - Steel | 1.68 | 45 |
| Idaho - Type 3S2 | Truck | 39.5 | G2 | 2.50 | Design Flexure - Steel | 1.46 | 57 |
| Idaho - Type 3-3 | Truck | 39.5 | G2 | 2.50 | Design Flexure - Steel | 1.44 | 56 |
| Idaho - 121k | Truck | 60.5 | G2 | 2.50 | Design Flexure - Steel | 1.13 | 68 |
| NRL | Truck | 40 | G2 | 2.50 | Design Flexure - Steel | 1.20 | 48 |

| OPERATING RATINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rating Vehicle | Controlling Configuration | Weight (Tons) | Controlling Member | Controlling Location | Controlling Limit State | Rating Factor | Rating (Tons) |
| HS-20 | Truck | 36 | G2 | 2.50 | Design Flexure - Steel | 2.29 | 82 |
| Idaho - Type 3 | Truck | 27 | G2 | 2.50 | Design Flexure - Steel | 2.81 | 75 |
| Idaho - Type 3S2 | Truck | 39.5 | G2 | 2.50 | Design Flexure - Steel | 2.44 | 96 |
| Idaho - Type 3-3 | Truck | 39.5 | G2 | 2.50 | Design Flexure - Steel | 2.41 | 95 |
| Idaho - 121k | Truck | 60.5 | G2 | 2.50 | Design Flexure - Steel | 1.89 | 114 |
| NRL | Truck | 40 | G2 | 2.50 | Design Flexure - Steel | 2.01 | 80 |

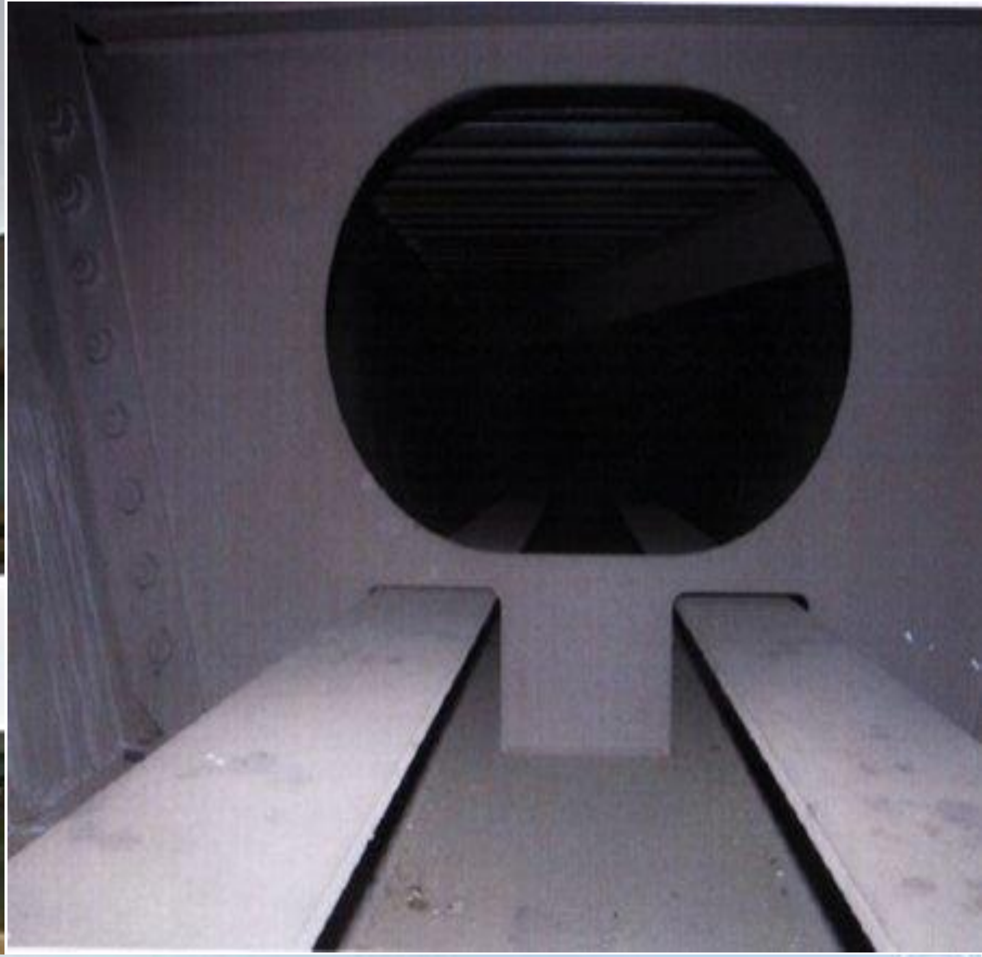


# THE TEAM

- HDR Idaho Bridge Group
- Kevin Gribble, HDR Kansas City

- Melissa Hennessy, Design Lead
- Alan Buehrig, Asset Management Lead

# QUESTIONS?



HDR

IDAHO TRANSPORTATION DEPARTMENT

AASHTOWare™ BRIDGE DESIGN AND RATING