

Appendix XIII

Section Properties of the Superstructure, Pier Cap Beam and Columns

Parapet

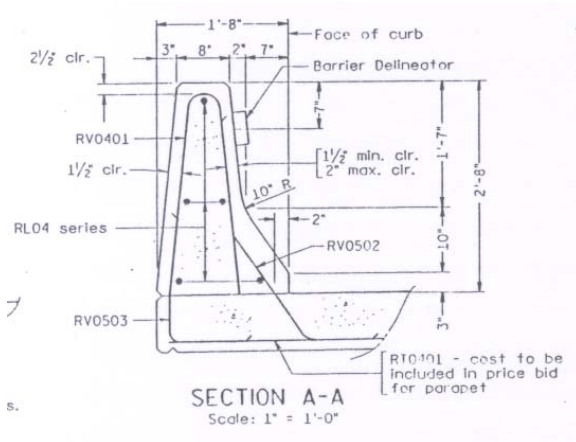


Figure XIII-1. The actual cross section of the parapet of the steel girder bridge [Brown, 1993]. The 1" = 1'-0' scale is no longer correct.

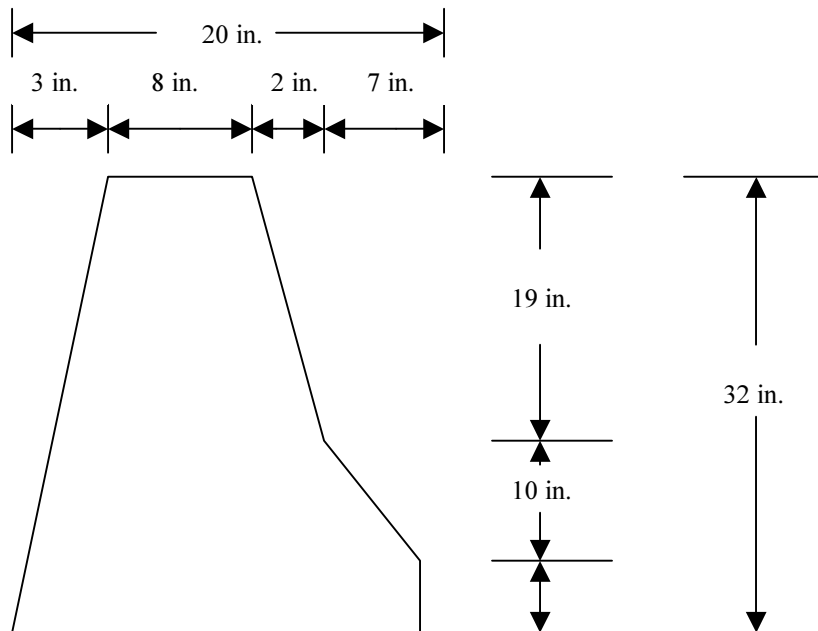


Figure XIII-2. The simplified cross section of the parapet.

$$\begin{aligned} \text{Area} &= \frac{(3\text{in})(32\text{in})}{2} + (8\text{in})(32\text{in}) + \frac{(2\text{in})(32\text{in} + 13\text{in})}{2} + \frac{(7\text{in})(13\text{in} + 3\text{in})}{2} \\ &= 405\text{in}^2 \end{aligned}$$

$$\begin{aligned} \bar{y} &= \frac{\left(\frac{1}{2}\right)(3)(32)\left(\frac{32}{3}\right) + (8)(32)(16) + \left(\frac{1}{2}\right)(2)(19)\left(\frac{52}{3}\right) + (2)(13)\left(\frac{13}{2}\right) + \left(\frac{1}{2}\right)(10)(7)\left(\frac{19}{3}\right) + (3)(7)\left(\frac{3}{2}\right)}{405} \\ &= 13.327\text{in.} \end{aligned}$$

$$\begin{aligned} \bar{x} &= \frac{\left(\frac{1}{2}\right)(3)(32)(2) + (8)(32)(7) + \left(\frac{1}{2}\right)(2)(19)\left(\frac{35}{3}\right) + (2)(13)(12) + \left(\frac{1}{2}\right)(10)(7)\left(\frac{46}{3}\right) + (7)(3)(16.5)}{405} \\ &= 8.160\text{in.} \end{aligned}$$

$$\begin{aligned} I_{xx} &= \left(\frac{1}{36}\right)(3)(32)^3 + \left(\frac{1}{2}\right)(3)(32)\left(13.327 - \frac{32}{3}\right)^2 + \left(\frac{1}{12}\right)(8)(32)^3 + (8)(32)(16 - 13.327)^2 \\ &+ \left(\frac{1}{36}\right)(2)(19)^3 + \left(\frac{1}{2}\right)(2)(19)\left(13 + \frac{19}{3} - 13.327\right)^2 + \left(\frac{1}{12}\right)(2)(13)^3 + (2)(13)(13.327 - 6.5)^2 \\ &+ \left(\frac{1}{36}\right)(7)(10)^3 + \left(\frac{1}{2}\right)(7)(10)\left(13.327 - 3 - \frac{10}{3}\right)^2 + \left(\frac{1}{12}\right)(7)(3)^3 + (3)(7)(13.327 - 1.5)^2 \\ &= 34,249\text{in}^4 \end{aligned}$$

$$\begin{aligned} I_{yy} &= \left(\frac{1}{36}\right)(32)(3)^3 + \left(\frac{1}{2}\right)(32)(3)(8.160 - 2)^2 + \left(\frac{1}{12}\right)(32)(8)^3 + (32)(8)(8.160 - 7)^2 \\ &+ \left(\frac{1}{36}\right)(19)(2)^3 + \left(\frac{1}{2}\right)(19)(2)\left(11 + \frac{2}{3} - 8.160\right)^2 + \left(\frac{1}{12}\right)(13)(2)^3 + (13)(2)(12 - 8.160)^2 \\ &+ \left(\frac{1}{36}\right)(10)(7)^3 + \left(\frac{1}{2}\right)(10)(7)\left(13 + \frac{7}{3} - 8.160\right)^2 + \left(\frac{1}{12}\right)(3)(7)^3 + (3)(7)(16.5 - 8.160)^2 \\ &= 7627.8\text{in}^4 \end{aligned}$$

West Bound Plate Girder

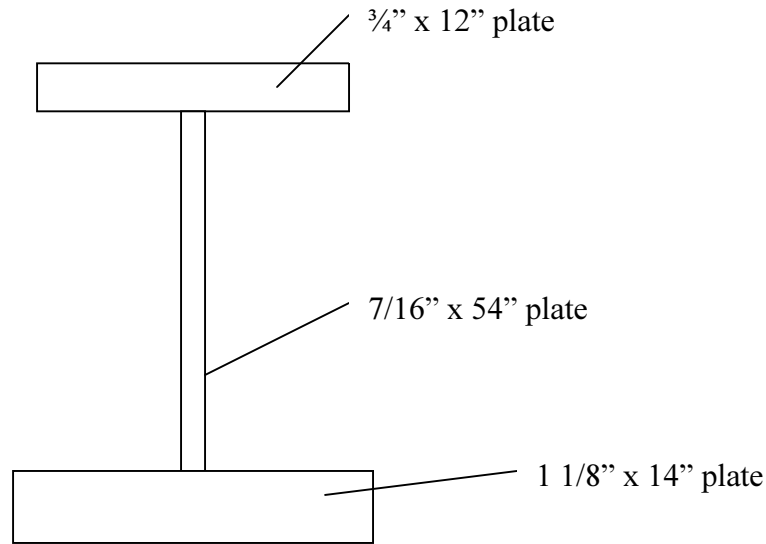


Figure XIII-3. The simplified cross section of the West Bound plate girder. This figure was not drawn to scale.

$$\bar{y} = \frac{\left(\frac{9}{8} \times 14 \times \frac{9}{16}\right) + \left(\frac{7}{16} \times 54 \times 28.125\right) + \left(\frac{3}{4} \times 12 \times 55.5\right)}{48.375}$$

$$= 24.244 \text{ in.}$$

$$\bar{x} = 7 \text{ in.}$$

$$I_{xx} = \left(\frac{1}{12}\right)(14)\left(\frac{9}{8}\right)^3 + \left(\frac{9}{8}\right)(14)(24.244 - 0.5625)^2$$

$$+ \left(\frac{1}{12}\right)\left(\frac{7}{16}\right)(54)^3 + \left(\frac{7}{16}\right)(54)(1.125 + 27 - 24.244)^2$$

$$+ \left(\frac{1}{12}\right)(12)\left(\frac{3}{4}\right)^3 + (12)\left(\frac{3}{4}\right)(1.125 + 54 + 0.375 - 24.244)^2$$

$$= 23,724 \text{ in}^4$$

$$I_{yy} = \left(\frac{1}{12}\right)(1.125)(14)^3 + \left(\frac{1}{12}\right)(54)\left(\frac{7}{16}\right)^3 + \left(\frac{1}{12}\right)\left(\frac{3}{4}\right)(12)^3$$

$$= 365.63 \text{ in}^4$$

$$A = \left(\frac{3}{4} \times 12\right) + \left(\frac{7}{16} \times 54\right) + \left(\frac{9}{8} \times 14\right)$$

$$= 48.375 \text{ in}^2$$

West Bound Superstructure

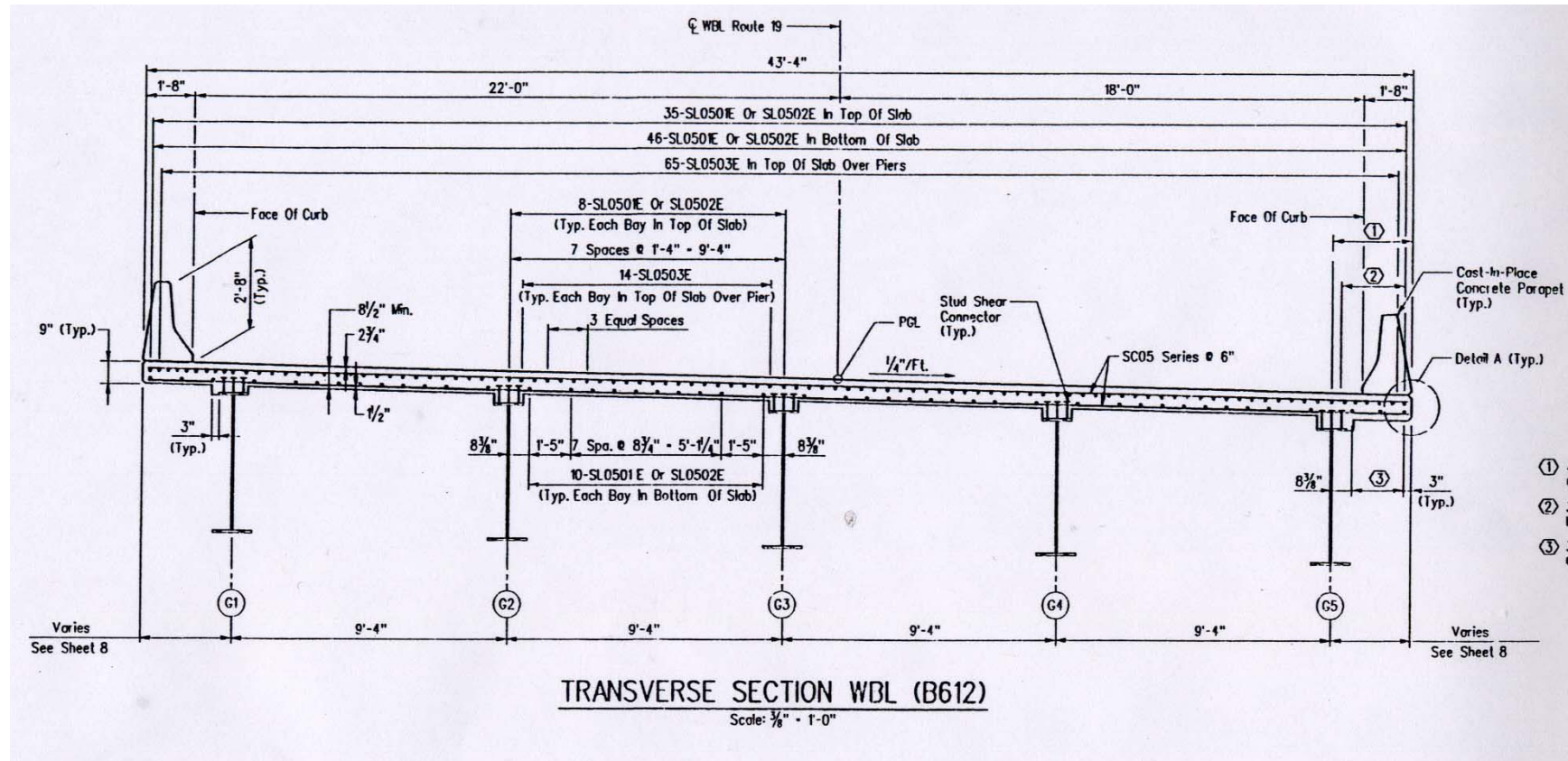


Figure XIII-4. The actual cross section of the West Bound superstructure [Brown, 1993]. The 3/8" = 1'-0" is no longer correct.

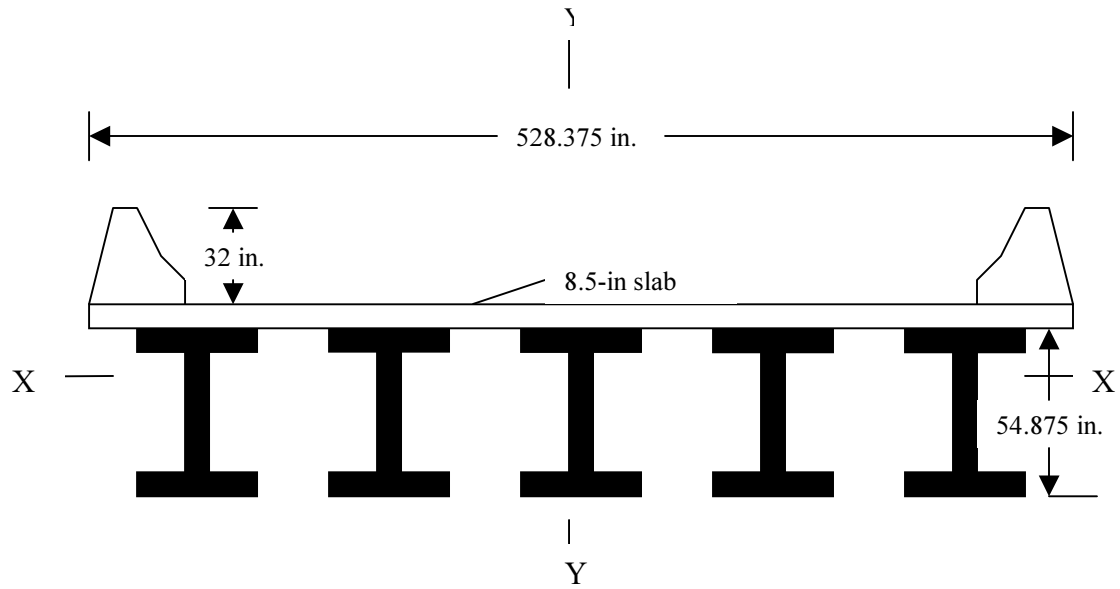


Figure XIII-5. The simplified cross section of the West Bound superstructure. This figure was not drawn to scale.

Parapets:

$$f_c' = 4,000 \text{ psi}$$

$$E_p = 57,000 \sqrt{4,000} \text{ psi} = 3,605 \text{ ksi}$$

Deck:

$$f_c' = 4,000 \text{ psi}$$

$$E_d = 57,000 \sqrt{4,000} \text{ psi} = 3,605 \text{ ksi}$$

Steel:

$$E_s = 29,000 \text{ ksi}$$

$$n = \frac{3,605 \text{ ksi}}{29,000 \text{ ksi}} = 0.124$$

$$A_r = (0.124 \times 2 \times 405 \text{ in}^2) + (0.124 \times 528.375 \text{ in.} \times 8.5 \text{ in.}) + (5 \times 48.375 \text{ in.}^2) = 899 \text{ in.}^2$$

$$\bar{y} = \frac{(0.124)(2)(405)(77.702) + (0.124)(528.375)(8.5)(60.125) + (5)(48.375)(24.244)}{899}$$

$$= 52.450 \text{ in.}$$

$$\begin{aligned} I_{xx} &= (0.124)(2)(34,249) + (0.124)(405)(2)(55.875 + 8.5 + 13.327 - 52.450)^2 \\ &+ (0.124)\left(\frac{1}{12}\right)(528.375)(8.5)^3 + (0.124)(528.375)(8.5)(55.875 + 4.25 - 52.450)^2 \\ &+ (5)(23,724) + (5)(48.375)(52.450 - 27.9375)^2 \\ &= 373,000 \text{ in.}^4 \end{aligned}$$

$$\bar{x} = \frac{(0.124)(405)[528.375] + (0.124)(528.375)(8.5)\left(\frac{528.375}{2}\right) + (48.375)(1295)}{899}$$

$$= 262.86 \text{ in.}$$

$$\begin{aligned} I_{yy} &= (0.124)(7627.8) + (0.124)(405)(262.86 - 8.160)^2 + (0.124)(7627.8) \\ &+ (0.124)(405)(528.375 - 8.160 - 262.86)^2 + (0.124)\left(\frac{1}{12}\right)(8.5)(528.375)^3 \\ &+ (0.124)(8.5)(528.375)(264.1875 - 262.86)^2 + 365.63 + (48.375)(262.86 - 35)^2 \\ &+ 365.63 + (48.375)(262.86 - 147)^2 + 365.63 + (48.375)(262.86 - 259)^2 \\ &+ 365.63 + (48.375)(371 - 262.86)^2 + 365.63 + (48.375)(371 - 262.86)^2 \\ &+ 365.63 + (48.375)(483 - 262.86)^2 \\ &= 25,600,000 \text{ in.}^4 \end{aligned}$$

East Bound Plate Girder

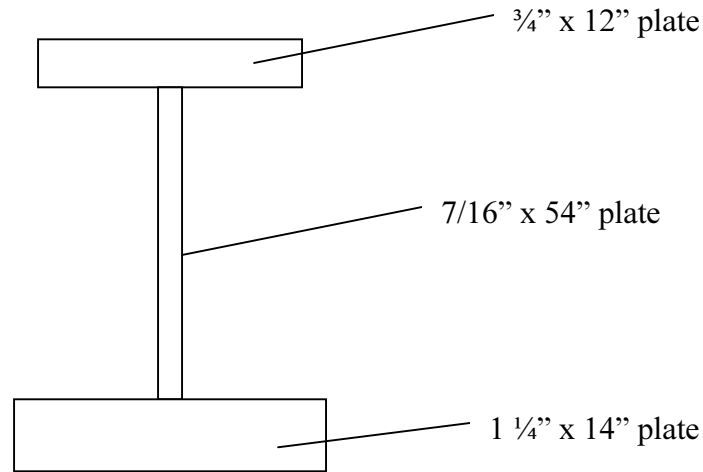


Figure XIII-6. The simplified cross section of the East Bound plate girder. This figure was not drawn to scale.

$$\begin{aligned}
 A &= \left(\frac{3}{4} \times 12\right) + \left(\frac{7}{16} \times 54\right) + \left(\frac{5}{4} \times 14\right) \\
 &= 50.125 \text{ in.}^2 \\
 \bar{y} &= \frac{\left(\frac{3}{4} \times 12 \times (1.25 + 54 + 0.375)\right) + \left(\frac{7}{16} \times 54 \times (1.25 + 27)\right) + \left(\frac{5}{4} \times 14 \times 0.625\right)}{50.125 \text{ in.}^2} \\
 &= 23.521 \text{ in.}
 \end{aligned}$$

$$\bar{x} = 7 \text{ in.}$$

$$\begin{aligned}
 I_{xx} &= \left(\frac{1}{12}\right)(14)\left(\frac{5}{4}\right)^3 + \left(\frac{5}{4}\right)(14)(23.521 - 0.625)^2 \\
 &+ \left(\frac{1}{12}\right)\left(\frac{7}{16}\right)(54)^3 + \left(\frac{7}{16}\right)(54)(28.25 - 23.521)^2 \\
 &+ \left(\frac{1}{12}\right)(12)\left(\frac{3}{4}\right)^3 + (12)\left(\frac{3}{4}\right)(55.625 - 23.521)^2 \\
 &= 24,722 \text{ in.}^4
 \end{aligned}$$

$$I_{yy} = \left(\frac{1}{12}\right)(1.125)(14)^3 + \left(\frac{1}{12}\right)(54)\left(\frac{7}{16}\right)^3 + \left(\frac{1}{12}\right)\left(\frac{3}{4}\right)(12)^3$$
$$= 394.21in.^4$$

East Bound Superstructure

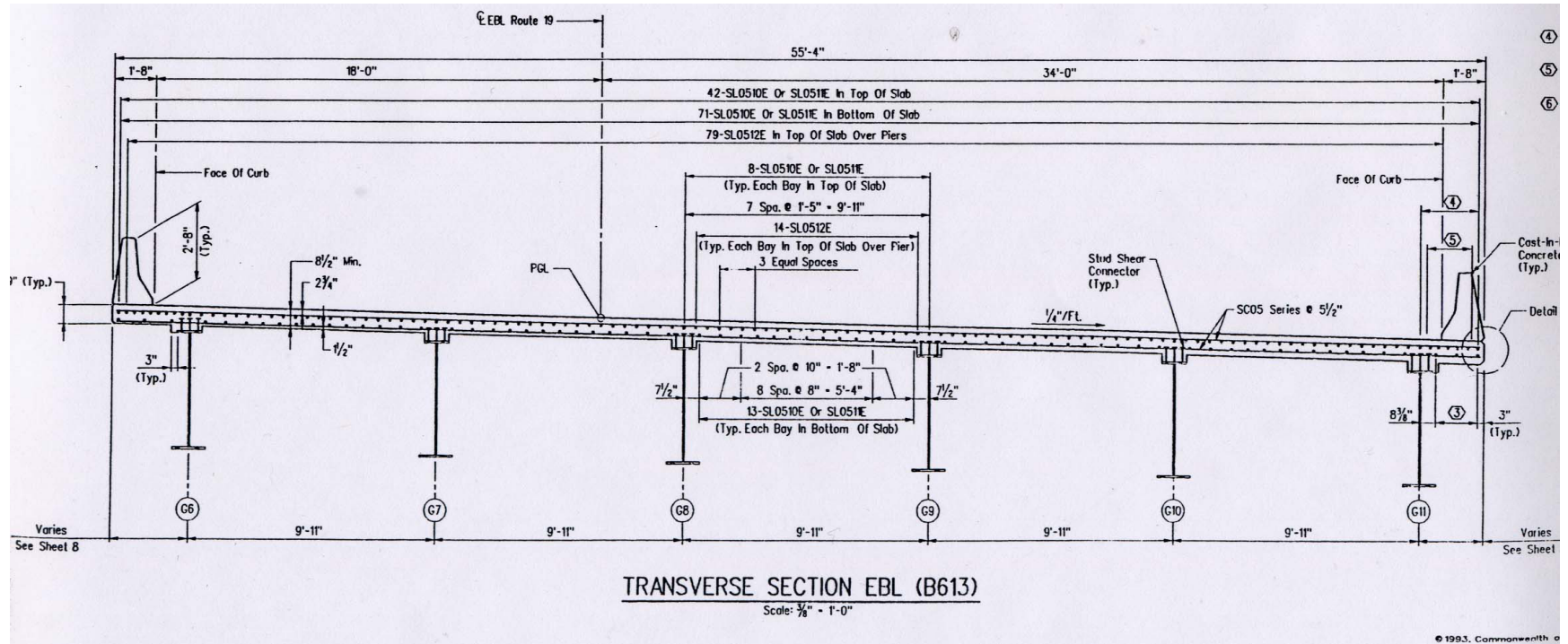


Figure XIII-7. The actual cross section of the East Bound superstructure [Brown, 1993]. The 3/8" = 1'-0" scale is no longer correct.

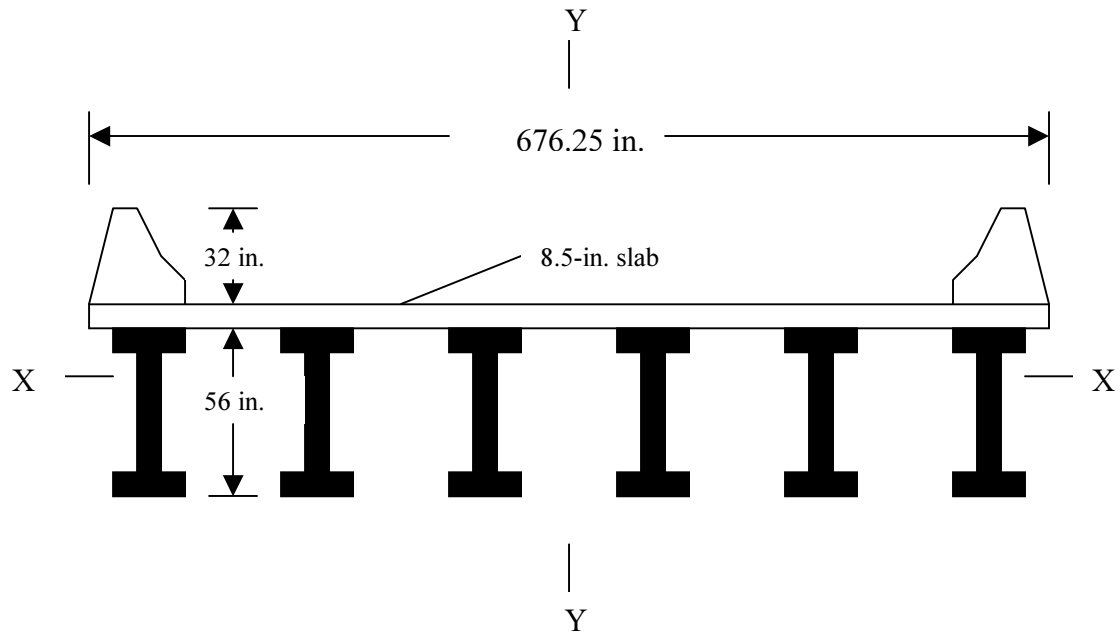


Figure XIII-8. The simplified cross section of the East Bound superstructure [Brown, 1993].

Parapets:

$$f_c' = 4,000 \text{ psi}$$

$$E_p = 57,000\sqrt{4,000} \text{ psi} = 3,605 \text{ ksi}$$

Deck:

$$f_c' = 4,000 \text{ psi}$$

$$E_d = 57,000\sqrt{4,000} \text{ psi} = 3,605 \text{ ksi}$$

Steel:

$$E_s = 29,000 \text{ ksi}$$

$$n = \frac{3,605 \text{ ksi}}{29,000 \text{ ksi}} = 0.124$$

$$A_r = (0.124 \times 2 \times 405 \text{ in}^2) + (0.124 \times 676.25 \text{ in.} \times 8.5 \text{ in.}) + (6 \times 50.125 \text{ in.}^2) = 1114 \text{ in.}^2$$

$$\bar{y} = \frac{(0.124)(2)(405)(77.827) + (0.124)(676.25)(8.5)(60.25) + (6)(50.125)(23.521)}{1114}$$

$$= 51.917 \text{ in.}$$

$$\begin{aligned} I_{xx} &= (0.124)(2)(34,249) + (0.124)(405)(2)(56 + 8.5 + 13.327 - 51.917)^2 \\ &+ (0.124)\left(\frac{1}{12}\right)(676.25)(8.5)^3 + (0.124)(676.25)(8.5)(56 + 4.25 - 51.917)^2 \\ &+ (6)(24,722) + (6)(50.125)(51.917 - 23.521)^2 \\ &= 521,000 \text{ in.}^4 \end{aligned}$$

$$\bar{x} = \frac{(0.124)(405)[676.25] + (0.124)(676.25)(8.5)\left(\frac{676.25}{2}\right) + (50.125)(1995)}{1114}$$

$$= 336.59 \text{ in.}$$

$$\begin{aligned} I_{yy} &= (0.124)(7627.8) + (0.124)(405)(336.59 - 8.160)^2 + (0.124)(7627.8) \\ &+ (0.124)(405)(676.25 - 8.160 - 336.59)^2 + (0.124)\left(\frac{1}{12}\right)(8.5)(676.25)^3 \\ &+ (0.124)(8.5)(676.25)(338.125 - 336.59)^2 + 394.21 + (50.125)(336.59 - 35)^2 \\ &+ 394.21 + (50.125)(336.59 - 154)^2 + 394.21 + (50.125)(336.59 - 273)^2 \\ &+ 394.21 + (50.125)(392 - 336.59)^2 + 394.21 + (50.125)(511 - 336.59)^2 \\ &+ 394.21 + (50.125)(630 - 336.59)^2 \\ &= 50,500,000 \text{ in.}^4 \end{aligned}$$

West Bound and East Bound Pier Cap Beam

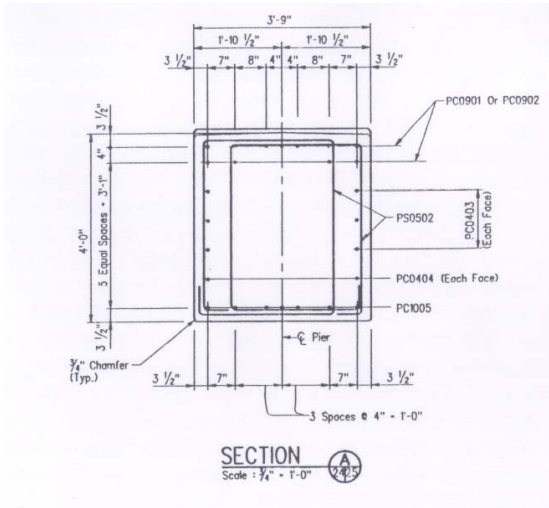


Figure XIII-9. The actual West Bound pier cap beam cross section [Brown, 1993]. The $\frac{3}{4}$ " = 1'-0" scale is no longer correct.

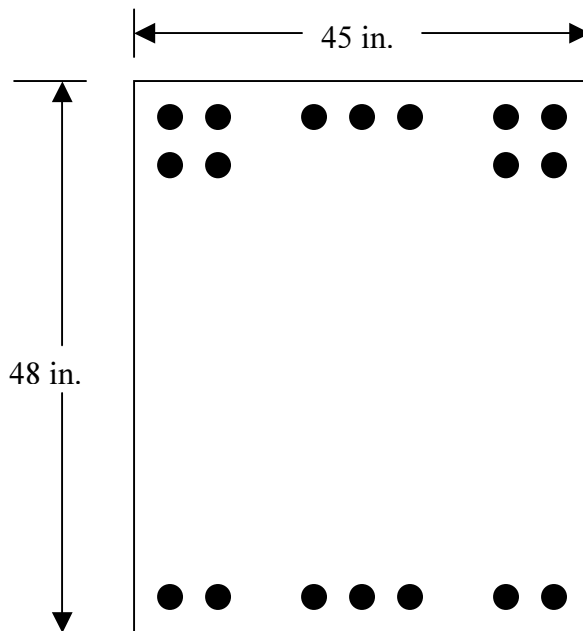


Figure XIII-10. The simplified West Bound pier cap beam cross section. This figure was not drawn to scale.

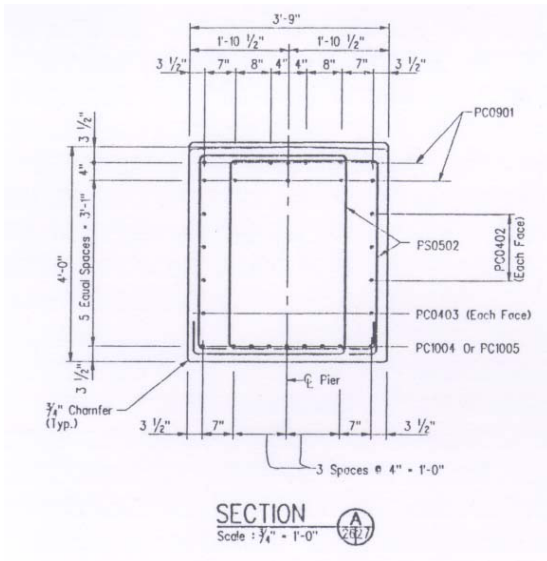


Figure XIII-11. The actual East Bound pier cap beam cross section [Brown, 1993]. The 3/4" = 1'-0" scale is no longer correct.

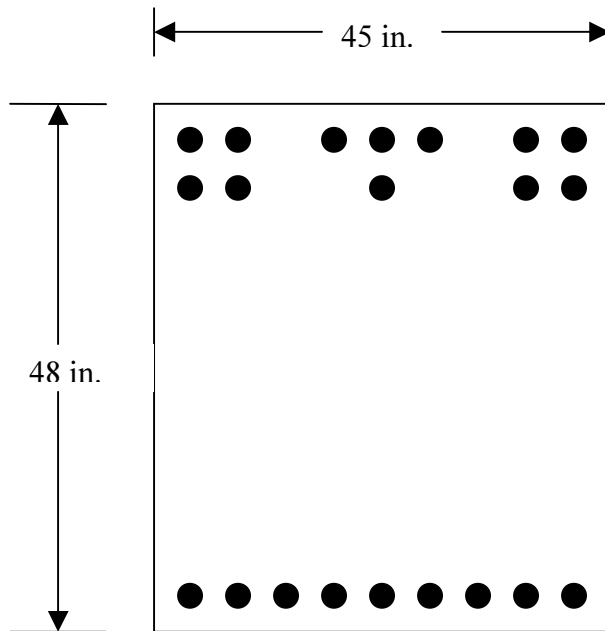


Figure XIII-12. The simplified East Bound pier cap beam cross section. This figure was not drawn to scale.

$$A = 2160in^2$$

$$I_{xx} = \frac{1}{12}(45in.)(48in.)^3 = 415,000in.^4$$

$$I_{yy} = \frac{1}{12}(48in.)(45in.)^3 = 365,000in.^4$$

West Bound and East Bound Columns

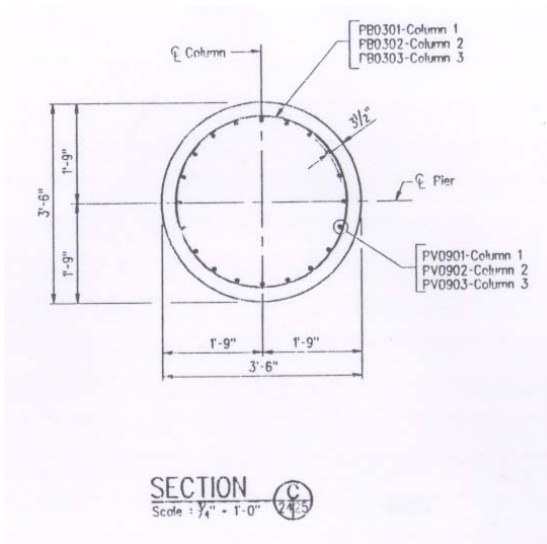


Figure XIII-13. The cross section of the West Bound column [Brown, 1993]. The $\frac{3}{4}'' = 1'-0''$ scale is no longer correct.

$$A = \frac{1}{4}\pi(42in.)^2 = 1385.4in.^2$$

$$I_{xx} = \frac{1}{64}\pi(42in.)^4 = 153,000in.^4$$

$$I_{yy} = \frac{1}{64}\pi(42in.)^4 = 153,000in.^4$$

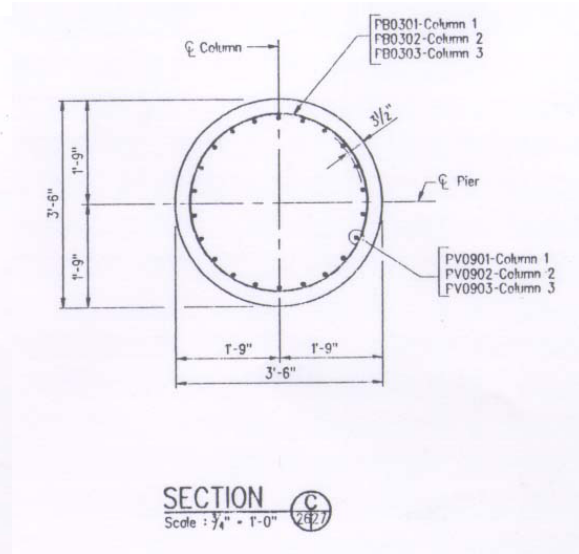


Figure XIII-14. The cross section of the East Bound column [Brown, 1993]. The $\frac{3}{4}'' = 1'-0''$ scale is no longer correct.