Appendix D Example 3 – Falsework Beam – Bi-Axial Bending – Canted > 2%

This example demonstrates how to calculate maximum bending stress in beams canted more than two percent. Refer to *Falsework Manual*, Section 5-4.04, *Bi-Axial Bending.*

Given Information

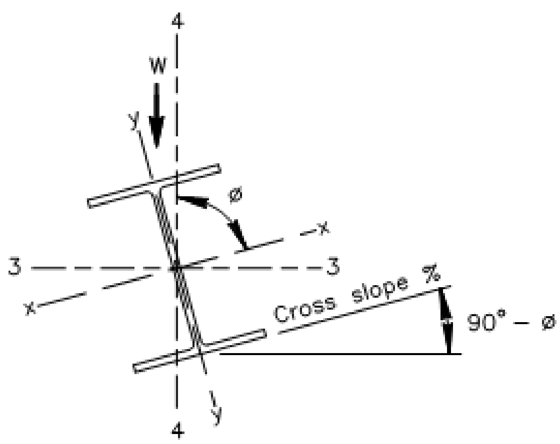
Span = 48 Ft

Member W 14 x 176

Cross slope = 10%

$I_{x\text{-}x}$ = 2140 In^4 $I_{y\text{-}y}$ = 838 In^4

D = 15.22 In b_f = 15.65 In



$Ø = 90^\circ - \tan^{-1}$ (cross slope)

$= 90^\circ - \tan^{-1}\left(\frac{10}{100}\right) = 84.29^\circ$

$y = \frac{d}{2} = \frac{15.20 \text{ inches}}{2} = 7.60$ inches

$x = \frac{b_f}{2} = \frac{15.70 \text{ inches}}{2} = 7.85$ inches

Uniform Load W:

Total Section:

Load A = Concrete (160 lb/ft^3) + Beam (176 lb/ft) + LL (20 lb/ft^2) = 1420 lb/ft

Load B = Concrete only (150 lb/ft^3) = 1000 lb/ft

Bottom slab and stems:

Load C = Concrete (150 lb/ft^3) = 649 lb/ft

Assume lateral bracing is adequate so that F_b = 22,000 psi maximum of the Standard Specifications is not exceeded.

$$\emptyset = 90° - \tan^{-1}\frac{10}{100} = 84.29°$$

Check Bending and Deflection

Check bending:

M = $\frac{WL^2}{8} = \frac{\left(1420\ {}^{lb}/_{ft}\right)(48\ ft)^2}{8} =$ 408,960 ft-lbs = 4,907,520 in-lbs

f_b = 4,907,520 $\left(\frac{7.60}{2140}\ \sin 84.29° + \frac{7.85}{838}\cos 84.29°\right)$ = 21,915 psi < 22,000 psi allowable **OK**

Check deflections:

Check x and y deflections versus L/240 using Load B:

Load in the y-direction W_y = I000(cos(90-84.29)) = 995.04 lb/ft

$$\Delta_y = \frac{5WL^4}{384EI_{x-x}} = \frac{5\left(995.04\ {}^{lb}/_{ft}\right)(48\ ft)^4\left(1728\frac{in^3}{ft^3}\right)}{384\ (30\ x\ 10^6\ psi)(2140\ in^4)}$$

= 1.85 in. < $\frac{L}{240} = \frac{(48)(12)}{240} =$ 2.4 inches allowable

Load in the x-direction W_x = I000(sin(90-84.29)) = 99.49 lb/ft

$$\Delta_x = \frac{5WL^4}{384EI_{y-y}} = \frac{5\left(99.49\ {}^{lb}/_{ft}\right)(48\ ft)^4\left(1728\frac{in^3}{ft^3}\right)}{384\ (30\ x\ 10^6\ psi)(838\ in^4)}$$

= 0.47 in. < $\frac{L}{240} = \frac{(48)(12)}{240} =$ 2.4 inches allowable

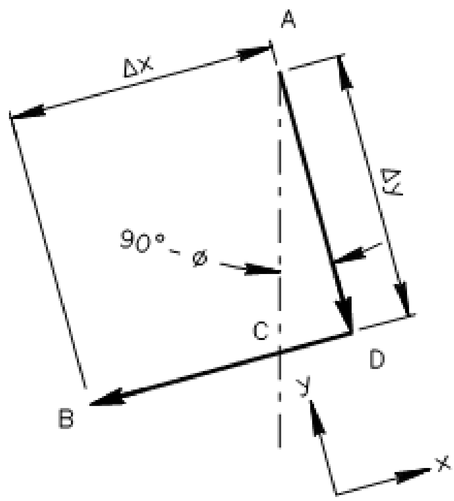
Check Δ_x versus max allowable of 1.5 inches using Load C:

Load in the x-direction W_x = 649 (sin (90-84.29)) = 64.57 lb/ft

$$\Delta_x = \frac{5WL^4}{384EI_{y-y}} = \frac{5\left(64.57\ {}^{lb}/_{ft}\right)(48\ \text{ft})^4\left(1728\ \text{in}^3/\text{ft}^3\right)}{384\ (30 \times 10^6\ \text{psi})(838\ \text{in}^4)} = 0.31\ \text{In.}$$

Load in the y-direction W_y = 649(cos(90-84.29)) = 645.78 lb/ft

$$\Delta_y = \frac{5WL^4}{384EI_{x-x}} = \frac{5(645.78\ \text{Lb/Ft})\ (48\ \text{Ft})^4\left(1728\ \text{In}^3/\text{Ft}^3\right)}{384\ (30 \times 10^6\ \text{psi})(2140\ \text{In}^4)} = 1.20\ \text{in.}$$



Lateral deflection = CB.

DC = AD [tan(90° - Ø)]

= 1.20 [tan(90° - 84.29°)]= 0.12 in.

CB = DB - DC

= 0.31 - 0.12 = 0.19 < 1.5 in. **OK**