

## IS 800-2007 Example 001

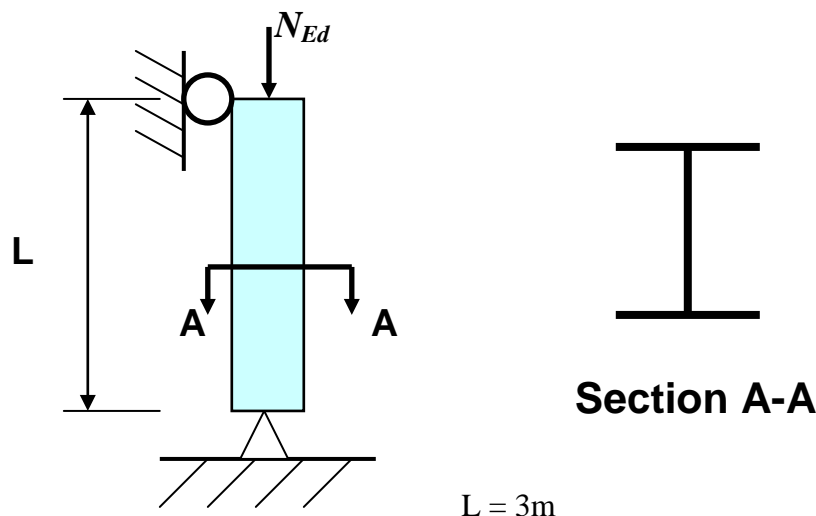
### WIDE FLANGE MEMBER UNDER COMPRESSION

#### EXAMPLE DESCRIPTION

The frame object axial strengths are tested in this example.

A continuous column is subjected to factored load  $N = 1$  kN. This example was tested using the Indian IS 800:2007 steel frame design code. The design capacities are compared with independent hand calculated results.

#### GEOMETRY, PROPERTIES AND LOADING



#### Material Properties

$E = 200 \times 10^3$  MPa  
 $\nu = 0.3$   
 $G = 76923$  MPa

#### Loading

$N = 1$  kN

#### Design Properties

$f_y = 250$  MPa  
 $f_u = 410$  MPa  
 Section: ISMB 350

#### TECHNICAL FEATURES TESTED

- Section compactness check (column)
- Member compression capacity

PROGRAM NAME: SAP2000  
REVISION NO.: 0

## RESULTS COMPARISON

Independent results are taken from hand calculations based on the CSI steel design documentation contained in the file “SFD-IS-800-2007.pdf,” which is available through the program “Help” menu. The example was taken from Example 9.2 on pp. 765-766 in “Design of Steel Structures” by N. Subramanian.

Output Parameter	SAP2000	Independent	Percent Difference
Compactness	Plastic	Plastic	0.00%
Design Axial Strength, $N_{crd}$	733.85	734.07	-0.03%

**COMPUTER FILE: IS 800-2007 Ex001**

## CONCLUSION

The results show an acceptable comparison with the independent results.

## HAND CALCULATION

### Properties:

Material: Fe 250

$$E = 200,000 \text{ MPa}$$

$$f_y = 250 \text{ MPa}$$

Section: ISMB 350

$$A = 6670 \text{ mm}^2$$

$$b = 140 \text{ mm}, t_f = 14.2 \text{ mm}, h = 350 \text{ mm}, t_w = 8.1 \text{ mm}, r = 1.8 \text{ mm}$$

$$d = h - 2(t_f + r) = 350 - 2(14.2 + 1.8) = 318 \text{ mm}$$

$$r_y = 28.4 \text{ mm}, r_z = 143 \text{ mm}$$

Member:

$$KL_y = KL_z = 3,000 \text{ mm (unbraced length)}$$

$$\gamma_{M0} = 1.1$$

### Loadings:

$$N_{Ed} = 1 \text{ kN}$$

### Section Compactness:

$$\varepsilon = \sqrt{\frac{250}{f_y}} = \sqrt{\frac{250}{250}} = 1$$

Localized Buckling for Flange:

$$\lambda_p = 8.4\varepsilon = 8.4 \bullet 1 = 8.4$$

$$\lambda_e = \frac{b}{t_f} = \frac{70}{14.2} = 4.93$$

$$\lambda_e = 4.93 < \lambda_p = 8.40$$

So Flange is Plastic in compression

## Localized Buckling for Web:

$$\lambda_p = N / A \quad \& \quad \lambda_s = 42\varepsilon = 42 \text{ for compression}$$

$$\lambda_e = \frac{d}{t_w} = \frac{318}{8.1} = 39.26$$

$$\lambda_e = 39.26 < \lambda_s = 42$$

So Web is Plastic in compression

Since Flange & Web are Plastic, Section is Plastic.

## **Member Compression Capacity:**

### Non-Dimensional Slenderness Ratio:

$$\frac{h}{b_f} = \frac{350}{140} = 2.5 > 1.2$$

and

$$t_f = 14.2 \text{ mm} < 40 \text{ mm}$$

So we should use the Buckling Curve 'a' for the z-z axis and Buckling Curve 'b' for the y-y axis (IS 7.1.1, 7.1.2.1, Table 7).

### Z-Z Axis Parameters:

For buckling curve a,  $\alpha = 0.21$  (IS 7.1.1, 7.1.2.1, Table 7)

$$\text{Euler Buckling Stress: } f_{cc} = \frac{\pi^2 E}{\left( \frac{K_z L_z}{r_z} \right)^2} = \frac{\pi^2 200,000}{\left( \frac{3,000}{143} \right)^2} = 4485 \text{ MPa}$$

$$\lambda_z = \sqrt{\frac{f_y}{f_{cc}}} = \sqrt{\frac{250}{4485}} = 0.2361$$

$$\phi = 0.5 \left[ 1 + \alpha (\lambda - 0.2) + \lambda^2 \right] = 0.5 \left[ 1 + 0.21 (0.2361 - 0.2) + 0.2361^2 \right]$$

$$\phi = 0.532$$

$$\text{Stress Reduction Factor: } \chi = \frac{1}{\phi + \sqrt{\phi^2 - \lambda^2}} = \frac{1}{0.532 + \sqrt{0.532^2 - 0.2361^2}} = 0.9920$$

$$f_{cd,z} = \chi \frac{f_y}{\gamma_{M0}} = 0.992 \bullet \frac{250}{1.1} = 255.5 \text{ MPa}$$

### Y-Y Axis Parameters:

For buckling curve b,  $\alpha = 0.34$  (IS 7.1.1, 7.1.2.1, Table 7)

$$\text{Euler Buckling Stress: } f_{cc} = \frac{\pi^2 E}{\left( \frac{K_z L_z}{r_z} \right)^2} = \frac{\pi^2 200,000}{\left( \frac{3,000}{28.4} \right)^2} = 177 \text{ MPa}$$

$$\lambda_y = \sqrt{\frac{f_y}{f_{cc}}} = \sqrt{\frac{250}{177}} = 1.189$$

$$\phi = 0.5 \left[ 1 + \alpha (\lambda - 0.2) + \lambda^2 \right] = 0.5 \left[ 1 + 0.34 (1.189 - 0.2) + 1.189^2 \right]$$

$$\phi = 1.375$$

$$\text{Stress Reduction Factor: } \chi = \frac{1}{\phi + \sqrt{\phi^2 - \lambda^2}} = \frac{1}{1.375 + \sqrt{1.375^2 - 1.189^2}} = 0.4842$$

$$f_{cd,y} = \chi \frac{f_y}{\gamma_{M0}} = 0.4842 \bullet \frac{250}{1.1} = 110.1 \text{ MPa} \quad \text{Governs}$$

$$P_d = A f_{cd,y} = 6670 \bullet 110.1$$

$$\boxed{P_d = 734.07 \text{ kN}}$$