

# POINT TORSIONAL STABILITY BRACING OF A BEAM.

## Beam torsional bracing: Point Bracing Example

#WeLoveSteelConstruction

- ตัวอย่าง จงตรวจสอบระบบค้ำยันทางขวางที่เป็น built-up beam H250x100x6x4 เกรด SS400 ของคานเหล็กเชื่อมประกอบ simple beam ยาว 12 เมตร 2 ตัว ขนาด 500x250x12x6 ที่มีการค้ำยัน ณ ตำแหน่ง 1/3 ของความยาวคาน โดยคานตัวนี้ รับ DL และ LL 400 และ 800 kg/m<sup>2</sup> ตามลำดับ
- Step 1: คำนวณ required moment
- Step 2: คำนวณ required brace force
- Step 3: คำนวณ required braced stiffness
- Step 4: คำนวณ available brace strength
- Step 5: คำนวณ available brace stiffness
- Step 6: ตรวจสอบ brace strength & stiffness

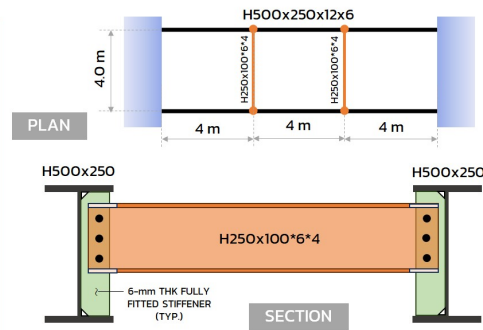


Figure 1: image

### Load

$$\text{Dead Load: } DL = 800 \frac{\text{kg}}{\text{m}^2}$$

$$DL_{line} = 1600 \frac{\text{kg}}{\text{m}}$$

$$\text{Live Load: } LL = 400 \frac{\text{kg}}{\text{m}^2}$$

$$LL_{line} = 800 \frac{\text{kg}}{\text{m}}$$

$$W_{factor} = 1.2 * (1600) + 1.6 * (800) = 3200 \frac{\text{kg}}{\text{m}}$$

### Material Property

$$\text{Yield Strength: } A_s = 245 \text{ MPa}$$

### Section Property of H-250x100x6x4

$$\text{Section Area: } A_s = 21.52 \text{ cm}^2$$

$$\text{Weight: } w = 16.9 \frac{\text{kg}}{\text{m}}$$

$$\text{Moment of inertia about x: } I_y = 100 \text{ cm}^4$$

$$\text{Moment of inertia about y: } I_x = 2256 \text{ cm}^4$$

### Section Property of H-500x250x12x6

Section Area:  $A_s = 88.56 \frac{kg}{m}$

Weight:  $w = 69.52 \frac{kg}{m}$

Moment of inertia about x:  $I_x = 41121 cm^4$

Moment of inertia about y:  $I_y = 3126 cm^4$

### 1. Required Moment.

ASD	LRFD
$M = \frac{W_u * l^2}{8} = \frac{2400 * 12^2}{8}$	$M = \frac{W_u * l^2}{8} = \frac{3200 * 12^2}{8}$
$M_r = 43200 kg.m$	$M_r = 57600 kg.m$

### 2. Required Brace Force (The required flexural strength for a point torsional brace).

ASD	LRFD
$M_{br} = 0.02 M_a$	$M_{br} = 0.02 M_u$
$M_{br} = 864 kg.m$	$M_{br} = 1152 kg.m$

### 3. Required Braced Stiffness.

ASD	LRFD
$\beta_T = \Omega \frac{2.4 * L}{nEI_{yeff}} \left( \frac{M_r}{C_b} \right)^2$	$\beta_T = \frac{1}{\phi} \frac{2.4 * L}{nEI_{yeff}} \left( \frac{M_r}{C_b} \right)^2$
$\beta_T =$	$\beta_T = \frac{1}{0.75} *$
$3 * \frac{2.4 * 12 * 10^3}{3 * 2 * 10^6 * 41121 * 10^4} \left( \frac{864 * 10^{-3} * 9.81}{1} \right)^2$	$\frac{2.4 * 12 * 10^3}{3 * 2 * 10^6 * 41121 * 10^4} \left( \frac{1152 * 10^{-3} * 9.81}{1} \right)^2$
$\beta_T = 2.52 * 10^{-9} \frac{N}{rad.}$	$\beta_T = 1.99 * 10^{-9} \frac{N}{rad.}$

### 4. Available Braced Strength.

From:

$$M_n = M_p = F_y Z \leq 1.6 * F_y S_x$$

$$Z = 203.04 cm^3$$

$$S_x = 178.87 cm^3$$

$$1.6 * F_y S_x = 1.6 * 245 * 178.87 * 10^3 = 70.12 * 10^6$$

$$M_n = F_y Z = 245 * 203.04 * 10^3 = 49.74 * 10^6 \leq 70.12 * 10^6 \text{ is true;}$$

## 5. Available Braced Stiffness and Design thickness of stiffeners.

$$\beta_{Tb} = \frac{6EI}{L} = \frac{6*2*10^6*2256*10^4}{12*10^3} \frac{N}{rad.}$$

$$\beta_{Tb} = 2.26 * 10^{10} \frac{N}{rad.}$$

From:

$$\frac{1}{\beta_T} = \frac{1}{\beta_{TB}} + \frac{1}{\beta_{sec}}$$

ASD	LRFD
$\frac{1}{2.52*10^{-9}} = \frac{1}{2.26*10^{10}} + \frac{1}{\beta_{sec}}$	$\frac{1}{1.99*10^{-9}} = \frac{1}{2.26*10^{10}} + \frac{1}{\beta_{sec}}$
$\beta_{sec} = 2.52 * 10^{-9} \frac{N}{rad.}$	$\beta_{sec} = 1.99 * 10^{-9} \frac{N}{rad.}$

Determine the required width, bs, of 4 mm.-thick of stiffeners.

From:

$$\beta_{sec} = \frac{3.3*E}{h_o} * \left[ \frac{1.5*h_o*t_w^3}{12} + \frac{t_{st}*b_s^3}{12} \right]$$

ASD	LRFD
$2.52 * 10^{-9} = \frac{3.3*2*10^6}{488} * \left[ \frac{1.5*488*6^3}{12} + \frac{4*b_s^3}{12} \right]$	$1.99 * 10^{-9} = \frac{3.3*E}{488} * \left[ \frac{1.5*488*6^3}{12} + \frac{4*b_s^3}{12} \right]$
$b_s^3 = -34mm. < 0$	$b_s^3 = -34mm. < 0$

## 6. Brace Strength & Stiffness Check.

ASD	LRFD
$\frac{M_n}{\Omega} = \frac{49.74*10^6}{3} = 16.58 * 10^6 kN.m$	$\phi M = 0.75 * 49.74 * 10^6 = 37.31 * 10^6 kN.m$
$16.58*10^6 kN.m > 8.64 kN.m$ (ok)	$37.31*10^6 kN.m > 11.52 kN.m$ (ok)