

Secondary Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
20	(18,8,3)	(18,16,3)	8	0.06	0.03
19	(18,0,3)	(18,8,3)	8	0.06	0.03
2	(0,8,3)	(0,16,3)	8	0.06	0.03
1	(0,0,3)	(0,8,3)	8	0.06	0.03

Design Limit state:

Combo: 1.2D+1.4L

Md: 0.06 t.m

Vd: 0.03 ton

Service Limit State

Combo: LIVE

Span: 8 m

Load: 0 t/m'

Design Checks

1-Check Local Buckling

$dw/tw = 15.58 < 81.98 \Rightarrow$ Compact Web

$c/tf = 3.06 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$Lu_{act} = 0 \text{ m} < Lu_{max} = 59.39 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

$f_{act} = 0.29 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

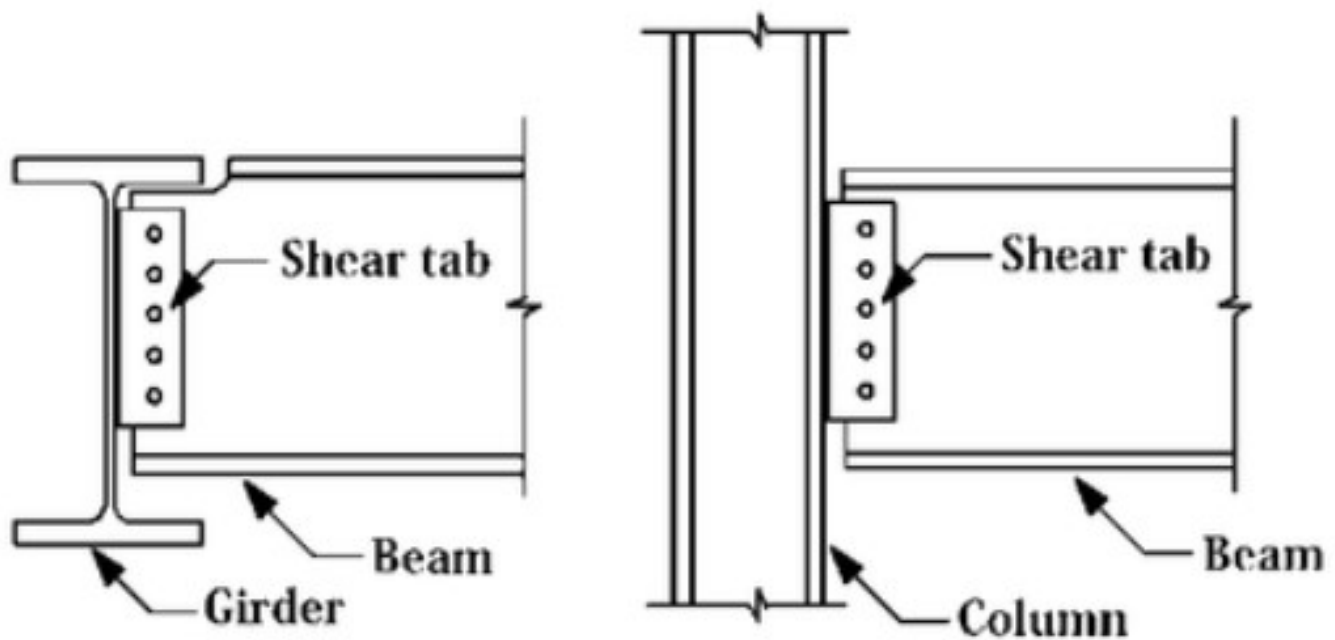
4-Check Shear Stress

$q_{act} = 0.01 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 0 \text{ cm} < d_{all} = 2.67 \text{ cm}$

Group Connection Design (Simple Shear Plate Connection)



1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 0.03$ ton

$R_{least} = 2.85$ ton

$N = 3$ with Pitch = 63 mm & Full Layout: (31;63 63 31.5)

2-Stresses Induced in Fillet Weld Lines at Plane(1-1)

$f = 0 \text{ t/cm}^2$ & $q = 0 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow$
OK

3-Stresses Induced in Fillet Weld Lines at Plane(2-2)

$q = 0 \text{ t/cm}^2$ & $q_{mt} = 0 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow$
OK

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow$ OK IPE270

Plate Layout $\Rightarrow L = 189 \text{ mm}$ & $t_p = 10 \text{ mm}$ & $S_w = 6 \text{ mm}$

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
16	(14,8,3)	(14,16,3)	8	9.66	4.83

15	(14,0,3)	(14,8,3)	8	9.66	4.83
14	(12,8,3)	(12,16,3)	8	9.66	4.83
13	(12,0,3)	(12,8,3)	8	9.66	4.83
12	(10,8,3)	(10,16,3)	8	9.66	4.83
11	(10,0,3)	(10,8,3)	8	9.66	4.83
17	(16,0,3)	(16,8,3)	8	9.66	4.83
9	(8,0,3)	(8,8,3)	8	9.66	4.83
8	(6,8,3)	(6,16,3)	8	9.66	4.83
7	(6,0,3)	(6,8,3)	8	9.66	4.83
6	(4,8,3)	(4,16,3)	8	9.66	4.83
5	(4,0,3)	(4,8,3)	8	9.66	4.83
4	(2,8,3)	(2,16,3)	8	9.66	4.83
3	(2,0,3)	(2,8,3)	8	9.66	4.83
18	(16,8,3)	(16,16,3)	8	9.66	4.83
10	(8,8,3)	(8,16,3)	8	9.66	4.83

Design Limit state:

Combo: 1.2D+1.4L

Md: 9.66 t.m

Vd: 4.83 ton

Service Limit State

Combo: LIVE

Span: 8 m

Load: 0 t/m'

Design Checks**1-Check Local Buckling** $dw/tw = 37.87 < 81.98 \Rightarrow$ Compact Web $c/tf = 5.64 < 10.91 \Rightarrow$ Compact Flange**2-Check Lateral Torsional Buckling** $Lu_{act} = 0 \text{ m} < Lu_{max} = 206.56 \text{ m} \Rightarrow$ Supported (No LTB)**3-Check Bending Stress**

Section: IPE330

$$f_{act} = 1.35 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$$

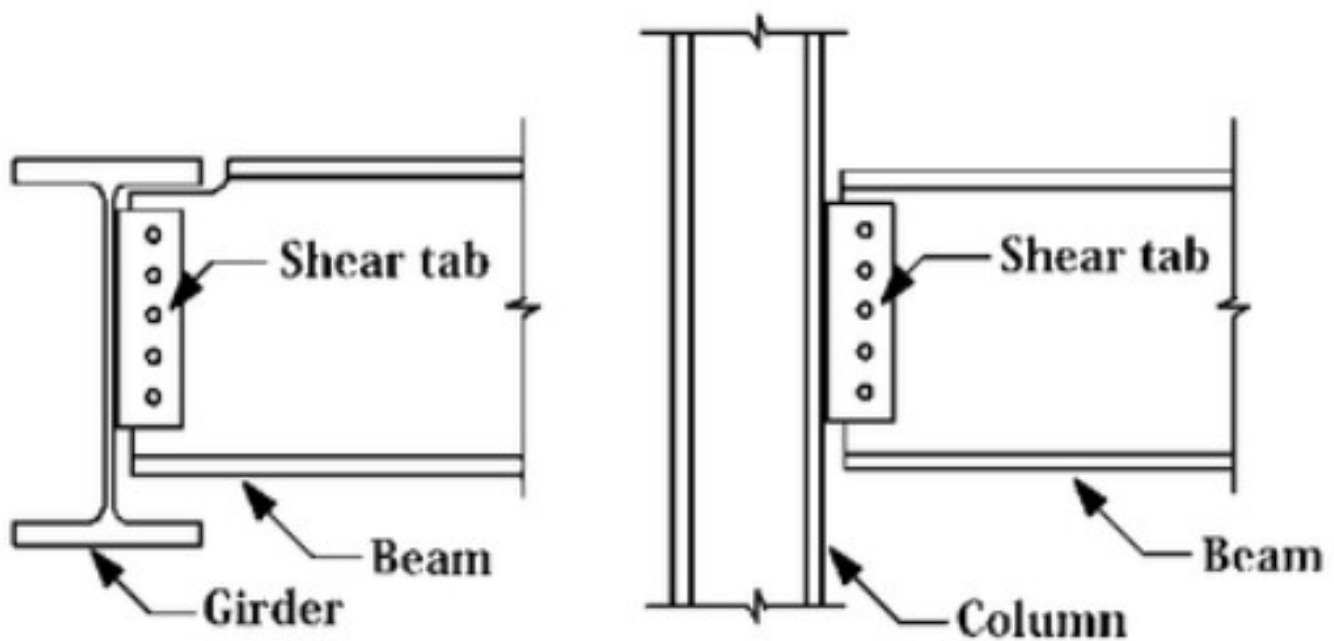
4-Check Shear Stress

$$q_{act} = 0.2 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$$

5-Check Deflection

$$\delta_{act} = 0 \text{ cm} < \delta_{all} = 2.67 \text{ cm}$$

Group Connection Design (Simple Shear Plate Connection)



1-Bolts Design

Bolts: M20 of Grade 8.8

$$V_d = 4.83 \text{ ton}$$

$$R_{least} = 3.24 \text{ ton}$$

N= 3 with Pitch= 77 mm & Full Layout: (38;77 77 38.5)

2-Stresses Induced in Fillet Weld Lines at Plane(1-1)

$$f = 0.23 \text{ t/cm}^2 \text{ \& } q = 0.18 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.38 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

3-Stresses Induced in Fillet Weld Lines at Plane(2-2)

$q = 0.18 \text{ t/cm}^2$ & $q_{mt} = 0.23 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.29 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.27 \text{ t/cm}^2 < 0.72 \cdot F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK IPE330}$

Plate Layout $\Rightarrow L = 231 \text{ mm}$ & $t_p = 10 \text{ mm}$ & $S_w = 6 \text{ mm}$

Main Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
9	(12,16,3)	(18,16,3)	6	9.69	4.85
8	(6,16,3)	(12,16,3)	6	9.69	4.85
7	(0,16,3)	(6,16,3)	6	9.69	4.85
3	(12,0,3)	(18,0,3)	6	9.69	4.85
2	(6,0,3)	(12,0,3)	6	9.69	4.85
1	(0,0,3)	(6,0,3)	6	9.69	4.85

Design Limit state:

Combo: 1.2D+1.4L

Md: 9.69 t.m

Vd: 4.85 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: 0 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 37.87 < 81.98 \Rightarrow \text{Compact Web}$

$c/t_f = 5.64 < 10.91 \Rightarrow \text{Compact Flange}$

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 206.56 \text{ m} \Rightarrow \text{Supported (No LTB)}$

3-Check Bending Stress

Section: IPE330

$$f_{act} = 1.36 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$$

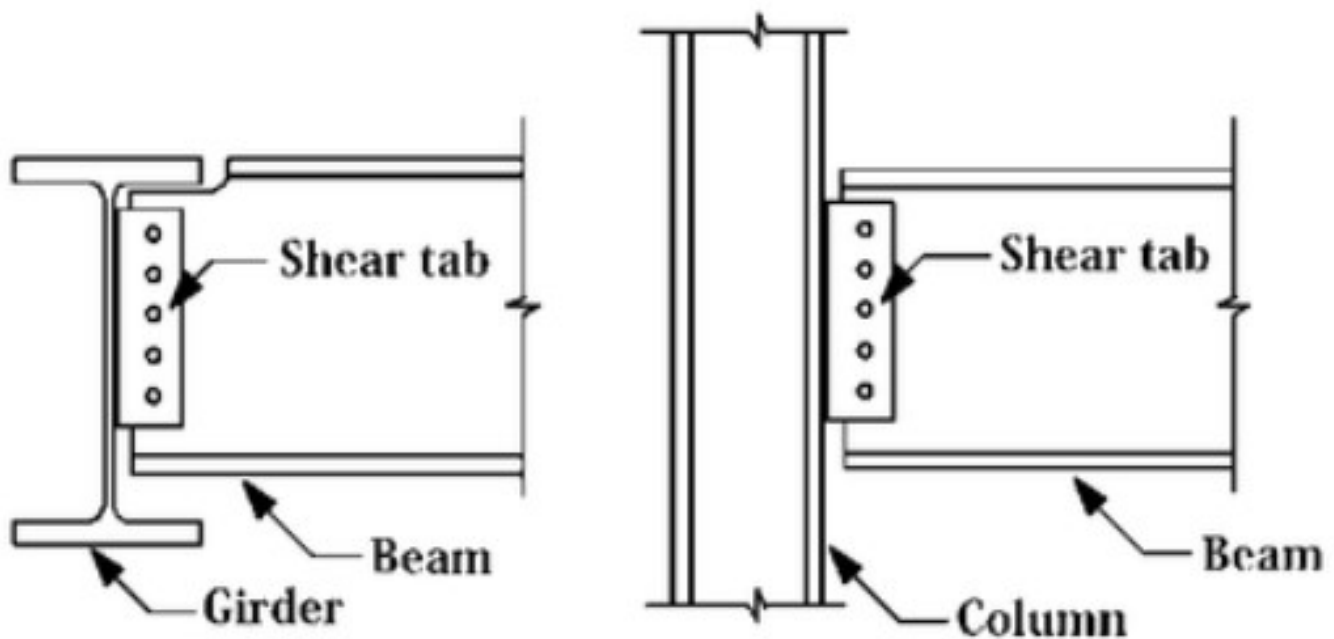
4-Check Shear Stress

$$q_{act} = 0.2 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$$

5-Check Deflection

$$\delta_{act} = 0 \text{ cm} < \delta_{all} = 2 \text{ cm}$$

Group Connection Design (Simple Shear Plate Connection)



1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 4.85 \text{ ton}$

$R_{least} = 3.24 \text{ ton}$

$N = 3$ with Pitch = 77 mm & Full Layout: (38;77 77 38.5)

2-Stresses Induced in Fillet Weld Lines at Plane(1-1)

$$f = 0.23 \text{ t/cm}^2 \text{ \& } q = 0.18 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.39 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

3-Stresses Induced in Fillet Weld Lines at Plane(2-2)

$$q = 0.18 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.23 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.29 \text{ t/cm}^2 < 0.2F_u = 0.72$$

$t/cm^2 \Rightarrow OK$

4-Check Thickness of Plate

$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.27 \text{ t/cm}^2 < 0.72 \cdot F_y = 1.73 \text{ t/cm}^2 \Rightarrow OK \text{ IPE330}$

Plate Layout $\Rightarrow L = 231 \text{ mm} \ \& \ t_p = 10 \text{ mm} \ \& \ S_w = 6 \text{ mm}$

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
6	(12,8,3)	(18,8,3)	6	19.35	9.68
5	(6,8,3)	(12,8,3)	6	19.35	9.68
4	(0,8,3)	(6,8,3)	6	19.35	9.68

Design Limit state:

Combo: 1.2D+1.4L

Md: 19.35 t.m

Vd: 9.68 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: 0 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 41.66 < 81.98 \Rightarrow \text{Compact Web}$

$c/t_f = 5.19 < 10.91 \Rightarrow \text{Compact Flange}$

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 245.29 \text{ m} \Rightarrow \text{Supported (No LTB)}$

3-Check Bending Stress

Section: IPE450

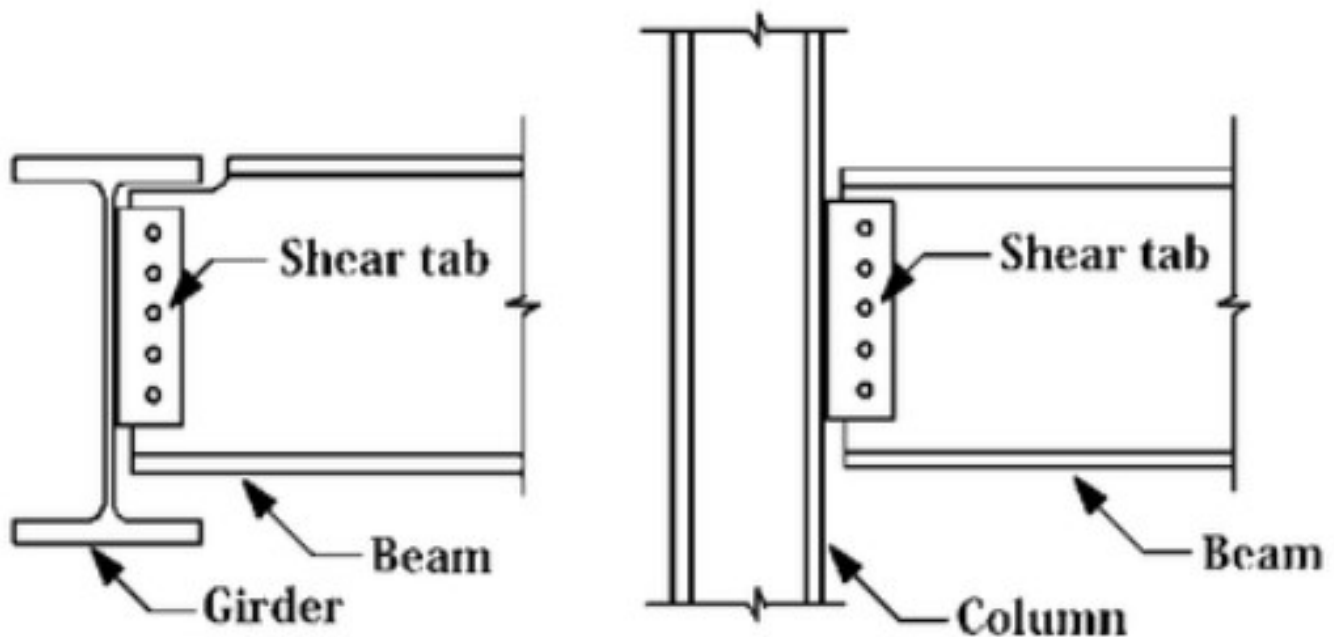
$f_{act} = 1.29 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.23 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 0 \text{ cm} < d_{all} = 2 \text{ cm}$

Group Connection Design (Simple Shear Plate Connection)1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 9.68$ ton

$R_{least} = 4.06$ ton

$N = 3$ with Pitch = 105 mm & Full Layout: (52;105 105 52.5)

2-Stresses Induced in Fillet Weld Lines at Plane(1-1)

$f = 0.24 \text{ t/cm}^2$ & $q = 0.26 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.51 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

3-Stresses Induced in Fillet Weld Lines at Plane(2-2)

$q = 0.26 \text{ t/cm}^2$ & $q_{mt} = 0.24 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.36 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.29 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK IPE450}$

Plate Layout $\Rightarrow L = 315 \text{ mm}$ & $t_p = 10 \text{ mm}$ & $S_w = 6 \text{ mm}$

Columns

Column ID	Start Point	End Point	Height (m)	Nmax (ton)
6	(6,8,0)	(6,8,3)	3	-29.04
7	(12,8,0)	(12,8,3)	3	-29.04
2	(6,0,0)	(6,0,3)	3	-14.55
3	(12,0,0)	(12,0,3)	3	-14.55
10	(6,16,0)	(6,16,3)	3	-14.55
11	(12,16,0)	(12,16,3)	3	-14.55
5	(0,8,0)	(0,8,3)	3	-9.76
8	(18,8,0)	(18,8,3)	3	-9.76
1	(0,0,0)	(0,0,3)	3	-4.9
4	(18,0,0)	(18,0,3)	3	-4.9
9	(0,16,0)	(0,16,3)	3	-4.9
12	(18,16,0)	(18,16,3)	3	-4.9

Design Limit state:

Combo: 1.2D+1.4L

Nd: -29.04 ton

1-Check Local Buckling

$dw/tw = 15.58 < 37.44 \Rightarrow$ Compact Web

$c/tf = 3.06 < 10.91 \Rightarrow$ Compact Flange

2-Check Normal Stress

Section: IPE80

$\lambda = 285.71 > 100$

$f_c = 3.8 \text{ t/cm}^2 < F_c = 0.09 \text{ t/cm}^2$
