

Design Calculation Sheet for Project

Designer: Designer

Location: Cairo

City: Cairo

Country: Egypt

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- Design For Flexural and shear
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Secondary Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
44	(20,4,4)	(20,8,4)	4	0.04	0.04

Design Limit state:

Combo: 1*Dead + 1*Live

Md: 0.04 t.m

Vd: 0.04 ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: 0 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 15.58 < 81.98 \Rightarrow$ Compact Web

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

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 59.39 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

$f_{act} = 0.22 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$d_{act} = 0 \text{ cm} < d_{all} = 1.33 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 0.04$ 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)

$f = 0$ t/cm² & $q = 0$ t/cm² $\Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0$ t/cm² $< 1.1 * 0.2F_u = 0.79$ t/cm² \Rightarrow OK

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

$q = 0$ t/cm² & $q_{mt} = 0$ t/cm² $\Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0$ t/cm² $< 0.2F_u = 0.72$ t/cm² \Rightarrow OK

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0$ t/cm² $< 0.72 * F_y = 1.73$ t/cm² \Rightarrow OK

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

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
66	(8,10,4)	(12,10,4)	4	1.04	1.04
40	(18,0,4)	(18,4,4)	4	1.04	1.04
17	(2,4,4)	(2,8,4)	4	1.04	1.04
20	(4,4,4)	(4,8,4)	4	1.04	1.04
34	(14,0,4)	(14,4,4)	4	1.04	1.04
36	(14,8,4)	(14,12,4)	4	1.04	1.04
37	(16,0,4)	(16,4,4)	4	1.04	1.04
39	(16,8,4)	(16,12,4)	4	1.04	1.04
42	(18,8,4)	(18,12,4)	4	1.04	1.04

43	(20,0,4)	(20,4,4)	4	1.04	1.04
45	(20,8,4)	(20,12,4)	4	1.04	1.04
63	(10,5,4)	(14,5,4)	4	1.04	1.04
64	(10,7,4)	(14,7,4)	4	1.04	1.04
14	(0,4,4)	(0,8,4)	4	1.04	1.04
62	(6,6,4)	(10,6,4)	4	1.18	1.18

Design Limit state:

Combo: 1*Dead + 1*Live

Md: 1.18 t.m

Vd: 1.18 ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: -0.3 t/m'

Design Checks

1-Check Local Buckling

$dw/tw = 26.08 < 81.98 \Rightarrow$ Compact Web

$c/tf = 4.21 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$Lu_{act} = 0 \text{ m} < Lu_{max} = 105.86 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

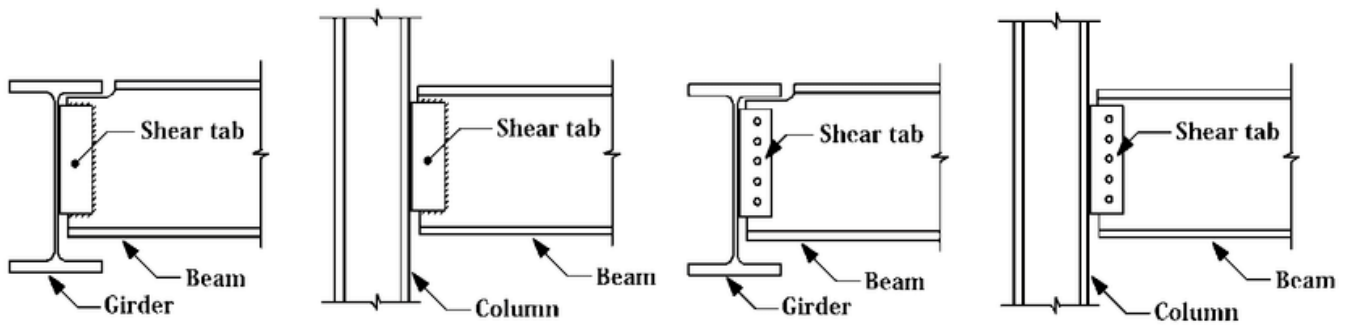
$f_{act} = 1.08 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.15 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 0.55 \text{ cm} < d_{all} = 1.33 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 1.18$ 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)

$f = 0.08$ t/cm² & $q = 0.05$ t/cm² $\Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.12$ t/cm² < $1.1 * 0.2F_u = 0.79$ t/cm² \Rightarrow OK

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

$q = 0.05$ t/cm² & $q_{mt} = 0.08$ t/cm² $\Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.1$ t/cm² < $0.2F_u = 0.72$ t/cm² \Rightarrow OK

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.1$ t/cm² < $0.72 * F_y = 1.73$ t/cm² \Rightarrow OK

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

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
65	(0,10,4)	(6,10,4)	6	2.35	1.57

Design Limit state:

Combo: 1*Dead + 1*Live

Md: 2.35 t.m

Vd: 1.57 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -0.3 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 29.65 < 81.98 \Rightarrow$ Compact Web

$c/t_f = 4.56 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 129.1 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

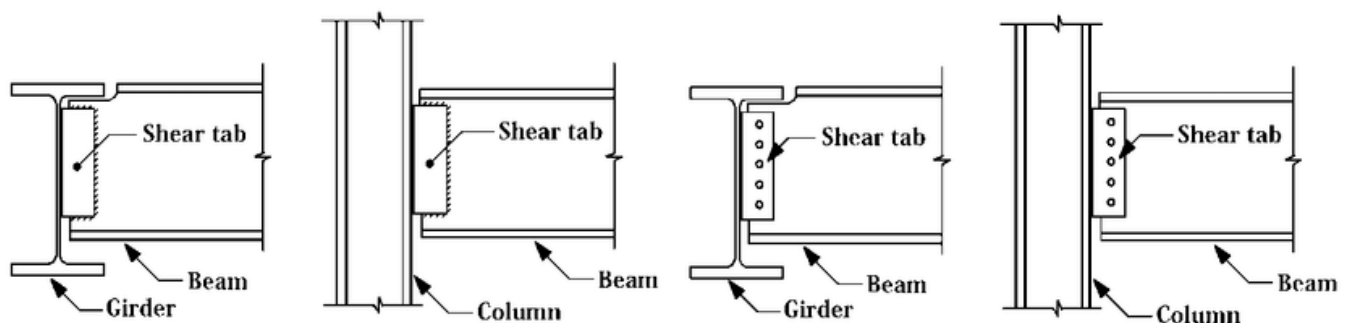
$f_{act} = 1.21 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.14 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 1.24 \text{ cm} < d_{all} = 2 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 1.57 \text{ ton}$

$R_{least} = 2.85 \text{ ton}$

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

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

$f = 0.11 \text{ t/cm}^2$ & $q = 0.07 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.17 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.07 \text{ t/cm}^2$ & $q_{mt} = 0.11 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.13 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.13 \text{ t/cm}^2 < 0.72 \cdot F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

Main Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
35	(14,4,4)	(14,8,4)	4	1.09	1.09
23	(6,4,4)	(6,8,4)	4	1.23	0.64

Design Limit state:

Combo: 1*Dead + 1*Live

Md: 1.23 t.m

Vd: 0.64 ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: -0.3 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 26.08 < 81.98 \Rightarrow \text{Compact Web}$

$c/t_f = 4.21 < 10.91 \Rightarrow \text{Compact Flange}$

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 105.86 \text{ m} \Rightarrow \text{Supported (No LTB)}$

3-Check Bending Stress

Section: IPE270

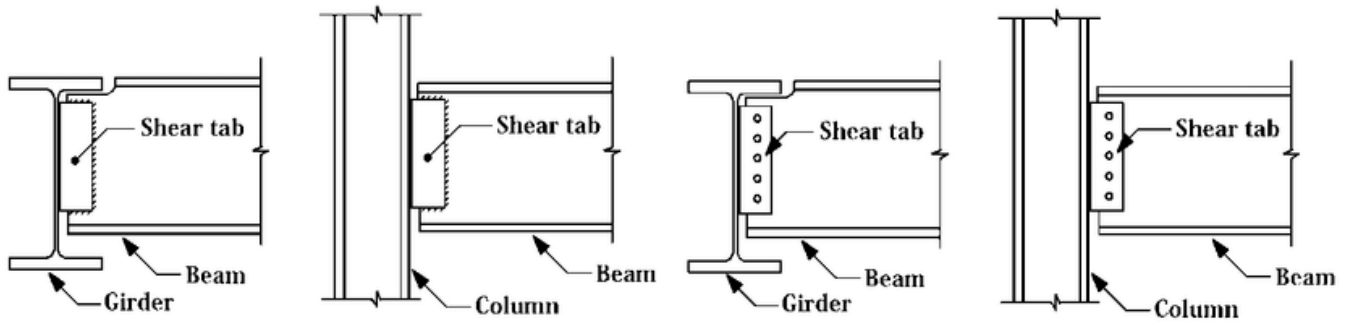
$f_{act} = 1.12 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.08 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$$d_{act} = 0.55 \text{ cm} < d_{all} = 1.33 \text{ cm}$$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$$V_d = 0.64 \text{ ton}$$

$$R_{least} = 2.85 \text{ ton}$$

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

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

$$f = 0.04 \text{ t/cm}^2 \text{ \& } q = 0.03 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.07 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

$$q = 0.03 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.04 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.05 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

$$f = (6 * V_d * e) / (t_p * L^2) = 0.05 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
33	(12,8,4)	(12,12,4)	4	2.09	1.57
27	(8,8,4)	(8,12,4)	4	2.09	1.57
6	(14,4,4)	(20,4,4)	6	2.25	1.15
3	(14,0,4)	(20,0,4)	6	2.25	1.15
12	(14,12,4)	(20,12,4)	6	2.25	1.15
9	(14,8,4)	(20,8,4)	6	2.25	1.15
4	(0,4,4)	(6,4,4)	6	2.25	1.15
29	(10,4,4)	(10,8,4)	4	2.27	1.68

10	(0,12,4)	(6,12,4)	6	2.41	1.61
15	(0,8,4)	(0,12,4)	4	2.61	1.83
24	(6,8,4)	(6,12,4)	4	2.61	1.83

Design Limit state:

Combo: 1*Dead + 1*Live

Md: 2.61 t.m

Vd: 1.83 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -0.2 t/m'

Design Checks

1-Check Local Buckling

$dw/tw = 29.65 < 81.98 \Rightarrow$ Compact Web

$c/tf = 4.56 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$Lu_{act} = 0 \text{ m} < Lu_{max} = 129.1 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

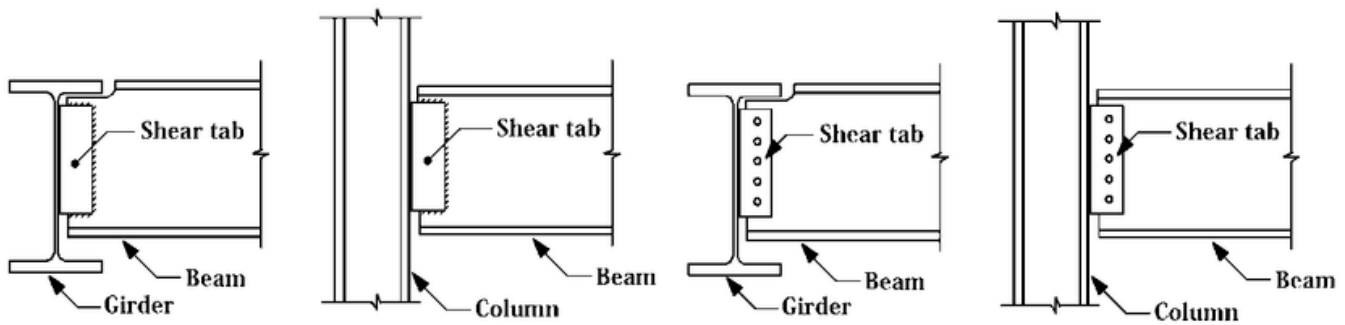
$f_{act} = 1.35 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.16 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 0.83 \text{ cm} < d_{all} = 2 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 1.83$ 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)

$f = 0.13 \text{ t/cm}^2$ & $q = 0.08 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.19 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.08 \text{ t/cm}^2$ & $q_{mt} = 0.13 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.15 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.15 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$

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)
11	(6,12,4)	(14,12,4)	8	3.42	1.71
7	(0,8,4)	(6,8,4)	6	4.5	2.65

Design Limit state:

Combo: 1*Dead + 1*Live

$M_d = 4.5 \text{ t.m}$

$V_d = 2.65$ ton

Service Limit State

Combo: LIVE

Span: 8 m

Load: -0.22 t/m'

Design Checks

1-Check Local Buckling

$dw/tw = 32.39 < 81.98 \Rightarrow$ Compact Web

$c/tf = 4.81 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 154.92 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

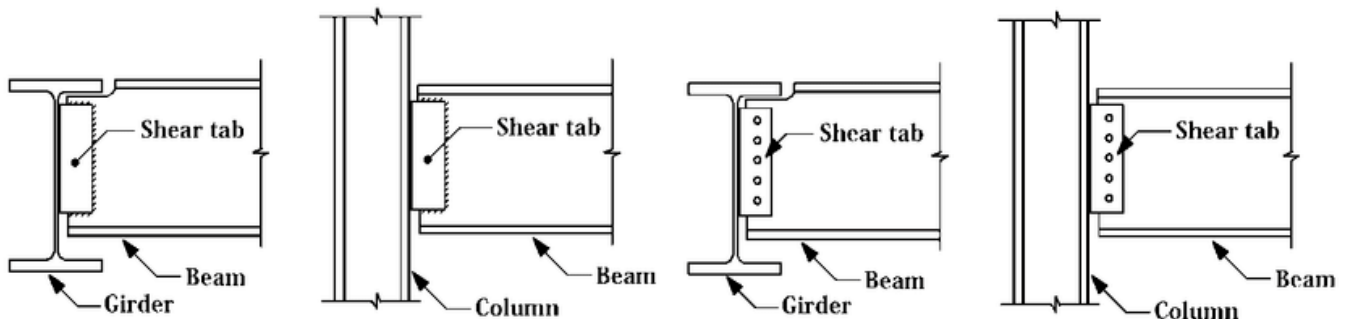
$f_{act} = 1.39 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.18 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$\delta_{act} = 1.47 \text{ cm} < \delta_{all} = 2.67 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 2.65 \text{ ton}$

$R_{least} = 2.85 \text{ ton}$

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

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

$f = 0.19 \text{ t/cm}^2$ & $q = 0.12 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.28 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.12 \text{ t/cm}^2$ & $q_{mt} = 0.19 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.22 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.22 \text{ t/cm}^2 < 0.72 \cdot F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$

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)
5	(6,4,4)	(14,4,4)	8	7.65	2.98
8	(6,8,4)	(14,8,4)	8	10.78	4.55

Design Limit state:

Combo: 1*Dead + 1*Live

Md: 10.78 t.m

Vd: 4.55 ton

Service Limit State

Combo: LIVE

Span: 8 m

Load: -0.41 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

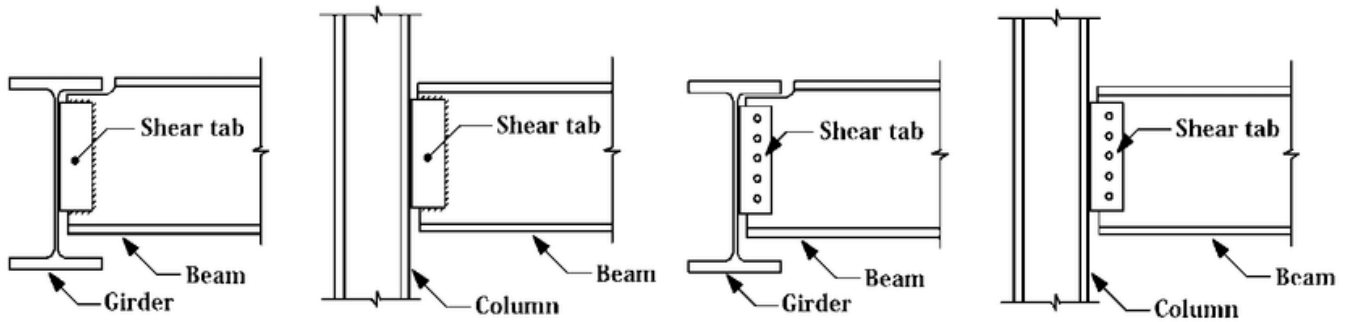
$f_{act} = 1.51 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.18 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$$d_{act} = 0.89 \text{ cm} < d_{all} = 2.67 \text{ cm}$$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$$V_d = 4.55 \text{ ton}$$

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

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

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

$$f = 0.21 \text{ t/cm}^2 \text{ \& } q = 0.17 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.36 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

$$q = 0.17 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.21 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.27 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

$$f = (6 * V_d * e) / (t_p * L^2) = 0.26 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

Columns

Column ID	Start Point	End Point	Height (m)	Nmax (ton)
55	(6,8,0)	(6,8,4)	4	-9.84
56	(14,8,0)	(14,8,4)	4	-8.01
52	(14,4,0)	(14,4,4)	4	-6.44
54	(0,8,0)	(0,8,4)	4	-5.7
59	(6,12,0)	(6,12,4)	4	-5.32
51	(6,4,0)	(6,4,4)	4	-4.94

60	(14,12,0)	(14,12,4)	4	-4.08
58	(0,12,0)	(0,12,4)	4	-3.61
53	(20,4,0)	(20,4,4)	4	-2.41
57	(20,8,0)	(20,8,4)	4	-2.41
48	(14,0,0)	(14,0,4)	4	-2.37
49	(20,0,0)	(20,0,4)	4	-2.37
50	(0,4,0)	(0,4,4)	4	-2.37
61	(20,12,0)	(20,12,4)	4	-2.37

Design Limit state:

Combo: 1*Dead + 1*Live

Nd: -9.84 ton

1-Check Local Buckling

$dw/tw = 36.23 < 37.44 \Rightarrow$ Compact Web

$c/tf = 5.68 < 10.91 \Rightarrow$ Compact Flange

2-Check Normal Stress

Section: IPE300

$\lambda = 119.4 > 100$

$f_c = 0.18 \text{ t/cm}^2 < F_c = 0.53 \text{ t/cm}^2$
