

Design Calculation Sheet for AUTRA

Designer: CEI

Location: Smart Village

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)
7	(20,0,6)	(20,4,6)	4	0.07	0.07

Design Limit state:

Combo: D+L

Md: 0.07 t.m

Vd: 0.07 ton

Service Limit State

Combo: LIVE

Span: 4 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

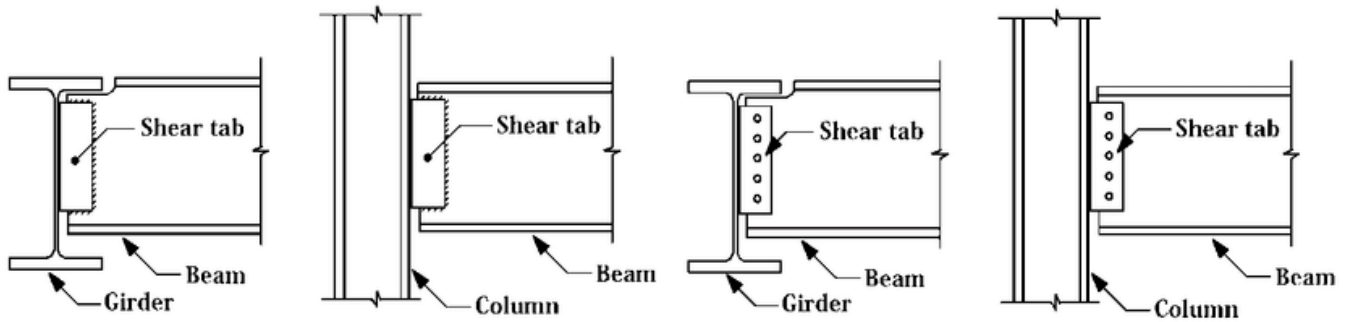
$f_{act} = 0.36 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.02 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

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

$V_d = 0.07$ 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)

$f = 0.01$ t/cm² & $q = 0$ t/cm² $\Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.01$ 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 & $q_{mt} = 0.01$ t/cm² $\Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.01$ t/cm² $< 0.2F_u = 0.72$ t/cm² \Rightarrow OK

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.01$ 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)
8	(20,4,6)	(20,8,6)	4	1.57	1.57
1	(0,0,6)	(0,4,6)	4	1.57	1.57

Design Limit state:

Combo: D+L

$M_d = 1.57$ t.m

$V_d = 1.57$ ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: -0.5 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 27.93 < 81.98 \Rightarrow$ Compact Web

$c/t_f = 4.36 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 117.48 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

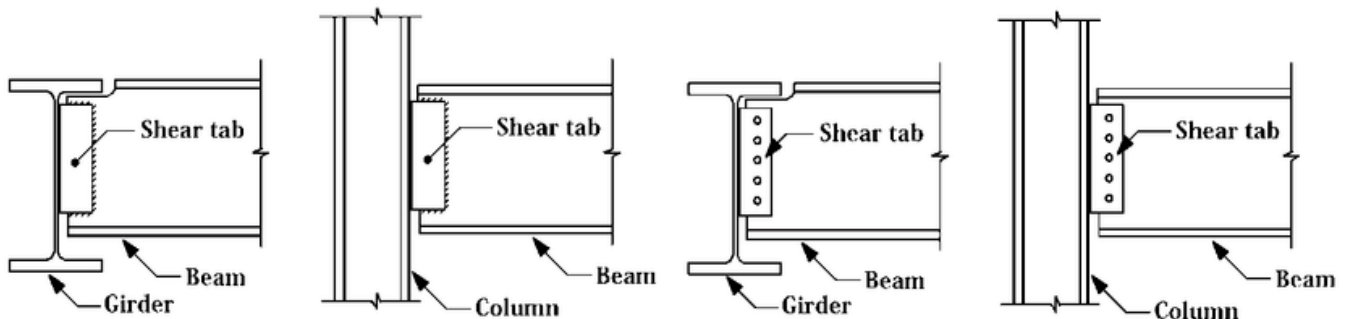
$f_{act} = 1.08 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$\delta_{act} = 0.6 \text{ cm} < \delta_{all} = 1.33 \text{ cm}$



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

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
13	(10,3,6)	(14,3,6)	4	3.04	3.04
12	(10,1,6)	(14,1,6)	4	3.04	3.04
10	(8,6,6)	(12,6,6)	4	3.04	3.04
6	(18,4,6)	(18,8,6)	4	3.07	3.07
5	(16,4,6)	(16,8,6)	4	3.07	3.07
4	(14,4,6)	(14,8,6)	4	3.07	3.07
3	(4,0,6)	(4,4,6)	4	3.07	3.07
2	(2,0,6)	(2,4,6)	4	3.07	3.07
11	(6,2,6)	(10,2,6)	4	3.13	3.13

Design Limit state:

Combo: D+L

Md: 3.13 t.m

Vd: 3.13 ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: -1 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 31.06 < 81.98 \Rightarrow \text{Compact Web}$

$c/t_f = 4.66 < 10.91 \Rightarrow \text{Compact Flange}$

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 142.01 \text{ m} \Rightarrow \text{Supported (No LTB)}$

3-Check Bending Stress

Section: IPE270

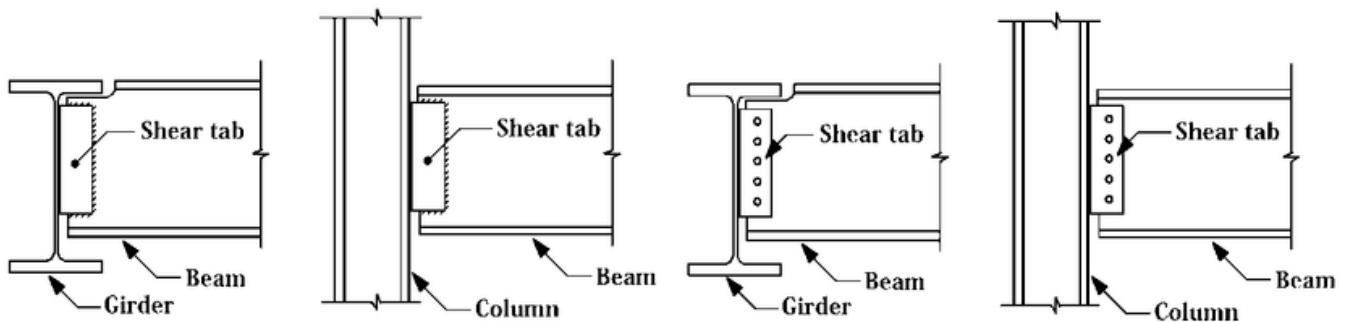
$$f_{act} = 1.24 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$$

4-Check Shear Stress

$$q_{act} = 0.24 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$$

5-Check Deflection

$$\delta_{act} = 0.57 \text{ cm} < \delta_{all} = 1.33 \text{ cm}$$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$$V_d = 3.13 \text{ ton}$$

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

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

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

$$f = 0.22 \text{ t/cm}^2 \text{ \& } q = 0.14 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.33 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

$$q = 0.14 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.22 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.26 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

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

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

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
9	(0,6,6)	(6,6,6)	6	6.91	4.61

Design Limit state:

Combo: D+L

Md: 6.91 t.m

Vd: 4.61 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -1 t/m'

Design Checks**1-Check Local Buckling**

$dw/tw = 36.23 < 81.98 \Rightarrow$ Compact Web

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

2-Check Lateral Torsional Buckling

$Lu_{act} = 0 \text{ m} < Lu_{max} = 193.65 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE300

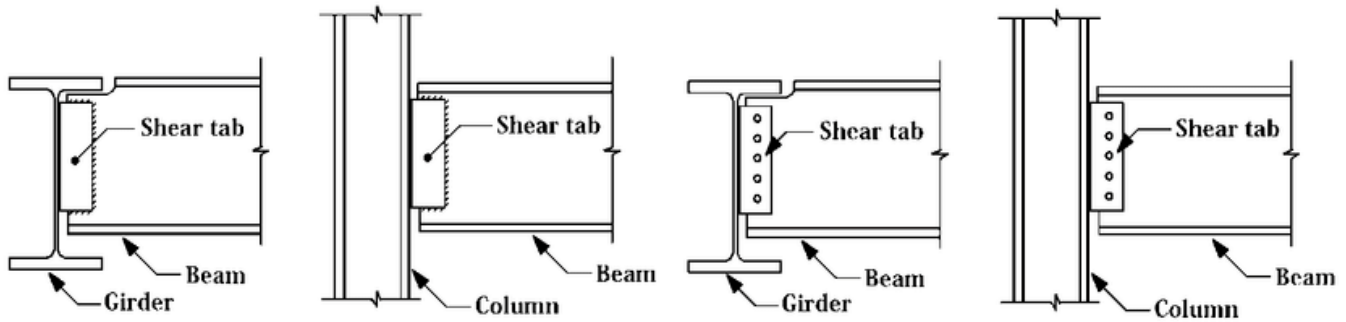
$f_{act} = 1.24 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.22 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 0.96 \text{ cm} < d_{all} = 2 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 4.61$ ton

$R_{least} = 3.07$ ton

$N = 3$ with Pitch = 70 mm & Full Layout: (35;70 70 35)

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

$f = 0.26$ t/cm² & $q = 0.18$ t/cm² $\Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.41$ t/cm² $< 1.1 * 0.2F_u = 0.79$ t/cm² \Rightarrow OK

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

$q = 0.18$ t/cm² & $q_{mt} = 0.26$ t/cm² $\Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.32$ t/cm² $< 0.2F_u = 0.72$ t/cm² \Rightarrow OK

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.31$ t/cm² $< 0.72 * F_y = 1.73$ t/cm² \Rightarrow OK

Plate Layout $\Rightarrow L = 210$ mm & $t_p = 10$ mm & $S_w = 6$ mm

Main Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
10	(14,0,6)	(20,0,6)	6	0.16	0.11

Design Limit state:

Combo: D+L

$M_d = 0.16$ t.m

$V_d = 0.11$ ton

Service Limit State

Combo: LIVE

Span: 6 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

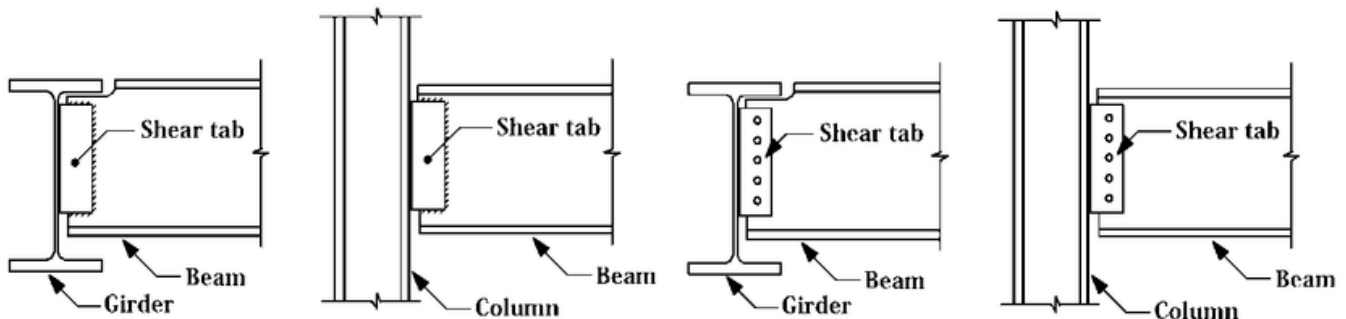
$f_{act} = 0.81 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.04 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

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

$V_d = 0.11 \text{ ton}$

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

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

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

$f = 0.01 \text{ t/cm}^2$ & $q = 0 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.01 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0 \text{ t/cm}^2$ & $q_{mt} = 0.01 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.01 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.01 \text{ t/cm}^2 < 0.72 \cdot F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$

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	(8,4,6)	(8,8,6)	4	3.12	1.59
4	(12,4,6)	(12,8,6)	4	3.12	1.59
1	(14,0,6)	(14,4,6)	4	3.12	3.12
3	(6,0,6)	(6,4,6)	4	3.2	1.64
14	(0,8,6)	(6,8,6)	6	3.54	2.36

Design Limit state:

Combo: D+L

Md: 3.54 t.m

Vd: 2.36 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -0.5 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 32.39 < 81.98 \Rightarrow \text{Compact Web}$

$c/t_f = 4.81 < 10.91 \Rightarrow \text{Compact Flange}$

2-Check Lateral Torsional Buckling

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

3-Check Bending Stress

Section: IPE270

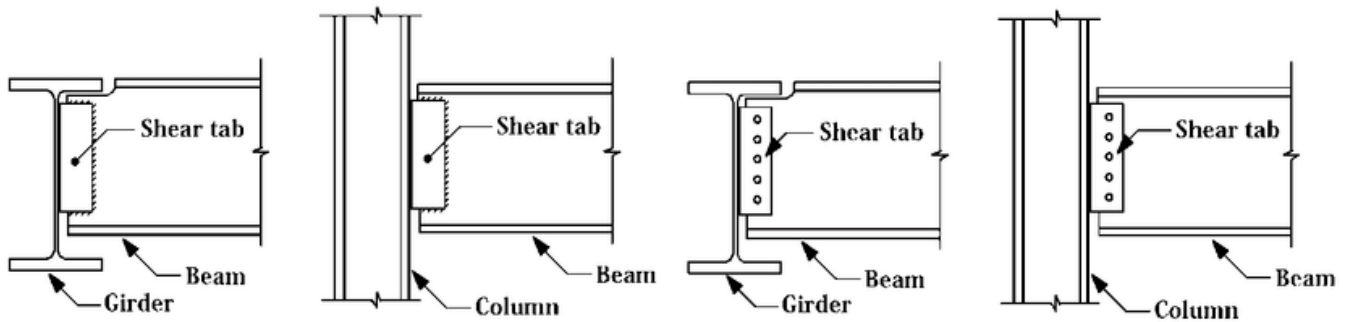
$f_{act} = 1.09 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$$d_{act} = 1.03 \text{ cm} < d_{all} = 2 \text{ cm}$$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$$V_d = 2.36 \text{ ton}$$

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

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

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

$$f = 0.17 \text{ t/cm}^2 \text{ \& } q = 0.11 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.25 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

$$q = 0.11 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.17 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.2 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

$$f = (6 * V_d * e) / (t_p * L^2) = 0.2 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
7	(0,4,6)	(0,8,6)	4	4.68	2.38
6	(6,4,6)	(6,8,6)	4	4.68	2.38
2	(10,0,6)	(10,4,6)	4	6.25	4.68
16	(14,8,6)	(20,8,6)	6	6.31	3.18
13	(14,4,6)	(20,4,6)	6	6.31	3.18
8	(0,0,6)	(6,0,6)	6	6.31	3.18

Design Limit state:

Combo: D+L

Md: 6.31 t.m

Vd: 3.18 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -0.67 t/m'

Design Checks**1-Check Local Buckling**

$dw/tw = 34.73 < 81.98 \Rightarrow$ Compact Web

$c/tf = 5.3 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$Lu_{act} = 0 \text{ m} < Lu_{max} = 174.28 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

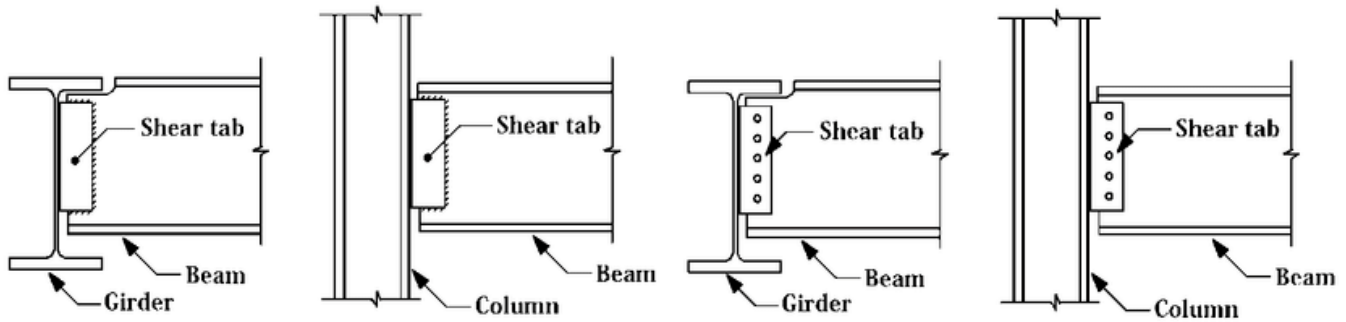
$f_{act} = 1.47 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$d_{act} = 0.93 \text{ cm} < d_{all} = 2 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 3.18$ 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)

$f = 0.22$ t/cm² & $q = 0.14$ t/cm² $\Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.34$ t/cm² $< 1.1 * 0.2F_u = 0.79$ t/cm² \Rightarrow OK

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

$q = 0.14$ t/cm² & $q_{mt} = 0.22$ t/cm² $\Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.27$ t/cm² $< 0.2F_u = 0.72$ t/cm² \Rightarrow OK

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.27$ 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)
15	(6,8,6)	(14,8,6)	8	9.48	4.74
9	(6,0,6)	(14,0,6)	8	9.66	2.49
11	(0,4,6)	(6,4,6)	6	9.68	5.43

Design Limit state:

Combo: D+L

$M_d = 9.68$ t.m

$V_d = 5.43$ ton

Service Limit State

Combo: LIVE

Span: 8 m

Load: -0.75 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

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

3-Check Bending Stress

Section: IPE330

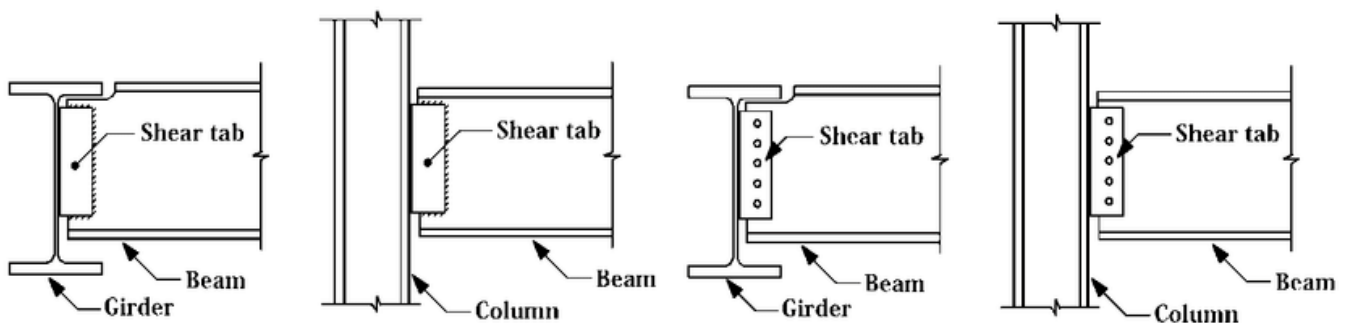
$f_{act} = 1.36 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.22 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 1.62 \text{ cm} < d_{all} = 2.67 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 5.43 \text{ ton}$

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

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

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

$f = 0.25 \text{ t/cm}^2$ & $q = 0.2 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.43 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79$

$t/cm^2 \Rightarrow OK$

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

$q = 0.2 t/cm^2$ & $q_{mt} = 0.25 t/cm^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.32 t/cm^2 < 0.2F_u = 0.72 t/cm^2 \Rightarrow OK$

4-Check Thickness of Plate

$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.31 t/cm^2 < 0.72 \cdot F_y = 1.73 t/cm^2 \Rightarrow OK$

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)
12	(6,4,6)	(14,4,6)	8	18.84	7.08

Design Limit state:

Combo: D+L

Md: 18.84 t.m

Vd: 7.08 ton

Service Limit State

Combo: LIVE

Span: 8 m

Load: -1.12 t/m'

Design Checks

1-Check Local Buckling

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

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

2-Check Lateral Torsional Buckling

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

3-Check Bending Stress

Section: IPE450

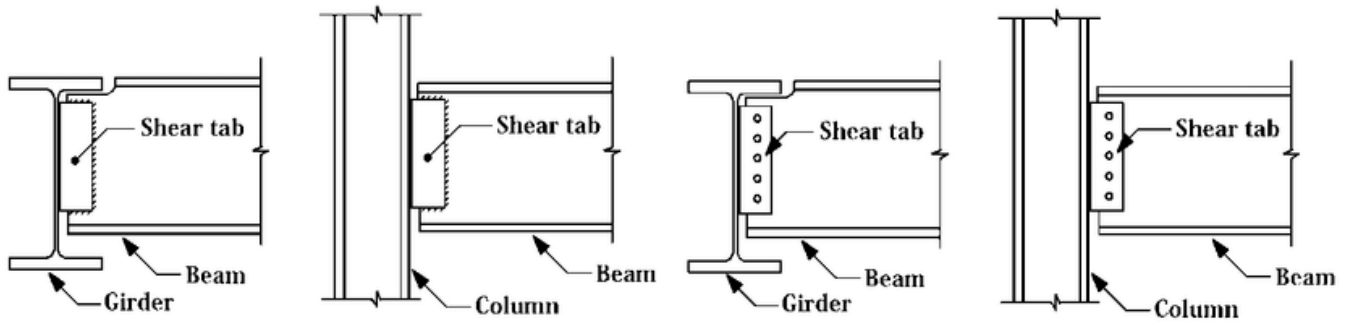
$f_{act} = 1.26 t/cm^2 < F_b = 1.54 t/cm^2$

4-Check Shear Stress

$q_{act} = 0.17 t/cm^2 < q_{all} = 0.84 t/cm^2$

5-Check Deflection

$$d_{act} = 0.85 \text{ cm} < d_{all} = 2.67 \text{ cm}$$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$$V_d = 7.08 \text{ ton}$$

$$R_{least} = 4.06 \text{ ton}$$

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

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

$$f = 0.18 \text{ t/cm}^2 \text{ \& } q = 0.19 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.38 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

$$q = 0.19 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.18 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.26 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

$$f = (6 * V_d * e) / (t_p * L^2) = 0.21 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

Columns

Column ID	Start Point	End Point	Height (m)	Nmax (ton)
6	(6,4,0)	(6,4,6)	6	-16.78
7	(14,4,0)	(14,4,6)	6	-16.7
11	(14,8,0)	(14,8,6)	6	-11.24
10	(6,8,0)	(6,8,6)	6	-9.73
5	(0,4,0)	(0,4,6)	6	-9.63
2	(6,0,0)	(6,0,6)	6	-7.56

3	(14,0,0)	(14,0,6)	6	-5.96
8	(20,4,0)	(20,4,6)	6	-5.08
12	(20,8,0)	(20,8,6)	6	-5.01
1	(0,0,0)	(0,0,6)	6	-5.01
9	(0,8,0)	(0,8,6)	6	-4.99
4	(20,0,0)	(20,0,6)	6	-0.43

Design Limit state:

Combo: D+L

Nd: -16.78 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

$\lambda = 179.1 > 100$

$f_c = 0.31 \text{ t/cm}^2 < F_c = 0.23 \text{ t/cm}^2$
