

Design Calculation Sheet for ITI40

Designer: Civil

Location: Alex

City: Alex

Country: Japan

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Secondary Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
22	(20,4,6)	(20,8,6)	4	1.54	1.54
21	(20,0,6)	(20,4,6)	4	1.54	1.54
2	(0,4,6)	(0,8,6)	4	1.54	1.54
1	(0,0,6)	(0,4,6)	4	1.54	1.54

Design Limit state:

Combo: D+L

Md: 1.54 t.m

Vd: 1.54 ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: -0.5 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

$f_{act} = 1.42 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.19 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 0.91 \text{ cm} < d_{all} = 1.33 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 1.54$ 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)

$f = 0.11$ t/cm² & $q = 0.07$ t/cm² $\Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.16$ t/cm² $< 1.1 \cdot 0.2F_u = 0.79$ t/cm² \Rightarrow OK

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

$q = 0.07$ t/cm² & $q_{mt} = 0.11$ t/cm² $\Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.13$ t/cm² $< 0.2F_u = 0.72$ t/cm² \Rightarrow OK

4-Check Thickness of Plate

$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.13$ t/cm² $< 0.72 \cdot F_y = 1.73$ 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)
18	(16,4,6)	(16,8,6)	4	3.04	3.04
8	(6,4,6)	(6,8,6)	4	3.04	3.04
20	(18,4,6)	(18,8,6)	4	3.04	3.04
3	(2,0,6)	(2,4,6)	4	3.04	3.04
4	(2,4,6)	(2,8,6)	4	3.04	3.04
5	(4,0,6)	(4,4,6)	4	3.04	3.04
6	(4,4,6)	(4,8,6)	4	3.04	3.04
7	(6,0,6)	(6,4,6)	4	3.04	3.04
9	(8,0,6)	(8,4,6)	4	3.04	3.04

10	(8,4,6)	(8,8,6)	4	3.04	3.04
12	(10,4,6)	(10,8,6)	4	3.04	3.04
13	(12,0,6)	(12,4,6)	4	3.04	3.04
14	(12,4,6)	(12,8,6)	4	3.04	3.04
15	(14,0,6)	(14,4,6)	4	3.04	3.04
16	(14,4,6)	(14,8,6)	4	3.04	3.04
11	(10,0,6)	(10,4,6)	4	3.04	3.04

Design Limit state:

Combo: D+L

Md: 3.04 t.m

Vd: 3.04 ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: -1 t/m'

Design Checks

1-Check Local Buckling

$dw/tw = 31.06 < 81.98 \Rightarrow$ Compact Web

$c/tf = 4.66 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$Lu_{act} = 0 \text{ m} < Lu_{max} = 142.01 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

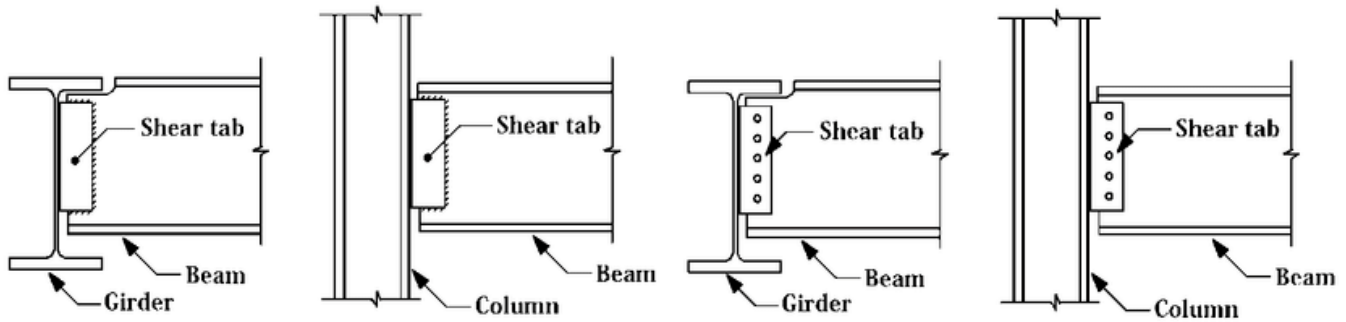
$f_{act} = 1.21 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

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



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 3.04$ 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)

$f = 0.21 \text{ t/cm}^2$ & $q = 0.14 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.32 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.14 \text{ t/cm}^2$ & $q_{mt} = 0.21 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.25 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

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

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)
17	(16,0,6)	(16,4,6)	4	5.04	5.04
19	(18,0,6)	(18,4,6)	4	5.04	5.04

Design Limit state:

Combo: D+L

$M_d = 5.04 \text{ t.m}$

$V_d = 5.04$ ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: -2 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 34.73 < 81.98 \Rightarrow$ Compact Web

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

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 174.28 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

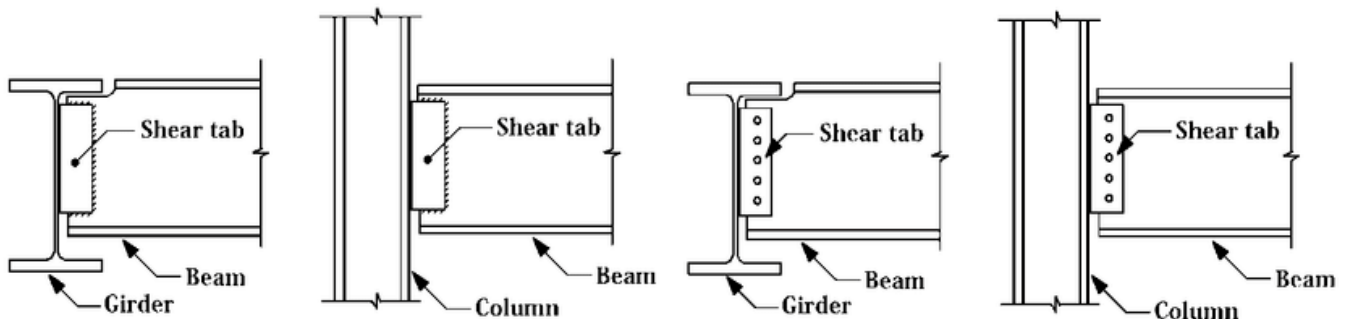
$f_{act} = 1.18 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.28 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

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



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 5.04 \text{ ton}$

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

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

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

$f = 0.35 \text{ t/cm}^2$ & $q = 0.23 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.53 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.23 \text{ t/cm}^2$ & $q_{mt} = 0.35 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.42 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.42 \text{ t/cm}^2 < 0.72 \cdot F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$

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)
9	(14,8,6)	(20,8,6)	6	6.25	3.15
7	(0,8,6)	(6,8,6)	6	6.25	3.15
1	(0,0,6)	(6,0,6)	6	6.25	3.15

Design Limit state:

Combo: D+L

Md: 6.25 t.m

Vd: 3.15 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -0.67 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 34.73 < 81.98 \Rightarrow \text{Compact Web}$

$c/t_f = 5.3 < 10.91 \Rightarrow \text{Compact Flange}$

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 174.28 \text{ m} \Rightarrow \text{Supported (No LTB)}$

3-Check Bending Stress

Section: IPE270

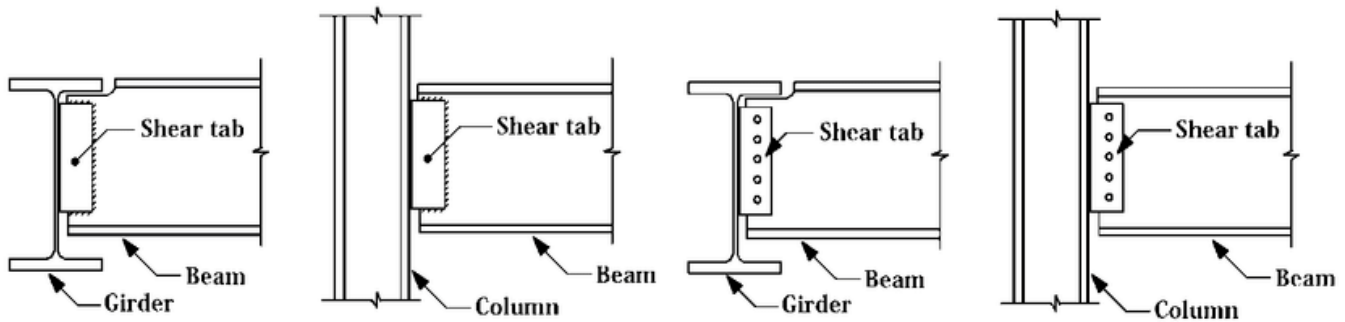
$f_{act} = 1.46 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

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

$$V_d = 3.15 \text{ ton}$$

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

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

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)
3	(14,0,6)	(20,0,6)	6	10.25	5.15
4	(0,4,6)	(6,4,6)	6	12.34	6.2
8	(6,8,6)	(14,8,6)	8	12.47	4.71
2	(6,0,6)	(14,0,6)	8	12.47	4.71

Design Limit state:

Combo: D+L

Md: 12.47 t.m

Vd: 4.71 ton

Service Limit State

Combo: LIVE

Span: 8 m

Load: -0.75 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 38.65 < 81.98 \Rightarrow$ Compact Web

$c/t_f = 5.38 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 219.47 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE360

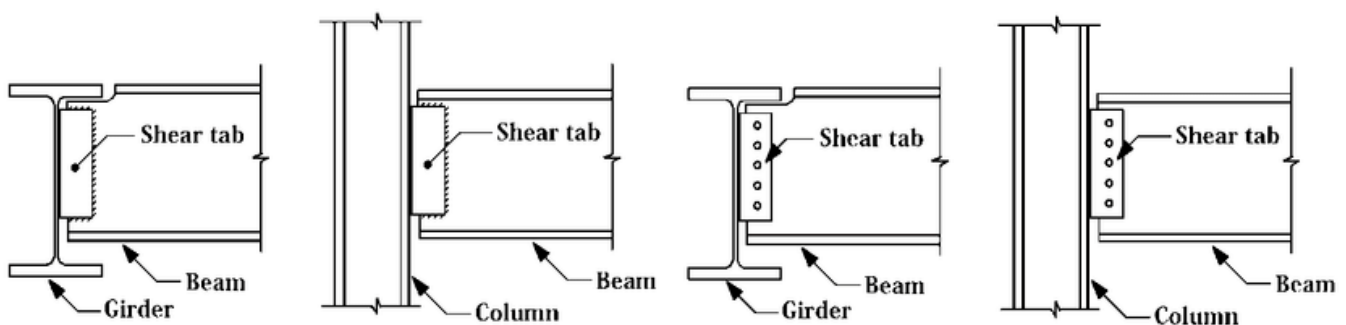
$f_{act} = 1.38 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$\delta_{act} = 1.17 \text{ cm} < \delta_{all} = 2.67 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

Vd= 4.71 ton

Rleast= 3.46 ton

N= 3 with Pitch= 84 mm & Full Layout: (42;84 84 42)

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

$f = 0.19 \text{ t/cm}^2$ & $q = 0.16 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.33 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.16 \text{ t/cm}^2$ & $q_{mt} = 0.19 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.24 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

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

Plate Layout $\Rightarrow L = 252 \text{ mm}$ & $t_p = 10 \text{ mm}$ & $S_w = 6 \text{ mm}$

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
6	(14,4,6)	(20,4,6)	6	16.34	8.2

Design Limit state:

Combo: D+L

Md: 16.34 t.m

Vd: 8.2 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -2 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 40.24 < 81.98 \Rightarrow \text{Compact Web}$

$c/t_f = 5.35 < 10.91 \Rightarrow \text{Compact Flange}$

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 232.38 \text{ m} \Rightarrow \text{Supported (No LTB)}$

3-Check Bending Stress

Section: IPE400

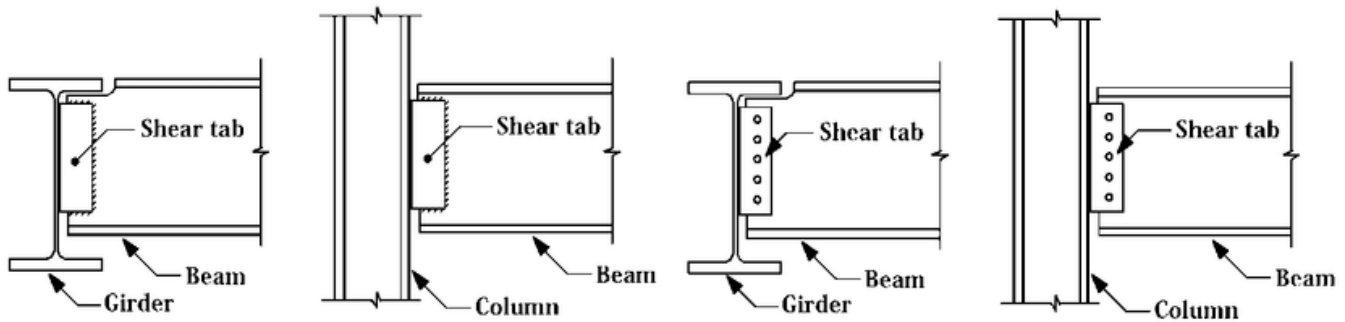
$f_{act} = 1.41 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$$\delta_{act} = 0.69 \text{ cm} < \delta_{all} = 2 \text{ cm}$$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$$V_d = 8.2 \text{ ton}$$

$$R_{least} = 3.72 \text{ ton}$$

$$N = 3 \text{ with Pitch} = 93 \text{ mm \& Full Layout: (46;93 93 47.5)}$$

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

$$f = 0.26 \text{ t/cm}^2 \& q = 0.25 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.5 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

$$q = 0.25 \text{ t/cm}^2 \& q_{mt} = 0.26 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.36 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

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

$$\text{Plate Layout} \Rightarrow L = 280 \text{ mm \& } t_p = 10 \text{ mm \& } S_w = 6 \text{ mm}$$

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
5	(6,4,6)	(14,4,6)	8	24.65	9.28

Design Limit state:

Combo: D+L

Md: 24.65 t.m

Vd: 9.28 ton

Service Limit State

Combo: LIVE

Span: 8 m

Load: -1.5 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 42.75 < 81.98 \Rightarrow$ Compact Web

$c/t_f = 4.94 < 10.91 \Rightarrow$ Compact Flange

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 258.2 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE500

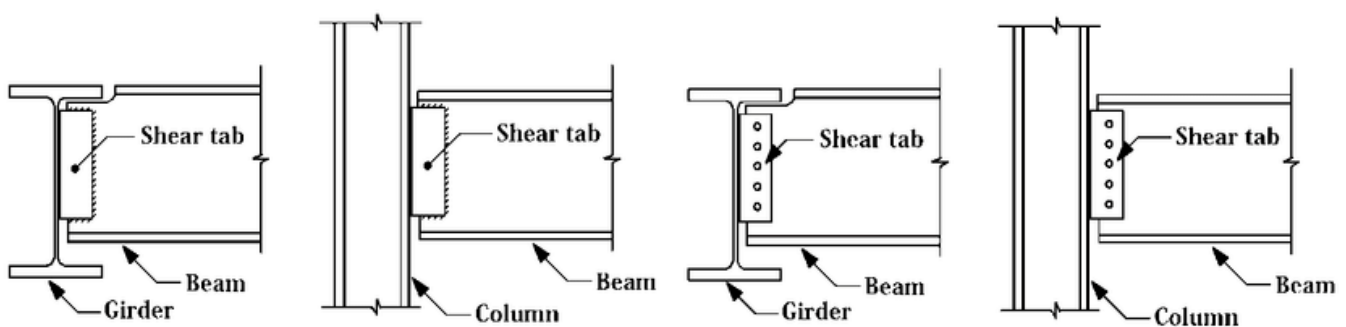
$f_{act} = 1.28 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$\delta_{act} = 0.79 \text{ cm} < \delta_{all} = 2.67 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

Vd= 9.28 ton

Rleast= 4.41 ton

N= 3 with Pitch= 116 mm & Full Layout: (58;116 116 60)

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

$f = 0.19 \text{ t/cm}^2$ & $q = 0.22 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.43 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.22 \text{ t/cm}^2$ & $q_{mt} = 0.19 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.29 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.23 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$

Plate Layout $\Rightarrow L = 350 \text{ mm}$ & $t_p = 10 \text{ mm}$ & $S_w = 6 \text{ mm}$

Columns

Column ID	Start Point	End Point	Height (m)	Nmax (ton)
7	(14,4,0)	(14,4,6)	6	-23.82
6	(6,4,0)	(6,4,6)	6	-21.82
3	(14,0,0)	(14,0,6)	6	-13.16
8	(20,4,0)	(20,4,6)	6	-11.54
2	(6,0,0)	(6,0,6)	6	-11.16
10	(6,8,0)	(6,8,6)	6	-11.16
11	(14,8,0)	(14,8,6)	6	-11.16
5	(0,4,0)	(0,4,6)	6	-9.54
4	(20,0,0)	(20,0,6)	6	-6.95
12	(20,8,0)	(20,8,6)	6	-4.95
1	(0,0,0)	(0,0,6)	6	-4.95
9	(0,8,0)	(0,8,6)	6	-4.95

Design Limit state:

Combo: D+L

Nd: -23.82 ton

1-Check Local Buckling

$d_w/t_w = 36.23 < 37.44 \Rightarrow \text{Compact Web}$

$c/t_f = 5.68 < 10.91 \Rightarrow \text{Compact Flange}$

2-Check Normal Stress

Section: IPE300

$\lambda = 179.1 > 100$

$f_c = 0.44 \text{ t/cm}^2 < F_c = 0.23 \text{ t/cm}^2$
