

Design Calculation Sheet for Iksd

Designer:

Location:

City:

Country:

Date: 2020-06-21 08:22:24

Table of Contents

1-Secondary Beams

- Design For Flexural and shear
- Design For serviceability
- Connections Design

2-Main Beams

- Design For Flexural and shear
- Design For serviceability
- Connections Design

3-Columns

- Design For Normal Stress

Secondary Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
1	(0,0,3)	(4,0,3)	4	1.51	1.51
2	(4,0,3)	(8,0,3)	4	1.51	1.51

Design Limit state:

Combo: D+L

Md: 1.51 t.m

Vd: 1.51 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

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

4-Check Shear Stress

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

5-Check Deflection

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



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 1.51$ 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 $< 1.1 * 0.2F_u = 0.79$ 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

$f = (6 * V_d * e) / (t_p * L^2) = 0.13$ 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)
21	(0,14.5,3)	(4,14.5,3)	4	3.01	3.01
3	(0,1,3)	(4,1,3)	4	3.01	3.01
4	(4,1,3)	(8,1,3)	4	3.01	3.01
5	(0,2,3)	(4,2,3)	4	3.01	3.01
6	(4,2,3)	(8,2,3)	4	3.01	3.01
7	(0,3,3)	(4,3,3)	4	3.01	3.01
8	(4,3,3)	(8,3,3)	4	3.01	3.01
22	(4,14.5,3)	(8,14.5,3)	4	3.01	3.01
10	(4,4,3)	(8,4,3)	4	3.76	3.76

9	(0,4,3)	(4,4,3)	4	3.76	3.76
12	(4,5.5,3)	(8,5.5,3)	4	4.51	4.51
13	(0,7,3)	(4,7,3)	4	4.51	4.51
14	(4,7,3)	(8,7,3)	4	4.51	4.51
11	(0,5.5,3)	(4,5.5,3)	4	4.51	4.51

Design Limit state:

Combo: D+L

Md: 4.51 t.m

Vd: 4.51 ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: -1 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

$Lu_{act} = 0 \text{ m} < Lu_{max} = 154.92 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE270

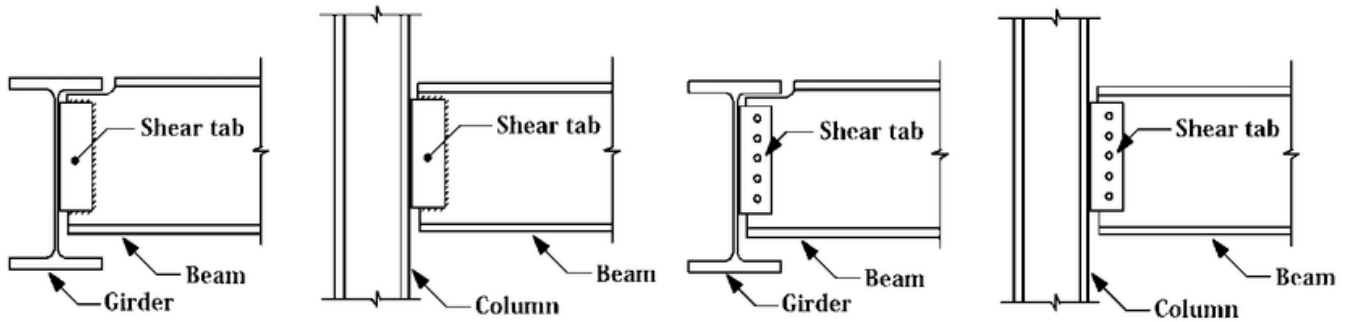
$f_{act} = 1.39 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.3 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 0.41 \text{ cm} < d_{all} = 1.33 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 4.51$ 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)

$f = 0.32 \text{ t/cm}^2$ & $q = 0.21 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.48 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.21 \text{ t/cm}^2$ & $q_{mt} = 0.32 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.38 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.38 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$

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)
15	(0,8.5,3)	(4,8.5,3)	4	5.26	5.26
16	(4,8.5,3)	(8,8.5,3)	4	5.26	5.26
17	(0,10.5,3)	(4,10.5,3)	4	6.01	6.01
18	(4,10.5,3)	(8,10.5,3)	4	6.01	6.01
19	(0,12.5,3)	(4,12.5,3)	4	6.01	6.01
20	(4,12.5,3)	(8,12.5,3)	4	6.01	6.01

Design Limit state:

Combo: D+L

Md: 6.01 t.m

Vd: 6.01 ton

Service Limit State

Combo: LIVE

Span: 4 m

Load: -1.75 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

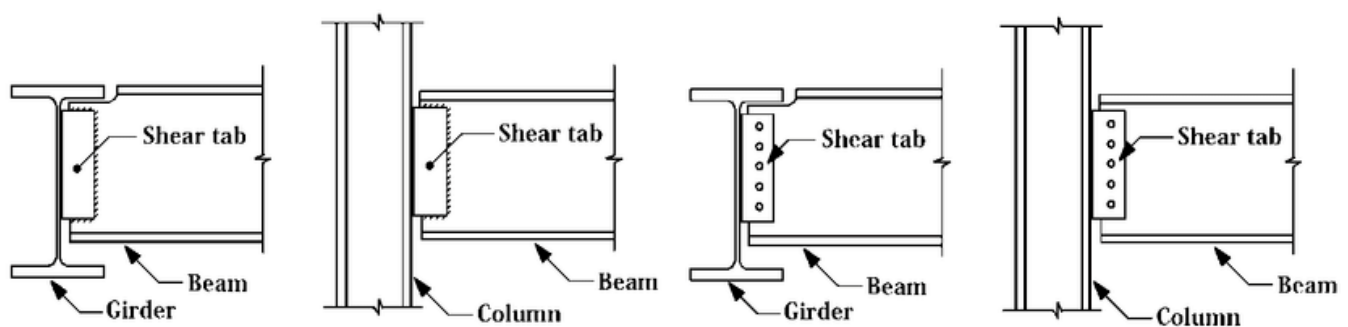
$f_{act} = 1.4 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.34 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$\delta_{act} = 0.48 \text{ cm} < \delta_{all} = 1.33 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

Vd= 6.01 ton

Rleast= 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)

$f = 0.42 \text{ t/cm}^2$ & $q = 0.27 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.63 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.27 \text{ t/cm}^2$ & $q_{mt} = 0.42 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.5 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.51 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

Main Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
7	(8,0,3)	(8,4,3)	4	6.04	4.53
1	(0,0,3)	(0,4,3)	4	6.04	4.53
8	(8,4,3)	(8,8.5,3)	4.5	6.78	4.53
2	(0,4,3)	(0,8.5,3)	4.5	6.78	4.53

Design Limit state:

Combo: D+L

Md: 6.78 t.m

Vd: 4.53 ton

Service Limit State

Combo: LIVE

Span: 4.5 m

Load: -1.33 t/m'

Design Checks

1-Check Local Buckling

$d_w/t_w = 36.23 < 81.98 \Rightarrow \text{Compact Web}$

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

2-Check Lateral Torsional Buckling

$L_{uact} = 0 \text{ m} < L_{umax} = 193.65 \text{ m} \Rightarrow \text{Supported (No LTB)}$

3-Check Bending Stress

Section: IPE300

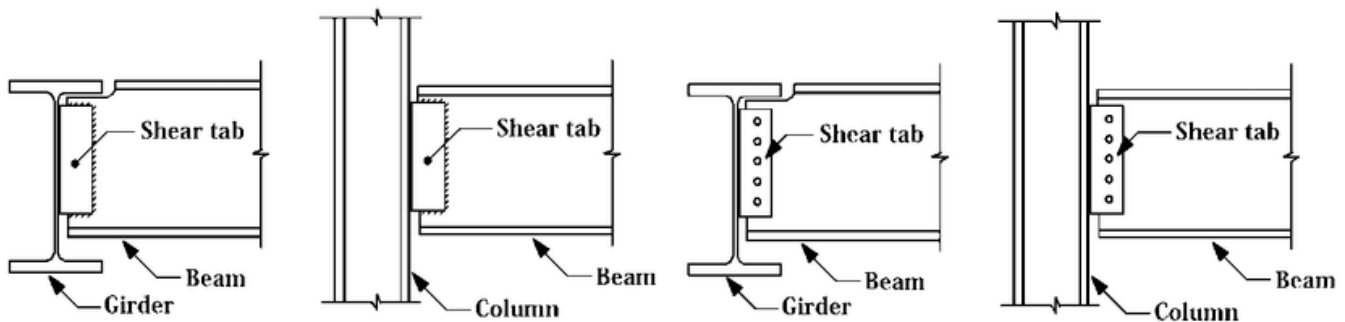
$$f_{act} = 1.22 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$$

4-Check Shear Stress

$$q_{act} = 0.21 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$$

5-Check Deflection

$$d_{act} = 0.41 \text{ cm} < d_{all} = 1.5 \text{ cm}$$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$$V_d = 4.53 \text{ ton}$$

$$R_{least} = 3.07 \text{ ton}$$

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

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

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

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

$$q = 0.18 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.26 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.31 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

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

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

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
9	(8,8.5,3)	(8,14.5,3)	6	12.05	6.03
3	(0,8.5,3)	(0,14.5,3)	6	12.05	6.03

4	(4,0,3)	(4,4,3)	4	12.06	9.05
5	(4,4,3)	(4,8.5,3)	4.5	13.55	9.04

Design Limit state:

Combo: D+L

Md: 13.55 t.m

Vd: 9.04 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -1.33 t/m'

Design Checks

1-Check Local Buckling

$dw/tw = 38.65 < 81.98 \Rightarrow$ Compact Web

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

2-Check Lateral Torsional Buckling

$Lu_{act} = 0 \text{ m} < Lu_{max} = 219.47 \text{ m} \Rightarrow$ Supported (No LTB)

3-Check Bending Stress

Section: IPE360

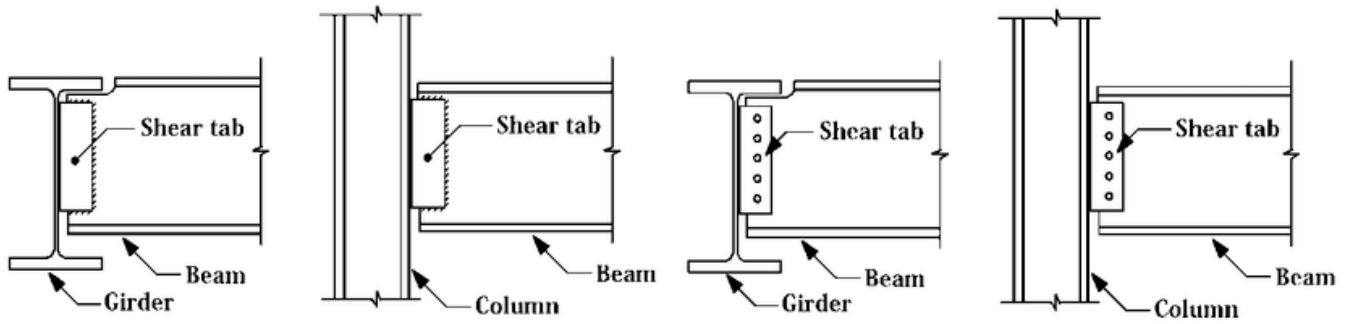
$f_{act} = 1.5 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

$q_{act} = 0.31 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

5-Check Deflection

$d_{act} = 0.66 \text{ cm} < d_{all} = 2 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 9.04$ ton

$R_{least} = 3.46$ ton

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

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

$f = 0.36 \text{ t/cm}^2$ & $q = 0.3 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.63 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.3 \text{ t/cm}^2$ & $q_{mt} = 0.36 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.47 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.43 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK}$

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	(4,8.5,3)	(4,14.5,3)	6	24.08	12.04

Design Limit state:

Combo: D+L

$M_d = 24.08 \text{ t.m}$

$V_d = 12.04$ ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -2.67 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

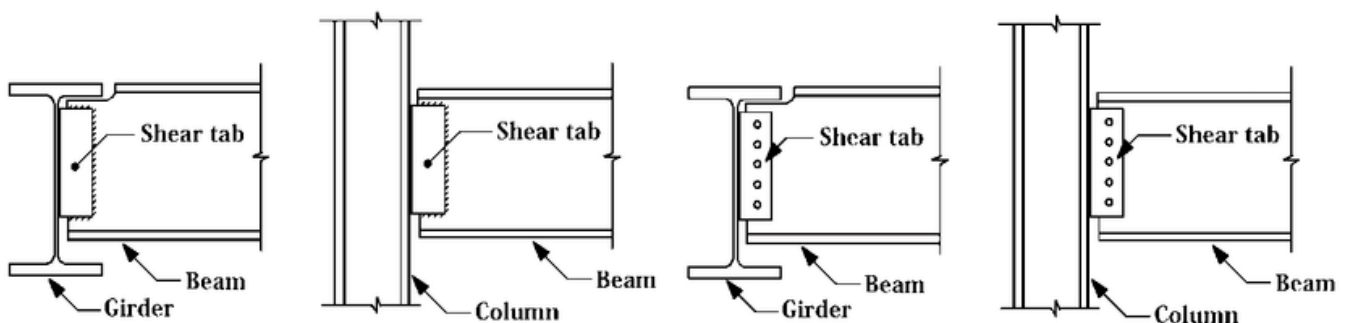
$f_{act} = 1.25 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$d_{act} = 0.44 \text{ cm} < d_{all} = 2 \text{ cm}$



Group Connection Design (Simple Shear Plate Connection)

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 12.04 \text{ ton}$

$R_{least} = 4.41 \text{ ton}$

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

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

$f = 0.25 \text{ t/cm}^2$ & $q = 0.29 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.55 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.29 \text{ t/cm}^2$ & $q_{mt} = 0.25 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.38 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

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

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	(4,8.5,0)	(4,8.5,3)	3	-31.62
6	(4,4,0)	(4,4,3)	3	-25.63
8	(4,14.5,0)	(4,14.5,3)	3	-18.08
3	(0,8.5,0)	(0,8.5,3)	3	-15.84
11	(8,8.5,0)	(8,8.5,3)	3	-15.84
2	(0,4,0)	(0,4,3)	3	-12.84
10	(8,4,0)	(8,4,3)	3	-12.84
5	(4,0,0)	(4,0,3)	3	-12.09
4	(0,14.5,0)	(0,14.5,3)	3	-9.06
12	(8,14.5,0)	(8,14.5,3)	3	-9.06
1	(0,0,0)	(0,0,3)	3	-6.06
9	(8,0,0)	(8,0,3)	3	-6.06

Design Limit state:

Combo: D+L

Nd: -31.62 ton

1-Check Local Buckling

$d_w/t_w = 15.58 < 37.44 \Rightarrow \text{Compact Web}$

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

2-Check Normal Stress

Section: IPE80

$\lambda = 285.71 > 100$

$f_c = 4.14 \text{ t/cm}^2 < F_c = 0.09 \text{ t/cm}^2$