

Secondary Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
20	(18,5,6)	(18,10,6)	5	3.21	2.57
19	(18,0,6)	(18,5,6)	5	3.21	2.57
2	(0,5,6)	(0,10,6)	5	3.21	2.57
1	(0,0,6)	(0,5,6)	5	3.21	2.57

Design Limit state:

Combo: 1.2D+1.4L

Md: 3.21 t.m

Vd: 2.57 ton

Service Limit State

Combo: LIVE

Span: 5 m

Load: -0.5 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

$f_{act} = 1.27 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$d_{act} = 0.7 \text{ cm} < d_{all} = 1.67 \text{ cm}$

Group Connection Design (Simple Shear Plate Connection)

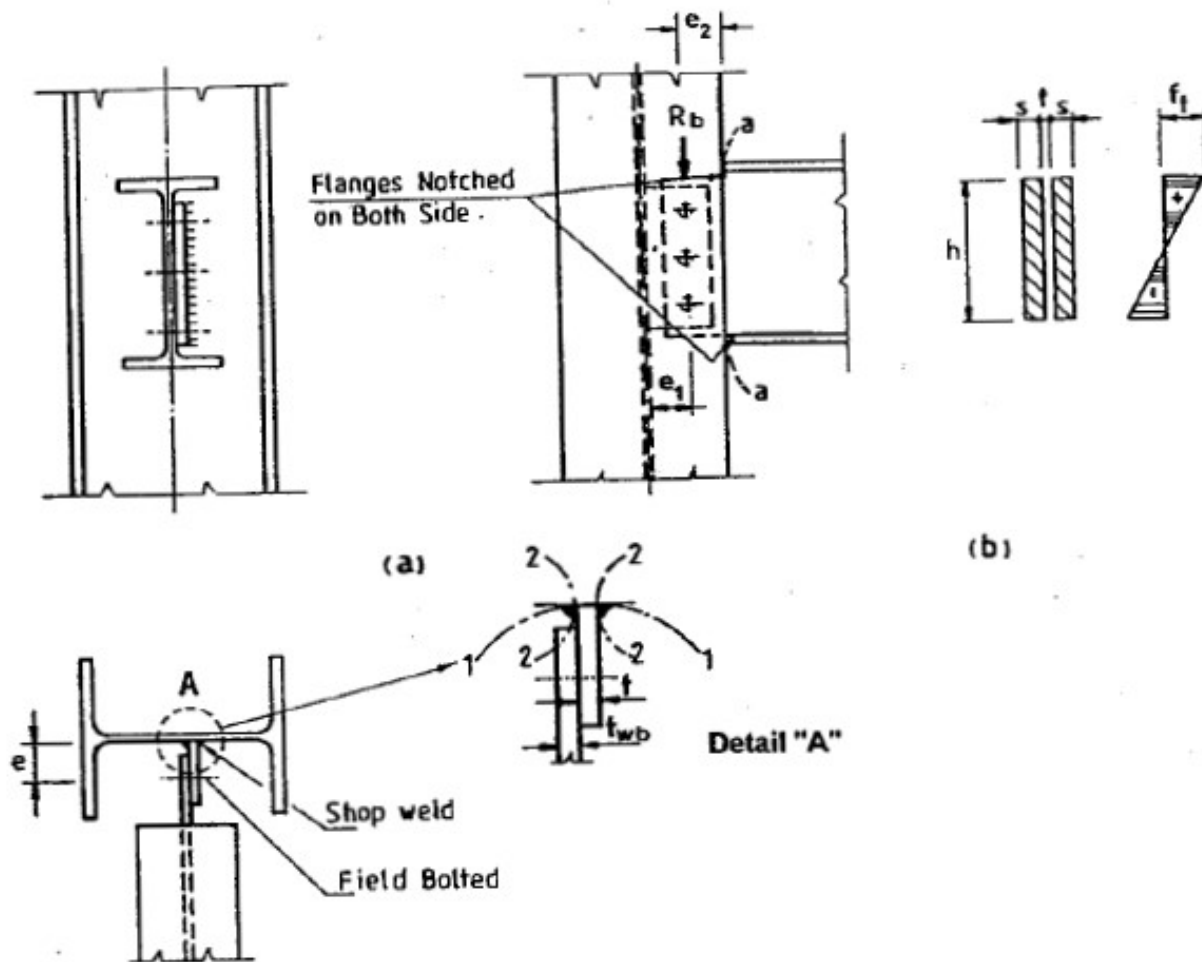


Fig. 4.8 Cleat Plate

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 2.57 \text{ ton}$

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

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

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

$$f = 0.18 \text{ t/cm}^2 \text{ \& } q = 0.12 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.27 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

$$q = 0.12 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.18 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.21 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

$$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.22 \text{ t/cm}^2 < 0.72 \cdot F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK IPE270}$$

Plate Layout => L = 189 mm & tp = 10 mm & Sw = 6 mm

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
16	(14,5,6)	(14,10,6)	5	6.33	5.07
15	(14,0,6)	(14,5,6)	5	6.33	5.07
14	(12,5,6)	(12,10,6)	5	6.33	5.07
13	(12,0,6)	(12,5,6)	5	6.33	5.07
12	(10,5,6)	(10,10,6)	5	6.33	5.07
11	(10,0,6)	(10,5,6)	5	6.33	5.07
17	(16,0,6)	(16,5,6)	5	6.33	5.07
9	(8,0,6)	(8,5,6)	5	6.33	5.07
8	(6,5,6)	(6,10,6)	5	6.33	5.07
7	(6,0,6)	(6,5,6)	5	6.33	5.07
6	(4,5,6)	(4,10,6)	5	6.33	5.07
5	(4,0,6)	(4,5,6)	5	6.33	5.07
4	(2,5,6)	(2,10,6)	5	6.33	5.07
3	(2,0,6)	(2,5,6)	5	6.33	5.07
18	(16,5,6)	(16,10,6)	5	6.33	5.07
10	(8,5,6)	(8,10,6)	5	6.33	5.07

Design Limit state:

Combo: 1.2D+1.4L

Md: 6.33 t.m

Vd: 5.07 ton

Service Limit State

Combo: LIVE

Span: 5 m

Load: -1 t/m'

Design Checks

1-Check Local Buckling

dw/tw= 34.73 < 81.98 => Compact Web

c/tf= 5.3 < 10.91 => 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

$f_{act} = 1.48 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$d_{act} = 0.67 \text{ cm} < d_{all} = 1.67 \text{ cm}$

Group Connection Design (Simple Shear Plate Connection)

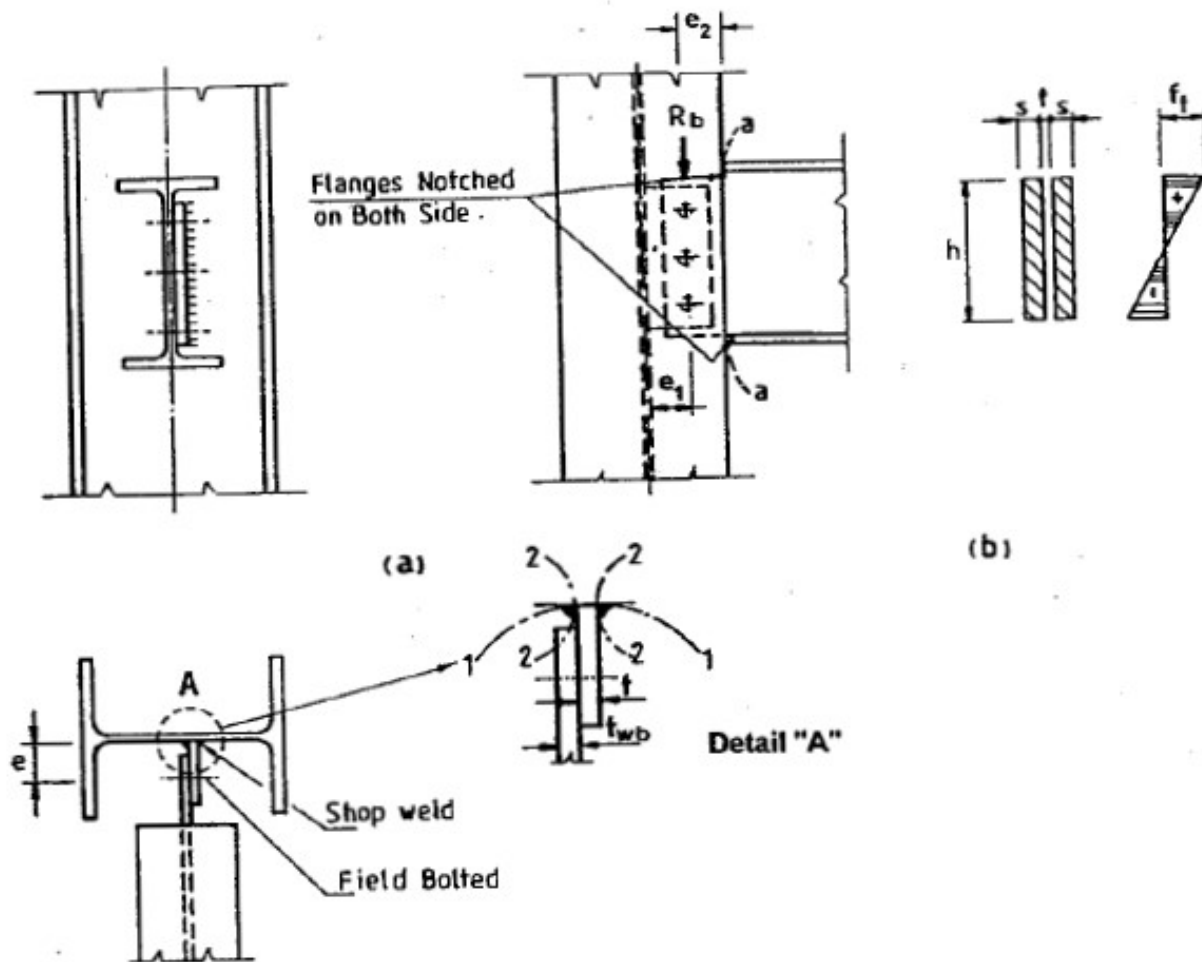


Fig. 4.8 Cleat Plate

1-Bolts Design

Bolts: M20 of Grade 8.8

Vd= 5.07 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).

$$f = 0.36 \text{ t/cm}^2 \text{ \& } q = 0.23 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.53 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

$$q = 0.23 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.36 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.42 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

$$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.43 \text{ t/cm}^2 < 0.72 \cdot F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK IPE270}$$

Plate Layout => L = 189 mm & tp = 10 mm & Sw = 6 mm

Main Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
9	(12,10,6)	(18,10,6)	6	10.33	5.2
8	(6,10,6)	(12,10,6)	6	10.33	5.2
7	(0,10,6)	(6,10,6)	6	10.33	5.2
3	(12,0,6)	(18,0,6)	6	10.33	5.2
2	(6,0,6)	(12,0,6)	6	10.33	5.2
1	(0,0,6)	(6,0,6)	6	10.33	5.2

Design Limit state:

Combo: 1.2D+1.4L

Md: 10.33 t.m

Vd: 5.2 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -0.83 t/m'

Design Checks

1-Check Local Buckling

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

$c/t_f = 5.64 < 10.91 \Rightarrow$ 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

$f_{act} = 1.45 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

4-Check Shear Stress

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

5-Check Deflection

$$d_{act} = 0.57 \text{ cm} < d_{all} = 2 \text{ cm}$$

Group Connection Design (Simple Shear Plate Connection)

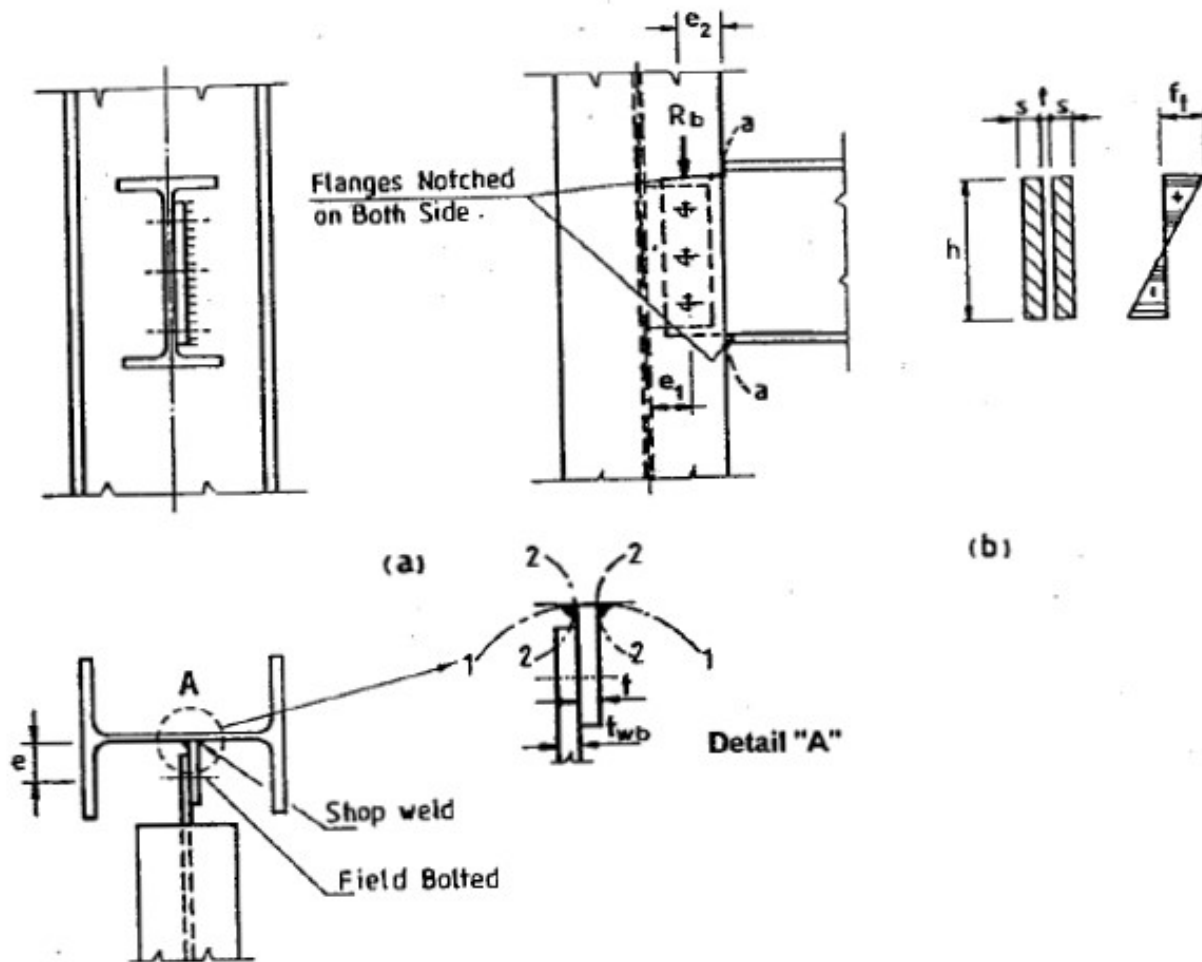


Fig. 4.8 Cleat Plate

1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 5.2 \text{ ton}$

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

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

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

$$f = 0.24 \text{ t/cm}^2 \text{ \& } q = 0.19 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.41 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$$

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

$$q = 0.19 \text{ t/cm}^2 \text{ \& } q_{mt} = 0.24 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.31 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$$

4-Check Thickness of Plate

$$f = (6 \cdot V_d \cdot e) / (t_p \cdot L^2) = 0.29 \text{ t/cm}^2 < 0.72 \cdot F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK IPE330}$$

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	(12,5,6)	(18,5,6)	6	20.46	10.26
5	(6,5,6)	(12,5,6)	6	20.46	10.26
4	(0,5,6)	(6,5,6)	6	20.46	10.26

Design Limit state:

Combo: 1.2D+1.4L

Md: 20.46 t.m

Vd: 10.26 ton

Service Limit State

Combo: LIVE

Span: 6 m

Load: -1.67 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

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

4-Check Shear Stress

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

5-Check Deflection

$$d_{act} = 0.4 \text{ cm} < d_{all} = 2 \text{ cm}$$

Group Connection Design (Simple Shear Plate Connection)

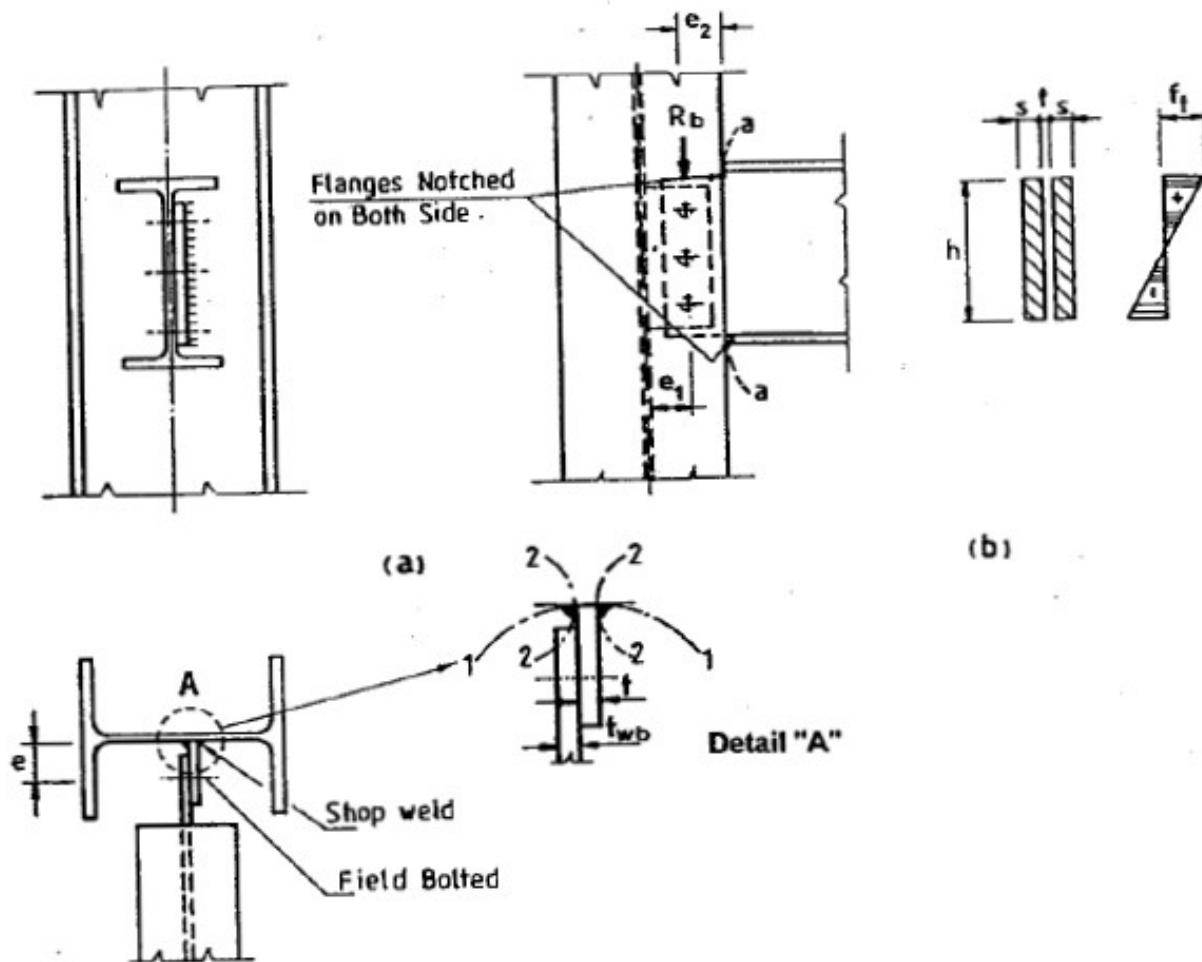


Fig. 4.8 Cleat Plate

1-Bolts Design

Bolts: M20 of Grade 8.8

Vd= 10.26 ton

Rleast= 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)

$f = 0.26 \text{ t/cm}^2$ & $q = 0.28 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.55 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

$q = 0.28 \text{ t/cm}^2$ & $q_{mt} = 0.26 \text{ t/cm}^2 \Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.38 \text{ t/cm}^2 < 0.2F_u = 0.72 \text{ t/cm}^2 \Rightarrow \text{OK}$

4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.31 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow \text{OK IPE450}$

Plate Layout => L = 315 mm & tp = 10 mm & Sw = 6 mm

Columns

Column ID	Start Point	End Point	Height (m)	Nmax (ton)
6	(6,5,0)	(6,5,6)	6	-30.97
7	(12,5,0)	(12,5,6)	6	-30.97
2	(6,0,0)	(6,0,6)	6	-15.77
3	(12,0,0)	(12,0,6)	6	-15.77
10	(6,10,0)	(6,10,6)	6	-15.77
11	(12,10,0)	(12,10,6)	6	-15.77
5	(0,5,0)	(0,5,6)	6	-15.7
8	(18,5,0)	(18,5,6)	6	-15.7
1	(0,0,0)	(0,0,6)	6	-8.07
4	(18,0,0)	(18,0,6)	6	-8.07
9	(0,10,0)	(0,10,6)	6	-8.07
12	(18,10,0)	(18,10,6)	6	-8.07

Design Limit state:

Combo: 1.2D+1.4L

Nd: -30.97 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

$\lambda = 179.1 > 100$

$f_c = 0.58 \text{ t/cm}^2 < F_c = 0.23 \text{ t/cm}^2$