

## Design Calculation Sheet for fgdg

Designer: fgf

Location: fgf

City: fgf

Country: gfg

Date: 2020-06-22 10:09:49

# 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)
8	(20,4,6)	(20,8,6)	4	0.07	0.07
7	(20,0,6)	(20,4,6)	4	0.07	0.07
1	(0,0,6)	(0,4,6)	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/cm<sup>2</sup> &  $q = 0$  t/cm<sup>2</sup>  $\Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.01$  t/cm<sup>2</sup>  $< 1.1 * 0.2F_u = 0.79$  t/cm<sup>2</sup>  $\Rightarrow$  OK

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

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

### 4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.01$  t/cm<sup>2</sup>  $< 0.72 * F_y = 1.73$  t/cm<sup>2</sup>  $\Rightarrow$  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)
13	(10,3,6)	(14,3,6)	4	3.04	3.04
12	(10,1,6)	(14,1,6)	4	3.04	3.04
11	(6,2,6)	(10,2,6)	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

**Design Limit state:**

Combo: D+L

Md: 3.07 t.m

Vd: 3.07 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

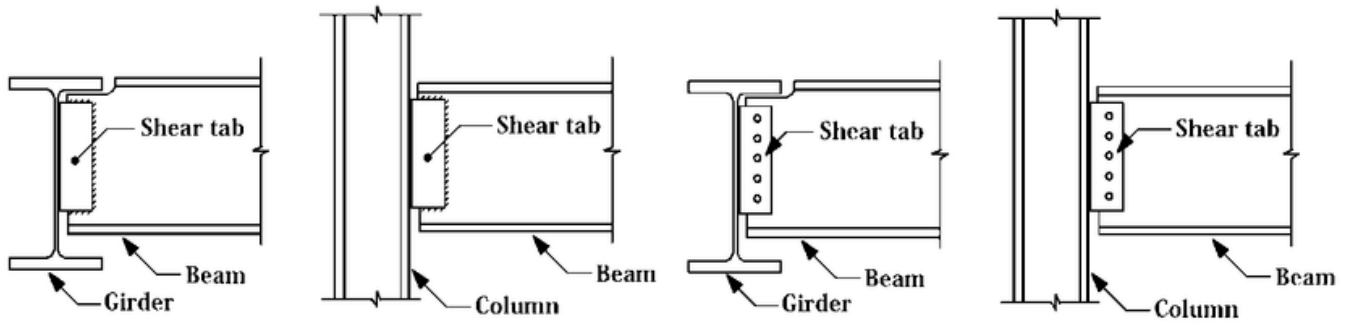
$f_{act} = 1.22 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

**4-Check Shear Stress**

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

**5-Check Deflection**

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



### Group Connection Design (Simple Shear Plate Connection)

#### 1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 3.07$  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)

$f = 0.22 \text{ t/cm}^2$  &  $q = 0.14 \text{ t/cm}^2 \Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.32 \text{ t/cm}^2 < 1.1 * 0.2F_u = 0.79 \text{ t/cm}^2 \Rightarrow \text{OK}$

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

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

#### 4-Check Thickness of Plate

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

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	6.85	4.57

#### Design Limit state:

Combo: D+L

Md: 6.85 t.m

Vd: 4.57 ton

#### Service Limit State

Combo: LIVE

Span: 6 m

Load: -1 t/m'

## Design Checks

### 1-Check Local Buckling

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

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

### 2-Check Lateral Torsional Buckling

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

### 3-Check Bending Stress

Section: IPE300

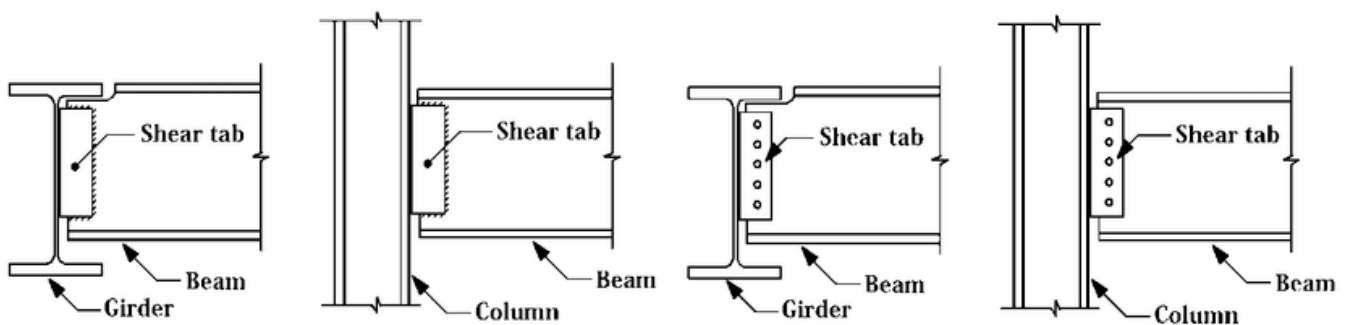
$f_{act} = 1.23 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

### 4-Check Shear Stress

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

### 5-Check Deflection

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



## Group Connection Design (Simple Shear Plate Connection)

### 1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 4.57 \text{ ton}$

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

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

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

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

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

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

#### 4-Check Thickness of Plate

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

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

## Main Beams

Beam ID	Start Point	End Point	Span (m)	Mmax (t.m)	Vmax (ton)
14	(0,8,6)	(6,8,6)	6	0.1	0.07
10	(14,0,6)	(20,0,6)	6	0.1	0.07

#### Design Limit state:

Combo: D+L

Md: 0.1 t.m

Vd: 0.07 ton

#### Service Limit State

Combo: LIVE

Span: 6 m

Load: 0 t/m'

#### Design Checks

##### 1-Check Local Buckling

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

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

##### 2-Check Lateral Torsional Buckling

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

##### 3-Check Bending Stress

Section: IPE270

$f_{act} = 0.5 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

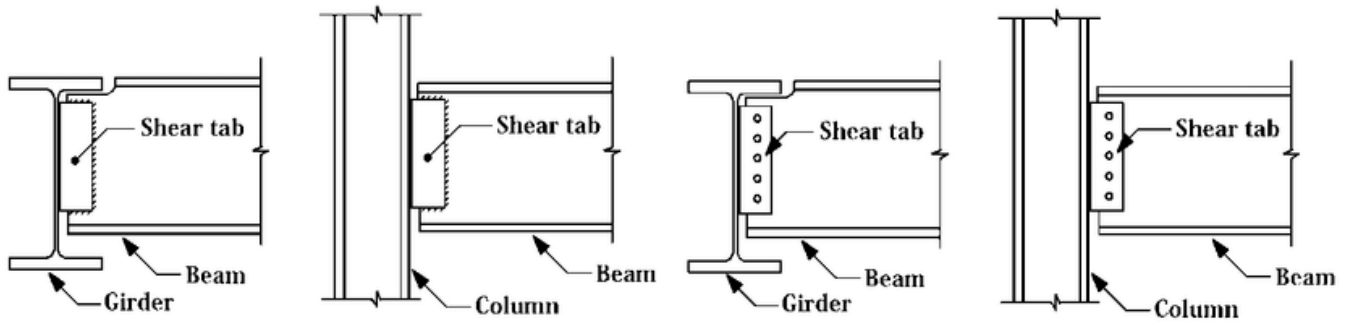
##### 4-Check Shear Stress

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

##### 5-Check Deflection



dact= 0 cm < dall= 2 cm



### Group Connection Design (Simple Shear Plate Connection)

#### 1-Bolts Design

Bolts: M20 of Grade 8.8

Vd= 0.07 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)

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

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

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

#### 4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.01 \text{ t/cm}^2 < 0.72 * F_y = 1.73 \text{ t/cm}^2 \Rightarrow$  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
3	(6,0,6)	(6,4,6)	4	3.12	1.59
1	(14,0,6)	(14,4,6)	4	3.12	3.12
15	(6,8,6)	(14,8,6)	8	3.37	1.68
7	(0,4,6)	(0,8,6)	4	4.64	2.36
6	(6,4,6)	(6,8,6)	4	4.64	2.36

#### Design Limit state:

Combo: D+L

Md: 4.64 t.m

Vd: 2.36 ton

### Service Limit State

Combo: LIVE

Span: 8 m

Load: -0.25 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

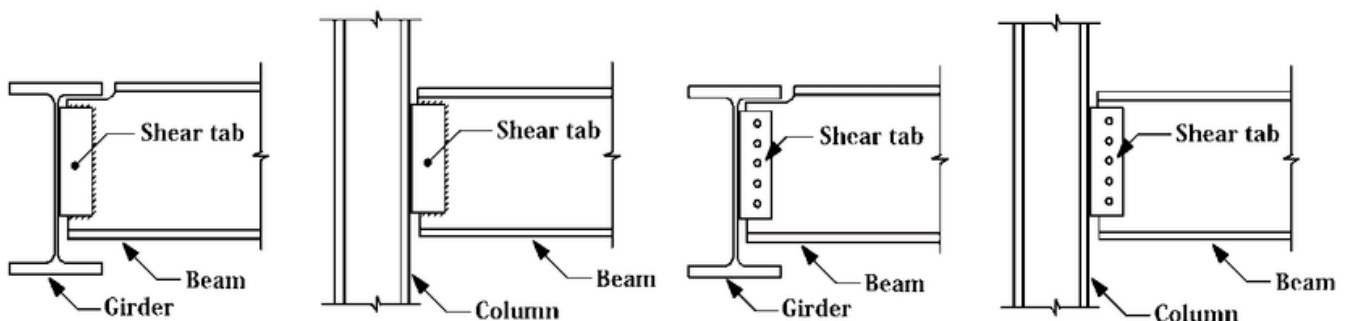
$f_{act} = 1.08 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

#### 4-Check Shear Stress

$q_{act} = 0.13 \text{ t/cm}^2 < q_{all} = 0.84 \text{ t/cm}^2$

#### 5-Check Deflection

$d_{act} = 1.1 \text{ cm} < d_{all} = 2.67 \text{ cm}$



### Group Connection Design (Simple Shear Plate Connection)

#### 1-Bolts Design

Bolts: M20 of Grade 8.8

Vd= 2.36 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)

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

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

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

#### 4-Check Thickness of Plate

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

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)
2	(10,0,6)	(10,4,6)	4	6.16	4.64
16	(14,8,6)	(20,8,6)	6	6.25	3.14
13	(14,4,6)	(20,4,6)	6	6.25	3.14
11	(0,4,6)	(6,4,6)	6	6.25	3.14
8	(0,0,6)	(6,0,6)	6	6.25	3.14

#### Design Limit state:

Combo: D+L

Md: 6.25 t.m

Vd: 3.14 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

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

### 3-Check Bending Stress

Section: IPE270

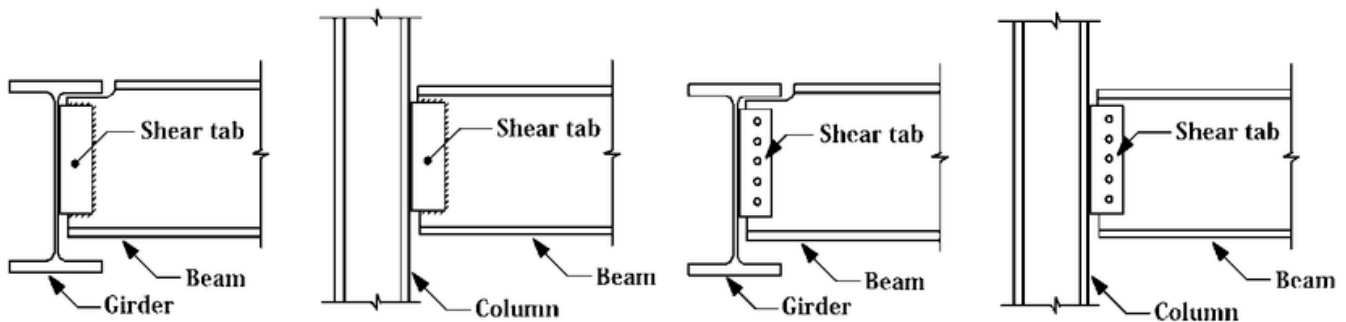
$f_{act} = 1.46 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

### 4-Check Shear Stress

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

### 5-Check Deflection

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



## Group Connection Design (Simple Shear Plate Connection)

### 1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 3.14 \text{ ton}$

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

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

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

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

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

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

### 4-Check Thickness of Plate

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

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	(6,0,6)	(14,0,6)	8	9.46	2.41
12	(6,4,6)	(14,4,6)	8	12.65	4

### Design Limit state:

Combo: D+L

Md: 12.65 t.m

Vd: 4 ton

### Service Limit State

Combo: LIVE

Span: 8 m

Load: -0.38 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

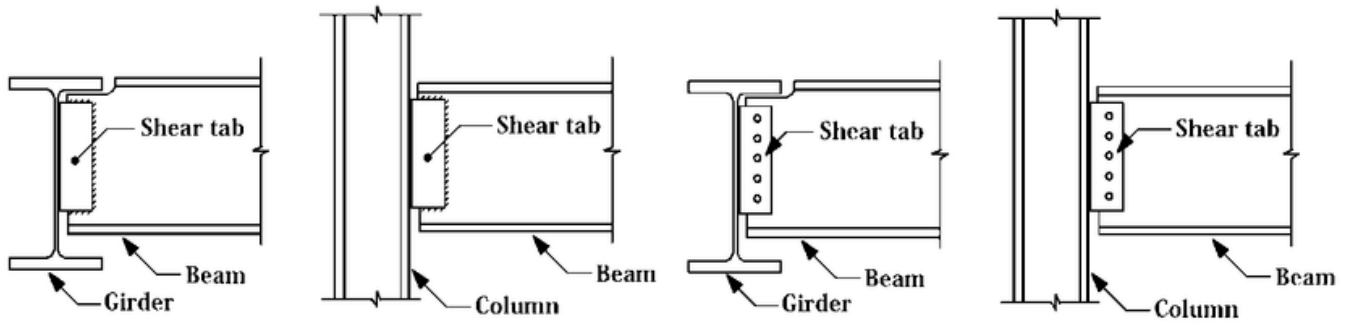
$f_{act} = 1.4 \text{ t/cm}^2 < F_b = 1.54 \text{ t/cm}^2$

#### 4-Check Shear Stress

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

#### 5-Check Deflection

$d_{act} = 0.59 \text{ cm} < d_{all} = 2.67 \text{ cm}$



## Group Connection Design (Simple Shear Plate Connection)

### 1-Bolts Design

Bolts: M20 of Grade 8.8

$V_d = 4$  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)

$f = 0.16$  t/cm<sup>2</sup> &  $q = 0.13$  t/cm<sup>2</sup>  $\Rightarrow f_{eq} = (f^2 + 3q^2)^{0.5} = 0.28$  t/cm<sup>2</sup> <  $1.1 * 0.2F_u = 0.79$  t/cm<sup>2</sup>  $\Rightarrow$  OK

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

$q = 0.13$  t/cm<sup>2</sup> &  $q_{mt} = 0.16$  t/cm<sup>2</sup>  $\Rightarrow q_{res} = (q^2 + q_{mt}^2)^{0.5} = 0.21$  t/cm<sup>2</sup> <  $0.2F_u = 0.72$  t/cm<sup>2</sup>  $\Rightarrow$  OK

### 4-Check Thickness of Plate

$f = (6 * V_d * e) / (t_p * L^2) = 0.19$  t/cm<sup>2</sup> <  $0.72 * F_y = 1.73$  t/cm<sup>2</sup>  $\Rightarrow$  OK

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

## Columns

Column ID	Start Point	End Point	Height (m)	Nmax (ton)
7	(14,4,0)	(14,4,6)	6	-13.59
6	(6,4,0)	(6,4,6)	6	-11.35
11	(14,8,0)	(14,8,6)	6	-8.15
2	(6,0,0)	(6,0,6)	6	-7.4
3	(14,0,0)	(14,0,6)	6	-5.85
5	(0,4,0)	(0,4,6)	6	-5.82
10	(6,8,0)	(6,8,6)	6	-4.36
8	(20,4,0)	(20,4,6)	6	-3.54

1	(0,0,0)	(0,0,6)	6	-3.46
12	(20,8,0)	(20,8,6)	6	-3.46
9	(0,8,0)	(0,8,6)	6	-2.68
4	(20,0,0)	(20,0,6)	6	-0.39

### **Design Limit state:**

Combo: D+L

Nd: -13.59 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

$\lambda = 179.1 > 100$

$f_c = 0.25 \text{ t/cm}^2 < F_c = 0.23 \text{ t/cm}^2$

---