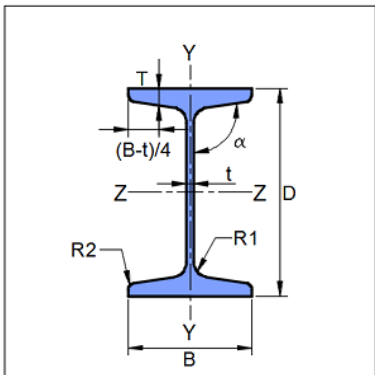
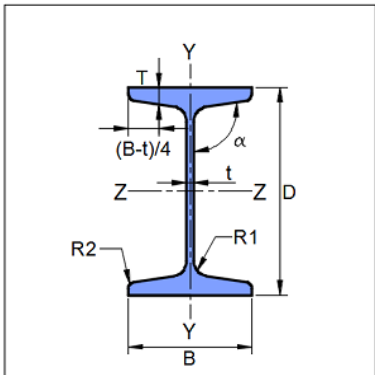




Company Name	IIT Bombay	Project Title	Shear Connection
Group/Team Name	Osdag	Subtitle	Fin Plate
Designer	Engineer#1	Job Number	1.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

1 Input Parameters

Main Module		Shear Connection		
Module		Fin Plate Connection		
Connectivity		Beam-Beam		
Shear Force (kN)		160.0		
Axial Force (kN)		20.0		
Supporting Section - Mechanical Properties				
	Supporting Section		WB 400	
	Material		E 300 (Fe 440)	
	Ultimate Strength, F_u (MPa)		440	
	Yield Strength, F_y (MPa)		300	
	Mass, m (kg/m)	66.71	I_z (cm ⁴)	23400.0
	Area, A (cm ²)	85.0	I_y (cm ⁴)	1380.0
	D (mm)	400.0	r_z (cm)	16.6
	B (mm)	200.0	r_y (cm)	4.04
	t (mm)	8.6	Z_z (cm ³)	1170.0
	T (mm)	13.0	Z_y (cm ³)	138.0
	Flange Slope	96	Z_{pz} (cm ³)	1320.0
	R_1 (mm)	13.0	Z_{py} (cm ³)	234.0
	R_2 (mm)	6.5		
	Supported Section - Mechanical Properties			
	Supported Section		MB 300	
	Material		E 300 (Fe 440)	
	Ultimate Strength, F_u (MPa)		440	
	Yield Strength, F_y (MPa)		300	
	Mass, m (kg/m)	46.02	I_z (cm ⁴)	8990.0
	Area, A (cm ²)	58.6	I_y (cm ⁴)	486.0
	D (mm)	300.0	r_z (cm)	12.3
	B (mm)	140.0	r_y (cm)	2.87
	t (mm)	7.7	Z_z (cm ³)	599.0
	T (mm)	13.1	Z_y (cm ³)	69.4
	Flange Slope	98	Z_{pz} (cm ³)	681.0
	R_1 (mm)	14.0	Z_{py} (cm ³)	117.0
	R_2 (mm)	7.0		



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Bolt Details - Input and Design Preference	
Diameter (mm)	[16, 20, 24]
Property Class	[8.8, 10.9]
Type	Friction Grip Bolt
Hole Type	Standard
Bolt Tension	Pre-tensioned
Slip Factor, (μ_f)	0.48
Detailing - Design Preference	
Edge Preparation Method	Rolled, machine-flame cut, sawn and planed
Gap Between Members (mm)	5.0
Are the Members Exposed to Corrosive Influences?	False
Plate Details - Input and Design Preference	
Thickness (mm)	[16, 18, 20, 22]
Material	E 250 (Fe 410 W)A
Ultimate Strength, F_u (MPa)	410
Yield Strength, F_y (MPa)	250
Weld Details - Input and Design Preference	
Weld Type	Fillet
Type of Weld Fabrication	Shop Weld
Material Grade Overwrite, F_u (MPa)	440.0



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Designer	Engineer#1	Job Number	1.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

2 Design Checks

Design Status	Pass
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2.1 Initial Section Check

Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)	160.0	$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{260.0 \times 7.7 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 315.23$ <p>[Ref. IS 800:2007, Cl.10.4.3]</p>	Pass
Allowable Shear Capacity (kN)	160.0	$V_d = 0.6 V_{dy}$ $= 0.6 \times 315.23$ $= 189.14$ <p>[Limited to low shear]</p>	Pass
Tension Yielding Capacity (kN)	20.0	$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 260.0 \times 7.7$ $= \frac{2002.0 \times 300}{1.1 \times 10^3}$ $= 546.0$ <p>[Ref. IS 800:2007, Cl.6.2]</p>	Pass

2.2 Load Consideration

Check	Required	Provided	Remarks
Applied Axial Force (kN)	20.0	20.0	



Company Name	IIT Bombay	Project Title	Shear Connection
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Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Applied Shear Force (kN)	160.0	$V_{y\min} = \min(0.15V_{dy}, 40.0)$ $= \min(0.15 \times 315.23, 40.0)$ $= 40$ $V_u = \max(V_y, V_{y\min})$ $= \max(160.0, 40)$ $= 160.0$ [Ref. IS 800:2007, Cl.10.7]	

2.3 Bolt Design

Check	Required	Provided	Remarks
Diameter (mm)		24.0	
Property Class		10.9	
Plate Thickness (mm)	$t_w = 7.7$	16.0	Pass
No. of Bolt Columns		1	Pass
No. of Bolt Rows		3	
Min. Pitch Distance (mm)	$p_{\min} = 2.5d$ $= 2.5 \times 24.0$ $= 60.0$ [Ref. IS 800:2007, Cl.10.2.2]	60	Pass
Max. Pitch Distance (mm)	$p/g_{\max} = \min(32t, 300)$ $= \min(32 \times 7.7, 300)$ $= \min(246.4, 300)$ $= 246.4$ Where, $t = \min(16.0, 7.7)$ [Ref. IS 800:2007, Cl.10.2.3]	60	Pass



Company Name	IIT Bombay	Project Title	Shear Connection
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Designer	Engineer#1	Job Number	1.1.1.3.1
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Check	Required	Provided	Remarks
Min. Gauge Distance (mm)	$p_{\min} = 2.5d$ $= 2.5 \times 24.0$ $= 60.0$ [Ref. IS 800:2007, Cl.10.2.2]	0.0	
Max. Gauge Distance (mm)	$p/g_{\max} = \min(32t, 300)$ $= \min(32 \times 7.7, 300)$ $= \min(246.4, 300)$ $= 246.4$ Where, $t = \min(16.0, 7.7)$ [Ref. IS 800:2007, Cl.10.2.3]	0.0	
Min. End Distance (mm)	$e_{\min} = 1.5d_0$ $= 1.5 \times 26.0$ $= 39.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	40	Pass
Max. End Distance (mm)	$e_{\max} = 12t\varepsilon; \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 16.0 \times \sqrt{\frac{250}{250}} = 192.0$ $e_2 = 12 \times 7.7 \times \sqrt{\frac{250}{300}} = 84.35$ $e_{\max} = \min(e_1, e_2) = 84.35$ [Ref. IS 800:2007, Cl.10.2.4.3]	40	Pass
Min. Edge Distance (mm)	$e'_{\min} = 1.5d_0$ $= 1.5 \times 26.0$ $= 39.0$ [Ref. IS 800:2007, Cl.10.2.4.2]	40	Pass



Company Name	IIT Bombay	Project Title	Shear Connection
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Designer	Engineer#1	Job Number	1.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e'_{\max} = 12t\varepsilon; \varepsilon = \sqrt{\frac{250}{f_y}}$ $e_1 = 12 \times 16.0 \times \sqrt{\frac{250}{250}} = 192.0$ $e_2 = 12 \times 7.7 \times \sqrt{\frac{250}{300}} = 84.35$ $e'_{\max} = \min(e_1, e_2) = 84.35$ <p>[Ref. IS 800:2007, Cl.10.2.4.3]</p>	40	Pass
Moment Demand (kNm)		$M_d = (V_u \times ecc + M_w)$ <p>ecc = eccentricity M_w = external moment acting on web</p> $= \frac{(160.0 \times 10^3 \times 45.0 + 0.0 \times 10^6)}{10^6}$ $= 7.2$	
Bolt Force Parameter(s) (mm)	$l_n = \text{length available}$ $l_n = p (n_r - 1)$ $= 60 \times (3 - 1)$ $= 120$ $y_{\max} = l_n / 2$ $= 120 / 2$ $= 60.0$ $x_{\max} = g(n_c - 1) / 2$ $= 0.0 \times (1 - 1) / 2$ $= 0.0$		



Company Name	IIT Bombay	Project Title	Shear Connection
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Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Bolt Force (kN)	$v_b v_c = V_u / (n_r \times n_c)$ $= \frac{160.0}{(3 \times 1)}$ $= 53.33$ $t_m h = \frac{M_d \times y_{\max}}{\sum r_i^2}$ $= \frac{7.2 \times 60.0}{7.2}$ $= 60.0$ $t_m v = \frac{M_d \times x_{\max}}{\sum r_i^2}$ $= \frac{7.2 \times 0.0}{7.2}$ $= 0.0$ $a_b h = \frac{A_u}{(n_r \times n_c)}$ $= \frac{20.0}{(3 \times 1)}$ $= 6.67$ $v_{\text{res}} = \sqrt{(v_b v_c + t_m v)^2 + (t_m h + a_b h)^2}$ $= \sqrt{(53.33 + 0.0)^2 + (60.0 + 6.67)^2}$ $= 85.37$		
Slip Resistance (kN)		$V_{dsf} = \frac{\mu_f n_e K_h F_o}{\gamma_{mf}}$ <p>Where , $F_o = 0.7 f_{ub} A_{nb}$</p> $V_{dsf} = \frac{0.48 \times 1 \times 1.0 \times 0.7 \times 1040.0 \times 353}{1.25 \times 10^3}$ $= 98.68$ <p>[Ref. IS 800:2007, Cl.10.4.3]</p>	



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Group/Team Name	Osdag	Subtitle	Fin Plate
Designer	Engineer#1	Job Number	1.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Long Joint Reduction Factor	<p>if $l_j \geq 15d$ then $V_{rd} = \beta_{lj} V_{db}$</p> <p>if $l_j < 15d$ then $V_{rd} = V_{db}$</p> <p>where,</p> <p>$\beta_{lj} = ((n_c \text{ or } n_r) - 1) \times (p \text{ or } g)$</p> <p>$\beta_{lj} = 1.075 - l/(200d)$ but $0.75 \leq \beta_{lj} \leq 1.0$</p> <p>[Ref. IS 800:2007, Cl.10.3.3.1]</p>	<p>$l_j = (n_r - 1) \times p$ $= (3 - 1) \times 60 = 120$</p> <p>$l = 120$ $15 \times d = 15 \times 24.0 = 360.0$</p> <p>since, $l_j < 15 \times d$ then $\beta_{lj} = 1.0$</p> <p>[Ref. IS 800:2007, Cl.10.3.3.1]</p>	
Capacity (kN)	85.37	98.68	Pass

2.4 Plate Design

Check	Required	Provided	Remarks
Min. Plate Height (mm)	<p>$0.6 \times (d_b - 2 \times t_f - 2 \times r_r)$ $= 0.6 \times (300.0 - 2 \times 13.1 - 2 \times 14.0)$ $= 147.48$</p> <p>[Ref. INSDAG, Ch.5, sec.5.2.3]</p>	200	Pass
Max. Plate Height (mm)	<p>$d_b - t_{bf} + r_{b1} - notch_h$ $= 300.0 - 13.1 + 14.0 - 40$ $= 222.9$</p>	200	Pass
Min. Plate Width (mm)	<p>$2e_{min} + (n_c - 1)p_{min}$ $= 2 \times 39.0 + (1 - 1) \times 60.0$ $= 83.0$</p>	85.0	Pass
Min. Plate Thickness (mm)	$t_w = 7.7$	16.0	Pass



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Designer	Engineer#1	Job Number	1.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{200 \times 16.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 419.89$ <p>[Ref. IS 800:2007, Cl.10.4.3]</p>	
Allowable Shear Capacity (kN)	$V = 160.0$	$V_d = 0.6 V_{dy}$ $= 0.6 \times 419.89$ $= 251.93$ <p>[Limited to low shear]</p>	Pass
Shear Rupture Capacity (kN)		$V_{dn} = \frac{0.75 A_{vn} f_u}{\sqrt{3} \gamma_{m1}}$ $= 1 \times \frac{(200 - (3 \times 26.0)) \times 16.0 \times 410}{\sqrt{3} \times 1.25}$ $= 600.24$ <p>[Ref. AISC, sect. J4]</p>	
Block Shear Capacity in Shear (kN)		$V_{db1} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $V_{db} = \min(V_{db1}, V_{db2}) = 404.51$ <p>[Ref. IS 800:2007, Cl.6.4]</p>	
Shear Capacity (kN)	160.0	$V_d = \min(S_c, V_{dn}, V_{db})$ $= \min(251.93, 600.24, 404.51)$ $= 251.93$ <p>[Ref. IS 800:2007, Cl.6.1]</p>	Pass



Company Name	IIT Bombay	Project Title	Shear Connection
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Designer	Engineer#1	Job Number	1.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 200 \times 16.0$ $= \frac{3200.0 \times 250}{1.1 \times 10^3}$ $= 727.27$ <p>[Ref. IS 800:2007, Cl.6.2]</p>	
Tension Rupture Capacity (kN)		$T_{dn} = \frac{0.9 A_n f_u}{\gamma_{m1}}$ $= \frac{1 \times 0.9 \times (200 - 3 \times 26.0) \times 16.0 \times 410}{1.25}$ $= 821.84$ <p>[Ref. IS 800:2007, Cl.6.3.1]</p>	
Block Shear Capacity in Tension (kN)		$T_{db1} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{db} = \min(T_{db1}, T_{db2}) = 489.13$ <p>[Ref. IS 800:2007, Cl.6.4]</p>	
Tension Capacity (kN)	20.0	$T_d = \min(T_{dg}, T_{dn}, T_{db})$ $= \min(727.27, 821.84, 489.13)$ $= 489.13$ <p>[Ref. IS 800:2007, Cl.6.1]</p>	Pass
Moment Capacity (kNm)	7.2	$M_{dz} = \frac{\beta_b Z_p f_y}{\gamma_{m0} \times 10^6}$ $= \frac{1.0 \times 160000.0 \times 250}{1.1 \times 10^6}$ $= 36.36$ <p>[Ref. IS 800:2007, Cl.8.2.1.2]</p>	Pass



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Check	Required	Provided	Remarks
Interaction Ratio	≤ 1	$\frac{7.2}{36.36} + \frac{20.0}{489.13} = 0.24$ [Ref. IS 800:2007, Cl.10.7]	Pass

2.5 Section Design

Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v f_y}{\sqrt{3} \gamma_{m0}}$ $= \frac{260.0 \times 7.7 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 315.23$ [Ref. IS 800:2007, Cl.10.4.3]	
Allowable Shear Capacity (kN)	$V = 160.0$	$V_d = 0.6 V_{dy}$ $= 0.6 \times 315.23$ $= 189.14$ [Limited to low shear]	Pass
Shear Rupture Capacity (kN)		$V_{dn} = \frac{0.75 A_{vn} f_u}{\sqrt{3} \gamma_{m1}}$ $= 1 \times \frac{(260.0 - (3 \times 26.0)) \times 7.7 \times 440}{\sqrt{3} \times 1.25}$ $= 462.46$ [Ref. AISC, sect. J4]	
Block Shear Capacity in Shear (kN)		$V_{db1} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $V_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $V_{db} = \min(V_{db1}, V_{db2}) = 217.79$ [Ref. IS 800:2007, Cl.6.4]	



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Check	Required	Provided	Remarks
Shear Capacity (kN)	160.0	$V_d = \min(S_c, V_{dn}, V_{db})$ $= \min(189.14, 462.46, 217.79)$ $= 189.14$ [Ref. IS 800:2007, Cl.6.1]	Pass
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{m0}}$ $A_g = lt = 260.0 \times 7.7$ $= \frac{2002.0 \times 300}{1.1 \times 10^3}$ $= 546.0$ [Ref. IS 800:2007, Cl.6.2]	
Tension Rupture Capacity (kN)		$T_{dn} = \frac{0.9 A_n f_u}{\gamma_{m1}}$ $= \frac{1 \times 0.9 \times (260.0 - 3 \times 26.0) \times 7.7 \times 440}{1.25}$ $= 443.96$ [Ref. IS 800:2007, Cl.6.3.1]	
Block Shear Capacity in Tension (kN)		$T_{dbl1} = \frac{A_{vg} f_y}{\sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{dbl2} = \frac{0.9 A_{vn} f_u}{\sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{db} = \min(T_{db1}, T_{db2}) = 262.87$ [Ref. IS 800:2007, Cl.6.4]	
Tension Capacity (kN)	20.0	$T_d = \min(T_{dg}, T_{dn}, T_{db})$ $= \min(546.0, 443.96, 262.87)$ $= 262.87$ [Ref. IS 800:2007, Cl.6.1]	Pass



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Check	Required	Provided	Remarks
Moment Capacity (kNm)	7.2	$M_{dz} = \frac{\beta_b Z_p f_y}{\gamma_{m0} \times 10^6}$ $= \frac{1.0 \times 681000.0 \times 300}{1.1 \times 10^6}$ $= 185.73$ [Ref. IS 800:2007, Cl.8.2.1.2]	Pass
Interaction Ratio	≤ 1	$\frac{7.2}{185.73} + \frac{20.0}{262.87} = 0.11$ [Ref. IS 800:2007, Cl.10.7]	Pass

2.6 Weld Design

Check	Required	Provided	Remarks
Min. Weld Size (mm)	$t_{w_{min}}$ based on thinner part $= \max(8, 8)$ s_{min} based on thicker part = 5 [Ref. IS 800:2007, Table 21, Cl.10.5.2.3]	6	Pass
Max. Weld Size (mm)	Thickness of thinner part $= \min(8.6, 16.0) = 8.6$ $s_{max} = 10$ [Ref. IS 800:2007, Cl.10.5.3.1]	6	Pass



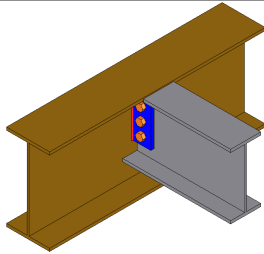
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Designer	Engineer#1	Job Number	1.1.1.3.1
Date	04 /02 /2021	Client	Mr. Somnath Mukherjee, Kolkata

Check	Required	Provided	Remarks
Weld Strength (N/mm)	$R_w = \sqrt{(T_{wh} + A_{wh})^2 + (T_{wv} + V_{wv})^2}$ $T_{wh} = \frac{M \times y_{max}}{I_{pw}} = \frac{7200000.0 \times 94.0}{1107445.33}$ $T_{wv} = \frac{M \times x_{max}}{I_{pw}} = \frac{7200000.0 \times 0.0}{1107445.33}$ $V_{wv} = \frac{V}{l_w} = \frac{160000.0}{376}$ $A_{wh} = \frac{A}{l_w} = \frac{20000.0}{376}$ $R_w = \sqrt{(611.14 + 53.19)^2 + (0.0 + 425.53)^2}$ $= 788.93$	$f_w = \frac{t_t f_u}{\sqrt{3} \gamma_{mw}}$ $= \frac{4.2 \times 410}{\sqrt{3} \times 1.25}$ $= 795.36$ <p>[Ref. IS 800:2007, Cl.10.5.7.1.1]</p>	Pass

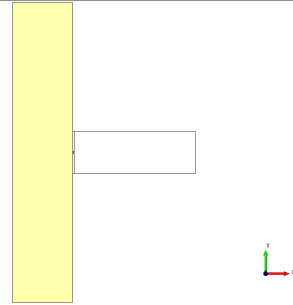


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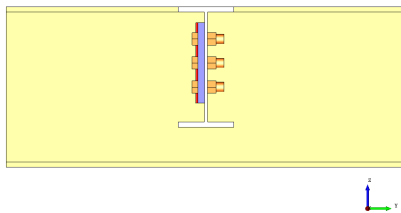
3 3D Views



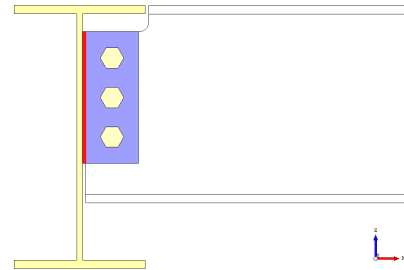
(a) 3D View



(b) Top View



(c) Side View



(d) Front View

4 Design Log

2021-02-04 11:55:35 - Osdag - INFO - === End Of Design ===