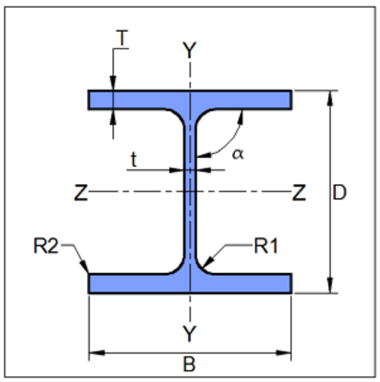
1 Input Parameters

Module	Beam Cover Plate - Welded
Main Module	Moment Connection
Bending Moment (kNm)	235.0
Shear Force (kN)	150.0
Axial Force (kN)	20.0

Beam Section - Mechanical Properties



Beam Section		UB 686 x 254 x 140	
Material		E 300 (Fe 440)	
Ultimate Strength, f_u (MPa)		440	
Yield Strength, f_y (MPa)		300	
Mass, m (kg/m)	140.1	I_z (cm^4)	136267.0
Area, A (cm^2)	17840.0	I_y(cm^4)	5182.0
D (mm)	684.0	r_z (cm)	27.6
B (mm)	253.7	r_y (cm)	5.4
t (mm)	12.4	Z_z (cm^3)	3987.0
T (mm)	19.0	Z_y (cm^3)	409.0
Flange Slope	90	Z_{pz} (cm^3)	4558.0
R_1 (mm)	15.2	Z_{py} (cm^3)	638.0
R_2 (mm)	0.0		

Weld Details - Input and Design Preference	
Weld Type	Fillet
Type of Weld Fabrication	Field weld
Material Grade Overwrite, Fu (MPa)	550.0

Plate Details - Input and Design Preference	
Preference	Outside + Inside
Ultimate Strength, Fu (MPa)	410
Yield Strength, Fy (MPa)	250
Material	E 250 (Fe 410 W)A
Thickness (mm)	[8, 10, 12, 14, 16, 18, 20, 22, 25, 28, 32, 36, 40, 45, 50, 56, 63, 75, 80, 90, 100, 110, 120]

2 Design Checks

Design Status	Pass

2.1 Member Capacity

Check	Required	Provided	Remarks
Section Classification		$Plastic$ $[Ref: Table\ 2, Cl.3.7.2\ and\ 3.7.4\ IS\ 800:2007]$	
Axial Capacity Member (kN)	$P_x = 20.0$	$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $= \frac{17840.0 \times 300}{1.1 \times 10^3}$ $= 4865.45$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.2]$	
Shear Capacity Member (kN)		$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{646.0 \times 12.4 \times 300}{\sqrt{3} \times 1.1 \times 1000}$ $= 1261.31$ $[Ref. IS\ 800:2007, Cl.10.4.3]$	
Allowable Shear Capacity (kN)	$V_y = 150.0$	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 1261.31$ $= 756.79$ $[Limited\ to\ low\ shear]$	Pass
Plastic Moment Capacity (kNm)		$M_{dzz} = \frac{\beta_b \times Z_p \times fy}{\gamma_{mo} \times 10^6}$ $= \frac{1 \times 4558000.0 \times 300}{1.1 \times 10^6}$ $= 1243.09$ $[Ref.\ IS\ 800:2007,\ Cl.\ 8.2.1.2]$	

Check	Required	Provided	Remarks
Moment Deformation Criteria (kNm)		$Mdc = \frac{1.5 \times Z_e \times fy}{1.1 \times 10^6}$ $= \frac{1.5 \times 3987000.0 \times 300}{1.1 \times 10^6}$ $= 1631.05$ $[Ref.\ IS\ 800:2007,\ Cl.\ 8.2.1.2]$	
Moment Capacity Member (kNm)	$M_z = 235.0$	$M_{dzz} = min(M_{dzz}, Mdc)$ $= min(1243.09, 1631.05)$ $= 1243.09$ $[Ref.\ IS\ 800:2007,\ Cl.\ 8.2]$	

2.2 Load Consideration

Check	Required	Provided	Remarks
Interaction Ratio		$IR\ axial = P_x/T_{dg}$ $= 20.0/4865.45$ $= 0.0041$ $IR\ moment = M_z/M_{dzz}$ $= 235.0/1243.09$ $= 0.189$ $IR\ sum = IR\ axial + IR\ moment$ $= 0.0041 + 0.189$ $= 0.1931$	

Check	Required	Provided	Remarks
Minimum Required Load	$if\ \ IR\ axial < 0.3\ and\ IR\ moment < 0.5$ $P_{x\,min} = 0.3 \times T_{dg}$ $M_{z\,min} = 0.5 \times M_{dzz}$ $elif\ \ sum\ IR <= 1.0\ and\ IR\ moment < 0.5$ $if\ \ (0.5 - IR\ moment) < (1 - sum\ IR)$ $M_{z\,min} = 0.5 \times M_{dzz}$ $else$ $M_{z\,min} = M_z + ((1 - sum\ IR) \times M_{dzz})$ $P_{x\,min} = P_x$ $elif\ \ sum\ IR <= 1.0\ and\ IR\ axial < 0.3$ $if\ \ (0.3 - IR\ axial) < (1 - sum\ IR)$ $P_{x\,min} = 0.3 \times T_{dg}$ $else$ $P_{x\,min} = P_x + ((1 - sum\ IR) \times T_{dg})$ $M_{z\,min} = M_z$ $else$ $P_{x\,min} = P_x$ $M_{z\,min} = M_z$ $Note: \ AL = \ User\ Applied\ Load$	$M_{z\,min} = 621.55$ $P_{x\,min} = 1459.64$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.7]$	
Applied Axial Force (kN)	$P_x = 20.0$	$P_u = max(P_x,\ P_{x\,min})$ $= max(20.0, 1459.64)$ $= 1459.64$	

Check	Required	Provided	Remarks
Applied Shear Force (kN)	$V_y = 150.0$	$V_{y_{min}} = min(0.15 \times V_{dy}, 40.0)$ $= min(0.15 \times 1261.31, 40.0)$ $= 40.0$ $V_u = max(V_y,\ V_{y_{min}})$ $= max(150.0, 40.0)$ $= 150.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.7]$	
Applied Moment (kNm)	$M_z = 235.0$	$M_u = max(M_z,\ M_{z_{min}})$ $= max(235.0,\ 621.55)$ $= 621.55$ $[Ref.\ IS\ 800:2007,\ Cl.\ 8.2.1.2]$	
Force Carried by Web		$A_w = Axial\ force\ in\ web$ $= \frac{(D-2T)\ t\ Au}{A}$ $= \frac{(684.0 - 2 \times 19.0) \times 12.4 \times 1459.64}{17840.0}$ $= 655.4\ kN$ $M_w = Moment\ in\ web$ $= \frac{Z_w \times Mu}{Z}$ $= \frac{1293679.6 \times 621.55}{4558000.0}$ $= 176.41\ kNm$	

Check	Required	Provided	Remarks
Force Carried by Flange		$A_f = Axial\ force\ in\ flange$ $= \frac{Au\ B\ T}{A}$ $= \frac{1459.64 \times 253.7 \times 19.0}{17840.0}$ $= 394.39\ kN$ $M_f = Moment\ in\ flange$ $= Mu - M_w$ $= 621.55 - 176.41$ $= 445.13\ kNm$ $F_f = flange\ force$ $= \frac{M_f \times 10^3}{D - T} + A_f$ $= \frac{445.13 \times 10^3}{684.0 - 19.0} + 394.39$ $= 1063.76\ kN$	

2.3 Flange Weld Design

Check	Required	Provided	Remarks
Min. Flange Plate Thickness (mm)	$T = 9.5$	$t_{fp} = 16.0$	**Pass**
Min. Weld Size (mm)	$t_{w_{min}}\ based\ on\ thinner\ part$ $= 16\ or\ 16$ $s_{min}\ based\ on\ thicker\ part = 5$ $[Ref\ IS\ 800:2007, Table\ 21\ (Cl 10.5.2.3)]$	$t_w = 14$	**Pass**
Max. Weld Size (mm)	$Thickness\ of\ thinner\ part$ $= min(19.0, 16.0) = 16.0$ $s_{max} = 16.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.3.1]$	$t_w = 14$	**Pass**

Check	Required	Provided	Remarks
Clearance (mm)	$sp = max(15, (t_w + 5))$ $= max(15, (14 + 5))$ $= 19$	$sp = 19$	Pass
Throat Thickness (mm)	$t_t \geq 3$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.5.3.1]$	$t_t = 0.7 t_w$ $= 0.7 \times 14$ $= 9.8$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.5.3.1]$	Pass
EffLength. Outer+Inner flange		$l_{eff} = (6 \times l_w) + B_{fp} + (2 \times B_{ifp}) - 6 \times t_w$ $= (6 \times 255) + 215 + 2 \times 65 - 6 \times 14$ $= 1800$	
Flange Weld Strength (N/mm)	$Stress = \frac{F_f \times 10^3}{l_{eff}}$ $= \frac{1063.76 \times 10^3}{1800}$ $= 592.1$	$f_w = \frac{t_t\ f_u}{\sqrt{3}\ \gamma_{mw}}$ $= \frac{9.8 \times 410}{\sqrt{3} \times 1.5}$ $= 1855.83$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.5.7.1.1]$	Pass
Weld Strength (post long joint) (N/mm)	$if\ l \geq 150 t_t\ then\ V_{rd} = \beta_{l_w} V_{db}$ $if\ l < 150 t_t\ then\ V_{rd} = V_{db}$ $where,$ $l\ = pt.length\ or\ pt.height$ $\beta_{l_w} = 1.2 - \frac{(0.2 l)}{(150 t_t)}$ $but\ 0.6 \leq \beta_{l_w} \leq 1.0$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.5.7.3]$	$l\ = pt.length\ or\ pt.height$ $l_l = 2(255 + (2 \times 14)) + 5.0$ $= 571.0$ $l_h = 215$ $l\ = 571.0$ $150 \times t_t = 150 \times 9.8 = 1470.0$ $since,\ l < 150 \times t_t$ $then\ V_{rd} = V_{db}$ $V_{rd} = 1855.83$ $[Ref.\ IS\ 800 : 2007,\ Cl.\ 10.5.7.3]$	
Weld Strength (N/mm)	592.1	1855.83	Pass

2.4 Flange Plate Dimension Check - Outside/Inside

Check	Required	Provided	Remarks
Min. Flange Plate Width (mm)	50	$B_{fp} = B - 2sp$ $= 253.7 - 2 \times 19$ $= 215$	Pass
Max. Flange Plate Width (mm)	$B_{fp} = B - 2sp$ $= 253.7 - 2 \times 19$ $= 215$	215	Pass
Min. Flange Plate Length (mm)	253.7	$L_{fp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (255 + 2 \times 14) + 5.0]$ $= 571.0$	Pass
Min. Inner Plate Width (mm)	50	$B_{ifp} = \frac{B - 4sp - t - 2R1}{2}$ $= \frac{253.7 - 4 \times 19 - 12.4 - 2 \times 15.2}{2}$ $= 65$	Pass
Max. Inner Plate Width (mm)	$B_{ifp} = \frac{B - 4sp - t - 2R1}{2}$ $= \frac{253.7 - 4 \times 19 - 12.4 - 2 \times 15.2}{2}$ $= 65$	65	Pass
Min. Inner Plate Length (mm)	253.7	$L_{fp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (255 + 2 \times 14) + 5.0]$ $= 571.0$	Pass
Min. Flange Plate Thickness (mm)	$T = 9.5$	$t_{fp} = 16.0$	Pass
Plate Area Check (mm2)	$pt.area >=$ $connected\ member\ area \times 1.05$ $= 5061.32$ $[Ref: Cl.8.6.3.2\ IS\ 800:2007]$	$pt.area = (B_{fp} + (2 \times B_{ifp})) \times t_{ifp}$ $= (215 + (2 \times 65)) \times 16.0$ $= 5520.0$	Pass

2.5 Web Weld Design

Check	Required	Provided	Remarks
Min. Web Plate Thickness (mm)	$t = 6.2$	$t_{wp} = 12.0$	Pass
Min. Weld Size (mm)	$t_{w_{min}}$ *based on thinner part* $= 12\ or\ 12$ s_{min} *based on thicker part* $= 5$ $[Ref\ IS\ 800:2007, Table\ 21\ (Cl 10.5.2.3)]$	$t_w = 10$	Pass
Max. Weld Size (mm)	*Thickness of thinner part* $= min(12.4, 12.0) = 12.0$ $s_{max} = 12.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.3.1]$	$t_w = 10$	Pass
Effective Length (mm)		$l_{eff} = (2 \times l_w) + W_{wp} - 2 \times t_w$ $= (2 \times 125) + 585 - 2 \times 10$ $= 815$	
Clearance (mm)	$sp = max(15, (t_w + 5))$ $= max(15, (10 + 5))$ $= 15$	$sp = 15$	Pass
Throat Thickness (mm)	$t_t \geq 3$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.3.1]$	$t_t = 0.7 t_w$ $= 0.7 \times 10$ $= 7.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.3.1]$	Pass
Moment Demand (kNm)	$M_d = (V_u \times ecc + M_w)$ $ecc = eccentricity$ $M_w = external\ moment\ acting\ on\ web$ $= \frac{(75.0 \times 10^3 \times 105.83 + 88.21 \times 10^6)}{10^6}$ $= 96.14$		

Check	Required	Provided	Remarks
Web Weld Strength (N/mm)	$R_w = \sqrt{(T_{wh}+A_{wh})^2+(T_{wv}+V_{wv})^2}$ $T_{wh} = \frac{M_d \times y_{max}}{Ipw} = \frac{96142543.83 \times 19.17}{35984263.87}$ $T_{wv} = \frac{M_d \times x_{max}}{Ipw} = \frac{96142543.83 \times 282.5}{35984263.87}$ $V_{wv} = \frac{V_u}{l_{eff}} = \frac{75000.0}{815}$ $A_{wh} = \frac{A_u}{l_{eff}} = \frac{327698.18}{815}$ $R_w = \sqrt{(51.22+402.08)^2+(754.78+92.02)^2} = 960.5$	$f_w = \frac{t_t\ f_u}{\sqrt{3}\ \gamma_{mw}} = \frac{7.0 \times 410}{\sqrt{3} \times 1.5} = 1325.6$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.1.1]$	**Pass**

Check	Required	Provided	Remarks
Weld Strength (post long joint) (N/mm)	$if\ l \geq 150t_t\ then\ V_{rd} = \beta_{l_w} V_{db}$ $if\ l < 150t_t\ then\ V_{rd} = V_{db}$ $where,$ $l\ = pt.length\ or\ pt.height$ $\beta_{l_w} = 1.2 - \frac{(0.2l)}{(150t_t)}$ $but\ 0.6 \leq \beta_{l_w} \leq 1.0$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.3]$	$l\ = pt.length\ or\ pt.height$ $l_l = 2(125 + (2 \times 10)) + 5.0$ $= 295.0$ $l_h = 585$ $l\ = 585$ $150 \times t_t = 150 \times 7.0 = 1050.0$ $since,\ l < 150 \times t_t$ $then\ V_{rd} = V_{db}$ $V_{rd} = 1325.6$ $[Ref.\ IS\ 800:2007,\ Cl.\ 10.5.7.3]$	
Weld Strength (N/mm)	960.5	1325.6	**Pass**

2.6 Web Plate Dimension Check

Check	Required	Provided	Remarks
Min. Web Plate Height (mm)	$= 0.6 \times D$ $= 0.6 \times 684.0$ $= 369.36$ $[Ref: INSDAG - Chp\ 5,$ $Sect.5.2.3]$	$W_{wp} = D - 2T - 2R1 - 2sp$ $= 684.0 - 2 \times 19.0 - (2 \times 15.2) - 2 \times 15$ $= 585$	**Pass**
Min. Web Plate Width (mm)	253.7	$L_{wp} = [2 \times (l_w + 2 \times t_w) + g]$ $= [2 \times (125 + 2 \times 10) + 5.0]$ $= 295$	**Pass**
Min. Web Plate Thickness (mm)	$t = 6.2$	$t_{wp} = 12.0$	**Pass**

Check	Required	Provided	Remarks
Plate Area Check (mm2)	$pt.area >=$ $connected\ member\ area \times 1.05$ $= 8410.92$ $[Ref: Cl.8.6.3.2\ IS\ 800:2007]$	$pt.area = 2 \times W_{wp} \times t_{wp}$ $= 2 \times 585 \times 12.0$ $= 14040.0$	**Pass**

2.7 Member Check

Check	Required	Provided	Remarks
Flange Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = l \times t = 253.7 \times 19.0$ $= \frac{4820.3 \times 300}{1.1 \times 10^3}$ $= 1314.63$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.2]$	
Flange Tension Capacity (kN)	$F_f = 1063.76$	$T_d = T_{dg}$ $= 1314.63$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.1]$	**Pass**
Web Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = l \times t = 646.0 \times 12.4$ $= \frac{8010.4 \times 300}{1.1 \times 10^3}$ $= 2184.65$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.2]$	

Check	Required	Provided	Remarks
Web Block Shear Capacity (kN)		$T_{dbl1} = \frac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{dbl2} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 2636.09$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.4]$	
Web Tension Capacity (kN)	$A_w = 655.4$	$T_d = min(T_{dg}, T_{dn}, T_{db})$ $= min(2184.65, 2537.69, 2636.09)$ $= 2184.65$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.1]$	**Pass**

2.8 Flange Plate Capacity Check for Axial Load - Outside/Inside

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = l \times t = 345 \times 16.0$ $= \frac{5520.0 \times 250}{1.1 \times 10^3}$ $= 1254.55$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.2]$	
Flange Plate Tension Capacity (kN)	$F_f = 1063.76$	$T_d = T_{dg}$ $= 1254.55$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.1]$	**Pass**

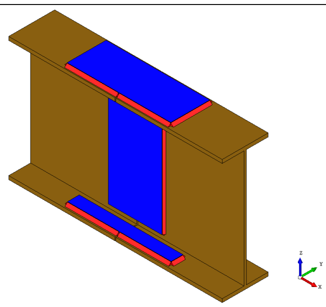
2.9 Web Plate Capacity Check for Axial Load

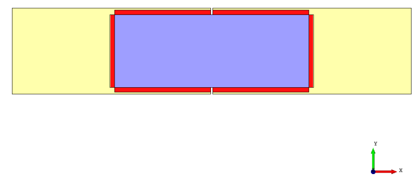
Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$ $A_g = 2l \times t = 2 \times 585 \times 12.0$ $= \frac{7020.0 \times 250}{1.1 \times 10^3}$ $= 3190.91$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.2]$	
Web Plate Tension Capacity (kN)	$A_w = 655.4$	$T_d = T_{dg}$ $= 3190.91$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.1]$	Pass

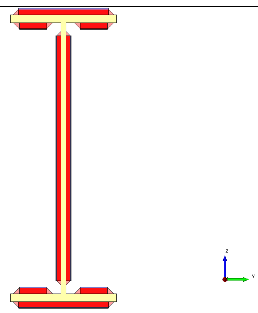
2.10 Web Plate Capacity Check for Shear Load

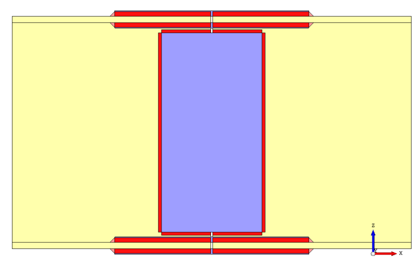
Check	Required	Provided	Remarks
Shear Yielding Capacity (kN)		$V_{dy} = \frac{A_v\ f_y}{\sqrt{3}\ \gamma_{mo}}$ $= \frac{2 \times 585 \times 12.0 \times 250}{\sqrt{3} \times 1.1 \times 1000}$ $= 1842.27$ $[Ref. IS\ 800:2007, Cl.10.4.3]$	
Allowable Shear Capacity (kN)	$V = 150.0$	$V_d = 0.6\ V_{dy}$ $= 0.6 \times 1842.27$ $= 1105.36$ $[Limited\ to\ low\ shear]$	Pass
Web Plate Shear Capacity (kN)	$V_u = 150.0$	$V_d = S_c$ $= 1105.36$ $[Ref.\ IS\ 800:2007,\ Cl.\ 6.1]$	Pass

3 3D Views


(a) 3D View


(b) Top View


(c) Side View


(d) Front View

4 Design Log

2020-12-18 00:04:09 - Osdag - INFO - The Load(s) defined is/are less than the minimum recommended value [Ref. IS 800:2007, Cl.10.7].

2020-12-18 00:04:09 - Osdag - INFO - The value of load(s) is/are set at minimum recommended value as per IS 800:2007, Cl.10.7.
2020-12-18 00:04:09 - Osdag - INFO - : Overall beam cover plate welded connection design is safe.