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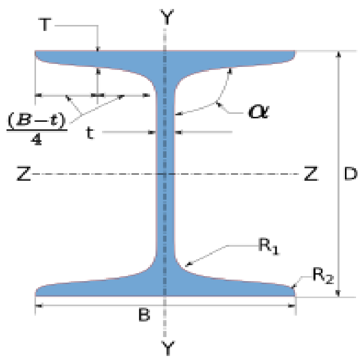
1 Input Parameters

Module	Beam Coverplate Connection
MainModule	Moment Connection
Moment(kNm)*	10.0
Shear(kN)*	10.0
Axial (kN) *	10.0

Section



Beam Section *		NPB 330x160x49.1	
Preferences		Outside	
Material *		E 250 (Fe 410 W)A	
Ultimate strength, fu (MPa)		410	
Yield Strength , fy (MPa)	230	R2(mm)	0.0
Mass	49.15	Iz(mm4)	117669000.0
Area(mm2) - A	6260.0	Iy(mm4)	7869000.0
D(mm)	330.0	rz(mm)	137.10000000000002
B(mm)	160.0	ry(mm)	35.5
t(mm)	7.5	Zz(mm3)	713150.0
T(mm)	11.5	Zy(mm3)	98360.0
FlangeSlope	90	Zpz(mm3)	804330.0
R1(mm)	1.8	Zpy(mm3)	98360.0

Bolt Details

Diameter (mm)*	[12.0, 16.0, 20.0, 24.0, 30.0, 36.0]
Grade *	[3.6, 4.6, 4.8, 5.6, 5.8, 6.8, 8.8, 9.8, 10.9, 12.9]
Type *	Bearing Bolt
Bolt.fu	500.0
Bolt.fy	300.0
Bolt hole type	Standard
Slip factor (µ_f)	0.3
Type of edges	a - Sheared or hand flame cut
Gap between beam and support (mm)	10.0
Are the members exposed to corrosive influences	False

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2 Design Checks

2.1 Member Capacity

Check	Required	Provided	Remarks
Axial Capacity (kN)		$Ac = \frac{A * f_y}{\gamma_{m0} * 1000}$ $= \frac{6260.0 * 230}{1.1 * 1000}$ $= 1308.91$	
Shear Capacity (kN)		$S_c = \frac{A_v * f_y}{\sqrt{3} * \gamma_{mo} * 1000}$ $= \frac{307.0 * 7.5 * 230}{\sqrt{3} * 1.1 * 1000}$ $= 277.95$	
Plastic Moment Capacity (kNm)		$Pmc = \frac{\beta_b * Z_p * fy}{\gamma_{mo} * 1000000}$ $= \frac{1 * 176717 * 230}{1.1 * 1000000}$ $= 36.95$	
Moment Deformation Criteria (kNm)		$Mdc = \frac{1.5 * Z_e * fy}{1.1 * 1000000}$ $= \frac{1.5 * 713150.0 * 230}{1.1 * 1000000}$ $= 223.67$	
Moment Capacity (kNm)		$M_c = min(Pmc, Mdc)$ $= min(36.95, 223.67)$ $= 36.95$	

2.2 Load Considered

Check	Required	Provided	Remarks
Axial Load (kN)	$Ac_{min} = 0.3 * A_c$ $= 0.3 * 1308.91$ $= 392.67$	$Au = max(A, Ac_{min})$ $= max(10.0, 392.67)$ $= 392.67$	Pass
Shear Load (kN)	$Vc_{min} = 0.6 * S_c$ $= 0.6 * 277.95$ $= 166.77$	$Vu = max(V, Vc_{min})$ $= max(10.0, 166.77)$ $= 166.77$	Pass
Moment Load (kNm)	$Mc_{min} = 0.5 * M_c$ $= 0.5 * 36.95$ $= 18.47$	$Mu = max(M, Mc_{min})$ $= max(10.0, 18.47)$ $= 18.47$	Pass
Forces Carried by Web		$A_w = Axial\ force\ in\ web$ $= \frac{(D - 2 * T) * t * Au}{A}$ $= \frac{(330.0 - 2 * 11.5) * 7.5 * 392.67}{6260.0}$ $= 144.43$ $M_w = Moment\ in\ web$ $= \frac{Z_w * Mu}{Z}$ $= \frac{176717 * 18.47}{804330.0}$ $= 4.06$	
Forces Carried by Flange		$A_f = Axial\ force\ in\ flange$ $= \frac{Au * B * T}{A}$ $= \frac{392.67 * 160.0 * 11.5}{6260.0}$ $= 115.42$ $M_f = Moment\ in\ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange\ force$ $= \frac{M_f * 1000}{D - T} + A_f$ $= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42$ $= 160.68$	

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2.3 Flange Bolt Checks

Check	Required	Provided	Remarks
Diameter (mm)	Bolt Quantity Optimisation	$d = 12.0$	
Grade	Bolt Grade Optimisation	5.6	
Hole Diameter (mm)		$d_0 = 13.0$	
Shear Capacity (kN)		$V_{dsb} = \frac{f_{ub}\ n_n\ A_{nb}}{1000 * \sqrt{3}\ \gamma_{mb}}$ $= \frac{500.0 * 1 * 84.3}{1000 * \sqrt{3}\ *\ 1.25}$ $= 19.47$	
Bearing Capacity (kN)		$V_{dpb} = \frac{2.5\ k_b\ d\ t\ f_u}{1000 * \gamma_{mb}}$ $= \frac{2.5\ * 0.52 * 12.0 * 11.5 * 410}{1000 * 1.25}$ $= 58.84$	
Bolt Capacity (kN)		$V_{db} = min\ (V_{dsb}, V_{dpb})$ $= min\ (19.47, 58.84)$ $= 19.47$	
No of Bolts	$R_u = \sqrt{V_u^2 + A_u^2}$ $n_{trial} = R_u / V_{bolt}$ $R_u = \frac{\sqrt{0.0^2 + 160.68^2}}{19.47}$ $= 18$	20	
No of Columns		$n_c = 10$	
No of Rows		$n_r = 2$	
Min. Pitch (mm)	$p/g_{min} = 2.5\ d$ $= 2.5 * 12.0 \quad = 30.0$	30	Pass
Max. Pitch (mm)	$p/g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 *\ 11.5,\ 300\ mm)$ $= 300$	30	Pass
Min. Gauge (mm)	$p/g_{min} = 2.5\ d$ $= 2.5 * 12.0 \quad = 30.0$	0.0	N/A
Max. Gauge (mm)	$p/g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 *\ 11.5,\ 300\ mm)$ $= 300$	0.0	N/A
Min. End Distance (mm)	$e/e`_{min} = [1.5\ or\ 1.7] * d_0$ $= 1.7 * 13.0 = 22.1$	25	Pass
Max. End Distance (mm)	$e/e`_{max} = 12\ t\ \varepsilon$ $\varepsilon = \sqrt{\frac{250}{f_y}}$ $e/e`_{max} = 12\ * 14.0 * \sqrt{\frac{250}{230}}$ $= 174.72$	25	Pass

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Check	Required	Provided	Remarks
Min. Edge Distance (mm)	$e/e`_{min} = [1.5\ or\ 1.7] * d_0$ $= 1.7 * 13.0 = 22.1$	37.225	Pass
Max. Edge Distance (mm)	$e/e`_{max} = 12\ t\ \varepsilon$ $\varepsilon = \sqrt{\frac{250}{f_y}}$ $e/e`_{max} = 12\ * 14.0 * \sqrt{\frac{250}{230}}$ $= 174.72$	37.225	Pass
Long Joint Reduction	$if\ l \geq 15 * d\ then\ V_{rd} = \beta_{ij} * V_{db}$ $if\ l < 15 * d\ then\ V_{rd} = V_{db}$ $where,$ $l = ((nc\ or\ nr) - 1) * (p\ or\ g)$ $\beta_{ij} = 1.075 - l/(200 * d)$ $but\ 0.75 \leq \beta_{ij} \leq 1.0$	$l = ((nc\ or\ nr) - 1) * (p\ or\ g)$ $= (10 - 1) * 30 = 270$ $= (2 - 1) * 0.0 = 0.0$ $l = 270$ $15 * d = 15 * 12.0 = 180.0$ $since,\ l \geq 15 * d\ then\ V_{rd} = \beta_{ij} * V_{db}$ $\beta_{ij} = 1.075 - 270/(200 * 12.0) = 0.96$ $V_{rd} = 0.96 * 19.47 = 19468.25$	

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2.4 Web Bolt Checks

Check	Required	Provided	Remarks
Shear Capacity (kN)		$V_{dsb} = \dfrac{f_{ub}\ n_n\ A_{nb}}{1000 * \sqrt{3}\ \gamma_{mb}}$ $= \dfrac{500.0 * 2 * 84.3}{1000 * \sqrt{3}\ *\ 1.25}$ $= 38.94$	
Bearing Capacity (kN)		$V_{dpb} = \dfrac{2.5\ k_b\ d\ t\ f_u}{1000 * \gamma_{mb}}$ $= \dfrac{2.5\ * 0.52 * 12.0 * 7.5 * 410}{1000 * 1.25}$ $= 38.38$	
Bolt Capacity (kN)		$V_{db} = min\ (V_{dsb}, V_{dpb})$ $= min\ (38.94, 38.38)$ $= 38.38$	
No of Bolts	$R_u = \sqrt{V_u^2 + A_u^2}$ $n_{trial} = R_u / V_{bolt}$ $R_u = \dfrac{\sqrt{166.77^2 + 144.43^2}}{38.38}$ $= 12$	20	
No of Columns		$n_c = 4$	
No of Rows		$n_r = 5$	
Min. Pitch (mm)	$p/g_{min} = 2.5\ d$ $= 2.5 * 12.0 \quad = 30.0$	30	Pass
Max. Pitch (mm)	$p/g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 *\ 6.0,\ 300\ mm)$ $= 192.0$	30	Pass
Min. Gauge (mm)	$p/g_{min} = 2.5\ d$ $= 2.5 * 12.0 \quad = 30.0$	65	Pass
Max. Gauge (mm)	$p/g_{max} = \min(32\ t,\ 300\ mm)$ $= \min(32 *\ 6.0,\ 300\ mm)$ $= 192.0$	65	Pass
Min. End Distance (mm)	$e/e`_{min} = [1.5\ or\ 1.7] * d_0$ $= 1.7 * 13.0 = 22.1$	25	Pass
Max. End Distance (mm)	$e/e`_{max} = 12\ t\ \varepsilon$ $\varepsilon = \sqrt{\dfrac{250}{f_y}}$ $e/e`_{max} = 12\ * 6.0 * \sqrt{\dfrac{250}{230}}$ $= 74.88$	25	Pass
Min. Edge Distance (mm)	$e/e`_{min} = [1.5\ or\ 1.7] * d_0$ $= 1.7 * 13.0 = 22.1$	25	Pass

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Check	Required	Provided	Remarks
Max. Edge Distance (mm)	$e/e`_{max} = 12\ t\ \varepsilon$   $\varepsilon = \sqrt{\frac{250}{f_y}}$   $e/e`_{max} = 12\ * 6.0 * \sqrt{\frac{250}{230}}$ $= 74.88$	25	Pass
Parameters required for bolt force		$l_n = length\ available$ $l_n = (n_r - 1) * g$ $= (5 - 1) * 65$ $= 260$ $y_{max} = l_n/2$ $= 260/2$ $= 130.0$ $x_{max} = p * (n_c - 1)/2$ $= 30 * (4 - 1)/2 \quad = 15.0$	
Moment Demand		$M_d = (V_u * ecc + M_w)$ $= (166.77 * 45.0 + 4.06)$ $= 11.56$	
Bolt.Force		$vbv = V_u/(n_r * n_c)$ $= \frac{166.77}{(5 * 4)}$ $= 16.68$ $tmh = \frac{M_d * y_{max}}{\Sigma r_i^2}$ $= \frac{11.56 * 130.0}{86.75}$ $= 17.33$ $tmv = \frac{M_d * x_{max}}{\Sigma r_i^2}$ $= \frac{11.56 * 15.0}{86.75}$ $= 2.0$ $abh = \frac{A_u}{(n_r * n_c)}$ $= \frac{144.43}{(5 * 4)}$ $= 14.44$ $vres = \sqrt{(vbv + tmv)^2 + (tmh + abh)^2}$ $= \sqrt{(16.68 + 2.0)^2 + (17.33 + 14.44)^2}$ $= 36.85$	

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Check	Required	Provided	Remarks
Long Joint Reduction	$if\ l \geq 15 * d\ then\ V_{rd} = \beta_{ij} * V_{db}$ $if\ l < 15 * d\ then\ V_{rd} = V_{db}$ $where,$ $l = ((nc\ or\ nr) - 1) * (p\ or\ g)$ $\beta_{ij} = 1.075 - l/(200 * d)$ $but\ 0.75 \leq \beta_{ij} \leq 1.0$	$l = ((nc\ or\ nr) - 1) * (p\ or\ g)$ $= (4 - 1) * 30 = 90$ $= (5 - 1) * 65 = 260$ $l = 260$ $15 * d = 15 * 12.0 = 180.0$ $since,\ l \geq 15 * d\ then\ V_{rd} = \beta_{ij} * V_{db}$ $\beta_{ij} = 1.075 - 260/(200 * 12.0) = 0.97$ $V_{rd} = 0.97 * 38.38 = 37.1$	
Capacity (kN)	36.85	37.1	Pass

2.5 Outer flange plate Checks

Check	Required	Provided	Remarks
Min. Plate Height (mm)	$min\ flange\ plate\ ht = beam\ width$ $= 160.0$	160.0	Pass
Min. Plate Length (mm)	$2[2 * e_{min} + (\frac{bolt\ lines}{2} - 1) * p_{min})]$ $+ \frac{gap}{2}]$ $= 2 * [(2 * 22.1 + (\frac{10}{2} - 1) * 30.0$ $= + \frac{10.0}{2}]$ $= 338.4$	350.0	Pass
Min.Plate Thickness (mm)	$t_w = 11.5$	14.0	Pass

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2.6 Member Checks

Check	Required	Provided	Remarks
Flange Tension Yielding Capacity (kN)		$T_{dg} = \frac{l * t_p * f_y}{1000 * \gamma_{mo}}$ $= \frac{160.0 * 11.5 * 230}{1000 * 1.1}$ $= 384.73$	
Flange Tension Rupture Capacity (kN)		$T_{dn} = \frac{0.9 * A_n * f_u}{1000 * \gamma_{m1}}$ $= \frac{0.9 * (160.0 - 2 * 13.0) * 11.5 * 410}{1000 * 1.25}$ $= 454.9$	
Flange Block Shear Capacity (kN)		$T_{db1} = \frac{A_{vg} f_y}{1000 * \sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{1000 * \gamma_{m1}}$ $T_{db2} = \frac{0.9 * A_{vn} f_u}{1000 * \sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{1000 * \gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 518.1$	
Flange Tension Capacity (kN)	$f_f = 160.68$	$T_d = Min(T_{dg}, T_{dn}, T_{db})$ $= Min(384.73, 454.9, 518.1)$ $= 384.73$	Pass
Web Tension Yielding Capacity (kN)		$T_{dg} = \frac{l * t_p * f_y}{1000 * \gamma_{mo}}$ $= \frac{307.0 * 7.5 * 230}{1000 * 1.1}$ $= 481.43$	
Web Tension Rupture Capacity (kN)		$T_{dn} = \frac{0.9 * A_n * f_u}{1000 * \gamma_{m1}}$ $= \frac{0.9 * (307.0 - 5 * 13.0) * 7.5 * 410}{1000 * 1.25}$ $= 535.79$	
Web Block Shear Capacity (kN)		$T_{db1} = \frac{A_{vg} f_y}{1000 * \sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{1000 * \gamma_{m1}}$ $T_{db2} = \frac{0.9 * A_{vn} f_u}{1000 * \sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{1000 * \gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 615.45$	
Web Tension Capacity (kN)	$A_w = 144.43$	$T_d = Min(T_{dg}, T_{dn}, T_{db})$ $= Min(481.43, 535.79, 615.45)$ $= 481.43$	Pass

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2.7 Flange Plate Capacity Checks in Axial-Outside

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{l * t_p * f_y}{1000 * \gamma_{mo}}$ $= \frac{160.0 * 14.0 * 230}{1000 * 1.1}$ $= 468.36$	
Tension Rupture Capacity (kN)		$T_{dn} = \frac{0.9 * A_n * f_u}{1000 * \gamma_{m1}}$ $= \frac{0.9 * (160.0 - 2 * 13.0) * 14.0 * 410}{1000 * 1.25}$ $= 553.8$	
Block Shear Capacity (kN)		$T_{db1} = \frac{A_{vg} f_y}{1000 * \sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{1000 * \gamma_{m1}}$ $T_{db2} = \frac{0.9 * A_{vn} f_u}{1000 * \sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{1000 * \gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 663.22$	
Plate Tension Capacity (kN)	$f_f = 160.68$	$T_d = Min(T_{dg}, T_{dn}, T_{db})$ $= Min(468.36, 553.8, 663.22)$ $= 468.36$	Pass

2.8 Web Plate Capacity Checks in Axial

Check	Required	Provided	Remarks
Tension Yielding Capacity (kN)		$T_{dg} = \frac{l * t_p * f_y}{1000 * \gamma_{mo}}$ $= \frac{310 * 6.0 * 230}{1000 * 1.1}$ $= 449.07$	
Tension Rupture Capacity (kN)		$T_{dn} = \frac{0.9 * A_n * f_u}{1000 * \gamma_{m1}}$ $= \frac{0.9 * (310 - 5 * 13.0) * 6.0 * 410}{1000 * 1.25}$ $= 867.89$	
Block Shear Capacity (kN)		$T_{db1} = \frac{A_{vg} f_y}{1000 * \sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{1000 * \gamma_{m1}}$ $T_{db2} = \frac{0.9 * A_{vn} f_u}{1000 * \sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{1000 * \gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 984.73$	
Plate Tension Capacity (kN)	$A_w = 144.43$	$T_d = Min(T_{dg}, T_{dn}, T_{db})$ $= Min(777.82, 867.89, 984.73)$ $= 777.82$	Pass

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2.9 Web Plate Capacity Checks in Shear

Check	Required	Provided	Remarks
Shear yielding Capacity (V_dy) (kN)		$V_{dy} = \frac{A_v * f_y}{1000 * \sqrt{3} * \gamma_{mo}}$ $= \frac{310 * 6.0 * 230}{1000 * \sqrt{3} * 1.1}$ $= 449.07$	
Shear Rupture Capacity (V_dn) (kN)		$V_{dn} = \frac{0.9 * A_{vn} * f_u}{1000 * \sqrt{3} * \gamma_{mo}}$ $= \frac{0.9 * (310 - (2.0 * 13.0)) * 6.0 * 410}{1.1 * 1000 * \sqrt{3}}$ $= 501.08$	
Block Shear Capacity in Shear (V_db) (kN)		$T_{db1} = \frac{A_{vg} f_y}{1000 * \sqrt{3} \gamma_{m0}} + \frac{0.9 A_{tn} f_u}{1000 * \gamma_{m1}}$ $T_{db2} = \frac{0.9 * A_{vn} f_u}{1000 * \sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{1000 * \gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 601.24$	
Plate Shear Capacity (kN)	$V_u = 166.77$	$V_d = min(V_{dy}, V_{dn}, V_{db})$ $= min(449.07, 501.08, 984.73)$ $= 449.07$	Pass

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3 3D View

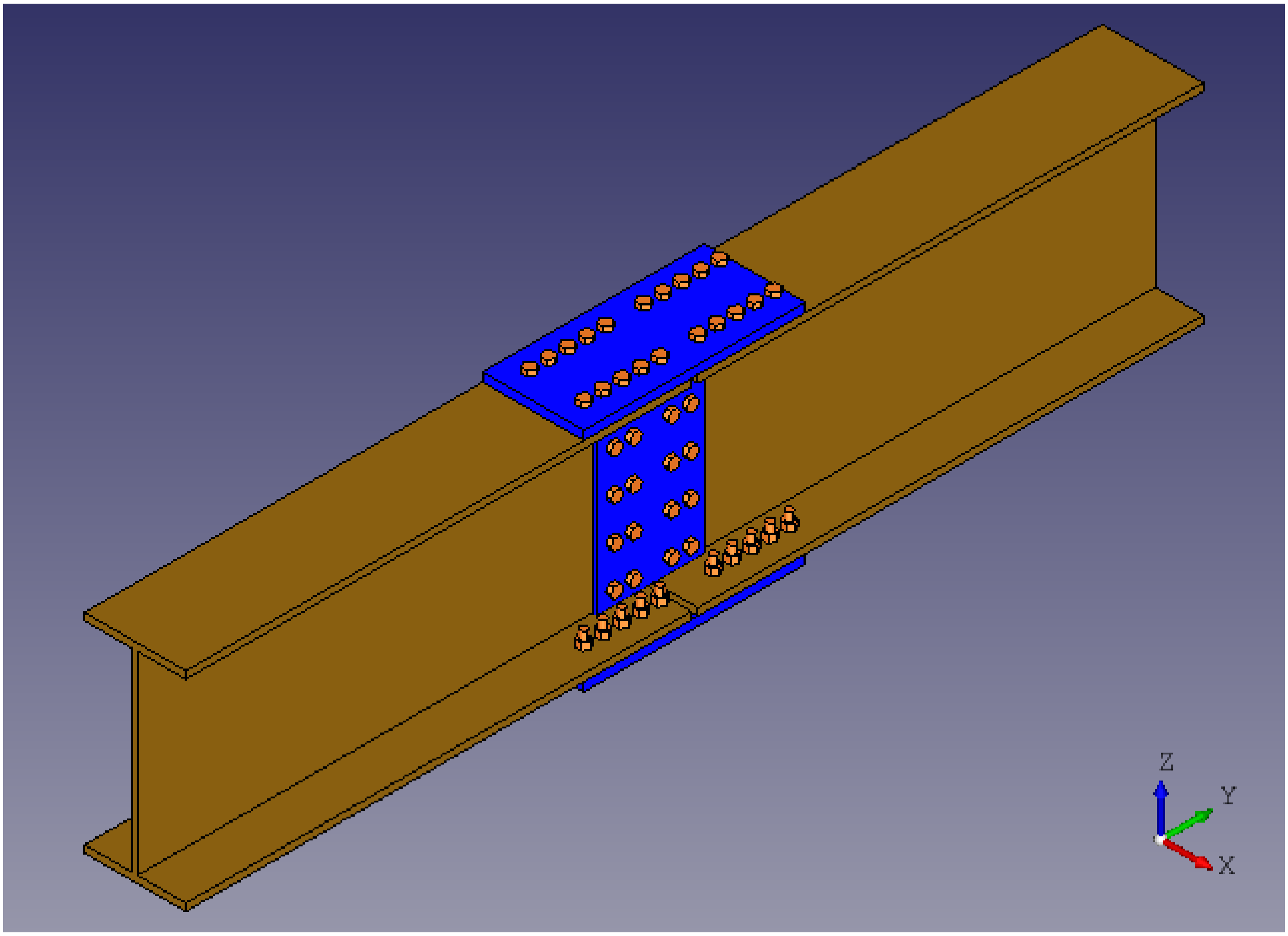

Figure 1: 3D View