| Company Name | | Project Title |
|-----------------|--------------|---------------|
| Group/Team Name | | Subtitle |
| Designer | | Job Number |
| Date | 11 /05 /2020 | Client |

1 Input Parameters

| Modu | ıle | | Bea | m Coverplate Connection |
|----------------------------|---------------------------------|----------------|-------------------|---|
| MainMo | odule | | Moment Connection | |
| Moment(kNm)* | | | | 10.0 |
| Shear(l | (N)* | | | 10.0 |
| Axial (k | (N) * | | | 10.0 |
| | · | Section | | |
| | Beam S | ection * | | NPB 330x160x49.1 |
| | Prefe | rences | | Outside |
| т Ү | Mate | erial * | | E 250 (Fe 410 W)A |
| | Ultimate stren | ngth, fu (MPa) | | 410 |
| <u>(B-t)</u> t | Yield Strength , fy (MPa) | 230 | R2(mm) | 0.0 |
| | Mass | 49.15 | Iz(mm4) | 117669000.0 |
| R ₁ | Area(mm2) - | 6260.0 | Iy(mm4) | 7869000.0 |
| В | D(mm) | 330.0 | rz(mm) | 137.10000000000000 |
| Y | 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 | ` ' | | [12.0, | 16.0, 20.0, 24.0, 30.0, 36.0 |
| Grade | e * | | [3.6, 4.6, 4.8 | 8, 5.6, 5.8, 6.8, 8.8, 9.8, 10.9, 12.9] |
| Туре | * | | | Bearing Bolt |
| Bolt. | fu | | | 500.0 |
| Bolt. | fy | | | 300.0 |
| Bolt hole | e type | | | Standard |
| Slip factor | r (µ_f) | | | 0.3 |
| Type of | edges | | a - S | 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 | |

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2.2 Load Considered

| $ \begin{array}{c} A x \\ A x $ | Check | Required | Provided | Remarks |
|---|--------------------------|------------------------|--|---------|
| $\begin{array}{c} = 392.67 \\ Vc_{min} = 0.6 * S_c \\ = 0.6 * 277.95 \\ = 166.77 \\ = 166.77 \\ = 166.77 \\ = 166.77 \\ = 166.77 \\ = 166.77 \\ = 166.77 \\ = 166.77 \\ = 166.77 \\ = 166.77 \\ = 18.47 \\ \\ & = \frac{max(10.0, 18.47)}{Au = max(M, Mc_{min})} \\ = max(10.0, 18.47) \\ = 18.47 \\ & = \frac{(330.0 - 2*11.5)*7.5*392.67}{6260.0} \\ = 144.43 \\ M_w = Moment in web \\ = \frac{Z_w * Mu}{Z} \\ = \frac{176717*18.47}{804330.0} \\ = 4.06 \\ & = \frac{Au*id force in flange}{Ag330.0} \\ = \frac{Au*id force in flange}{Ag430.0} \\ = \frac{Au*id force in flange}{Au*id force in flange} \\ = Au*id force in flang$ | | $Ac_{min} = 0.3 * A_c$ | $Au = max(A, Ac_{min})$ | |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$ | Axial Load (kN) | = 0.3 * 1308.91 | = max(10.0, 392.67) | Pass |
| $\begin{array}{llllllllllllllllllllllllllllllllllll$ | | | | |
| $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$ | | $Vc_{min} = 0.6 * S_c$ | $Vu = max(V, Vc_{min})$ | |
| $ \begin{array}{c} Moment \ Load \ (kNm) \end{array} \begin{tabular}{l} Mc_{min} = 0.5 * M_c \\ = 0.5 * 36.95 \\ = 18.47 \\ \end{tabular} \begin{tabular}{l} Mu = max(M, Mc_{min}) \\ = max(10.0, 18.47) \\ = 18.47 \\ \end{tabular} \begin{tabular}{l} Pass \\ = 18.47 \\ \end{tabular} \begin{tabular}{l} Mu = max(M, Mc_{min}) \\ = 18.47 \\ \end{tabular} \begin{tabular}{l} Pass \\ = 18.47 \\ \end{tabular} \begin{tabular}{l} A_w = Axial \ force \ in \ web \\ = (D-2*T)*t*Au \\ A_W = Axial \ force \ in \ web \\ = (330.0-2*11.5)*7.5*392.67 \\ \hline 6260.0 \\ = 144.43 \\ \end{tabular} \begin{tabular}{l} Mw = Moment \ in \ web \\ = \frac{Z_w * Mu}{Z} \\ = \frac{176717*18.47}{804330.0} \\ = 4.06 \\ \end{tabular} \begin{tabular}{l} A_f = Axial \ force \ in \ flange \\ = Au*8*T \\ \hline A_f = Axial \ force \ in \ flange \\ = \frac{Au*8*T}{A} \\ = \frac{392.67*160.0*11.5}{6260.0} \\ = 115.42 \\ \end{tabular} \begin{tabular}{l} Mm = 10.00 \\ \end{tabular} \begin{tabular}{l} M_f = Moment \ in \ flange \\ = Mu - M_w \\ = 18.47 - 4.06 \\ = 14.42 \\ \end{tabular} \begin{tabular}{l} Hu = \frac{Mu}{A} \\ = \frac{M_f * 1000}{D-T} + A_f \\ = \frac{14.42*1000}{14.42*1000} \\ = \frac{14.42*1000}{330.0-11.5} + 115.42 \\ \end{tabular} \begin{tabular}{l} Mu = max(10.0,18.47) \\ = 18.47 \\ = 10.00$ | Shear Load (kN) | = 0.6 * 277.95 | = max(10.0, 166.77) | Pass |
| $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$ | | | | |
| = 18.47 | | $Mc_{min} = 0.5 * M_c$ | $Mu = max(M, Mc_{min})$ | |
| $A_{w} = Axial \ force \ in \ web$ $= \frac{(D-2*T)*t*Au}{A}$ $= \frac{(330.0-2*11.5)*7.5*392.67}{6260.0}$ $= 144.43$ $M_{w} = Moment \ in \ web$ $= \frac{Z_{w}*Mu}{Z}$ $= \frac{176717*18.47}{804330.0}$ $= 4.06$ $A_{f} = Axial \ force \ in \ flange$ $= \frac{Au*B*T}{A}$ $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_{f} = Moment \ in \ flange$ $= Mu - M_{w}$ $= 18.47 - 4.06$ $= 14.42$ $F_{f} = flange \ force$ $= \frac{M_{f}*1000}{D-T} + A_{f}$ $= \frac{14.42*1000}{330.0-11.5} + 115.42$ | Moment Load (kNm) | = 0.5 * 36.95 | = max(10.0, 18.47) | Pass |
| Forces Carried by 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} $ $= 4.06$ $A_f = Axial force in flange$ $= \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 $ $= \frac{14.42*1000}{330.0-11.5} + 115.42$ | | = 18.47 | | |
| Forces Carried by Web $ = \frac{(330.0 - 2*11.5)*7.5*392.67}{6260.0} $ $= 144.43$ $M_w = Moment in web$ $= \frac{Z_w * M_u}{Z}$ $= \frac{176717*18.47}{804330.0}$ $= 4.06$ $A_f = Axial force in flange$ $= \frac{Au*8*T}{A}$ $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_f = Moment in flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange force$ $= \frac{M_f*1000}{D - T} + A_f$ $= \frac{14.42*1000}{330.0 - 11.5} + 115.42$ | | | $A_w = Axial \ force \ in \ web$ | |
| Forces Carried by Web $ = \frac{(330.0 - 2*11.5)*7.5*392.67}{6260.0} $ $= 144.43$ $M_w = Moment in web$ $= \frac{Z_w * M_u}{Z}$ $= \frac{176717*18.47}{804330.0}$ $= 4.06$ $A_f = Axial force in flange$ $= \frac{Au*8*T}{A}$ $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_f = Moment in flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange force$ $= \frac{M_f*1000}{D - T} + A_f$ $= \frac{14.42*1000}{330.0 - 11.5} + 115.42$ | | | -(D-2*T)*t*Au | |
| Forces Carried by Web $ = \frac{144.43}{M_w = Moment \ in \ web} $ $= \frac{Z_w * Mu}{Z} $ $= \frac{176717 * 18.47}{804330.0} $ $= 4.06 $ $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 $ | | | 11 | |
| Forces Carried by Web $ = \frac{144.43}{M_w = Moment \ in \ web} $ $= \frac{Z_w * Mu}{Z} $ $= \frac{176717 * 18.47}{804330.0} $ $= 4.06 $ $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 $ | | | $= \frac{(330.0 - 2 * 11.5) * 7.5 * 392.6'}{2}$ | 7 |
| Forces Carried by Web $ \begin{aligned} M_w &= Moment \ in \ web \\ &= \frac{Z_w * Mu}{Z} \\ &= \frac{176717 * 18.47}{804330.0} \\ &= 4.06 \end{aligned} $ $ \begin{aligned} 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 \end{aligned} $ Forces Carried by Flange $ \begin{aligned} E_f &= \frac{M_f * 1000}{D - T} + A_f \\ &= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42 \end{aligned} $ | | | | |
| $= \frac{Z_w * Mu}{Z}$ $= \frac{176717 * 18.47}{804330.0}$ $= 4.06$ $A_f = Axial force in flange$ $= \frac{Au * B * T}{A}$ $= \frac{392.67 * 160.0 * 11.5}{6260.0}$ $= 115.42$ $M_f = Moment in flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange force$ $= \frac{M_f * 1000}{D - T} + A_f$ $= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42$ | Forces Carried by Web | | | |
| $= \frac{176717*18.47}{804330.0}$ $= 4.06$ $A_f = Axial \ force \ in \ flange$ $= \frac{Au*B*T}{A}$ $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_f = Moment \ in \ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f*1000}{D-T} + A_f$ $= \frac{14.42*1000}{330.0 - 11.5} + 115.42$ | | | | |
| $= \frac{176717*18.47}{804330.0}$ $= 4.06$ $A_f = Axial \ force \ in \ flange$ $= \frac{Au*B*T}{A}$ $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_f = Moment \ in \ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f*1000}{D-T} + A_f$ $= \frac{14.42*1000}{330.0 - 11.5} + 115.42$ | | | $=\frac{Z_w * Mu}{Z}$ | |
| $= 4.06$ $A_f = Axial \ force \ in \ flange$ $= \frac{Au*B*T}{A}$ $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_f = Moment \ in \ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f*1000}{D-T} + A_f$ $= \frac{14.42*1000}{330.0 - 11.5} + 115.42$ | | | 2 | |
| $= 4.06$ $A_f = Axial \ force \ in \ flange$ $= \frac{Au*B*T}{A}$ $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_f = Moment \ in \ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f*1000}{D-T} + A_f$ $= \frac{14.42*1000}{330.0 - 11.5} + 115.42$ | | | =1000000000000000000000000000000000000 | |
| $= \frac{Au*B*T}{A}$ $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_f = Moment \ in \ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f*1000}{D-T} + A_f$ $= \frac{14.42*1000}{330.0 - 11.5} + 115.42$ | | | =4.06 | |
| $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_f = Moment \ in \ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f*1000}{D-T} + A_f$ $= \frac{14.42*1000}{330.0 - 11.5} + 115.42$ | | | $A_f = Axial \ force \ in \ flange$ | |
| $= \frac{392.67*160.0*11.5}{6260.0}$ $= 115.42$ $M_f = Moment \ in \ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f*1000}{D-T} + A_f$ $= \frac{14.42*1000}{330.0 - 11.5} + 115.42$ | | | -Au*B*T | |
| Forces Carried by Flange $= 115.42$ $M_f = Moment \ in \ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f * 1000}{D - T} + A_f$ $= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42$ | | | - A | |
| Forces Carried by Flange $= 115.42$ $M_f = Moment \ in \ flange$ $= Mu - M_w$ $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f * 1000}{D - T} + A_f$ $= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42$ | | | $=\frac{392.67*160.0*11.5}{6260.0}$ | |
| Forces Carried by 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 $ | | | | |
| Forces Carried by 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 $ | | | | |
| Forces Carried by Flange $= 18.47 - 4.06$ $= 14.42$ $F_f = flange \ force$ $= \frac{M_f * 1000}{D - T} + A_f$ $= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42$ | | | | |
| $= 14.42$ $F_f = flange \ force$ $= \frac{M_f * 1000}{D - T} + A_f$ $= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42$ | Forces Carried by Flange | | | |
| $F_f = flange\ force$ $= rac{M_f*1000}{D-T} + A_f$ $= rac{14.42*1000}{330.0-11.5} + 115.42$ | | | | |
| $= \frac{M_f * 1000}{D - T} + A_f$ $= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42$ | | | | |
| $= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42$ | | | | |
| $= \frac{14.42 * 1000}{330.0 - 11.5} + 115.42$ | | | $=\frac{M_f * 1000}{D_f} + A_f$ | |
| | | | 1 2 2 | |
| | | | $=\frac{11.12 \times 1000}{330.0 - 11.5} + 115.42$ | |
| = 100.08 | | | = 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) | $p/g_{min} = 2.5 d$ = $2.5 * 12.0 = 30.0$ | 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) | $p/g_{min} = 2.5 d$ $= 2.5 * 12.0 = 30.0$ | 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) | $e/e'_{min} = [1.5 \text{ or } 1.7] * d_0$ = 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) | $e/e^{\circ}_{min} = [1.5 \text{ or } 1.7] * d_0$ = 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 | $if \ l \ge 15 * d \ then \ V_{rd} = \beta_{ij} * V_{db}$ $if \ l < 15 * d \ then \ V_{rd} = V_{db}$ $where,$ $l = ((nc \ or \ nr) - 1) * (p \ or \ g)$ $\beta_{ij} = 1.075 - l/(200 * d)$ $but \ 0.75 \le \beta_{ij} \le 1.0$ | $l = ((nc \ or \ nr) - 1) * (p \ or \ g)$ $= (10 - 1) * 30 = 270$ $= (2 - 1) * 0.0 = 0.0$ $l = 270$ $15 * d = 15 * 12.0 = 180.0$ $since, \ l \ge 15 * d \ then \ V_{rd} = \beta_{ij} * V_{d}$ $\beta_{ij} = 1.075 - 270/(200 * 12.0) = 0.90$ $V_{rd} = 0.96 * 19.47 = 19468.25$ | |

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2.4 Web Bolt Checks

| Check | Required | Provided | Remarks |
|-------------------------|--|---|---------|
| Shear Capacity (kN) | | $V_{dsb} = \frac{f_{ub} \ n_n \ A_{nb}}{1000 * \sqrt{3} \ \gamma_{mb}}$ $= \frac{500.0 * 2 * 84.3}{1000 * \sqrt{3} \ * 1.25}$ $= 38.94$ | |
| Bearing Capacity (kN) | | $V_{dpb} = \frac{2.5 \ k_b \ d \ t \ f_u}{1000 * \gamma_{mb}}$ $= \frac{2.5 \ * 0.52 * 12.0 * 7.5 * 410}{1000 * 1.25}$ $= 38.38$ | |
| Bolt Capacity (kN) | | $V_{db} = min (V_{dsb}, V_{dpb})$ = $min (38.94, 38.38)$ = 38.38 | |
| No of Bolts | $R_{u} = \sqrt{V_{u}^{2} + A_{u}^{2}}$ $n_{trial} = R_{u}/V_{bolt}$ $R_{u} = \frac{\sqrt{166.77^{2} + 144.43^{2}}}{38.38}$ $= 12$ | 20 | |
| No of Columns | | $n_c = 4$ | |
| No of Rows | | $n_r = 5$ | |
| Min. Pitch (mm) | $p/g_{min} = 2.5 d$ $= 2.5 * 12.0 = 30.0$ | 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) | $p/g_{min} = 2.5 d$ = $2.5 * 12.0 = 30.0$ | 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) | $e/e^{\circ}_{min} = [1.5 \text{ or } 1.7] * d_0$ = 1.7 * 13.0 = 22.1 | 25 | Pass |
| Max. End Distance (mm) | $e/e'_{max} = 12 \ t \ \varepsilon$ $\varepsilon = \sqrt{\frac{250}{f_y}}$ $e/e'_{max} = 12 \ *6.0 * \sqrt{\frac{250}{230}}$ $= 74.88$ | 25 | Pass |
| Min. Edge Distance (mm) | $e/e^{\circ}_{min} = [1.5 \text{ or } 1.7] * d_0$ = 1.7 * 13.0 = 22.1 | 25 | Pass |

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|------------------------------------|--|---|---------|
| 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 | | $\begin{array}{ll} l_n &= length \ available \\ l_n &= (n_r - 1) * g \\ &= (5 - 1) * 65 \\ &= 260 \\ y_{max} &= l_n/2 \\ &= 260/2 \\ &= 130.0 \\ x_{max} &= p * (n_c - 1)/2 \\ &= 30 * (4 - 1)/2 \\ &= 15.0 \\ M_d &= (V_u * ecc + M_w) \end{array}$ | |
| Moment Demand | | = (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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|----------------------|---|---|---------|
| | | $l = ((nc \ or \ nr) - 1) * (p \ or \ g)$ | |
| | $if l \ge 15 * d then V_{rd} = \beta_{ij} * V_{db}$ | = (4-1) * 30 = 90 | |
| | if $l < 15 * d$ then $V_{rd} = V_{db}$ | = (5-1) * 65 = 260 | |
| I I-: D - l +: | where, | l = 260 | |
| Long Joint Reduction | $l = ((nc \ or \ nr) - 1) * (p \ or \ g)$ | 15 * d = 15 * 12.0 = 180.0 | |
| | $\beta_{ij} = 1.075 - l/(200 * d)$ | since, $l \ge 15 * d then V_{rd} = \beta_{ij} * V_{db}$ | |
| | $but \ 0.75 \le \beta_{ij} \le 1.0$ | $\beta_{ij} = 1.075 - 260/(200 * 12.0) = 0.97$ | |
| | | $V_{rd} = 0.97 * 38.38 = 37.1$ | |
| Capacity (kN) | 36.85 | 37.1 | Pass |

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2.5 Outer flange plate Checks

| Check | Required | Provided | Remarks |
|--------------------------|--|----------|---------|
| Min. Plate Height (mm) | | 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 |
|----------------------------------|----------------|---|---------|
| | | $T_{dg} = \frac{l * t_p * f_y}{1000 * \gamma_{mo}}$ | |
| Flange Tension Yielding | | | |
| Capacity (kN) | | $=\frac{160.0*11.5*230}{1000*1.1}$ | |
| | | - 384 73 | |
| | | $T_{dn} = \frac{0.9 * A_n * f_u}{1000 * \gamma_{m1}}$ | |
| | | | |
| Flange Tension Rupture | | $= \frac{0.9 * (160.0 - 2 * 13.0) * 11.5 *}{1000 * 1.25}$ | 410 |
| Capacity (kN) | | | |
| | | =454.9 | |
| | | $T_{db1} = \frac{A_{vg}f_y}{1000 * \sqrt{3}\gamma_{m0}} + \frac{0.9A_{tn}f_u}{1000 * \gamma_{m1}}$ | |
| | | | |
| Flange Block Shear Capacity (kN) | | $T_{db2} = \frac{0.9 * A_{vn} f_u}{1000 * \sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{1000 * \gamma_{m0}}$ | |
| | | | |
| | | $T_{db} = min(T_{db1}, T_{db2}) = 518.1$ $T_d = Min(T_{dg}, T_{dn}, T_{db})$ | |
| Flange Tension Capacity | $f_f = 160.68$ | = Min(384.73, 454.9, 518.1) | Pass |
| (kN) | | = 384.73 | |
| | | $T_{dg} = \frac{l * t_p * f_y}{1000 * \gamma_{mo}}$ | |
| | | $I^{dg} = 1000 * \gamma_{mo}$ | |
| Web Tension Yielding Ca- | | $=\frac{307.0*7.5*230}{1000*1.1}$ | |
| pacity (kN) | | 1000 * 1.1 | |
| | | =481.43 | |
| | | $= 481.43$ $T_{dn} = \frac{0.9 * A_n * f_u}{1000 * \gamma_{m1}}$ | |
| Web Tension Rupture Ca- | | | 10 |
| pacity (kN) | | $= \frac{0.9 * (307.0 - 5 * 13.0) * 7.5 * 4}{1000 * 1.25}$ | |
| | | =535.79 | |
| | | $= 535.79$ $T_{db1} = \frac{A_{vg}f_y}{1000 * \sqrt{3}\gamma_{m0}} + \frac{0.9A_{tn}f_u}{1000 * \gamma_{m1}}$ | |
| Web Block Shear Capac- | | $0.9 * A_{vn} f_u \qquad A_{ta} f_u$ | |
| ity (kN) | | $T_{db2} = \frac{0.9 * A_{vn} f_u}{1000 * \sqrt{3} \gamma_{m1}} + \frac{A_{tg} f_y}{1000 * \gamma_{m0}}$ | |
| | | $T_{db} = min(T_{db1}, T_{db2}) = 615.45$ $T_d = Min(T_{dq}, T_{dn}, T_{db})$ | |
| | | $T_d = \overline{Min(T_{dg}, T_{dn}, T_{db})}$ | |
| Web Tension Capacity | $A_w = 144.43$ | = Min(481.43, 535.79, 615.45) | Pass |
| (kN) | | =481.43 | |

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2.7 Flange Plate Capacity Checks in Axial-Outside

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

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2.8 Web Plate Capacity Checks in Axial

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

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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) | | $V_{dn} = \frac{0.9 * A_{vn} * f_u}{1000 * \sqrt{3} * \gamma_{mo}}$ $= \frac{0.9 * (310 - (2.0 * 13.0)) * 6.0 *}{1.1 * 1000 * \sqrt{3}}$ $= 501.08$ | * 410 |
| Block Shear Capacity in Shear (V_db) (kN) | | $T_{db1} = \frac{A_{vg}f_y}{1000 * \sqrt{3}\gamma_{m0}} + \frac{0.9A_{tn}f_u}{1000 * \gamma_{m1}}$ $T_{db2} = \frac{0.9 * A_{vn}f_u}{1000 * \sqrt{3}\gamma_{m1}} + \frac{A_{tg}f_y}{1000 * \gamma_{m0}}$ $T_{db} = min(T_{db1}, T_{db2}) = 601.24$ | |
| 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

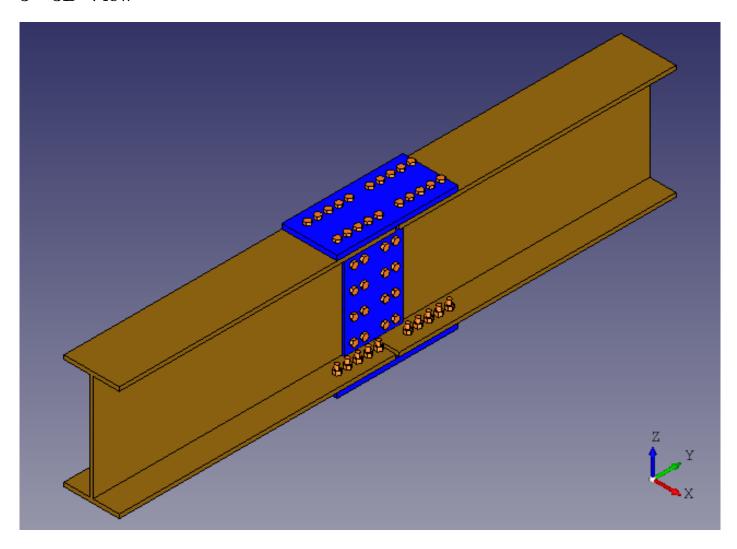


Figure 1: 3D View