Check the following beam to hollow section column joint for the design forces shown using Blind Bolts to the column.

In this example the tie force is less than the shear force.

The connections should be checked independently for shear forces and tying forces and not for both forces acting at the same time.

Design Information:
- **Bolts**: M20 Blind Bolts
- **Welds**: 6 mm leg length fillet welds
- **Column**: S355
- **Beams**: S275
- **End plates**: S275

This worked example should be read in conjunction with P358: Joints in Steel Construction: Simple Joints to Eurocode 3
### CONNECTION DESIGN USING RESISTANCE TABLES

Although the connection resistance tables are based on ordinary bolts, they may be used to determine the vertical shear resistance of connections with Blind Bolts, because bolt shear resistance is generally not critical. The tables for ordinary bolts cannot be used to determine the connection tying resistance, as the bolt tension resistance has a significant influence on the tying resistance of the connection.

<table>
<thead>
<tr>
<th>406 x 178 x 74 UKB, S275</th>
<th>533 x 210 x 92 UKB, S275</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>End plate, 150 x 10 S275</strong></td>
<td><strong>End plate, 200 x 12 S275</strong></td>
</tr>
<tr>
<td>Welds 6 mm fillet</td>
<td>Welds 6 mm fillet</td>
</tr>
<tr>
<td>Bolts M20</td>
<td>Bolts M20</td>
</tr>
<tr>
<td>Bolts at 90 cross centres</td>
<td>Bolts at 140 cross centres</td>
</tr>
<tr>
<td>4 rows of bolts</td>
<td>6 rows of bolts</td>
</tr>
</tbody>
</table>

From Resistance Table G.4:

- **Connection shear resistance**
  - End plate, 150 x 10 S275: \( \frac{394 \text{ kN}}{340 \text{ kN}} \)
  - End plate, 200 x 12 S275: \( \frac{621 \text{ kN}}{550 \text{ kN}} \)

- **Minimum support thickness in S355**
  - End plate, 150 x 10 S275: \( \frac{3.2 \text{ mm}}{12.5 \text{ mm}} \)
  - End plate, 200 x 12 S275: \( \frac{3.4 \text{ mm}}{12.5 \text{ mm}} \)

- **Connection tying resistance**
  - End plate, 150 x 10 S275: *Table cannot be used*
  - End plate, 200 x 12 S275: *Table cannot be used*

**Note:**

1. For connections using Blind Bolts, the tying resistance of the connection is the least of the values obtained from Checks 11, 12 & 13.
2. The hollow section wall must also be checked as shown in Check 15.
### SUMMARY OF FULL DESIGN CHECKS FOR EXAMPLE 4a

**Notes:**

1. Checks 1 to 4 and 9 are as shown in Example 1.
2. Tying forces are ignored when checking the shear resistance and shear is ignored calculating the tying resistance.

<table>
<thead>
<tr>
<th>Sheet No.</th>
<th>CHECK</th>
<th>406 UKB (S275)</th>
<th>533 UKB (S275)</th>
<th>SHS Column, S355</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Resist</td>
<td>Design force</td>
<td>Resist</td>
</tr>
<tr>
<td>Check 1</td>
<td>Recommended detailing practice</td>
<td>All recommendations adopted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check 2</td>
<td>Supported beam Welds (kN)</td>
<td>Full strength welds adopted – Not critical</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>Check 3</td>
<td>Not applicable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check 4</td>
<td>Supported beam Web in shear</td>
<td>Shear resistance (kN)</td>
<td>394</td>
<td>340</td>
</tr>
<tr>
<td>Checks 5, 6, 7</td>
<td>Not applicable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Check 8</td>
<td>Connection Bolt group</td>
<td>Bolt group (kN)</td>
<td>487</td>
</tr>
<tr>
<td>Check 9</td>
<td>Connection End plate in shear</td>
<td>Shear resistance (kN)</td>
<td>691</td>
<td>340</td>
</tr>
<tr>
<td>6</td>
<td>Check 10</td>
<td>Supporting column Shear and bearing</td>
<td>Shear and Bearing resistance (kN)</td>
<td>Not applicable</td>
</tr>
<tr>
<td>8</td>
<td>Check 11</td>
<td>Tying resistance Plates and bolts</td>
<td>Tension (kN)</td>
<td>323</td>
</tr>
<tr>
<td>10</td>
<td>Check 12</td>
<td>Structural Integrity Supported beam web</td>
<td>Tension (kN)</td>
<td>1027</td>
</tr>
<tr>
<td>10</td>
<td>Check 13</td>
<td>Structural Integrity Welds</td>
<td>Tension (kN)</td>
<td>Full strength welds adopted – not critical</td>
</tr>
<tr>
<td>Check 14</td>
<td>Not applicable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Check 15</td>
<td>Structural Integrity Supporting column wall</td>
<td>Tension (kN)</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
**Example 4a – Partial depth end plate – Beam to hollow section column using Blind Bolts**

### CONNECTION DESIGN FOLLOWING THE DESIGN PROCEDURES

#### Check 8: Connection – Bolt group

**Basic requirement:** \( V_{Ed} \leq F_{Rd} \)

The resistance of the bolt group, \( F_{Rd} \), is as follows:

- If \( F_{Rd} \leq 0.8 F_{v, Rd} \) then \( F_{Rd} = n F_{b, Rd} \)
- If \( F_{Rd} > 0.8 F_{v, Rd} \) then \( F_{Rd} = 0.8 n F_{v, Rd} \)

Shear resistance of a single bolt. For M20 Blind Bolts:

Conservatively assume the shear plane is over the slot:

\[
F_{v, Rd} = F_{v, Rd, slot} = 76.1 \text{ kN}
\]

Bearing resistance of a single bolt:

\[
F_{b, Rd} = \min(F_{b, Rd, p}; F_{b, Rd, 2})
\]

\[
F_{b, Rd, p} = \frac{k_{1, p} \alpha_{b, p} f_{u, p} d_{p}}{\gamma_{M2}}
\]

\[
F_{b, Rd, 2} = \frac{k_{1, 2} \alpha_{b, 2} f_{u, 2} d_{2}}{\gamma_{M2}}
\]

### 406 x 178 x 74 UKB, S275

For an M20 Blind Bolt: \( d = 20 \text{ mm} \) \( d_0 = 22 \text{ mm} \) \( f_{u, b} = 1000 \text{ N/mm}^2 \)

Bearing on the end plate:

\[
k_{1, p} = \min\left(2.8 \frac{e_2}{d_0}; 1.7; 1.4 \frac{p_3}{d_0}; 1.7; 2.5\right)
\]

\[
k_{1, p} = \min\left(2.8 \frac{30}{22}; 1.7; 1.4 \frac{90}{22}; 1.7; 2.5\right) = \min(2.1; 4.0; 2.5) = 2.1
\]

\[
\alpha_{b, p} = \min\left(\frac{e_1}{3d_0}; \frac{p_1}{3d_0}; 1; \frac{f_{u, p}}{4 f_{u, b}}; 1.0\right) = \min\left(\frac{40}{3 \times 22}; \frac{70}{3 \times 22}; 0.25; \frac{1000}{410}; 1.0\right)
\]

\[
\alpha_{b, p} = \min(0.6; 0.81; 2.44; 1.0) = 0.61
\]

\[
F_{b, Rd, p} = \frac{2.1 \times 0.61 \times 410 \times 20 \times 10^{-3}}{1.25} = 84.0 \text{ kN}
\]

Since plate is 150 mm wide and \( p_2 = 90 \text{ mm} \) then: \( e_2 = 30 \text{ mm} \)

340 kN
Bearing on the supporting column:
Since the hollow section wall is 12.5 mm thick and S355, clearly the end plate is critical.
Therefore can be assumed that:

\[ F_{b,Rd,2} > F_{b,Rd,p} \]

\[ F_{b,Rd} = \min(F_{b,Rd,p}; F_{b,Rd,2}) = 84.0 \text{ kN} \]

\[ 0.8F_{v,Rd} = 0.8 \times 76.1 = 60.9 \text{ kN} \]

\[ \therefore F_{b,Rd} = 84.0 \text{ kN} > 60.9 \text{ kN} \]

\[ \therefore V_{Ed} = 340 \text{ kN} < 487 \text{ kN} \]

\[ \therefore \text{O.K.} \]

\[ 533 \times 210 \times 92 \text{ UKB, S275} \]

Since plate is 200 mm wide and \( p_2 = 140 \text{ mm} \) then: \( e_2 = 30 \text{ mm} \)
Bearing on the end plate:

\[ k_{1,p} = \min\left(\frac{2.8 \cdot e_2}{d_0}; \frac{1.4 \cdot p_3}{d_0}; 2.5\right) \]

\[ = \min\left(\frac{2.8 \times 30}{22}; \frac{1.4 \times 140}{22}; 2.5\right) = \min\left(2.1; 7.2; 2.5\right) = 2.1 \]

\[ \alpha_{b,p} = \min\left(\frac{e_1}{3d_0}; \frac{p_1}{3d_0}; \frac{1}{4}; \frac{f_{ub}}{f_{u,p}}; 1.0\right) = \min\left(\frac{40}{3 \times 22}; \frac{70}{3 \times 22}; \frac{1000}{410}; 1.0\right) \]

\[ = \min(0.6; 0.8; 2.44; 1.0) = 0.61 \]

\[ F_{b,Rd,p} = \frac{2.1 \times 0.61 \times 410 \times 20 \times 12 \times 10^{-3}}{1.25} = 100.8 \text{ kN} \]

Bearing on the supporting column:
Since the hollow section wall is 12.5 mm thick and S355, clearly the end plate is critical.
Therefore can be assumed that:

\[ F_{b,Rd,2} > F_{b,Rd,p} \]

\[ F_{b,Rd} = \min(F_{b,Rd,p}; F_{b,Rd,2}) = 100.8 \text{ kN} \]

\[ 0.8F_{v,Rd} = 0.8 \times 76.1 = 60.9 \text{ kN} \]

\[ \therefore F_{b,Rd} = 100.8 \text{ kN} > 60.9 \text{ kN} \]

\[ \therefore V_{Ed} = 550 \text{ kN} < 731 \text{ kN} \]

\[ \therefore \text{O.K.} \]
Check 10: Supporting column – Shear and bearing

Local shear and bearing resistance of the hollow section column wall

(i) Shear:

Basic requirement: \( \frac{V_{Ed}}{2} \leq V_{Rd,min} \)

\[
V_{Rd,min} = \min\left( \frac{A_v f_y,2}{\sqrt{3} \gamma_{M0}}, \frac{A_{v,net} f_u,2}{\sqrt{3} \gamma_{M2}} \right)
\]

406 x 178 x 74 UKB, S275

Critical sections

wall thickness \( t_2 = 12.5 \text{ mm} \)

\[ \frac{V_{Ed}}{2} = 170 \text{ kN} \]

Shear area of gross section: \( A_v = t_2 (e_t + (n_1 - 1)t_1 + e_t) \)

\[ e_b = \min\left( e_{1,b}; \frac{p_3}{2}; 5d \right) \]

Since the connection is not near the bottom of the column \( e_{1,b} \) is not applicable.

\[ e_b = \min\left( \frac{p_3}{2}; 5d \right) = \min\left( \frac{90}{2}; 5 \times 20 \right) = 45 \text{ mm} \]

\[ e_t = \min\left( e_{1,t}; 5d \right) \]

Since the connection is not near the top of the column \( e_{1,t} \) is not applicable.

\[ e_t = 5 \times 20 = 100 \text{ mm} \]

\[ A_v = 12.5 \times (100 + (4 - 1) \times 70 + 45) = 4438 \text{ mm}^2 \]

\( t_2 < 16 \text{ mm} \), hence \( f_{u,2} = 355 \text{ N/mm}^2 \)

Therefore the resistance of the gross section is:

\[ \frac{A_v f_y,2}{\sqrt{3} \gamma_{M0}} = \frac{4438 \times 355}{\sqrt{3} \times 1.0} \times 10^{-3} = 910 \text{ kN} \]

Shear area of net section: \( A_{v,net} = A_v - n_1 d_0 t_2 \)

\[ A_{v,net} = 4438 - 4 \times 22 \times 12.5 = 3338 \text{ mm}^2 \]

Therefore the resistance of the net section is:

\[ \frac{A_{v,net} f_u,2}{\sqrt{3} \gamma_{M2}} = \frac{3338 \times 470}{\sqrt{3} \times 1.1} \times 10^{-3} = 823 \text{ kN} \]

\[ V_{Rd,min} = \min(910; 823) = 823 \text{ kN} \]

\[ \frac{V_{Ed}}{2} = 170 \text{ kN} < 823 \text{ kN} \]

\( f_{u,2} \) for S355 from Table A.3 of EN 10210

\( \therefore \text{O.K.} \)
Shear area of gross section: \( A_v = t_b (e_t + (n_1 - 1)p_1 + e_b) \)
\[
e_b = \min \left( e_{1,b} \cdot \frac{p_1}{2} ; 5d \right)
\]
Since the connection is not near the bottom of the column \( e_{1,b} \) is not applicable.
\[
e_b = \min \left( \frac{p_1}{2} ; 5d \right) = \min \left( \frac{140}{2} ; 5 \times 20 \right) = 70 \text{ mm}
\]
\[
e_t = \min (e_{1,t} ; 5d)
\]
Since the connection is not near the top of column \( e_{1,t} \) is not applicable.
\[
e_t = 5 \times 20 = 100 \text{ mm}
\]
\[
A_v = 12.5 \times (100 + (6 - 1) \times 70 + 70) = 6500 \text{ mm}^2
\]
Therefore the resistance of the gross section is:
\[
M_{0,y,2v} = \frac{A_v f_y}{3 \gamma_{M0}} = \frac{6500 \times 355 \times 10^{-3}}{\sqrt{3} \times 1.0} = 1332 \text{ kN}
\]
Shear area of net section: \( A_{v,\text{net}} = A_v - n_1 d_0 t_2 \)
\[
A_{v,\text{net}} = 6500 - 6 \times 22 \times 12.5 = 4850 \text{ mm}^2
\]
Therefore the resistance of the net section is:
\[
M_{2,u,2v,\text{net}} = \frac{A_{v,\text{net}} f_y}{3 \gamma_{M2}} = \frac{4850 \times 470 \times 10^{-3}}{\sqrt{3} \times 1.1} = 1196 \text{ kN}
\]
\[
V_{Ed,\text{min}} = \min (1332; 1196) = 1196 \text{ kN}
\]
\[
\frac{V_{Ed}}{2} = 275 \text{ kN} < 1196 \text{ kN}
\]

(ii) Bearing resistance
Bearing resistance in the column wall will not be critical when compared to the bearing resistance in the end plates (see Check 8).
Check 11: Tying resistance – Plate and bolts

Resistance of end plate

Basic requirement: \( F_{Ed} \leq \min(F_{Rd,u,1}; F_{Rd,u,2}; F_{Rd,u,3}) \)

\[ 406 \times 178 \times 74 \text{ UKB, S275} \]

\[ \Sigma l_{eff} \]

Mode 1:

\[ F_{Rd,u,1} = \frac{(8n - 2e_w)M_{pl,1,Rd,u}}{2mn - e_w(m + n)} \]

\( \Sigma l_{eff} \) is the effective length of the equivalent T-stub = \( h_p = 290 \text{ mm} \)

\[ M_{pl,1,Rd,u} = \frac{0.25 \Sigma l_{eff} f_p^2 f_{up}}{y_{Mu}} = \frac{0.25 \times 290 \times 10^2 \times 410 \times 10^{-6}}{1.1} = 2.7 \text{ kNm} \]

\( a\sqrt{2} \) is the weld leg length = 6 mm

\[ m = \frac{p_3 - t_{w,pl} - 2 \times 0.8 \times a\sqrt{2}}{2} = \frac{90 - 9.5 - 2 \times 0.8 \times 6}{2} = 35.5 \text{ mm} \]

\[ e_w = \frac{d_w}{4} = \frac{37}{4} = 9.25 \text{ mm} \]

\[ n = \min(8; 1.25m) = \min(30; 1.25 \times 35.5) = 30 \text{ mm} \]

\[ \therefore F_{Rd,u,1} = \frac{(8 \times 30 - 2 \times 9.25) \times 2.7 \times 10^6 \times 10^{-3}}{2 \times 35.5 \times 30 - 9.25 \times (35.5 + 30)} = 392 \text{ kN} \]

Mode 2:

\[ F_{Rd,u,2} = \frac{2M_{pl,2,Rd,u} + nF_{I,Rd,u}}{m + n} \]

\[ M_{pl,2,Rd,u} = M_{pl,1,Rd,u} = 2.7 \text{ kNm} \]

\[ F_{I,Rd,u} = 65.7 \text{ kN} \]

\[ F_{Rd,u,2} = \frac{2 \times 2.7 \times 10^6 + 30 \times 8 \times 65.7 \times 10^3 \times 10^{-3}}{35.5 + 30} = 323 \text{ kN} \]

Mode 3:

\[ F_{Rd,u,3} = \Sigma F_{I,Rd,u} = 8 \times 65.7 = 526 \text{ kN} \]

\[ \min(F_{Rd,u,1} , F_{Rd,u,2} , F_{Rd,u,3}) = \min(392, 323, 526) = 323 \text{ kN} \]

\[ F_{Ed} = 200 \text{ kN} < 323 \text{ kN} \]

\( \therefore \text{O.K.} \)
**End plates – Worked examples with partial depth end plate – Example 4a**

**Title Example 4a – Partial depth end plate – Beam to hollow section column using Blind Bolts**

Sheet 9 of 11

---

**533 x 210 x 92 UKB, S275**

\[ e_1 = 40 \]

\[ p_1 = 70 \]

\[ p_1 = 70 \]

\[ p_1 = 70 \]

\[ p_1 = 70 \]

\[ e_1 = 40 \]

\[ p_3 = 140 \]

\[ \Sigma I_{\text{eff}} \]

\[ 275 \text{kN} \]

\[ m \]

Mode 1:

\[ F_{\text{Rd,u,1}} = \frac{(8n - 2e_w)M_{pl,1,Rd,u}}{2mn - e_w(m + n)} \]

\[ \Sigma I_{\text{eff}} \] is the effective length of the equivalent T-stub = \( h_p = 430 \text{ mm} \)

\[ M_{pl,1,Rd,u} = \frac{0.25\Sigma I_{\text{eff}}t_p^2f_{up}}{\gamma_{M,u}} = \frac{0.25 \times 430 \times 12^2 \times 410 \times 10^{-6}}{1.1} = 5.77 \text{kNm} \]

\[ a\sqrt{2} \] is the weld leg length = 6 mm

\[ m = \frac{p_3 - t_{w,b1} - 2 \times 0.8 \times a\sqrt{2}}{2} = \frac{140 - 10.1 - 2 \times 0.8 \times 6}{2} = 60.15 \text{ mm} \]

\[ e_w = \frac{d_w}{4} = \frac{37}{4} = 9.25 \text{ mm} \]

\[ n = \min\left(e_1; 1.25m\right) = \min\left(30; 1.25 \times 60.15\right) = 30 \text{ mm} \]

\[ \therefore F_{\text{Rd,u,1}} = \left(\frac{8 \times 30 - 2 \times 9.25}{2 \times 60.15 + 30} - 9.25 \times 60.15 + 30\right) = 461 \text{kN} \]

**Mode 2:**

\[ F_{\text{Rd,u,2}} = \frac{2M_{pl,2,Rd,u} + nF_{t,Rd,u}}{m + n} \]

\[ M_{pl,2,Rd,u} = M_{pl,1,Rd,u} = 5.77 \text{kNm} \]

\[ F_{t,Rd,u} = 65.7 \text{kN} \]

\[ F_{\text{Rd,u,2}} = \frac{2 \times 5.77 \times 10^6 + 30 \times 12 \times 65.7 \times 10^3 \times 10^{-3}}{60.15 + 30} = 390 \text{kN} \]

**Mode 3:**

\[ F_{\text{Rd,u,3}} = \sum F_{t,Rd,u} = 12 \times 65.7 = 788 \text{kN} \]

\[ \min\left(F_{\text{Rd,u,1}}, F_{\text{Rd,u,2}}, F_{\text{Rd,u,3}}\right) = \min\left(461, 390, 788\right) = 390 \text{kN} \]

\[ F_{\text{Ed}} = 275 \text{kN} < 390 \text{kN} \]

\[ \therefore \text{O.K.} \]
Check 12: Tying resistance – Supported beam web

Resistance of the beam web

Basic requirement: \( F_{Ed} \leq F_{Rd} \)

**406x178x74 UKB, S275**

\[
F_{Rd} = \frac{t_{web} h_p f_{ub1}}{\gamma_{Mu}} = \frac{9.5 \times 290 \times 410}{1.1} \times 10^{-3} = 1027 \text{kN}
\]

\( F_{Ed} = 200 \text{kN} < 1027 \text{kN} \)

\( \therefore O.K. \)

**533x210x92 UKB, S275**

\[
F_{Rd} = \frac{t_{web} h_p f_{ub1}}{\gamma_{Mu}} = \frac{10.1 \times 430 \times 410}{1.1} \times 10^{-3} = 1619 \text{kN}
\]

\( F_{Ed} = 275 \text{kN} < 1619 \text{kN} \)

\( \therefore O.K. \)

Check 13: Tying resistance – Welds

Basic requirement: \( a \leq 0.40 t_{web1} \)

**406x178x74 UKB, S275**

Throat thickness:

\[
a = \frac{6}{\sqrt{2}} = 4.24 \text{ mm}
\]

\( 0.40 t_{web1} = 0.40 \times 9.5 = 3.8 \text{ mm} \)

\( a = 4.24 \text{ mm} \geq 3.8 \text{ mm} \)

\( \therefore O.K. \)

**533x210x92 UKB, S275**

Throat thickness:

\[
a = \frac{6}{\sqrt{2}} = 4.24 \text{ mm}
\]

\( 0.40 t_{web1} = 0.40 \times 10.1 = 4.04 \text{ mm} \)

\( a = 4.24 \text{ mm} \geq 4.04 \text{ mm} \)

\( \therefore O.K. \)
Check 15: Tying resistance – Supporting column wall

Resistance of hollow section wall

Basic requirement: \( F_{Ed} \leq F_{Rd} \)

\[
F_{Rd} = \frac{8M_{p,Rd,u}}{(1-\beta_1)(n_1 + 1.5(1-\beta_1)\gamma^{0.5}(1-\gamma^{0.5}))}
\]

\[
M_{p,Rd,u} = \frac{f_{u,c}t_2^2}{4\gamma_{M,u}}
\]

406 x 178 x 74 UKB, S275

\[ b = 250 \]

\[ t_u = 12.5 \]

\[ \rho_3 = 90 \text{ for } 406 \times 178 \text{ UKB} \]

\[ 140 \text{ for } 533 \times 210 \text{ UKB} \]

\[ p_1 \]

\[ (n_1 - 1)p_1 \]

\[ 250 \times 250 \times 12.5 \text{ SHS} \]

Grade S355

\[ f_{u,c} \text{ for S355 from Table A.3 of EN 10210-1} \]

\[ f_{u,c} = 355 \text{ MPa} \]

\[ Tying Force \]

Check 533 x 210 x 92 UKB, S275

\[ M_{p,Rd,u} = \frac{470 \times 12.5^2}{4 \times 1.1} \times 10^{-3} = 16.7 \text{ kNm/mm} \]

\[ \beta_1 = \frac{\rho_3}{b-3t_2} = \frac{90}{250 - 3 \times 12.5} = 0.424 \]

\[ \gamma = \frac{d_0}{b-3t_2} = \frac{22}{250 - 3 \times 12.5} = 0.104 \]

\[ \eta_1 = \frac{(n_1 - 1)p_1 - \frac{n_1}{2}d_0}{b-3t_2} = \frac{(4-1) \times 70 - \frac{4}{2} \times 22}{250 - 3 \times 12.5} = 0.781 \]

\[ F_{Rd,u} = \frac{8 \times 16.7}{(1 - 0.424)} \times (0.781 + 1.5 \times (1 - 0.424)^{0.5} \times (1 - 0.104)^{0.5}) = 431 \text{ kN} \]

\[ F_{Ed} = 200 \text{ kN} \leq 431 \text{ kN} \]

\[ :: \text{ O.K.} \]

533 x 210 x 92 UKB, S275

\[ M_{p,Rd,u} = \frac{470 \times 12.5^2}{4 \times 1.1} \times 10^{-3} = 16.7 \text{ kNm/mm} \]

\[ \beta_1 = \frac{\rho_3}{b-3t_2} = \frac{140}{250 - 3 \times 12.5} = 0.659 \]

\[ \gamma = \frac{d_0}{b-3t_2} = \frac{22}{250 - 3 \times 12.5} = 0.104 \]

\[ \eta_1 = \frac{(n_1 - 1)p_1 - \frac{n_1}{2}d_0}{b-3t_2} = \frac{(6-1) \times 70 - \frac{6}{2} \times 22}{250 - 3 \times 12.5} = 1.34 \]

\[ F_{Rd,u} = \frac{8 \times 16.7}{(1 - 0.659)} \times (1.34 + 1.5 \times (1 - 0.659)^{0.5} \times (1 - 0.104)^{0.5}) = 850 \text{ kN} \]

\[ F_{Ed} = 275 \text{ kN} \leq 850 \text{ kN} \]

\[ :: \text{ O.K.} \]