Joint Types

CL 5.2.2.2 ‘Nominally pinned’ joints are capable of transmitting internal forces without developing significant moments, and capable of accepting the resulting rotations under the design loads.

CL 5.2.2.3 ‘Rigid and full strength’ joints have sufficient rotational stiffness to justify analysis based on full continuity.

‘Semi-rigid’ joints lie somewhere between ‘nominally pinned’ and ‘rigid’.

Eurocode 3

- Principles mostly the same as BS 5950
- Results are similar although EC3 results are slightly more conservative and this is due to the larger partial safety factor (γM2 = 1.25)

Bolt Strength

These values should be adopted as characteristic values in design calculations:

<table>
<thead>
<tr>
<th>Bolt classes</th>
<th>4.6</th>
<th>5.6</th>
<th>8.8</th>
<th>10.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>fub (N/mm²)</td>
<td>240</td>
<td>300</td>
<td>640</td>
<td>900</td>
</tr>
<tr>
<td>fis (N/mm²)</td>
<td>400</td>
<td>500</td>
<td>800</td>
<td>1000</td>
</tr>
</tbody>
</table>

EN 1993-1-8 Clause 2.2

- Partial safety factors, γM for joints are given in Table 2.1 of EC-3-8.
- Refer to NA to get the required values of the different partial safety factors
- Resistance of bolts and welds, γM2 = 1.25

Bolted Joints – Table 3.4

Table 3.4 of EN 1993-1-8 gives the different checks required for individual fasteners subjected to shear and/or tension.

Checks need to be carried out for a number of possible failure modes:

- Shear resistance per shear plate
- Bearing Resistance
- Tension Resistance
- Combined shear and tension

Bolted Joints – Tension

Tension resistance for ordinary bolts:

\[ F_{t,Rd} = k_2 f_{ub} \frac{A_s}{\gamma_{M2}} \]

where:

- \( A_s \) is the tensile stress area of the bolt
- \( \gamma_{M2} = 1.25 \)
- \( f_{ub} \) is the ultimate tensile strength of the bolt
- \( k_2 = 0.63 \) for countersunk bolt, otherwise \( k_2 = 0.9 \)

Bolted Joints – Shear

Shear resistance per shear plane for ordinary bolts where the shear plane passes through the threaded portion of the bolt:

\[ F_{v,Rd} = \alpha_v f_{ub} \frac{A_s}{\gamma_{M2}} \]

where:

- \( A_s \) is the tensile stress area of the bolt
- \( f_{ub} \) is the ultimate tensile strength of the bolt
- \( \gamma_{M2} = 1.25 \)

<table>
<thead>
<tr>
<th>Bolt classes</th>
<th>4.6</th>
<th>4.8</th>
<th>5.6</th>
<th>5.8</th>
<th>6.8</th>
<th>8.8</th>
<th>10.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha_v )</td>
<td>0.6</td>
<td>0.5</td>
<td>0.6</td>
<td>0.5</td>
<td>0.5</td>
<td>0.6</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Shear resistance per shear plane for ordinary bolts where the shear plane passes through the unthreaded portion of the bolt:

\[ F_{v,Rd} = 0.6 f_{ub} \frac{A}{Y_{M2}} \]

where:
- \( A \) is the gross cross-section of the bolt
- \( f_{ub} \) is the ultimate tensile strength of the bolt
- \( Y_{M2} = 1.25 \)

Bolted Joints – Bearing

Bearing resistance for ordinary bolts:

\[ F_{b,Rd} = k_1 \alpha_b f_u \frac{dt}{Y_{M2}} \]

where:
- \( d \) is the bolt diameter
- \( t \) is the thickness
- \( Y_{M2} = 1.25 \)
- \( f_u \) is the ultimate tensile strength

\[ \alpha_b = \min \left( \frac{e_1}{3d_0}, \frac{f_{ub}}{f_u}; 1.0 \right) \] for end bolts

\[ \alpha_b = \min \left( \frac{p_1}{3d_0}, \frac{1}{4}, \frac{f_{ub}}{f_u}; 1.0 \right) \] for inner bolts

Perpendicular to the direction of load transfer:

\[ k_1 = \min \left( \frac{2.8 e_2}{d_0} - 1.7; 2.5 \right) \] for edge bolts

\[ k_1 = \min \left( \frac{1.4 p_2}{d_0} - 1.7; 2.5 \right) \] for inner bolts

Bolted Joints – Position of Holes

Table 3.3 of EN 1993-1-8 gives the maximum and minimum spacing, end and edge distances

<table>
<thead>
<tr>
<th></th>
<th>Minimum distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>End distance ( e_1 )</td>
<td>1.2d_0</td>
</tr>
<tr>
<td>Edge distance ( e_2 )</td>
<td>1.2d_0</td>
</tr>
<tr>
<td>Spacing ( p_1 )</td>
<td>2.2d_0</td>
</tr>
<tr>
<td>Spacing ( p_2 )</td>
<td>2.4d_0</td>
</tr>
</tbody>
</table>

where \( d_0 \) = hole diameter

Welded Joints

Simplified method for design resistance of fillet weld (CL 4.5.3.3 and Table 4.1 EN 1993-1-8)

\[ F_{w,Ed} \leq F_{w,Rd} \] (4.2)

\( F_{w,Ed} \) is the design value of the weld force per unit length

\( F_{w,Rd} \) is the design resistance per unit length

\[ F_{w,Rd} = f_{vw,a} \]

\( f_{vw,d} \) is the design shear strength of the weld

\( a \) is the effective throat thickness (see Figure 1)

\[ f_{vw,d} = \frac{f_u}{\beta_w Y_{M2}} \] (4.4)

\( f_u \) is the minimum ultimate tensile strength of the connected parts

\( \beta_w \) is a correlation factor (See Table 4.1)

\( Y_{M2} = 1.25 \)

Steel grade | Correlation factor \( \beta_w \)
-------------|-------------------|
S275        | 0.85              |
S355        | 0.90              |

Extract from Table 4.1 from EN 1993-1-8: Values for correlation factor \( \beta_w \)