WORKED EXAMPLE 3.2
Welds of a Fin Plate Connection

Check the resistance of the fillet-welded connection of the fin plate, shown in Figure 1WE3-2
The connection is subject to the vertical factored force $V_{Sd} = 300\ kN$, acting at an eccentricity $e = 60\ mm$.
The steel is Grade S235, and the material partial safety factors are $\gamma_{M0} = 1{,}0$ and $\gamma_{Mw} = 1{,}25$.

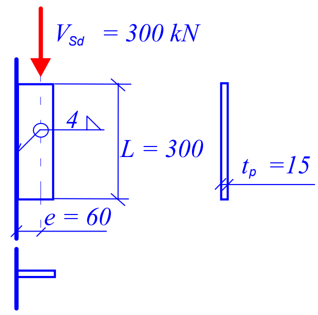


Figure 1WE3-2

The structural welds should be (i) longer than $40\ mm$, and (ii) longer than $6\ a_u = 6 * 4 = 24\ mm$. Both of these are satisfied. The full length of the weld can be taken into account in the strength calculation, because $150 a_w = 50 * 4 = 600 mm > 300 mm$.
The shear stress perpendicular to the weld cross-section is

$$\tau_{II} = \frac{V_{Sd}}{a_w\ 2\ L} = \frac{300 * 10^3}{4 * 2 * 300} = 125{,}0\ MPa\ .$$

The maximum normal stress parallel to the weld cross-section, based on an elastic distribution of bending stresses is

$$\sigma_w = \frac{M}{W_{el.w}} = \frac{V_{Sd}\ e}{\frac{2\ a_w\ L^2}{6}} = \frac{300 * 10^3 * 60}{\frac{2 * 4 * 300^2}{6}} = 150{,}0\ MPa\ ,$$

which may be decomposed (see Fig. 3WE22) into the shear across the critical plane (the weld throat) and the normal stress perpendicular to this plane:

$$\tau_{\perp} = \sigma_{\perp} = \frac{\sigma_w}{\sqrt{2}} = \frac{150}{\sqrt{2}} = 106{,}1\ MPa\ .$$

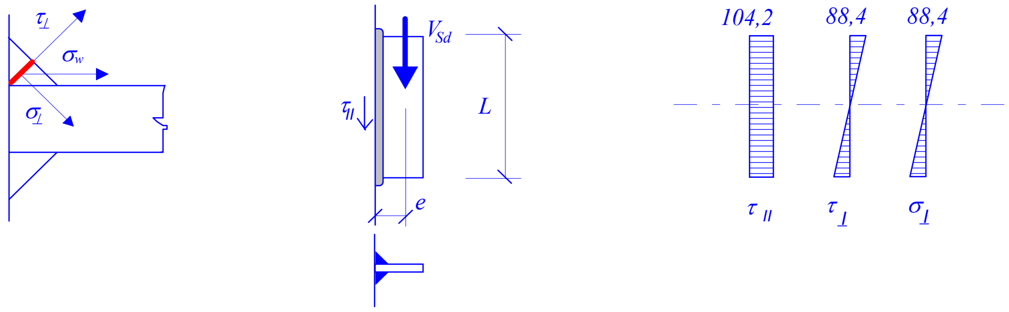


Figure 2WE3-1

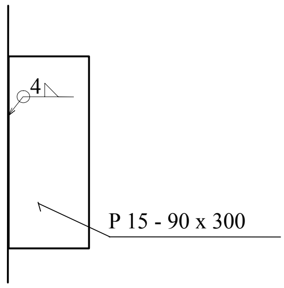
Check of the weld design resistance:

$$\sqrt{\sigma_{\perp}^2 + 3\left(\tau_{\perp}^2 + \tau_{//}^2\right)} = \sqrt{106{,}1^2 + 3 * \left(106{,}1^2 + 125{,}0^2\right)} = 303{,}2\ MPa < \frac{f_u}{\beta_w\ \gamma_{Mw}} = \frac{360}{0{,}8 * 1{,}25} = 360{,}0\ MPa\ ,$$

and

$$\sigma_{\perp} = 106{,}1\ MPa < \frac{f_u}{\gamma_{Mw}} = \frac{360}{1{,}25} = 288\ MPa\ .$$

The weld strength is satisfactory.



Steel S235 J2

Scale: 1 :10

Figure 3WE3-2. Design drawing of the connection

Note:

1) The weld resistance may conservatively be checked independent of the loading direction as follows:

$$\sqrt{\sigma_w^2 + \tau_{II}^2} = \sqrt{150{,}0^2 + 125{,}0^2} = 195{,}3\ MPa < \frac{f_u}{\beta_w \gamma_{Mw} \sqrt{3}} = \frac{360}{0{,}8 * 1{,}25 * \sqrt{3}} = 207{,}8\ MPa\ .$$

2) The plate's resistance in shear is

$$V_{pl.Rd} = \frac{A_v f_y}{\gamma_{M0} * \sqrt{3}} = \frac{15 * 300 * 235}{1{,}0 * \sqrt{3}} = 610{,}5 * 10^3\ N > V_{Sd} = 300\ kN\ .$$

and in bending:

$$M_{c.Rd} = W_{el}\ f_y / \gamma_{M0} = \frac{15 * 300^2}{6} * 235 / 1{,}0$$

$$= 52{,}9 * 10^6\ Nmm > M_{Sd} = 300 * 10^3 * 60 = 18 * 10^6\ Nmm\ .$$

The interaction of bending and shear need not be checked, because the shear resistance is more than double the shear force acting:

$$610{,}5 * 10^3 / 2 = 305{,}2 * 10^3\ N > 300kN\ .$$

3) The elastic distribution of stresses in the welds is used because the above is an elastic check of the fin-plate connection. A plastic check of the welds may be performed, based on the expression

$$\sigma_w = \frac{M}{W_{pl.w}} = \frac{V_{Sd}\ e}{\frac{2\ a_w\ L^2}{4}}\ .$$

Prepared based on [Wald et al, 2001].