WORKED EXAMPLE 2.2
Bolted Truss Connection

Check the bolted connection of the tension member of two equal-leg angles, shown in Figure 1WE2-2. The connection is subject to the factored force $F_{Sd} = 140\ kN$. Plate is P 15. The steel Grade S275. The fully threaded bolts M 20, Grade 8.8, are in holes $22\ mm$. The material partial safety factors are $\gamma_{M0} = 1{,}0$, $\gamma_{M2} = 1{,}10$ and $\gamma_{Mb} = 1{,}25$.

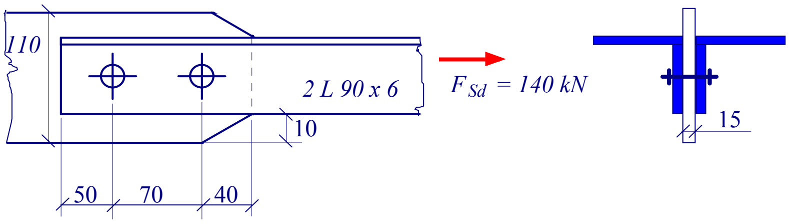

Figure 1WE2-2

Shear resistance

The design shear resistance per two bolts with two shear plane, if the shear is not passing through threaded part of the bolt, is

$$F_{v,Rd} = 2\,n\frac{0{,}6\ f_{ub}\ A_s}{\gamma_{Mb}} = 2*2*\frac{0{,}6*800*245}{1{,}25} = 376{,}3*10^3\,N > 140\ kN\,.$$

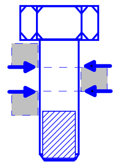

Figure 2WE2-2

Bearing resistance

The bolt bearing resistance of the plate:

$$\alpha = \frac{e_1}{3d_0} = \frac{40}{3*22} = \underline{0{,}61} \quad \text{(limit)}$$

$$\alpha = \frac{p_1}{3\ d_0} - \frac{1}{4} = \frac{70}{3*22} - \frac{1}{4} = 0{,}81$$

$$\alpha = \frac{f_{ub}}{f_u} = \frac{800}{430} = 1{,}86$$

$$\alpha = 1{,}0$$

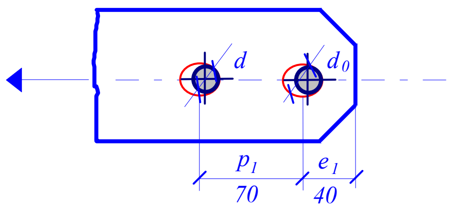

Figure 3WE2-2

$$F_{b.Rd} = \frac{2{,}5\ \alpha\ f_u\ d\ t}{\gamma_{Mb}} = \frac{2{,}5*0{,}61*430*20*15}{1{,}25} = 157{,}4*10^3\,N > F_{v.Sd} = 140\ kN\,.$$

The bolts shear resistance is satisfactory.

The bolt bearing resistance of the angles:

$$\alpha = \frac{e_1}{3\ d_0} = \frac{50}{3*22} = \underline{0{,}76} \quad \text{(limit)}$$

$$\alpha = \frac{p_1}{3\ d_0} - \frac{1}{4} = \frac{70}{3*22} - \frac{1}{4} = 0{,}81$$

$$\alpha = \frac{f_{ub}}{f_u} = \frac{800}{430} = 1{,}86$$

$$\alpha = 1{,}0$$

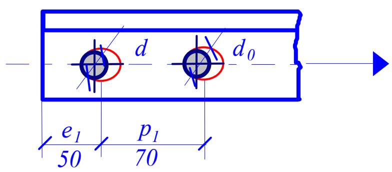

Figure 4WE2-3

$$F_{b.Rd} = \frac{2,5\ \alpha\ f_u\ d\ t}{\gamma_{Mb}} = \frac{2,5 * 0,76 * 430 * 20 * 2 * 6}{1,25} = 156,8 * 10^3\ N\ > F_{v.Sd} = 140\ kN\ .$$

The bolts resistance is satisfactory.

Section resistance

The reduction factors for the angles connected by one leg (linear transition) is

$$\beta_2 = 0,4 + \frac{0,7 - 0,4}{5\ d_0 - 2,5\ d_0}\left(p_1 - 2,5\ d_0\right) = 0,4 + \frac{0,3}{5 * 22 - 2,5 * 22}\left(70 - 2,5 * 22\right) = 0,482\ .$$

The resistance at the net section with two bolts in the force direction is

$$N_{u.Rd} = \frac{\beta_2\ A_{net}\ f_u}{\gamma_{M2}} = \frac{0,482 * \left(1050 - 22 * 6\right) * 430}{1,10} = 173,0 * 10^3\ N > 140 / 2\ kN\ .$$

The member resistance in tension is

$$N_{pl.Rd} = \frac{A\ f_y}{\gamma_{M0}} = \frac{2 * 1050 * 275}{1,0} = 577,5 * 10^3\ N\ > F_{v.Sd} = 140\ kN\ .$$

The net area of the connection plate is

$$N_{pl.Rd} = \frac{0,9\ A_{net}\ f_y}{\gamma_{M2}} = \frac{0,9 * 15 * \left(120 - 22\right) * 275}{1,10} = 330,7 * 10^3 N > 140\ kN\ .$$

The section resistance in connection is satisfactory.

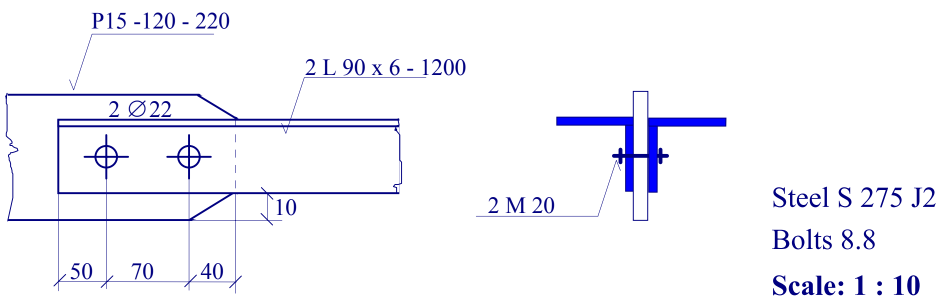

Figure 5WE2-2 The design drawing of the connection

Note:

1) The eccentricity of the fasteners at the end connections and the effects of the spacing and edge distances of the bolts may be taken into account by analyss. The design resistance of the net section is in this case checked directly.
2) The bolt end distances are in the connections often the same (e.g. 50 + 70 + 50). In this case the bearing resistance is checked for both sides of the connection together, e.g. just for the sum of the thinner plates acting in one direction.

Prepared based on [Wald et al, 2001].