WORKED EXAMPLE 2.1
Bolted Connection of Tie

Check the resistance of the bolted connection of a tie, shown in Figure 2WE2-1, loaded in tension by the factored force F_{Sd} =150 kN. The steel is Grade S355. The bolts M16, Grade 5.6, are the not preloaded. The shear plane passes through the unthreaded portion of the bolts. The material partial safety factors are $\gamma_{M2} = 1,10$ and $\gamma_{Mb} = 1,25$.

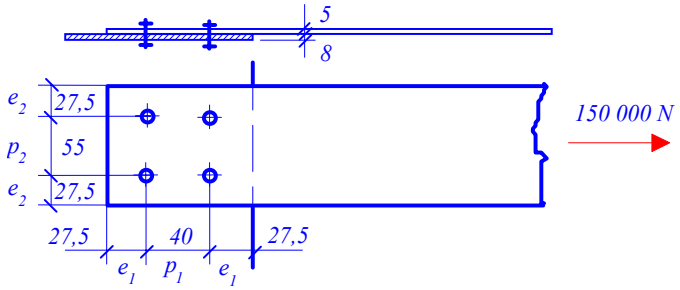

Figure 1WE2-1

The bolt spacing is satisfying the design rules

$$1,5\ d_0 = 1,5 * 17 = 25,5 \le e_2$$
$$3,0\ d_0 = 3,0 * 17 = 51,0 \le p_2 .$$

The force per bolt is $F_{v.Sd} = \frac{150\ 000}{4} = 37\ 500\ N$.

The shear resistance per a bolt M 16 (at one shear plane) is

$$F_{v,Rd} = \frac{0,6\ f_{ub}\ A}{\gamma_{Mb}} = \frac{0,6 * 500 * \frac{\pi * 16^2}{4}}{1,25} = 48,2 * 10^3\ N > 37\ 500\ N .$$

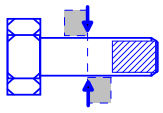

Figure 2WE2-1

The factor of the bearing resistance is

$$\alpha = \frac{e_1}{3\ d_0} = \frac{27,5}{3 * 17} = 0,539 \text{ (limit)},$$
$$\alpha = \frac{p_1}{3\ d_0} - \frac{1}{4} = \frac{50}{3 * 17} - \frac{1}{4} = 0,73 ,$$
$$\alpha = \frac{f_{ub}}{f_u} = \frac{500}{510} = 0,98 ,$$
$$\alpha = 1,0 .$$

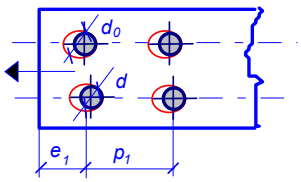

Figure 2WE2-1

The bearing resistance per bolt in the plate *5 mm* is

$$F_{b,Rd} = \frac{2,5\ \alpha\ f_u\ d\ t}{\gamma_{Mb}} = \frac{2,5 * 0,539 * 510 * 16 * 5}{1,25} = 43,9 * 10^3\ N > F_{v.Sd} = 37,5\ kN .$$

The resistance of the member net section is

$$N_{u.Rd} = 0{,}9\,\frac{A_{net}\,f_u}{\gamma_{M2}} = 0{,}9\,\frac{5*(110-2*17)*510}{1{,}10} = 158{,}6*10^3\ N > 150\ kN\ .$$

The connection resistance is satisfactory.

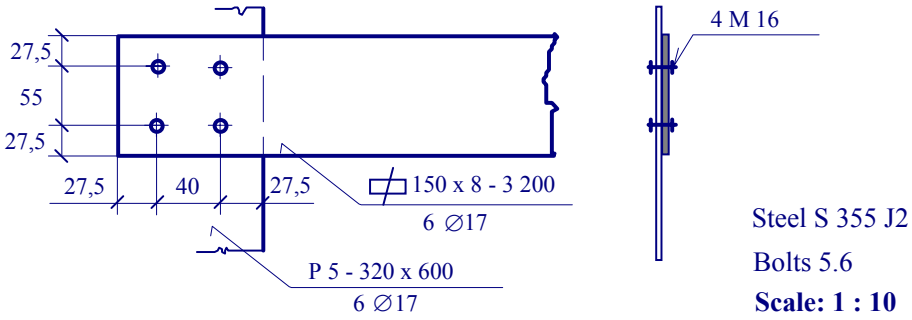

Figure 5WE2-1 The design drawing of the connection

Prepared based on [Wald et al, 2001].