WORKED EXAMPLE 2.3
Bolted Slip Resistant Connection

Evaluate resistance of the bolted connection of a tie, shown in Figure 1WE2-3, with the slip on the ultimate limit state. The steel is Grade S235. The bolts M 20, Grade 10.9, are preloaded (the bolt net area $A_s = 245\ mm^2$) in holes $\varnothing\ 22$. The material partial safety factors are $\gamma_{Ms.ult} = 1{,}10$, $\gamma_{M2} = 1{,}10$ and $\gamma_{Mb} = 1{,}25$.

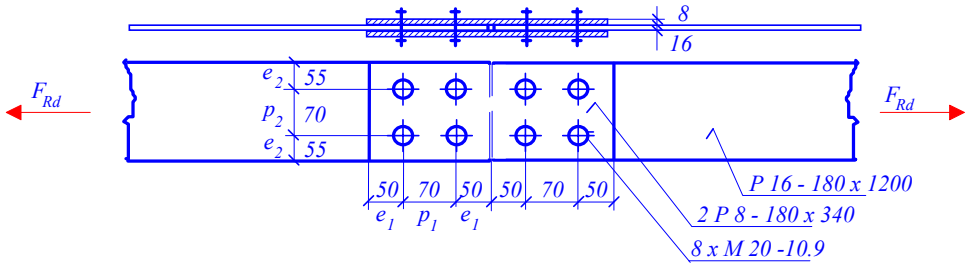

Figure 1WE2-3

Slip resistance

The design preloading force (net section of the bolt $A_s = 245\ mm^2$) is

$$F_{p.Cd} = 0{,}7\ f_{ub}\ A_s = 0{,}7 * 1\,000 * 245 = 171{,}5 * 10^3\ N\ .$$

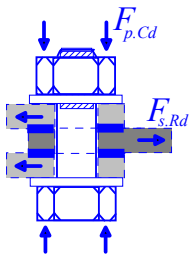

Figure 2WE2-3

The slip factor is for surface blasted with shot $\mu = 0{,}5$ (Class A surface). There are two slip surfaces, as shown in Fig. 5.6.2. The design slip resistance of one bolt under the ultimate limit state (Connection Category C):

$$F_{s.Rd} = \frac{k_s\ n\ \mu}{\gamma_{Ms.ult}}\ F_{p.Cd} = \frac{1{,}0 * 2 * 0{,}50}{1{,}10}\ 171{,}5 = 155{,}9\ kN\ .$$

Bearing resistance

The bearing resistance is derived for the plate *16 mm*:

$$\alpha = \frac{e_1}{3\ d_0} = \frac{50}{3 * 22} = \underline{0{,}758}\ \ \text{(limit)}$$

$$\alpha = \frac{p_1}{3\ d_0} - \frac{1}{4} = \frac{70}{3 * 22} - \frac{1}{4} = 0{,}811\ ,$$

$$\alpha = \frac{f_{ub}}{f_u} = \frac{1\,000}{360} = 2{,}778\ ,$$

$$\alpha = 0{,}508\ ,$$

$$F_{b.Rd} = \frac{2{,}5\ \alpha\ f_u\ dt}{\gamma_{Mb}} = \frac{2{,}5 * 0{,}758 * 360 * 20 * 16}{1{,}25} = 174{,}6 * 10^3\ N\ .$$

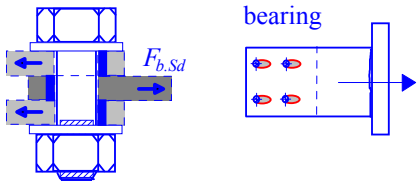

Figure 3WE2-3

Net section

The design resistance of net cross section is

$$N_{net.Rd} = 0{,}9\ \frac{A_{net}\ f_u}{\gamma_{M2}} = 0{,}9 * \frac{16 * (180 - 2 * 22) * 360}{1{,}10} = 640{,}9 * 10^3\ N\ .$$

The connection resistance is $4 * 155,9 = 623,6 \ kN$.

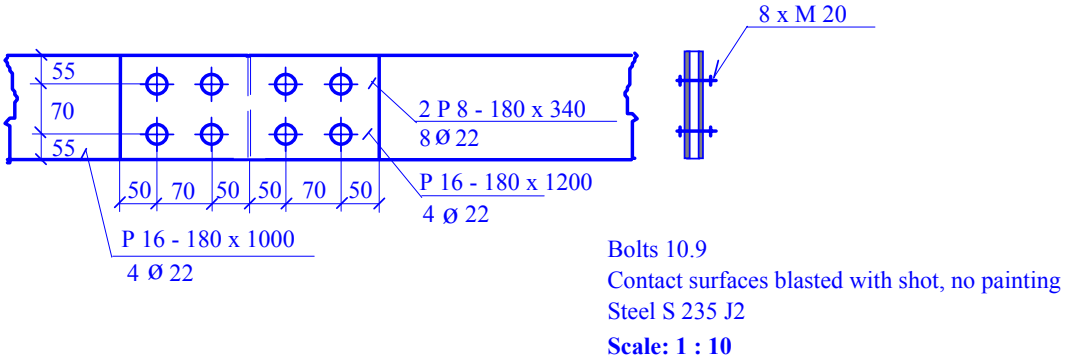

Figure 4WE2-3 Design drawing of the connection

Prepared based on [Wald et al, 2001].