

WORKED EXAMPLE 2.4

Single Lap Connection with One Bolt

Check the resistance of the single lap connection. The connection is subject to the factored force $F_{Sd} = 45 \text{ kN}$, shown in Figure 1WE2-4. The steel is Grade S355. The non-preloaded bolt M16 is Grade 5.6 in hole $\varnothing 17 \text{ mm}$. The shear passes through the untreated portion of the bolt. The material partial safety factors are $\gamma_{M2} = 1,10$, $\gamma_{Mb} = 1,25$.

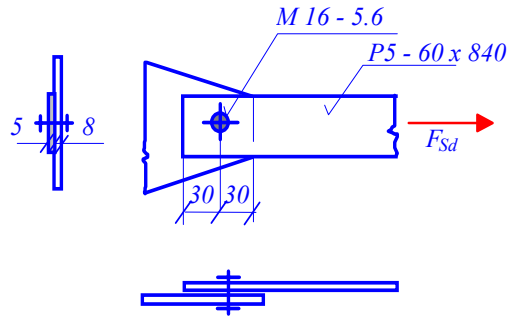


Figure 1WE2-4

The design shear resistance of one bolt M 16 of one shear plane is

$$F_{v,Rd} = \frac{0,6 f_{ub} A}{\gamma_{Mb}} = \frac{0,6 * 500 * \frac{\pi * 16^2}{4}}{1,25} = 48,3 * 10^3 \text{ N} > 45 \text{ kN} .$$

The design bearing resistance of one bolt for plate 5 mm is calculated for the smallest α

$$\alpha = \frac{e_1}{3 d_0} = \frac{30}{3 * 17} = \underline{0,588} \text{ (limit)}; \alpha = \frac{f_{bu}}{f_u} = \frac{500}{510} = 0,980; \alpha = 1,0$$

as

$$F_{b,Rd} = \frac{2,5 \alpha f_u d t}{\gamma_{Mb}} = \frac{2,5 * 0,588 * 510 * 16 * 5}{1,25} = 48,0 * 10^3 \text{ N} > 45 \text{ kN} .$$

The bearing resistance of single lap joint with one bolt is

$$F_{b,Rd} \leq \frac{1,5 f_u d t}{\gamma_{Mb}} = \frac{1,5 * 510 * 16 * 5}{1,25} = 49,0 * 10^3 \text{ N} > 45 \text{ kN} .$$

The net section resistance is

$$N_{u,Rd} = 0,9 \frac{A_{net} f_u}{\gamma_{M2}} = 0,9 * \frac{(5 * 60 - 5 * 17) * 510}{1,10} = 89,7 * 10^3 \text{ N} > 45 \text{ kN} .$$

The connection is satisfactory.

Note:

The connections with single bolt are used for structural purposes in special cases only, e.g. for the transmission electric towers and less important structures. In this type of connection is the washer positioned under the bolt nut as well as bolt head due to the shear and bending of the bolt.

Prepared based on [Wald et al, 2001].