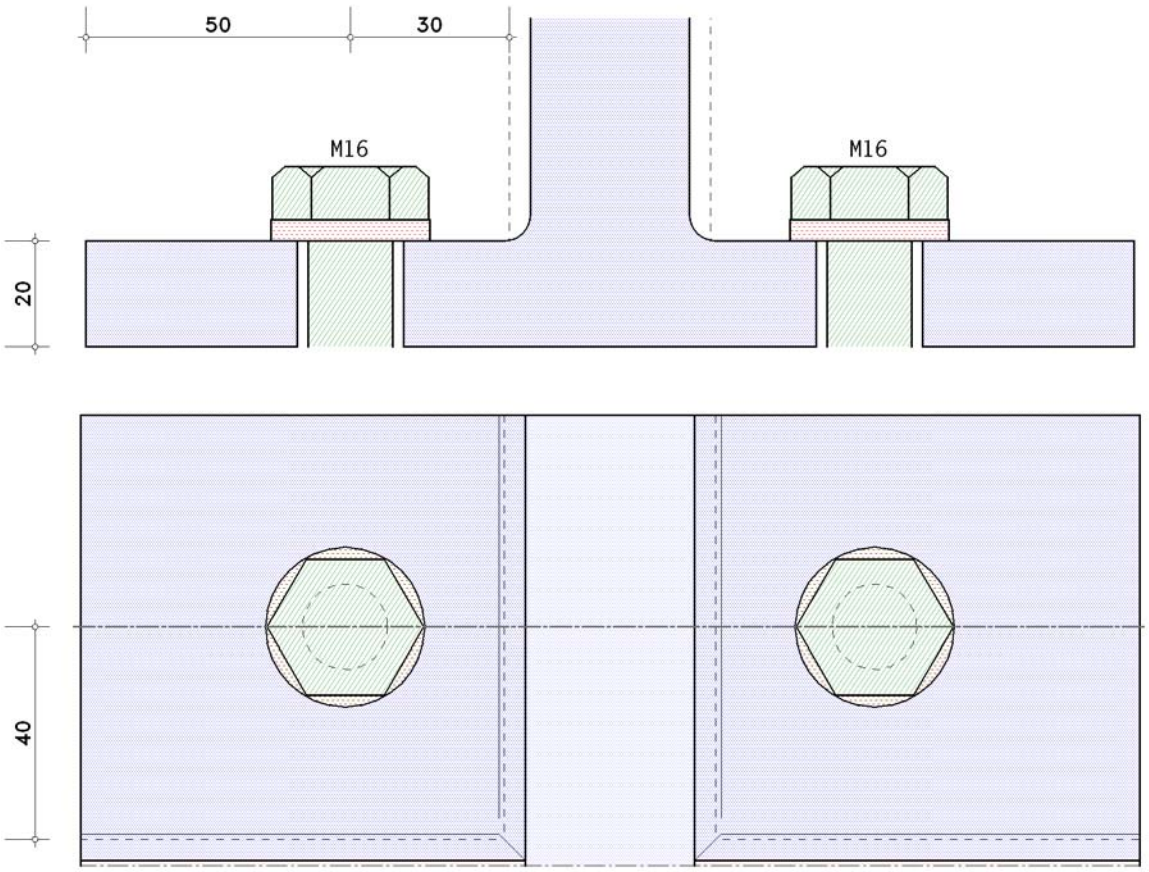
1. T-stub in tension

EC 3-1-8 (04.25), NA: Deutschland

1.1. input report



T-stub flange with thickness t_f = 20.0 mm, steel grade S235

connection device

bolt class 10.9, bolt size M16

large wrench size (high strength bolt), preloaded (for info: preloading $F_{p,C}$* = 0.7·f_{yb}·A_s = 98.7 kN)

loading

design value of the tensile force per bolt $F_{t,Ed}$ = 110.0 kN

verification parameters

verification of the column flange

number of bolts per bolt-row n_{sr} = 2

application of method 2

distance centre-line of the bolt to the edge of the column flange e = 50.0 mm

distance centre-line of the bolt to the free edge of the column flange (end row) e_1 = 0.0 mm

distance centre-line of the bolt to the periphery of the column web m = 30.0 mm

distance centre-line of the bolt to the periphery of the next web stiffener m_2 = 40.0 mm

bolt-row (2 bolts per row) considered individually (n_b = 1)

inner bolt-row adjacent to a stiffener

partial safety factors for material

resistance of cross-sections γ_{M0} = 1.00

1.2. resistance

effective length of the T-stub flange (column flange)

coefficient for stiffened column flanges and end-plates:

$\alpha = 4+1.67 \cdot e/m \cdot (m/m_2)^{2/3}$ = 6.30, e = 50.0 mm, m = 30.0 mm, m_2 = 40.0 mm

end bolt-row next to a transverse stiffener

$l_{eff,cp,si} = 2 \cdot \pi \cdot m$ = 188.5 mm

$l_{eff,nc,si} = \alpha \cdot m$ = 188.9 mm

in mode 1: $\Sigma l_{eff,1} = l_{eff,1} = \min(l_{eff,nc}, l_{eff,cp})$ = 188.5 mm

in mode 2: $\Sigma l_{eff,2} = l_{eff,2} = l_{eff,nc}$ = 188.9 mm

distance centre-line of the bolt to the edge of stub flange e_{min} = 50.0 mm

tension resistance of the T-stub flange

$n = \min(e_{min}, 1.25 \cdot m)$ = 37.5 mm, e_{min} = 50.0 mm, m = 30.0 mm

resisting plastic moments:

in mode 1: $M_{pl,1,Rd} = (0.25 \cdot \Sigma l_{eff,1} \cdot t_f^2 \cdot f_y) / \gamma_{M0} = 4.43$ kNm, $t_f = 20.0$ mm, $f_y = 235.0$ N/mm², $\gamma_{M0} = 1.00$
in mode 2: $M_{pl,2,Rd} = (0.25 \cdot \Sigma l_{eff,2} \cdot t_f^2 \cdot f_y) / \gamma_{M0} = 4.44$ kNm
design value of tension resistance:
tension resistance of one bolt: $F_{t,Rd} = (k_2 \cdot f_{ub} \cdot A_s) / \gamma_{M2} = 112.82$ kN, $k_2 = 0.90$, $f_{ub} = 1000.0$ N/mm²
in mode 3: $\Sigma F_{t,Rd} = 2 \cdot n_b \cdot F_{t,Rd} = 225.65$ kN, $n_b = 1$
prying forces always appear at preloaded bolts !
calculation with the alternative method
decisive diameter of the bolt $d_w = d_p = 30.00$ mm $\Rightarrow$ $e_w = d_w/4 = 7.5$ mm
mode 1: complete yielding of the T-stub flange
$F_{T,1,Rd} = ((8 \cdot n - 2 \cdot e_w) \cdot M_{pl,1,Rd}) / (2 \cdot m \cdot n - e_w \cdot (m+n)) = 723.99$ kN
mode 2: bolt failure simultaneously with yielding of the T-stub flange
$F_{T,2,Rd} = (2 \cdot M_{pl,2,Rd} + n \cdot \Sigma F_{t,Rd}) / (m+n) = 256.91$ kN
mode 3: bolt failure
$F_{T,3,Rd} = \Sigma F_{t,Rd} = 225.65$ kN
tension resistance of the T-stub flange: $F_{T,Rd} = \min(F_{T,1,Rd}, F_{T,2,Rd}, F_{T,3,Rd}) = 225.65$ kN

verification

$F_{T,Ed} = 2 \cdot F_{t,Ed} = 220.0$ kN $<$ $F_{T,Rd} = 225.65$ kN $\Rightarrow$ utilization $U = 0.975 < 1$ ok

maximum utilization $U_{max} = 0.975 < 1$ ok

verification succeeded

2. Regulations

EN 1990, Eurocode 0: Grundlagen der Tragwerksplanung;
Deutsche Fassung EN 1990:2002 + A1:2005 + A1:2005/AC:2010, Ausgabe Dezember 2010
EN 1990/NA, Nationaler Anhang zur EN 1990, Ausgabe Dezember 2010

EN 1993-1-1, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau;
Deutsche Fassung EN 1993-1-1:2022, Ausgabe April 2025
EN 1993-1-1/A1, Ergänzungen zur EN 1993-1-1, Ausgabe Juli 2014
EN 1993-1-1/NA, Nationaler Anhang zur EN 1993-1-1, Ausgabe Oktober 2022

EN 1993-1-8, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-8: Bemessung von Anschlüssen;
Deutsche Fassung EN 1993-1-8:2024, Ausgabe April 2025
EN 1993-1-8/NA, Nationaler Anhang zur EN 1993-1-8, Ausgabe November 2020