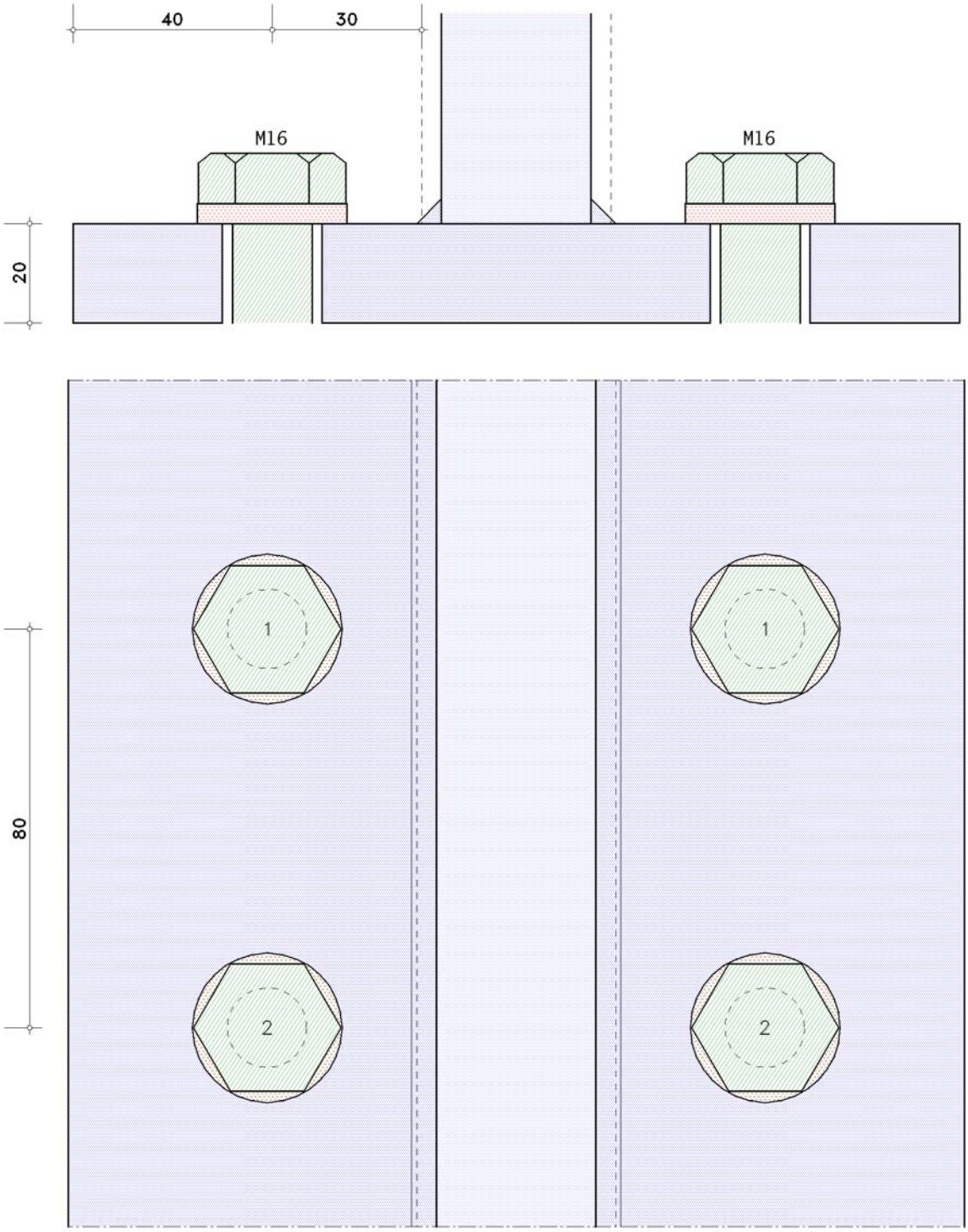
4H-EC3BV version: 1/2012-4k

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 tensile force bolt in row 1 $F_{t,Ed}$ = 100.0 kN
design value of tensile force bolt in row 2 $F_{t,Ed}$ = 100.0 kN
verification parameters
verification of the connection plate (end-plate) between the beam flanges
number of bolts per bolt-row n_{sr} = 2
application of method 2
distance centre-line of the bolt to the free end of the connection plate e = 40.0 mm

distance centre-line of the bolt to the periphery of the beam web m = 30.0 mm
number of bolt-rows (2 bolts per row) n_b = 2
distance between bolt-rows p = 80.0 mm
bolt-row considered individually

partial safety factors for material

resistance of cross-sections γ_{M0} = 1.00

1.2. resistance

effective length of the T-stub flange (end-plate)

group of 2 bolt-rows:

The effective length of a group of bolt-rows is calculated with the values of the individual bolt-row.

inner bolt-row

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

$l_{eff,nc,a} = 4 \cdot m + 1.25 \cdot e = 170.0$ mm

inner bolt-row

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

$l_{eff,nc,i} = 4 \cdot m + 1.25 \cdot e = 170.0$ mm

$\Rightarrow \Sigma l_{eff,cp} = l_{eff,cp,a} = 377.0$ mm

$\Rightarrow \Sigma l_{eff,nc} = l_{eff,nc,a} = 340.0$ mm

in mode 1: $\Sigma l_{eff,1} = \min(\Sigma l_{eff,nc}, \Sigma l_{eff,cp}) = 340.0$ mm

in mode 2: $\Sigma l_{eff,2} = \Sigma l_{eff,nc} = 340.0$ mm

distance centre-line of the bolt to the edge of stub flange e_{min} = 40.0 mm

tension resistance of the T-stub flange

$n = \min(e_{min}, 1.25 \cdot m) = 37.5$ mm, $e_{min} = 40.0$ mm, $m = 30.0$ mm

resisting plastic moments:

in mode 1+2: $M_{pl,Rd} = (0.25 \cdot \Sigma l_{eff} \cdot t_f^2 \cdot f_y) / \gamma_{M0} = 7.99$ kNm, $t_f = 20.0$ mm, $f_y = 235.0$ N/mm², $\gamma_{M0} = 1.00$

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: $\Sigma F_{t,Rd} = 2 \cdot n_b \cdot F_{t,Rd} = 451.30$ kN, $n_b = 2$

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

$F_{T,1,Rd} = ((8 \cdot n - 2 \cdot e_w) \cdot M_{pl,1,Rd}) / (2 \cdot m \cdot n - e_w \cdot (m+n)) = 1305.89$ kN

mode 2: bolt failure simultaneously with yielding of the T-stub flange

$F_{T,2,Rd} = (2 \cdot M_{pl,2,Rd} + n \cdot \Sigma F_{t,Rd}) / (m+n) = 487.46$ kN

mode 3: bolt failure

$F_{T,3,Rd} = \Sigma F_{t,Rd} = 451.30$ kN

tension resistance of the T-stub flange: $F_{T,Rd} = \min(F_{T,1,Rd}, F_{T,2,Rd}, F_{T,3,Rd}) = 451.30$ kN

verification

$F_{T,Ed} = 2 \cdot \Sigma F_{t,Ed} = 400.0$ kN $<$ $F_{T,Rd} = 451.30$ kN $\Rightarrow$ utilization $U = 0.886 < 1$ ok

maximum utilization $U_{max} = 0.886 < 1$ 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