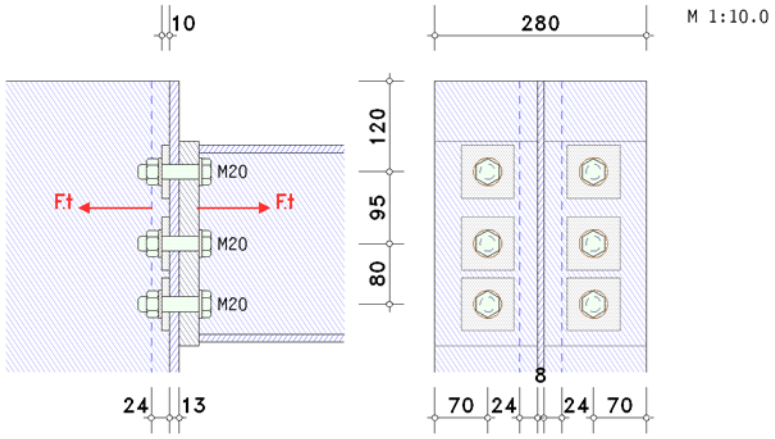
POS. 26: COLUMN FLANGE IN BENDING

4H-EC3GK version: 1/2012-1k

column flange in bending

Basic component 4

EC 3-1-8 (12.10), NA: Germany



column flange:
plate thickness t_{fc} = 13.0 mm, width b_{fc} = 280.0 mm, steel grade S 275
thickness of column web t_{wc} = 8.0 mm
root resp. leg length of the web weld s_c = 24.0 mm
connection device:
bolt, property class 8.8, bolt size M20
large width across flats (high tensile bolt), preloaded
packing: plate thickness t_{bp} = 10.0 mm, steel grade S 235
number of bolt-rows in tension n_z = 3
distance of first bolt-row to the free edge of the column e_{1s} = 120.0 mm
distance between bolt rows p_{1-2} = 95.0 mm, p_{2-3} = 80.0 mm
distance of outer bolts to lateral edge of the column flange e_{2s} = 70.0 mm
partial safety factors for material: γ_{M0} = 1.00, γ_{M2} = 1.25
stress:
Lk 1 : $F_{fc,Ed}$ = 50.0 kN per bolt

design resistance

unstiffened flange of column and bolted connection
equivalent T-stub flange (each bolt-row decisive):
here: number of bolt rows n_b = 1

row 1

effective length of the T-stub flange (column flange):
in mode 1: $\Sigma l_{eff,1} = l_{eff,1} = \min(l_{eff,nc}, l_{eff,cp})$ = 257.4 mm
in mode 2: $\Sigma l_{eff,2} = l_{eff,2} = l_{eff,nc}$ = 257.4 mm
design tension resistance of the T-stub flange:
in mode 1+2: $M_{pl,Rd} = (0.25 \cdot \Sigma l_{eff} \cdot t_f^2 \cdot f_y) / \gamma_{M0}$ = 2.99 kNm
tension resistance of all bolts: $\Sigma F_{t,Rd} = 2 \cdot n_b \cdot F_{t,Rd}$ = 282.24 kN, $F_{t,Rd}$ = 141.12 kN
$L_b \le L_b^*$ $\Rightarrow$ prying forces may develop
$F_{T,1,Rd} = (4 \cdot M_{pl,1,Rd}) / m$ = 255.56 kN
$F_{T,2,Rd} = (2 \cdot M_{pl,2,Rd} + n \cdot \Sigma F_{t,Rd}) / (m+n)$ = 213.59 kN, n = 58.5 mm
$F_{T,3,Rd} = \Sigma F_{t,Rd}$ = 282.24 kN
tension resistance of T-stub flange: $F_{T,Rd} = \min(F_{T,1,Rd}, F_{T,2,Rd}, F_{T,3,Rd})$ = 213.59 kN

row 2

effective length of the T-stub flange (column flange):
in mode 1: $\Sigma l_{eff,1} = l_{eff,1} = \min(l_{eff,nc}, l_{eff,cp})$ = 274.7 mm
in mode 2: $\Sigma l_{eff,2} = l_{eff,2} = l_{eff,nc}$ = 274.7 mm
design tension resistance of the T-stub flange:
in mode 1+2: $M_{pl,Rd} = (0.25 \cdot \Sigma l_{eff} \cdot t_f^2 \cdot f_y) / \gamma_{M0}$ = 3.19 kNm
tension resistance of all bolts: $\Sigma F_{t,Rd} = 2 \cdot n_b \cdot F_{t,Rd}$ = 282.24 kN, $F_{t,Rd}$ = 141.12 kN
$L_b \le L_b^*$ $\Rightarrow$ prying forces may develop
$F_{T,1,Rd} = (4 \cdot M_{pl,1,Rd}) / m$ = 272.79 kN
$F_{T,2,Rd} = (2 \cdot M_{pl,2,Rd} + n \cdot \Sigma F_{t,Rd}) / (m+n)$ = 217.42 kN, n = 58.5 mm

$F_{T,3,Rd} = \Sigma F_{t,Rd} = 282.24$ kN

tension resistance of T-stub flange: $F_{T,Rd} = \min(F_{T,1,Rd}, F_{T,2,Rd}, F_{T,3,Rd}) = 217.42$ kN

row 3

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

in mode 1: $\Sigma l_{eff,1} = l_{eff,1} = \min(l_{eff,nc}, l_{eff,cp}) = 274.7$ mm

in mode 2: $\Sigma l_{eff,2} = l_{eff,2} = l_{eff,nc} = 274.7$ mm

design tension resistance of the T-stub flange:

in mode 1+2: $M_{pl,Rd} = (0.25 \cdot \Sigma l_{eff} \cdot t_f^2 \cdot f_y) / \gamma_{M0} = 3.19$ kNm

tension resistance of all bolts: $\Sigma F_{t,Rd} = 2 \cdot n_b \cdot F_{t,Rd} = 282.24$ kN, $F_{t,Rd} = 141.12$ kN

$L_b \le L_b^*$ $\Rightarrow$ prying forces may develop

$F_{T,1,Rd} = (4 \cdot M_{pl,1,Rd}) / m = 272.79$ kN

$F_{T,2,Rd} = (2 \cdot M_{pl,2,Rd} + n \cdot \Sigma F_{t,Rd}) / (m+n) = 217.42$ kN, $n = 58.5$ mm

$F_{T,3,Rd} = \Sigma F_{t,Rd} = 282.24$ kN

tension resistance of T-stub flange: $F_{T,Rd} = \min(F_{T,1,Rd}, F_{T,2,Rd}, F_{T,3,Rd}) = 217.42$ kN

design resistance of column flange in bending (per bolt-row)

$F_{fc,Rd,1} = 213.6$ kN, ass. $l_{eff} = 257.4$ mm

$F_{fc,Rd,2} = 217.4$ kN, ass. $l_{eff} = 274.7$ mm

$F_{fc,Rd,3} = 217.4$ kN, ass. $l_{eff} = 274.7$ mm

equivalent T-stub flange (group of bolt-rows decisive):

here: number of bolt rows $n_b = 3$

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

in mode 1: $\Sigma l_{eff,1} = \min(\Sigma l_{eff,nc}, \Sigma l_{eff,cp}) = 335.0$ mm, $\Sigma l_{eff,cp} = 577.0$ mm

in mode 2: $\Sigma l_{eff,2} = \Sigma l_{eff,nc} = 335.0$ mm

design tension resistance of the T-stub flange:

in mode 1+2: $M_{pl,Rd} = (0.25 \cdot \Sigma l_{eff} \cdot t_f^2 \cdot f_y) / \gamma_{M0} = 3.89$ kNm

tension resistance of all bolts: $\Sigma F_{t,Rd} = 2 \cdot n_b \cdot F_{t,Rd} = 846.72$ kN, $F_{t,Rd} = 141.12$ kN

$L_b \le L_b^*$ $\Rightarrow$ prying forces may develop

$F_{T,1,Rd} = (4 \cdot M_{pl,1,Rd}) / m = 332.67$ kN

$F_{T,2,Rd} = (2 \cdot M_{pl,2,Rd} + n \cdot \Sigma F_{t,Rd}) / (m+n) = 544.33$ kN, $n = 58.5$ mm

$F_{T,3,Rd} = \Sigma F_{t,Rd} = 846.72$ kN

tension resistance of T-stub flange: $F_{T,Rd} = \min(F_{T,1,Rd}, F_{T,2,Rd}, F_{T,3,Rd}) = 332.67$ kN

design resistance of column flange in bending (group of bolts, 3 rows)

$F_{fc,Rd} = 332.7$ kN, ass. $l_{eff} = 335.0$ mm

verification

Lk 1: per bolt-row: $F_{Ed} = 2 \cdot F_{fc,Ed} = 100.0$ kN

row 1: $F_{Ed} = 100.0$ kN $<$ $F_{Rd} = 213.6$ kN $\Rightarrow$ utilization $= 0.468 < 1$ **ok.**

row 2: $F_{Ed} = 100.0$ kN $<$ $F_{Rd} = 217.4$ kN $\Rightarrow$ utilization $= 0.460 < 1$ **ok.**

row 3: $F_{Ed} = 100.0$ kN $<$ $F_{Rd} = 217.4$ kN $\Rightarrow$ utilization $= 0.460 < 1$ **ok.**

group of bolts (between stiffeners): $F_{Ed} = 2 \cdot 3 \cdot F_{fc,Ed} = 300.0$ kN

$F_{Ed} = 300.0$ kN $<$ $F_{Rd} = 332.7$ kN $\Rightarrow$ utilization $= 0.902 < 1$ **ok.**