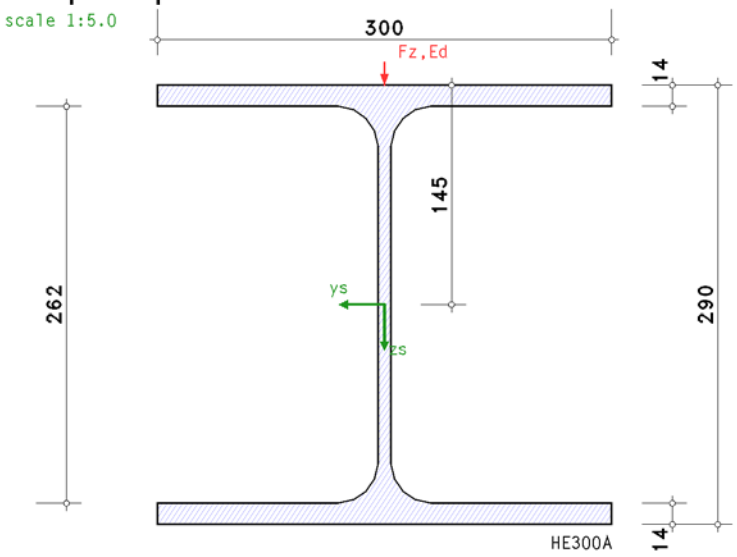
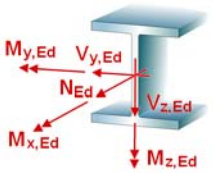
POS. 7: BSP. 5 SINGLE LOAD TOP FLANGE

detailed problems acc. to Eurocode 3, EC 3-6 (12.10), NA: Deutschland

1. input report



steel grade
steel grade S235
cross-section
beam: section HE300A
loading
internal forces and moments at limit state of resistance (ULS):



Lk 1: beam 2
$M_{y,Ed}$ = -264.0 kNm, $V_{z,Ed}$ = 187.0 kN
Lk 2: beam 1
$M_{y,Ed}$ = -351.0 kNm, $V_{z,Ed}$ = 75.0 kN
transverse loading on top flange:
vertical single load $F_{z,Ed,ULS}$ = 180.00 kN, rigid loading length s_s = 300.0 mm
verification in beam field
partial safety factors for material
resistance of cross-sections γ_{M0} = 1.00
resistance of members in stability failure γ_{M1} = 1.10

2. verification der local loading

assumption: flange induced web buckling is excluded.
assumption: plated structures-/shear buckling is excluded.

cross-sectional properties: A = 112.53 cm², z_s = 145.0 mm, I_y = 18263.71 cm⁴, y_s = -0.0 mm, I_z = 6309.56 cm⁴

effective loading length $l_{eff} = s_s + 2 \cdot t_f$ = 328.0 mm
refering to outer edge of flange $s_s = l_{eff} - 2 \cdot t_f$ = 300.0 mm / auf den webanschnitt $s_w = l_{eff} + 2 \cdot r$ = 382.0 mm

2.1. compression of web (ULS)

permissible stresses: $\sigma_{Rd} = f_y/\gamma_{M0}$ = 235.0 N/mm², $\tau_{Rd} = f_y/(3^{1/2} \cdot \gamma_{M0})$ = 135.7 N/mm²

compression of single load at first cut of web:
local stresses $\sigma_{oz,Ed}$ = -55.4 N/mm², $\tau_{oxz,Ed}$ = 0.0 N/mm²
$|\sigma_{oz,Ed}|$ = 55.4 N/mm² < σ_{Rd} = 235.0 N/mm² ⇒ U = 0.236 < 1 ok

stresses at first cut of web:
Lk 1: $M_{y,Ed}$ = -264.0 kNm, $V_{z,Ed}$ = 187.0 kN
stresses $\sigma_{x,Ed}$ = -55.4 N/mm², $\tau_{xz,Ed}$ = 0.0 N/mm²
$|\sigma_{x,Ed}|$ = 150.3 N/mm² < σ_{Rd} = 235.0 N/mm² ⇒ U = 0.640 < 1 ok
$|\tau_{xz,Ed}|$ = 50.2 N/mm² < τ_{Rd} = 135.7 N/mm² ⇒ U = 0.370 < 1 ok
σ_v = 203.9 N/mm² < σ_{Rd} = 235.0 N/mm² ⇒ U = 0.867 < 1 ok
Lk 2: $M_{y,Ed}$ = -351.0 kNm, $V_{z,Ed}$ = 75.0 kN
stresses $\sigma_{x,Ed}$ = -55.4 N/mm², $\tau_{xz,Ed}$ = 0.0 N/mm²
$|\sigma_{x,Ed}|$ = 199.9 N/mm² < σ_{Rd} = 235.0 N/mm² ⇒ U = 0.851 < 1 ok

$|\tau_{xz,Ed}| = 20.1\ N/mm^2 < \tau_{Rd} = 135.7\ N/mm^2 \Rightarrow U = 0.148 < 1$ ok
$\sigma_v = 235.2\ N/mm^2 > \sigma_{Rd} = 235.0\ N/mm^2 \Rightarrow U = 1.000 \leq 1$ ok

maximum utilization: max $U_{ULS} = 1.000 \leq 1$ ok

2.2. buckling of transverse loading (ULS)

slenderness $\lambda_F = (F_y/F_{cr})^{1/2} = 0.608$, $F_y = 987.5$ kN
reduction factor $\chi_F = 0.822$
resistance of buckling $F_{z,Rd} = f_y \cdot L_{eff} \cdot t_w/\gamma_{M1} = 737.98$ kN, $L_{eff} = \chi_F \cdot l_y = 406.4$ mm, $l_y = 494.3$ mm
verification: $F_{z,Ed}/F_{z,Rd} = 0.244 < 1$ ok

interaction (without plated structures-/shear buckling):
transverse loading and equivalent stress $(\eta_2 + 0.8 \cdot \eta_1) / 1.4 = 0.746 < 1$ ok
with $\eta_2 = F_{z,Ed}/F_{z,Rd} = 0.244$, $\eta_1 = \max U_{ULS} = 1.000$

3. final result

maximum utilization: max $U = 1.000 \leq 1$ ok

verification succeeded