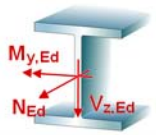
POS. 6: SK'15, LENER, BSP.1B, S.244

detailed problems acc. to Eurocode 3

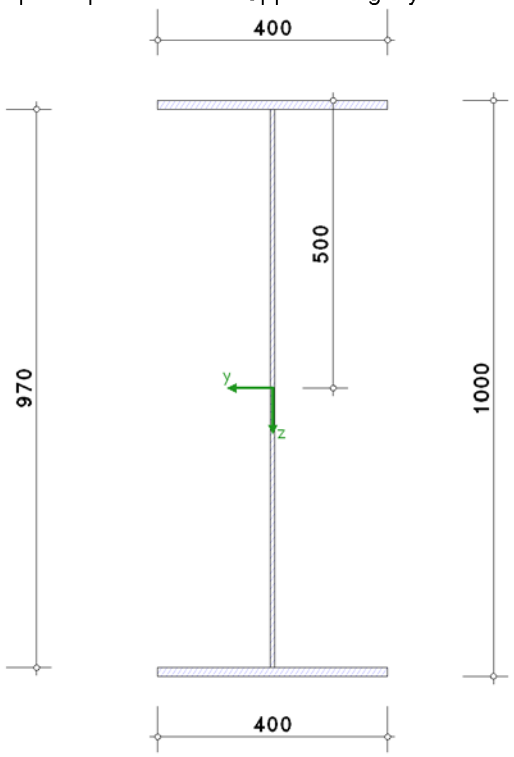
EC 3-1-5 (12.10), NA: Deutschland

steel grade
steel grade S 355
cross-section
beam: parameter (I-section):
h = 1000.0 mm, t_w = 8.0 mm, b_f = 400.0 mm, t_f = 15.0 mm
parameters
length of buckling field a = 2000.0 cm
method of reduced stresses
verification in beam field
calculation of buckling factors with 4H-tool
loading
Lk 1: N_{Ed} = -1000.0 kN M_{Ed} = 1500.0 kNm
partial safety factors for material
resistance of cross-sections γ_{M0} = 1.00
resistance of members in stability failure γ_{M1} = 1.10



verifications of buckling resistance

assumption: flange induced web buckling is excluded.
assumption: plate area is supported rigidly.



Lk 1:

method of reduced stresses
EC 3-convention, compressive stresses positive
shear distortions are ignored.
cross-sectional properties: A = 197.60 cm², z_s = 500.0 mm, I_y = 351934.87 cm⁴, y_s = -0.0 mm, I_z = 16004.14 cm⁴
maximum/minimum stresses: σ_o = 263.7 N/mm², σ_u = -162.5 N/mm²
section class: 4 ⇒ verification of buckling resistance required !!
buckling factors (4H-tool)
web: α_{cr} = 0.765
reduced stresses
flange top:
σ_{Ed} = 260.5 N/mm²
non-dimensional slenderness ratio $\lambda_p = \lambda_c = \lambda_w = (\alpha_{ult}/\alpha_{cr})^{1/2}$ = 0.860, α_{ult} = 1.363, α_{cr} = 1.841
reduction factor $\rho = (\lambda_p - 0.188)/\lambda_p^2$ = 0.908 ≤ 1 for λ_p > 0.748, ψ = 1.000
ultimate buckling stress $\sigma_{Rd} = \rho \cdot f_y/\gamma_{M1}$ = 293.1 N/mm²
verification: σ_{Ed}/σ_{Rd} = 0.889 < 1 ok.
flange bottom:
buckling stresses σ_{Ed} = -159.3 N/mm² ≤ 0 ⇒ verification not required
web:
σ_{Ed} = 257.3 N/mm²
non-dimensional slenderness ratio $\lambda_p = \lambda_c = \lambda_w = (\alpha_{ult}/\alpha_{cr})^{1/2}$ = 1.342, α_{ult} = 1.380, α_{cr} = 0.765 (4H-tool)
reduction factor $\rho = (\lambda_p - 0.055\cdot(3+\psi))/\lambda_p^2$ = 0.672 ≤ 1 for $\lambda_p > 0.5 + (0.085 - 0.055\cdot\psi)^{1/2}$ = 0.844, ψ = -0.607
ultimate buckling stress $\sigma_{Rd} = \rho \cdot f_y/\gamma_{M1}$ = 216.8 N/mm²
verification: σ_{Ed}/σ_{Rd} = 1.187 > 1 not ok. !!

total utilization: U = 1.187 > 1 not ok. !!

Final Result

maximum utilization: max U = 1.187 > 1 not ok. !!

design resistance not ensured !!

Regulations

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

DIN EN 1993-1-1, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau;
Deutsche Fassung EN 1993-1-1:2005 + AC:2009, Ausgabe Dezember 2010
DIN EN 1993-1-1/NA, Nationaler Anhang zur DIN EN 1993-1-1, Ausgabe Dezember 2010

DIN EN 1993-1-5, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-5: Plattenförmige Bauteile;
Deutsche Fassung EN 1993-1-5:2006 + AC:2009, Ausgabe Dezember 2010
DIN EN 1993-1-5/NA, Nationaler Anhang zur DIN EN 1993-1-5, Ausgabe Dezember 2010