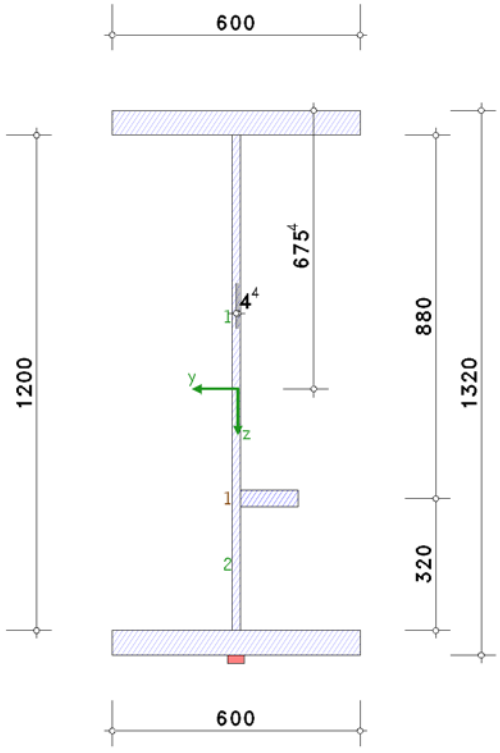
detailed problems acc. to Eurocode 3

EC 3-1-5 (12.10), NA: EC-standard parameters

steel grade
steel grade S 355
cross-section
beam: parameter (I-section):
h = 1320.0 mm, t_w = 20.0 mm, b_f = 600.0 mm, t_f = 60.0 mm
longitudinal stiffeners: number n_{st} = 1
section parameters (flat steel):
h = 140.0 mm, t = 40.0 mm
distance of stiffener to the top edge of beam $d_{st,0}$ = 940.0 mm
parameters
length of buckling field a = 240.0 cm
method of effective cross-sectional area
verification in beam field
calculation of buckling factors acc. to EC 3-1-5
effective cross-section values from resulting distribution of longitudinal stresses
loading
internal forces and moments refering to the stiffened cross-section:
transverse loading on lower edge of cross-section:
design value of the vertical single load $F_{z,Ed}$ = 4000.0 kN, loading length s_s = 600.0 mm
partial safety factors for material
resistance of cross-sections γ_{M0} = 1.00
resistance of members in stability failure γ_{M1} = 1.00

verifications of buckling resistance

assumption: flange induced web buckling is excluded.
assumption: local buckling of stiffeners is excluded.
assumption: rotational ability of stiffeners for stress redistribution is sufficient.
assumption: plate area is supported rigidly.
the assumptions are not checked !!



Lk 1:

method of effective cross-sectional area
EC 3-convention, compressive stresses positive
buckling of transverse loading: loading length > distance of two single loads, double load is not investigated !!
shear distortions are ignored.
cross-sectional properties: $A = 1016.00\ cm^2$, $z_s = 675.4\ mm$, $I_y = 3189398.76\ cm^4$, $y_s = 4.4\ mm$, $I_z = 220381.12\ cm^4$
maximum/minimum stresses: $\sigma_z = 333.3\ N/mm^2$

buckling of transverse loading
reduction factor $\chi_F = 0.535$
resistance of buckling $F_{z,Rd} = f_y \cdot L_{eff} \cdot t_w / \gamma_{M1} = 5544.35\ kN$, $L_{eff} = \chi_F \cdot l_y = 780.9\ mm$, $l_y = 1459.7\ mm$
verification: $F_{z,Ed}/F_{z,Rd} = 0.721 < 1$ ok.

total utilization: $U = 0.721 < 1$ ok.

Final Result

maximum utilization: $\max U = 0.721 < 1$ ok.

verifications succeeded

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