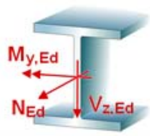
POS. 3: SK'09, KUHLMANN, 4.7, S.418

detailed problems acc. to Eurocode 3

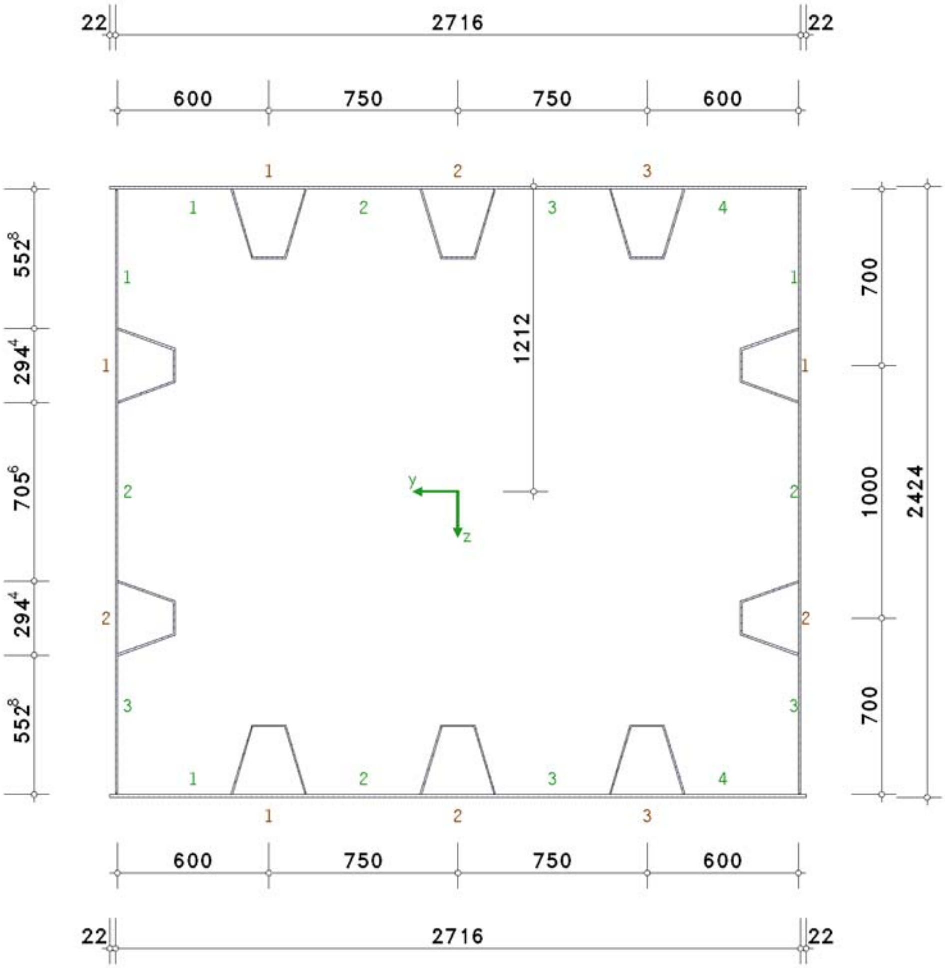
EC 3-1-5 (12.10), NA: Deutschland

steel grade
steel grade S 355
cross-section
beam: section parameters (box section):
h = 2424.0 mm, t_w = 8.0 mm (2x), b_f = 2716.0 mm, $b_ü$ = 22.0 mm, t_f = 12.0 mm
longitudinal stiffeners:
beam web: number n_{st} = 2
section parameters (trapezoidal section):
h = 230.0 mm, b_f = 135.0 mm, t = 8.0 mm, b = 300.0 mm
distance of the first stiffener to the top edge of beam $d_{st,0}$ = 712.0 mm
constant distance of stiffeners d_{st} = 1000.0 mm
flange top: number n_{st} = 3
section parameters (trapezoidal section):
h = 275.0 mm, b_f = 135.0 mm, t = 6.0 mm, b = 300.0 mm
distance of the first stiffener to the edge of flange right (without projection) $d_{st,0}$ = 608.0 mm
constant distance of stiffeners d_{st} = 750.0 mm
flange bottom: number n_{st} = 3
section parameters (trapezoidal section):
h = 275.0 mm, b_f = 135.0 mm, t = 6.0 mm, b = 300.0 mm
distance of the first stiffener to the edge of flange right (without projection) $d_{st,0}$ = 608.0 mm
constant distance of stiffeners d_{st} = 750.0 mm
parameters
length of buckling field a = 400.0 cm
method of effective cross-sectional area
rigid support stiffener
verification at intermediate support
effective girder length (shear distortion) L_e = 2890.0 cm
calculation of buckling factors acc. to EC 3-1-5
overall buckling fields as equivalent orthotropic plate (three or more longitudinal stiffeners)
effective cross-section values from resulting distribution of longitudinal stresses
verification of stability acc. to EC 3-1-1, 6.3
loading
internal forces and moments refering to the stiffened cross-section:
Lk 1: M_{Ed} = -29850.0 kNm V_{Ed} = 3300.0 kN
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: local buckling of stiffeners is excluded.
assumption: rotational ability of stiffeners for stress redistribution is sufficient.
assumption: plate area is supported rigidly.



Lk 1:

method of effective cross-sectional area

EC 3-convention, compressive stresses positive

shear distortion

flange top: $b_0 = b_{fo}/2 = 1354.0$ mm $\geq$ $L_e/50 = 578.0$ mm:
factor $\beta_{ult} = \beta^{\kappa} = 0.985$, $\beta = 0.759$, $\kappa = 0.06$
effective width $b_{eff} = 2 \cdot \beta_{ult} \cdot b_0 = 2675.2$ mm, β\ult = 0.985
flange bottom: $b_0 = b_{fu}/2 = 1354.0$ mm $\geq$ $L_e/50 = 578.0$ mm:
factor $\beta_{ult} = \beta^{\kappa} = 0.985$, $\beta = 0.759$, $\kappa = 0.06$
effective width $b_{eff} = 2 \cdot \beta_{ult} \cdot b_0 = 2675.2$ mm, β\ult = 0.985
replaced width from shear distortion $b_{fo} = 2675.2$ mm, $b_{fu} = 2675.2$ mm
cross-sectional properties: A = 1483.12 cm², $z_s = 1212.0$ mm, $I_y = 14573090.09$ cm⁴, $y_s = 0.0$ mm, $I_z = 14603346.59$ cm⁴
maximum/minimum stresses: $\sigma_o = -248.3$ N/mm², $\sigma_u = 248.3$ N/mm², $\tau = 85.9$ N/mm²
section class: 4 $\Rightarrow$ verification of plate buckling required !!

plate buckling

effective cross-sectional area

after 3 iteration steps:
web:
single buckling field 1:
effective width $b_{t,eff} = b = 552.8$ mm
buckling fields of stiffener 1: stiffener in tension zone
single buckling field 2:
section class 4 for $\alpha = 0.656$ and $69.46 < c/t = 88.20$
critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E = 336.5$ N/mm², $\sigma_E = 24.4$ N/mm², $k_\sigma = 13.79$
buckling slenderness ratio $\lambda_p = (f_y/\sigma_{cr,p})^{1/2} = 1.027$
reduction factor $\rho = (\lambda_p - 0.055 \cdot (3+\psi))/\lambda_p^2 = 0.844 \leq 1$ for $\lambda_p > 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.837$, $\psi = -0.524$
effective width $b_{c,eff} = (\rho \cdot b) / (1-\psi) = 391.0$ mm ($b_{e1} = 156.4$ mm, $b_{e2} = 234.6$ mm), $b_{t,eff} = 242.6$ mm, $\psi = -0.524$
buckling fields of stiffener 2: local buckling excluded ok.
single buckling field 3:

section class 4 for $39.76 < c/t = 69.10$
critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E = 200.2$ N/mm², $\sigma_E = 39.7$ N/mm², $k_\sigma = 5.04$
buckling slenderness ratio $\lambda_p = (f_y/\sigma_{cr,p})^{1/2} = 1.332$
reduction factor $\rho = (\lambda_p - 0.055 \cdot (3+\psi))/\lambda_p^2 = 0.640 \leq 1$ for $\lambda_p > 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.731$, $\psi = 0.578$
effective width $b_{c,eff} = \rho \cdot b = 353.8$ mm ($b_{e1} = 160.0$ mm, $b_{e2} = 193.8$ mm)

overall buckling field, stiffener 1:
stiffener in tension zone $\Rightarrow \rho = 1$
effective widths of adjacent buckling fields $b_{1,e2,eff} = \rho \cdot b_{1,c,eff} = 276.4$ mm, $b_{2,e1,eff} = \rho \cdot b_{2,c,eff} = 234.6$ mm
effective area of stiffener $A_{sl,eff} = \rho \cdot A_{st} = 48.77$ cm²

overall buckling field, stiffener 2:
EC 3-1-5, appendix A.2.2 (fictitious member with elastic bedding):
critical buckling stress $\sigma_{cr,p} = \sigma_{cr,p,sl} \cdot \sigma_1/\sigma_{sl} = 2046.8$ N/mm², $\sigma_1/\sigma_{sl} = 2.147$, $\sigma_{cr,p,sl} = 953.2$ N/mm²
buckling slenderness ratio $\lambda_p = (\beta_A \cdot f_y/\sigma_{cr,p})^{1/2} = 0.395$, $\beta_A = A_{sl,eff}/A_{sl} = 0.901$
reduction factor $\rho = 1$ for $\lambda_p < 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.862$, $\psi = -0.832$
critical buckling stress $\sigma_{cr,c} = \sigma_{cr,c,sl} \cdot \sigma_1/\sigma_{sl} = 2031.1$ N/mm², $\sigma_1/\sigma_{sl} = 2.147$, $\sigma_{cr,c,sl} = 945.9$ N/mm²
buckling slenderness ratio $\lambda_c = (\beta_A \cdot f_y/\sigma_{cr,c})^{1/2} = 0.397$, $\beta_A = A_{sl,eff}/A_{sl} = 0.901$
reduction factor $\chi_c = 0.911 \leq 1$ for $\lambda_c > 0.2$
final reduction factor $\rho = (\rho-\chi_c) \cdot \xi \cdot (2-\xi) + \chi_c = 0.913$ with $\xi = 0.008$
$\sigma_{sl} = 142.1$ N/mm² $< \rho \cdot f_y/\gamma_{M1} = 294.5$ N/mm² $\Rightarrow$ rotational ability of stiffener sufficient **ok.**
effective widths of adjacent buckling fields $b_{2,e2,eff} = \rho \cdot b_{2,c,eff} = 142.7$ mm, $b_{3,e1,eff} = \rho \cdot b_{3,c,eff} = 176.9$ mm
effective area of stiffener $A_{sl,eff} = \rho \cdot A_{st} = 44.51$ cm²

flange induced web buckling:
$h_w/t_w = 300.00 < (k \cdot E)/(f_y \cdot (A_w/A_{fc})^{1/2}) = 355.84$ **ok.** with $k = 0.55$, $A_w = 192.00$ cm², $A_{fc} = 160.51$ cm²

flange top:
stresses at edge of plate $\sigma_o = -255.2$ N/mm² ≤ 0, $\sigma_u = -255.2$ N/mm² ≤ 0 $\Rightarrow$ no buckling !!

flange bottom:
single buckling field 1:
section class 4 for $34.17 < c/t = 35.91$
critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E = 588.7$ N/mm², $\sigma_E = 147.2$ N/mm², $k_\sigma = 4.00$
buckling slenderness ratio $\lambda_p = (f_y/\sigma_{cr,p})^{1/2} = 0.777$
reduction factor $\rho = (\lambda_p - 0.055 \cdot (3+\psi))/\lambda_p^2 = 0.923 \leq 1$ for $\lambda_p > 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.673$, $\psi = 1.000$
effective width $b_{c,eff} = \rho \cdot b = 397.7$ mm ($b_{e1} = 198.9$ mm, $b_{e2} = 198.9$ mm)

buckling fields of stiffener 1: local buckling cannot be excluded

single buckling field 2:
section class 4 for $34.17 < c/t = 37.72$
critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E = 533.5$ N/mm², $\sigma_E = 133.4$ N/mm², $k_\sigma = 4.00$
buckling slenderness ratio $\lambda_p = (f_y/\sigma_{cr,p})^{1/2} = 0.816$
reduction factor $\rho = (\lambda_p - 0.055 \cdot (3+\psi))/\lambda_p^2 = 0.895 \leq 1$ for $\lambda_p > 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.673$, $\psi = 1.000$
effective width $b_{c,eff} = \rho \cdot b = 405.3$ mm ($b_{e1} = 202.6$ mm, $b_{e2} = 202.6$ mm)

buckling fields of stiffener 2: local buckling cannot be excluded

single buckling field 3:
section class 4 for $34.17 < c/t = 37.72$
critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E = 533.5$ N/mm², $\sigma_E = 133.4$ N/mm², $k_\sigma = 4.00$
buckling slenderness ratio $\lambda_p = (f_y/\sigma_{cr,p})^{1/2} = 0.816$
reduction factor $\rho = (\lambda_p - 0.055 \cdot (3+\psi))/\lambda_p^2 = 0.895 \leq 1$ for $\lambda_p > 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.673$, $\psi = 1.000$
effective width $b_{c,eff} = \rho \cdot b = 405.3$ mm ($b_{e1} = 202.6$ mm, $b_{e2} = 202.6$ mm)

buckling fields of stiffener 3: local buckling cannot be excluded

single buckling field 4:
section class 4 for $34.17 < c/t = 35.91$
critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E = 588.7$ N/mm², $\sigma_E = 147.2$ N/mm², $k_\sigma = 4.00$
buckling slenderness ratio $\lambda_p = (f_y/\sigma_{cr,p})^{1/2} = 0.777$
reduction factor $\rho = (\lambda_p - 0.055 \cdot (3+\psi))/\lambda_p^2 = 0.923 \leq 1$ for $\lambda_p > 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.673$, $\psi = 1.000$
effective width $b_{c,eff} = \rho \cdot b = 397.7$ mm ($b_{e1} = 198.9$ mm, $b_{e2} = 198.9$ mm)

overall buckling field, stiffener 1:
EC 3-1-5, appendix A.1 (equivalent orthotropic plate):
critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E = 1035.7$ N/mm², $\sigma_E = 3.9$ N/mm², $k_\sigma = 267.97$
buckling slenderness ratio $\lambda_p = (\beta_A \cdot f_y/\sigma_{cr,p})^{1/2} = 0.575$, $\beta_A = A_{sl,eff}/A_{sl} = 0.963$
reduction factor $\rho = 1$ for $\lambda_p < 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.673$, $\psi = 1.000$
critical buckling stress $\sigma_{cr,c} = \sigma_{cr,c,sl} \cdot \sigma_1/\sigma_{sl} = 1117.7$ N/mm², $\sigma_1/\sigma_{sl} = 1.000$, $\sigma_{cr,c,sl} = 1117.7$ N/mm²
buckling slenderness ratio $\lambda_c = (\beta_A \cdot f_y/\sigma_{cr,c})^{1/2} = 0.553$, $\beta_A = A_{sl,eff}/A_{sl} = 0.963$
reduction factor $\chi_c = 0.825 \leq 1$ for $\lambda_c > 0.2$
final reduction factor $\rho = (\rho-\chi_c) \cdot \xi \cdot (2-\xi) + \chi_c = 0.825$ with $\xi = 0.000$
$\sigma_{sl} = 306.5$ N/mm² $> \rho \cdot f_y/\gamma_{M1} = 266.2$ N/mm² $\Rightarrow$ rotational ability of stiffener not sufficient
effective widths of adjacent buckling fields $b_{1,e2,eff} = \rho \cdot b_{1,c,eff} = 164.0$ mm, $b_{2,e1,eff} = \rho \cdot b_{2,c,eff} = 167.1$ mm
effective area of stiffener $A_{sl,eff} = \rho \cdot A_{st} = 34.56$ cm²

overall buckling field, stiffener 2:
EC 3-1-5, appendix A.1 (equivalent orthotropic plate):
critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E = 1035.7$ N/mm², $\sigma_E = 3.9$ N/mm², $k_\sigma = 267.97$
buckling slenderness ratio $\lambda_p = (\beta_A \cdot f_y/\sigma_{cr,p})^{1/2} = 0.573$, $\beta_A = A_{sl,eff}/A_{sl} = 0.957$
reduction factor $\rho = 1$ for $\lambda_p < 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.673$, $\psi = 1.000$

critical buckling stress $\sigma_{cr,c} = \sigma_{cr,c,sl} \cdot \sigma_1/\sigma_{sl}$ = 1110.3 N/mm², σ_1/σ_{sl} = 1.000, $\sigma_{cr,c,sl}$ = 1110.3 N/mm²
buckling slenderness ratio $\lambda_c = (\beta_A \cdot f_y/\sigma_{cr,c})^{1/2}$ = 0.553, $\beta_A = A_{sl,eff}/A_{sl}$ = 0.957
reduction factor $\chi_c = 0.824 \leq 1$ for $\lambda_c > 0.2$
final reduction factor $\rho = (\rho-\chi_c) \cdot \xi \cdot (2-\xi) + \chi_c = 0.824$ with $\xi = 0.000$
σ_{sl} = 306.5 N/mm² > $\rho \cdot f_y/\gamma_{M1}$ = 266.1 N/mm² ⇒ rotational ability of stiffener not sufficient
effective widths of adjacent buckling fields $b_{2,e2,eff} = \rho \cdot b_{2,c,eff}$ = 167.1 mm, $b_{3,e1,eff} = \rho \cdot b_{3,c,eff}$ = 167.1 mm
effective area of stiffener $A_{sl,eff} = \rho \cdot A_{st}$ = 34.55 cm²

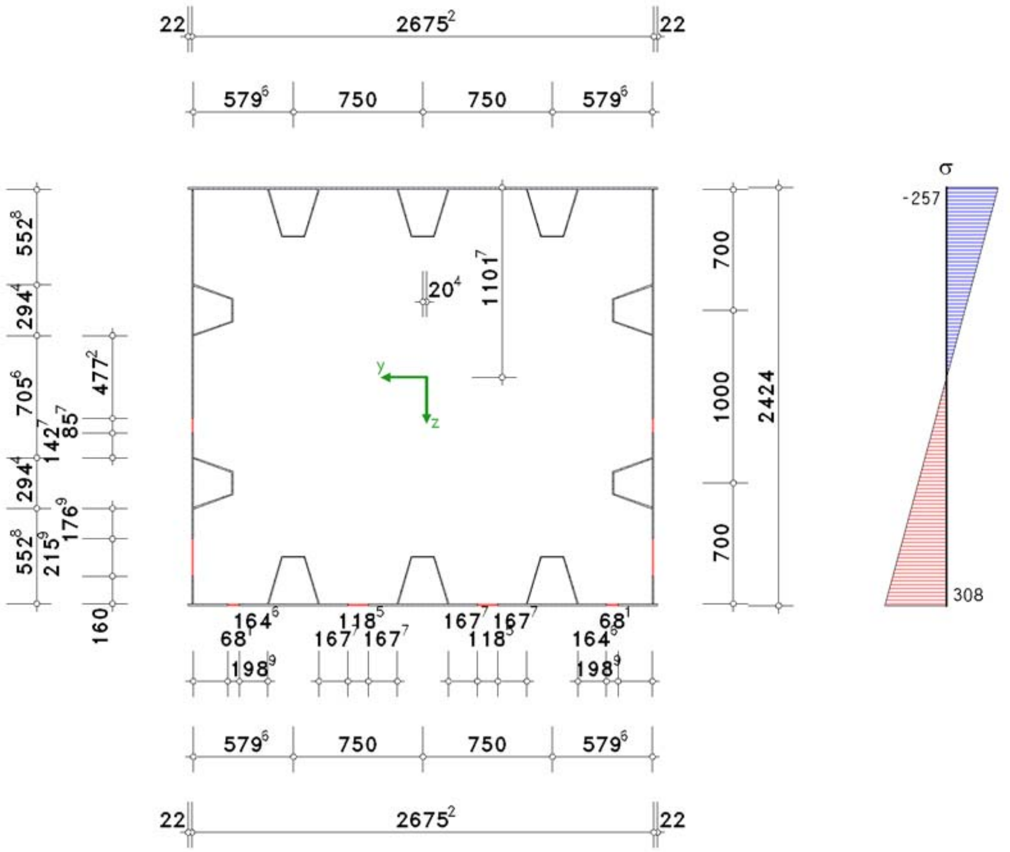
overall buckling field, stiffener 3:

EC 3-1-5, appendix A.1 (equivalent orthotropic plate):

critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E$ = 1035.7 N/mm², σ_E = 3.9 N/mm², k_σ = 267.97
buckling slenderness ratio $\lambda_p = (\beta_A \cdot f_y/\sigma_{cr,p})^{1/2}$ = 0.575, $\beta_A = A_{sl,eff}/A_{sl}$ = 0.963
reduction factor $\rho = 1$ for $\lambda_p < 0.5 + (0.085-0.055 \cdot \psi)^{1/2} = 0.673$, $\psi = 1.000$
critical buckling stress $\sigma_{cr,c} = \sigma_{cr,c,sl} \cdot \sigma_1/\sigma_{sl}$ = 1117.7 N/mm², σ_1/σ_{sl} = 1.000, $\sigma_{cr,c,sl}$ = 1117.7 N/mm²
buckling slenderness ratio $\lambda_c = (\beta_A \cdot f_y/\sigma_{cr,c})^{1/2}$ = 0.553, $\beta_A = A_{sl,eff}/A_{sl}$ = 0.963
reduction factor $\chi_c = 0.825 \leq 1$ for $\lambda_c > 0.2$
final reduction factor $\rho = (\rho-\chi_c) \cdot \xi \cdot (2-\xi) + \chi_c = 0.825$ with $\xi = 0.000$
σ_{sl} = 306.5 N/mm² > $\rho \cdot f_y/\gamma_{M1}$ = 266.2 N/mm² ⇒ rotational ability of stiffener not sufficient
effective widths of adjacent buckling fields $b_{3,e2,eff} = \rho \cdot b_{3,c,eff}$ = 167.1 mm, $b_{4,e1,eff} = \rho \cdot b_{4,c,eff}$ = 164.0 mm
effective area of stiffener $A_{sl,eff} = \rho \cdot A_{st}$ = 34.56 cm²

limit loads refering to the reduced cross-section:

res. stresses σ_o = -256.6 N/mm², σ_u = 308.0 N/mm²
distance of centroid from top $z_{s,eff}$ = 1101.7 mm
cross-sectional area A_{eff} = 1318.66 cm²
second moment of area $I_{y,eff}$ = 12816639.18 cm⁴
section moduli of the pin $W_{y,eff,o}$ = 116970.57 cm³, $W_{y,eff,u}$ = 97369.78 cm³
load capacities $N_{Rd} = (f_y \cdot A_{eff}) / \gamma_{M1}$ = 42556.90 kN
$M_{Rd,o} = (f_y \cdot W_{eff,o}) / \gamma_{M1}$ = 37749.59 kNm, $M_{Rd,u} = (f_y \cdot W_{eff,u}) / \gamma_{M1}$ = 31423.88 kNm



verification

$|M_{Ed}|/M_{Rd,u}$ = 0.950 < 1 **ok.**

shear buckling

single buckling field 1:

shear buckling: $h_w/t_w = 69.10 > 72 \cdot \varepsilon/\eta = 48.82$ ⇒ particular verification is required !!
buckling factor of shear for $a/h_w = 7.24 > 1$: $k_\tau = 5.34 + 4/(a/h_w)^2 = 5.42$
critical buckling stress of shear $\tau_{cr,p} = k_\tau \cdot \sigma_E$ = 215.3 N/mm², σ_E = 39.7 N/mm²
modified slenderness $\lambda_w = 0.76 \cdot (f_y/\tau_{cr,p}) = 0.976$
reduction factor $\chi_w = 0.83/\lambda_w = 0.850$ for $0.83/\eta = 0.692 \leq \lambda_w < 1.08$

resistance $V_{bw,Rd} = (\chi_w \cdot f_y \cdot h_w \cdot t_w) / (3^{1/2} \cdot \gamma_{M1}) = 3042.57$ kN
2 webs $\Rightarrow$ $V_{bw,Rd} = 6085.14$ kN
design value of resistance $V_{b,Rd} = V_{bw,Rd} = 6085.1$ kN
buckling field at the stiffener 1:
shear buckling: $h_w/t_w = 36.80 \le 72 \cdot \varepsilon/\eta = 48.82$ ok.
single buckling field 2:
shear buckling: $h_w/t_w = 88.20 > 72 \cdot \varepsilon/\eta = 48.82$ $\Rightarrow$ particular verification is required !!
buckling factor of shear for $a/h_w = 5.67 > 1$: $k_\tau = 5.34 + 4/(a/h_w)^2 = 5.46$
critical buckling stress of shear $\tau_{cr,p} = k_\tau \cdot \sigma_E = 133.3$ N/mm², $\sigma_E = 24.4$ N/mm²
modified slenderness $\lambda_w = 0.76 \cdot (f_y/\tau_{cr,p}) = 1.240$
reduction factor $\chi_w = 1.37/(0.7+\lambda_w) = 0.706$ for $\lambda_w \ge 1.08$
resistance $V_{bw,Rd} = (\chi_w \cdot f_y \cdot h_w \cdot t_w) / (3^{1/2} \cdot \gamma_{M1}) = 2526.10$ kN
2 webs $\Rightarrow$ $V_{bw,Rd} = 5052.20$ kN
design value of resistance $V_{b,Rd} = V_{bw,Rd} = 5052.2$ kN
buckling field at the stiffener 2:
shear buckling: $h_w/t_w = 36.80 \le 72 \cdot \varepsilon/\eta = 48.82$ ok.
single buckling field 3:
shear buckling: $h_w/t_w = 69.10 > 72 \cdot \varepsilon/\eta = 48.82$ $\Rightarrow$ particular verification is required !!
buckling factor of shear for $a/h_w = 7.24 > 1$: $k_\tau = 5.34 + 4/(a/h_w)^2 = 5.42$
critical buckling stress of shear $\tau_{cr,p} = k_\tau \cdot \sigma_E = 215.3$ N/mm², $\sigma_E = 39.7$ N/mm²
modified slenderness $\lambda_w = 0.76 \cdot (f_y/\tau_{cr,p}) = 0.976$
reduction factor $\chi_w = 0.83/\lambda_w = 0.850$ for $0.83/\eta = 0.692 \le \lambda_w < 1.08$
resistance $V_{bw,Rd} = (\chi_w \cdot f_y \cdot h_w \cdot t_w) / (3^{1/2} \cdot \gamma_{M1}) = 3042.57$ kN
2 webs $\Rightarrow$ $V_{bw,Rd} = 6085.14$ kN
design value of resistance $V_{b,Rd} = V_{bw,Rd} = 6085.1$ kN
overall buckling field:
shear buckling: $h_w/t_w = 300.00 > 31 \cdot \varepsilon \cdot k_\tau^{1/2}/\eta = 89.23$, $k_\tau = 18.02$ $\Rightarrow$ particular verification is required !!
contribution of the flanges:
resisting moment $M_{f,Rd} = f_{N,f} \cdot M_{f,k}/\gamma_{M0} = 28444.8$ kNm, $M_{f,k} = 28444.8$ kNm, $f_{N,f} = 1.00$
$M_{Ed} \ge M_{f,Rd}$: flanges fully exploited, resistance $V_{bf,Rd} = 0$
contribution of the web:
buckling factor of shear for $a/h_w = 1.67 < 3$: $k_\tau = 4.1 + (6.3+0.18 \cdot I_{sl}/(h_w \cdot t_w^3))/(a/h_w)^2 + 2.2 \cdot (I_{sl}/(h_w \cdot t_w^3))^{1/3} = 18.02$
critical buckling stress of shear $\tau_{cr,p} = k_\tau \cdot \sigma_E = 38.0$ N/mm², $\sigma_E = 2.1$ N/mm²
modified slenderness $\lambda_w = 0.76 \cdot (f_y/\tau_{cr,p}) = 2.323$
reduction factor $\chi_w = 1.37/(0.7+\lambda_w) = 0.453$ for $\lambda_w \ge 1.08$
resistance $V_{bw,Rd} = (\chi_w \cdot f_y \cdot h_w \cdot t_w) / (3^{1/2} \cdot \gamma_{M1}) = 1621.43$ kN
2 webs $\Rightarrow$ $V_{bw,Rd} = 3242.86$ kN
design value of resistance $V_{b,Rd} = V_{bw,Rd} = 3242.9$ kN
load capacities $V_{b,Rd,min} = 3242.9$ kN, $V_{bw,Rd,min} = 3242.9$ kN
verification: $V_{Ed}/V_{b,Rd,min} = 1.018 > 1$ not ok. !!

interaction between shear, internal moment and axial force
utilization due to shear buckling of the web $\eta_3 = V_{Ed}/V_{bw,Rd,min} = 1.018 > 0.5$
utilization due to plate buckling $\eta_1 = M_{Ed}/M_{pl,Rd} = 0.673 > \eta_{1,lim} = M_{f,Rd}/M_{pl,Rd} = 0.641$
with $M_{pl,Rd} = 44352.9$ kNm, $M_{f,Rd} = 28444.8$ kNm
verification: $\eta_1 + (1-\eta_{1,lim}) \cdot (2 \cdot \eta_3 - 1)^2 = 1.057 > 1$ not ok. !!

total utilization: $U = 1.057 > 1$ not ok. !!
assumptions not succeeded !!

Final Result

maximum utilization: max $U = 1.057 > 1$ not ok. !!
assumptions: not succeeded !!

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