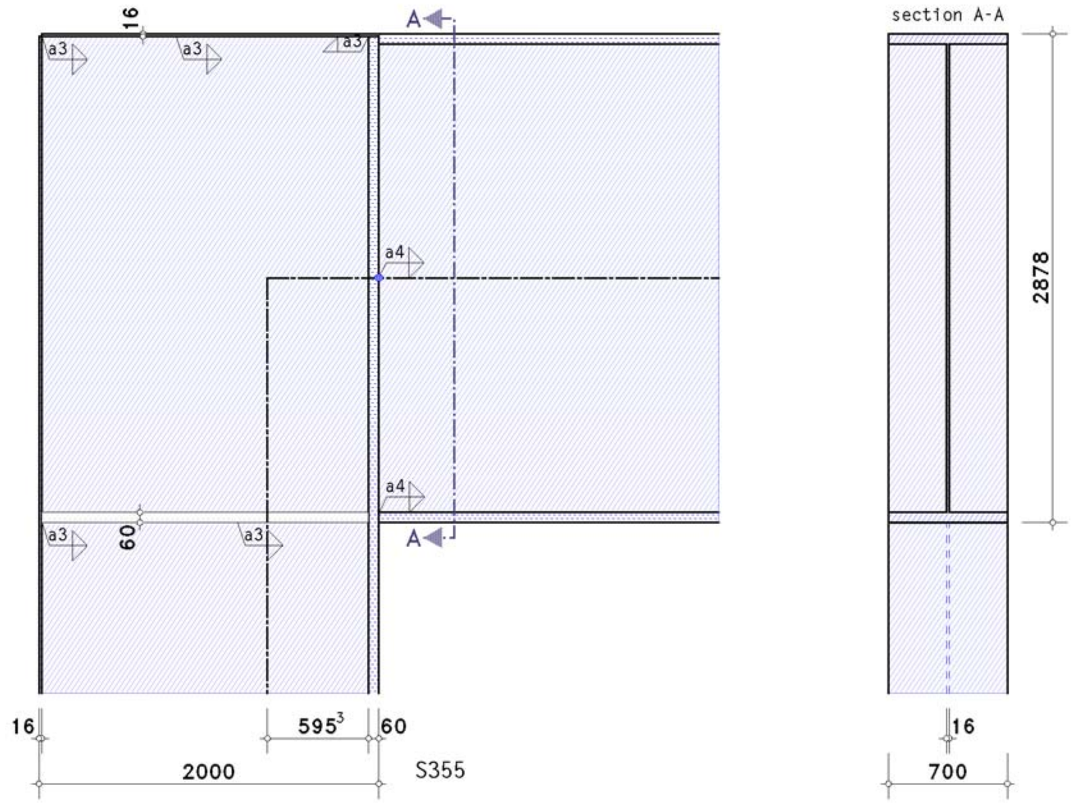
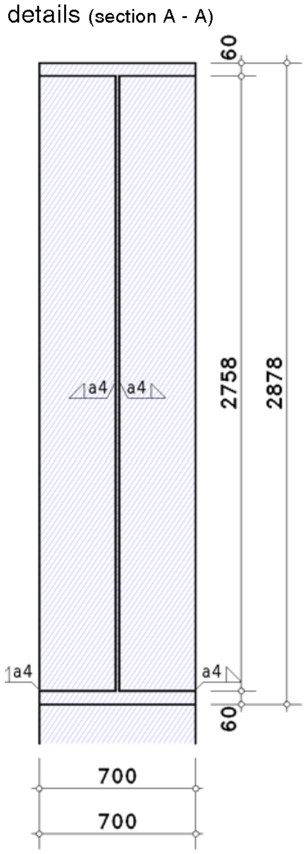
POS. 9: BSP. BUCKLING

frame corner EC 3-1-8 (04.25), NA: Deutschland 4H-EC3RE version: 2/2020-2q

1. input report



details (section A - A)



steel grade

steel grade S355

column parameters

parameter (I-section):

overall depth h = 2000.0 mm, web thickness t_w = 16.0 mm

flange width top b_{fo} = 700.0 mm, flange thickness top t_{fo} = 16.0 mm

flange width below b_{fu} = 700.0 mm, flange thickness below t_{fu} = 60.0 mm, gewalzt
reinforcement of the section with transverse stiffeners (web stiffeners, d_{st} = 2840.0 mm):
thickness t_{st} = 60.0 mm, width b_{st} = 342.0 mm, length l_{st} = 1924.0 mm
recess at stiffeners c_{st} = 0.2 mm
welds $a_{st,f}$ = 3.0 mm, $a_{st,w}$ = 3.0 mm

beam parameters

section parameters (H-section):
overall depth h = 2878.0 mm, web thickness t_w = 16.0 mm
flange width b_f = 700.0 mm, flange thickness t_f = 60.0 mm, gewalzt

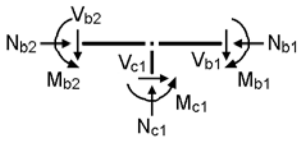
verification parameters

welded connection

tension plate: thickness t_z = 16.0 mm, width b_z = 700.0 mm
welds $a_{z,f}$ = 3.0 mm, $a_{z,w}$ = 3.0 mm
welds at the connection point:
fillet weld, weld thickness a = 0.0 mm
beam web: fillet weld, weld thickness a = 4.0 mm
beam flange below: fillet weld, weld thickness a = 4.0 mm

internal forces and moments at the joint periphery refering to the system axes

Lc 1: $N_{b,Ed}$ = 2323.00 kN $M_{b,Ed}$ = 8650.00 kNm $V_{b,Ed}$ = 6000.00 kN



partial safety factors for material

resistance of cross-sections γ_{M0} = 1.00
resistance of members in stability failure γ_{M1} = 1.10
resistance of bolts, welds, plates in bearing γ_{M2} = 1.25

notes

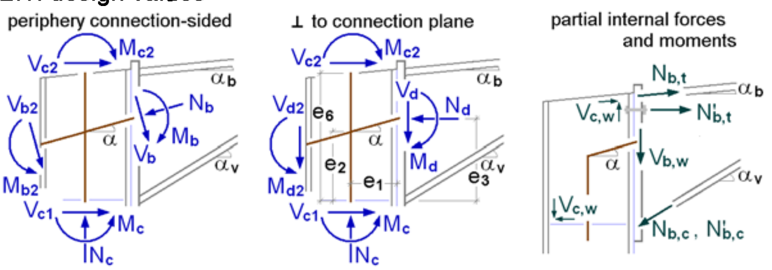
no verification for cross-sections.
local resistance of weld is not respected.
no verification of web stiffeners.
shear area is not investigated.
local shear resistance of column flange/beam webs is not respected.

check of data

ok

2. Lc 1

2.1. design values



slope angle: $\alpha_b = \alpha = \alpha_v = 0°$
distances: e_1 = 655.3 mm, e_3 = 1409.0 mm, e_2 = 1409.0 mm, e_6 = 2840.0 mm

internal forces and moments perpendicular to the connection planes

periphery beam
N_d = 2323.00 kN, M_d = 8650.00 kNm, V_d = 6000.00 kN
periphery column (below, calculated)
N_c = 6000.00 kN, M_c = 9308.47 kNm, V_c = 2323.00 kN

partial internal forces and moments

$N_{b,t} = -N_d \cdot z_{bu}/z_b + M_d/z_b$ = 1908.05 kN, z_b = 2818.0 mm, z_{bu} = 1409.0 mm
$N_{b,c} = N_d \cdot z_{bo}/z_b + M_d/z_b$ = 4231.05 kN, z_b = 2818.0 mm, z_{bo} = 1409.0 mm
$V_{b,t} = -N_{b,t} \cdot \sin(\alpha_b)$ = 0.00 kN, $V_{b,c} = N_{b,c} \cdot \sin(\alpha_b)$ = 0.00 kN, $V_{b,w} = V_d - V_{b,t} - V_{b,c}$ = 6000.00 kN

2.2. verifications

2.2.1. verification of buckling resistance

column web

requirements concerning stiffeners: verification of web stiffeners required !!
plate buckling: section class of the web plate 4 > 2 $\Rightarrow$ particular verification is required !!
shear buckling: h_p/t_p = 120.25 > $72 \cdot \varepsilon/\eta$ = 50.25 $\Rightarrow$ particular verification is required !!
buckling field: a = 2802.0 mm, b = 1923.8 mm, t = 16.0 mm, σ_1 = -175.50 N/mm², σ_2 = 182.06 N/mm², τ = 73.98 N/mm²
buckling stresses: σ_{Ed} = 182.06 N/mm², τ_{Ed} = 73.98 N/mm²

plate buckling

two-side supported plated panel: stress ratio $\Psi = \sigma_2/\sigma_1$ = -0.964 $\Rightarrow$ buckling factor k_σ = 22.96
critical buckling stress $\sigma_{cr,p} = k_\sigma \cdot \sigma_E$ = 301.5 N/mm², σ_E = 13.1 N/mm²

shear buckling
buckling factor of shear for $a/h_w = 1.46 > 1$: $k_\tau = 5.34 + 4/(a/h_w)^2 = 7.23$
critical buckling stress of shear $\tau_{cr,p} = k_\tau \cdot \sigma_E = 94.8$ N/mm², $\sigma_E = 13.1$ N/mm²
modified slenderness $\lambda_w = 0.76 \cdot (f_{yw}/\tau_{cr,p})^{1/2} = 1.428$
reduction factor for $\lambda_w \geq 1.08$: $\chi_w = 1.37/(0.7+\lambda_w) = 0.644$
verification: $\tau_{Ed}/\tau_{Rd} = 0.654 < 1$ ok
load increase factor for stresses $\alpha_{ult} = 1.505$
load increase factor for stability $\alpha_{cr} = 1.012$
non-dimensional slenderness ratio $\lambda_p = \lambda_w = (\alpha_{ult}/\alpha_{cr})^{1/2} = 1.220$
reduction factor for $\lambda_p > 0.5 + (0.085-0.055 \cdot \Psi)^{1/2} = 0.872$: $\rho = (\lambda_p - 0.055 \cdot (3+\Psi))/\lambda_p^2 = 0.745 \leq 1$
reduction factor for $\lambda_w \geq 1.08$: $\chi_w = 1.37/(0.7+\lambda_w) = 0.714$
ultimate buckling stresses $\sigma_{Rd} = \rho \cdot f_y/\gamma_{M1} = 226.8$ N/mm², $\tau_{Rd} = \chi_w \cdot f_y/\gamma_{M1} = 217.3$ N/mm²
verification: $(\sigma_{Ed}/\sigma_{Rd})^2 + 3 \cdot (\tau_{Ed}/\tau_{Rd})^2 = 0.992 < 1$ ok

2.2.2. verification result

maximum utilization: max U = 0.992 < 1 ok

3. final result

maximum utilization: max U = 0.992 < 1 ok

verification succeeded

4. Regulations

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

EN 1993-1-1, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau;
Deutsche Fassung EN 1993-1-1:2022, Ausgabe April 2025
EN 1993-1-1/NA, Nationaler Anhang zur EN 1993-1-1, Ausgabe April 2026

EN 1993-1-8, Eurocode 3: Bemessung und Konstruktion von Stahlbauten -
Teil 1-8: Bemessung von Anschlüssen; Deutsche Fassung EN 1993-1-8:2024, Ausgabe April 2025
EN 1993-1-8/NA, Nationaler Anhang zur EN 1993-1-8, Ausgabe April 2026

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 + A1:2017 + A2:2019, Ausgabe Oktober 2019
EN 1993-1-5/NA, Nationaler Anhang zur EN 1993-1-5, Ausgabe Dezember 2010