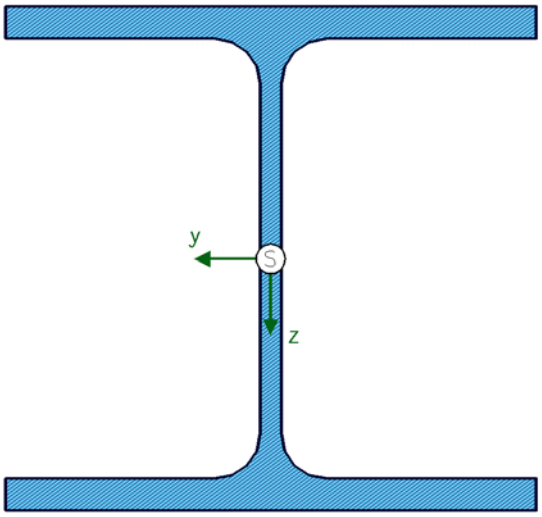
verification of stability EC 3-1-2 (12.10), NA: Deutschland 4H-EC3ST version: 12/2021-1b

1. input data

1.1. general information
verifications of stability acc. to EN 1993-1-1
c/t-verification (classification of cross-section)
flexural buckling with the method of fictitious bars, no buckling direction

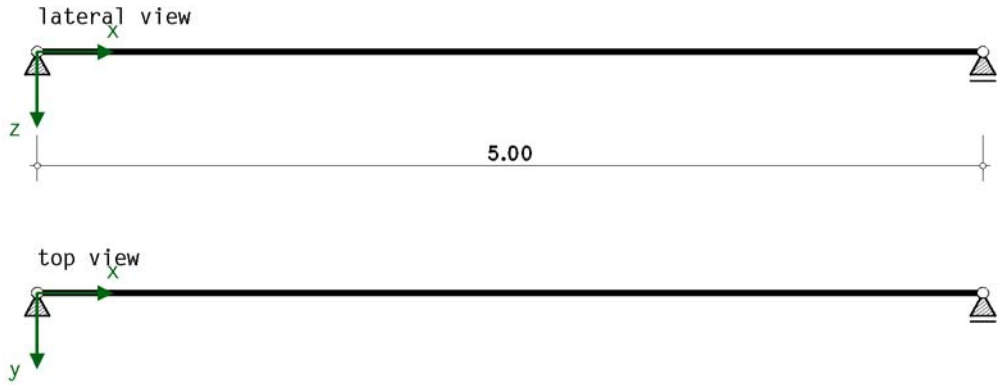
1.2. safety factor of material
resistance of cross-sections γ_{M0} = 1.00
resistance of members in stability failure γ_{M1} = 1.10

1.3. cross-section
material: S235 (St37) (E = 210000 N/mm^2, G = 80769 N/mm^2, $f_{y,k}$ = 235 N/mm^2)
section: HE140A
section scale 1:2.0



1.4. cross-section values (related to the centre of gravity S)
I_y = 1030.0 cm^4, I_z = 389.0 cm^4, I_ζ = 1030.0 cm^4, I_η = 389.0 cm^4, α = 0.0°
I_ω = 15060.0 cm^6, I_T = 8.2 cm^4
W_y = 155.0 cm^3, W_z = 55.6 cm^3, $W_{pl,y}$ = 173.0 cm^3, $W_{pl,z}$ = 84.7 cm^3
$z_{m,y}$ = 0.0 mm, $z_{m,z}$ = 0.0 mm, A = 31.4 cm^2

1.5. static system
all bearings with fork restraint, bar length 5.000 [m]
no intermediate bearing in z-direction, no intermediate bearing in y-direction



1.6. buckling coefficients

$\perp$ y-axis: $\beta_y = 1.000$, $\perp$ z-axis: $\beta_z = 1.000$
warping restraint intensity $\beta_0 = 1.000$

1.7. design member forces (load combinations)

Lk	N_d kN
1	159.00

N_d: constant axial force in the bar

2. verifications

2.1. classification of cross-section

2.1.1. load combination 1 ⇒ section class 3

no	c mm	t mm	c/t -	ε -	σ_1 N/mm²	σ_2 N/mm²	tab 5.2	α -	ψ -	k_σ -	class -
1	55.3	8.5	6.50	1.000	50.64	50.64	single 1/1	---	---	---	1
2	55.3	8.5	6.50	1.000	50.64	50.64	single 1/1	---	---	---	1
3	92.0	5.5	16.73	1.000	50.64	50.64	both 2/1	---	---	---	1
4	55.3	8.5	6.50	1.000	50.64	50.64	single 1/1	---	---	---	1
5	55.3	8.5	6.50	1.000	50.64	50.64	single 1/1	---	---	---	1

compressive stresses have a positive sign acc. to EC 3.
verifications are carried out in the **specified** cross-section class 3: $U_{c/t} = 0.464 < 1$ ok

2.2. flexural buckling around z-axis

$I_p = 1419$ cm⁴, $I_T = 8$ cm⁴, $i_p^2 = 4519$ mm², $c^2 = 24408$ mm², $i_m^2 = 4519$ mm²
$i_z = 35.2$ mm, $\beta_y = 1.00$ ($\perp$ y-axis), $L_{cr,y} = 5.000$ m, $\lambda_1 = 93.913$
$\lambda_z = 1.513$, z-buckling curve c ⇒ $\alpha_z = 0.49$, $\Phi_z = 1.966$, $\chi_z = 0.310$, **$N_{bz,Rd} = 208.27$ kN**

2.2.1. utilisations

Lk	N_d kN	U_z -
1	159.00	**0.763**

max U = 0.763 < 1 ok

3. final result

maximum utilisation	U = 0.763 < 1 ok
c/t-utilisation	U = 0.464 < 1 ok

verification succeeded

4. Selected Design Parameters of the National Annex

DIN EN 1993-1-1 (EC 3, Hochbau), NA Deutschland

chapter	value	definition
6.1(1)	permanent/transient situation	partial safety factors for structural steel
	γ_{M0} = 1.00	collapse of cross-section
	γ_{M1} = 1.10	instability
	γ_{M2} = 1.25	fracture cross-sections in tension
	accidental situation	partial safety factors for structural steel
	γ_{M0} = 1.00	collapse of cross-section
	γ_{M1} = 1.00	instability
	γ_{M2} = 1.25	fracture cross-sections in tension
6.3.2.2(2)	factor f to modify	lateral torsional buckling
	χ_{LT}	general case
6.3.2.3(1)	$\lambda_{LT,0}$ = 0.40	slenderness eqn. (6.75)
	β = 0.75	correction factor eqn. (6.75)
6.3.2.3(2)	coefficient k_c from tab. 6.6	calculation of the reduction factor χ_{LT}

DIN EN 1993-1-2 (EC 3, Brandfall), NA Deutschland

chapter	value	definition
2.3(1)	event of fire	partial safety factor for
	$\gamma_{M,fi}$ = 1.00	mechanical failure