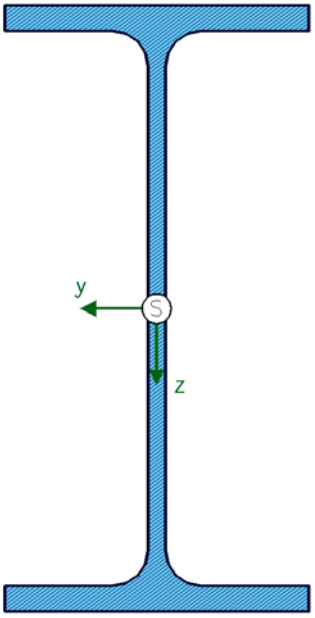
verification of stability EC 3-1-2 (12.10), NA: Deutschland 4H-EC3ST version: 12/2021-1b

1. input data

1.1. general information
verifications of stability acc. to EN 1993-1-1
c/t-verification (classification of cross-section)
lateral torsional buckling with the method of fictitious bars for My

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

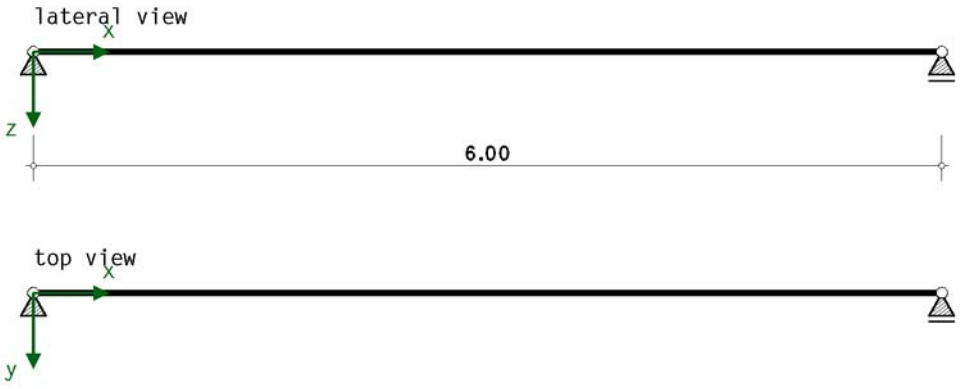
1.3. cross-section
material: S235 (St37) (E = 210000 N/mm^2, G = 80769 N/mm^2, $f_{y,k}$ = 235 N/mm^2)
section: IPE200
section scale 1:2.5



1.4. cross-section values (related to the centre of gravity S)
I_y = 1940.0 cm^4, I_z = 142.0 cm^4, I_ζ = 1940.0 cm^4, I_η = 142.0 cm^4, α = 0.0°
I_ω = 12990.0 cm^6, I_T = 7.0 cm^4
W_y = 194.0 cm^3, W_z = 28.5 cm^3, $W_{pl,y}$ = 221.0 cm^3, $W_{pl,z}$ = 44.7 cm^3
$z_{m,y}$ = 0.0 mm, $z_{m,z}$ = -0.0 mm, A = 28.5 cm^2

1.5. load application point (related to the center of the surrounding rectangle)
y_{load} = 0.0 mm (centroid)
z_{load} = 100.0 mm (lower edge of cross-section)

1.6. static system
all bearings with fork restraint, bar length 6.000 [m]
no intermediate bearing in z-direction, no intermediate bearing in y-direction



1.7. buckling coefficients

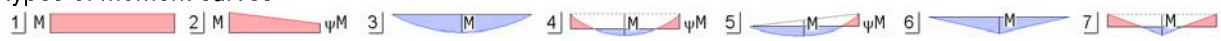
⊥ y-axis: β_y = 1.000, ⊥ z-axis: β_z = 1.000
warping restraint intensity β_0 = 1.000

1.8. design member forces (load combinations)

Lk	type -y-	$M_{0y,d}$ kNm	ψ_y -	$k_{c,y}$ -	ζ_y -
1	3	20.00	1.000	0.940	1.128

type (y): type of moment curves each direction; $M_{0y,d}, \psi_y$: reference values of moment curve; $k_{c,y}, \zeta_y$: coefficients for calculation

types of moment curves



2. verifications

2.1. classification of cross-section

2.1.1. load combination 1 ⇒ section class 1

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	35.2	8.5	4.14	1.000	98.71	98.71	single 1/1	---	---	---	1
2	35.2	8.5	4.14	1.000	98.71	98.71	single 1/1	---	---	---	1
3	159.0	5.6	28.39	1.000	81.96	-81.96	both 1/1	---	---	---	1
4	35.2	8.5	4.14	1.000	-98.71	-98.71	---	---	---	---	---
5	35.2	8.5	4.14	1.000	-98.71	-98.71	---	---	---	---	---

compressive stresses have a positive sign acc. to EC 3.
verifications are carried out in the **specified** cross-section class 3: $U_{c/t}$ = 0.296 < 1 ok

2.2. lateral torsional buckling for bending around y-axis

c^2 = 78305 mm², buckling curve b ⇒ α_{LT} = 0.34, N_{cr} = 81.75 kN

2.2.1. utilisations

Lk	M_{cr} kNm	λ_{LT} -	f -	Φ_{LT} -	χ_{LT} m	$\chi_{LT,mod}$ m	M_{Ed} kNm	$M_{b,Rd}$ kNm	U -
1	30.83	1.216	0.980	1.193	0.570	0.581	20.00	24.10	**0.830**

max U = 0.830 < 1 ok

3. final result

maximum utilisation U = 0.830 < 1 ok
c/t-utilisation U = 0.296 < 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