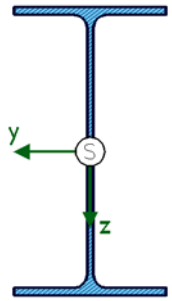
POSITION 47: 8.12 KLASSIFIZIERUNG

1. Input parameters

1.1. General statements
results acc. to DIN EN 1993:2010, Germany
verification of classification of the cross-section (width to thickness ratio)
torsional-flexural buckling by the method of fictitious bars acc. to EN 1993-1-1 6.3.3 with N+My

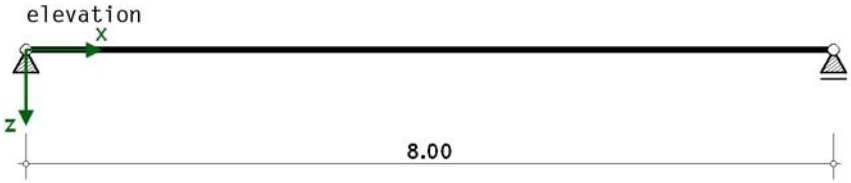
1.2. Cross-section
material: S235 (St37)
section: HE600AA
section scale 1:15

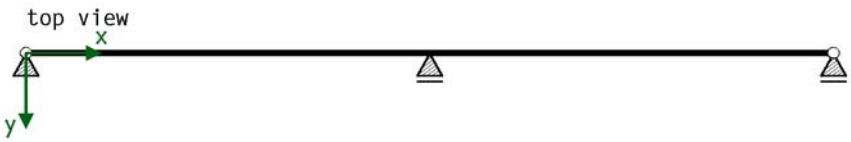


1.3. Section properties (refering to centroid S)
I_y = 91870 cm^4, I_z = 6993 cm^4, I_w = 5381000.0 cm^6, I_t = 150.00 cm^4
W_y = 3218.00 cm^3, W_z = 466.00 cm^3, $W_{pl,y}$ = 3623.00 cm^3, $W_{pl,z}$ = 724.00 cm^3
$z_{m,y}$ = 0 mm, $z_{m,z}$ = 0 mm, A = 16400 mm^2, cross-section is susceptible to torsional deformations

1.4. Load application point (refering to centroid S)
z_{load} = -285 mm (top edge of cross-section),

1.5. Structural system
all supports with fork conditions, beam length 8.000 [m]
no support in z-direction, 1 support in y-direction



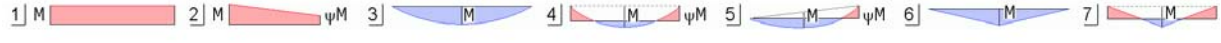


1.6. Buckling factors
about the y-axis: β_z = 1.000, about the z-axis: β_y = 1.000
warping restraint intensity β_0 = 1.000

1.7. Combinations of design internal forces

Nr	$M_{0y,d}$ kNm	type -	ψ_y -	$k_{c,y}$ -	ζ_y -	A
1	400.00	3	1.000	0.940	1.311	

moment diagram types



2. Verifications acc. to DIN EN 1993, Germany

DIN EN 1993-1-1 (EC 3)

chapter	value	definition
6.1(1)	permanent/transient sit.	partial factors for structural steel
	γ_{M0} = 1.00	Cross-section failure
	γ_{M1} = 1.10	instability
	γ_{M2} = 1.25	fracture cross-sections in tension
	accidental situation	partial factors for structural steel
	γ_{M0} = 1.00	Cross-section failure
	γ_{M1} = 1.00	instability
	γ_{M2} = 1.15	fracture cross-sections in tension
6.3.2.2(2)	factor f for modifying of χ_{LT}: setting	buckling curve torsional-flexural buckling general case

2.1. Classification of cross-sections acc. to DIN EN 1993-1-1, 5.5.2

2.1.1. Load combination 1 ⇒ class of cross-section 3

Nr	c mm	t mm	c/t -	ε -	σ_1 N/mm²	σ_2 N/mm²	Tab 5.2	α -	ψ -	k_σ -	class -
1	117.0	15.5	7.55	1.000	-77.00	-77.00	ones. 1/1	---	---	---	1
2	117.0	15.5	7.55	1.000	-77.00	-77.00	ones. 1/1	---	---	---	1
3	486.0	12.0	40.50	1.000	-77.00	-74.58	double 3/3	0.953	-1.000	---	**3**
4	117.0	15.5	7.55	1.000	-74.58	-74.58	ones. 1/1	---	---	---	1
5	117.0	15.5	7.55	1.000	-74.58	-74.58	ones. 1/1	---	---	---	1

verification is done with the smallest possible class of cross-section 3, U = 0.327

2.2. Torsional-flexural buckling acc. to DIN EN 1993-1-1, 6.3.3

I_p = 98863 cm⁴, I_T = 150 cm⁴, i_p^2 = 60282 mm, c^2_y = 90361 mm², c^2_z = 9941 mm², i_m^2 = 141793 mm²
i_y = 236.7 mm, β_y = 1.00 (about the z-axis), $L_{cr,y}$ = 4.000 m, λ_1 = 93.913
i_z = 65.3 mm, β_z = 1.00 (about the y-axis), $L_{cr,z}$ = 8.000 m
λ_y = 0.360, y-buckling curve a ⇒ α_y = 0.21, **λ_z = 0.652**, z-buckling curve b ⇒ α_z = 0.34
Φ_y = 0.582, **χ_y = 0.963, $N_{by,Rd}$ = 3374.17 kN**, Φ_z = 0.790, **χ_z = 0.810, $N_{bz,Rd}$ = 2837.82 kN**

2.2.0.1. Utilizations

Nr	N_d kN	U_y -	U_z -
1	1243.00	**0.368**	**0.438**

2.2.1. Torsional-flexural buckling acc. to DIN EN 1993-1-1 6.3.2 about the y-y-axis

c^2 = 90361 mm², buckling curve b ⇒ α_{LT} = 0.34, N_{cr} = 9058.63 kN

2.2.1.1. Utilizations

Nr	class	M_{cr} kNm	λ_{LT} -	f -	Φ_{LT} -	χ_{LT} -m	M_{Ed} kNm	$M_{b,Rd}$ kNm	U -
1	3 ⇒ $W_{el,y}$	2257.50	0.579	0.973	0.656	0.927	400.00	654.73	**0.611**

2.2.2. Utilizations interaction

Nr	axis	C_{my} -	k_{yy} -	C_{mLT} -	k_{zy} -	U Gl.(6.61) -	U Gl.(6.62) -
1	y-y	0.950	1.026	0.800	---	**1.012**	---
2	z-z	---	---	0.800	0.960	---	**1.041**

max U = 1.041 > 1 ⇒ verification failed!
the total utilization is: U = 1.041