POSITION 44: SCHNEIDER BT 8.41

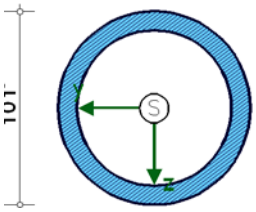
1. Input parameters

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

self defined material with: E = 210000 N/mm², G = 81000 N/mm², $f_{y,k}$ = 240 N/mm², $f_{y,k40}$ = 215 N/mm²
designation: L50X30X5 hot finished, d = 101.60 mm, t = 10.00 mm
section scale 1:40



1.3. Section properties (refering to centroid S)

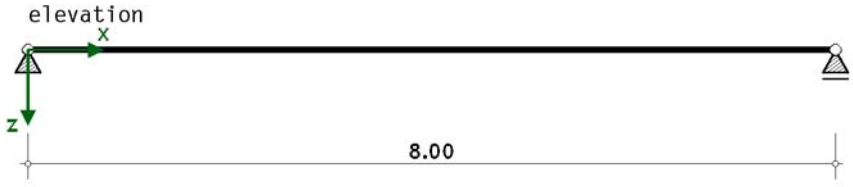
I_y = 305 cm⁴, I_z = 305 cm⁴, I_w = 0.0 cm⁶, I_t = 610.83 cm⁴
W_y = 60.12 cm³, W_z = 60.12 cm³, $W_{pl,y}$ = 82.29 cm³, $W_{pl,z}$ = 82.29 cm³
$z_{m,y}$ = 0 mm, $z_{m,z}$ = 0 mm, A = 2878 mm², cross-section is susceptible to torsional deformations

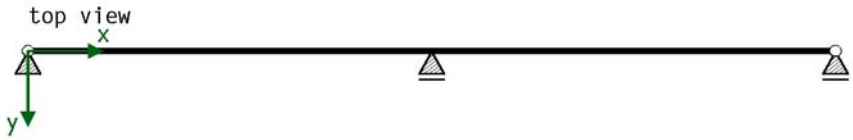
1.4. Load application point (refering to centroid S)

z_{load} = 0 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





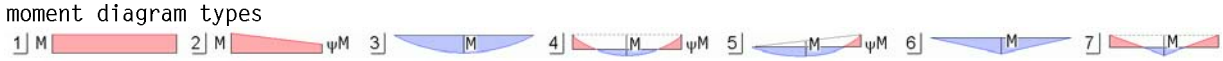
1.6. Buckling factors

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	N_d kN	$M_{0y,d}$ kNm	type -	ψ_y -	$k_{c,y}$ -	ζ_y -	A
1	300.00	32.00	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	buckling curve torsional-flexural buckling
	of χ_{LT}: setting	general case

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

LK	d mm	t mm	Tab 5.2	class -
1	101.6	10.0	tube 1	1

verification is done in the predefined class of cross-section 2, U = 0.145

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

2.2.1. flexural and torsional buckling acc. to DIN EN 1993-1-1, 6.3.1

verification about the y-y and z-z - axis
λ_y = 2.615 > λ_T = 0.944 ⇒ flexural buckling (λ_y) decisive
λ_z = 1.307 > λ_T = 0.944 ⇒ flexural buckling (λ_z) decisive
I_p = 611 cm⁴, I_T = 611 cm⁴, i_p^2 = 2123 mm², c^2_y = 1250593 mm², c^2_z = 5002372 mm², i_m^2 = 2123 mm²
i_y = 32.6 mm, β_y = 1.00 (about the z-axis), $L_{cr,y}$ = 4.000 m, λ_1 = 93.913
i_z = 32.6 mm, β_z = 1.00 (about the y-axis), $L_{cr,z}$ = 8.000 m
λ_y = 2.615, y-buckling curve a ⇒ α_y = 0.21, **λ_z = 1.307**, z-buckling curve a ⇒ α_z = 0.21
Φ_y = 4.172, **χ_y = 0.135, $N_{by,Rd}$ = 82.82 kN**, Φ_z = 1.471, **χ_z = 0.466, $N_{bz,Rd}$ = 286.61 kN**

2.2.1.1. Utilizations

Nr	N_d kN	U_y -	U_z -
1	300.00	**3.622**	**1.047**

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

c^2 = 1250593 mm², buckling curve c ⇒ α_{LT} = 0.49, N_{cr} = 395.63 kN

2.2.2.1. Utilizations

Nr	M_{cr} kNm	λ_{LT} -	f -	Φ_{LT} -	χ_{LT} -m	M_{Ed} kNm	$M_{b,Rd}$ kNm	U -
1	580.24	0.183	1.000	0.459	1.000	32.00	17.58	**1.820**

2.2.3. 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	3.703	0.800	---	**10.363**	---
2	z-z	---	---	0.800	0.810	---	**2.520**

max U = 10.363 > 1 ⇒ verification failed!
the total utilization is: U = 10.363