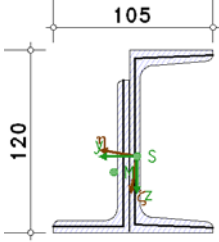


POS. 2: 4H-QUER-SECTION

fire design EC 3-1-2 (12.10), NA: Deutschland

1. input report



steel

steel grade S235

material safety factor

resistance of cross-sections $\gamma_{M0} = 1.00$

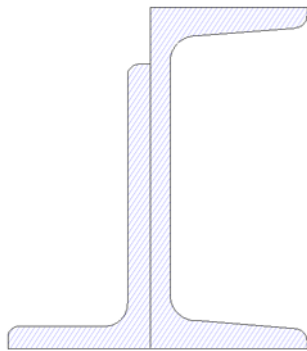
resistance of components in the event of fire $\gamma_{M,fi} = 1.00$

geometry

dimensions of cross-section: $y_{min} = 486.2 \text{ mm}$, $y_{max} = 591.2 \text{ mm}$, $z_{min} = 128.2 \text{ mm}$, $z_{max} = 248.2 \text{ mm}$

width,height of cross-section: $b = 105.0 \text{ mm}$, $h = 120.0 \text{ mm}$

centroid, rotation angle of main axis: $e_y = 536.1 \text{ mm}$, $e_z = 197.8 \text{ mm}$, $\alpha = -9.70^\circ$



cross-sectional area	A	=	28.43 cm ²
bending moment of inertia	I_η	=	532.46 cm ⁴
bending moment of inertia	I_ζ	=	101.71 cm ⁴
section modulus	$W_{\eta+}$	=	90.43 cm ³
section modulus	$W_{\eta-}$	=	69.10 cm ³
section modulus	$W_{\zeta+}$	=	21.85 cm ³
section modulus	$W_{\zeta-}$	=	17.63 cm ³
torsional moment of inertia	I_T	=	6.20 cm ⁴

cross-section temperature

thermal action due to the standard curve, fire resistance time $t = 60 \text{ min}$

cross-sectional surface exposed to fire $A_m = 493.5 \text{ mm}^2/\text{mm}$

surface of the enclosing box exposed to fire $A_b = 411.8 \text{ mm}^2/\text{mm}$

resistance

elastic verification incl. c/t-verification

fire design at temperature level

adjustment factors for uneven temperature distribution

across the cross section $\kappa_1 = 1.00$, along the beam $\kappa_2 = 1.00$

internal forces and moments (event of fire)

σ -generating forces (N, M) work at centroid, τ -generating forces (V, T_i) work at shear center

Lk 1: $M_{y,fi} = 2.00 \text{ kNm}$, $M_{z,fi} = -3.00 \text{ kNm}$

notes

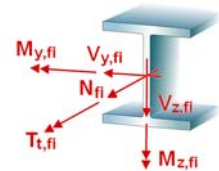
stability is not investigated.

2. cross-section temperature

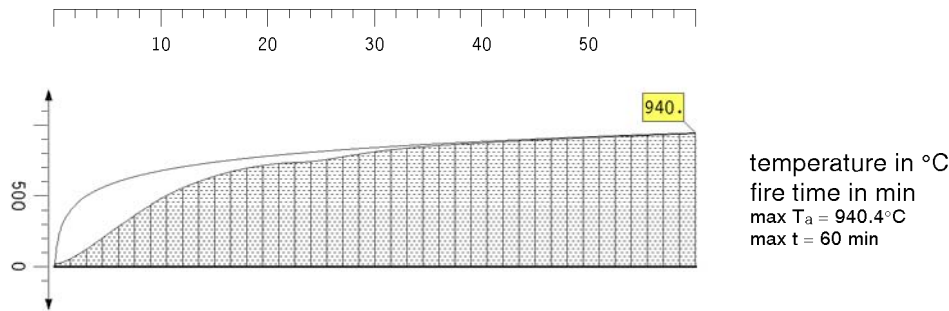
section factor of the unprotected component $A_m/V = 493.5 / 2842.9 \cdot 10^3 = 173.6 \text{ 1/m}$

section factor for the enclosing box $A_b/V = 411.8 / 2842.9 \cdot 10^3 = 144.9 \text{ 1/m}$

correction factor $k_{sh} = (A_b/V) / (A_m/V) = 144.9 / 173.6 = 0.834$



temperature development:



cross-section temperature acc. to $t = 60$ min: $T_a = 940.4^\circ\text{C}$

3. Lk 1

3.1. fire design

internal forces and moments (event of fire) referring to local axes of cross-section:

$$M_{y,fi} = 2.00 \text{ kNm}, M_{z,fi} = -3.00 \text{ kNm}$$

3.1.1. elastic verification

3.1.1.1. verification at temperature level

Utilisation rate at time $t = 0$ (normal temperature)

elastic verification for $M_y = 2.00 \text{ kNm}$, $M_z = -3.00 \text{ kNm}$

$$\text{verification: } \sigma_v = 145.43 \text{ N/mm}^2 < \sigma_{v,Rd} = 235.00 \text{ N/mm}^2 \Rightarrow U_\sigma = 0.619 < 1 \text{ ok}$$

critical temperature $T_{a,cr} = 39.19 \cdot \ln[1/(0.9674 \cdot \mu_0^{3.833}) - 1] + 482 = 548.8^\circ\text{C}$ with $\mu_0 = 0.619$

existing temperature $T_a = 940.4^\circ\text{C}$

$$\text{verification: } U_T = T_a/T_{a,cr} = 1.713 > 1 \text{ fault !!}$$

cross-section in class 1, material coefficient $\varepsilon = 0.85 \cdot (235/235.0)^{0.5} = 0.850$

c/t-verification: outstand flange: utilization $U_{c/t} = 0.364 < 1 \text{ ok}$

total: utilization $U_{c/t} = 0.364 < 1 \text{ ok}$ (reg. section class 3)

4. final result

maximum utilization:	temperature	max $U_T = 1.713 > 1 \text{ fault !!}$
	stress	max $U_{\sigma,t=0} = 0.619 < 1 \text{ ok}$
	c/t-ratio	max $U_{c/t} = 0.364 < 1 \text{ ok}$
	resistance	max $U = 1.713 > 1 \text{ fault !!}$

resistance not ensured !!

5. Regulations

DIN EN 1990, Eurocode 0: Grundlagen der Tragwerksplanung;

Deutsche Fassung EN 1990:2002 + A1:2005 + A1:2005/AC:2010, Ausgabe Dezember 2010

DIN EN 1990/NA, Nationaler Anhang zur DIN EN 1990, Ausgabe Dezember 2010

DIN EN 1991-1-2, Eurocode 1: Einwirkungen auf Tragwerke - Teil 1-2: Allgemeine Einwirkungen -

Brandeinwirkungen auf Tragwerke; Deutsche Fassung EN 1991-1-2, Ausgabe Dezember 2010

DIN EN 1991-1-2/NA, Nationaler Anhang zur DIN EN 1991-1-2, Ausgabe September 2015

DIN EN 1993-1-2, Eurocode 3: Bemessung und Konstruktion von Stahlbauten - Teil 1-2: Allgemeine Regeln -

Tragwerksbemessung für den Brandfall; Deutsche Fassung EN 1993-1-2, Ausgabe Dezember 2010

DIN EN 1993-1-2/NA, Nationaler Anhang zur DIN EN 1993-1-2, Ausgabe Dezember 2010