

## Check of steel - fire resistance

Linear calculation, Extreme : Member

Selection : B3

Combinations : CO1

Cross-section : CS3 - CFRHS180X180X6

### EN 1993-1-2 Fire Resistance Code Check

National annex: Standard EN

<b>Member B3</b>	<b>3,600 m</b>	<b>CFRHS180X180X6</b>	<b>S 355</b>	<b>CO1/1</b>	<b>0,98 -</b>
------------------	----------------	-----------------------	--------------	--------------	---------------

Partial safety factors	
Gamma M0 for resistance of cross-sections	1,00
Gamma M1 for resistance to instability	1,00
Gamma M2 for resistance of net sections	1,25
Gamma M,fi for resistance to fire	1,00

Material		
Yield strength fy	355,0	MPa
Ultimate strength fu	510,0	MPa
Fabrication	Cold formed	

### Fire resistance

Verification in Temperature domain according to EN 1993-1-2 article 4.2.4

Fire resistance		
Temperature-time curve	ISO 834 curve	
Coefficient of heat transfer by convection alpha,c	25,00	W/m²K
Emissivity related to fire compartment epsilon,f	1,00	
Emissivity related to surface material epsilon,m	0,70	
Configuration factor for radiation heat flux phi	1,00	
Required fire resistance R	30,00	min
Gas temperature theta,g	841,80	°C
Material temperature theta,a,t	822,55	°C
Critical material temperature theta,a,cr	839,32	°C
Fire resistance t,cr	32,35	min
Beam exposure	All sides	
Adaptation factor for cross-section kappa,1	1,00	
Adaptation factor for beam kappa,2	1,00	
Section factor for unprotected steel members Am/V	1,7120e+02	1/m
Adaptation factor for the shadow effect k,sh	1,00	
Reduction factor for the yield strength ky,theta	0,08	
Reduction factor for the E modulus k,E,theta	0,08	
Unity check	0,98	-

The check results shown hereafter are given at the critical material temperature theta,a,cr = 839,32 °C. These results have been used to determine the critical temperature i.e. the temperature at which the unity checks become near to 1,00.

### .....SECTION CHECK:....

#### Classification for cross-section design

According to EN 1993-1-2 article 4.2.2

#### Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	27,00
Class 1 Limit	22,82
Class 2 Limit	26,28
Class 3 Limit	29,05

=> Section classified as Class 3 for cross-section design

The critical check is on position **0.000 m**

Internal forces	Calculated	Unit
N,fi,Ed	-39,86	kN
Vy,fi,Ed	-0,15	kN
Vz,fi,Ed	0,00	kN
T,fi,Ed	0,00	kNm
My,fi,Ed	0,00	kNm
Mz,fi,Ed	0,14	kNm

#### Compression check

According to EN 1993-1-2 article 4.2.3.2 and formula (4.5)

A	4,0830e-03	m <sup>2</sup>
N,fi,t,Rd	113,86	kN
Unity check	0,35	-

**Bending moment check for Mz**

According to EN 1993-1-2 article 4.2.3.4 and formula (4.18)

W <sub>el,z,min</sub>	2,2628e-04	m <sup>3</sup>
M <sub>el,z,Rd</sub>	80,33	kNm
M <sub>z,fi,theta,Rd</sub>	6,31	kNm
M <sub>z,fi,t,Rd</sub>	6,31	kNm
Unity check	0,02	-

**Shear check for Vy**

According to EN 1993-1-2 article 4.2.3.4 and formula (4.20)

Eta	1,20	
A <sub>v</sub>	2,0415e-03	m <sup>2</sup>
V <sub>pl,y,Rd</sub>	418,42	kN
V <sub>y,fi,t,Rd</sub>	32,87	kN
Unity check	0,00	-

**Combined bending, axial force and shear force check**

According to EN 1993-1-2 article 4.2.3

According to EN 1993-1-1 article 6.2.9.2 and formula (6.42)

Normal stresses		
Fibre	5	
σ <sub>N,fi,Ed</sub>	9,8	MPa
σ <sub>My,fi,Ed</sub>	0,0	MPa
σ <sub>Mz,fi,Ed</sub>	0,6	MPa
σ <sub>tot,fi,Ed</sub>	10,4	MPa
Unity check	0,37	-

The member satisfies the section check.

**.....STABILITY CHECK:....**

**Classification for member buckling design**

Decisive position for stability classification: 0,000 m

**Classification of Internal Compression parts**

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	27,00
Class 1 Limit	22,82
Class 2 Limit	26,28
Class 3 Limit	29,05

=> Section classified as Class 3 for member buckling design

**Flexural Buckling check**

According to EN 1993-1-2 article 4.2.3.2 and formula (4.5)

Buckling parameters	yy	zz	
Sway type	sway	sway	
System length L	3,600	3,600	m
Buckling factor k	2,00	1,15	
Buckling length L <sub>cr</sub>	7,209	4,155	m
Critical Euler load N <sub>cr</sub>	812,28	2444,83	kN
Slenderness λ	102,07	58,83	
Relative slenderness λ <sub>rel</sub>	1,34	0,77	
Relative slenderness λ <sub>rel,theta</sub>	1,31	0,76	
Imperfection α	0,53	0,53	
Reduction factor χ <sub>fi</sub>	0,36	0,62	
Buckling resistance N <sub>b,fi,t,Rd</sub>	40,65	70,34	kN

Flexural Buckling verification		
Cross-section area A	4,0830e-03	m <sup>2</sup>
Buckling resistance N <sub>b,fi,t,Rd</sub>	40,65	kN
Unity check	0,98	-

**Torsional(-Flexural) Buckling check**

According to EN 1993-1-2 article 4.2.3.2 and formula (4.5)

**Note:** The cross-section concerns a RHS section which is not susceptible to Torsional(-Flexural) Buckling.

**Bending and axial compression check**

According to EN 1993-1-2 article 4.2.3.5 and formula (4.21c),(4.21d)

Bending and axial compression check parameters		
Cross-section area A	4,0830e-03	m <sup>2</sup>
Cross-section elastic modulus Wel,z	2,2628e-04	m <sup>3</sup>
Design compression force N,fi,Ed	39,86	kN
Design bending moment My,fi,Ed	0,00	kNm
Design bending moment Mz,fi,Ed	0,14	kNm
Reduction factor Chi,min,fi	0,36	
Reduction factor Chi,z,fi	0,62	
Equivalent moment factor beta,M,z	2,05	
Factor mu,z	0,76	
Interaction factor k,z	0,57	

Unity check (4.21c) =  $0,98 + 0,00 + 0,01 = 0,99$  -

Unity check (4.21d) =  $0,57 + 0,00 + 0,01 = 0,58$  -

The member satisfies the stability check.