Fire design of a protected IPE steel beam

Access Steel Document SX047a-EN-EU

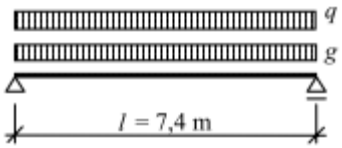
Scia Engineer Version 10.0.86

Introduction

This benchmark concerns the example *SX047a-EN-EU Fire design of protected IPE section beam exposed to parametric fire curve* of *Access Steel, http://www.access-steel.com/, 2006.*

This worked illustrates the fire design of a simply supported non-composite beam. Heat transfer into the section is calculated using the equation for protected members given in EN1993-1-2, which is evaluated using an iterative calculation procedure. The structural resistance is calculated using the simple calculation model for members in bending, given in EN1993-1-2.

A steel beam forms part of a floor structure of an office building. The beam is uniformly load and restrained against lateral torsional buckling by a concrete slab. The beam is required to achieve 60 minutes fire resistance and will be fire protected using sprayed vermiculite cement. The thermal actions will be determined using the parametric temperature - time curve.



Reference Results

The reference gives following results:

Fire Situation	
Ap/V	188 m^{-1}
θg at 42,5 min	562,1 °C
θa,t at 42,5 min	582,5 °C
ky,θ	0,525

Classification		
Flanges	c/tf	5,3
	Class 1 limit	7,07
		⇒ Flanges Class 1
Web	c/tw	35
	Class 1 limit	56,6
		⇒ Web Class 1

Shear resistance	
Av,z	2568 mm²
Vfi,t,Rd	214,1 kN

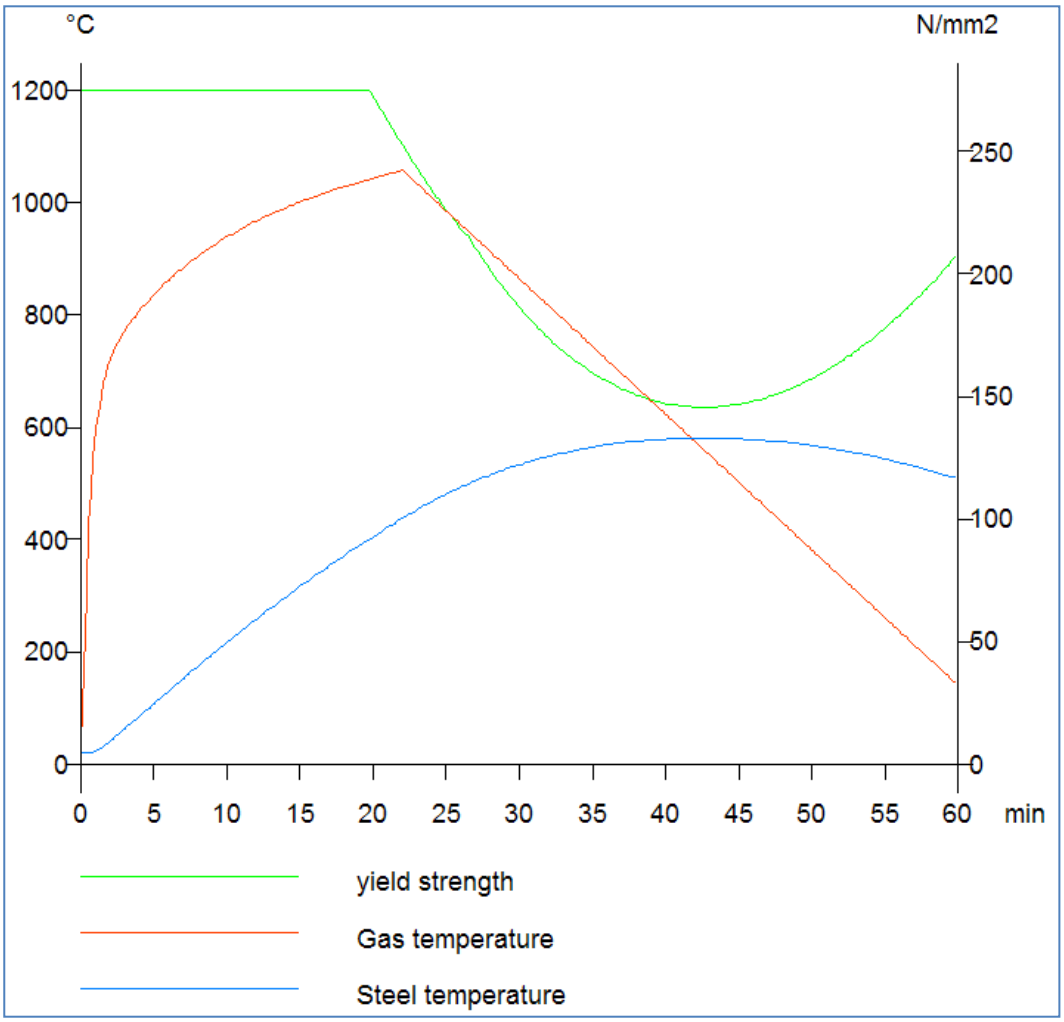
Bending resistance	
κ1	0,85
κ2	1,0
Mfi,t,Rd	106,7 kNm

Scia Engineer Results

Fire resistance according to EN 1993-1-2 in resistance domain.
Results are given for checks at time t = 42.6 min

Fire resistance data		
Coefficient of heat transfer by convection Alfa,c	25.00	W/m2K
Emissitivity related to fire compartment Epsilon,f	1.00	
Emissitivity related to surface material Epsilon,m	0.70	
Configuration factor for radiation heat flux Fi	1.00	
Required fire resistance	60.00	min
Material temperature Teta a,t	580.87	°C
Gas temperature Teta,g	559.41	°C
Correction factor Kappa 1	0.85	
Correction factor Kappa 2	1.00	
Beam exposure	3 sides	
Covered flange	Upper flange	
ky,Teta	0.53	
kE,Teta	0.37	

Insulation properties		
Name:	Vermiculite cement (high density)	
Thickness	10.00	mm
Incasement type	Contour encasement	
Insulation type	Spray	
Unit mass	550.00	kg/m^3
Thermal conductivity	0.12	W/mK
Specific heat	1100.00	J/kgK
Ap/V	0.188	1/mm



Width-to-thickness ratio for internal compression parts (EN 1993-1-1 : Tab.5.2. sheet 1).
ratio 35.01 on position 0.74 m

ratio		
maximum ratio	1	56.57
maximum ratio	2	65.22
maximum ratio	3	97.43

==> Class cross-section 1
Width-to-thickness ratio for outstand flanges (EN 1993-1-1 : Tab.5.2. sheet 2).
ratio 5.28 on position 0.74 m

ratio		
maximum ratio	1	7.07
maximum ratio	2	7.86
maximum ratio	3	10.82

==> Class cross-section 1

Shear check (Vz)
according to article EN 1993-1-2 : 4.2.3.3 and formula EN 1993-1-2 : (4.16)

Table of values		
Vz,fi,t,Rd	215.72	kN
unity check	0.12	

Bending moment check (My)
according to article EN 1993-1-2 : 4.2.3.3. and formula EN 1993-1-2 : (4.10)
Section classification is 1.

Table of values		
Mfi,t,Rd	107.61	kNm
unity check	0.45	

Comments

- The results correspond to the benchmark results.