

3.10 Fire safety engineering in Portugal- some case studies (short version)

Lopes N., Portugal

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Fire safety engineering in Portugal - Some case studies

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- Evaluation of the temperature of the external structural elements of the Torre Sky Business Luanda, Angola
- Numerical modelling of the temperature field of precast concrete slabs to determine its fire resistance
- Evaluation of the fire resistance of the steel structure of the Shopping Centre Barreiro Retail Park, Portugal

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External fire in a steel structure

Evaluation of the temperature of the external structural elements of the Torre Sky Business Luanda, Angola

Annex B of EN 1991-1-2 - Thermal actions for external members – Simplified calculation method

Annex B of EN 1993-1-2 - Heat transfer to external steelwork

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External fire in a steel structure

Characteristics of flames and compartment

Column in the smaller facade

A_t	192	[m ²]
A_{st}	33	[m ²]
W_t	64	[m]
h_{eq}	3	[m]
A_f	462	[m ²]
A_c	1358.6	[m ²]
q_{fu}	409	[MJ/m ²]
t_f	1200	[s]
D/W	0.515625	
O	0.244776796	[m ^{1/2}]
Q	157.465	[MW]
Ω	369.9720058	
T ₀	293	[K]
T _f	942.956864	[K]
L _c	0.46276466	[m]
Largura Chama	11	[m]
L _H	1	[m]
L _r	1.96276466	[m]
T _w	1127.583306	[K]
T _f (inquiry)	1014.296432	[K]
T _f (value manual)	868.9544358	[K]
T _f (EC3)	887.169889	[K]
d _{eq}	0.3	[m]

Note >> Column involved in flames

a_s	6.711167279	[W/m ² K]
a_r	0.563423806	
c_s	0.451188364	
l_f	3650.801877	
l_z	21987.64906	

Temperature _{steel} 823.42 [K]
Temperature _{steel} 550.42 [°C]

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Fire resistance of precast concrete slabs

Numerical modelling of the temperature field of precast concrete slabs to determine its fire resistance

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Fire resistance of precast concrete slabs

Materials:

- Steel (EN1992-1-2)
- Concrete (EN1992-1-2)

• The minimum limit for the thermal conductivity was used (Annex O of EN 13369)

• Convection coefficient on hot surfaces 25 W/m²K

• Convection coefficient on cold surfaces 9 W/m²K

$\varepsilon_f = 0.8$

$\varepsilon_m = 0.7$

➤ Expandable Polystyrene blocs (Annex H of EN 13747)

Temperature (°C)	Density (kg/m ³)	Specific heat (J/kgK)	Thermal conductivity (W/mK)
0	15	1210	0.04
100	15	1210	0.1
500	1	1000	33
1500	1	1000	33

To simulate a void (EN 13747, Annex H)

➤ Mineral fibre sprays (10 mm)

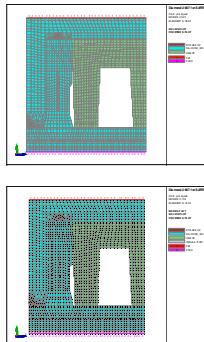
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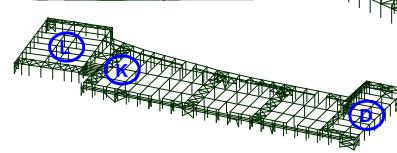
Fire resistance of precast concrete slabs

Numerical model:



Fire resistance of steel structures

Evaluation of the fire resistance of the steel structure of the Shopping Centre Barreiro Retail Park, Portugal, using structural fire engineering and a performance based approach



Fire resistance requirement

- Parts D to K - R60
- Parts B, C and L - R90

Fire resistance of steel structures

Fire scenarios:

➤ Compartment fires (6 fire scenarios)

- Natural fire considering 1 or 2 zone models (Ozone v2.2)
- Compartment height 12.67 m
- Linear openings variation from 10% at 20°C until 30% at temperature of 300°C and after until 100% openings at 500°C and a fast fire grow rate.
- Forced ventilation by smoke extractors with 2m of diameter
- $RHR_f = 500 \text{ kW/m}^2$

➤ Localized fires

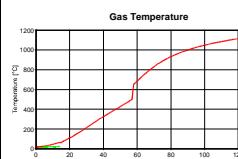
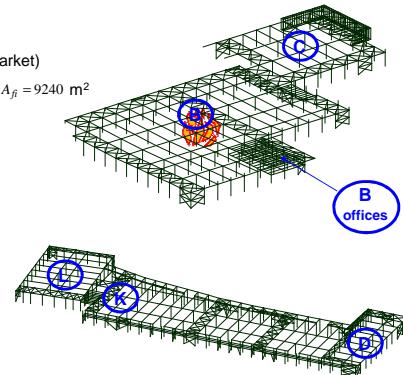
- $RHR_f = 500 \text{ kW/m}^2$
- Fast fire grow rate

Fire resistance of steel structures

Compartment fires

➤ Scenario 1

- Fire in Part B (large supermarket)
- Maximum fire area $A_{f,max} = A_{fi} = 9240 \text{ m}^2$
- Openings $6 \times 37.2 = 223.2 \text{ m}^2$
- 25 smoke extractors



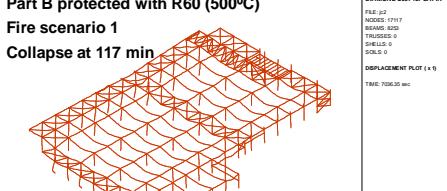
Fire resistance of steel structures

Mechanical analysis (Safir)

Part B protected with R60 (500°C)

Fire scenario 1

Collapse at 117 min



Fire resistance of steel structures

Insulation required

Fire resistance requirement	Insulation necessary to resist standard fire of (min)	θ_{cr} (°C)	
Part B	R90	R60	500
Part B (offices)	R90	R60	500
Part C	R90	R60	650 or lower
Part D	R60	R60	650 or lower
Part K	R60	R60	650 or lower
Part L	R90	R60	650 or lower