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Concrete and Concrete Structures 2013 Conference

EUROCODES: Structural Fire Design

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Abstract

The European Commission together with European Committee for Standardisation organized and supported on 27-28 November 2012 in Brussels, Belgium – International workshop with worked examples: STRUCTURAL FIRE DESIGN. In the workshop took part 117 participants from 28 countries. Author of this paper was in Brussels the only representative from the Slovak Republic. The workshop sessions presented the **fire resistance assessment** of structures according to the Eurocodes. Each session focused on a specific structural material (steel, steel and concrete composite, concrete, masonry, and timber with the exception of aluminium) and addressed the principles and design methods followed by worked example(s) [1]. Definitions of actions in fire situations were also presented with basic principles and examples at the beginning of the workshop sessions.

The principal objectives of the workshop were to:

- transfer knowledge and information to representatives of key organisations/institutions, industry and technical associations in the Member States of European Committee for Standardisation;
- provide state-of-the-art training material, background information and worked examples to Eurocodes trainers and users;
- facilitate exchange of views, networking and cooperation.

Contribution includes review of background and applications concerning structural fire design of **concrete structures**, presented at the workshop.

Keywords: Eurocodes – Parts 1-2; structural fire design; fire resistance; basic design methods; worked examples; E – integrity criterion; I – thermal insulation criterion; R – load-bearing criterion; M – mechanical criterion

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1. Introduction

Parts 1-2 of Eurocodes deal with the design of structures for the **accidental situation of fire exposure.** They only identifie differences from, or supplements to, normal temperature design – **normal temperature** means **20 ˚C.** These parts deal only with **passive methods of fire protection**. Active methods are not covered.

Eurocode 2: Design of **concrete structures** – Part 1-2: General rules – Structural fire design [2-3] however does not cover:

- **structures with prestressing by external tendons,**
- **shell structures.**

The methods given in Part 1-2 of EN 1992 [2-3] are applicable to normal weight concrete up to strength class C90/105 and for lightweight concrete up to strength class LC55/60.

Design safety in the fire situation is important part of structural design of structures**.** One of the components of the design safety in case of fire is **fire resistance** of the structure**.** Fire resistance belongs to the essential requirements to the structures, the same as the requirements to mechanical resistance and stability.

Nomenclature

$t_{fi,req}$	required time of fire resistance
$t_{fi,d}$	design value of time of fire classification for a standard fire
$E_{fi,d,t}$	design effect of actions for the fire situation, including effects of thermal expansions and deformations in determined time t
$R_{fi,d,t}$	design resistance in the fire situation in time t
θ_d	design value of temperature of concrete
$\theta_{d,cr}$	design value of critical temperature of concrete
a	nominal axis distance of reinforcing or prestressing steel from the nearest exposed surface
E_d	design value of the corresponding force or moment for normal temperature, for a fundamental combination of actions
η_{fi}	reduction factor for the design load level for the fire situation, its‘ suggested value for concrete is 0,7
E 60	member meeting the integrity criterion E for 60 minutes in standard fire exposure
I 60	member meeting the thermal insulation criterion I for 60 minutes in standard fire exposure
R 60	member meeting the load bearing criterion R for 60 minutes in standard fire exposure
M 90	member meeting the mechanical resistance criterion M for 90 minutes in standard fire exposure

The fire terms is it possible to express according to [4] as follows – from the point of view:

- **time** $t_{fi,req} \leq t_{fi,d}$ (1)
- **limit load** $E_{fi,d,t} \leq R_{fi,d,t}$ (2)
- **temperature** $\theta_d \leq \theta_{d,cr}$ (3)