

Fire resistance of concrete

Introduction

Concrete has inherent fire resistance and is a material ideally suited for providing fire safe construction. However, fires in tunnels and the collapse of the World Trade Centre towers on September 11th 2001 focused attention on the robustness of all construction materials in a fire. Also, the concrete design Eurocode (EN 1992: 1-2) includes design methodology which can lead to more efficient design in concrete but is still unfamiliar to UK designers.

How does fire affect concrete?

Concrete is non-combustible and emits no toxic fumes. As concrete is a good insulator, the temperature of the concrete will usually be much less than the flame temperature. As its temperature rises, concrete progressively loses moisture and gradually loses strength. The loss of strength is greatest at concrete temperatures above 450- 600°C (the exact temperature depends on the aggregate type). Wet or moist concrete can spall in a fire, due to the build up of steam pressure within the concrete, leading to separation and loss of the surface layer. In most fires, concrete will retain its structural integrity and the structure can be successfully repaired.

What about reinforcement?

The insulating properties of concrete normally protect the embedded steel reinforcement for the required fire period. If the concrete surface spalls-off, the reinforcement can be exposed to high temperatures when it softens and loses effectiveness; modern design methods take account of spalling.

Can the fire resistance of concrete be improved?

Concretes containing limestone aggregates retain greater strength in fires than those with flint gravel aggregate. Dry concrete is more resistant to spalling. Inclusion of synthetic fibres in the concrete (which melt in the fire allowing steam to escape more easily from the concrete) significantly reduces spalling. Consideration of whole building behaviour and the effect of continuity leads to improved competitiveness of concrete buildings.

What has MPA Cement done to address the key issues in concrete and fire?

MPA Cement (formerly BCA) led the industry consortium in the full-scale fire testing on a concrete structure at BRE Cardington, which confirmed the excellent fire resistance of concrete structures. However, spalling was observed in the concrete slab due to its high strength and high moisture content. MPA Cement's and MPA The Concrete Centre's (MPA TCC) strategy for developing design aids for the Eurocodes included methods for efficient

fire design. MPA Cement and MPA TCC set up the Concrete Fire Forum www.concretefireforum.org.uk and support research programs with the universities and BRE to address the key technical issues.

Where can I find out more?

Contact: Professor Pal Chana at MPA Cement, Tel: +44(0)20 7963 8000, pal.chana@mineralproducts.org

MPA Cement

Mineral Products Association

Gillingham House

38 - 44 Gillingham Street

London SW1V 1HU

Tel +44(0)20 7963 8000

Fax +44(0)20 7963 8001

<http://cement.mineralproducts.org>

Document No: ST/FS/1	Revision No: 2
Author: P S Chana	Drafted: April 2006 Last revised: 25 March 2013