Introduction

The fib Workshop on Concrete Structures in Fire aims at creating a fundamental understanding on the behaviour of concrete materials and concrete structures that are exposed to elevated temperatures and fire. The principles of designing concrete structures for fire resistance are presented, focusing on the practical aspects of material selection, structural detailing and protective measures. Based on recent European case studies on the design of concrete tunnel structures for fire resistance, new developments in material technology and design procedures are discussed.

The main problems experienced by reinforced concrete structures in fire are deterioration of material properties (concrete and steel), damage caused by thermal deformations, and spalling, which can be addressed by careful mix design and structural detailing.

Traditionally, concrete has been considered fireproof because of its incombustibility and its high thermal insulation properties. However, recent incidents of fire damage (for example caused by tunnel fires in Europe) have resulted in research and development of new materials, structural systems, and protective measures to improve fire resistance of concrete structures. The use of modern concretes such as high strength concrete, self-compacting concrete and fibre reinforced concrete has resulted in new design methods for concrete structures in fire, including performance-based approaches. In line with these developments the Workshop topics cover fundamental aspects of fire damage and fire resistance of concrete structures as well as new developments in materials technology and performance evaluation.

In addition to design and performance-assessment of new structures, the Workshop presents a brief overview on the principles of damage assessment and repair of fire-damaged concrete structures.

fib - International Federation for Structural Concrete

The objectives of fib are to develop at an international level the study of scientific and practical matters capable of advancing the technical, economic, aesthetic and environmental performance of concrete construction. These objectives are achieved, amongst others, by the stimulation of research, the synthesis of findings from research and practice, the dissemination of the results by way of publications, guidance documents and the organisation of international congresses and symposia, and the production of recommendations for the design and construction of concrete structures.
Topics and Scope

- Fundamental aspects of elevated temperatures and fire
  - Origin, development, spread and phases of fire; influencing parameters (ventilation, fire source, energy release, etc)
  - Toxic properties, toxic influence on human health

- Influence of elevated temperatures and fire on material behaviour
  - Material property changes (concrete, steel)
  - Thermal conductivity, heating of elements, etc
  - Concrete deterioration and damage
    - Aggregate behaviour
    - Dehydration, removal of chemically and physically bound water
    - Strength loss, deformation, cracking; influence of porosity and permeability
    - Progression (spread and depth) of damage

- Improving fire resistance of concrete
  - Shotcrete, cast-in-place concrete, precast concrete
  - Mix design, choice of materials (aggregates, binder types, chemical admixtures and additions, fibres)
  - Surface treatments, thermal insulation, protective shielding, cladding

- Influence of members size and geometry
  - Cover thickness, rebar configuration, loading, member orientation
  - Influence of the above on temperature distribution in the member, temperature gradients, spalling and structural behaviour
  - Loss of structural capacity due to spalling; influence of material behaviour on structural behaviour

- Structural response of concrete structures in fire
  - Tunnels, columns, walls, frames, floors

- Structural possibilities to enhance fire resistance

- National and international standards and guidelines
  - Common rules and regulations, best practice
  - fib bulletin 38 (Fire design of concrete structures – materials, structures and modelling)
  - fib bulletin 46 (Fire design of concrete structures – structural behaviour and assessment)

- Damage assessment of fire-damaged concrete structures, repair principles

- Performance-based fire design
  - Test methods, material selection
  - Case studies on the design of tunnels (concrete technology, structural design, verification/validation of full scale models, fire testing)
    - North-South Line Amsterdam, the Netherlands
    - Metroline 9, Barcelona, Spain
    - M30 Bypass, Madrid, Spain

Literature and Handouts
Printed material and handouts will be provided.

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Programme and Timetable

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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>07:30 - 08:00</td>
<td>Registration</td>
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<tr>
<td>08:00 – 09:30</td>
<td>Introduction; Elevated temperatures and fire: fundamental aspects, material properties and material response</td>
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<td>09:30 - 10:00</td>
<td>Tea and coffee break</td>
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<tr>
<td>10:00 - 11:15</td>
<td>Structural response of concrete structures in fire: tunnels, columns, walls, frames, etc</td>
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<td>11:15 - 12:30</td>
<td>Possibilities to enhance fire resistance of concrete structures: concrete technology aspects, structural aspects, protective systems</td>
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<td>12:30 - 13:30</td>
<td>Lunch break</td>
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<td>13:30 - 15:00</td>
<td>National and international standards and general rules for designing concrete structures for fire resistance</td>
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<td>15:00 – 15:30</td>
<td>Tea and coffee break</td>
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<td>15:30 – 16:00</td>
<td>Performance-based fire design and test procedures for concrete materials and structures</td>
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<tr>
<td>16:00 – 16:30</td>
<td>Damage assessment and repair principles for fire-damaged concrete structures</td>
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<td>16:30 – 17:30</td>
<td>Discussions and closure</td>
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Presenters

Professor Frank Dehn, University of Leipzig / MFPA Leipzig, Germany
Dr. Hans Beushausen, University of Cape Town

Dr. Frank Dehn is Professor at the University of Leipzig, Germany, and Managing Director of the Leipzig Institute for Materials Research and Testing (MFPA Leipzig). He is Chairman of fib Commission 8 (Concrete) and Co-Convenor of fib Task Group 8.10 (Performance-based Specifications for Concrete).

With a size of 120 employees, the MFPA is the leading materials testing institute in eastern Germany, focussing on the five business divisions building materials, load-bearing structures and constructions, structural fire protection, building physics and geotechnics. As a worldwide recognised testing, inspection and certifying authority the MFPA is actively involved in large scale construction projects mainly in Europe and Asia.

Professor Dehn was involved in the performance-based fire design of various concrete tunnel structures in Europe, recent projects including the North-South Line in Amsterdam, the Netherlands, Metroline 9 in Barcelona, Spain, and the M30 Bypass in Madrid, Spain.

Dr. Beushausen performs research and lectures in the fields of structural engineering, construction material technology, and structural condition assessment at the University of Cape Town. He is a member of the Concrete Materials & Structural Integrity Research Unit (CoMSIRU) at UCT, which focuses on infrastructure performance and renewal research. His research interests include concrete durability (material aspects, durability testing, durability design and specification), performance assessment of concrete structures, repair systems for concrete structures, and bonded concrete overlays. He is Chairman of RILEM TC PSC (Performance-based specification and control of concrete durability) and Co-Convenor of fib Task Group 8.10 (Performance-based Specifications for Concrete).