CrossFire - Advanced Structural Fire Engineering At Intersections Among Disciplines

Lake Como School of Advanced Studies, May 23-27, 2022

Home

Structural Fire Engineering witnessed an impressive advance in the last decades, thanks to the advent of performance-based design codes and the development of viable numerical tools for the analysis of the construction behaviour under this extreme load condition.

However, some recent tragic events (fires at Grenfell Tower and Notre-Dame) showed that many complex aspects require further studies fostered by a closer cooperation among scientists active in different fields.

The kinetics of natural fires and its impact on structural endurance, the response to blaze of novel and traditional materials, the mutual influence of thermal and mechanical loads, are among the subjects on which young researchers should be encouraged to focus in the forthcoming years.

In this perspective, the proposed School aims at gathering distinguished scientists sharing a hands-on approach and a critical aptitude. The goal is to convey both advanced theories and operative tools, to highlight contentious aspects and research needs at fields intersections, to fuel open discussions and participative learning. Debated issues and open problems will be in CrossFire!

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Programme

The School is organized in 5 days (23-27 May, 2022), each one divided in two sessions (Morning and Afternoon) involving couples of distinct but closely interrelated topics. Each session will be opened by the general lecture given by the chair. Then, the floor will be left to short presentations and extensive discussion involving the audience. The goal is envisaging future lines of research in the related fields.

Monday May 23, Morning

Luke Bisby – University of Edinburgh (UK)

The Foundations of Structural Fire Safety – Regulation, Testing, Competence

Luke will discuss foundational aspects of structural fire engineering, by providing historical context to the evolution and development of current practices within this discipline. He will discuss the roles and motivations of regulation and testing, presenting the underlying logic that underpins contemporary "fire resistance" design; and leading to questions of what this means for practitioners seeking to perform more advanced, so-called performance-based structural fire engineering.

Monday May 23, Afternoon

Ruben van Coile – Ghent University (Belgium)

Structural robustness and probabilistic aspects

Every decision related to fire safety is a fire risk decision, as nicely stated by Watts and Hall in the SFPE Handbook of Fire Protection Engineering. Structural fire engineering can thus be understood as aiming at risk mitigation, by managing the probabilities and consequences of different scenarios.

This presentation will explore the interaction between structural fire engineering and the concepts of probability and robustness, providing researchers the tools to frame their structural fire engineering analyses within the framework of risk.

Tuesday May 24, Morning

Olivier Vassart – Arcelor Mittal, University of Leuven (Belgium)

Natural fires: available models and implementation strategies

Modern fire engineering allows engineers and architects to significantly optimise their design by defining the most adapted fire protection strategy. The new generation of Eurocodes has been improved in order to tackle more advanced phenomenon and calculation concepts.

Tuesday May 24, Afternoon

Andrea Frangi – ETH Zurich (CH)

Timber structures in the era of tall timber buildings

Due to the combustibility of timber, the fire safety of timber buildings has always been a major safety concern for authorities, the building owners, the fire brigades and the designers. Based on fundamental experimental and numerical analysis, new design models have been developed for the fire design of timber structures, which will be included e.g. in the revision of the Eurocode 5. Due to the increasing use of timber as building material in complex large and/or tall buildings, several fundamental questions remain open. The presentation will review the past and recent achievements and will look into the future development of timber fire engineering.

Wednesday May 25, Morning

Thomas Gernay – Johns Hopkins University – Baltimore (US)

Burnout resistance: assessing stability throughout natural fires

This presentation will discuss the issue of structural failure during the cooling phase of natural fires. We will show that fire resistance rating falls short of informing about stability to full burnout. We will introduce alternative methods and metrics to characterize the ability of structural members to survive a fire event, which supports designs that consider safety of occupants and rescue services throughout the fire and promote repairability and resilience.

Wednesday May 25, Afternoon

Roberto Felicetti – Politecnico di Milano (Italy)

Post fire damage assessment: a blend of skills takes the field

The assessment of structural fire damage involves a series of multidisciplinary tasks, like debris examination, recognition of the kind of fire scenario, implementation of non-destructive testing techniques, comprehension of structural effects of material damage and thermal strain. The presentation will discuss how the fragmented indications provided by the above activities can be harmonized in a coherent picture by validating a tentative model of the fire scenario.

Thursday May 26, Morning

Jean-Marc Franssen – Liege University (Belgium)

Coherence between structural models and fire scenario

There are many different ways to represent the thermal action of a fire on a structure, from simplistic time-temperature curves to CFD models. There are also different ways to represent a structure, concerning the type of finite element used and the type of thermal action. This talk will present the different options available with a particular attention paid to the coherence that must be ensured between both aspects, modelling the fire and modelling the structure.

Thursday May 26, Afternoon

Giuseppe Abbiati – Aarhus University (Denmark)

Hybrid testing: fire tests tickled by structural models

The failure mode of a structural component subjected to fire loading is sensitive to its mechanical boundary conditions. For example, thermally induced buckling of a restrained column exposed to fire might occur or not depending on the stiffness of beam-column joints. Simulating the correct boundary conditions is indeed crucial for obtaining meaningful experimental results. Hybrid fire testing has been developed for this purpose. Specifically, a structural component under test is loaded using servo-controlled actuators while exposed to thermal loading (e.g., using gas burners or electric heaters). Actuator positions are adjusted in real time based on measured reaction forces. As a result, the interaction between the tested structural component and a virtual yet realistic subassembly is experimentally reproduced. This lecture will provide an overview of the state of the art in this area together with an outlook on future challenges.

Friday May 27, Morning

Stefano Dal Pont – Université Grenoble Alpes (France)

Coupled thermo-hygral transients: new perspectives on explosive spalling

The talk will focus on the synergy between advanced modelling of transport phenomena and ad-hoc experiments for cement-based materials at high temperature. The close relationship between theoretical-numerical developments and top-notch experiments, ie. full-field techniques such as neutron imaging, allow an in-depth understanding of the thermo-hydric phenomena in concrete subjected to a fire.

Friday May 27, Afternoon

Patrick Bamonte – Politecnico di Milano (Italy)

Deformation and capacity of concrete structures under sustained load

The behaviour of structural members in fire is characterized by highly complex phenomena. All these phenomena are to be taken care of when performing structural analyses in fire. This presentation aims to highlight the possible strategies for working out deformations, displacements and bearing capacity, with reference to specific types of structural members. Attention will be focused on the differences with the usual calculation procedures which are used in ordinary conditions.

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Organizing Committee & Speakers

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- **Jean-Marc Franssen** – Liege University (Belgium)

Invited Speakers

- **Giuseppe Abbiati** – Aarhus University (Denmark)
- **Patrick Bamonte** – Politecnico di Milano (Italy)
- **Luke Bisby** – University of Edinburgh (UK)
- **Stefano Dal Pont** – Université Grenoble Alpes (France)
- **Andrea Frangi** – ETH Zurich (CH)
- **Thomas Gernay** – Johns Hopkins University – Baltimore (US)
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