STATIK & DYNAMIK

RUHR UNIVERSITÄT BOCHUM RUB

COMPUTATIONAL MULTISCALE MODELING OF LOW-CARBON CONCRETES AT ELEVATED TEMPERATURES

Doctoral defense by SIMON PETERS

Friday, 12.09.2025 – 10:00 - 12:00 – IC 02/158-88

Despite decades of research, the underlining mechanism of explosive concrete spalling at elevated temperatures remains unknown. This thesis proposes a fully coupled numerical chemo-thermo-hygro-mechanical model, advanced through a micromechanical framework, providing a deeper understanding of the multiphysical nature of explosive spalling.

Key contributions include the development and validation of the micromechanical framework to analyze the binder-specific dehydration behavior, chemically induced material evolution and microstructure. This framework enhances applicability and reduces experimental calibration requirements for the well-established multiphysical macroscale model, particularly for concretes based on CO2-reduced cements.

By means of virtual parametric studies, the main findings of the thesis are: i) The binder-specific dehydration behavior of CO2-reduced cement pastes is not the primary driving mechanism behind fire-induced concrete spalling. ii) Aggregates characterized by high thermal conductivity can lead to a significant increase (even more than 35%) in pore pressure when compared to aggregates with lower thermal conductivity. iii) The dense microstructure is the primary factor driving the susceptibility of concretes containing CO2-reduced cements to fire-induced concrete spalling compared to ordinary concretes. iv) The moisture clog theory is not supported.

Zoom Link
Meeting-ID: 681 5878 2038
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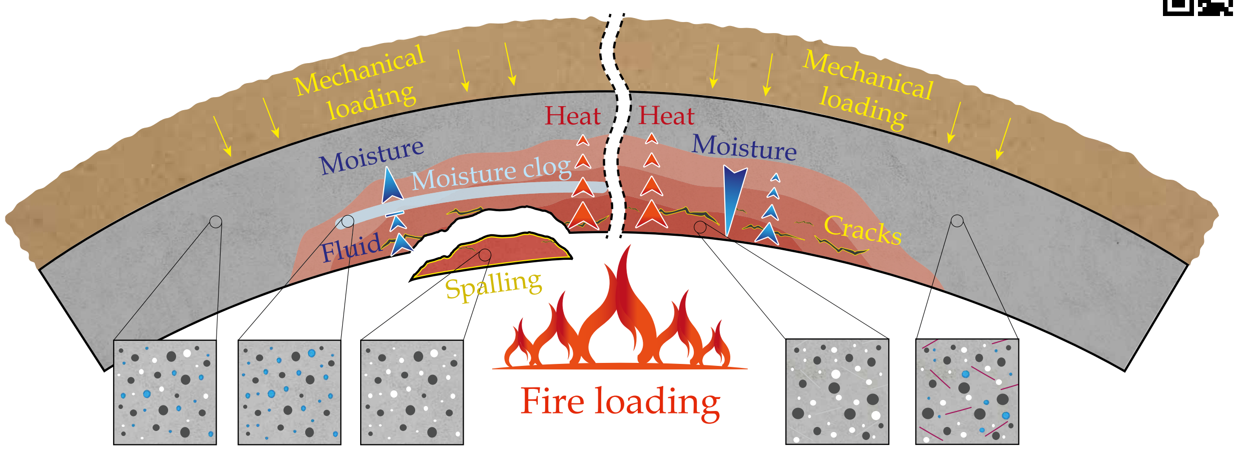

Figure: Schematic illustration of the multiphysical processes in concrete exposed to elevated temperatures, including heat and moisture transport, mechanical loading, crack formation, and the onset of explosive spalling.

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