Popular science summary of the PhD thesis

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Title of the PhD thesis	Advanced fire engineering tool for integrated analysis of structural design parameters
PhD school/Department	Department of Civil and Mechanical Engineering

Science summary

* Please give a short popular summary in Danish or English (approximately half a page) suited for the publication of the title, main content, results and innovations of the PhD thesis also including prospective utilizations hereof. The summary should be written for the general public interested in science and technology. Before the thesis defence, the summary is sent to DTU's Office for Communication and Media and to the media *Ingeniøren*:

A fire in a Hydrogen Fuel Cell Vehicle (HFCV) can potentially trigger a hydrogen jet fire with the activation of a Thermal Pressure Relief Device (TPRD) or trigger a hydrogen tank rupture without TPRD activation. This thesis investigates the impact of such incidents on surrounding structures, mainly focusing on two scenarios: HFCV fires in a car park and a hydrogen tank rupture in a tunnel.

In the scenario involving HFCV fires in a semi-open concrete car park, a one-way CFD-FEM coupling interface is used to link the HFCV fire model in FDS with the concrete ceiling slab model in ANSYS. The HFCV fire model comprises the HFCV main body fire model and the hydrogen jet fire model. The HFCV main body fire is modeled by prescribing the heat release rate per unit area on the surface of a solid obstruction, while the hydrogen jet fire is modeled by introducing Lagrangian particles released from a virtual nozzle. The adiabatic surface temperature and the convection heat coefficient are automatically transferred from FDS to ANSYS as boundary conditions for transient thermal analysis. To investigate the thermal behaviors of a concrete ceiling slab, seven scenarios are analyzed, varying the TPRD nozzle diameters and the fire spread times between adjacent HFCVs. The analysis reveals that an increase in the TPRD nozzle diameter results in a higher maximum concrete surface temperature. Additionally, the maximum heat release rate increases with a larger TPRD nozzle diameter and a shorter fire spread time among HFCVs.

In the case of a hydrogen tank rupture in a tunnel, the overpressure from the CFD analysis is manually extracted and imposed on the FEM model to study the mechanical behavior of the concrete tunnel slab. The concrete tunnel slab model is built individually in two Finite Element (FE) software programs, ANSYS and DIANA. Materials, boundary conditions, and impulses are analyzed in this case. The parameter analysis indicates that the maximum deflection of the Reinforced Concrete (RC) slab increases with the enhancement of the explosion impulse. Implementing measures such as expanding the diameter of rebars or restricting the RC structural freedom can somewhat decrease the deflection of RC structures. In general, this thesis provides guidance for engineers on designing structural safety in the event of HFCV fire incidents.

Please email the summary to the PhD secretary at the department