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Simulation-based reliability analysis of fire barriers

Title of the dissertation Uncertainty management for the probabilistic simulation of the thermal resistance of fire barriers (Epävarmuuden hallinta osastoivien rakenteiden palonkeston todennäköisyyspohjaisessa simuloinnissa)

Contents of the dissertation Fire barriers are physical systems designed to resist fire and smoke spreading. Currently, the fire barrier design is certified by repeatedly heating the barrier material in a high-temperature furnace and ensuring that the material sufficiently resists fire. The main issue of such a certification process is that it is expensive, and it does not assure the product reliability against the batch production uncertainty. This study serves as a proof of concept for simulation-based reliability analysis. The challenges were the complexity of the thermal behaviour of fibrous barriers to be simulated, the high computational cost of the stochastic simulations accounting for the input uncertainties, and the model uncertainty propagation in stochastic simulations. The challenges were overcome by multiphysics modelling of the fibrous layer, utilizing the surrogate modelling techniques, and by deriving an uncertainty management model. The presented methods help to optimize the product before the actual fire test and also for the certification of the products that comply with the European standard for extended application. Although the study illustrates the methods in the context of fire barrier resistance evaluation, they are not limited to such an application.

Field of the dissertation Fire Safety Engineering

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