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optimised fire safe and energy efficient design of insulated assemblies using a multi-criteria approach

The need to reduce energy consumption in buildings has led to increased use of insulation materials. Some insulation materials are combustible, which introduce a fire hazard since the pyrolysis onset may be achieved quickly, thus reducing the available safe egress time.

The objective of this thesis is to establish a framework to design assemblies consisting of insulation based on a multi-criteria approach, accounting for fire safety and energy efficiency. Quantitative performance-based methodologies are presented for both principles. Numerical analyses are performed to determine the performance of assemblies consisting of insulation (PIR, EPS and PF) and lining (MgO, plasterboard and brick) of different thickness. Results are compared to established critical performance criteria used to define failure (critical time and critical heat loss). Through both models optimum thicknesses are identified.

Non-combustible insulation assemblies (deemed fire safe) are further considered. Assuming the established acceptable fire performance, combustible solutions show a thickness approximately 10% thinner than non-combustible solutions for optimal energy efficiency performance. Metal-faced combustible insulation assemblies, also investigated, however always show prompt failure from a fire safety perspective.

In order to validate the fire methodology, numerical and experimental data are compared. Results indicate that, due to founding assumptions, this methodology is conservative.