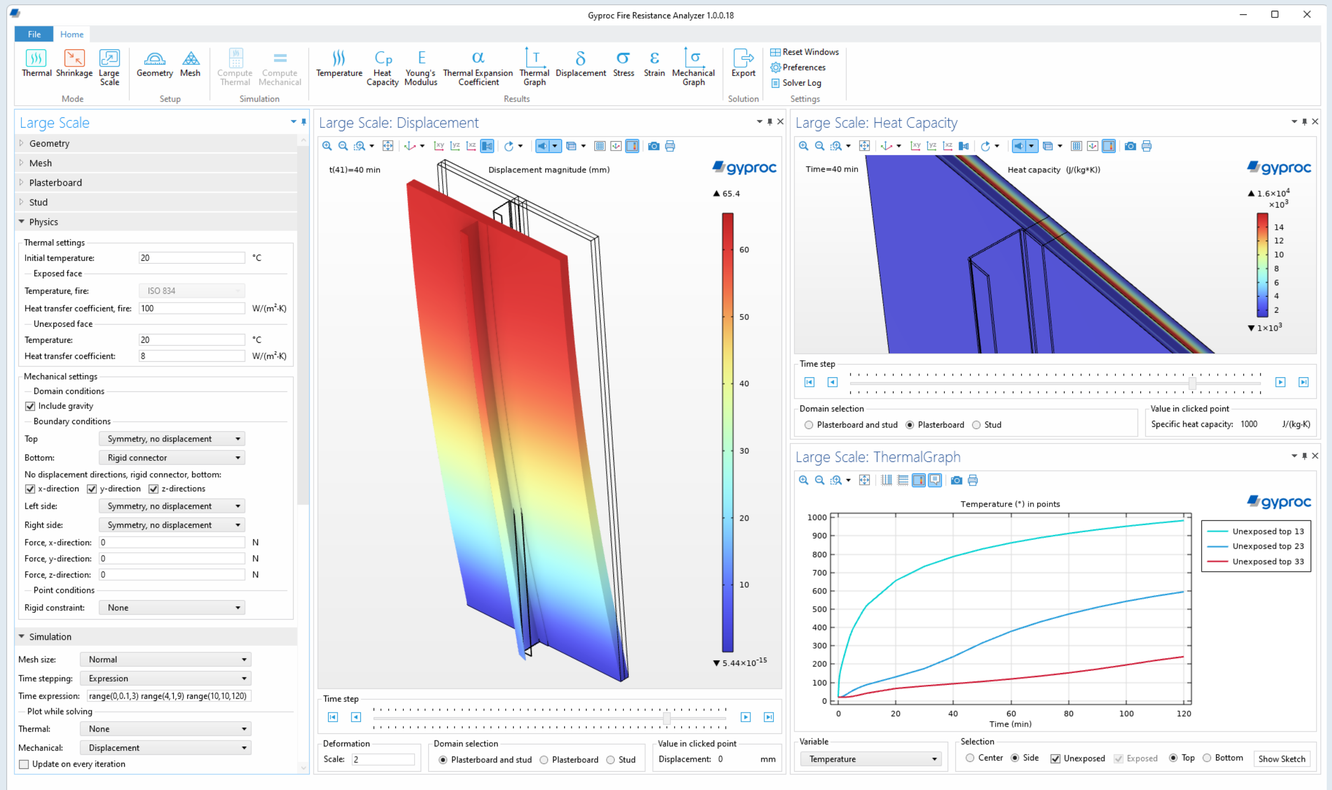

Gyproc Fire Resistance Analyzer

A COMSOL® App for Evaluating the Fire Performance of Gypsum Wall Systems

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Introduction

Passive fire protection is a critical aspect of building design. Fire resistance in non-load bearing walls is assessed through tests according to EN 1364-1. While these tests are effective for system classification, they are less useful for development and deeper understanding due to their high cost. The data gathered is also limited because the tests are destructive, and for safety reasons, only lab personnel can closely inspect the test specimens during testing.

To address these challenges, Gyproc, a lightweight system producer within the Saint-Gobain group, and Deflexional AB, a certified COMSOL consultant, have developed a COMSOL® App for non-load bearing fire resistance tests in accordance with the EN 1364-1 standard. The app enhances understanding of the underlying mechanisms, aids in improving existing systems, and supports the design of new ones.

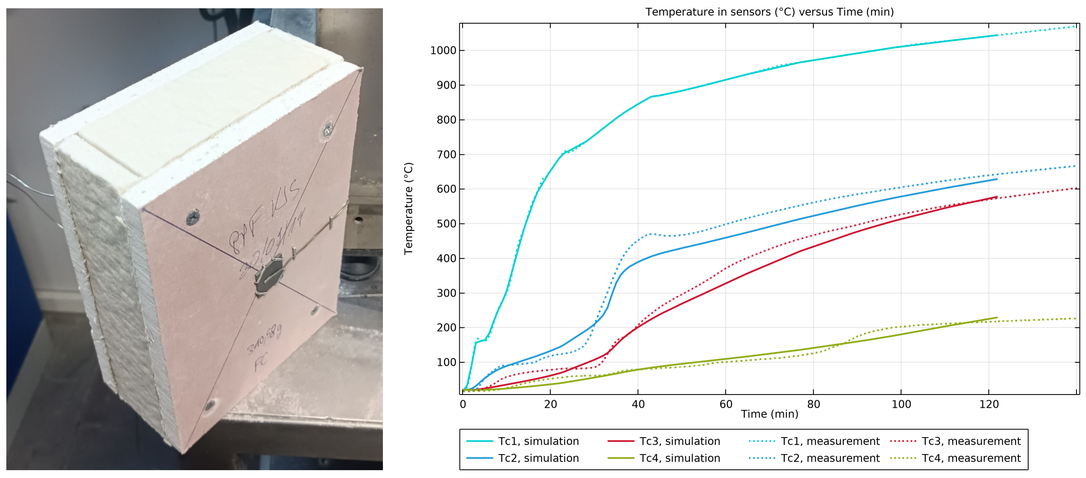

FIGURE 1. Left: Small-scale test piece for insulation testing, consisting of plasterboard mounted on both sides of a metal stud and insulation in the center. Right: Temperature measurements and results from the app.

Methodology

The app was developed in COMSOL Multiphysics® using the Heat Transfer Module and the Structural Mechanics Module. It builds on the research by I. Rahmanian [1] and includes various sub-models to assess different material properties of gypsum boards. The app was converted into stand-alone application using COMSOL Compiler™.

Figure 1 shows results from the insulation sub-model, inspired by B. Weber [2]. Users can modify the material properties of gypsum boards to match specific types. The focus is on adjusting the temperature-dependent heat capacity, as it is crucial to capture the calcination process, which occurs around 100°C. At this stage, approximately 20% of the board's weight is converted into water vapor.

Results

The final part of the app is a thermo-mechanical model for full-scale EN 1364-1 tests, with adjustable geometry to accommodate the most common gypsum wall constructions. The app offers several post-processing options to visualize displacements, stresses, temperature, and material properties over time. Figure 2 shows a comparison between large-scale test results and a simulation.

The application enables rapid evaluation of the fire resistance performance of gypsum wall systems, reducing the need for expensive and time-consuming physical tests. It also supports the optimization and innovation of wall systems to meet fire safety standards and customer requirements.

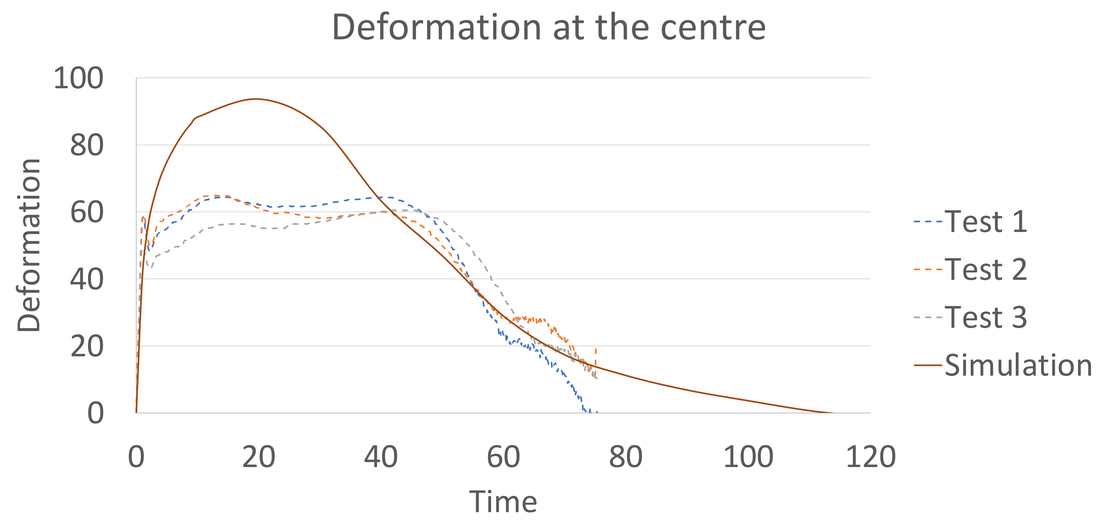

FIGURE 2. Comparison between simulation results and large-scale tests (3 x 3 m) showing deflection at the center of the construction.

REFERENCES

1. I. Rahmanian, “Thermal and Mechanical Properties of Gypsum Boards and Their Influences on Fire Resistance of Gypsum Board Based Systems”, University of Manchester, School of Mechanical, Aerospace and Civil Engineering, 2011.
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