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Recent NBB research and development in TUNI

Civil Engineering, Building Physics Research Group

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Examples of product development in the Stalk and Biosivu projects

Development of reed starch board

Reed preparation

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Mikpolis

Development of production technology

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Mikpolis

Variations of the board


Lake reed, coarse shredding


Lake reed, fine shredding


Oil hemp, fine shredded


Porous board, 20 mm, 500 kg/m³


Porous board, 25 mm, 270 kg/m³


Porous board, 20 mm, 400 kg/m³


Dense board, 10 mm, 600 kg/m³


Dense board, 10 mm, 550 kg/m³


Dense board, 10 mm, 500 kg/m³

REED AND OIL HEMP BOARDS

- 270x260 mm, thicknesses 30-10 mm
- densities 270-700 kg/m³
- barley or potato starch as a binder
- thermal compression 220 °C, 10 min + 5 min
- Cooling
- drying 50 °C, 12 h
- sanded surfaces (evenness, dimensional accuracy)

XAMK

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Development of fire protection clay products

Nature-based thermal heat insulators are bio-based, i.e. combustible (fire class B, C, D...)

In order for materials to have climate impact, they must be suitable for high-rise building

Can bio-based heat insulators be used in the outer shell of a high-rise building according Finnish fire standards?

A high-rise building of fire class P1 must have a non-combustible frame structure > Concrete/steel > low-carbon building materials?

In the outer shell of a wooden high-rise building in fire class P2, all materials must be in reaction-to-fire class A > Not compatible

Through functional fire design, it is possible to demonstrate the fire safety of a (wooden-framed) building in fire class P0 also when using bio-based insulation. The inner surface of the outer shell will presumably require fire protection cladding of at least class **A2** and fire protection for 30 minutes (**K2 30**).

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Development of fire protection clay board

Dry clay powder, hemp shives and water were mixed and the jute mesh was dipped in clay slurry

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The clay board was made by rolling several layers of clay-hemp shives mass. Jute mesh is placed on the lower surface and 3 mm from the upper surface. A full-sized board weighs less than 50 kg.

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The board was dried in a stream of air and the surface of the plate was painted with clay starch paint

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Development of fire protection clay mortar

The base mortar consists of clay, sand and biochar, and the surface mortar consists of clay and sand. The mortars do not shrink or mold when dried. Fescon produced a test batch that is now being tested by plastering masters.

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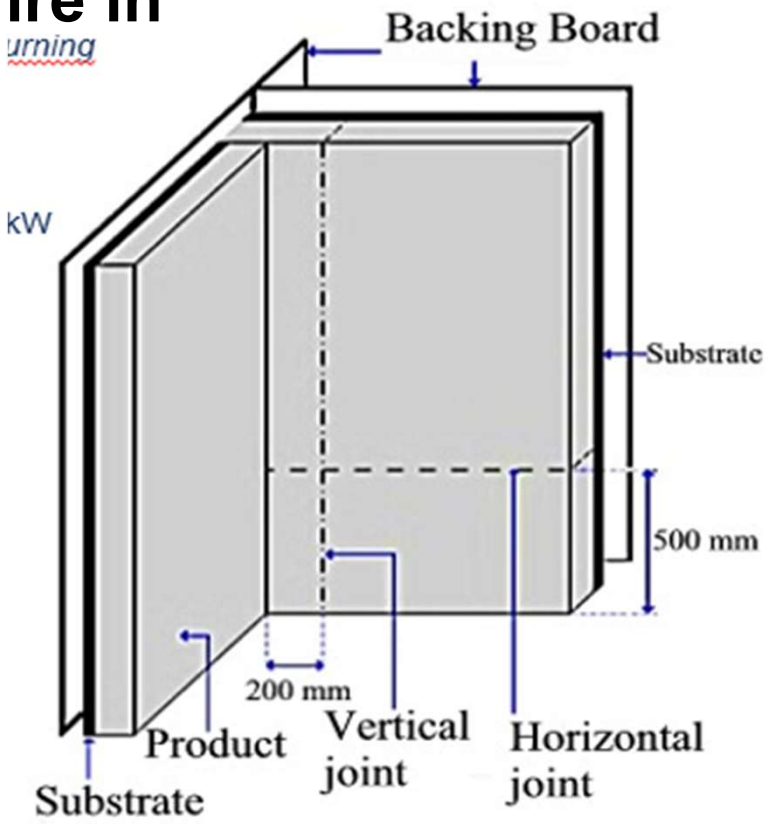
Testing the reaction-to-fire in Eurofins



The clay boards were made into test specimens, which were tested at Eurofins using the SBI test of the EN13823 standard. It also indicates that the clay board belong to fire class A2/B, that their smoke output is very low (s1) and that there are no flammable droplets (d0) in the fire.

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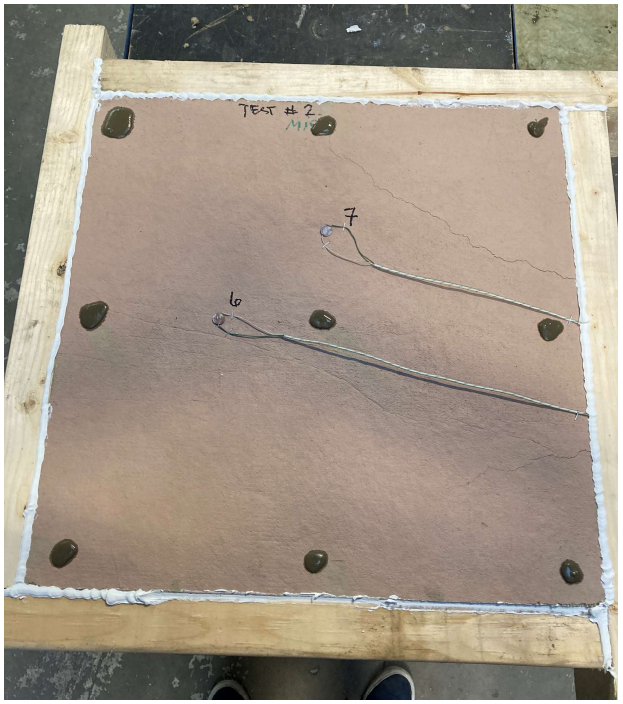
Testing the fire protection ability in DBI



In addition to temperature measurements carried out in conjunction with cone calorimeter tests, clay boards were also tested with DBI (Danske brand institute) test furnace, which simulated the fire protection time test according to EN 14135. The temperature increase was measured between the clay plate and the underlying substrate (chipboard), as well as on the fire-exposed side of the clay boards.

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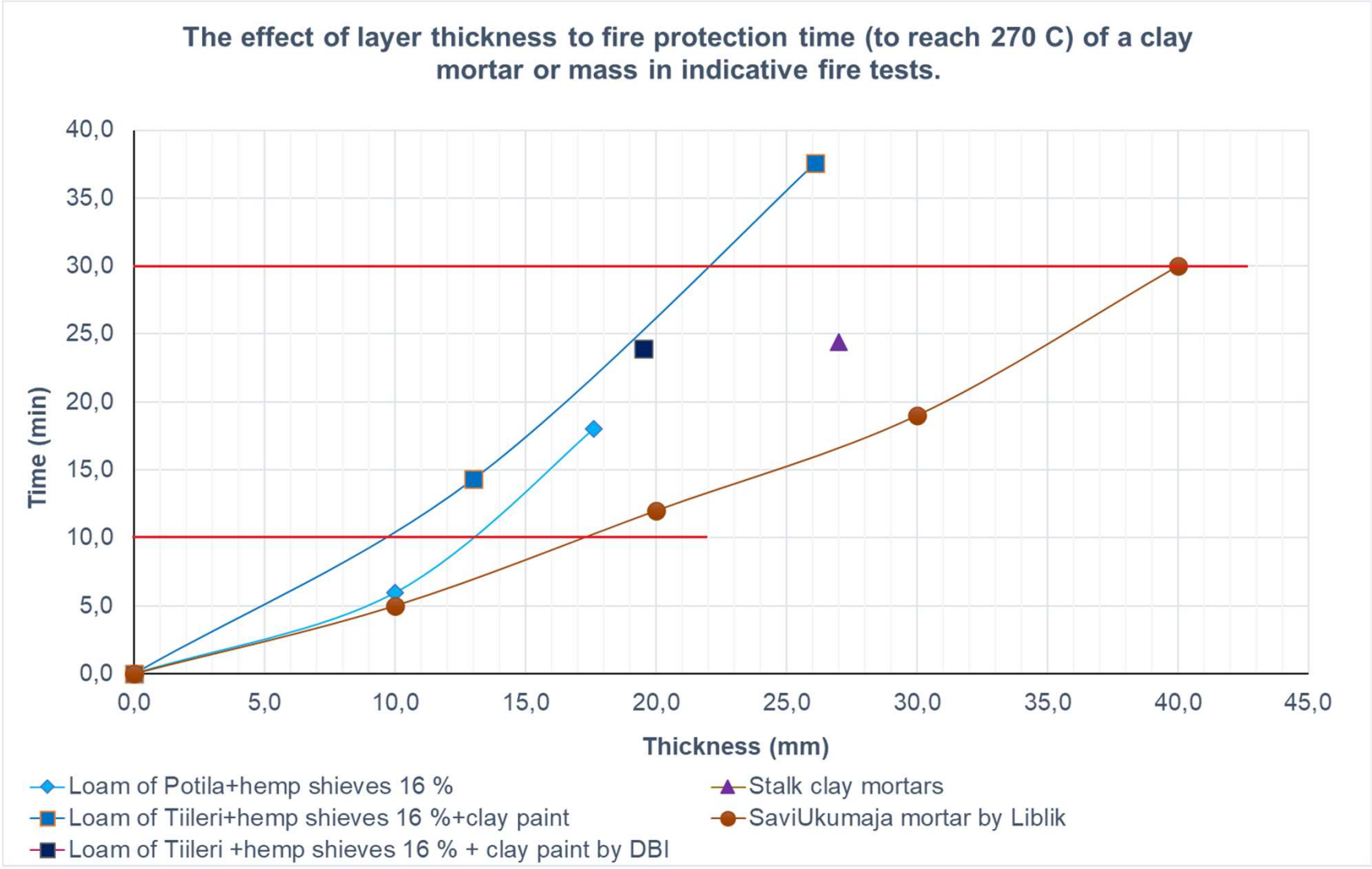

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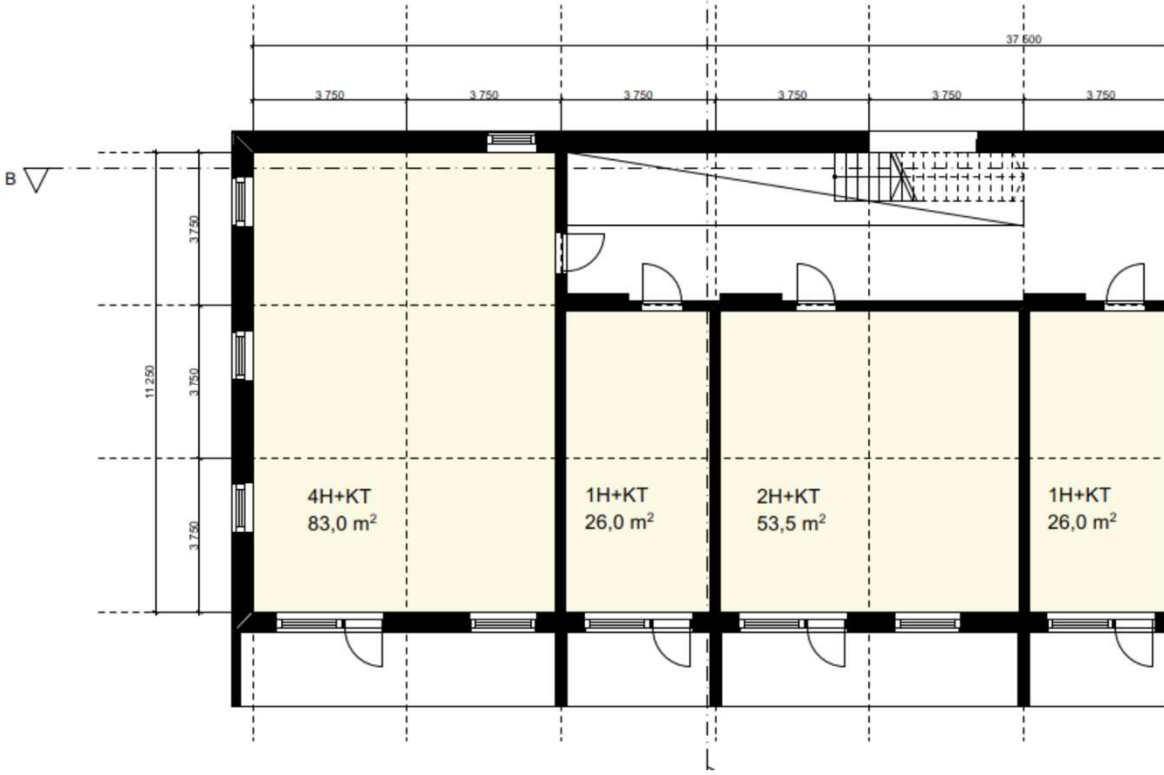
Fire simulation

Fire Technical Engineering Office Markku Kauriala Oy



Types of structures examined in fire simulations

Type of external wall construction:

- Loam+hemp board (K2 30, 24 mm)
- Straw element, wooden frame, 400 mm
- Air barrier membrane
- Loam+hemp board (K2 10, 10 mm)
- Vertical + horizontal wooden frame, fire retardant treated to class B-s2, d0
- Wood cladding, fire retardant treated to class B-s2, d0

Type of construction of the vertical roof:

- Loam-hemp board (K2 60, 38 mm)
- Assembly and electrical installations
- Air barrier paper
- Wooden frame + cutter chips-sawdust insulation (at least the top layer clayed)

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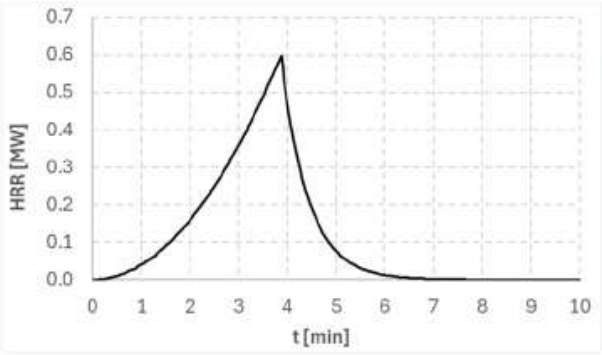
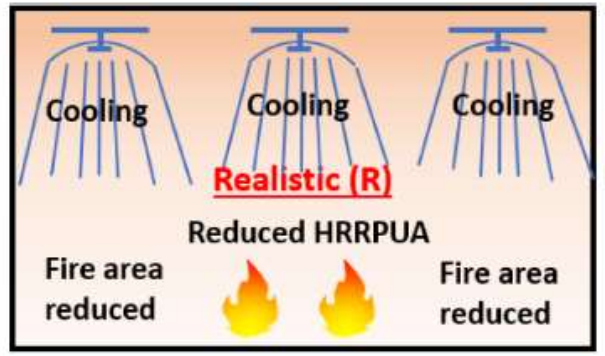
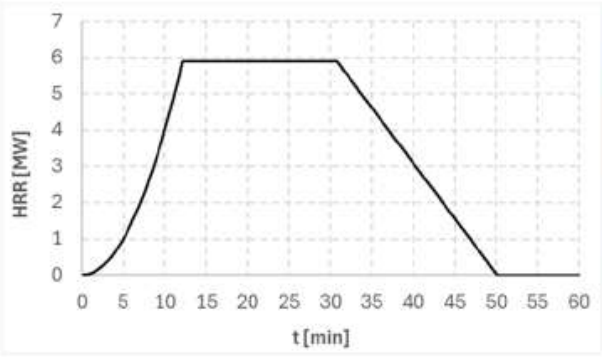
Dimensioning fires

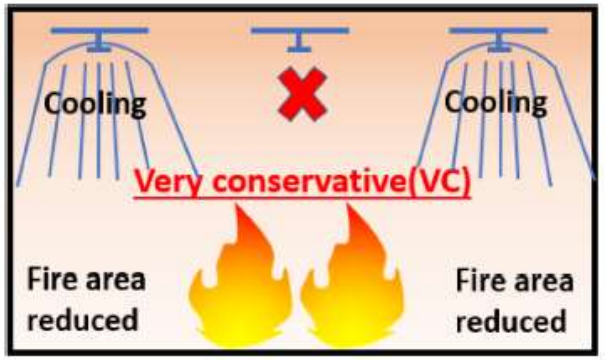
- **Fire I**: Sprinkler works as designed
- **Fire II**: Sprinkler only partially works
- **Fire III**: Sprinkler not working at all

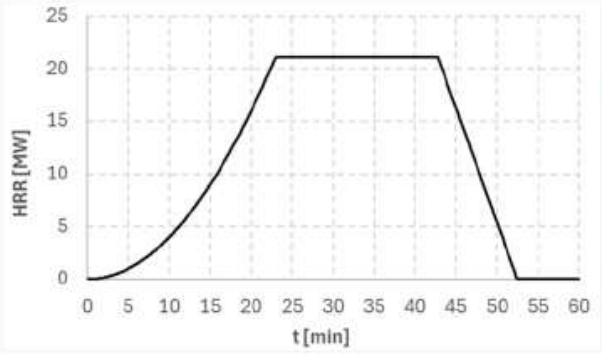
(in addition to these, there are also the proportions of the fire output of flammable structures)

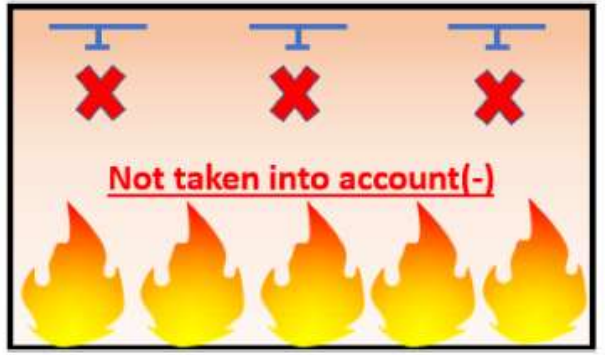












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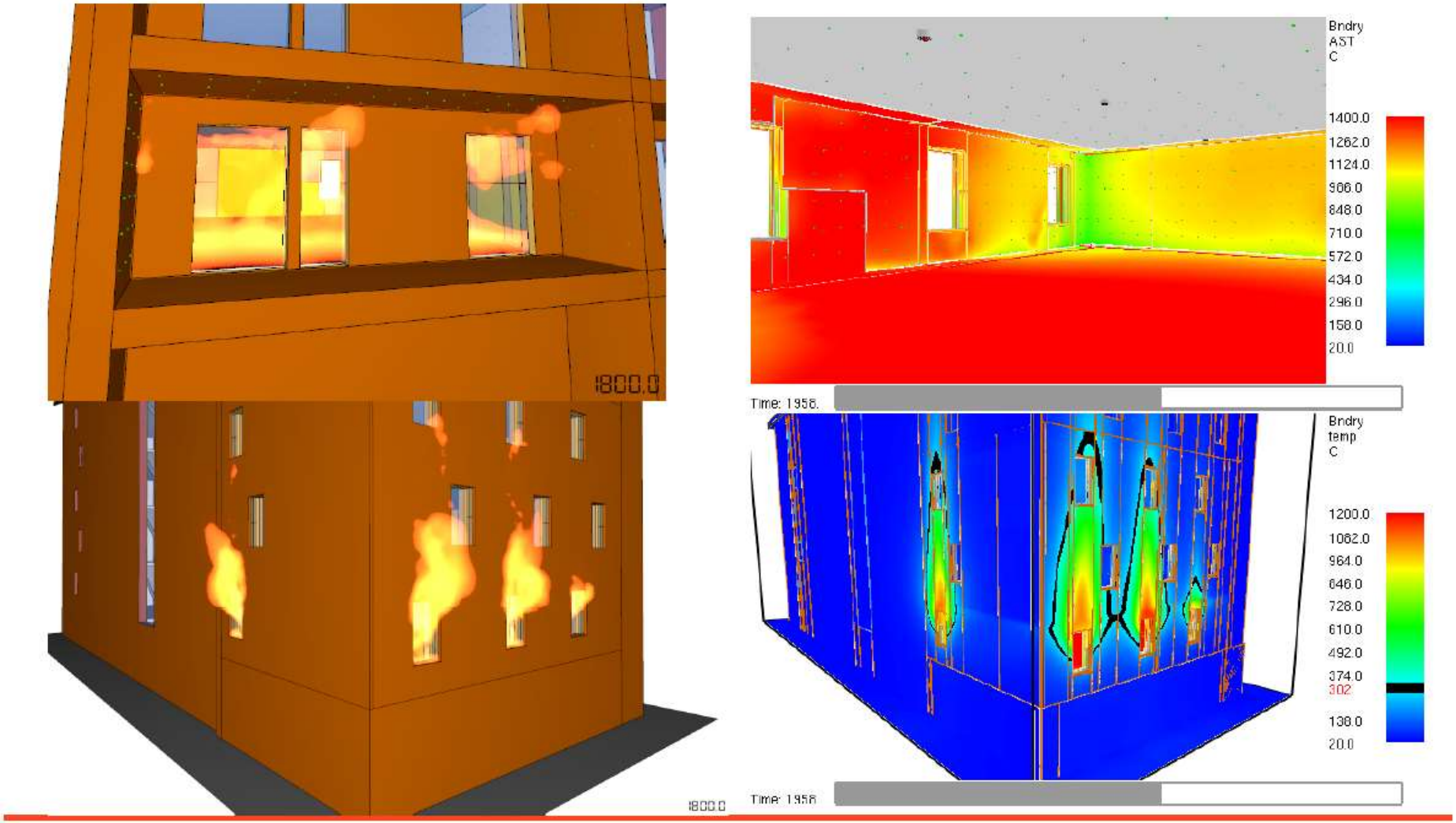
Fire simulation: Fire III



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Conclusions

- Protective cladding requirement **K2 30** for the inner surface of the external wall and **K2 10** for the inner surface of the ventilation gap. That is, the same requirement as for the table dimensioning of a wooden high-rise building with fire class P2.
- Protective cladding requirement **K2 60** for the lower surface of the vertical roof. Thus, the upper surface of cutter chip insulation should be clayed or coated e.g. with wood boarding.
- Fire resistance of load-bearing structures **R70** (or R75). In other words, the requirement is slightly higher than for a similar residential building in fire class P2 or P1 (where the requirement in question is R60).
- Surface class requirement **B-s2, d0** for the outer surface of the outer wall and the inner surface of the ventilation gap. "When using wood panels, the cladding and cladding must be treated with fire retardant. The propagation of fire in the ventilation gap must be prevented in layers.
- Overlapping of windows on floors (excl. balconies and stairwell). Balcony surfaces **B-s2, d0**.
- The results can be extended up to 8 storeys (28 m high) residential buildings
- The results also apply to other protective cladding methods, as long as the K2 class remains the same (and the cladding surface A2-s1, d0).

MK

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Thank you for your interest!

More information about projects and products (mostly still in Finnish):

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https://research.tuni.fi/rakennusfysiikka/luonnonmukainen-rakentaminen/

Reports and descriptions can be downloaded from the projects' own pages.