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COMPARATIVE STUDY ON DETERMINING THE FIRE RESISTANCE OF MASONRY WALLS

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Abstract

In the current context of the implementation of the provisions of the new P118-1:2025 on the fire safety of buildings in Romania, an important role falls to testing laboratories for determining the fire resistance of building elements, in order to increase the fire safety of the built environment. For these reasons, the assessment of the fire behaviour of building elements made of non-load-bearing masonry is an essential component for fulfilling the fundamental requirement of fire safety of buildings. The tests for determining the fire resistance of building elements in Romania, are carried out within the INCERC Testing Laboratory from Bucharest and consist of applying standardized fire resistance testing methods that are harmonized at the level of the countries of the European Union. Recently, researchers from this laboratory conducted several experimental tests to compare the fire resistance of non-load-bearing masonry walls of varying thicknesses.

Key words*: cladding systems, compartment fires, experimental research, fire resistance tests.*

INTRODUCTION

Theoretical studies and experimental research have highlighted that every fire has its own evolution that makes it unique, with no two fires following an identical path. This uniqueness must be understood as referring to the entire set of factors and consequences of a fire (Simion & Dragomir, 2025).
In the Romanian construction sector, autoclaved aerated concrete (AAC) blocks are highly favoured, owing to their superior performance under fire conditions. Autoclaved Aerated Concrete (AAC) is an eco-friendly building material composed of cement, water, lime, silica-based materials (such as sand, ash, or silica fume), an expansion agent (aluminium powder), and other additives (Sherin & Saurabh, 2018; Hammond & Jones, 2008).
Besides its relatively light weight, this material provides benefits like fire resistance, low thermal and acoustic conductivity, and is easy to cut, handle, install, and transport (Mollaei et al., 2022). AAC block masonry utilizes adhesive mortar to bond the blocks (Song et al., 2024). This adhesive mortar behaves differently and can make the AAC masonry vulnerable to fire if not applied in a thin layer.
Researchers at INCERC Bucharest recently conducted experimental studies to assess the fire performance of non-load-bearing masonry walls of varying thicknesses, constructed with autoclaved aerated concrete (AAC) blocks (density: 480 kg/m^3, compressive strength: 3.5 N/mm^2) and class M2.5 bonding mortar (compressive strength 2.5 N/mm^2) (Stanescu et al., 2021).

MATERIALS AND METHODS

The purpose of this study was to evaluate the fire resistance performance of a single type of AAC masonry wall with the following thicknesses: 150 mm, 200 mm, and 300 mm (Figure 1 and Figure 2).
The experimental tests were conducted at the Fire Safety Laboratory within INCERC Bucharest and consisted of applying a standardized method, harmonized across European Union countries, for testing the fire resistance of non-load-bearing walls.

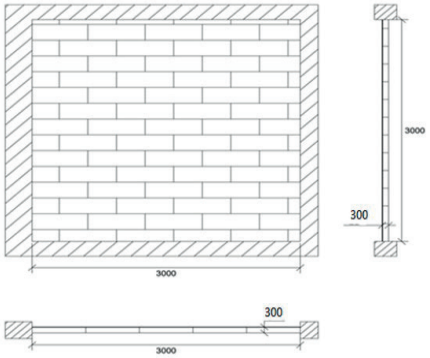


Figure 1. Non-load-bearing AAC masonry wall with a thickness of 300 mm designed for fire resistance testing



Figure 2. Non-load-bearing wall made of AAC masonry with a thickness of 300 mm, prepared for fire resistance testing

The fire resistance testing technology for non-load-bearing walls involved installing the walls (test samples) in the opening of a vertical fire resistance test furnace, conditioning the specimens for a period of 30 days after installation, and testing them under a controlled fire.

This fire followed the ISO 834 standard temperature-time curve, maintained by the furnace's automation system throughout the entire duration of the tests (Figure 3).

During the fire resistance tests, the walls were exposed to a controlled temperature variation regime inside the furnace to evaluate the integrity (*E*) and thermal insulation (*I*) criteria, in accordance with the test method standards "SR EN 1363-1:2020 Fire resistance tests. Part 1: General requirements" and "SR EN 1364-1:2015 Fire resistance tests for non-loadbearing elements. Part 1: Walls" (Figure 4 and Figure 5).

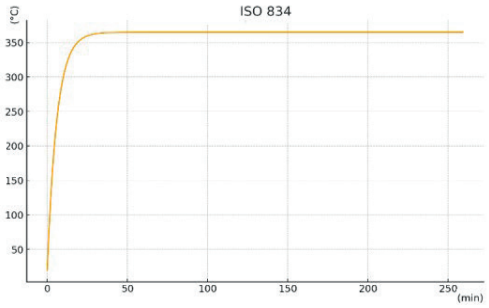


Figure 3. ISO 834 standard temperature-time curve

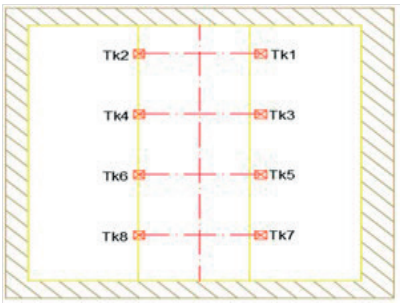


Figure 4. Thermocouple placement inside the furnace

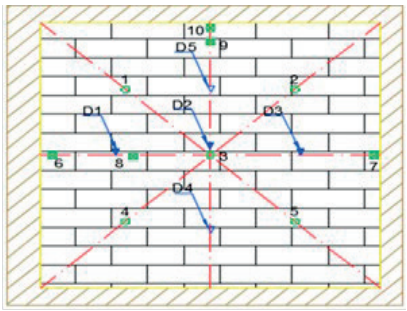


Figure 5. Positioning of thermocouples on the unexposed surface of the sample

RESULTS AND DISCUSSIONS

After conducting the fire resistance tests on the AAC masonry walls, the testing supervisor prepared the fire resistance test reports for each wall type tested, in accordance with the testing laboratory's internal procedures (a RENAR-accredited laboratory) and the requirements of the harmonized fire resistance testing standards for non-load-bearing walls.

Following the monitoring, recording, and processing of the testing parameters, as well as visual observations regarding the behaviour and

integrity of the specimens during the tests, a series of data was obtained and subsequently included in the fire resistance test reports for the three specimens.

This information consisted of: the temperature evolution inside the furnace compared to the ISO 834 standard curve, as well as on the unexposed surface of the samples; the deformation of the samples during the tests; the moments when the fire resistance criteria samples were lost (expressed in full minutes); the evolution of environmental conditions in the testing hall; the intensity of smoke release on the unexposed surfaces of the samples during the tests; the monitoring of cracks, fissures, and sustained flaming; the ignition time of the cotton pad; the verification of the gap gauge insertion into the cracks formed in the samples; the observation of any material spalling or detachment; the start and end times of the tests, etc.

During the tests, researchers observed the appearance of fissures and cracks on the unexposed surface of the three AAC masonry samples at the following times: at minute 20 for the 150 mm thick sample, at minute 35 for the 200 mm thick sample, and at minute 50 for the 300 mm thick sample. Using a FLIR thermal imaging camera, the temperature variation on the unexposed surface of each sample was measured from the beginning until the end of the fire resistance tests (Figure 6, Figure 7, Figure 8 and Figure 9).



Figure 6. The unexposed surface of the 200 mm thick sample at the beginning of the fire resistance test

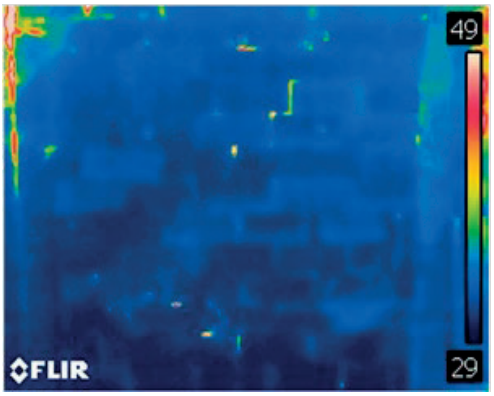


Figure 7. Temperature measurement on the unexposed surface of the 200 mm thick sample at the start of the fire resistance test



Figure 8. The unexposed surface of the 200 mm thick sample at minute 220, at the conclusion of the fire resistance test

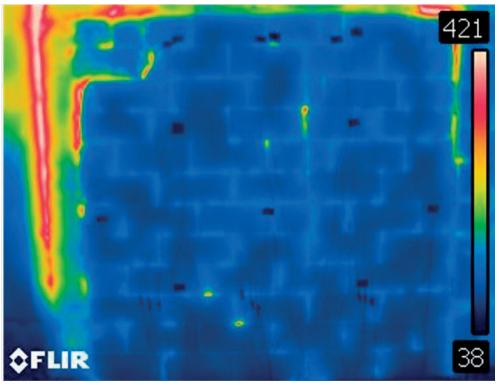


Figure 9. Temperature measurement on the unexposed surface of the 200 mm thick sample at minute 220, upon completion of the fire resistance test

The deformations of the three samples during the fire resistance tests were, as follows (Figure 10, Figure 11 and Figure 12):

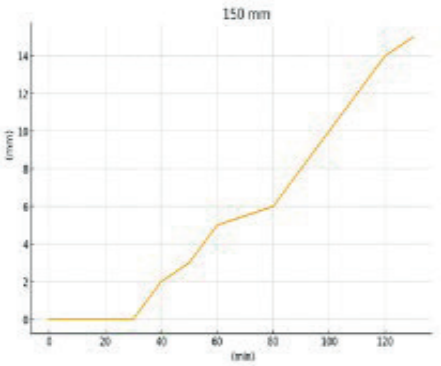


Figure 10. Deformation of the 150 mm thick AAC masonry wall during the test

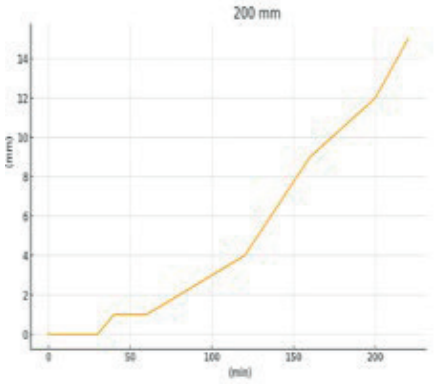


Figure 11. Deformation of the 200 mm thick AAC masonry wall during the test

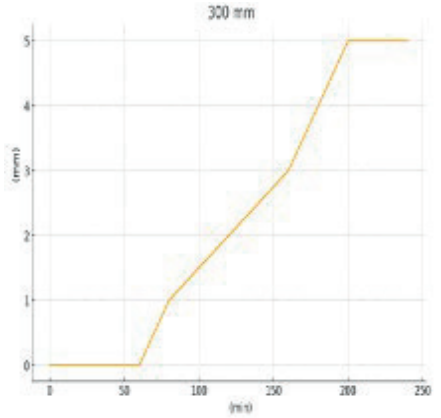


Figure 12. Deformation of the 300 mm thick AAC masonry wall during the test

It is observed that the deformations of the 300 mm thick sample were approximately three times smaller in magnitude than those of the other two samples.

During the fire resistance tests, the three non-load-bearing masonry walls maintained their thermal insulation criterion (*I*) and fire integrity criterion (*E*) as follows:

- For the 150 mm thick wall, criteria *I* and *E* were maintained for 129 minutes and were both lost at minute 130 when criterion *E* failed (Figure 13);



Figure 13. Loss of integrity (E) criterion through the ignition of the cotton pad for the 150 mm thick sample

- For the 200 mm thick wall, the thermal insulation criterion (*I*) and fire integrity criterion (*E*) were maintained for 219 minutes and were both lost at minute 220, when the fire integrity criterion *E* was failed (Figure 14).



Figure 14. Loss of fire integrity criterion (*E*) by ignition of the cotton pad for the 200 mm thick sample

- The 300 mm thick wall did not lose any of its thermal insulation (*I*) or fire integrity (*E*) criteria

until the end of the fire resistance test at minute 244.

The classification of the tested samples into fire resistance classes was conducted by laboratory researchers based on the data from the test reports (total minutes during which the specimens maintained their integrity for fire integrity *E* and thermal insulation *I* criteria) and was performed according to the standard "SR EN 13501-2:2023 Fire classification of construction products and building elements. Part 2: Classification using data from fire resistance and/or smoke control tests, excluding ventilation services".

The fire resistance classes for the three AAC masonry walls were as follows: class *EI 120* for the 150 mm thick AAC masonry wall, class *EI 180* for the 200 mm thick AAC masonry wall, and class *EI 240* for the 300 mm thick AAC masonry wall.

CONCLUSIONS

Masonry ranks among the oldest structural materials, distinguished by a vast diversity in its units, mortars, and construction techniques. For innovative, affordable, and sustainable building alternatives, Autoclaved Aerated Concrete (AAC) blocks serve as an excellent modern solution (Kałuża, 2024).

This experimental study highlights the importance of laboratory testing in determining the fire resistance of non-load-bearing AAC (Autoclaved Aerated Concrete) masonry walls, which are used in numerous buildings (Daware & Naser, 2021). The research results confirm the applicability and relevance of the testing method in evaluating the fire behaviour of these construction elements, thereby contributing to the consolidation of the national technical framework for implementing the requirements of the new P118-1:2025 Romanian standard regarding the fire safety of buildings (P118, 2025).

Through the experimental research conducted, researchers from INCERC Bucharest contributed to a better understanding of the fire behaviour of these AAC construction elements, ensuring a high level of fire safety for the built environment in our country.

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