FIRE RESISTANCE TESTING OF ETICS SYSTEMS IN ROMANIA

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ABSTRACT

The fire security of buildings can be increased by the decrease of fire propagation intensity resulting from compartment fires and by using sustainable building enveloping solutions, with the role of limiting the spread of fires to neighboring floors and adjacent buildings. In this regard, research in the international literature highlights the need of conducting large-scale fire tests on the thermal insulation of buildings. The researchers from INCERC Bucharest have configured and adapted, for the first time in Romania, a large-scale stand designed to perform experimental tests to evaluate the fire resistance behavior of External Thermal Insulation Composite Systems (ETICS). The fire testing stand was designed following the analysis of fire resistance testing concepts of ETICS systems at European level.

Keywords: research; experimental tests; buildings; fire security

REZUMAT

Creșterea securității la incendiu a clădirilor se poate realiza prin scăderea intensității de propagare a focului rezultat în urma incendiilor de compartiment și prin utilizarea unor soluții durabile de anvelopare a clădirilor, cu rolul de a limita răspândirea incendiilor la etajele învecinate și clădirile adiacente. În acest sens, cercetările din literatura internațională evidențiază necesitatea efectuării unor teste de incendiu la scară largă a izolației termice a clădirilor. Cercetătorii de la INCERC București au configurat și adaptat, pentru prima dată în România, un stand de mari dimensiuni, conceput pentru efectuarea de experimente pentru evaluarea rezistenței la foc a sistemelor compozite de izolare exterioară a fațadelor, ETICS. Standul de testare la foc a fost conceput în urma analizei conceptelor de testare a rezistentei la foc a sistemelor ETICS la nivel european.

Cuvinte cheie: cercetare; teste experimentale; clădiri; securitate la incendiu

1. INTRODUCTION

Construction materials are divided into classes depending on how they influence the initiation of a fire, its spread and the production of smoke [4].

At present, a wide range of both harmonized and non-harmonized tests are used at European level to demonstrate that construction products are in compliance with the legal requirements for fire safety.

Within the INCERC Bucharest Branch, experimental research was carried out in order to develop a fire testing method for External Thermal Insulation Composite Systems (ETICS) at natural scale.

Through these tests, a series of conclusive results were obtained regarding the action of compartment fires on different types of facades made up of ETICS systems.

The experimental tests reproduced as accurately as possible the development phases of a compartment fire, the evolution of temperatures inside the combustion chamber and the action of spreading fire on the combustible facade of a building.

2. TEST AND CLASSIFICATION METHODS

The team of researchers from INCERC Bucharest, following the analysis of the fire testing concepts of ETICS systems at European level, designed and built a fire resistance test stand for such systems.

The test stand has similar characteristics to the fire test stand of the British standard BS 8414 (1), with the difference that at 2 m distance, opposite the combustion chamber, there is a reinforced concrete diaphragm on the entire height of the stand (8.5 m), which has the role both of accentuating the hot upward current [16] during the tests as well as of protecting the burning phenomenon from the possible wind gusts from the North direction (Fig. 1).

Fig. 1. Detail of the construction of the fire resistance test stand of ETICS systems

The researchers installed an ETICS system on the facades of the two wings of the stand, in accordance with the constructive provisions of the technical regulation SC 007-2013 [13], in order to determine its fire resistance.

The ETICS system was made of expanded polystyrene and 10 cm thick basalt mineral wool.

The polystyrene slabs were glued on their perimeter contour with adhesive mortar, after which they were fixed with dowels on the support layer (Fig. 2).

Fig. 2. Method to apply the adhesive mortar on polystyrene tiles

When applying the ETICS system on the stand, basalt mineral wool barriers with a thickness of 10 cm and a width of 30 cm were installed, along the edge of the combustion chamber and next to the floors on the 1st and 2nd floors, on all the widths of the two wings of the system (Fig. 3)

The expanded polystyrene was flame retardant type EPS 80 - AF 80, with a density of 14.5 kg / m³, being classified for reaction to fire in class E, according to SR EN 13501-1.

Fig. 3. Basalt mineral wool edging of the perimeter of the fire compartment and next to the floor on the 1st floor

Over the polystyrene, a layer of reinforcement, consisting of an outer fiberglass mesh embedded in adhesive mortar for plastering, was applied using a metal trowel.

After the putty dried, a primer was applied on it and then a layer of decorative exterior plaster of type 2R.

The combustion chamber was lined with 10 cm-thick ceramic mineral wool, which was attached to the support layer with high temperature resistant refractory anchors.

On the floor of the combustion chamber, a 20 mm-thick plate of magnesium oxide was placed.

Over this, an industrial scale with electronic display was placed, to measure in real time the variation of the thermal load mass of a softwood stack. The provided data were recorded by a computer (Fig. 4).

Fig. 4. Method to apply the adhesive mortar on polystyrene tiles

The scale was protected against the action of fire with a 10 cm-thick layer of ceramic wool (Fig. 2).

The wooden stack consisted of softwood cushions with a section of 5 × 5 cm and lengths of 1 m and 1.5 m respectively, which were conditioned before the test to reach a humidity between 13 and 15% (Fig. 5).

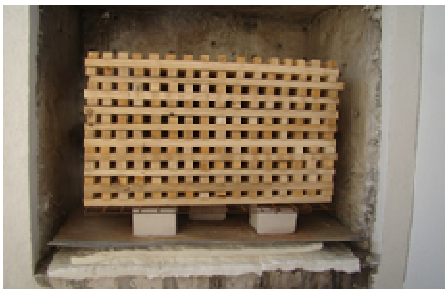

Fig. 5. Wooden stack made of wooden cushions

For a good assessment of the height of the flames, on the edge of the heating system (above the combustion chamber) there were marked with a marker, lines at every 10 cm on a height of 1 m (Fig. 6).

The climatic conditions for testing the fire resistance of the ETICS system were: air temperature: 20°C; wind speed: 0.08 m/s, relative humidity: 60%, initial weight of the wood stack: 334.2 kg.

After starting the burning of the wooden stack and during the experimental test (fig. 7), the researchers made recordings of temperature variation in the combustion chamber (fire compartment) and on the facade of the ETICS system, 2.5 m and 5 m above the compartment fire, by means of 24 K-type thermocouples (Fig. 7).

Fig. 6. ETICS system ready for fire testing

Fig. 7. Large scale fire testing of ETICS system

The most suggestive recordings of temperatures on the facade of the ETICS system are represented below (Figures 8, 9, 10).

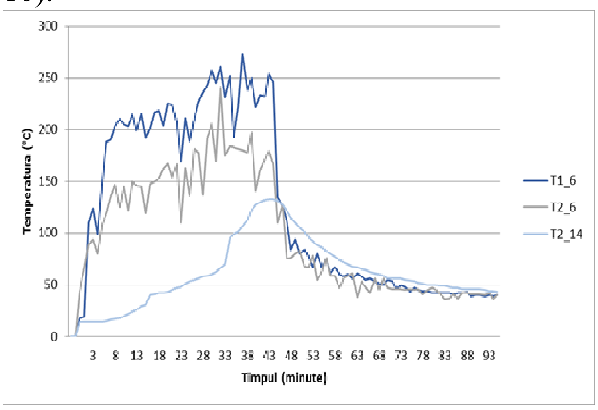

Fig. 8. Variation of maximum temperatures on the facade of the ETICS system at floor level 1

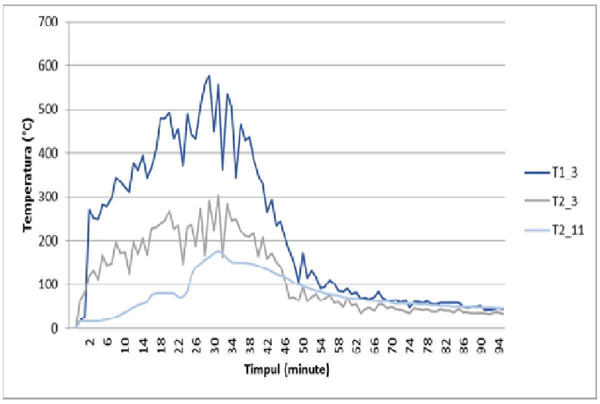

Fig. 9. Variation of maximum temperatures on the facade of the ETICS system at floor level 2

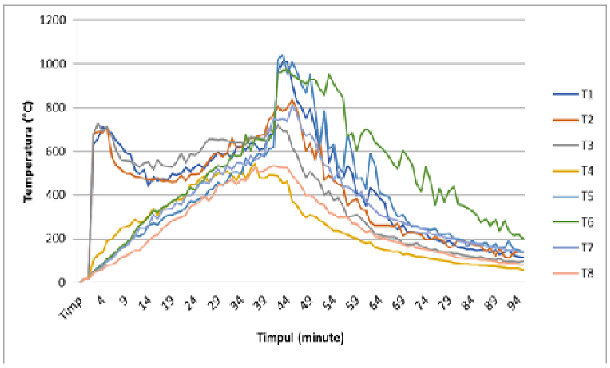

Fig. 9. Temperature variation in the fire compartment

3. RESULTS AND DISCUSSIONS

During the experiment for testing the fire resistance of an ETICS system, the researchers measured a series of qualitative parameters in order to evaluate the response of the construction materials from which the thermal insulation was made to the spread of fire over the height.

These parameters were: the ignition of the system, the variation of temperatures in the fire compartment and on the height of the facade, the variation of the thermal load mass, the height of the flames, the detachment of the elements from the system, the losses of local stability and the amount of smoke.

From the records presented above, the evolution of the maximum temperatures on the ETICS type facade during the experiment was determined.

The temperatures recorded in the specific conditions of the test highlight and provide data on how the fire spreads in the combustion chamber, starting with the time of initiation and ending with its regression.

It was found that the maximum height of the flames was reached in about 30 minutes, the flames spreading above the combustion chamber at about 2.5 m height.

No components of the ETICS system came off during the test and no burning particles fell.

The amount of smoke released into the atmosphere was relatively constant, slightly accentuating around the flash-over moment.

During the experiment, a uniform evolution of temperatures on the height of the tested ETICS system was generally observed.

It is also found that the spread of fire over the height has influenced the predominant increase in temperatures on the outer surface of the ETICS system and, to a lesser extent, on the inside of the thermal system.

Following the action of the fire on the thermal system, the ETICS system preserved its integrity and underwent a flaming phenomenon of a few centimeters, in the central area of direct action of flames above the combustion chamber.

The tested ETICS system did not favor the fire propagation vertically or laterally.

The maximum temperatures recorded were as follows: in the combustion chamber - above 1000ºC, on the facade above the combustion chamber - approximately 600ºC and inside the thermal system on the 2nd floor - about 180° C (a value that is lower than the ignition temperature of polystyrene of 345° C).

The variation of the thermal load mass during the burning of the wood stack was in accordance with the variations of the temperatures in the combustion chamber and on the surface exposed to fire of the ETICS system.

From the obtained data, it results that the implementation of the ETICS system according to the design norms in the NP 135-2013 norm [11] and of the constructive measures regarding the interruption of the thermal insulation of the ETICS system with incombustible barrier solutions, according to the provisions of SC007-2013, ensures a high degree of fire safety.

4. CONCLUSIONS

In the recent period, in Romania, in order to reduce energy consumption and for environmental protection, the External Thermal Insulation Composite Systems of buildings with wet facade systems (ETICS) is widely used [5].

With the implementation of the concept of exterior insulation of buildings with this type of thermal insulation, a number of issues started to appear, related to the fire behavior of the materials of which ETICS systems are composed [12].

In Romania, the norm P118 / 1999 [14] imposes clear regulations on the use of combustible exterior cladding systems, but tests on a natural scale, through which to determine the fire resistance of different types of ETICS systems used for thermal insulation buildings in Romania, are not accepted, as is the case in the vast majority of European Union countries (8).

In order to meet this desideratum, the researchers from the INCERC Bucharest branch created for the first time in the country, a unique test stand for fire resistance of ETICS systems, open to both the academic and the industry environment, through which the answer can be determined.

Based on experimental research, the researchers obtained unique data at national level on the development of fire on the facades of thermally insulated buildings with ETICS systems, with results that can be transposed to the normative level and with applicability from the design phases of constructions.

Thus, the researchers from INCERC Bucharest contributed to the development of the database to support the establishment of criteria and performance levels for the ETICS systems used in construction, so that they provide a high degree of security to fire [7].

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