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IDENTIFICATION OF THE MODEL OF DESTRUCTION OF THE VENTILATED FAÇADE WITH CLADDING OF FIBER-CEMENT BOARDS UNDER THE INFLUENCE OF FIRE

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Abstract:

Ventilated façades are an increasingly popular technical solution for façades and are synonymous with sustainable development of construction due to i.a. their thermodynamic properties. A ventilated façade means a complete system consisting of an external façade cladding, mechanically or adhesively attached to the substructure, also called the grating. The grating is in turn mechanically attached to the external wall of the building. The assembly of the substructure to the wall is usually done through consoles – adjustable elements that maintain the appropriate plane of the external cladding on an imperfectly made external wall – structural or curtain ones.

Comprehensive literature studies were carried out in the field of: formal requirements set in Poland and Europe for individual elements and complete systems of ventilated façades, issues and effects occurring in the field of fire development on ventilated façades, including: fire spreading between storeys, chimney effect and detachment of ventilated façade elements during a fire, information and composition of fiber-cement boards, destruction of fiber-cement boards under the influence of high temperatures. Literature studies revealed the need to perform research in order to identify the model of destruction of the ventilated façade with cladding of fiber-cement boards under the influence of fire.

Large-scale tests were used to assess the phenomena occurring during a façade fire and solve the scientific problem, including tests on a real model of the façade in a full-scale test carried out in an accredited laboratory, and tests on the façade of a model building. In the case of real models, the temperature course was used in accordance with the standard curve, and the source of fire was a gas burner. Large-scale tests allow for a very good mapping of a critical situation, which is a fire affecting the façade of the building.

The tests of large-scale models were carried out on a sample of 10 models marked as series from A to J. Subsequently, local tests of the micro- and macrostructure of fiber and cement boards were carried out, taking samples from three models (test series D, J, F). The individual series of tests were a cross-section of materials available on the market for the use of façade cladding, with the largest number of models with cladding made of fiber-cement boards. For all series of tests, a visual assessment and evaluation of the course of a large-scale test were carried out, specifying the elements detaching from the façade and their dimensions. Using the results obtained from thermocouples for individual series of tests, global temperature maps were created for the previously tested models.

Then, a "local" assessment of the degree of destruction of fiber-cement boards taken from the real model and the model building in the characteristic zones was performed. An analysis and assessment of fiber-cement boards exposed to fire were carried out by use of: *MOR* bending strength test according to PN-EN 12467, surface analysis under a digital microscope, structure analysis under a scanning microscope, visual analysis of samples. On the basis of research using a digital microscope and a scanning electron microscope, the views and structure of samples taken after being exposed to high temperatures were analyzed and compared with reference samples. As a result, appropriate destruction levels were assigned to individual samples: insignificant destruction, significant destruction, and critical destruction.

On the basis of the classified destruction levels, proprietary global maps of destruction zones were developed, showing the extent of the critical zone, which means significant and critical destruction.

Based on the research, an original model of sample destruction was developed. The destruction model for the dispersed phase is dependent on exceeding the critical temperature, the initial destruction is indicated by the "discoloration" of the fibers. Real models have shown that it is impossible to determine the boundary indicating a place with significant destruction. In the case of a matrix phase, the function of time and temperature is critical – the cement matrix withstands short exposures even at very high temperatures.

Conclusions from research were presented in the field of: identification of the model of destruction of the ventilated façade with cladding of fiber-cement boards under the influence of fire, identification of the global problem of detachment of façade cladding elements during fire and other conditions. Then, the proposed line of research and practical application of the results obtained in this doctoral dissertation have been described.

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