FDS SIMULATION OF FIRE SPREAD EPS INSULATED FACADE AND COMPARISON OF MODEL RESULTS WITH EXPERIMENTAL DATA

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Widespread use of thermal insulation and finishing systems of exterior walls of houses not only improves the thermal modernization of the building and promotes improvement of the architectural appearance of buildings and structures, but also increases the fire hazard of such objects. The combustion of the facade systems structures with thermal insulation occurs due to non-compliance with the rules of fire safety during their installation, as well as during the usage of the finishing facade system. Examples of fires with the fire spread on the surface of the insulation and finishing facade systems were considered in [1]. Thus, the problems of providing fire safety of facade systems of the external walls of buildings, as well as analysis of organizational and technical measures aimed at increasing the fire safety of these systems, are becoming acute.

Combustion of polymers is a complex physical and chemical phenomenon, it involves processes of heat and mass transfer, chemical kinetics of reactions both in the condensed and gas phases, as well as other factors [2]. In the construction industry, about 80% of the thermal insulation material is foam polystyrene, which has significant disadvantages in terms of fire hazard: it is a combustible material, during the fire it releases toxic products, and also significantly affects the fire resistance of building structures with facade insulation. The peculiarity of the fire hazard of the facade systems of buildings is the possibility of fire spread on the higher floors of the building. The threat of fire spread through the thermal insulation and finishing system is due not only to the fire hazard of the material used in it, but also depends on the structural features of a particular building and the parameters of the fire itself [3]. During a fire, the destruction of the layer of decoration and ignition of a large area of combustible insulation causes the formation of high temperatures and significant haze.

There are three typical scenarios (Fig. 1) of fire spread on the surface of the thermal insulating and finishing systems [4]: 1 – as a result of thermal radiation on the adjacent building; 2 – transfer of fire from the source of fire, which is located near the front of the direct influence of the flame (fire on garbage on the balcony, fire on parked cars in the immediate vicinity of the house, etc.); 3 – transfer of fire from the window slope of the building on the upper floors as a result of intense fire on the premises.

The most common causes of ignition of thermal insulation and finishing systems of exterior walls is the transfer of fire from the window slope of the building as a result of intense fire in the room. In such conditions, the convective heat flows are capable of taking the flammable lining of the outer walls.

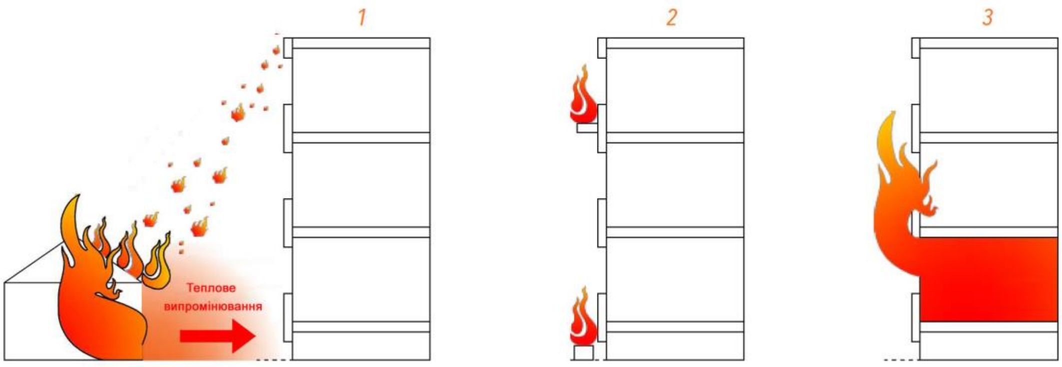

Fig.1. Typical scenarios of fire spread by the surface of the heat-insulating and finishing system [4]

A number of factors influence the process of fire spread on facade systems. Among them are the following: external conditions (heat fluxes from the window opening, temperature modes of combustion of heat-insulating material); fire and technical characteristics of the thermal insulation material (ignition temperature, rate of fire spread on the material, temperature of self-ignition, etc.); architectural and planning characteristics of the building.

Investigation of fire safety problems of facade systems, in particular ventilated hinges, was carried out by many Ukrainian and foreign researchers. Not only full-scale testing of thermal insulation systems for fire spread according to current standards, but also use of special software Fire Dynamics Simulator (FDS) [5] for computer simulation of fire spread and comparison of experimental and numerical data is quite popular [6-8]. The FDS software package is designed to simulate fire and fire processes. The algorithms included in it are based on the physical laws of hydrodynamics and heat transfer.

The study was carried on fastened facade insulation with a plaster coating and a heater of foam polystyrene slabs. Tests were conducted in accordance with [9]. The test method consists in determining the extent of damage to the heat-insulating and finishing system and the value of raised the temperature inside the facade system, which was applied to a fragment of a two-story building (Fig. 2 a) with a total height of 5.6 m, on the first floor which was created for 30 minutes, the temperature regime, to the standard temperature mode (Fig. 2 b).

Based on full-scale fire test on fire spread, the authors carried out a numerical simulation of the dynamics of the development and spread of fire on the surface of the thermal insulation system in FDS software using PyroSim graphical interface.

FDS numerically solves the Navier-Stokes equation. This tool allows accurate determination of the rate of heat generation and the speed of heat and mass transfer during a fire (Fig. 2. c, d). The intensity of the heat flux and temperature is calculated by the finite element method on a three-dimensional grid, with an accuracy of 10-20%, depending on the size of the grid.

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Fig. 2. Fragment of the building before the test (a), during the tests (b) of thermal insulation system and its FDS model (c, d)

The results of FDS-simulation were used to quantify the values of temperature in the fire chamber, inside and close to the surface of the facade insulation to compare them with experimental data.

The main objective of this study was to obtain numerical indicators which characterize the process of occurrence, spread and development of the fire of the thermal insulation and finishing system of the external wall of the building. The obtained results of computer modeling allowed proper simulation of the real conditions of the test. On comparing the experimental data with numerical calculations, satisfactory results of temperature and heat flow were obtained.

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