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Investigation Of Methods To Increase The Fire Resistance Of Reinforced Concrete Structures By Treatment With Thin-Layer Fire-Resistant Inflatable Coatings

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ABSTRACT

It is known from the statistics of world fires that the number of fires occurring in the world every year reaches millions. People die in fires and more people get various injuries. In addition, fires cause significant damage to the economies and ecology of states. Despite research on scientific and technical solutions to problems in the field of fire safety, the number of major fires in the world in the XXI century is still growing. For example, fires have caused the collapse of buildings and industrial facilities, resulting in many deaths. Therefore, in the construction of modern buildings and industrial facilities, great attention is paid to their effective fire safety.

KEYWORDS

Heating, Fire Resistance, Thin-Layer, Temperature.

INTRODUCTION

This issue is also one of the topical issues of fire safety of reinforced concrete slabs and columns.

There are a number of methods and tools available to increase the flammability limit of concrete structures and prevent explosive concrete damage. In construction practice, several weak methods of fire protection are used, namely, concreting, application of plaster coatings, screen and surface coatings, thin-layer swelling coatings. Each of the fire protection means of the given reinforced concrete structures has its pros and cons.

In the process of heating properties of reinforced concrete structures with thin-layer fire-resistant swelling coatings and non-

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reinforced concrete structures in case of fire, the slabs were heated on one side and the columns on four sides.

For this experiment, fragments of several monolithic slabs were prepared according to working drawings used in the construction of high-rise buildings (with a height of more than 75 m). Fragments of slabs measuring 1100 x 1100 x 200 mm were prepared together with various protective layers in the range from concrete to reinforcement. The grade of B 600 grade concrete used was assumed to have a density level of 2300 kg / m3.

The test samples were based on factory technology. The carcass of the plates was assembled on the basis of the application of the armature, and the periodic profile of this armature consisted of a cross-sectional armature with a cross-section of 10 mm, longitudinal armature and cable cross-section with DTP mark. The cores were interconnected at the intersection and the core was connected to each other by a winding wire. On the outer surface of the armature are mounted thermocouples brand HK, which allow to observe the kinetics of temperature.

In the study, reinforced concrete columns with a cross section of 500x500 mm and a height of 2500 mm were used and the protective layer up to the reinforcement of the concrete was 50 mm, mainly the refractory level of reinforced concrete columns should be at least R180.

The carcass of the columns was assembled using reinforcement with ATTT periodic profile, the cross-section of which was 16 mm-reinforcement and wire wrapping, the cross-sectional reinforcement was 8 mm. The rods were reinforced with wire wrapped around each other along the core and with cross-reinforcement. The carcass of the slabs was assembled based on the application of reinforcement. On the outer surface of the armature were mounted thermocouples brand HK, which were designed to monitor changes in temperature.

The applied fire-fighting brand "Djoker M" appears in the form of a dry compound. Prior to application, the dry part is mixed with water and then a fire-resistant coating is applied to the concrete surface until the required thickness is achieved. The results of fire testing of reinforced concrete slabs without a fire-resistant coating are studied. Several samples of reinforced concrete slabs without a fire-resistant coating were used in the tests. The heating of the plate, which had a horizontal position, was only one-sided. An explosive degradation process of the concrete was recorded 10–12 min after the start of the test. The protective layer of concrete in direct contact with the combustion products in the test furnace was damaged. The definition of deformation of the protective layer from concrete to reinforcement was as follows. In all samples, a large piece of separated concrete with a length of 500 mm, a width of 300 mm and a thickness of up to 15 mm was identified. After that, a series of small crackling noises were heard, and as a result, small pieces of concrete measuring 30x20x5 mm began to separate from the concrete.

During the first 30-35 minutes of heating, traces of moisture and water separation appeared on the short sides of the concrete,

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and they later left conical marks with a well-visible white color. The condition of the coating on a reinforced concrete slab with a thickness of 20 mm of fire-resistant protective concrete coating after reaching a temperature of 500 ° C in the load-bearing reinforcement for 60 minutes.

When analyzing the heating rate of the armature, it should be noted that the temperature is 50 ° C from to 200 ° C was recorded from 10 min to 20 min, i.e., during the strongest explosive destruction of concrete. From the 25th minute of the fire test, a uniform increase in temperature was observed on the surface of the load-bearing armature.

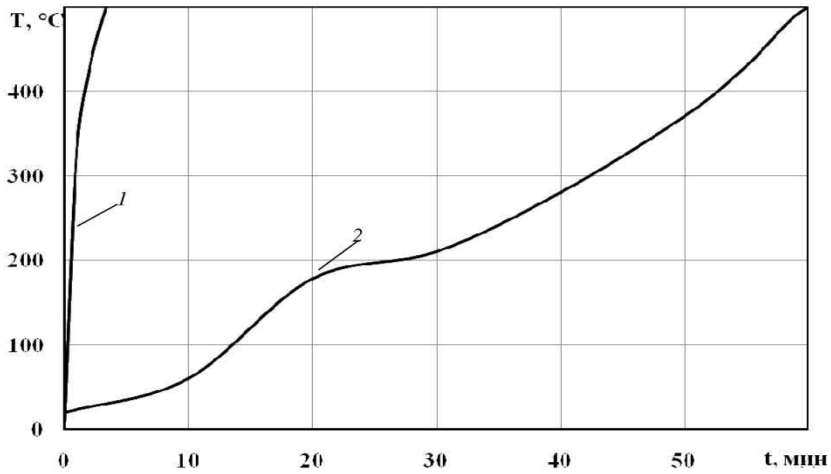

Fig.1. Temperature kinetics of reinforced concrete slab reinforcement without fire-resistant coating (thickness of the protective layer of concrete to the reinforcement is 20 mm):

1. Standard fire effect;
2. The effect of temperature on the load-bearing armature of plate.

The heating result of the load-bearing reinforcement for the reinforced concrete slab covered with a protective layer from the concrete to the reinforcement is shown in Figure 2.

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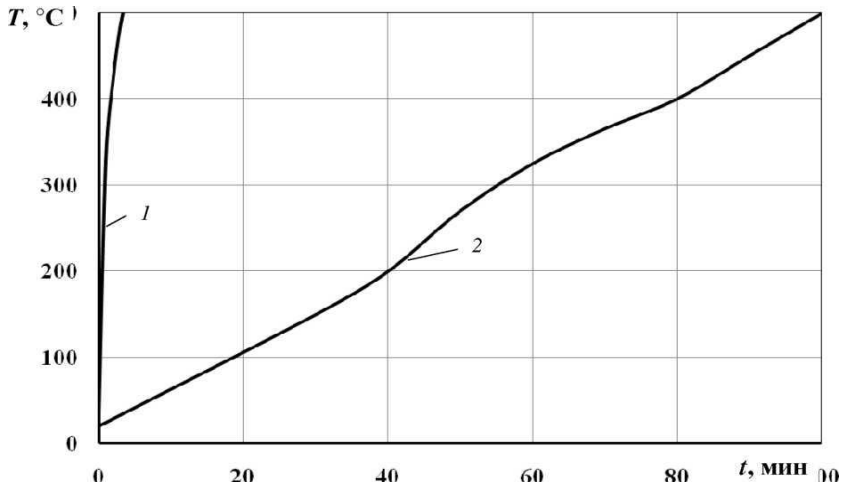

Figure 2. Temperature kinetics of reinforced concrete slab reinforcement without fire-resistant coating (protective layer of concrete to reinforcement 40 mm):

1. Standard fire effect;
2. The effect of temperature on the load-bearing armature of plate.

When analyzing the graph of the heating rate of the reinforcement in the reinforced concrete slab with a protective layer of concrete 40 mm shown in Figure 2, it should be noted that the temperature increase during fire tests occurred without abrupt changes. The process of explosive deterioration of concrete is recorded as the parameters in the 20 mm protective layer of concrete for the slab.

The degree of fire resistance of the plate reached the critical temperature of the armature at 500 ° C in 98 min. It should be noted that the fire resistance limit of this slab should not be less than 120 minutes without the occurrence of explosive degradation of concrete. We explain the difference in the starting times of the boundary condition as a result of a decrease in the thickness of the protective layer of concrete, which led to an increase in the heating rate of the load-bearing reinforcement of the test specimen.

To determine the effectiveness of the refractory coating of a new graphite and dolomite-based compound, a number of other experiments use reinforced concrete slabs for fire testing.

Testing of fire-resistant coating coated and uncoated reinforced concrete structures under the influence of fire temperature is carried out on the basis of a single technology, and reinforced concrete slabs are produced in one batch.

The columns in the fire chamber of the test furnace were arranged vertically, and the heating was carried out on four sides. During the fire test, the process of explosive deterioration in the concrete structure was observed after 16 minutes in the first sample and after 17 minutes in the second sample. The start time of the explosive decay process is consistent with the following work. The rupture of small pieces of concrete up to 80x100x10 mm occurs along with the sound

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of a bullet being fired. Flying of broken concrete pieces in the space of the furnace will damage the inner surface of the furnace. Shown in Figure 3.

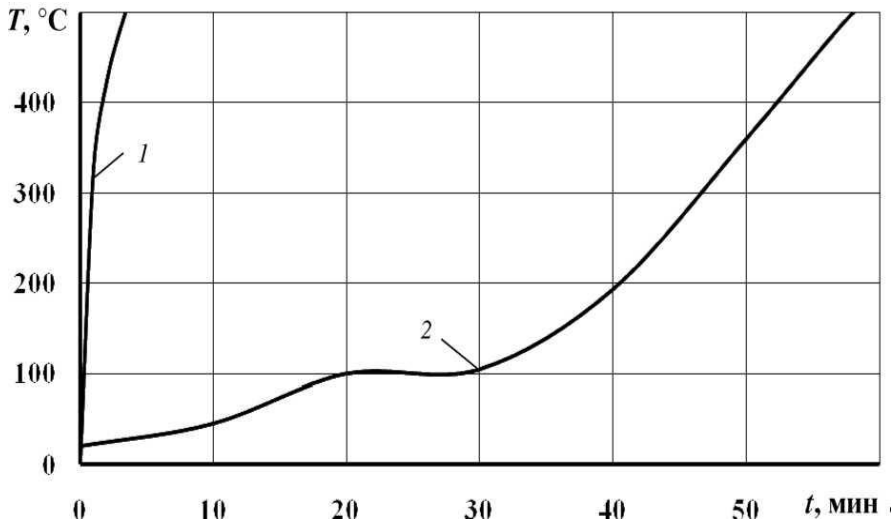

Figure 3. Temperature kinetics of a column armature without a fire-resistant coating:

1 - Temperature in the column armature;

2 - Fire temperature.

The explosive demolition process of the concrete protective layer occurred at the section of the element being tested. The decrease in the thickness of the concrete protective layer led to the rapid heating of the load-bearing reinforcement. Heating of the column load-bearing armature to a critical temperature of 500 ° C took place within 60 min. The process of explosive destruction of concrete was observed in about 42 min. At the 30-60th minute of the fire test of the concrete, a high temperature was recorded, as a result of which the thickness of the protective layer of concrete was reduced to 2 times and in some places fell to 20-30 mm. When testing the fire resistance level of concrete in fire tests, we saw that concrete with a protective layer of 50 mm could withstand 60 minutes, but

according to the data, the specific fire resistance of concrete with such properties is not less than 180 minutes without the impact of explosive decomposition process.

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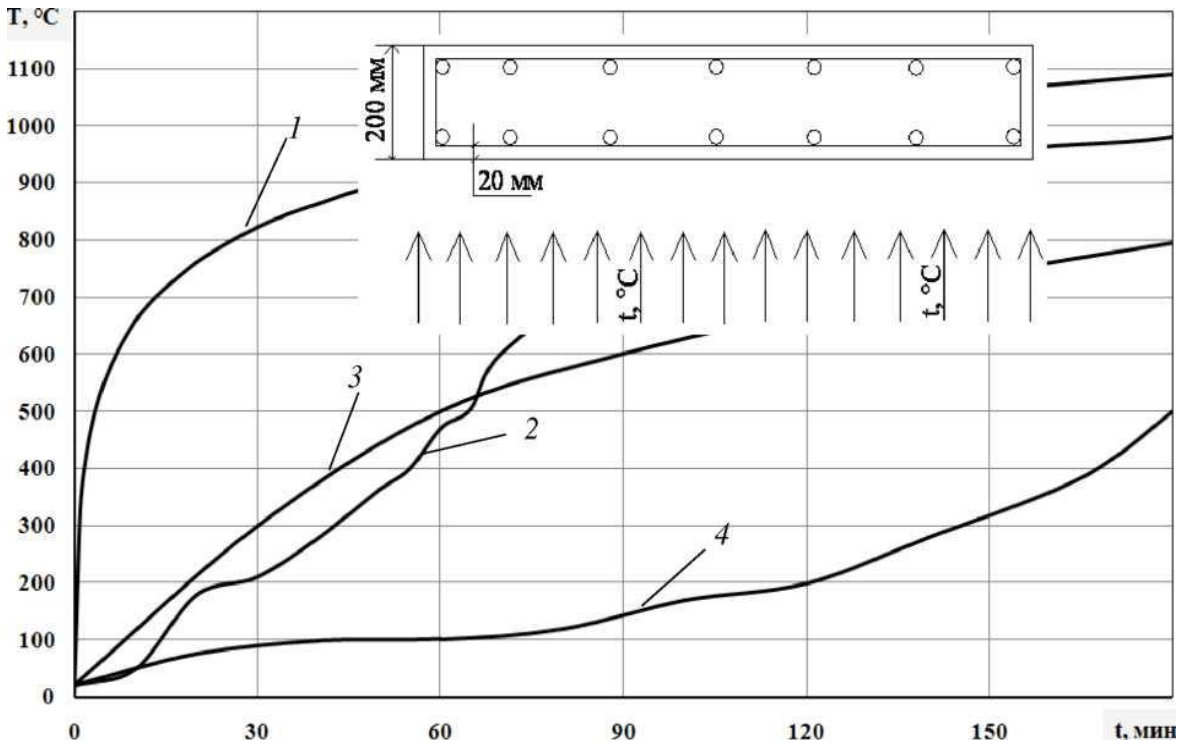

Figure 4. Temperature kinetics of reinforced concrete slab reinforcement with a protective layer of 20 mm:

1. Standard fire dependence;
2. Reinforced concrete slab damaged by explosion;
3. Non-explosive reinforced concrete slab without protective coating;

Reinforced concrete slab covered with a new composition of fire protection with a thickness of 4 - 2 mm.

The temperature at which the mechanical properties of the armature are lost, i.e. the critical temperature, is 520 ° C. According to the results of the experiment, taking into account that the critical moisture content of heavy concrete is 3.5%, it was achieved that the process of explosive decomposition does not occur at a moisture content of 3.1% of concrete. Of course, the experiments conducted allowed to increase the thermal effect of reinforced concrete structures to 12-17%. It allowed to increase the resistance to dynamic impacts by 3-5%. Ways to conduct and conduct these experiments sequentially continue.

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