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Difficult Heat-Insulating Compositions for Increasing the Heat Resistance of Reinforced Concrete Structures

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ABSTRACT: The article describes the production of slow-burning insulating compounds based on local raw materials to increase the fire resistance of reinforced concrete building structures. Tests of building structures for seismic and fire hazard factors have shown that when reinforced compositions with needle-like Wallastite and heat-resistant perlitoconcrete most are able to increase the resistance to the joint vector of seismic-thermal effects.

KEYWORDS: Wallastite, ceramic fibers, foam plastic, glass wool, binder (sodium liquid glass), damper.

I.INTRODUCTION

The urgency of increasing fire safety of seismic protective devices lies in the fact that in the pursuit of seismic resistance, developers forget about the degree of importance of ensuring the safety of the seismic protective devices themselves. On the damper devices more often on the technology are bearing columns of buildings and structures. As a result, the destruction of the damper devices destroys the entire building.

One of the basic requirements of modern times for all the economies of the world is the transition to energy-saving and fireproof materials. Today's building materials market offers a wide range of flame-retardant materials with effective heat and flame-retardant properties.

Most of the previously used and currently used building materials have a high thermal conductivity, in most cases exceeding the coefficient of 0.1, which does not meet modern international standards. So, single-layer concrete structures, widely used in previous years for the construction of buildings, do not meet modern energy requirements. And currently widely used for finishing the internal surfaces of walls (partitions) and suspended ceilings in civilian (residential, public, administrative, etc.) building panels are highly fire hazardous. Also relevant is the issue of preventing the spread of burning on the outer surface of buildings lined with aluminum composite panels (ACP).

II. RELATED WORK

To achieve the required level of energy saving and fire safety in buildings and structures, it is necessary to use materials that have specified thermal and fire safety characteristics, as well as other equally important characteristics, such as: lower thermal conductivity, water and moisture absorption, low values of fire danger, increased durability and relatively low cost price.

It is a consequence of the requirements of modern urban planning: improving energy efficiency and fire safety of various types of buildings and structures, reducing the total weight of structures, modern design, began to appear on the building materials market. The so-called modern materials of structural and non-structural nature, such as sandwich panels, highly efficient thermal insulation materials which in modern construction displaced bulky and heavy materials.

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III.OBJECT AND METHODS OF RESEARCH

The analysis showed that under conditions of a sharply continental climate in the Republic (high temperatures in summer, requiring air conditioning, and low temperatures in winter, requiring heating), almost half of all energy consumption falls on heating and hot water supply of buildings. Therefore, improving the energy efficiency of buildings can also have significant social effects. The introduction of energy-efficient buildings will contribute to the creation of productive employment both within the construction, thermal insulation and energy-efficient equipment sectors, and in related industries. Saving and reducing the cost of the population for utilities for heating and electricity supply by 25-30% can contribute to the direction of savings further improve the energy efficiency of homes, to meet other needs of the population, the development of entrepreneurial activities.

There are also environmental benefits: higher energy efficiency will reduce emissions into the atmosphere by 25-30% and, accordingly, reduce the impact of energy consumption on climate change. In addition, energy efficiency in the residential sector is a measure to adapt to climate change by improving the protection of homes from adverse weather conditions.

The use of modern insulation materials in construction can increase the degree of industrialization of work, since they provide the ability to manufacture large-sized prefabricated structures and parts, reduce the range of structures, reduce the need for building materials, and significantly reduce heating costs. Therefore, the economic efficiency of thermal insulation is obvious and the cost of it pays off by saving heat for 1 - 1.5 years of operation.

IV. METHODOLOGY

Temperature resistance (limiting temperature of application) - the ability of the material to maintain physical properties (structure, strength, density, shape) without significant structural changes during temperature effects. When determining the temperature resistance with the help of devices, the change in material properties — temperature linear shrinkage or expansion (temperature coefficient of linear expansion of thermal expansion coefficient), mechanical strength and density, etc. — is established. Temperature resistance determines the highest allowable temperature for the materials used. For various materials, temperature resistance, ° C, is as follows:

Wollastonite ………………………………. ……. 1100;
Heat-resistant perlitobeton …………… .. ……. 500-1000;
Stone wool …………………………………… 900-1000;
Ceramic fibers ………………………… ..1100-1300;
Foam plastics …………………………………. ... 70-150;
Glass wool …………………………………. 180-450;
Binder (sodium liquid glass) .... 700-900.

Research conducted in the direction of developing a new generation of flame-retardant and non-combustible compounds with effective heat and flame retardant properties based on highly dispersed, nano-sized, powdery dispersed means based on local mineral raw materials such as vermiculite, wollastonite and various silicates.

Vermiculite, wollastonite and silicates of different dispersion can used as a source of local raw materials.

Vermiculite is a natural layered material from the group of hydromica belonging to aluminum-magnesium silicates.

When heated to 900–1000 ºC, natural vermiculite increases in volume by 15–20 times. When cooled, vermiculite fluffed up in this way retains its volume with the thinnest pads of air between the mica plates, which gives the mineral many of its valuable properties.

Studies have shown that mineral raw materials (vermiculite, wollastonite) successfully used as a material for a non-combustible insulation, as it has high thermal insulation and heat-resistant properties, non-toxic, non-rotting, prevents the spread of mold, does not smell. For example, baked vermiculite. Effective insulation for filling partitions, floors and ceilings in residential and industrial premises, cottages and country houses. With its fluidity, when filling it fills even the smallest voids. A vermiculite layer of 20 cm in thermal protection is equivalent to a brick wall 1.5 m thick or a concrete wall 2 m thick. A layer of vermiculite on attic ceilings 5 cm thick reduces heat loss by 75%, 7.5 cm thick by 85%, and 10 cm thick by 92%.

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V. EXPERIMENTAL RESULTS

Compared with conventional (sandy) mortars, vermiculite-wollastonite solutions have a mass density of 1–2 times and 4–6 times less thermal conductivity and belong to the group of light solutions.

A layer of cement-vermiculite-wollastonite plasters thickness

2.5 cm can replace a layer of cement-sand mortar in 10−15 cm. When the thickness of the cement-vermiculite-wollastonite plaster layer

3 cm thickness of a brick wall can reduced by 25%, reinforced concrete structures by 15-20%.

Vermiculite-wollastonite compounds used as thermal insulation in industrial power engineering during high-temperature technological processes belong to the class of heat-resistant heat insulators. In fig. 1-6 presents, the results of tests of reinforced concrete structures reinforced (treated) with various compositions [3].

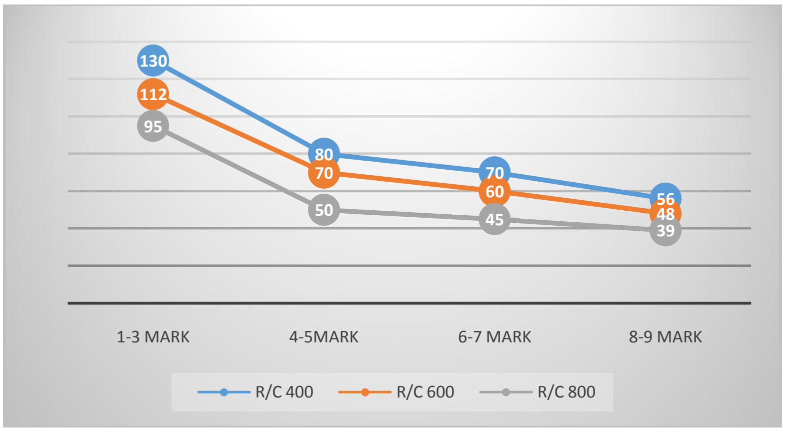

Fig. 1 Schedule of tests for seismic and fire resistance of reinforced concrete structures treated with wollastonite composition

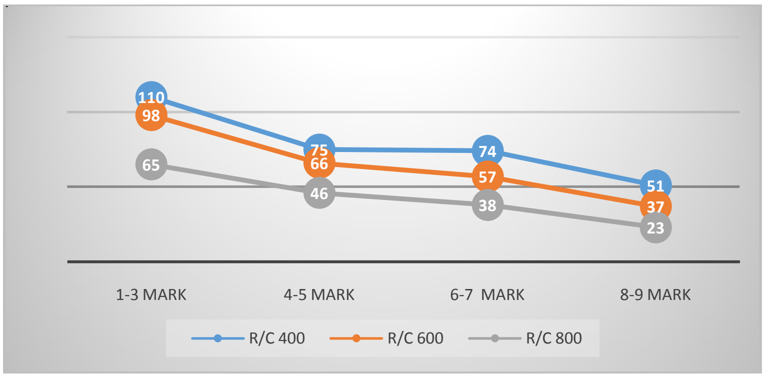

Fig. 2 Schedule tests on seismic and fire resistance of reinforced concrete structures reinforced with stone wool

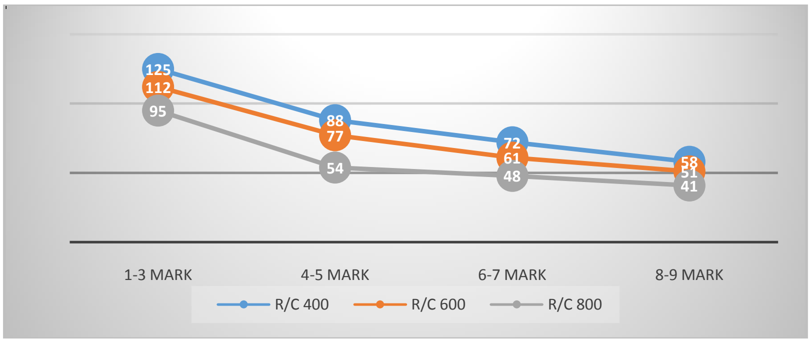

Fig. 3 Schedule tests on seismic and fire resistance of reinforced concrete structures treated with vermiculite composition

The maximum temperature of their use is 900 ° -1100 ° C, the thermal conductivity coefficient is 0.09 W / (m K), the porosity is 80–85%, the compressive strength is 1.1–1.2 MPa, the bulk density is up to 600 kg / m3, linear temperature shrinkage at a temperature of 900 ° C not more than 2%.

Dimensions of vermiculite-wollastonite plates: length 600 and 1200 mm, width 600 mm, thickness from 20 to 65 mm. (on graphs 1-6, the y-axis means - time of resistance to burning).

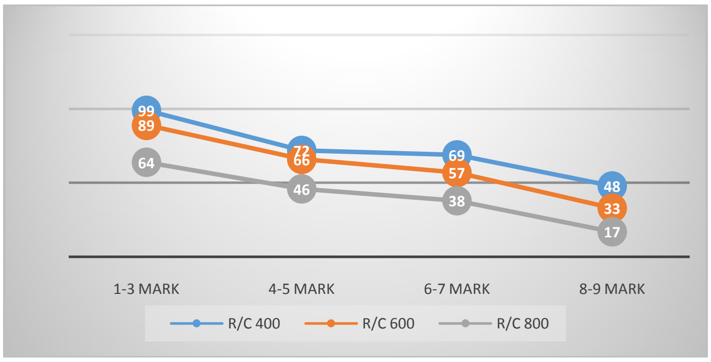

Fig. 4 Schedule tests on seismic and fire resistance of reinforced concrete structures reinforced with glass wool

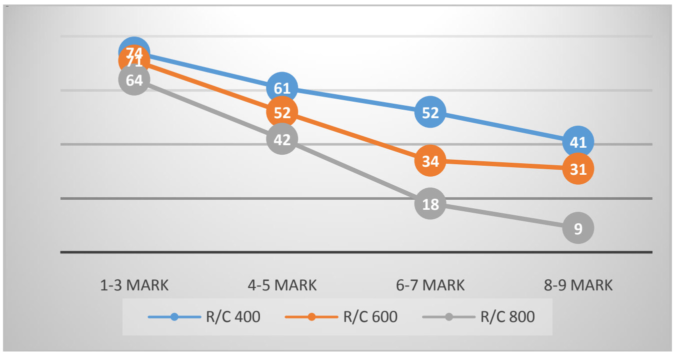

Fig. 5 Schedule tests on seismic and fire resistance of reinforced concrete structures treated with vermiculite-wollastonite composition

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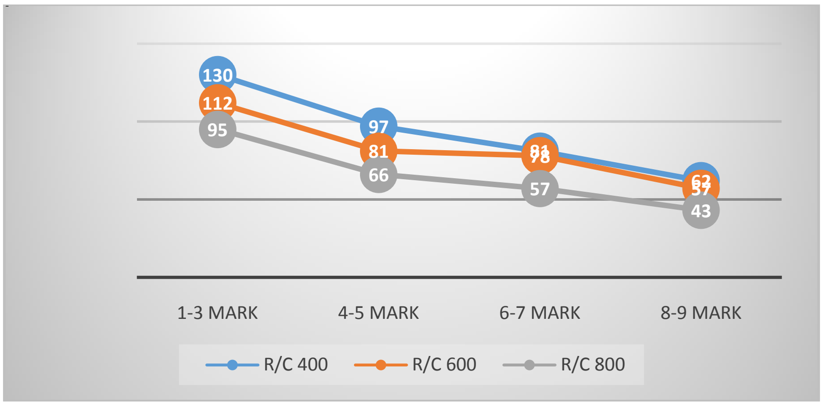

Fig. 6 Schedule tests on seismic and fire resistance of reinforced concrete structures treated with wollastonite composition

VI. CONCLUSION AND FUTURE WORK

Thus, it is most effective to pre-reinforce buildings and structures with special seismic protection devices, but with high resistance to fire. Tests of building structures for seismic and fire hazard factors have shown that when processing reinforced concrete structures with vermiculite-volostonite compositions, they are most capable of increasing resistance to the joint vector of seismic and thermal effects.

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