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Enhancing the Fire Resistance of Concrete Structures by Applying Fire - Retardant Temperature-Resistant Metal Coatings

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Abstract. The issues relating to an increase in the fire-resistance of concrete structures by applying (heat dissipating) fire-retardant and fire resistant metal coatings onto them was considered. The experimental investigation data obtained for the heating rate of the brick coated with the aluminum layer as heat dissipating coating were given. The investigation was carried out through the comparison of a time-dependent change in the temperature of the material coated with the aluminum layer with the temperature of uncoated material. The obtained research results proved a decrease in the heating rate of the coated brick exposed to the thermal irradiation.

Introduction

Nowadays, concrete structures find a broad application for construction purposes. The main advantages of the use of concretes for construction purposes are attributed to their properties, in particular the strength, compactness, durability, water resistance, frost resistance, low shrinkage and mobility (expansion), heat conduction and fire resistance [1, 2]. During use of the building the fires can break out [3] that result in the collapse of building structures due to the action of a high temperature onto concrete structures [4, 5, 6] and it results in their reduced strength [7, 8, 9]. Therefore, the measures taken to enhance the fire resistance of concrete structures are rather topical.

The research data given in [10, 11] manifest the following conditions for the loss of strength in concrete structures. It was established that:

– in the case of fire outbreak, the compression strength of the concrete remains actually unchanged at a temperature of up to 200 °C. When the concrete humidity exceeds 3.5% a slight failure of the concrete exposed to the fire is possible at a temperature of 250°C;

– in the temperature range of 250 to 350°C the cracks are mainly formed due to the thermal shrinkage of the concrete;

– in the temperature range of up to 450°C the cracks are mainly formed due to the difference in the temperature strain of the cement stone and the fillers;

– in the temperature range above 450 °C the concrete structure is damaged due to the dehydration of Ca(OH)2, when a free lime is slaked in the cement stone due to the air humidity with the subsequent increase in volume;

– in the temperature range above 573 °C the damage of the concrete structure is observed due to the modified α-quarz - to - β-quarz conversion in granite and the filler is increased in volume;

– when the temperature exceeds 750 °C the concrete structure is totally ruined.

According to [12, 13], the standard temperature mode adopted for the fire –resistance tests of concrete structures is defined by the relationship: