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DETERMINATION OF THE FIRE-RETARDANT EFFICIENCY OF HEAT-INSULATING MIXTURES ON GEOCEMENT-BASED FOR THE PROTECTION OF METAL STRUCTURES FROM FIRE

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ВИЗНАЧЕННЯ ВОГНЕЗАХИСНОЇ ЕФЕКТИВНОСТІ ТЕПЛОІЗОЛЯЦІЙНИХ СУМІШЕЙ НА ГЕОЦЕМЕНТНІЙ ОСНОВІ ДЛЯ ЗАХИСТУ МЕТАЛЕВИХ КОНСТРУКЦІЙ ВІД ВОГНЮ

Abstract. The paper presents the results of determining the fire-retardant efficiency of heat-insulating mixtures based on geocement to protect metal structures from fire. After fire tests, it was found that with a coating thickness of 25 mm, the metal surface of an I-beam is heated to a critical temperature of 500 °C in 113 minutes of testing, which ensures the fire resistance class of metal structures P90-P120 and group III of fire retardant efficiency.

Introduction. Fire protection of building structures is always relevant. For this, both the fire-retardant materials themselves and design solutions based on them we created. The presented work is a continuation of the cycle of works in the field of fire protection of metal structures [1]. Recently, consumers are interested in environmentally friendly fire-retardant materials based on geocement (aluminosilicate) binders [2-4], modified with carbonate additives [5, 6], as well as organo-mineral binders of intumescent type [7-10]. To improve the thermal insulation properties of such materials, it is advisable to introduce fillers in the form of perlite and vermiculite sand, microspheres, etc. [11–13].

The purpose of the work is to determine the fire-retardant efficiency of heat-insulating mixtures based on geocement to protect metal structures from fire.

To achieve this goal, it is necessary to solve the following problems:

- to test the protected metal structure for fire resistance at standard temperature conditions;
- calculate the fire resistance limit of steel structures according to Eurocode 3.
- to compare the results obtained by the experimental and calculation methods.

Materials and Test methods. A two-component heat-insulating mixture we used as a fire-retardant material. The liquid component we represented by a geocement suspension with an average density of 1.427 g/cm^3, a dynamic viscosity of 1987 cP at 25 rpm, and a surface tension of 46.9 mN/m. A rationally selected mixture of aluminosilicate granules, expanded perlite and technological additives represents the dry component. The bulk density of the mixture is 0.560 g/cm^3, the thermal conductivity coefficient is within 0.0958 W/m·K. Before use, the liquid and dry components of the heat-insulating mixture they mixed in a container with a construction mixer for 3 minutes. Fire tests they carried out on I-beam hot-rolled steel No. 20 GOST 8239-89.

Results and Discussion. In **Fig.** shows a graph of the temperature distribution on the side flanges and the I-beam wall.

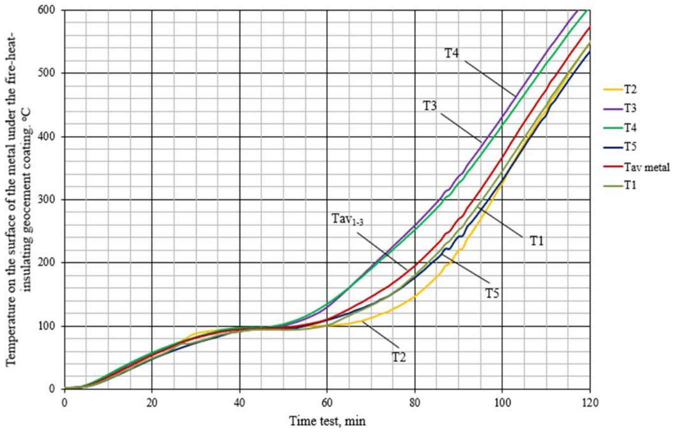

Fig. Evolution of temperature on the metal surfaces of the I-beam: T1-T3 – the main thermocouples adapted on the I-beam; Tav1-3 – average values of thermocouples T1-T3; T4-T5 – additional thermocouples. The appearance of the magnesite composite during testing we provided as inset.

After the completion of the firing tests, a comparison we made between the experimental and calculated data given in the **Table** and for the given parameters of the mixture. Experiment data: reaching the critical temperature of heating the I-beam up to 500 °C with a fireproof coating thickness of 25 mm they carried out for 113 minutes of fire tests; the fire resistance class of the steel column ranges from R90 to R120.

Table. Comparison of the minimum thicknesses of geocement perlite containing thermal insulation mixture (d_ρ, mm)[1]

Geocement perlite containing thermal insulation mixture, ρ=0.560 [g/cm^3], $\lambda_\rho(\lambda_c)$=0.1 [W/m·°C][2], Cp=1130 [J/kg·K]						
Profile section coefficient, A_m/V, [m^{-1}]	Calculation method	Fire resistance class				
		R60	R90	R120	R150	R180
345-140	Eurocode 3					
	Equation 3					
						
2 According to Equation 1, the thermal conductivity of a fire-retardant system is temperature dependent. The calculation took into account the data obtained during tests according to DSTU B V1.1.-17: 2007						

Estimated data for Eurocode 3 and Equation 3: reaching the critical temperature of heating the I-beam up to 538 °C with a fire-retardant coating thickness of 25 mm they carried out for 116 minutes; the fire resistance class of the steel column ranges from R90 to R120.

To ensure the fire resistance class R120, in the future, it is necessary to increase the thickness of the geocement-perlite thermal insulation mixture to 30 mm, which will increase the fire efficiency of the proposed fire-retardant material.

Summary. According to the results of fire tests, it they found that with a coating thickness of 25 mm, the metal surface of the I-beam heats up to a critical temperature of 500 °C for 113 minutes of the test. This indicator provides the fire resistance class of metal structures R90-R120 and the III group of fire-retardant efficiency of steel structures. Based on the calculated data according to Eurocode 3, it we established that the critical heating temperature of the I-beam up to 538 ° C with a fireproof coating thickness of 25 mm we achieved for 116 minutes. This ensures the fire resistance class of the steel column R90 - R120 and the III group of fire-retardant efficiency.

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