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Durability of Expanded Polystyrene Concrete on Recycled Polystyrene

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ABSTRACT: The article deals with obtaining polystyrene concrete from secondary polystyrene crushed in a rotary crusher from foam plastic packaging waste production. According to the strength characteristics of polystyrene concrete, they can be attributed to thermal insulation, used for insulation of load-bearing structures of buildings, as well as structural-thermal insulation, used as a load-bearing layer of the outer walls of low-rise buildings.

KEYWORDS: secondary polystyrene, polystyrene concrete, strength

I. INTRODUCTION

Concrete is an artificial stone material of a conglomerate structure, which is obtained as a result of the molding and hardening of a concrete mixture. In construction, concrete is one of the main materials. From a technical and economic point of view, the advantage of using concrete is the use of local materials, which means that the costs of manufacturing and production are reduced. Depending on the necessary conditions for using concrete, you can change its parameters such as durability and density. Concrete is durable and fire resistant [1-6].

Expanded polystyrene concrete is a fundamentally new class of heat-insulating and structural concretes that meet the increased requirements of energy and resource conservation in the field of construction [7-9]. Unlike the closest analogue - aerated concrete - expanded polystyrene concrete is heat-insulating and structural concrete with unique properties: increased on average 2.5 times tensile durability in bending and 10-15% compressive durability; reduced by 1.5 times in water absorption, by 10-30% thermal conductivity and 2.7 times in vapor permeability. In addition, the thermotechnical potential of expanded polystyrene concrete, manufactured using traditional technology, currently has significant reserves associated with the possibility of technological control of material properties based on the calculated model of dependences of durability, density and thermal conductivity of expanded polystyrene concrete on the composition and quality of its components [10-15].

Expanded polystyrene concrete as an effective heat-insulating material, can be used both structural and heat-insulating material. The use of increased durability expanded polystyrene concrete, as one of the most effective in construction in terms of economics and principles of energy conservation, is in demand today and is a promising direction in the future.

A characteristic feature of expanded polystyrene concrete in comparison with other lightweight concretes on porous aggregates is the huge difference between the density of the aggregate granules and the cement matrix.

II. SIGNIFICANCE OF THE SYSTEM

The article deals with obtaining polystyrene concrete from secondary polystyrene crushed in a rotary crusher from foam plastic packaging waste production. The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. METHODOLOGY

For carrying out physical and mechanical tests, there were prepared samples-cubes of expanded polystyrene concrete from recycled polystyrene with a size of 100 x 100 x 100 mm from solid blocks of expanded polystyrene concrete. The dimensions of solid expanded polystyrene concrete blocks are 600 x 300 x 200 mm. Samples of blocks

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were made on the technological equipment for the production of foam and aerated concrete by “Blizar” LLC. The tests were carried out in accordance with GOST 33929-2016 “Expanded polystyrene concrete. Technical conditions”.

IV. EXPERIMENTAL RESULTS

Unlike expanded polystyrene concrete in accordance with GOST 33929-2016, the proposed expanded polystyrene concrete uses foam waste crushed in a rotary crusher (Fig. 1). The use of crushed polystyrene is not only advisable from the point of view of reducing the cost of concrete, but also from the point of view of disposal of waste from other industries in construction.

As can be seen from the pictures shown in Fig. 1, the quality indicators of the use of expanded polystyrene granules, which are equal to 2.5-5.0 mm and depends on the initial polystyrene used, are quite suitable for their reuse in the composition of concrete.

Figure 1. Milled recycled polystyrene.

The composition of the cement composition includes Portland cement without additives CEM 0 in accordance with GOST 31108-2020, a porous filler - recycled crushed polystyrene and a hardening accelerator - sodium sulfate (Table 1). It should be noted that due to the use of polystyrene filler, in contrast to foam concrete and aerated concrete, there are no cracks in the samples (Fig. 2).

Figure 2. Appearance of samples

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Table 1.
Compositions of expanded polystyrene concrete on recycled polystyrene

№	Expanded polystyrene concrete composition				
	cement	sand	accelerated hardening Na_2SO_4	water	recycled polystyrene
H-1	295 kg	35 kg	3,5-4,5 kg	175 l.	1,5 m^3
H-2	305 kg	35 kg	3,5-4,5 kg	186 l.	1,5 m^3
H-3	315 kg	35 kg	3,5-4,5 kg	192 l.	1,5 m^3

The samples were tested for compressive durability after reaching the design durability (Fig. 3, a). The load increased gradually. The samples were destroyed without the formation of cracks characteristic of other types of concrete (Fig. 3, b). The moment when the arrow of the press device stopped was taken as the test result, since after this moment the samples were compressed without destruction.

a) Before testing **b) after testing**

Figure 3. Test of samples for durability characteristics

Durability indicators of expanded polystyrene concrete on recycled polystyrene are given in table 2.

Table 2.
Durability characteristics of expanded polystyrene concrete on recycled polystyrene

№	Sample weight, g	Density grade	Sample durability	Concrete grade
H-1	538 545 469	D500	350 kgf 450 kgf 350 kgf	B0,35
H-2	200 380 230	D250	254 kgf 261 kgf 253 kgf	M5
H-3	442 445 465	D450	440 kgf 540 kgf 840 kgf	B0,5

From the data obtained, it can be seen that, in terms of the durability characteristics of expanded polystyrene concrete on recycled polystyrene, it can be attributed to heat-insulating, used for warming the load-bearing structures of buildings (composition H-2), as well as to structural and thermal insulation, used as a load-bearing layer of the outer walls of low-rise buildings (compositions H-1 and H-2).

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V. CONCLUSION AND FUTURE WORK

Thus, the use of recycled polystyrene in the composition of the cement composition has a positive effect both on the creation of popular building materials that meet modern requirements for saving energy resources, and in the waste disposal from other industries in the construction industry.

The use of recycled polystyrene as a filler in the composition of concrete can replace lightweight expanded clay, which is currently considered a scarce and expensive raw material.

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