Processing of exterior light concrete wall panels

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Abstract: The characteristics of wall panels, the facing element of which is porous concrete, are given. For exterior wall panels, laboratory suggested the exposed porous concrete of grades B7,5 and B10 based on white and grey cements M400. As aggregates, one uses limestone and granite mined in the corresponding quarry. Air-entangling additives are applied in concrete manufacturing, due to which placeability of concrete mix is improved and volumetric weight of concrete is reduced. In its turn, it allowed reducing water absorption and enhancing freeze resistance of products. Presence of fine-splitted air in formation of closed pores (pore forming) improves the structure of exposed concrete, bringing its properties closer to the ones of porous claydite-concrete as the essential material of exterior wall panel. Homogeneity of concrete by durability came to 0,70 with variability coefficient equal to 0,11, what exceeds regulatory requirements. Its factory features and way of production are indicated. The range of application and the actual cost of such panels are identified.

1 Introduction

At present it is used exposed concretes while processing wall panels [1]. For example, Selikatnenskiy plant (Podolsk city, Moscow region) produces exterior wall panels of porous claydite-concrete. Annual output of large-panel house-building shops comes to 70 thousand m² of residential area and more. Other plants in Russian Federation use exposed concretes based on lightweight aggregates (tuff, perlite and etc.). Formerly in accordance with a project one made the front finishing layer with cement-sand grout following «face up» formation technology [2, 3, 4, 9]. Such a method of exterior wall panels finishing does not meet requirements of modern civil engineering as the finishing layer made of cement-sand grout is not exposed one and requires additional coating [9, 10, 12].

2 Methods

Yet in 1969 on Selikatnenskiy plant (Podolsk city, Moscow region) it was applied a new technology of concrete finish processing, designed by Russian scientists.

Following this technology having steamed the front layer they process it on machine equipped with replaceable working tools [6- 8, 12, 19].

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The basic condition in manufacture of finishing concretes is the application of graded aggregate (maximum grain size of breakstone is 20 mm). To improve the exposing qualities of concrete it is recommended to apply sand of the same bedrock as the breakstone, especially while using light shade aggregates. Dust-like fractions (up to 0,15 mm) should be eliminated.

Table 1. Composition of external wall panels.

Type of aggregates	Quarry	Material consumption, kg per 1 m ² (water in l)					Volumetric weight of concrete kg/m ³	Durability of concrete, MPa	Adhesion strength with porous claydite-concrete,
		Cement	Breakstone 5-20	Sand	Frother SNV (resin, air-entangling, neutralized)	Water			
Limestone	Muratovskiy	280	1230	300	1,12	176	1750	94	14,8
Limestone	Kaluzhskiy	280	1250	270	1,12	176	1770	97	15
Granite	Silnitskiy	280	1420	360	1,12	145	1900	92	14,9
Granite	Zapasnenskiy	280	1410	340	1,12	145	1920	90	14,7

For exterior wall panels laboratory suggested the exposed porous concrete of grades B7,5 and B10, based on white and grey cements M400. As aggregates one uses limestone and granite mined in the corresponding quarry (table 1).

While concretes manufacturing it is applied air-entangling additives due to which placeability of concrete mix is improved and volumetric weight of concrete is reduced, what in its turn allowed to reduce water absorption and to enhance freeze resistance of products [1,3,4, 20]. Presence of fine-splitted air while formation of closed pores (porus forming) improves the structure of exposed concrete, bringing its properties closer to the ones of porous claydite-concrete as the essential material of exterior wall panel [13, 14, 16, 17].

Homogeneity of concrete by durability came to 0,70 with variability coefficient equal to 0,11 what exceeds regulatory requirements [7,8,9,11, 18].

The finish layer of pilot batch panels serial number NS-4A ((N)Exterior (S)Wall – 4A) was made of dark-grey granite mined from Silnitskiy quarry. Mixing of the concrete mix was carried out in the central concrete mixing unit of the plant for 4-5 minutes; the volume of air involved was 10%. The mobility of the concrete mix was characterized by a draught of 5 cm by truncated cone Story TSNIL (a device to measure mobility of mortar mix). The finish layer was spreaded with a shaft mounted on a concrete spreader. Durability of exposed porus concrete after steaming was equal to 90-95 MPa, its volumetric weight was 1950-2000 kg/sm³.

3 Results

After steaming the panels were vertically set on the special stand where the front layer was processed by using the installation for panel texture processing, equipped with replaceable working tools: planetary cutter, metal brushes, diamond cutting and grinding tools. While processing the panels were generously irrigated with water to prevent overheating of tools and to eliminate dusting. As a result of machining different textures of concrete are obtained (figure 1). In order to get corrugated texture one applied the diamond-charged cutting wheels with diameter of 250 mm, manufactured by Kabardino-Balkarian plant of diamond-charged tools. The diamond-bearing layer of the wheels has the following characteristics: density of diamonds 50%, bound M-50, grain size A-63. The feed rate of the tool came to 2,5 m/min [10,12].

Fig. 1. Obtained textures after machining a - striated, b - grinded, c – corrugated, d - bumpy.

The panels with grinded and striated textures were obtained as a result of processing the front layer with diamond-charged grinder and planetary cutter. A staggered tooth side cutter beat out the grains of aggregate that was reducing the exposing qualities of finish layer. Nevertheless such a cutter can be used if one applies as aggregates more soft bedrock (limestone, dolomite, tuff), while processing which a partial beating out of aggregate's grains takes place that significantly improves the exposing qualities of the front layer.

While producing the panels with texture processing of finish layer by metal brushes in order to enhance the efficiency of their application the surface layer of concrete was loosening by application cement hardening retarder (25% aqueous solution of dextrin). The solution of dextrin was applied with a pistol upon spread surface of the layer in 20-30 minutes after formation. Then the surface was powdered with a layer of sawdust of thickness 5-8 mm. After steaming the front layer of the panel was processed with metal brushes. The cement pellicle was easily removed from aggregate in a single tool pass, the depth of relief came to 2-5 mm.

The width of working tool with set of brushes is 500 mm. While simultaneous installation of four sets of brushes the panel NS-4A was processed for 5 minutes.

Application of a special installation for machining the front layer of panels allows mechanizing one of the most complex finishing processes, producing texture processing the panels by industrial method, excluding manual operations, eliminating extra finishing processes for panels.

4 Discussion

This method allows obtaining variable textures of concrete surfaces notable by durability, texture permanence and shade constancy. At the same time using texture machining one can

achieve the smoothness of colour tone. It should be noted that the exposed concrete quality greatly improved with the use of light-shade aggregates.

Labor consumption of machining of 1 m³ of concrete surface depending on type of a tool is calculated based on the cost of materials used and is corrected based on their change (table 2), and the total labor consumption of arranging the finish layer of exposed porous concrete with further texture processing comes to 0,075-0,05 man-hour/m².

Table 2. Technical and economic characteristics of finish layer.

Type of texture	Texture obtaining method	Tool	Relief characteristics		Texture freeze resistance, Cycle number	Labor consumption of obtaining the texture, an-hour/m ²
			Depth, mm	Distance between peaks, mm		
Evenly rough surface	Manually	Float	0-1	-	50	0,075
Smooth grinded surface	Machining upon a stationary installation	Diamond-charged	0-0,5	-	200	0,02
Striated surface	Machining upon a stationary installation	Inertia milling cutter	4-5	6-8	75	0,02
Corrugated surface	Machining upon a stationary installation	Diamond-charged	3-3,5	5-6	200	0,03
Evenly bumpy surface	Machining upon a stationary installation	Steel brushes	1-3	2-10	200	0,03
Evenly bumpy surface obtained by exposure of aggregates by flushing	Manually	Nozzle-stick	2-5	5-15	50-75	0,05

5 Conclusions

Experience has shown the panels with finish porous concrete with processed texture surface by durability and exposed quality most fully meets civil engineering requirements.

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