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Light concrete on the base of industrial and agricultural waste.

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Construction complex is a specific field of economy in Kazakhstan and requires new highly-effective construction materials for the housing errection. One of the ways to reduce production costs is to use local raw materials including various waste industrial and agricultural products.

Arbolit manufactured from a certain mixture of astringent organic filling ingredients of plant origin, water and chemical additions is considered to be such a material. The waste of timber milling, lumbering and annual agricultural plants: bonfire of hept, flax, cotton stalks as well as barks - waste of the manufacturers of bark extracts are used as organic filling ingredients. [l]

Kazakhstan has the richest sources for arbolit manufacturing. In the forestless regions of Kazakhstan cotton stalks, rice straw and husk resources of which are inexhaustible nowadays can be used as the necessary raw material. [2]

The possibility of manufacturing arbolit from crushed stalks of cotton, rice husk added to astringent cement Class 1.0 - 1.5 was investigated at Almaty Scientific Research Institute of Construction Projects "Minpromstroimaterials". On their base panels of 3.0 x 1.5 x 0.2 m size were manufactured at the test-experimental enterprise of this instrument. These panels meet the strength requirements of the state standard 19222-73 concerning "Arbolit and its goods" and can be used as thermal insulating and construction material. [3]

But the growing demands to the quality of arbolit set an aim to increase the strength indices of this type of material with optimal structure. New compositions are being worked up and the known ones and methods of production of arbolit products are being modernized. Tests carried out at the Scientific Research Institute of Ferro-concrete Constructions showed that in order to increase the effectiveness of production, to simplify the technology of manufacturing arbolit goods and to improve the characteristics of this material, it is necessary to make target-aimed changes of characteristics and structure of arbolit mixture by porosity. Research indicates on the heightened deformation of this material, so additional experimental work should be done. [4]

Using technical foam in arbolit mixtures in the process of preparation promotes the formation of natural friction of hard particles in arbolit mixtures, which in its way courses their steady distribution when mixed together with cement and solid packing when forming the goods.

Porous arbolit mixture is distinguished by its high bonding, heightened dampness and comfortable laying and as a result the use of such mixture simplifies the process of manufacturing goods. Porous arbolit mixture is being set firm by vibration (without additional loading) on the vibro-platform vibrators, vibrapacking, etc., just in the same technological way as when manufacturing concrete with porous filling ingredients. This method can be used in manufacturing constructions of any configuration (blind, with window and door apertures, etc.), with high quality of the surface of the goods, because porous arbolit possesses solid structure with streamlined closed porosity. When manufacturing the panels of the exterior walls in the horizontal moulds with the surface upward, they can be formed starting from interior-textural lay, as thanks to the solid structure porous arbolit mixture provides smooth surface which doesn't need any plastering.

If compared with the general method, the technology of manufacturing porous arbolit has common features as well as a number of principle differences. Common is the technological process in general, and such elements as storage of cement, wood crushes, fitting works, preparing of moulds, control operations, storage and transportation of the final goods. [5]

Distinctive features are preparing and applying foam-making and chemical additions, dosing, mixing of filling ingredients and forming of goods.

It is expedient to prepare porous arbolit mixture using standard equipment of the cement manufacturers with porous filling ingredients applying mixers of forced mixing Type CB 35(C-773), CB-62 (C-951), Cb-93., etc.

To increase the stability of the inlet air into arbolit mixture, the strength and homogeneity of the material it is recommended to use turbulent mixture Type CB-108. High velocity of mixing makes it possible to disperse bubbles of the air and to increase their quantity by lowering the size and to distribute them evenly in the mass of cement paste, creating thicker and solid covering around the air bubbles as compared with the general mixing.

Besides in the mixing process of arbolit mixture in the turbulent mixer, partial activation of cement takes place. Its particles penetrate into the pores of organic filling ingredients collimating them.

As the result, the output of extractive elements from organic filling ingredients reduces, but its cohesion with cement stones increases.

The consequent is that using the same material the strength of arbolit when compressed increases by 20-35% and freeze-resistance increases in 2-2.5 times, the indices of changeability of strength and mass volume are improved in 2-3 times, a number of exploiting specifications improves too. Mastering the use of the technology of porous arbolit can be fulfilled at any plant manufacturing arbolit goods without any essential expenditure for its reconstruction.

The mixing compartment should be installed with additional equipment and tanks for preparing, supply and dosing of the mortar porous additions and foam. It is easy to produce such equipment and install it in the acting concrete mixers.

Minimal is the additional investment connected with re-construction of manufacturing and mainly aimed at installation of tanks and foam-making pumps.

Research carried out at the Scientific Research Institute of Ferro-Concrete Constructions revealed that more effective for porous arbolit are foam-makers on the basis of synthetic surface-active substances and liquid glass foam-makers.

As for chemical additions in producing porous arbolit, preference should be done in favour of complex additions, consisting of the liquid glass and salts of the following metals (CaC12, A12 (SO4)3, FeC13). [6]

The main cohesion and deformation specifications of porous arbolit are shown in Table 1.1

When investigating deformation features of porous arbolit, the initial modulus of compression is determined under the pressure of 0.3 R_b.

As under such loading considerable deformation happens from short-time creeping, then we can define modulus of deformation which is equal to the ratio of the value of tension σ_0=O.3 R_b to the value of complete deformation which occurs under such tension.

The analysis of the experimental data showed that the modulus of elasticity of porous arbolit exceeds 50% over the modulus of the general arbolit and the modulus of deformation is 50% higher accordingly.

Table 1.1. Cohesion and deformation specifications of porous arbolit

#	Indices	Measurement unit	Indices of arbolit's project cohesion		
			1.0	1.5	2.0
1.	Consumption of cement M 400 x 1 m^2	kg	290	320-340	350-360
2.	Mass volume in dry state	kg/m^3	500-550	550-600	600-650
3.	Prismatic cohesion under pressure (R_{bn})	MPa	1.2	2.0	2.5
4.	Models of elasticity under compression E_b	MPa	1000	1200	1400
5.	Cohesion under axis tensity (R_{bn})	MPa	0.25	0.40	0.55
6.	Diminution	mm/m	-	4-5	-

Modulus of elasticity and deformation of porous arbolit when tensile was 25-20% lower of certain specifications of arbolit under pressure. Taking into consideration simultaneous dependence of the modulus of elasticity and deformation upon cubicle strength and mass volume of porous arbolit, empiric dependences of these indices on the product were received: $\gamma \sqrt{0.1R}$ (1)

$E_{el}=4.9\, \gamma \sqrt{0.1R}$ (2)

$E_{def}=4.1\, \gamma \sqrt{0.1R}$ (3)

Where γ - porous arbolit mass volume, kg/m^3
R- Cubicle strength, MPa

Initial coefficient of lateral deformation (*Poisson* coefficient) for porous arbolit can be equal to 0.2 as well as for other types of light concrete. The porous arbolit's volume of maximum clench and stretch, coefficient of elasticity under pressure, close to distruction is in the same bounds as general arbolit has. Porous arbolit's physical and heat-insulating features are just as good as general arbolit's. As for its freeze-resistance, thermal conductivity, watertightness they even surpasses the latter. (See Table 1.2)

Table 1.2. Physical-mechanical specifications of porous arbolit

Class of porous arbolit	Mass volume in dry state, kg/m^3	Coefficient of heat-conductivity Kcal/m hour./gr.	Water-absorption, in mass		Freeze-resistance coefficient through a number of cycles on variable freezing and thawing		
			in an hour	in 48 hours			
B 1.5	560	0.8	70	75	0.95	0.90	0.85
B 2.5	600	0.1	60	65	1.0	0.95	0.90

According to the new technology, crushed cotton stalks and rice straw can be used as organic filling ingredients. This technology improves the quality of goods, increases homo-geneity in cohesion when clenched, decreases density, increases freeze-resistance, decreases the coefficient of heat-conductivity. Production of porous arbolit is done according to the typical scheme but with addition of the foam-generator, linked with 2 collecting tanks and electric engine with capacity of 8-12 kw and not less than 3000 rotations per minute. Improvement of characteristics and structure of arbolit is achieved by porosity of mixture with technical foam in combination with the accelerator of solidity and temporal decelerator of gypsum solidity in the period of forming, which plays the role of the foam-stabilizer.

Mixture of porous arbolit includes crushed cotton stalks, cement, gypsum, chemical additions and water. [7]

Crushed cotton stalks should meet the state standard 19222-84. In order to mineralize organic fillers and acceleration of the process of viscous solidity it is necessary to use complex additions, including liquid glass, aqueous solution of chlorite calcium. For the stability of foam it is recommended to use initary and secondary alkidsulphates, and liquid-glass foam-maker, hydrolized blood, which can be taken in great amounts at the meat-packing factories.

To create steady foam, liquid components of foam-makers together with aqueous solutions accelerate in the system of locked cycle of foam-generator for 20-30 minutes and then it is loaded into the foam-concrete mixer with components of the arboreal mixture.

10 minutes is enough to form porous mixture. Incidentally, there is a possibility of manufacturing heat- When manufacturing heat-insulating arbolit, arbolit mixture is put into moulds exceeding the volume of the matrix for 3-4% without additional loading and compression. When producing insulating and constructive arbolit applying different schemes, constructive arbolit the volume of mixture should prevail 10-15% over the volume of matrix.

To avert "unpressing", moulds with locked lid fixing mixture in compressed state should be used. Mixture is distributed steadily and compressed by vibration (without any loading). The duration of vibration depends on the mobility of mixture and defined in testing way. If the amplitude of oscillation is 0.3-0.6 mm and the rate is 5 htz, the duration mustn’t exceed 1.5-2 minutes.

After being compressed, mixture is subjected to heat processing under the temperature of 50-60°. Textular (protective-finishing) mixtures can be put as well in the process of forming. Neotextular goods made of arbolit are protected outside by cement-perchlorvinil pigments and inside - by chalk-latex-silicon organic pigments.

It is ascertained that in case of re-orientation of the work- shops producing arbolit to manufacturing cold proofing and constructive arbolit on the base of gypsum-percement-vinil with porosity of arbolit mixtures, manufacturing labour-power consume is decreased to 0,5 man/m, metal volume is reduced to 5 kg/m^3.

The main results of the research are examined when producing experimental lot of wall blocks from porous arbolit at Aktobe Intergrated Plant of Building Constructions. In Table 1.3. you can find our suggestions concerning the composition of porous arbolit. As a result of technical-economic calculations it is ascertained that porosity of arbolit mixture leads to decreasing the specific metal volume of moulds from 28.8 to 17.9 kg/m.

Table 1.3. Suggested compositions for porous arbolit

Indices	Measurement unit	Indices of arbolit				
		B0.75	B1.0	B1.5	B2.5	B3.5
1	2	3	4	5	6	7
1. Expenditure of trass cement M 400	kg	250	280	300	325	350
2. Expenditure of gypsum M 100	kg	100	1000	1000	110	120
3. Expenditure of dry organic filling ingredients (cotton stalks)	kg	175	195	215	235	250
4. Expenditure of water per m^3 of arbolit mixture with dry organic filling ingredients	l/m^3	270	300	325	350	370
5. Expenditure of liquid in foaming state (in case of locking and mixing wet organic filling ingredients, cement, additions)	l/m^3	60	60	60	80	90
6. Expenditure of grinded sand	kg	75	80	85	90	95
7. Expenditure of marble dust	kg	5	6	6.5	7	7.5
8. Expenditure of mineralizer and accelerator of solidity (complex addition):						
liquid glass	kg/m^3	10	10	12	12	12
chloride calcium	kg/m^3	6	6	6	6	8
9. Expenditure of the foam fixator in suspended state (calcium)	gr/l	10-12	11-13	12-14	13-15	15-16
10. Solidity in dry state	kg/m^3	400-430	450-460	500-540	540-590	590-640
11. Prism cohesion under pressure (standard resistance) R_{bn}	MPa	0.3	0.6	0.95	1.65	2.1
12. Cohesion under axis stretch (R_{btn})	MPa	0.1	0.2	0.3	0.39	0.44
13. Modulus of elasticity under pressure $\sigma = 0.3\ R_{btn}$	MPa	200-250	250-400	400-650	650-1100	1000-1300
14. Liquid absorption (according to mass) in 48 hours	%	95	85	75	67	45
15. Freeze resistance	cycle	5	20	35	50	75
16. coefficient of heat-conductivity	$wt/m^2\ K$	0.05	0.065	0.085	0.10	0.135

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