ENGINEER

international scientific journal

SPECIAL ISSUE

E-ISSN
3030-3893

ISSN
3060-5172

A bridge between science and innovation

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

ENGINEER

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E-ISSN: 3030-3893

ISSN: 3060-5172

SPECIAL ISSUE

24-april, 2025

engineer.tstu.uz

MUHAMMADAMIN KABULOVICH TOHIROVNING TAVALLUDINING 80 YILLIGIGA BAG‘ISHLANGAN "SAMARALI QURILISH MATERIALLARI, KONSTRUKSIYALARI VA TEXNOLOGIYALARI" MAVZUSIDAGI XALQARO ILMIY-AMALIY KONFERENSIYASI ILMIY ISHLARI TO‘PLAMI

Toshkent davlat transport universiteti Rossiya Arxitektura va qurilish fanlari akademiyasining akademigi, O‘zbekiston Respublikasida xizmat ko‘rsatgan yoshlar murabbiysi, texnika fanlari doktori, professor **Muhammadamin Kabulovich Tohirovning tavalludining 80 yilligiga** bag‘ishlangan **"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari"** mavzusidagi xalqaro ilmiy-amaliy konferensiya ilmiy ishlari to‘plami chop etildi.

Muhammadamin Kabulovich kompozitsion qurilish materiallarining polistrukturaviy nazariyasini rivojlantirishga ulkan hissa qo‘shgan olimdir. 1995-yilda Muhammadamin Kabulovich Rossiya Arxitektura va qurilish fanlari akademiyasining (RAASN) xorijiy a’zosi etib saylangan, bu esa ularning qurilish materialshunosligi sohasiga qo‘shgan ilmiy hissasining xalqaro miqyosdagi e’tirofi bo‘ldi. Ular o‘z ilmiy faoliyati davomida 6 ta monografiya, 200 dan ortiq ilmiy maqola va 25 ta ixtiroga mualliflik guvohnomasi yaratganlar.

Ushbu konferensiyaning asosiy maqsadi – qurilish materialshunosligi, bino va inshootlarni loyihalash hamda qurilish sohasidagi zamonaviy ilmiy tadqiqotlar natijalarini muhokama qilish, shuningdek, muhandislik ta’limini takomillashtirish yo‘llarini aniqlashdir.

Konferensiyada O‘zbekiston Respublikasi hamda xorijiy mamlakatlarning oliy o‘quv yurtlari va ilmiy-tadqiqot institutlari olimlari, shuningdek, muhim ilmiy tadqiqot natijalariga ega bo‘lgan ishlab chiqarish vakillari o‘z ilmiy ishlari bilan ishtirok etdilar.

"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari" mavzusidagi xalqaro ilmiy-amaliy konferensiyaning asosiy yo‘nalishlari quyidagilardan iborat:

1. **Resurs va quvvatni tejaydigan qurilish materiallari va texnologiyalari** – zamonaviy ekologik va iqtisodiy talablarni qondirishga qaratilgan innovatsion yechimlar.
2. **Bino va inshootlarning qurilish konstruksiyalari, zamonaviy hisoblash va loyihalash usullari - muhandislik** va texnologik yechimlarni takomillashtirish yo‘nalishlari.
3. **Arxitektura va shaharsozlik** – estetik va funksional jihatlarni uyg‘unlashtirgan zamonaviy loyihalar yaratish.
4. **Zamonaviy muhandislik ta’limi tizimini takomillashtirish** – kelajak mutaxassislarini yuqori malakali darajada tayyorlash uchun ta’lim jarayonini modernizatsiya qilish.

Mazkur konferensiya ilmiy hamjamiyatning turli vakillarini bir joyga jamlab, qurilish materialshunosligi sohasidagi zamonaviy muammolar va istiqbollarni muhokama qilish uchun qulay platforma vazifasini bajardi.

Preparation of polymer cement adhesive (PCA) by dry construction mixtures technology (DCT)

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Abstract: In the article the properties of polymer cement adhesive obtained by the technology of DCT are investigated and the methods of testing and technological schemes of obtaining DCT are given, also rational duration of obtaining dry mixture is established and it is shown that at the content of sand filler with Sud. 1000 cm2/g - 50%, hyperplasticiser POLIMIXJBI - 1,0% it is possible to obtain PCA with required cohesive strength.
Keywords: polymer-cement adhesive, filler, dispersity, cohesion, adhesion, activation, mixer-activator

1. Introduction

The experience of dry mixes application in European countries unambiguously testifies that ‘wet’ technologies are a thing of the past. Throughout the ‘civilised world’, repair and restoration work is now carried out exclusively with dry mixtures. As for construction works, ‘wet’ mixtures account for no more than 5%. According to the estimations of western specialists, the use of dry construction mixtures increases the efficiency of construction and finishing works by 150-200%, and if small mechanisation means are used - by 400-500%. This means that works are carried out 5 times faster, much more economically and qualitatively.

Dry construction mix is obtained in factory conditions by grinding in a mill strictly dosed on the recipe components. The composition of a dry mix includes: binder (cement, gypsum, lime or their combinations), neutral filler to ensure optimum volume (most often it is sand) and special modifying additives that give the mixture the necessary properties.

Dry construction mixtures are distinguished by three main features:

1. by the type of binder;
2. by the dispersibility of the filler;
3. by the main purpose.

According to the type of binder, dry mixtures can be subdivided into:

- cement (cement-containing);
- cementless.

According to the dispersity of the filler, dry mixtures are subdivided into:

- coarse-grained - with filler size not more than 2.5 mm;
- fine-dispersed (fine-grained) - with filler size not more than 0.315 mm.

According to the main purpose of dry mixtures are divided into:

- masonry - for masonry of cellular concrete blocks of brick, stone;
- assembly - for installation of large panels and partitions;
- adhesive - for laying facing tiles, for gluing thermal insulation materials and reinforcing mesh in lightweight plaster thermal insulation systems;
- grout (fugues) - for filling joints between facing tiles;
- waterproofing - for vertical and horizontal waterproofing of plinths, basements, foundations, swimming pools, bathrooms, hydraulic structures;
- protective and finishing plaster - for interior and exterior decorative finishing of buildings;
- self levelling - for screeding and floor bases;
- putty - for filling sinks and irregularities on concrete and plaster bases;
- colouring - for interior and exterior finishing of buildings;
- plastering (levelling) - for levelling walls and ceilings;

Of those listed above, the most interesting are modified dry mixtures for adhesive purposes. Such dry mixtures are a mixture of mineral binders, fillers of strictly fixed dispersity, dispersive polymer powders and various modifying additives.

2. Research methodology

Compressive strength. The compressive strength of cement stone was determined on specimens of 20x20x20 mm and of concrete - 100x100x100 mm. The specimens were tested on CT-D2000 presses (Fig. 2.10) at 3, 7, 14, 28 days of age after storage in the normal curing chamber CU-40B.

The compressive strength of an individual specimen is calculated as the quotient of the failure load divided by the working area of the specimen. The tensile strength is calculated as the arithmetic mean of the four and highest test results of six specimens.

Concrete strength was calculated by the formula:

$$R сж = \alpha \frac{P}{F}, \qquad (2.3)$$

where: Rcj - compressive strength of concrete, MPa; P - breaking force, KN; F - average area of the working section of the specimen, cm2; α - scale factor equal to 0.95.

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Fig. 2. 10. Hydraulic press CT-D2000

Determination of specific surface. The specific surface of the binders, as well as the used filler was measured, according to GOST 310.2.-81, using the device PSX-11A (Fig. 2.5).

The device PSX-11A is designed for determination of specific surface area and average particle size of dispersed materials. The operation of the device is based on the Kozeny-Karman gas permeability method and consists in determining the time of passage of a fixed volume of air through the layer of a sample consisting of non-porous rounded powder particles. With the help of such devices the determination of external surfaces of particles without taking into account intraparticle dead-end pores is made.

The Kozeny-Carman equation has the following form:

$$S_0 = 14\sqrt{\frac{\Delta P * F * \delta^3}{Q * \eta * L(1-\delta)^2}}, \qquad (2.2)$$

where, S0 - surface area per unit volume; ΔP - pressure difference on the sides of the sample; δ - cross section of the sample; F - porosity coefficient; Q - air flow rate; η - air viscosity; L - height of the sample.

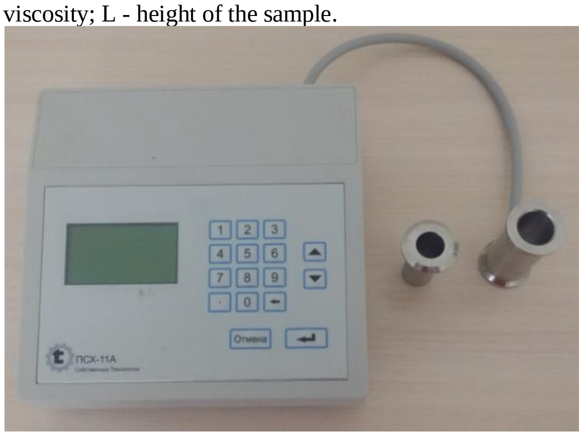

Fig. 2.5. Surface meter of dispersed materials PSX-11A

The tested powdery material is placed up to the cuvette, then the plunger is installed. A rubber hose is used to connect the cuvette to the instrument. This hose is used to connect the inlet connection of the instrument to the cuvette connection and to start the instrument.

The duration of the passage of a certain volume of air through a layer of powdery material depends on the value of its specific surface area, which allows to calculate its value.

All measurements and calculations in PSX-11A are automated, which eliminates the factor of subjective error.

3. Conclusion

The traditional technology of PCA production is based on adding water dispersions of polymers or water-soluble resins to the mixing water of mortar and concrete mixtures at the place of their preparation [1,2]. Such technology is relatively complex and does not meet modern requirements of intensification of construction processes. As already mentioned, in modern construction the use of dry construction mixtures (DCT) is expanding, the advantages of which are proved by the world experience of their use.

Therefore, we have investigated the possibility of using the technology of DCT to obtain PCA with POLIMIXJBI additive.

In the previously performed works two methods of obtaining DCT have been proposed [3,4]:

a) mixing in a compulsory mixer of dried sand (humidity not more than 0.5%) and other dosed components (binder, additive) until a homogeneous dry mixture is obtained, followed by packing in paper or polyethylene bags;

b) grinding in a mill dried sand, cement and a special additive, dosed strictly according to the composition of the CCS and packing into bags.

The first method essentially produces a dry mixture of ordinary mortar without filler, which does not meet the requirements of resource saving in the production of construction semi-finished products [3].

The second method is more effective, because the CSS contains 50% of sand filler and in the process of grinding there is activation of its components [4].

However, in the second method of obtaining DCT, it is practically impossible to determine the specific surface area of the sand component. And, as noted above, in accordance with the polystructural theory, in composite materials each type of filler should have its optimal dispersity. In addition, as shown in [5], the activity of fine mineral binders and fillers rapidly decreases in contact with air due to the hygroscopicity of their particles. Therefore, there is a need for activation of PCA components when mixing it with water. In this connection, we have proposed a two-stage activation of the components in the production of PCA. At the first stage, first, dried and dosed sand is ground in a mill to a certain dispersity. Cement and POLIMIXJBI are then loaded into the mill and by mixing them, the DCT is produced and bagged. In the second stage, the SCC is mixed with water at the site in a mixer-activator and PCA of appropriate composition is prepared.

Thus, in the process of research it was necessary to establish the rational duration of obtaining the CSS depending on the type of filler and mixing it with water in the mixer-activator. For this purpose, the experiments were performed in several stages.

At the first stage, as a result of preliminary experiments, the content, dispersibility and amount of sand filler for obtaining DCT and the limits of variation of POLIMIXJBI dosage were determined.

The sand was ground in a ball mill to a specific surface area of 1000, 2000 and 3000 cm2/g for 90, 115, 135 min, respectively.

The PCA was prepared manually by sequential mixing of dosed water, resin, cement and sand. The W/C was taken from the calculation of obtaining PCA with a flowability of

160 mm on a Suttard apparatus. The limits of variation of POLIMIXJBI and filler content were taken on the basis of earlier works [5].

Experimental data given in Tables 1, 2 show that for obtaining PCA it is reasonable to use sand filler with specific surface area of 1000 cm2/g at the content of 30-50% of cement mass, POLIMIXJBI in the amount of 0.5-1.5%.

Table 1

Dependence of cohesive strength of PCA on sand filler dispersity

$S_{уд}$. Sand, cm2/g	POLIMIXJBI content, %	Filler content, %	$R^{28}_{сж}$, MPa
0	1,0	0	72
1000	1,0	50	41
2000	1,0	50	35
3000	1,0	50	28

Table 2

Dependence of PCA cohesive strength on sand filler content

$S_{уд}$. Sand, cm2/g	POLIMIXJBI content, %	Filler content, %	$R^{28}_{сж}$, MPa
1000	1,0	30	58
1000	1,0	50	41
1000	1,0	70	34
1000	0,5	50	36
1000	1,5	50	32

At the second stage, the influence of the duration of preparation and POLIMIXJBI content, on the specific surface area of DCT and water consumption of PCA during preparation in a turbulent-type mixer-activator for 30, 60 and 90 s was investigated. The rotational speed of the working body was 350 rpm. In the preparation of sand-filled PCA, firstly for. 80 min in a laboratory ball mill sand was ground to Sud= 800 cm2/g, then cement and POLIMIXJBI were added and the dry mixture was stirred for another 20, 30 and 40 min. The results of the performed studies are given in Tables 3-7. At constant cement to filler ratio, the specific surface area (SUD) of the DCT increased with increasing duration of production and POLIMIXJBI content. At the same time POLIMIXJBI fulfilled the role of intensifier of dry mixture grinding.

In contrast to the above, not only POLIMIXJBI, but also sand filler has a positive effect on the intensification of DCT grinding, as evidenced by the data of Table 3. The analysis of the given data shows that if for 20-40 min of mixing Sd of DCT with sand filler without additive increased by 26-53, then with 0.5-1.5% additive - 34-66 and 54-93%.

Table 3

Variation of specific surface area of DCT from duration of production

Composition of DCT, %			Specific surface of DCT, m2/kg depending on the product, min			
cement	sand. fill.	POLIMIXJBI	0	20	30	40
66	33	0	226	285	321	345
		0,5	-	304	352	376
		1,0	-	323	378	394
		1,5	-	348	402	436

The consequence of the growth of dispersibility of DCT with sand filler is an increase in water consumption of PCA, which is confirmed by the data of Table 4. Comparison of the given data shows that with increasing dispersity of DCT and increasing the duration of production there is a natural increase in water consumption of PCA. At the same time, with the increase of POLIMIXJBI dosage and, accordingly, plasticising effect, the water consumption of PCA decreases.

Table 4

Dependence of W/C on the additive content and duration of DCT production

Composition of DCT, %			W/C depending on milling time, min			
cement	sand. fill.	POLIMIXJBI	0	20	30	40
66	33	0	0,37	0,39	0,41	0,43
		0,5	0,35	0,36	0,375	0,4
		1,0	0,33	0,34	0,355	0,375
		1,5	0,3	0,315	0,325	0,345

This is explained by two reasons. Firstly, in the case of DCT with coarse sand, the Sd of cement probably changes much more than that of the filler, since its initial Sd was about 800 cm2/g. In other words, the sand filler acts as an abrasive. It should also be noted that in this case we used the device PSX-2, which allows to determine the Sd of dispersed fillers only taking into account the geometrical shapes of particles. Secondly, the plasticising effect of POLIMIXJBI is greater the higher the cement content and dosage of the additive and the larger the filler particles. Since there is more than 2 times less sand filler in DCT, the water requirement of PCA is lower.

Experiments have shown that at constant filler content in SCC, at activation of water suspension, cohesive strength of PCA in the hardened form changes extremely with mah index at duration of mixing of the mixture 60 s. (Table 5).

Table 5

Dependence of PCA cohesive strength on the duration of mixing DCT with water

Stirring time, min	Content, %		$R_{сж}^{28}$, MPa
	sand filler	POLIMIXJBI	
30	50	1,0	47
60	50	1,0	52
90	50	1,0	49

The highest indicators of cohesive strength of PCA are achieved at duration of DCT production 30 and 40 min, content of POLIMIXJBI additive 1.0% (tab. 6). The analysis of the data of Tables 5 - 7 also shows that for obtaining PCA the content of sand filler is 50%.

Table 6

Dependence of cohesive strength of PCA on the duration of DCT production

$S_{уд}$. Sand, cm2/g	POLIMIXJBI content, %	Filler content, %	$R_{сж}^{28}$, MPa
20	1,0	50	45
30	1,0	50	52
40	1,0	50	54

Taking into account the performed researches the technological schemes for obtaining SCC have been proposed (Fig. 1).

Table 7

Dependence of PCA cohesive strength on the content of POLIMIXJBI resin

Content, %		$R_{сж}^{28}$, MPa
POLIMIXJBI	sand filler	
3	50	42
5	50	52
7	50	48

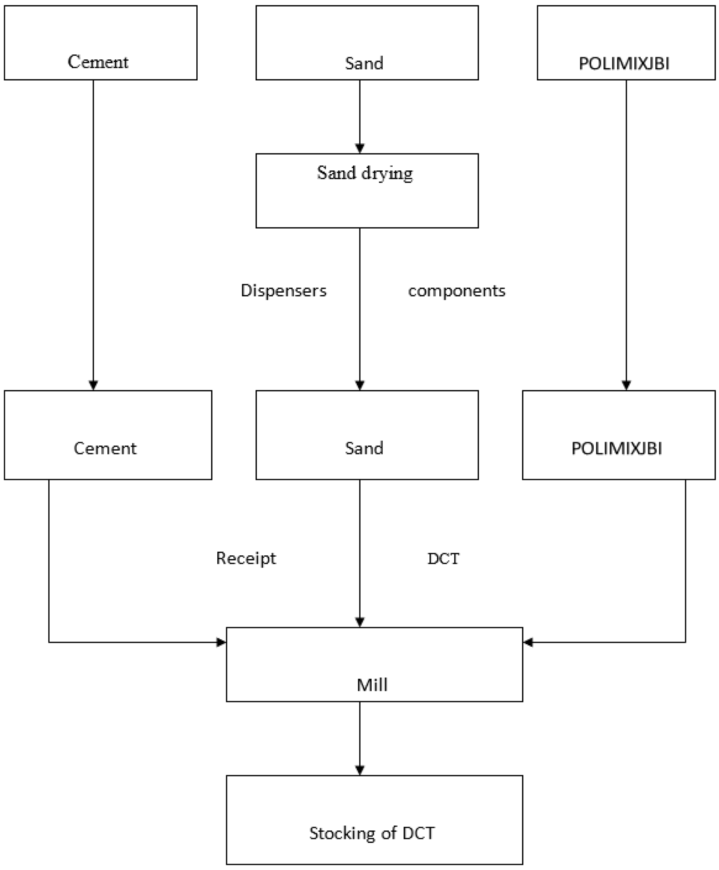

Fig. 1. Technological scheme of production of sand-filled DCT Storage bunkers

Thus, the conducted researches have shown the possibility of obtaining PCA with the use of water-soluble POLIMIXJBI according to the DCT technology.

4. Conclusion

1. Two-stage technology of PCA production was substantiated. At the first stage the technology of dry activation of PCA components is proposed, and the second stage - activation of aqueous suspension of PCA in a high-speed turbulent-type mixer.

2. Rational durations of dry mixture preparation (30 min) and high-speed mixture preparation (60 s.) are established.

3. It is shown that at the content of sand filler with Sud. 1000 cm2/g - 50%, POLIMIXJBI - 1.0% it is possible to obtain PCA with the required cohesive strength.

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