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Selection of Composition of Decorative Dry Mixtures and Study of Their Rheological Properties

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ABSTRACT

The use of dry building mixes (DBM) in the performance of masonry, finishing and installation work significantly improves the quality and productivity of labor, ensures high performance characteristics of the finished product.

The variety of consumer properties of such mixtures determines the need to use a complex of modifying additives for various purposes [3,13,14]. The use of imported additives in the composition of dry building mixtures leads to a significant increase in their cost. The use of local import-substituting, competitive in terms of properties additives in building mixtures is an important national economic task [8].

KEYWORDS: *plastic strength, carboxymethylcellulose, complex additive, Lime-clay, Lime-clay*

Main part

To obtain DBM prototypes, the specific surface area in various ratios by weight of lime and clay is Ssp = 4000 cm^2/g; Grind in a ball mill up to 10000 cm^2/g. The initial mixture was mixed with an aqueous solution of soda ash. In the control samples, the soda content was 1%. The water-solid ratio B/T = 0.55 was found to be the same for all formulations. To adjust the technological and operational properties of the DBM for plaster, the following additives were added: an aqueous dispersion of polyvinyl acetate (PVA glue - polyvinyl acetate), CMC- carboxymethylcellulose, LST-Lignosulfonate technical, KJ-3- complex additive Dzhalilov additive. Additives were added to the mixture as a percentage of the mass of the dry mixture, and the amount of sand - as a percentage of the mass in relation to the mixture of lime and clay.

The results of experimental studies are presented graphically in Figures 1 and 2.

An analysis of the data presented in these figures shows that the amount of soda ash has an effect on the incubation period of the solidification of the cosmetic composition. The DBM content, equal to Sud =10000 cm^2/g, is characterized by an intensive increase in plastic strength. For example, in compositions with a ratio of lime and clay of 1:1, a sharp increase in plastic strength is observed 6-9 minutes after adding water. The plastic strength of such compositions 5 minutes after adding water was 0.5 MPa with the addition of 1% soda ash and 0.6 MPa with the addition of 5% soda ash. The use of dehydrated clay in DBM enhanced the hydration process. In the case of fine-grained DBM with dehydrated clay, the transition from plastic to mechanical strength was observed 1-3 minutes after adding water to the mixture. At the same time, the incubation period of solidification of compositions containing 5% soda ash was not observed at all. The very rapid transition of the coagulation structure to the crystallization one is explained by the growth of $CaCO_3$ crystals formed as a result of the interaction of slaked slaked lime with soda ash in the initial period of solidification. Due to the high degree of grinding of the components, the instantaneous precipitation of calcium carbonate occurs in the following 2 stages: 1) $CaO + N_2O = Ca(ON)_2$; 2) $Ca(ON)_2 + Na_2CO_3 = CaCO_3\downarrow + 2\ NaOH$. Thus, the ratio of lime to clay is 1: Compounds equal to 1 and having a high relative surface area (Ssp = 10000 cm^2 / g) have unsatisfactory technological properties. DMB of this composition are characterized by instantaneous exchange reactions and, consequently, the rate of increase in plastic strength, and the solidification times of the mixture are very short, which does not allow them to be easily applied to the surface to be coated.

An increase in the proportion of clay in the composition of the DMB increases the incubation period of hardening, all other things being equal [1.8.9]. Figure 1 shows the results of testing the composition of dry clay based on dry clay (Fig. 1, curve 3). The decrease in the plastic strength of the amount of soda ash in the composition led to a decrease in the previously expected mixture and an increase in the incubation period of solidification. For example, DBM with a soda content of 5% is 0.003 MPa when hardened for 200 minutes, and with a soda content of 1% - 0%. It has a plastic strength of 0.002 MPa (curves 1 and 2 and 3). The use of lime with a higher activity in formulations leads to a corresponding increase in the plastic strength of the DBM (Fig. 2 and 3).

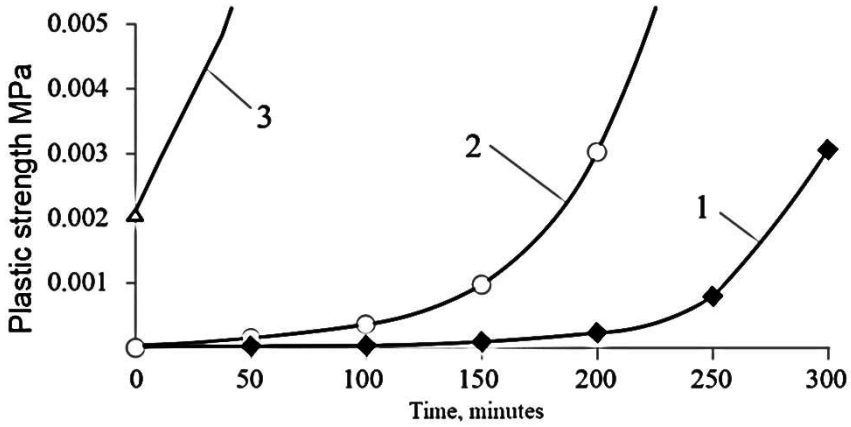

Figure 1. Change in the plastic strength of the CCC composition over time.

Lime-clay (Angren) ratio 1:3; Ssp = 10000 cm^2/g; lime activity 65% with the amount of 1,2,3-soda ash 1%, 5%, 10%, respectively.

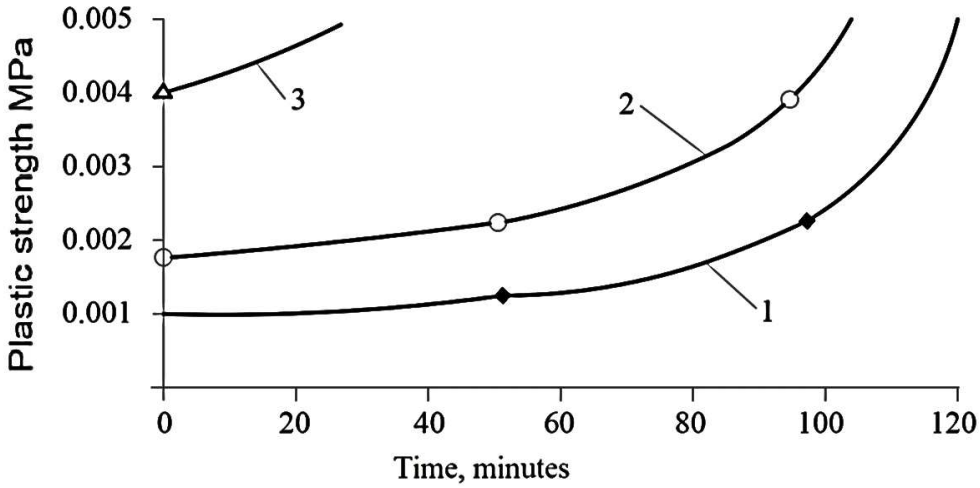

Figure 2. Change in the plastic strength of the DMB composition over time.

Lime-clay (Yangiyul) ratio 1:3; Ssp = 10000 cm^2/g; lime activity 90% with the amount of 1,2,3-soda ash 1%, 5%, 10%, respectively.

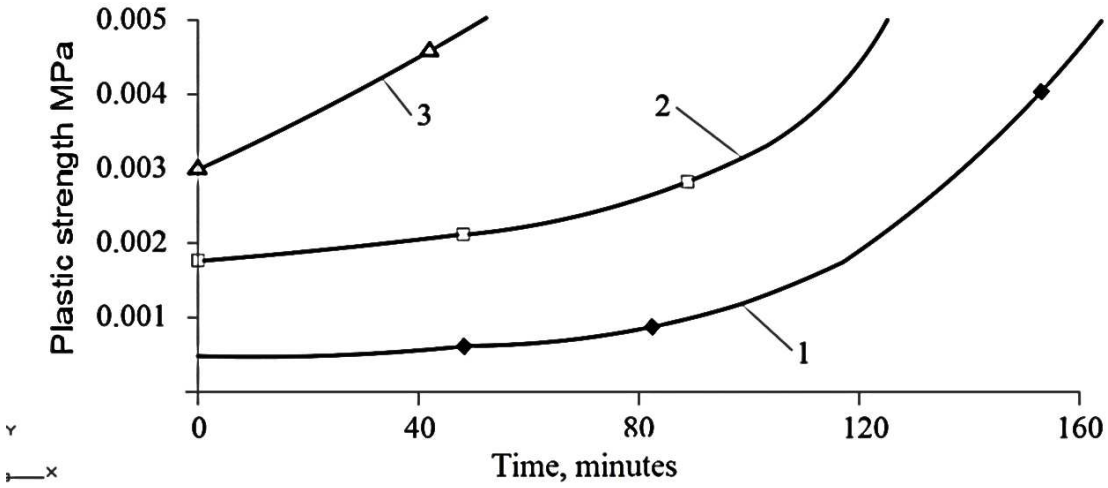

Figure 3. Change in the plastic strength of the DMB composition over time.

Lime-clay (Angren) ratio 1:3; Ssp = 10000 cm^2/g; lime activity 90% with the amount of 1,2,3-soda ash 1%, 5%, 10%, respectively.

The plastic strength and duration of the incubation period depend, among other things, on the dispersion of the system. Compositions with high dispersion are characterized by a short curing time and low plastic strength at the same water consumption. Taking into account the high energy consumption during the grinding of the DBM composition, it is inappropriate to use compositions with a large relative surface area in terms of technological qualities. For this recipe, compositions with a relative surface area Ssp = 4000 cm^2/g are considered optimal. When mixing the prepared ingredients with an aqueous soda solution, the process of calcium carbonate formation is significantly intensified by increasing the amount of the lime component. In this case, local formation of $CaCO_3$ occurred in the plasticized mixture.

Taking into account the rheological and technological properties, the optimal composition is 1 part lime to 3 parts dehydrated clay (25% lime + 75% dehydrated clay), the relative surface area Ssp = 4000 cm^2/g and the amount of soda in the dry mix content is 1% wt. This content has been accepted as reference content for future research.

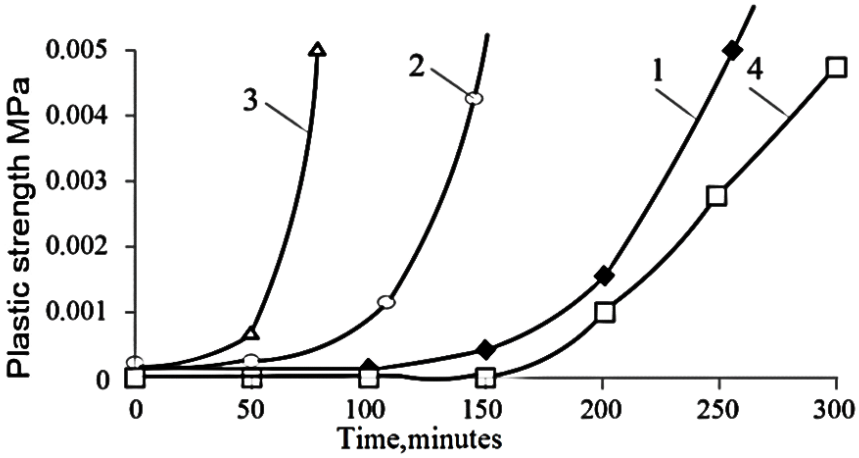

Figure 4. Change in the plastic strength of the composition of clay-based DBM over time.

Lime-clay (Yangiyul) ratio 1:2; Ssp = 4000 cm^2/g; with the amount of 1,2,3-soda ash 1%, 5%, 10%, respectively.

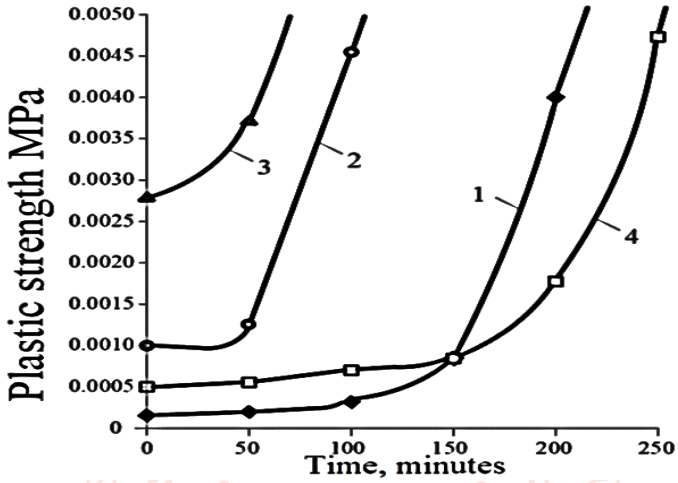

Figure 5. Change in the plastic strength of the clay-based DBM composition over time.

Lime-clayey (Yangiyul) ratio 3:1; Ssp = 4000 cm^2/g; with the amount of 1,2,3-soda ash 1%, 5%, 10%, respectively.

The introduction of various additives into the control composition led to a decrease in the plastic strength of the compositions (Fig. 6–7).

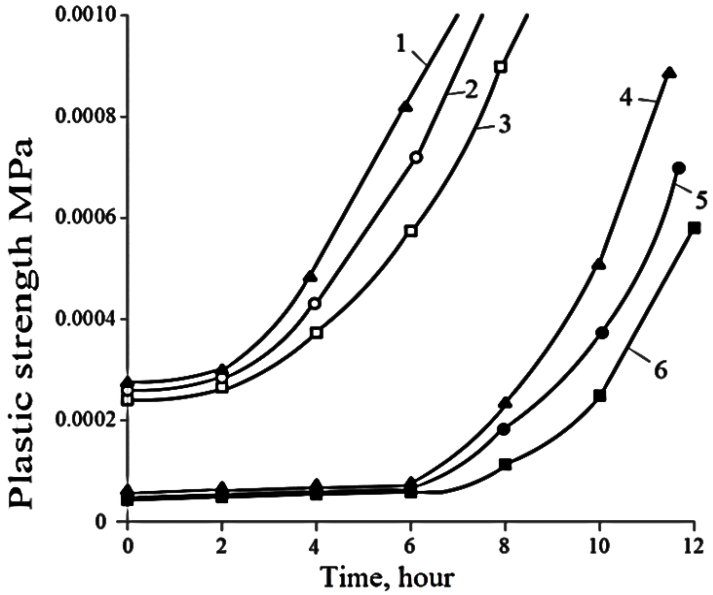

Figure 6. Change in plastic strength over time with the addition of superplasticizer KJ-3.

Lime-clay (Yangiyul) ratio 1:3; Ssp = 4000 cm^2/g;

1,2,3 - with the amount of superplasticizer 0.5%, 1%, 1.5%, respectively, control composition 4 (without additives); 5 control composition (without additives, in Angren algae); 6- Amount of superplasticizer 1%.

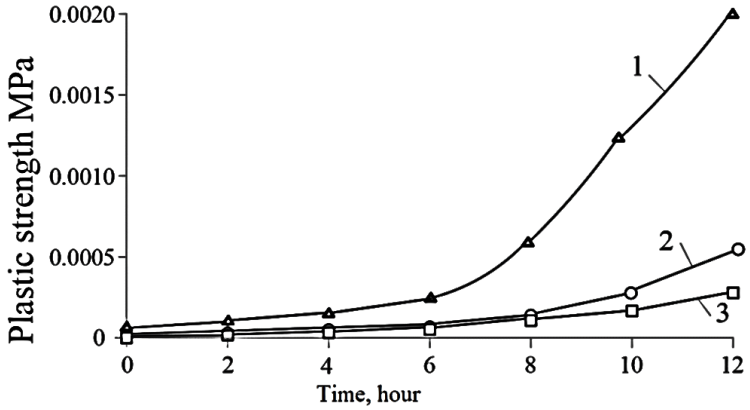

Figure 7. Change in the plastic strength of the DBM composition with the addition of PVAD over time.

Lime-clay (Yangiyul) ratio 1:3; Ssp = 4000 cm^2/g; 1,2,3 - with the amount of PVAD 10%, 20%, 30%, respectively.

For example, the addition of superplasticizer KJ-3 has a plasticizing effect on the DBM, while the mobility of the mixture increases in proportion to the additional concentration [2.10.11]. In particular, the addition of 0.5% KJ-3 to the dry weight of the mixture showed a plastic strength of 0.0011 MPa after 8 hours of mixing with water, while the addition of 1.5% of the added plastic added 0.0006 MPa after exactly the same time has shown elasticity. The introduction of an additive of 0.5% LST into the dry mass of the mixture showed a plastic strength of 0.0010 MPa 8 hours after mixing with water, while an additive in an amount of 1.25% showed a plastic strength of 0.0008 MPa after exactly the same time.

The assessment of the above indicators of the plastic strength of the DBM composition was carried out on a dense base (Fig. 1-7.). In practice, most decorative surfaces have a porous structure. The absorption of moisture from the mixture by the porous base led to an increase in the plastic strength index (Table 1).

Table 1 Plastic strength of the finishing composition on a porous basis.

Types of additives	Number of additives	Plastic strength, MPa	
		based on dehydrated Angren clay soil	based on dehydrated Yangiyul clayey soil
-	-	0,0030 / 0,00029	0,0033 / 0,00014
LST	1,0	0,0025 / 0,00023	0,0027 / 0,00012
KJ-3	1,0	0,0020 / 0,00020	0,0022 / 0,00010
MC	0,2	0,0023 / 0,00016	0,0025 / 0,00010
PVA glue	10	0,0023 / 0,00010	0,0024 / 0,00012
	20	0,0015 / 0,00008	0,0015 / 0,00008
	30	0,0010 / 0,00007	0,0010 / 0,00007
Note: Denominator- is the plastic strength of the mixture on a dense basis.			

The plastic strength of materials in terms of porosity is the same for both types of clays. The introduction of PVA glue into the composition of the DMB has a plasticizing effect. The high content of polyvinyl alcohol in the composition does not prevent the formation of $CaCO_3$. Analysis of the data presented in table. 2 shows that from the point of view of the rheological characteristics of the DMB components, it is necessary and sufficient to add PVA glue in an amount of 15% by weight of the mixture.

Table 2 The mobility of the finishing composition on the Suttard device.

№	Compounds with additives	Mixture flow Ø, mm
1	Control composition	70-80
2	1% **KJ-3**	100-120
3	10% PAD	90-100
4	20% PAD	120-140
5	30% PAD	140-160
6	20% PAD, 1 weight fraction of sand	120-140

Conclusion

It is proposed to improve the technology of finishing works, reduce their efficiency by spraying the finishing composition with an injector (performed by shotcrete) [4.11]. At the same time, in a mechanical or pneumatic injector, the mixture is sprayed with compressed air at high speed onto the surface under pressure at a pressure of 0.1 MPa. The quality of applying plaster mixtures depends on the selection of the optimal mobility of the mixture. Slow-moving mixtures are relatively often used when rubbing patches using the torque method [5, 6], however, the use of such compositions significantly reduces the service life of the injector nozzle.

The use of highly mobile mixtures, on the contrary, increases the likelihood that the mixture will drain from the treated surface.

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