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MORTARS WITH CARBON CONTAINING FILLER

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This work presents the results of the investigations of the basic properties of mortars and solutions with the carbon containing filler. The optimum amount of the filler for cement and lime plaster has been defined. The indicators of viability of mortars, their frost resistance and the degree of adhesion of solutions to the surface have been identified.

In the laboratories of the department of construction production complex studies of the fundamental properties of mortar mixtures and solutions with the carbon containing filler have been carried out. Feedstock for a large-tonnage filler is water treatment sludge, which is a secondary product of the Polotsk and Novopolotsk central electrical heat plants. 192 kg of cement-lime plaster type M 75 and lime- sand mortar where a ratio of lime to sand was 1: 6, the latter used for interior decorating, were taken for control. The mobility of mortars was 8 cm.

The optimum amount of filler was determined, on the grounds of indicators of strength of solutions, their peel ability and water-holding capacity. The results of the studies are shown in tables 1 and 2.

Table 1 – Key indicators of quality of cement plastering mortars and solutions

№ composition	Cement consumption 1 m^3, kg	Consumption filler 1 m^3, kg	W/S	Strength, MPa		Laminating, %	Water-retaining ability , %
				7 days	28 days		
1	168,6	33,2 (40*/20")	1,45	4,1	5,8	10,6	95,2
2	167,5	49,4 (60/30)	1,28	4,6	6,6	9,4	95,5
3	166	65,5 (80/40)	1,12	5,5	7,8	8,2	96,5
4	165	81,2 (100/50)	1,19	5,0	7,2	8,0	97,2
5	163,8	96,7 (120/60)	1,24	4,7	6,7	9,1	97,8

* – percentage of filler input from the calculated mass of lime;
" – percentage of filler input from the calculated weight of cement.

Table 2 – Key indicators of the quality of lime plastering mortars and solutions

№ composition	Consumption, kg			Strength, MPa		Laminating, %	Water-retaining ability, %
	lime	filler	water	7 days	28 days		
1	230	-	343	0,8	1,5	7,8	96,2
2	190	38 (20 %)*	328	0,6	1,5	7,8	96,5
3	169	58 (30 %)	314	0,8	1,6	7,9	96,3
4	147	78 (40 %)	305	1,3	1,8	8,1	96,6
5	124	99 (50 %)	301	0,9	1,5	8,0	96,4
6	99	118 (60 %)	301	0,7	1,2	8,3	96,0

* – percentage reduction of lime consumption by weight

The optimal addition of the filler with a maximum particle size of 80 microns to plaster cement mortars is 60 – 100 % of the estimated mass of lime. The strength of the control solutions, which are 7 days old, exceeds that of cement lime mortars by16-20 %. Experimental data based on the results of the research have revealed that for lime plaster mixtures the optimum lime consumption reduction is 40 – 50 % if the amount of the filler constitutes 80 % of the mass of the replaced lime. Peel ability and water retention are kept at the reference values , whereas the strength of the filled seven- day- old solution exceeds that of lime mortar by 60 % and the strength of twenty-eight-old day filled solution exceeds that of lime mortar by 15 %.

Additionally, it was found out that shrinkage deformation for cement - calcareous solutions was 1,5-1,8 mm/m, and for those with the cement filler 0,7-1,1 mm/m. In lime mortars shrinkage deformation control composition is 2,1 mm/m , while in lime mortars with the filler it is 1,2-1,4 mm/m.

Reduced shrinkage strain at 40 – 60 % promotes the formation of a more homogeneous structure, reduces the probability of occurrence of micro cracks and thus increases the strength of plaster containing the filler.

Viability is an important indicator in the production of plastering mortars. In order to find out the term of the possible use of mortars with the filler change in mobility over time was estimated.

Within half an hour a decrease in the mobility of cement and cement-lime mortars was recorded. After the first hour of the test only the mobility value of the filled cement mortar, where the amount of the filler constituted 100 % of the calculated weight of lime, remained unaltered. The greatest fall in the mobility by 1,6 cm was observed in cement mortar. 3 hours after the start of the test the mobility of the cement mixture reached 5 cm, and lime - cement – 5,5 cm. During the same time the mobility of the filled mortars decreased by 11 – 22 %. One hour later the mobility of cement -lime mortar was 4,9 cm and that of the filled ones amounted to 5,9 – 6,5 cm.

It was found that decrease in mobility of plaster mortars is much slower than that of cement or cement-lime and amounted to only 5cm after 6 – 8 hours after the start of the test. For plaster mixtures viability increases by 1 – 2 hours.

Intense change in mobility in plaster mixtures is due not only to low initial mobility, but also to a large amount of cement in plastering compositions.

In experimental plaster filler mixtures the increase of the dosage of the filler up to 100 % by weight of lime slows down the processes leading to hydration of cement and prolongs the term of its hardening, which can be explained by the increase in the amount of organic impurities containing in the filler – up to 10 % - and also by the presence of plaster – up to 9 %. At the initial stage of hydration there appears ettringit, which in a finely divided state slows hydration $3CaO \cdot Al_2O_3$ and prolongs the time of cement hardening.

An important indicator of durability of solutions is their frost resistance. When holding research there was determined the frost resistance of plaster mortars of M50 and M75 brands. The tests for frost resistance showed that changes in the strength of masonry solutions of M50 and M75 brands and their mass losses were not observed after 50 and 75 cycles, respectively.

In plastering compositions M50 brand strength reduction was observed after 55 cycles of freezing and thawing. During the examination of samples of plaster formulations after 60 cycles there was detected a slight peeling on the surface of the control and experimental compositions. After 60 cycles the cement-lime solution dropped in strength by 11 and the cement mortar with filler by 8 %.

It was recorded that the cement-lime mortar strength decreased by 25 % after 70 cycles. The strength of the filled mortar decreased by 17 %, and only after 80 cycles of the alternate freezing and thawing it decreased by 26 %.

In the samples of the plaster cement-lime mortar of type M 75 superficial peeling appeared after 75 cycles, with a slight decrease in strength by 8 %. Cement plaster filled mortar had no damage to the surface and only after 80 cycles slight peeling was noticed.

Strength test at 85 cycles of alternate freezing and thawing displayed the deterioration of the characteristics of the cement-lime mortar by 13 %, and those of the cement mortar with the filler by 7 %. After 90 cycles of testing the strength of the cement-lime solution decreased by 26 %. It must be noted that the magnitude of the fall in the strength of the experimental sample is half as much and is equaled to 12 %. The strength of the experimental sample reached the maximum permissible level only after 100 cycles and amounted to 23 %.

The decrease in frost resistance of mortars M50 and M75 within 5 – 10 cycles as compared to that of the masonry structures is determined by the difference in the composition as well as the granulometry of the filler, which is quartz sand. It causes the increase in the absorption of water. The dependence in question is confirmed by the data of water absorption by the mortars, which is 7,6 – 8,1 % and thus 15 % higher than that of masonry compositions.

For plaster M50 and M75 indicators of frost resistance differ by one brand. So cement- lime mortar M50 has a frost resistance brand F50, and a cement mortar with filler – brand F75. Lime-plaster cement composition M75 corresponds to frost resistance mark F75, and cement mortar with filler – mark F100.

Thermal performance of plastering mortars was determined on the mixtures of brand M 75. Cement-lime mortars served as control mortars. The control lime mortars had a ratio of components 1:6. The results are shown in tables 3 and 4. The indicators of density and a coefficient of thermal conductivity are for solutions in a dry state.

Table 3 – Heating technical parameters of cement mortars

№ compo-sition	Appointment solution	Consumption, kg		Density, kg/m^3	Coefficients. thermal con-ductivity (W/m·°C)	Thermal re-sistance, m^2·K /W	Factor vapor permeability, mg/(m·h ·Pa)
		lime	filler				
1	plaster	90	-	1820	0,51	0,048	0,1
2		-	72 (80 %)	1920	0,45	0,064	0,095
* – percentage filler input from the calculated mass of lime							

In experimental compositions with the filler density increases relatively to the control composition by 90 – 110 kg/m^3.The increase in the density of the solutions is due to the formation of a maximum dense structure of the cement filler, which lowers the initial emptiness of the system. It is also explained by a lower aquasolid interaction of the mortars with the filler.

Table 4 – Heating technical indicators of lime mortars

№ compo-sition	Appointment solution	Consumption, kg		Density, kg/m^3	Coefficients of thermal conductivity (W/m·°C)	Thermal resistance, m^2·K /W	Factor of vapor perme-ability, mg/(m·h ·Pa)
		lime	filler				
1	plaster	230	-	1690	0,39	0,081	0,12
2		147	78 (40 %)*	1780	0,35	0,095	0,11
* – percentage reduction of lime consumption by weight							

The coefficient of water vapor permeability of plaster lime mortars is 14 – 16 % higher than that of cement compositions. For cement mortars the coefficient of water vapor permeability virtually remains unchanged and is within 0,095 – 0,1 mg/(m·h·Pa) and for lime mortars it is 0,11 – 0,12 mg/(m·h·Pa)).

The formation of denser structure solutions with the filling results in lower open porosity as compared to control compositions. Therefore, despite the higher density of experimental compositions with a filler the indicators of factor conductivity are 11 – 15 % lower than those of the control compositions. Wherein the thermal resistance is increases by 15 – 25 %.

Thus, the heat engineering characteristics of cement and lime mortars containing the filler provide the necessary parameters for dressing both the exterior and the interior of buildings.

While determining the degree of adhesion of mortars containing the filler it was found that by using them as a base for ceramic bricks and concrete blocks, heavy fracture occurred within the solution, i.e. it bore a cohesive character. Despite the high surface roughness of gas silicate blocks destruction generally has an adhesive nature, with the partial destruction of the samples observed on the rough surface structure of silicate units. Adhesion strength to the surface of test solutions is 33 – 42 % higher than that of the control formulations and amounts to 0,3 – 0,59 MPa.

The results of the studies of adhesion of the filler-containing plastering mortar showed that in the control samples the degradation, regardless of the material of the base, occurred on the boundary between the mortar and the base whereas the contact surface of the solution remained virtually intact. The samples of lime mortars with the filler were destroyed within the structure of the solutions The adhesion strength of the test compositions reached 0,23 – 0,29 MPa which is 21 – 38 % higher than that of the solution with lime.

Research efforts reveal that the optimum filler for plastering cement mortars is that with the maximum size of particles amounting to 80 microns and the best share of it is 60 – 100% of the estimated mass of lime The durability strength of solutions with the filler within 7 days exceeds that of cement-lime mixtures by 14 – 17 %.

Optimum lime consumption reduction for plastering lime mixtures is 40 – 50 % with the introduction of the filler to an amount of 80 % of the replaced mass of lime. Water-retaining and peel ability remain at the level of the control data, whereas the strength of the filled mortars exceeds the strength of the lime composition by 60 % within 7 days and by 15 % within 28 days

The presence of the filler in cement plaster formulations can increase the viability of the mortars by 1,5 – 2 times which makes it possible to reduce the supply of the amount of the mortar to the construction sites thus decreasing labour intense and transport expenses. Cement plasters with the filler have a lower water absorption and lower strength drop in water-saturated state by 20 – 25 % compared to the cement-lime mortar which contributes to frost resistance increase by 15 % and ensures compliance with STB 1307 requirements.

Adhesion plaster cement and lime mortars filled more than 30 – 35 % of the performance of control formulations, which presumably would reduce the possibility of peeling plaster layer from the bottom in the operation of buildings in the event of exposure.

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DESIGN FOR SPECIAL POPULATIONS

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There is a small number of people that deviate from the healthy norm in society due to stages in human development, injury, traumas, congenital disease or genetic abnormalities. The design for special groups is created for these groups of people.

For many years, the needs of people with disabilities have been constantly ignored. Creation of necessary conditions for such people just was not considered important or essential.

But now, the design of interiors and buildings for the disabled has become of a different character. Design for people with special needs has become a standard component in the construction.

Nowadays people with disabilities can get into almost any office buildings, dwelling houses, shopping centres or cafes. Such opportunity has appeared through the creation of a special barrier-free environment.

Barrier-free environment or universal design allows all people, including older people and people with disabilities to move in the public space without anyone's help. It is an opportunity for people with disabilities to engage in social, professional and cultural spheres and sport life of the country, obtain decent education and qualified job and have a rich and full life [3].

Basic principles of the universal design are equality, respect towards each other's peculiarities and functionality.

A barrier-free environment is a space that allows free and safe movement, function and access for all, regardless of age, sex or condition. A space of services that can be accessed by all, without obstacles, with dignity