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Using concrete of different types for construction of road and airport coatings

Advantages of polymer-cement concrete in combination with simplicity of manufacturing and application, at small expenses of polymer do it not only effective, but also cost-effective materia

Due to the increase in the number of cars and their carrying capacity, intensity and speed of movement, the total load at airfields and highways, there is a need to expand the range of concrete mixtures and improve the quality of construction of cement concrete coatings.

World and domestic experience in the construction of roads and airfields from cement concrete has shown that this material is characterized by the ability to work for a long time not only without reducing strength, but also to increase it over time.

The main disadvantages of cement concrete coatings include: low tensile strength and tensile bending, low deformability, fragility, shrinkage in air, possible peeling with poor care of freshly laid concrete, etc. [1].

Improving the condition of cement-concrete coatings is possible through the use of modern types of concrete, namely:

- polymer cement concrete;
- dispersed reinforced concrete - fiber concrete;
- light concrete - foam concrete;
- high-strength concrete based on cast concrete mix;
- concrete on the basis of slag Portland cement.

This paper presents the results of research with polymer-cement concrete and fiber concrete, which were conducted at the National Aviation University at the Department of Reconstruction of Airports and Highways.

In the last decade in Ukraine and abroad much attention is paid to the use of polymeric materials for the preparation of cement-concrete mixtures. Polymer-cement concrete differs from the usual high tensile strength in bending and compression, impact, abrasion, has increased frost resistance, water resistance, resistance to aggressive environments.

The author investigated the effect of a polymer impurity based on unsaturated polyethylene terephthalate resin (PET), developed at the Institute of Physical Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine. Dynamics was added to the concrete mixture in the form of a polymer emulsion in the amount of 1.0% by weight of cement. It is characterized by the ability to polymerize in an alkaline environment of the hardening system and to actively influence the processes of structure formation of cement concrete.

Polyethylene terephthalate is adsorbed on the surface of hydrated neoplasms, which has a negative charge, reduces it to the "solid-water" boundary. At the boundary with the solid phase of cement clinker there is an increase in wettability by 1.3-1.5 times.

In addition, the introduction of a polymer additive reduces the modulus of elasticity of the sealing water, which increases the reactivity. This enhances the interaction between the excited water molecules and the binder, creating the conditions for better dispersion of cement particles and crystallization of more advanced tumors. As a result, a more dispersed, single-phase and strong structure of the curing system is formed [2].

The reinforcement does not corrode during the introduction of the polymer additive, no stains and effusions were observed on the surface.

To determine the effect of the polymer additive on the physical-mechanical and operational properties of concrete, studies were conducted on compressive strength, tensile bending and axial tensile, frost resistance, water resistance, abrasion, impact resistance. The research was carried out on samples made of concrete M 400. Cement Zdolbunivsky M 500. Samples hardened under normal conditions.

Performance properties include abrasion and impact strength.

Abrasion is determined on the circle LKI-3. Road surfaces and especially airfields are in difficult operating conditions.

Increasing the load capacity of cars, their number and speed increases the value of cement-concrete coating to wear, which causes due to the combined action of abrasion and impact. This effect is exacerbated during the winter operation of roads and airfields as a result of the action of sand or other abrasive materials during ice and the action of aggressive salts (NaCl and CaCl₂).

The ability of concrete to break under the influence of single or repeated instantaneous application of mechanical forces is characterized by impact strength, which depends on the structure, the nature of the adhesion of cement stone to the aggregate, the condition of the material.

The research results are shown in table 1.

Table 1.

The effect of polymer impurities on the strength of concrete

Indicator	Curing time	Cement mix	
		Without the addition of PET	With the addition of PET
Compressive strength, MPa	7	31,2	38,4
	28	37,2	44,5
Tensile strength in bending, MPa	7	3,25	5,84
	28	5,43	7,32
	60	4,96	7,66
Axial tensile strength, MPa	7	2,50	2,94
	28	2,95	3,76
	60	3,21	3,87

Table 1 shows that the impurity increases the strength of the cement-concrete pavement of roads and airfields (after 28 days of hardening, the increase in strength is from 12 to 20%).

Impact strength is higher in samples with a polymer additive because it has an effect on the damping properties of the mixture, which will stop the appearance of new ones and slow down the growth of existing cracks on the surface. Reducing the abrasion of cement concrete will increase the durability of the coating.

Thus, the introduction of a polymer impurity based on polyethylene terephthalate (PET) improves the physical and mechanical and operational properties of polymer cement by changing the number and nature of large pores due to increasing the degree of hydration of cement, the formation of a more uniform and homogeneous fine crystalline structure.

Fiber concrete. Disperse-reinforced cement concrete - fibroconcrete - is a material in which pieces of metal, glass, basalt, polymer and other fibers (fibers) are introduced, which increases crack resistance, abrasion, tensile and impact strength.

Fiber concrete products can be made without reinforcement with special nets and frames, which greatly simplifies the production technology and reduces its complexity.

Basalt fiber is characterized by significant tensile strength, modulus of elasticity, deformability, chemical resistance and is a domestic, economical material.

Two types of fiber were adopted for research, depending on the fiber thickness: coarse (GBF) - from 0.015 mm to 0.017 mm and thin (TBF) - from 0.009 mm to 0.012 mm. Fiber length 30-40 mm.

Physico-mechanical properties of basalt fiber are shown in table 2.

Table 2.

Physico-mechanical properties of basalt fiber					
Name of fiber	Physico-mechanical properties				
	Density, kg/m ³ x10 ³	Modulus of elasticity, MPa	Tensile strength, MPa	Deformation at gap, %	Fiber length, mm
coarse fiber (GBF)	4,4	900	4,5	2,1	40
thin fiber (TBF)	3,6	600	3,8	1,9	40

As can be seen from the data shown in table 2, the basalt fiber is characterized by high values of modulus of elasticity, tensile strength and slight deformation at break. In addition, the positive is that the temperature coefficient of linear expansion of the basalt fiber is close to the coefficient of cement stone.

Studies have shown that the introduction of basalt fiber reduces the resistance to cracking during prolonged loading, due to the intensive increase in creep deformation in the compressed zone and increase deflections, and in the stretched zone slower development of creep deformation.

Based on these data, we can conclude that the introduction of basalt fiber, both GBF and TBF significantly increases the physical, mechanical and operational performance of fiber concrete. This is due to improving the homogeneity of the

concrete and increasing the adhesion between the grains of the aggregate. This will ensure crack resistance, improve the deformable properties, ensure durability in accordance with applicable regulations.

Conclusions

1. As a result of the performed researches the possibility and prospects of application of polymer-cement concrete made with use of polymeric additive on the basis of unsaturated polyethylene terephthalate resin (PET) with high physical and mechanical properties (durability increases from 12 to 20%, frost resistance by 12%, water resistance in 3 times, abrasion is reduced by 50%).

2. The introduction of basalt fiber both HBV and TBV increases the physical and mechanical properties by about 20-25%, improves resistance to cracking and will help ensure durability in accordance with current regulations.

3. The optimal fiber content of 3% by weight of cement, length 30-40 mm, the introduction is better to perform in the aggregate. The clumping of the optimal amount of fiber when introduced into the mixture was not observed.

References

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