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Properties of Mortar With Addition of Fiber From Polymeric Waste

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Abstract: *In this paper the authors present the possibility to utilize some asphalt building waste materials to produce simple concrete. To prepare the mixes, Recycled Concrete Aggregate as a small aggregate of 0.16-5 mm fraction were used. Concretes with waste were mixed with 300 kg/m^2 of four types of cements. The concrete sample specimens were tested for mechanical properties which are related to durability. After 28 days compressive strength increase to 45 MPa and after 90 days 50 MPa were achieved.*

Polymer-modified mortar and concrete are prepared by mixing either a polymer or monomer in a dispersed, powdery or liquid form with fresh cement mortar and concrete mixtures, and subsequently cured, and if necessary, the monomer contained in the mortar or concrete is polymerized in-situ.

Key words: *mortar, polymeric waste materials, aggregate, durability*

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Introduction

Mortar, a key ingredient in masonry construction, is traditionally made by combining water with three constituents: Portland cement, hydrated lime and sand. Although altering the proportions of each of these provides a range of strength and other characteristics, traditional mortar has some disadvantages. Mortar with polymeric admixtures can be utilized advantageously and economically in certain circumstances. Polymer-modified mortar is made by replacing a portion of the traditional binders with polymers. Polymers are added to mortar to increase characteristics that may include adhesion, toughness, flexural or tensile strength, and resistance to chemicals. Polymers act to improve the workability and adhesion of nonhardened mortar and often require less added water than does traditional mortar, which results in fewer pores and stronger cements, subsequently reducing water ingress and permeability to salts. [1, 2, 3]. In addition to polymers, other types of materials are regularly added to mortars to achieve desired characteristics. Color pigments can sometimes be added to mortar to alter the mortar's appearance. Accelerators and retarders, when added, work to reduce or increase the length of time the mortar requires to cure, an important trait to manipulate in extremely cold or warm, humid weather. Other mortar additives include mineral additions, such as silica fume, aggregates and inert fillers, plasticizing chemical admixtures and fibers to help control shrinkage. A variety of cements were used CEM I 22.5, CEM I 32.5.

Materials and Methods

Portland cements CEM I 22.5 and CEM I 32.5 from Uzbek Cement Plant as per PN-EN 197 was used. As NA, river sand of 0,16-2,5 mm and 2,5-5 mm fractions were Zerafshan river. Water reducer Muraplast FK 88 was used. Regular tap water was used as mixing water.

Table 1. Proportions of mortar mixtures [kg/m3]

Material denomination	MIX-1	MIX-2	MIX-3	MIX-4
CEM I 22.5	300	300		
CEM I 32.5	-	-	300	300
metakaolin	20	20	20	20
natural sand 0,16-2,5	300	300	300	300
natural sand 2,5-5	600	600	600	600
polymeric fiber waste	400		400	
polymeric powder waste		300		300
water	160	150	160	150

*Previous to mixing mortar has been saturated, the saturation water is NOT incorporated in the ratio.

Four concrete mixtures were prepared. They contained 300 kg/m^3 of cement was used, together with metakaolin in an amount of 6%. Water reducer was used in the dosage of 5% by total mass of cement. Mix proportions are presented in Table 1. The workability of mortar mixtures was measured by flow table test, in accordance with EN 998-1:2016.

Compressive and Tensile Strength Test

Specimens were prepared and cured as per EN 998-1:2016. They were cast in steel moulds and underwent double compaction on vibrating table. After 2 days the specimens were demoulded and water-cured in the laboratory till the age of 28 days. The compressive strength tests were conducted in accordance with EN 998-1:2016 on 100 mm cube specimens after 28 and 90 days of hardening. The tensile splitting strength tests were conducted on the same type of specimens in accordance with EN 998-1:2016.

Results and discussion

Research results are presented in the Table 2. The results are mean values of four measurements. Only for fresh concrete mixtures, the result of flow is an average of three measured values.

Table 2. Test results

Concrete property / Sign of mixture	MIX-1	MIX-2	MIX-3	MIX-4
compr. strength 28d fcm [MPa]	15.1	24,5	30,0	31,2
tensile strength 28d fctm [MPa]	1,45	2,9	2,2	2,0
compr. strength 90d fcm [MPa]	26,9	29,0	34	35
tensile strength 90d fctm [MPa]	3.1	3,0	3,4	3,89
W/C	0,6	0,5	0,6	0,5

Compressive Strength of Mortar

The highest value of mean compressive strength 30,0 MPa was obtained for MIX-3 series containing CEM I cement. This mixture reached also the highest compressive strength of 34 MPa after

90 days, which means a strength gain of 28 % due to post hardening. A significant gain in compressive strength from 24,5 MPa after 28 days to 29 MPa after 90 days. Mixtures MIX-1 and MIX-2 did not obtain surprising gain in strength between 28 and 90 days, they were 14%, and 15% respectively. The difference was mainly the result of using 2,5-5 mm fraction of natural aggregate in MIX-1 concrete series instead of waste of the same fraction in MIX-2 concrete. This explains the requirement in EN-206 standard which exclude 0,16-5 mm fractions of waste from the usage in polymer production. At the same time if this strength decrease due to the fine waste is compensated, than the authors would not exclude the utilizability of such waste fractions [4, 5].

Tensile Strength of Mortar

In accordance with the compressive strength values, the highest splitting tensile strength after 28 days could be measured on the concrete out of MIX-4 mixture, which was 3,2 MPa. After 90 days the highest measured splitting tensile strength obtained was for concrete out of MIX-2 mixture, which was 5 MPa. As in the case of compressive strength concrete with fluidised fly ash gained only a small increase in splitting tensile strength after 28 days of hardening. The mean splitting tensile strength of the concretes is 5,89 MPa. Ehe average value for all concrete is 5.76. These are typical values for concrete of that level of average strength. Utilization of waste 5 mm fraction instead of NA resulted in 2.5% higher average tensile strength value.

Summary and Conclusions

Although polymers and monomers in any form such as latexes, water soluble polymers, liquid resins, and monomers are used in mortar and concrete, it is very important that both cement hydration and polymer phase formation proceed well to yield a monolithic matrix phase, with a network structure in which the hydrated cement phase and polymer phase interpenetrate into each other. In the polymer-modified mortar and concrete structures, aggregates are bound by such a co-matrix phase. The superior properties of the polymer-modified mortar and concrete to conventional mortar and concrete are characterized by such a distinct structure.

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