Research of light-weight concrete properties on base wollastonite addition

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ABSTRACT

An analysis the effect of using mineral Wollastonite as a small aggregate a in a mixes are reported. Four different mixes were prepared and tested, which Wollastonite was used as a sand from mass of quartz sand 10, 15 and 20%.in 2, 3 and 4 consists.

Investigated and test results showed, that incorporation Wollastonite mineral into a mix increase flexural straight to 134% and 132%

Key words: *Wollastonite, vermiculite, aggregate, compressive and flexural straight, aggregates, Light-weight concrete*

Introduction

Nowadays, to build and construction houses and other service house buildings are developed. Particularly, it can be reduce price of construction for heat insulating and energy-save houses and buildings from light-weight concrete in a places where are enough raw materials for it. Light-weight concrete and very light-weight concrete are main material in a building construction. This kind of material is calculated different type for using and standards. Day by day it is on the increase for building materials and products and quality of them.

There are new technology to get heat insulated concrete from waste and also used natural and synthetic aggregates. Such as light weight aggregate is vermiculite, reserve of raw materials are in Karakalpak Republic area. Vermiculite is getting from nature raw material swelling and roasting in 1000-1100^{0}C temperature.

Vermiculite has a porosity structure, so heat isolation material and can be useful as a large aggregate in a heat insolate light-weight concrete. Vermiculite is ecological clean, fire-resistive, bio-resistant and chemical inertness product. Its apparent density is 100-400 kg/m^3, real density is 1,1 g/sm^3, porosity is 70-80%, water-permeability is 40-45%.

Also, reinforcing is main aspects in concrete products. Wollastonite mineral is able for dispersion reinforcing in cement stone and concrete matrix, which influence of straight properties, manage of calculate light-weight concrete and develop it (picture 1). The concrete mixture is reinforcing with wollastonite fiber improve its plastic properties, decrease volume deformation and etc. Clearly, concrete mix during plastic condition the wollastonite fiber keep from micro and macro-cracks under adhesion [1].

Natural mineral, the so-called wollastonite is a natural calcium silicate of white or light gray color with the chemical formula $CaSiO_3$. Wollastonite - formed in the presence of insoluble residue Cao and

SiO_2. Wollastonite categorize with its sizes of fibers: 25 to 150 μm represents as a microfiber, less then 25 μm it is as a powder and more 150 μm like fiber. It was studied effect of natural wollastonite on functional properties, such building materials, as a cement and stone [1-8]. Up to date wollastonite was used basically paint and varnish and plastic industry. Unfortunately, wollastonite less used in cement compositions (concrete constructions), despite of needle-shape-structure, it has fine properties of straight [4].

a b

1-picture. Wollastonite mineral (a) and microstructure in 1700 times under microscope (b)

Experiments. Materials.

The experiments did in the laboratory №5 of Samarkand state civil engineering and architecture institute in Uzbekistan. (Cement-concrete testing center) For the experiments were used Portland cement of "Qizilqumcement" (CEM I 32.5N) 40 MPa similar to DRAFT INTERNATIONAL STANDARD ISO/DIS 679, quarts sand ISO (size of sand 0-2 mm) from career of Samarkand region and wollastonite sand delivered from Navoi region (Langar field). It consists of 60-70% wollastonite ($CaSiO_3$) and 250 kg/m^3 density of vermiculite coarse aggregate. During experiments were using press machine and numerical technology according standards.

There are characteristics and volume of concrete samples for tests in the given table.

№	Name of samples, sm	The age of concrete (day) and amount of samples (unit)				Total, unit	Main purpose of research
		7	28	60	90		
1	Cubes (vermiculite, quartz sand) 10x10x10 sm					12	Tests of light-weight concrete cube durability on base vermiculite and quartz
2	Cubes (vermiculite, quartz sand, wollasto-nite) 10x10x10 sm					12	Tests of light -weight concrete durability on base wollastonite

3	Prism (vermiculite, quartz sand) 4x4x16 sm	12	Tests of light -weight concrete prism durability on base vermiculite and quartz
4	Prism (vermi-culite, quartz sand, wollasto-nite) 4x4x16 sm	12	Tests of light -weight concrete prism durability on base wollastonite
5	Prism beam (vermiculite, quartz sand) 4x4x16 sm	6	Test of cement's durability

It has studied main properties of need components (cement, vermiculite, quartz sand, wollastonite) for preparing concrete mix. Also get mass every component to make B5 class concrete for first consist.

Light-weight concrete consist is calculate like this:

First consist (control) for $1m^3$: Cement-305 kg, quarts sand-300 kg, vermiculite coarse aggregate-245 kg, water-275 l. Components are given in C:S: Woll=1:1:0,9, there under W/C=275/305=0,9 (water-cement ratio). Volume weight of concrete is $\rho=930kg/m^3$.

Second one (introduce 20% wollastonite of mass of quartz sand): Cement-305 kg, quarts sand-240 kg, vermiculite coarse aggregate-245 kg, water-275 l, wollastonite -60 kg. Components are given in C:S: Woll=1:1:0,9, there under W/C=275/305=0,9 (water-cement ratio). Volume weight of concrete is $\rho=930kg/m^3$.

Third consist (introduce 17% wollastonite and vermiculite 16,5% of mass of quartz sand): Cement-305 kg, quarts sand-208 kg, vermiculite coarse aggregate-285 kg, water-275 l, wollastonite -52 kg. Components are given in C:S: Woll=1:1:0,9, there under W/C=275/305=0,9 (water-cement ratio). Volume weight of concrete is $\rho=930kg/m^3$.

Fourth consist (introduce 10% wollastonite and vermiculite 33% of mass of quartz sand): Cement-305 kg, quarts sand-176 kg, vermiculite coarse aggregate-325 kg, water-275 l, wollastonite -44 kg. Components are given in C:S: Woll=1:1:0,9, there under W/C=275/305=0,9 (water-cement ratio). Volume weight of concrete is $\rho=930kg/m^3$.

Preparation of mixture were executed on standard DRAFT INTERNATIONAL STANDARD ISO/DIS 679, using automatic mixer (Mixmatic). Mixture was compressed down on vibratory table in plastic forms of size 10x10x10 sm cube samples. Preparing concrete mix has density 870-900 kg/m^3 after 28-90 days hardening.

The experiments did in the accreditation laboratory № 5 of Samarkand state civil engineering and architecture institute in Uzbekistan. Samples are tested in 7, 28, 60- and 90-days ages. Compressive toughness of concrete cubes are checking in MS-50 hydraulic press.

Results and discussions.

Tested results were shown (look tab.1).

Table 1.

Results of samples on toughness of compressive

2mixes	Бетоннинг сиқилишдаги мустаҳкамликлари			
	7 days	28 days	60 days	90 days

	R_b,MPa	%	R_b,MPa	%	R_b,MPa	%	R_b,MPa	%
1-consist	3,0	100	4,0	100	4,3	100	4,4	100
2- consist	3,4	113	4,8	120	5,3	123	5,5	125
3- consist	3,5	100	4,9	123	5,7	132	5,9	134
4- consist	3,6	120	5,0	125	5,5	127	5,8	132

Note: there are wollastonite sand from mass of quartz sand 10, 15 and 20%.in 2, 3 and 4 consists.

Tested results were shown, that introduce the wollastonite sand bring to increase of boundary straight of light-weight concrete at W/C=0.9 in age 90 days at compressive to 34%. Also, consist of 10% wollastonite sand's toughness in 28 and 90 days are 5,3 and 5,5 MPa. Compare than control mix increase of toughness at 20% and 25 % in a 28- and 90-days ages. So, consist of 15% wollastonite sand's toughness in 28 and 90 days are increase of toughness at 23-25% and 34-32 % in a 28- and 90-days ages.

Summary and conclusions:

One more quality of Wollastonite extending on length structure crystal, under splitting which are formed grain-needle forms. Needle forms of grain of Wollastonite apply as a micro-reinforcing [2]. The crystals of Wollastonite, having needle forms the surface which, possessing certain roughness forms around itself if creative thinking, certain associates from surrounding materials, forming matrix of the main composition of cement compositions. Reducing thereby degree of their mobility independently of one another. So noticeably decrease the processes of the deforming the shrinkage, for instance when repeating over and over again to cement compositions (the concrete at usages). Possessing good adsorptive characteristic, it reduces tap-forming. Mircro-reinforcing characteristic of Wollastonite and high adhesion to surface provides increasing straight factors and value of toughness of the traction it with surface [3, 4].

1. Using wollastonite sand as a small aggregate with fineness modulus M=1,5-2,0 increase straight of heat insulate light weight concrete up 25-30%. It can be wide using of light weight concrete and very light weight concrete in construction.

2. The surface of Wollastonite at contact with water hydrolyze, forming hydroxide calcium, which provides alkalinity of the dispersion of Wollastonite. It possesses the strong buffer effect in tart solution due to liberation ion calcium. The product of hydration and transformations of Wollastonite in harden cement concrete presents itself on structure one-calcium hydro-silicate of calcium. The main mass of lime, standing out at hydrolysis and hydratation the cement, spontaneous accumulate in the manner of hydrate oxide calcium around grain of Wollastonite, forming thick crystalline framework. As well as was revealed as a result of experiment, its physic-mechanical characteristic with cement-consist raw materials composition, active electoral adsorption of the products hydration of connecting, renders the essential influence upon rheological parameters of mixtures, easy-shaping the structure, straight and deformative characteristic of hardened composites. This increase in hardening time prefixes the delays an hydration to proper increase Wollastonite concentrate in cement composition. Wollastonite really image in mixture as narrow framework surrounding cement particles to precluding penetration of water, and react on delays of hydration.

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