The investigation on the effect of the aggregate type in the modulus of elasticity and tensile strength in high strength concrete

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Abstract

Given the progress of the concrete technology and use of the high strength concrete (HSC), the transformation criterion designing the constructions and the strength of the material used will not be the only construction design criterion and some other considerations such as the tensile strength and the elastic hardness need to be taken account. In this research, among the parameters effective on the concrete properties, we investigate the effect of the aggregate type on the compressing strength property and the elasticity modules of the high strength concrete. In this direction, the concrete samples with the aggregate of Dolomite, Granite, Silica and limestone and with pettling and identical mixing design have been provided. In continuation, the results of the strength experiment in given ages have been presented for studying the characteristics of the tensile strength and elasticity modules in this concrete, the results have been shown that the aggregate type is very important in the strength features and the module elasticity in high-strength concrete but it's not very effective in the tensile strength.

Keywords: aggregate type, the tensile strength, elasticity modules, high strength concrete.

1- Introduction

Among the special concretes, high strength concrete is very important. Different sources have mentioned different definitions for this concrete. But the evidence says that the compressing strength basis 42 Mpa was chosen as the low limit of this concrete. The definition of the high strength concrete in relative and is related to the time of executing the project and its location. Although use of the high strength concrete in the armed concrete construction began in the 20th century, its practical application rapid growth refers to about 35 years ago. Despite the relative knowledge of designer engineers and the contractor with it, it seems its potential facilities haven't still been manifested [1-2-3-4].To calculate the transformation and the factorial leap, it is necessary to know the relationship between the tensile, strain and elasticity modules. Also, the tensile strength, usually it is ignored in designing the armed concrete members except for controlling the crack up of the sector that knowledge about this parameter is very necessary [5-6].

Therefore, in this research, we proceed to investigate the effect of the aggregate type in elasticity modules and the tensile strength of the high strength concrete (HSC) by using four types of different aggregates.

2- Laboratory research

2-1- Materials

In this research, we attempted to use the materials of the region. For this reason, we use the cement typ-2 in mazandaran cement factory. The density of the mentioned cement is 3.15 and the other properties of the cement have been mentioned in Table1.The silica fume used in this research is the one is Iranian, ferroalloy industries company “micro silica” in hydrolical powder included active particles Amorof sio_2 and from the products of Iranian faro silicate factory that possess the bulk density 205 kg/m^3 and added to the concrete mixture drily. Its color is grey whitish and the special level of the consumed silica fume is 14 m^2/gr. Also, the properties of the mentioned silica fume have been recalled in Table 1.

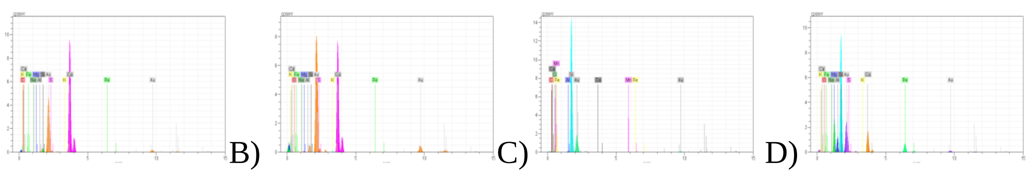
Chemical combinations	Percentage in cement	Percentage in silica fume	Chemical combinations	Percentage in cement	Percentage in silica fume
Sio_2	21.25	93.5	Cao	64.07	0.49
Al_2o_3	4.95	1.32	Mgo	1.20	0.97
Fe_2o_3	3.19	0.87	So_3	2.04	0.10
K_2o	0.63	0.63	Na_2o	0.38	0.31

Table 1. the chemical breakdown of cement and the consumed silica fume.

The materials used in the concrete generally play an important role in tolerating the loads imposed on the concrete. Gravel as the large flake pays an important role in tolerating the loads on the concrete and the grit as the small flake is applied to fill the empty spaces among the large flakes. In order to create the experimental samples some aggregates of the type of granite, dolomite, lime and silica were used. After comparing the results, pettling of all aggregates was used by identical pettling curve and the maximal size 19mm. Meanwhile, in this research, a trembler machine was used to sieve the loops. Also, the chemical and physical properties of the consumed aggregates are observed in Table 2 and Figure 1, respectively.

The Percentage of water absorption 24 hours	The Bulk single weight kg/m3	compressing strength Kg/cm^2	The quality of aggregate
5.5	1.736	840	Dolomite
11.8	1.565	540	limestone
2.75	1.902	930	granite
5.8	1.832	890	sillica

Table 2. the physical features of the stone material uses.



A) B) C) D)

A) The spectrum of chemical analysis in lime aggregate. B) The spectrum of chemical analysis in Dolomite aggregate.C) The spectrum of chemical analysis in Silica aggregate. D) The spectrum of chemical analysis in granite aggregate.

Figure 1: chemical analysis of the stone materials.

The super Plasticizers used in this research of "Vandchemiy" Company are with the P.C.E basis. This material is dark brown and in the temperature 20^0c, it single weight is 1.1 gr/cm^3. The consumed water is the beverage water in Babol.

2-2- Technique, order and design of mixing and curing

At first, stone spores completely prepared and cleaned before, assumed given the weight and the size of the concrete needed and the pettling curve based on the given studies and weigh the mixture design based on Table 3 in suitable ratio and pour from large pettles to smaller ones into the concrete, the mix them in the concrete for one minute and a little water add along with the extra smoother (about 10% consumed water in design), then the cement along with the silica fume weighed to the stone materials and we mix them for one minute and at the same time while the concrete machine is on add a little water along with the extra smoother. The turning time of the concrete machine is the same for all mixtures and about 4±1 minutes. After finishing for mixing the concrete, we use them in cube molds 10×10×10 cm completely cleaned and lubricated before in 3 layers with the same height and each layer along with 25 hits and in continuation of the experiments of the humid concrete. Summarily, the conditions of this experiment are based on the standard BS 1881: part 108:1983. To cure and the experiment time, the samples go out of the mold carefully and with no hit after 24 hours and the samples were retained in saturated environment (completely floated in water) and it the natural environment in the laboratory 27±7 degrees centigrade till 28 days.

The ratio of water to cement materials	Sand and gravel (kg/m^3)	Super Plasticizers (kg/m^3)	Silica fume (kg/m^3)	Water (kg/m^3)	Cement (kg/m^3)	Materials
23%	1450	6.96	123.5	177.90	650	(Design1)Dolomite
23%	1450	6.96	123.5	177.90	650	(Design 2) limestone
23%	1450	6.96	123.5	177.90	650	(Design 3)Granite
23%	1450	6.96	123.5	177.90	650	(Design 4)silica

Table 3.The mix proportions of the materials used.

To cure to the experiment time, the samples out of the mold carefully and with no hit and the approximate time 24 hours and some of the samples were retained in saturated environment (completely floated in water) and it the natural temperature of laboratory 27 ± 7^0c and till 28 days. The remainder of the samples in boiler was retained for 3 and 7 days and with the fixed temperature 85^0c.

2-3- compressing strength:

The digital electrohydraulic loading set with the capacity of 200 KN made of Azmoon company and the loading rate 4 (fixed for all samples) and all samples put in the environment of laboratory 2 hours before the experiment until their surface to be dried and the negative effect of the water compressor in the samples is in contact with the mold leading in decreasing the compressing strength of the concrete. The cube samples are put in two systems from the direction that the surface of the samples to be in contact with the die. Shortly, the conditions of this experiment is based on the standard BS 1881: part 108: 1983.

2-4- Splitting test:

This test is called indirect tensile test (Brazilian). The concrete cylinder is between the two stirrups and for better performance is under and above the cylinder in diameter 15 and height 30cm, two layers of boards with wood and the force is implemented so that the sample bursts and becomes two halves from the middle. Then, with reading the force imposed on the cylinder (p), we can find the tensile strength for the concrete. Shortly, the conditions of this test is based on the standard ASTM C496-90. In Figure 2 the method of testing the tensile strength and it system has been presented. The method of calculating the tensile strength is based on the equation 1:

$$F't = \frac{2P}{\pi LD} \qquad (1)$$

Where ft, the tensile strength (KPa), P is the imposed load (KN), L is the length of the sample (m), D is the diameter of the sample /m.

2-5- Elasticity module

To determine the elasticity moduleof the concrete from the cylinder samples in a diameter 15 and height 30cm was used. At first two metal strips that their vertical distance from each other is 150mm and the tension measuring was done according to Figure 2 and put into the cylinder, then along with the cylinder was put vertically under the compressing machine. By calculating the contradicted strength in the elastic scope of the concrete (40 percent of the compressing strength) the number of the compress are turnings after reaching the system indicator to the calculated strength was reviewed. Then 0.002 mm was multiplied until the changing of the two metal strips is resulted. The number turning of the tensile measurements was reviewed about the set. By specifying the pressure with two gratitude 50×10^{-6} was estimated.

$$E_c = \frac{(s_1 - s_2)}{E_1 - E_2} (2)$$

Where E_c is the hypotenuse elasticity module, S_2vthe tension equal to 40 percent the cylinder pressure strength, s_t the tension the length 50×10^{-6}, E_2 was calculated and reviewed by the strength system related to the pressure 50×10^{-6}.

2-6- Testing the dynamic elasticity module (ultrasonic)

The generator is related on the concrete surface. After passing the pulse from the length L from the concrete, the vibrations of the generation pulse of the secondary generator (receiver) turns into the electronical singles.The electronical circuit of the set can measure the pulse pass time in terms of microsecond T. pulse speed V (km/s or m/s) is obtained from the equation:

$$V = \frac{L}{T} (3)$$

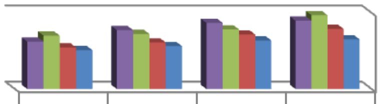
Where L is the length of pulse pass and the time when the pulse passes from the length L [7] The frequency of the sent pulses from the set was 54KH^2 and the pulse transition time is in terms of and carefully 0.1 micro second is displayed on the digital screen of the set. Based on the researches of the other researchers, use of the frequency 48-80 KHz is suitable to assess the concrete [8].Over each sample in the number of 7 readings from the time of passing the pulse was conducted in different parts of the concrete surface. The waves for each sample, the average speed in two surfaces vertical t each other were considered. After the test, by taking mean from the results, one number was recorded as the time of pulse transition for the given sample. In this research, the proposed relation of standard Iran was on Ghorbani Aghdam et al'sstudies, good results were conducted [9]. To determine the dynamic elasticity module, the relation 4 was used:

$$E_d = \rho V^2 \frac{(1+\mu)(1-2\mu)}{1-\mu} \qquad (4)$$

3-Experiment results

The results of the tests the testing concrete samples in this research given the presented conditions in the previous part after curing were tested. The results of all tests of the samples were the mean of the results for each sample that is hidden in the calculations. The results obtained by the compressing strength the samples with different aggregates have been shown in Figure 3.

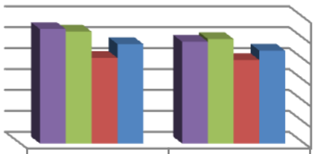
Figure 2:The technique of testing to determine the elasticity module and the system used for the ultrasonic test and the technique of putting the generators in it and the method of testing tensile strength (from right to hand, respectively).



	7 days	14 days	28 days	90 days
lime stone	51.1	56.38	63.9	65.2
doloomite	54.68	61.22	71.55	79
silis	70.12	72.35	78.28	97
granite	62.3	77.41	86.86	89.8

Figure 3:The results of the compressing strength test.

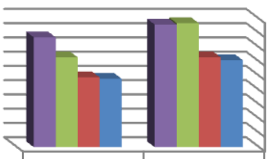
The results obtained by the tensile strength of the samples with the different aggregates were shown in Figure 4.In Figure 5 the results of module test shown.



	28 day	7 day
dolomit	4.76	4.44
limestone	4.09	3.99
silis	5.35	5.00
granite	5.47	4.87

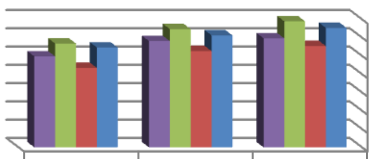
Figure 4:The results of the tensile strength test.

A)



	7 days	28 days
lime	48	61
dolomitte	49	63
sillis	63	87
granit	77	86

B)



	28 days	56 days	90 days
dolomite	54.62	61.25	65.34
limestone	43.48	52.69	55.43
granit	56.77	64.68	68.92
sillica	49.76	58.14	59.61

A)Results of elasticity moduletests. B) Result of dynamicmoduletests.

Figure 5:The results ofmodule tests.

4- Conclusion

Based on the conducted researches and with considering this topic that these results are related to the single sample of the aggregates in the laboratory project. All in most cases the decisive state needs the decisive need to the wider laboratory programs. The following cases are resulted:

The compressing strength of the high strength concrete is intensely influenced by the aggregate features and the technique of curing. Generally in the studies performed the samples with aggregate strength increase, the concrete strength increased (Figure 3). It's clear that the concrete compressing strength cannot sign if: cantly get more than the aggregate strength. We must note that the necessary strength for the aggregates must be more than the concrete strength. The type of the aggregate plays an effective role on the mechanical properties of the concrete. This efficiency has been observed in elasticity module of the concrete. And the ultrasonic pulse speed technique as one of the nondestructive tests in concrete in estimating its properties, it may have a good performance about the high strength concrete. By increasing the sonic speed and the dynamic elastic constants in aggregates, the final strength of the concrete becomes more. The constructed concrete with the granite aggregates shows increase in the wave speed. A sit was shown in above Figures (Figure 5), the samples of the concrete buit with aggregate silica has the highest static elasticity. This may be accounted for so that with the different, the concrete texture becomes harder and denser.

The tensile strength of the concrete high strength is very unimportant compared to its compressing strength. The concrete containing the aggregates don't follow the compressing strength but we can say that by increasing the age of the sample and strength of the aggregates, the tensile strength increase a little (Figure 4). The concrete containing aggregates that has the most compressing strength. The highest strength tensile is related to these samples more the pressing resistance is higher, less the tensile one.

That with increasing the pressure, the interior cracks in the paste widened and connects to the interior cracks in the tranpitional (Nold). On the other hand, under the tensile load, developing the cracks are faster while the cracks up fails and conducts the more cracks faster than the usual. For this reason, in the manner of fragile, the concrete is interrupted under the tensile loads while in the pressure for this reason the tensile autoreqrassion is lower than its pressing strength. Finally, we can say that the Dolomite due to being cheap and suitable to the other aggregate and being unimportant the differences, among equregates structurally.

5- References

[1]. Morteza hsannejad, (2011) "investigation physical and mechanical of high strength concrete" architecture and construction materials conference, sari, iran,

[2]. Adam Neville &j.j. brooks, (2002)"concrete technology" translated by hormoz family, publish by Building and housing research center

[3]. P. Kumar Mehta & Paulo J.M. Monteiro ,(2009) "Concrete Microstructure, Properties, and Materials" Third Edition translate by ramzanianpoor and others

[4]. P. Kumar Mehta & Paulo J.M. Monteiro , (2002) "Concrete Microstructure, Properties, and Materials" Third Edition

[5]. Kosmatka, S., Kerkhoff, B., Panarese, W., (2002) "Design and Control of Concrete Mixtures", (14th Edition), Portland cement Association

[6]. Adam Neville &j.j. brooks (2008) "concrete technology" translated by Ali akbarramzezannianpoor and others publish amir kabir university

[7]. Building and housing research center (2066) "standards for assessment of concrete strength in structure (non-destructive and semi destructive tests" Iranian building codes and standards no 316-Tehran

[8]. Saad A, Abo-Qudias (2005)"Effect of concrete mixing parameters on propagation of ultrasonic waves, construction and building materials, 19, pp 257-263
[9]. Mansur ghorbani vahdadzargari, hasan afshin (2007) "underestimate of some properties of high strength concrete with ultrasonic" 4 th national congress in civil engineering, Tehran university