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The Effect of Setting Retarder "Addiment Vz1'' Additive on the Compressive Strength of the Concrete

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ABSTRACT

The additives that set the hydration time of the cement in concrete and extend workable life of the concrete are called 'setting retarder additives'. The usage purposes of these additives can be listed as concrete pouring in hot weathers, the carriage of the concrete to far distances and the production of pumped concrete.
Totally 16 pieces of 15*30 cm cylinder samples were prepared for this study. The setting retarder Addiment VZ1 additive was used in four different proportions (0%, 0.5%, 1%, 1.5%). Four 15*30 cm cylinder samples were prepared for each proportion. At the end of 7 days, compression test was carried out on these samples and their compressive strength values were determined.
In conclusion, the compressive strength values of the concrete samples including setting retarder additive in certain extent were higher when compared to the samples not including any additive.
KEY WORDS: Setting, Concrete, Additive, Compression, Strength

1. INTRODUCTION

The additives are organic or inorganic chemical substances that are added to the concrete in small amounts except water, aggregate and cement. The usage of these substances is not a requirement for concrete production. These substances, which do not have extensive usage in our country, have a large practice area in the countries that have high technology and even the concrete production without additives is gradually diminishing. (2)

The usage of additives in concrete was considered as unnecessary until 1960s. However, later on, the concrete chemical additive agents has become the indispensible part of the concrete. It is observed that the 50% of the concrete produced in western countries include additive agents.

The usage of chemical additive agents has become widespread today. The concrete production without additive is not preferred any more. However, if the practice is not carried out properly, good results may not be obtained. Moreover, if the calculation, production and cure of the mixture is not performed in accordance with the methods, it is not possible do improve the quality of the concrete with the additives.

The additives have some negative side effects except their purpose. The concrete additive agents may show incongruity with cement and secondary binding materials or with other chemical additives used at the same time in the concrete they are used. Another problem is that the additives are usually added to the mixture in certain proportion of cement amount. Therefore this proportion should be paid attention and also the additives bring additional costs in a construction. (6)

Today, the usage of additives in concrete production has become inevitable. We cannot solve the problems as the blending of the concrete arising from the project conditions, the restrictions in placement times, unfavourable weather conditions and the problems that may arise during the placement. (1)

By using the setting retarder additives, we can increase the workability of the concrete. We can provide the mold and floating surfaces to be smoother, we can control the setting durations and especially we can prevent basic cracking in mass concretes.

The aim of this article is to predict the quality of the concrete with vz1 additive. The article consists of the following sections: Material and method, Experimental findings and evaluation, Results and Recommendations. The target of Material and Method section is to present the material and laboratory study facilities, and give the description of method. Experimental findings and evaluation section aims the finding data and evaluations. And finally in the section of Results and Recommendations it is tended what has been giving as a decision.

2. LITERATURE SCANNING

In the study conducted to retard the setting of the concrete, borax disodium phosphate and sugar were used as setting retarder. With the usage of these three additives, a certain increase in the strength of the concrete was observed.(3)

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In concretes produced by adding chalk flour to the concrete mixture, between 15-20 % increase in compressive strength was observed. (4)

In tests with setting retarder additive agents, it was found that the strength was 20% higher in the same cement amount than control concrete. (5)

In the tests with polyphosphate, gluconate and dextrin based setting retarder additives, by keeping the proportion of water- cement stable, an increase in 7 days compressive strength of the concrete samples was observed when compared to control concrete. A 24% increase was observed in compressive strength of concretes produced with hydrocarboxylic acid based setting retarder additive. (1)

3. MATERIAL AND METHOD

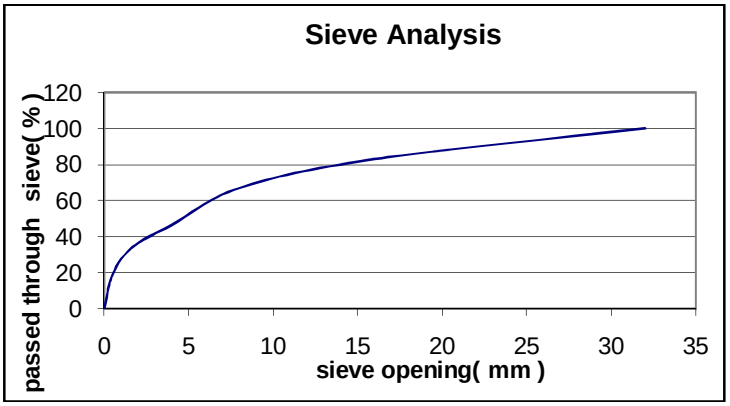
3.1. Material

In concrete production, Additive Portland Cement 32.5 cement that is prepared according to Turkish Standart 12143 standard was used as cement.

As additive agent, four different proportions (0%, 0.5%, 1%, 1.5%) Addiment VZ1 setting retarder produced by the company of Deitermann whose centre is in Datteln city, Germany, was used.

As a result of the sieve analysis performed, it is the aggregate whose maximum grain diameter (Dmax) is determined as 32 mm. As a result of the tests carried out on the aggregate that was used in the concrete mixture, the weight per unit of volume was found as 2,60 kg/lt and water absorption rate as 3,55 kg/lt. The sieve analysis graphic of the aggregate is shown in Figure 1.

Figure 1. The sieve analysis graphic of the aggregate used in the test



The results of the sieve analysis are given on table below..

Sieve Opening (mm)	32	16	8	4	2	1	0,5	0,25	Bottom
Passed through the sieve (%)	100	82,99	67,04	46,58	36,6	27,76	19,3	12,2	0

Table 1. The Results of Sieve Analysis

3.2. Method

3.2.1. The Preparation and Placement of Concrete Mixture

BS 20 concrete, whose maximum grain diameter is 32 mm, water/cement rate is 0,53 and slump value is 3 cm, was prepared in this study. In the prepared mixture for 1 m^3 concrete, the rates of aggregate, cement and water below were used.

Sand	**380 kg**	
crushed sand	874 kg	
pebble	247 kg	
angular aggregate	399 kg	
Cement	311 kg	
Water	165 kg	(12)

From the samples taken from the prepared concrete mass, standard cylinder samples (15*30 cm) and being four pieces for each additive proportion totally 16 samples were used.

3.2.2. The curing of Test Specimen

The concrete samples were removed from the molds after 24 hours from pouring process and were placed in curing tank that was at 200 ^{0}C heat. Then, they were made wait in the curing tank for 7 days.

3.2.3. The Devices Used in the Test

In order to determine the 7 days compressive strength of the concrete samples, hydraulic press device that can apply 1000 KN compression was used.

4. Experimental findings and evaluation

The data concerning concrete compressive strength performed on concrete samples are given on Table 2.

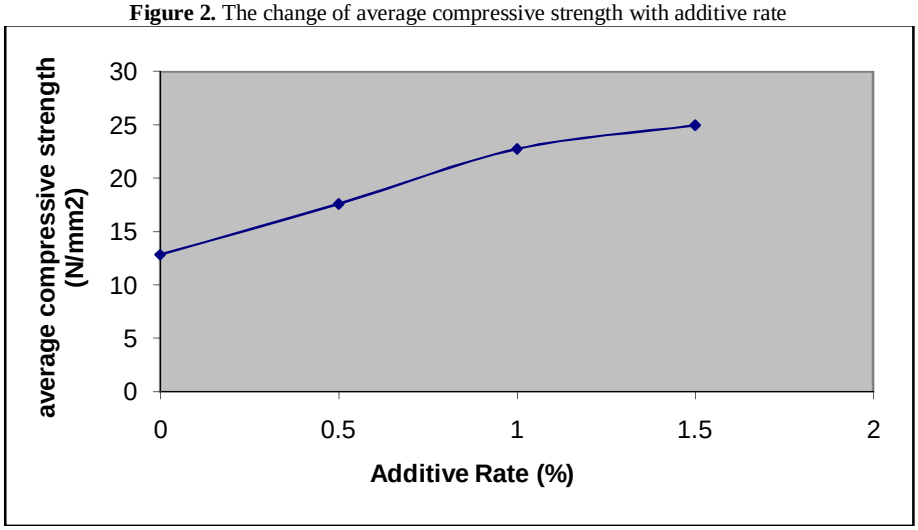
In order to see the effect of setting retarder Addiment VZ1 additive agent on concrete compressive strength, the technique of variance analysis was applied. The test is a four special level, four factors, four repetitive for each additive rate, completely random experiment. An also, the mechanical results concerning the test are given on Table 2 as graphics.

Tries	I	II	III	IV
Additive Rates	**% 0**	**% 0.5**	**% 1**	**% 1.5**
7 days compressive strength values (N / mm²)	13,05 11,97 12,60 13,61	16,67 19,30 15,99 18,31	23,60 22,41 21,77 23,09	25,33 24,67 25,50 24,27

Table 2. The concrete compressive strength of concrete samples that setting retarder additive agents were applied in several proportions

In the compressive strength values obtained according to different additive rates, minimum value was measured at 0% rate as 11, 97 N/ mm² and maximum value at 1, 5 % rate as 25, 50 N / mm².

Figure 2. The change of average compressive strength with additive rate



4.1. Single Direction Variance Analysis

In order to make the obtained data meaningful and compare them, single direction variance analysis was applied and it was studied whether the setting retarder Addiment VZ1 additive agent had any impact on compressive strength of the concrete.

The model equation belonging to our test for this was set as;

$Yij = \mu + \tau j + \varepsilon ij$

i = 1,2,3,4 j = 1,2,3,4 and the data outline obtained for the single direction variance analysis is given on Table 3.

Level	I	II	III	IV	
Repetitive measurements	13,05 11,97 12,60 13,61	16,67 19,30 15,99 18,31	23,60 22,41 21,77 23,09	25,33 24,67 25,50 24,27	
S.j	51,23	70,27	90,87	99,77	S.. = 312,14
Nj	4	4	4	4	N = 16
Nj					
$\sum_{j=1} Y^2_{ij}$	12,807	17,567	22,717	24,942	Y = 19,508

Table 3. The data outline for single direction variance analysis

Here; S.j , j. is the total of observations in test, , nj , j. is the number of the observations in test and Y.j , j. is the average of the observations in test. S.. is the general total of all of the observations and Y., is the average of all observations.

With the help of Table 2, the general sum of squares (SS) was calculated as follows:

$$SS_{general} = \sum_{j=1}^{k} \sum_{i=1}^{nj} Yij^2 - (S^2 / N) = 365,18.$$

Sum of Squares (SS) between tries were calculated as follows: :

$$SS_{try} = \sum_{j=1}^{n} (S^2ij / nj) - (S^2 / N) = 353,99$$

and from here Error sum of squares was found as follows:

SS Error = SS general – SS try= 11,19. With the help of these values found variance analysis table (Table 4) was created.

Source	Sd	SS	AS (Average of Squares
Between tries τj	3	353,99	117,99
Within try or error εij	12	11,19	0,932
General	15	365,18	

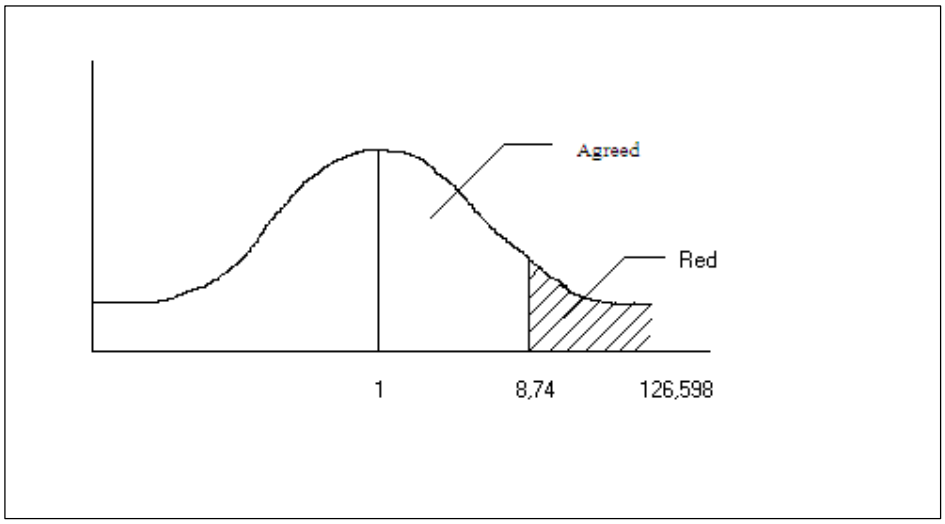
Table 4. Variance Analysis Table

To verify the accuracy of the test conducted and the data " F " test was chosen. According to this, F value with calculation method was calculated as

F3,12 = 126 , 598.

Considering α= 0,05 significance level, it is found as F(3,12) = 8,74 from " F " dispersion table. As it is F (calculation) > Table, it was found that the additive had an effect on the compressive strength of the concrete and the related significant graphics it as on the Table 3.

Figure 3. F Test Graphics (α = 0,05 Significance Graphics)



4.2. Right linear Relations

For the variance analysis control, right linear relations should be set up between the additive rates. As the degree of freedom between additive rates is 3, three right linear relations can be set for the molds, so it is as;

$$Cm = \sum_{J=1}^{3} C\,jm\,.S.j \quad \text{and} \quad \sum_{J=1}^{3} C\,jm = 0,$$

And right linear relations as

C1 = S1 - S 2

C2 = S1+S2-2S3

C3 = S1+S2+S3-3S4 are set up,

fullfilling the conditions of

$$Cm = C1m.S1 + C2m.\ S2 + C3m.S3 + C4m.S4 \quad (1)$$

C1m.S1 + C2m.S2 + C3m.S3 + C4m.S4 = 0.
The coefficients of these relations are shown on Table 5.

	S1	S2	S3	S4
C1	+1	-1	0	0
C2	+1	+1	-2	0
C3	+1	+1	+1	-3

Table 5. Right Coefficients Table

In the (1) equation given above, the values are put in their position and the results of each relation is found.
It is calculated as
C1= -19,04
C2= -60,24
C3= -86,94.

If the sum f squares concerning these is calculated using

$$SSCm = Cm^2 / (n \sum_{j=1}^{k} C^2jm) ;$$

it is found as follows:
SSC1 = 45,31
SSC2 = 151,20
SC3 = 157,47. A hypothesis test was carried out for each right linear relation and the obtained results were organised as seen on Table 6.

Hypothesis	A.S	S.S	F(3,12) - (calculation)	F(3,12) -(table)	Hypothesis Result
H1: S1=S2	0,932	45,31	48,61	8,74	Red
H2:S1+S2=2S3	0,932	151,20	162,23	8,74	Red
H3: S1+S2+S3=3S4	0,932	157,47	168,96	8,74	Red

Table 6. Hypothesis Test

At the end of "F" test performed at α = 0,05 significance level, as it is as F (calculation) > F (table), there is the effect of additive in different proportions on the compressive strength of the concrete. The average of the 7 days compressive strength values of concrete samples poured with additive in different proportions are differ from each other at α = 0,05 significance level.

4.3. Width Test

For the width test of test averages “Student - Newman -Keuls" width test was chosen. If we put in order the averages of the data of the concrete samples obtained from additive in 4 different proportions from the lowest to the highest;

Yj (Average)	12,807	17,567	22,717	24,942
Test No	1	2	3	4

The standard error of the average here is found as Syj = 0,4827.
According to Student test results, the magnitude greatness sequences considering difference levels are given on Table 7.

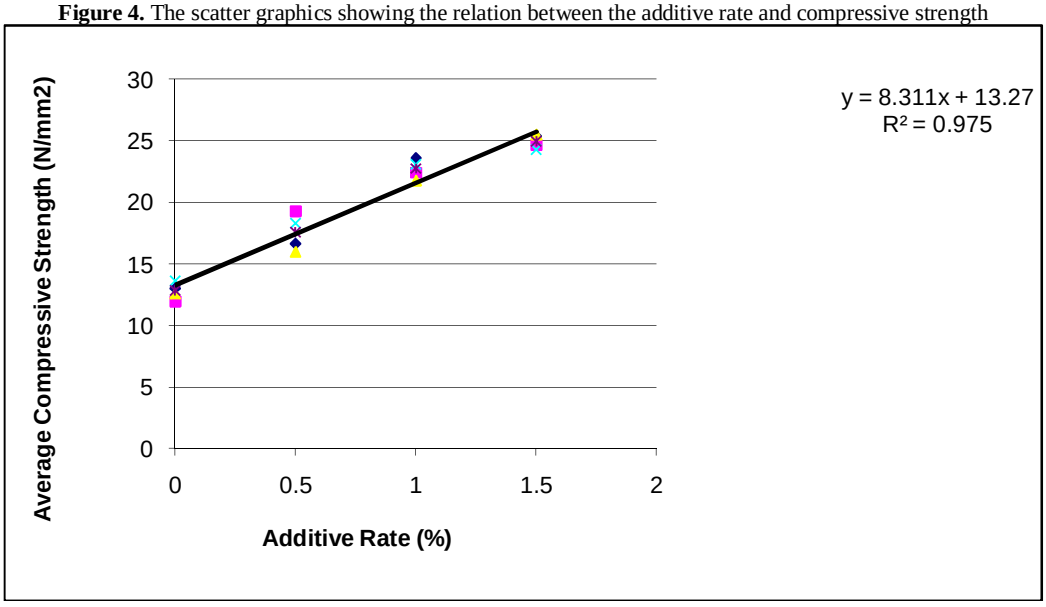
Test No	N (Test Numbers)	1	2	3	4
1 (% 0)	4	12,807			
2 (% 0,5)	4		17,567		
3 (% 1)	4			22,717	
4 (% 1,5)	4				24,942

Table 7. The indication of homogenous dispersions of group averages

4.4. REGRESSION ANALYSIS

In order to see the effect of the setting retarder additives on the compressive strength of the concrete linear regression analysis was performed. Yx = bo + b1 Xj model equation was set up and it was found as r2 = 0,9756. As a result of the regression analysis, the model equation was calculated as Yx = 13,275 + (8,311) Xj. The scatter graphics of data concerning regression analysis are shown on Figure 4.

Figure 4. The scatter graphics showing the relation between the additive rate and compressive strength



5. RESULTS AND RECOMMENDATIONS

It has been observed that the compressive strength of concrete samples produced with Addiment VZ1 setting retarder additive in four different proportions increases with the increase in the proportion of the additive.

According to results of variance analysis that was conducted on the data, it has been seen that the additive in different proportions applied on concrete samples increases the compressive strength values of the concrete. This means that the mechanical feature of the concrete strengthens with the applied additive in different proportions. While the average of 7 days compressive strength values at 0% additive proportion was 12,807 N/ mm², this value at 1.5 % additive proportion increased to 24,942 N/ mm².

Moreover, as a result of the regression analysis performed, it has been seen that the additive in different proportions affects compressive strength values of the concrete.

A smoother surface has been obtained in concrete samples produced with setting retarder additive than control concrete samples.

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