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The Study of Compressive Strength in Different Cement Types and Dosages of Concretes Made by Using 60% Pumice and 40% Perlite

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Abstract

In this study, it was tried to obtain bearing concrete by using the pumice and perlite aggregates in certain proportions. Different cement dosages were used in every mixture poured with portland cement and portland composite cement, the 60% pumice and 40% perlite aggregates of which were kept stable. The silica fume was added as much as 10% of cement amount in mixture. Mixtures from 200 to 500 doses were made and poured with every type of cement. The prepared samples left to water cure and their 7 and 28 days compressive strengths were determined.
The test results indicated that the mixtures poured with portland cement has a higher compressive strength than those poured with portland composite strength. While the concretes poured with portland composite cement up to 500 doses can be used only insulation, the concretes poured with portland cement at 450 doses and above show the characteristics of side bearing concrete.

Keywords: perlite, pumice, concrete, portland cement, composite cement, compressive strength, silica fume

1. Introductıon

Pumice that is produced in Ankara and perlite provided from Eti General Directorate of Mining Enterprises has been used as the main material of the study and it has been aimed to study the usability these materials in concrete bearer lightweight concrete production that will be produced with these materials.

1.1. Literature Scanning

Demirboğa, examined effect of silica fume and fly ash on light weighted concrete produced with perlite and pumice and observed in this study that the highest compressive strength has been given by the mixture of 60% pumice and 40% perlite. (1)
Çiçek, examined the physical, mechanical and chemical characteristics of construction material with clay brick, pumice concrete, gas concrete and perlite and observed that as the compressive strength of perlite is excessively low, when it is used only, it is a very good packing material and the load transferred to construction decreases to a great extent, with high heat and sound retention it is also resistant against fire.(2)
Şatana, determined the mechanical characteristics of bearer light weighted concrete with pumice and scoria aggregates, prepared several control mixtures in similar consistency and different cement dosages, prepared mixtures containing chemical and mineral additives, and finally observed that it can be used in production of bearer light weighted concrete.(3)
Bingöl, examined the strength of lightweight concretes against fire and observed that the highest resistance loss was in normal aggregate concrete and the lowest resistance loss 100% was in in concrete with pumice. (4)
Koksal, made a research about the Portland composite cement and the cements of the same strength class and observed that in first ages the compressive strength of PC 32.5 cementing mortar and concrete mixtures was higher than PCC/A 32.5R, PKCB 32.5R and KZC/A 32.5R cementing mortar and concrete mixtures and in advanced ages it reached the level of PÇ 32.5R and even exceeded. (5)

2. Materıal & Method

2.1. Material

PKC 32.5 portland composite cement and PC 32.5 portland cement obtained from Set Cement Factory that was prepared according to TS EN 197-1 in concrete production were used.
The silica fume used wastaken from Antalya Electrometallurgy Plant, the pumice was brought from Ankara Elmadağ region, maximum grain diameter was observed as 16mm, unit weight as 1.30 kg/dm^3, water absorption as 38%, specific weight as 1.12. Perlite was obtained from Eti Directorate General of Mining Plants and physical characteristics were determined as follows:
Intensity: 32-200
Colour: White
Fusion point: 1300°C
Heat conductivity: 0.034-0.045.
Ankara city water was used in concrete mixture.

2.2. Method

2.2.1. Preparation of Concrete Mixture

Mix Design TS 2511 was made according to basis of mix design of the bearer lightweight concretes. The pumice specific weight factors used in mix design are given in Table 1 and for %100 pumice with 200 doses the materials to be found in Im^3 concrete mixture are given in Table 2, for perlite the materials to be found in Im^3 concrete mixture are given in Table 3.

Table 1: Pumice Specific Weight Factors used mixture

0/2 grain class specific weight factor(gr/cm^3)	1.72
2/4 grain class specific weight factor(gr/cm^3)	1.12
4/8 grain class specific weight factor(gr/cm^3)	0.91
8/16 grain class specific weight factor(gr/cm^3)	0.79

Table 2: Im^3 lightweight concrete mixture for 200 Doses 100% Pumice

Material	Volume(dm)	Weight (kg)
Cement	63.49	200
Water	270	270
Air	30	0
0/2 grain class	159.13	273.70
0/2 grain class	44.56	178.22
0/2 grain class	222.78	202.73
0/2 grain class	210.04	75.43

Table 3: Im^3 lightweight concrete mixture for 200 Doses 100% Perlite

Material	Volume (dm^3)	Weight(kg)
Cement	63.49	200
Water	430	430
Air	30	0
Perlite	476.51	133.423

Also, silica fume amounting 10% of cement mount was used in every concrete mixture.

2.2.2. The preparation and Pouring of Mixture in Concrete Mixer

First of all, perlite was put and certain mount water was poured onto it and made waited for a while. Then cement was added and mixed and all other materials

were added and mixed for a few more minutes and the obtained concrete became ready to be poured to the mould.
In determining the compressive strength of the hardened concrete, 15x15x15 cube moulds were used. Totally 84 samples were poured being 3 samples each.

2.2.3. Test Cure of Test Samples

The concrete samples, were removed from the moulds 2 days after pouring process and were left to water cure.

2.2.4. The Devices used in Experiment

The compressive strength of the samples that gained 7 and 28 days strength was tested in concrete test device that can load 3000 KN with loading speed of 0.800 KN.

3. Experımental Fındıngs and Evaluatıon

3.1. Compressive Strength Results

The test results are shown as graphics in Figure 1 and Figure 2. The compressive strength results of samples are given in Table 4.

Figure 1: The relation between samples poured with PKC and PC in terms of 7 days compressive strength

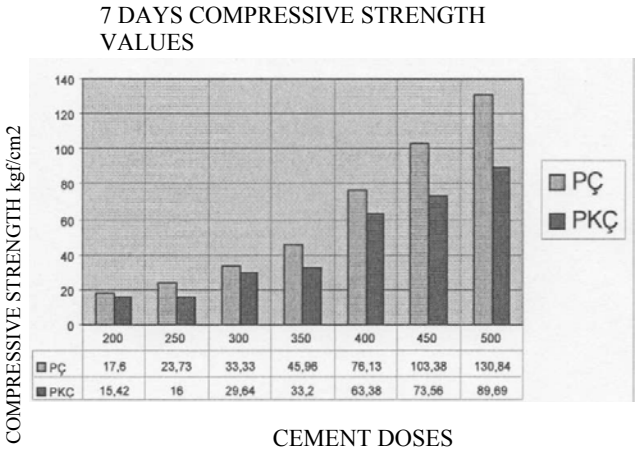
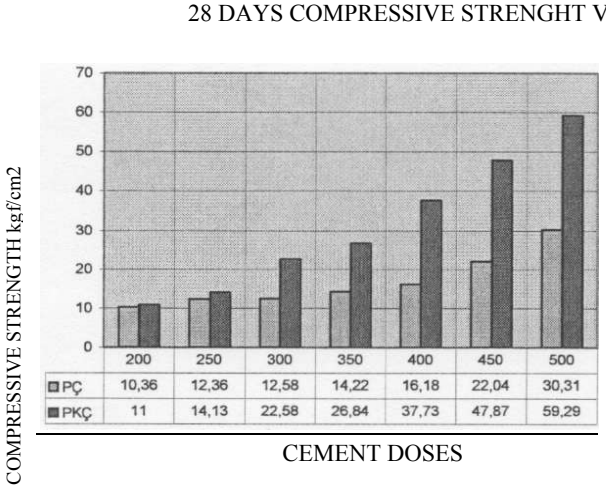


Figure 2: The relation between samples poured with PKC and PC in terms of 28 days compressive strength



3.2. One-Way Analyses Of Variance

To see the effect of cement dosage to compressive strength of the concrete, the analyses of variance technique was applied as inquiry method. For this the mathematical model equation was established as Yjj=n +Tj + Ejj and the results below were found.

The results of analyses of variance of 7 days compressive strength of cement dosage n lightweight concrete poured with PCC 32.5 are as follows: General sum of squares; GSS $_{general}$ = 5957,686, sum of squares between tests; SSBT test = 5939,315, Error sum of squares; ESS $_{error}$= 18,371, General average of squares; GAS $_{gen}$ei= 989,886, Error average of squares; EAS error ~ 1,312. Depending on these findings F_{cal}= 754,486 was found. In this case, F_{table}=2.85 F_{cal}>F_{table}, hypothesis is red.

The results of analyses of variance of 7 days compressive strength of cement dosage in lightweight concrete poured with PC 32.5 are as follows: General sum of squares; GSS$_{gen}$ei = 1004,523, sum of squares between tests; SSBT test = 985,461, Error average of squares; EAS error = 19.062, General average of squares; GAS $_{gen}$ei= 164,244, Error average of squares; EAS error= 1,362. In this case it is as F_{cal} = 120,590> F_{table}=2,85.

The results of analyses of variance of 28 days compressive strength of cement dosage in lightweight concrete poured with PCC 32.5 are as follows: General sum of squares; GSS $_{general}$ = 15352,120, sum of squares between tests; SSBT test = 15330,278, Error sum of squares; ESS $_{error}$ = 21,843. General average of squares; GAS $_{gen}$ei = 2555,046, Error average of squares; EAS error = 1,560. Depending on

these findings F_{cal}=1637,850 was found. As it is Fcal=1637,850> F_{table}=2,85 in this case, it has been accepted that the cement dosage increases the compressive strength in lightweight concrete poured with PCC32.5.

The results of analyses of variance of 28 days compressive strength of cement dosage in lightweight concrete poured with PC 32.5 are as follows: General sum of squares; GSS_{gen}ei = 34388,328, sum of squares between tests; SSBT test = 34363,929, Error average of squares; EAS error = 24,399, General average of squares; GAS $_{gen}$ei = 5727,321, Error average of squares; EAS error = 1,743. In this case, as it is F_{cal} =3285,899> F_{table}=2,85, it has been accepted that the cement dosage increases the compressive strength in lightweight concrete poured with PC32.5.

Table 4: The compressive strength of 7 and 28 days of samples

Cement dosages	7 days compressıves strength values (kgf/cm^2)		Cement dosages	28 days compressıves strength values (kgf/cm^2)	
	Pkç32.5	Pç32.5		Pkç32.5	Pç32.5
200	11	10,35	200	15,45	17,6
200	12	13,15	200	16,2	18,25
200	14	11,25	200	16,5	18,95
250	14,15	12,35	250	16	23,75
250	13,6	12,65	250	15,25	23,8
250	13,25	13	250	15,65	24,1
300	22,6	12,6	300	29,65	33,35
300	22,95	13	300	30,85	35,65
300	23,5	13,5	300	32,65	36,25
350	26,84	14,2	350	33,2	45,96
350	26,3	15,35	350	35,2	45,35
350	28	15,9	350	32,5	43,25
400	37,73	16,18	400	63,38	76,15
400	40	17,2	400	65,35	76,5
400	41,25	17,5	400	66,4	77,8
450	47,85	22,05	450	73,56	103,4
450	49,6	24,85	450	74,55	105,3
450	50,25	25,2	450	71,35	107,2
500	59,3	30,31	500	89,7	130,85
500	60,1	31,25	500	88,6	134,3
500	61,25	33,65	500	87,5	132,5

5. Results and Recommendatıons

Insulating concretes are the concretes that have a compressive strength lower than 100 kgf/cm^2, side bearer lightweight concretes are the concretes that have compressive strength of 100~170kgf/cm^2 and bearer concretes are the concretes that have a compressive strength of 170 kgf/cm^2.
According to test compressive strength results the concretes poured with PCC32.5 up to 500 doses can only be used for insulation. However, the concretes poured with PC32.5 can be used as insulation concrete up to 450 doses and for 450 and following doses it can be used as side bearer lightweight concrete.
Today, thought there are not many studies about light aggregates, it is a subject to focus on as there are rich recources in our country and the load coming to the construction can be reduced.
This study can be conducted by using pozzolanic additive cement in different cure conditions and different cure temperatures.

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