EFFECT OF POZZOLITH ON THE COMPRESSIVE STRENGTH OF CEMENT

Bazid Khan &*
*Khalid Nawaz***

ABSTRACT

The object of this paper is to investigate the influence of a commercial product, called 'Pozzolith100XR', on compressive strength of cement mortars. Pozzolith was incorporated in three different types of cement-mortars and cubes were tested for 2, 7, 14 and 28 days strength. The early strengths were improved but strengths after 28 days were not improved significantly, especially by higher dosages of the product. The 28 days strength of one type of cement (PKC/B32.5) was adversely affected by addition of Pozzolith to the mortar.

INTRODUCTION

When water is added to cement, hydration starts and various compounds, referred to collectively as gel, are formed. Mechanical properties, such as compressive strength of hardened cement depend very much on the physical structure of the products of hydration.

A higher temperature at the time of placing and setting increases the very early strengths, but adversely affects the strength from about seven days onward. The possible explanation is that a rapid initial hydration appears to form products of a poorer physical structure, probably more porous, so that a large proportion of the pores always remain unfilled[1].

It has been reported in literature that hot weather may affect the microstructure of cement-paste. Like most of the chemical reactions, the cement hydration proceeds more rapidly with increasing temperature. Because of their low solubility and diffusibility, cement hydration products would not be able to diffuse to a significant distance from the cement grains, in the time allowed by rapid hydration. Thus, elevated hydration-temperatures would result in a highly non-uniform distribution of the solid phases. It is believed that the dense hydration-products, around the cement-grains would serve as a diffusion barrier, either slowing or preventing further hydration. Another result of the uneven distribution of solid phases is a coarser pore structure[2].

The temperature of the mixture, at the time of placement, significantly affects the strength. The reduction in the 28 days strength ranges from 4% at 35^0C to 16% at 44^0C [3].

Compressive strength of concrete is the most significant property of concrete, as many other good properties depend upon it. When admixtures are used in concrete for some specific purpose, determination of the effects on compressive strength is a vital factor. Most of the admixtures improve the strength when lower dosages are used, but these badly affect strength when higher dosages are used. When set-retarders are used the one-day strength of concrete is reduced; however, ultimate strength is reported to be improved by using set-controlling admixtures[4].

Pozzolith is a commercial product, used in hot-weather concreting as a water-reducer and set-retarding admixture. The product is claimed by the manufacturer to retard the setting of cement and to improve the compressive strength of cement.

EXPERIMENTAL WORK

Materials

Cement: Three different types of cements were used for one type of test. The cements are designated as (PKÇ/A42.5), (PKÇ/B32.5) and PÇ42.5(According to Turkish Standard). Their oxide and compound compositions are given in Table-1.

Mixing Water and Retarding Admixture: Water fit for drinking was used as the mixing water. The retarding admixture used was Pozzolith100XR provided by Yapkim Yapi Kimya San.(YKS)-TURKEY. Its density was about1.2 mg/ml.

Sand: The sand used for compressive-strength tests was regular river-sand obtained from Agean region of Izmir, Turkey. The characteristics of the sand were determined by a series of tests performed according to Turkish Standard No.706, its loose and compacted dry densities were found as 1.40g/cm^2 and 1.540g/

* Asstt. Prof. B-Tech. Civil, Govt. College of Tech., Peshawar. ** Lecturer Civil Engg., Govt. College of Technology, Peshawar.

Table - 1: Oxide and Compound Composition of Cements

Name	Abbreviation	PKÇ/A 42.5	PKÇ/B 32.5	PÇ 42.5
Silica	SiO_2	23.79	33.06	19.3
Alumina	Al_2O_3	6.33	7.43	5.38
Ferric oxide	Fe_2O_3	3.52	3.33	2.89
Lime	CaO	57.2	45.03	62.78
Magnesia	MgO	0.69	0.9	1.66
Sodium	Na_2O	-	0.1	0.55
Potassium	K_2O	1.03	1.46	0.75
Sulfuric Anhydride	SO_3	2	2.07	3.17
Chloride	Cl^-	0.019	0.0266	0.0089
Loss on ignition	L.O.I.	2.14	4.21	3.29
Undetermined	-	3.28	-	-
%Free Lime	%F. CaO	1.37	0.39	0.77
Insoluble Residue	I.R.	-	29.06	0.42
Soundness (mm)	-	2	3	1
Specific gravity	-	3.03	-	3.08
Weight per liter (g/lt)	-	984	910	1050
Fineness-specific surface(cm^2/g)	-	3661	4963	3759
Lime Saturation Factor	L.S.F.	-	196.35	99.15
Hydraulic Modulus	H.M.	-	3.05	2.31
Silica Modulus	S.M.	-	0.37	2.29
Alumina Modulus	A.M.	-	2.23	1.86
Tricalcium Silicate	C_3S	-	-	59.51
Dicalcium Silicate	C_2S	-	-	10.76
Tricalcium Aluminate	C_3A	-	-	9.37
Tetracalcium Aluminoferrite	C_4AF	-	-	8.79

Table - 2: Sieve Analysis of Sand

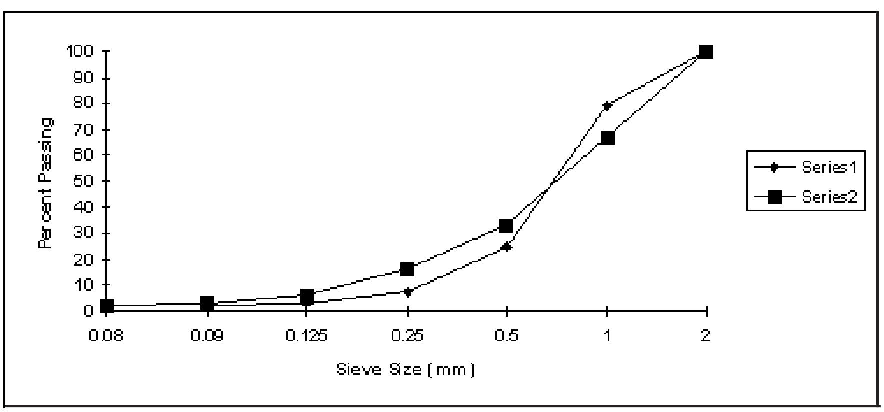

Figure - 1: Gradation Curves of Standard Sand and Test Sand

Table - 3: Results of Compressive Strength-Test of Cement PKÇ/A 42.5

Pozzolith (%)	Compressive Strength (kg / cm^2)			
	2-days	7-days	14-days	28-days
0.00	64.01	89.25	125.10	157.30
	68.46	105.70	131.80	181.70
	76.15	120.90	158.80	187.00
Average	**69.54**	**105.28**	**138.57**	**175.33**
0.125	63.55	76.31	117.30	135.30
	81.30	100.60	118.20	137.20
	83.63	122.00	147.90	173.80
Average	**76.16**	**99.64**	**127.80**	**148.77**
0.25	72.04	103.90	127.10	122.40
	74.68	113.50	128.30	134.60
	83.28	137.50	147.00	157.70
Average	**76.67**	**118.30**	**134.13**	**138.23**
0.375	81.73	132.90	148.80	152.70
	103.8	138.20	165.90	198.40
	115.00	138.50	185.30	222.30
Average	**100.18**	**136.53**	**166.67**	**191.13**

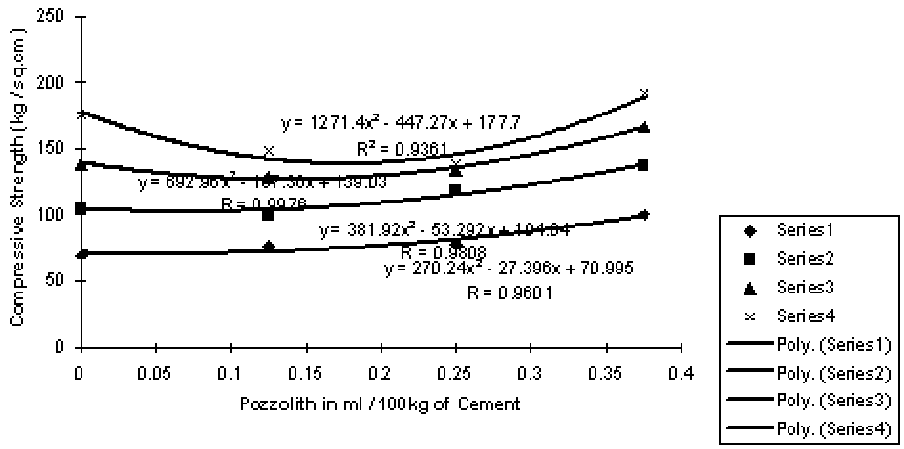

Figure - 2: Effect of Pozzolith on Compressive Strength of Cement (PKÇ/A 42.5)

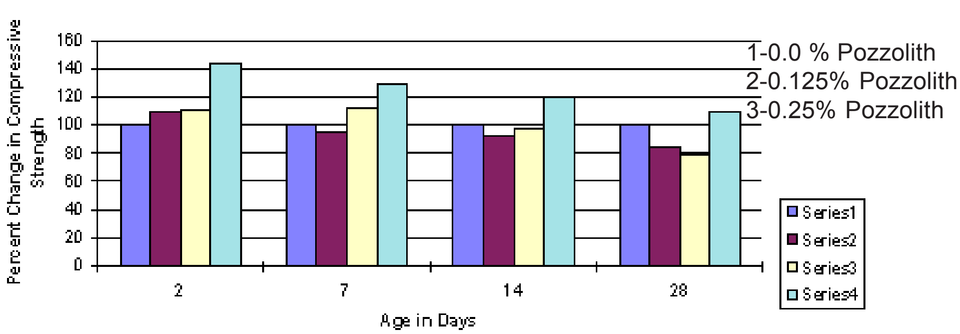

Figure - 3: Percentage Change in Compressive Strength of Cement (PKÇ/A42.5) with Various Pozzolith Contents

Effect of Pozzolith on the Compressive Strength of Cement

Table - 4: Compressive Strength-Test Results for Cement PKÇ/B 32.5

Pozzolith (%)	**Compressive Strength (kg / cm^2)**			
	2-days	7-days	14-days	28-days
0.00	57.07	72.23	70.74	70.79
	63.64	74.43	85.56	80.66
	64.38	84.84	90.57	115.80
Average of 3	**61.70**	**77.17**	**82.29**	**89.08**
0.125	62.15	82.02	107.80	95.40
	64.28	96.09	135.60	101.90
	69.59	96.63	145.20	137.00
Average of 3	**65.34**	**91.58**	**129.53**	**111.43**
0.25	49.87	96.80	118.70	99.46
	58.86	106.90	125.60	100.40
	59.84	111.00	135.40	141.00
Average of 3	**56.19**	**104.90**	**126.57**	**113.62**
0.375				72.81
	-	-	-	79.84
				85.89
Average of 3				**79.51**

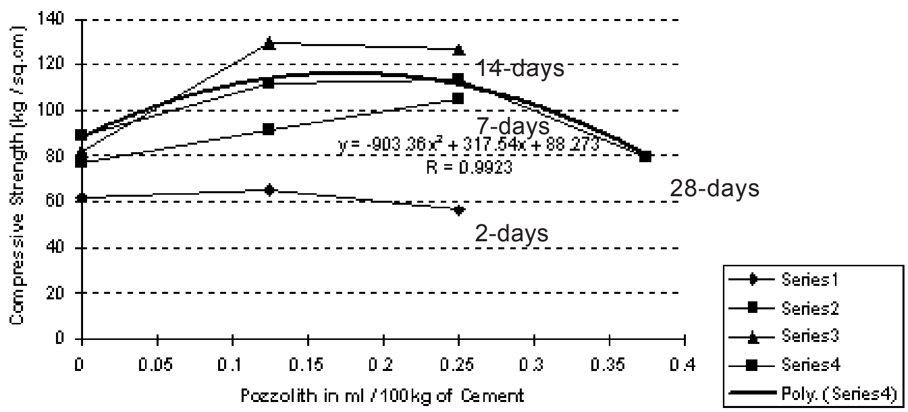

Figure - 4: Effect of Pozzolith on Compressive Strength of Cement (PKÇ/B 32.5)

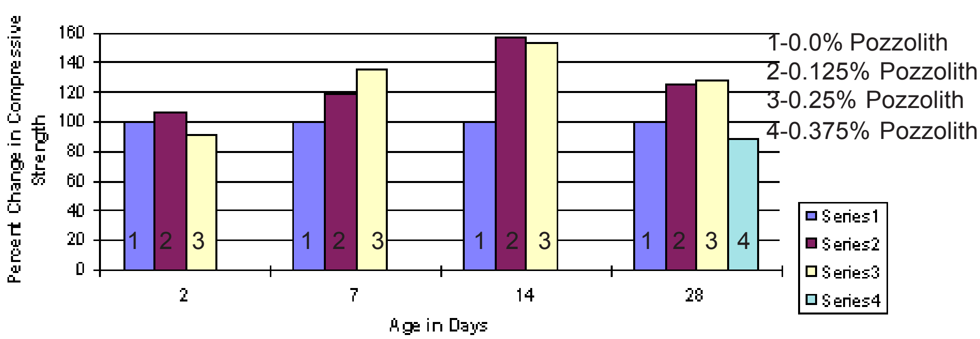

Figure - 5: Percentage Change in Compressive Strength of Cement (PKÇ/B 32.5) With Various Pozzolith Contents

Table - 5: Compressive Strength Test-Results for Cement PÇ 42.5

Pozzolith (%)	Compressive Strength (kg / cm^2)			
	2-days	7-days	14-days	28-days
0.00	73.17	98.57	132.70	148.70
	86.72	122.00	134.40	170.00
	89.78	123.20	181.70	187.57
Average of 3	**83.22**	**114.59**	**149.60**	**168.76**
0.125	73.77	94.57	143.60	182.90
	87.38	140.90	189.20	196.90
	96.27	144.30	196.00	197.40
Average of 3	**85.81**	**126.59**	**176.27**	**192.40**
0.25	76.49	136.20	179.70	201.20
	83.85	149.10	184.60	201.60
	93.04	149.80	194.30	212.50
Average of 3	**84.46**	**145.03**	**186.20**	**205.10**
0.375	116.70	226.90	204.60	231.70
	164.00	283.80	238.70	240.40
	165.80	291.80	325.70	256.30
Average of 3	**148.83**	**267.50**	**256.33**	**242.80**

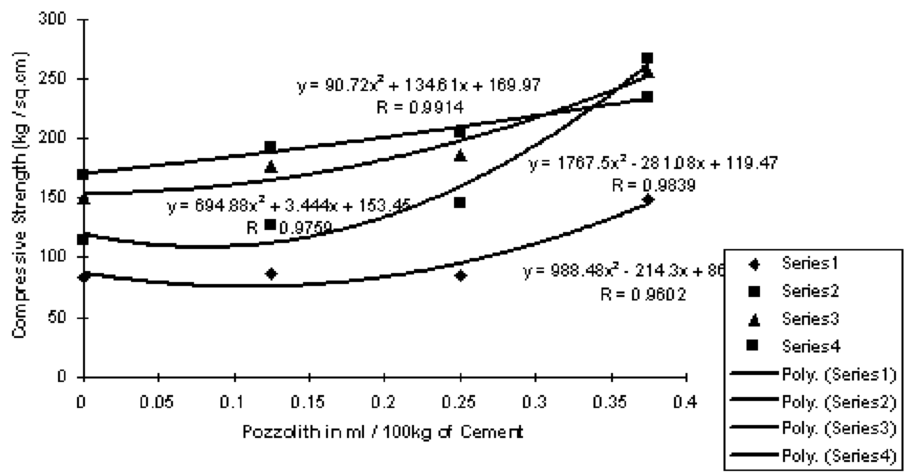

Figure - 6: Effect of Pozzolith on Compressive Strength of Cement (PÇ 42.5)

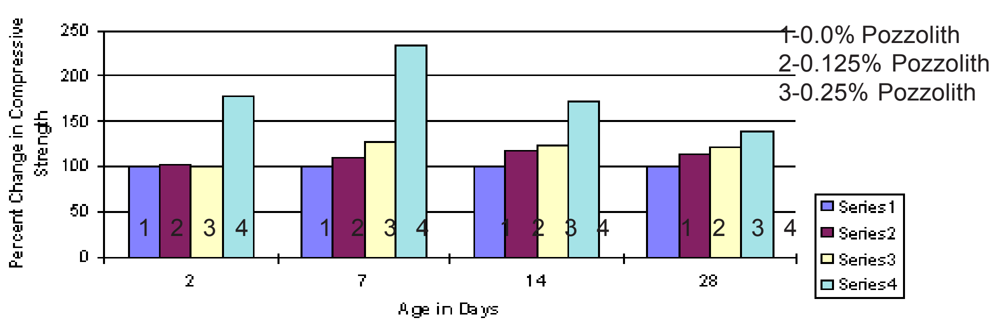

Figure - 7: Precentage Change in Compressive Strength of Cement PÇ 42.5 with Various Pozzolith Contents

cm^2, respectively. The gradation curve plotted from its Sieve Analysis is shown in Figure-1.

Here the sand from a single construction-site is selected for the strength-tests, because Pozzolith affects hydration-properties of cements, irrespective of sand-gradation. The effect of sand-gradation on the strength of cement with Pozzolith is generally the same as without Pozzolith. Thus, a little variation in sand-gradation, obtained from different construction-sites, will not produce too much different results.

PROCEDURE

For preparing and testing specimens, the TS. No.19 was followed. One part of cement and three parts of sand with w/c ratio of 0.5 (by weight) were used. About 450g of cement, 1350g of sand and 225ml of water were taken for preparing six cubes of 5cmx5cm x5cm. The pozzolith was added to the mixing water, before adding it to cement. The mixing was done in the Hober mixer, to ensure uniformity. The molds were filled in two layers; each layer was compacted by rodding (25 blows of a rod) and then placed on the vibrating table for one minute. The mortar specimens were kept in the mold for about 24 hours and then placed in water till the day of testing. The preparation and curing of the specimens were carried out at room temperature.

The compressive-strength tests were performed on the cubes after 2, 7, 14 and 28 days. On the day of testing, the specimens were taken out of the water and their surfaces were made dry with a piece of cloth. The specimens were placed in open air for 15 minutes and were then considered to be ready for testing. A 3000KN press with a loading-rate of 0.9KN/sec was used for crushing the cubes. The results are shown in the accompanying Tables and Figures.

The results of Table-3 are graphically shown in Figure-2. The best fitted Trendlines, along with their characteristics, are also indicated in the subject figure. The Trendlines reveal that the early strengths are a little improved by incorporation of Pozzolith, but the ultimate strength is not significantly improved. The same results are also shown in the form of bar charts in Figure-3 This indicates the percent change in strengths for different Pozzolith contents.

The results of Table-4 are graphically shown in Figure-4. The best fitted Trendlines, along with their characteristics, are also indicated in the figure. The Trendlines reveal that the early strengths are a little improved by incorporation of Pozzolith, but the ultimate strength is adversely affected. The same results are also shown in the form of bar charts in Figure-5 This indicates the per cent change in strengths for different Pozzolith contents.

The results of Table-5 are graphically shown in Figure-6. The best fitted Trendlines, along with their characteristics, are also indicated in the figure. The Trendlines reveal that the strengths are increasing with an increase in Pozzolith contents. The same results are also shown in the form of bar charts in Figure-7. This indicates the per cent change in the strengths for different Pozzolith contents.

CONCLUSION

The results show that early compressive strengths were improved but the 28 days strengths were not improved significantly, especially by higher dosages. The 28-days strength of one type of cement (PKÇ/B32.5) was adversely affected.

REFERENCES

1. Neville A.M. (1995). Properties of concrete(4th. E.D.), Longman Group Limited.
2. Kjellsen, K.O., Det Wilter J.R. & Gjørv. (1990). Pore structure of plain cement pastes hydrated at different temperatures. An International Journal of Cement and Concrete Research, Vol.20, No.6.
3. Al-Gahtani, H.L. et al. (1998). Concrete mixing design for hot weather: experimental and statistical analysis. Magazine of Concrete Research, Vol.50, No.2.
4. United States Department of Transportation – Federal Highway Administration.
5. www.fhwa.dot.gov/engineering/hng20/hng23/setretrd.htm