EFFECT OF LIMEWATER ON THE PROPERTIES OF BINARY BLENDED CEMENTITIOUS COMPOSITE

MINNALKODI. G[1], Dr. DHANALAKSHMI. G[2]

[1]*M.E. (Structural Engineering), Department of Civil Engineering, Oxford Engineering College, Tiruchirappalli, Tamilnadu , India*

[2]*Professor & Head, Department of Civil Engineering, Oxford Engineering College, Tiruchirappalli, Tamilnadu, India*

---***---

Abstract - *Industrial byproducts can be utilized to enhance the strength and water permeability characteristics of High Performance Concrete (HPC). The utilization of these industrial by products is becoming popular throughout the world because of the minimization of potential hazardous effects on environment. This study is planned to investigate the properties of Portland cement mixtures containing silica fume and mixed with saturated lime water. The main parameters were; type of mixing solution (water and lime-water) as well as the percentage of Portland cement replaced by silica fume in various percentages such as 10%, 20%, 30%, 40% and 50%. Initial and final setting time of cement, compressive strength development and tensile strength are the investigated properties in this work. The test results showed that using lime-water in mixing delays both initial and final setting times compared with normal water due to the common ion effect principles and the compressive strength, tensile strength and flexural strength are increased.*

Key words: Lime-Water, Portland cement, Silica Fume, Consistency, Setting time, Mechanical properties.

1. INTRODUCTION

Concrete is a mixture of cement, sand, coarse aggregate and water. Its success lies in its versatility as can be designed to withstand most harsh environments while taking on the most inspirational forms. Engineers and Scientists are further trying to increase the limits with the help of innovative chemical admixtures and various Supplementary Cementitious Materials (SCMs). More recently, strict environmental – pollution controls and regulations have produced an increase in the industrial wastes and their byproducts which can be used as SCMs such as fly ash, silica fume, and ground granulated blast furnace slag, etc. The use of SCMs in concrete constructions not only prevents these materials to check the pollution but also to enhance the properties of concrete in fresh and hydrated states. Silica fume is added to Portland Cement concrete to improve its properties, in particular its compressive strength, tensile strength, flexural strength and abrasion resistance. These improvements stems from the mechanical improvements resulting from addition of very fine powder to the cement paste mix and the pozzolanic reactions between the silica fume and free calcium hydroxide in the paste. Hydrated lime was used as an admixture in poured concrete in the beginning of the 20th century. This was due to the improved water tightness and impermeability. However, this use has largely disappeared due to increasing strength, finer grinding of Portland cement. From the other points of view, the employment of pozzolan mixed with lime, of similar fineness to that of the OPC. It will reduce the risk of concrete decalcification, even for large substitution of volumes starting by the pH rising of the water contained in pores, which would prevent the reinforcement passive protection. Moreover, the effects of hydrated lime and SF on fly ash concrete in improving its early age strength and other properties were studied.

2. MATERIALS USED

2.1 Cement

The Cement used for this study is Ordinary Portland Cement 43 grade as per IS 12269-1987.

Fig -1: Ordinary Portland Cement

2.2 Sand

In this study, Grade I of particle size less than 2 mm and greater than 1mm for testing the strength of mortar was chosen. The zone of fine aggregate is based on the percentage of passing through the IS sieves. Zone of the fine aggregate used in this work is zone II.

2.3 Micro Silica

Silica fume is also known as micro silica. It is an amorphous (non-crystalline) polymorph of silicon dioxide. Silica fume is an ultrafine airborne material with spherical particles less than 1µm in diameter, the average being about 0.1µm. This makes it approximately 100 times smaller than the average cement particle.

Fig -2: Micro silica

2.4 Water (W)

A tap water available in the concrete laboratory was used in preparation of the mortar. The qualities of water samples are uniform and potable. pH value lies between 6 to 8 and the water is free from organic matter and the solid content should be within permissible limit.

2.5 Lime Water (LW)

Lime water is prepared by using the saturated calcium hydroxide mixed with normal water in the range of 4g per liter.

3. PROPERTIES OF MATERIALS

Table -1: Properties of Cement

S.NO.	Property	Result
1	Initial setting time	42 minutes
2	Final setting time	454 minutes
3	Consistency	31%
4	Specific Gravity	3.10

Table -2: Properties of fine aggregate

S.NO.	Property	Result
1	Fineness modulus	2.563
2	Specific gravity	2.13
3	Grading zone	II

Table -3 Physical properties of silica fume

S.NO.	Property	Result
1	specific gravity	2.2
2	physical state	micronized powder
3	colour	white

4. RESULTS AND DISCUSSIONS

4.1 Setting time of the cement paste mix

The initial and final setting time of the cement are tabulated below:

Table -4: Setting time of the cement paste mix

Identification	Type of mix solution	SF (%)	Setting time (min)	
			Initial	Final
P0W	W	0	42	454
P10W		10	94	462
P20W		20	99	485
P30W		30	90	494
P40W		40	86	488
P50W		50	79	481
P0LW	LW	0	75	484
P10LW		10	115	512
P20LW		20	130	550
P30LW		30	110	564
P40LW		40	103	557
P50LW		50	98	548

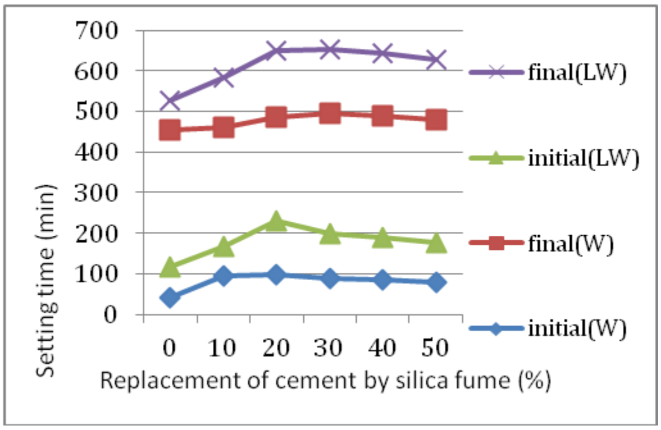

Chart -1: Comparison of Initial and final setting times of cement partially replaced by silica fume with and without limewater

To investigate the influence of using LW solution as mixing water, a preliminary study aimed at evaluating the degree of saturation on setting properties was conducted.

The attempted degrees of saturations are 0% and 100%. The recorded initial times of setting for the control mixes were 42 and 75 min at the degree of saturation 0% and 100% respectively. Whereas, the final setting times for the same mixes are 454 and 484 min, respectively. The above results concluded that the best retardation was achieved by using LW at 100% degree of saturation.

4.2 Compressive strength test of mortar cube

For the determination of cube compressive strength of cement mortar, the specimen of size 70.6mm x 70.6mm x 70.6mm were casted and cured for 28 days and 50 days using tap water. After that specimens were dried in open air, subjected to cube compression testing machine.

Table -5: The compressive strength of mortar

Identification	SF (%)	Compressive strength (MPa)	
		28th day	50th day
M0W	0	18.14	19.30
M10W	10	20.45	21.56
M20W	20	20.80	22.80
M30W	30	17.32	19.23
M40W	40	16.83	18.52
M50W	50	15.66	17.34
M0LW	0	18.10	18.90
M10LW	10	20.82	22.30
M20LW	20	22.11	24.21
M30LW	30	24.05	26.05
M40LW	40	23.60	24.89
M50LW	50	22.35	23.56

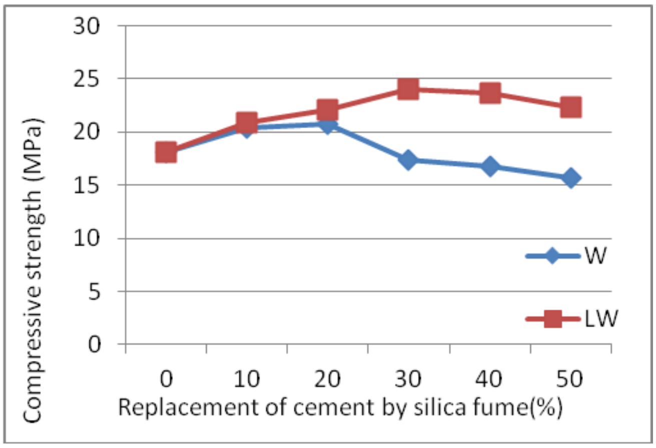

Chart -2: Compressive strength for various Percentage of silica fume with and without lime water at 28th day test

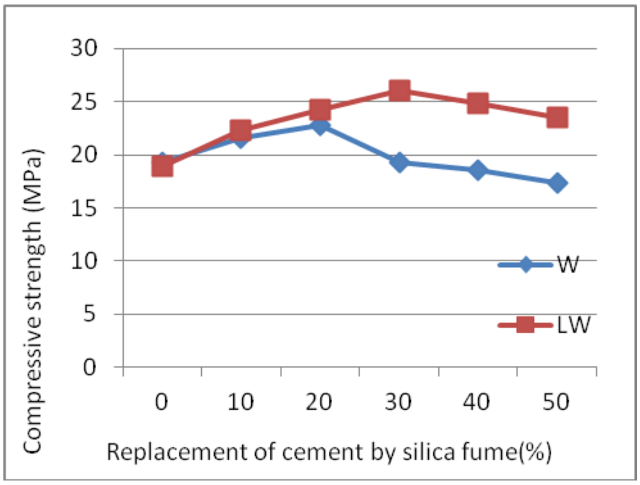

Chart -3: Compressive strength for various Percentage of silica fume with and without lime water at 50th day test

The results could be noticed that the compressive strength for mortar mixes increases with the increase of SF replacement with cement by weight up to a certain amount of SF content beyond which the strength was decreased.

The maximum enhancement in compressive strength was achieved at 20% SF for mix M20W as 18.13% over the control mix M0W at 28th and 50th day's age when using normal water.

The maximum enhancement was recorded at 30% SF for mix M30LW as 34.71% over the control mix M0W when using lime water.

4.3 Tensile strength test

For the determination of tensile strength of cement mortar with specimen of size 70.6mm x 70.6mm x 70.6mm were cast and cured for 28 days and 50 days in tap water. After that specimens were dried in open air, subjected to cube compression testing machine. In splitting tensile strength test same machine is used which are used in compressive strength test, the concrete block will be placed at an angle of 45^0.

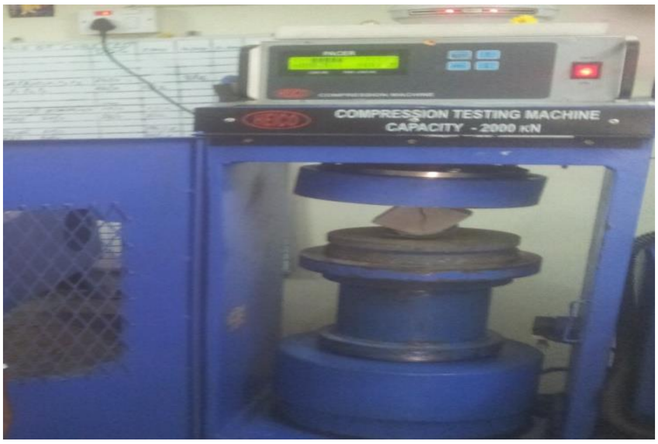

Fig -3: Tensile Strength test

Table -6: The tensile strength of cement mortar

Identification	SF (%)	Tensile strength (MPa)	
		28th day	50th day
M0W	0	2.89	3.92
M10W	10	3.48	4.43
M20W	20	3.97	4.96
M30W	30	3.20	4.23
M40W	40	2.90	3.16
M50W	50	2.72	2.94
M0LW	0	2.47	3.50
M10LW	10	3.72	4.96
M20LW	20	4.34	5.62
M30LW	30	5.08	6.31
M40LW	40	4.60	5.85
M50LW	50	3.98	4.68

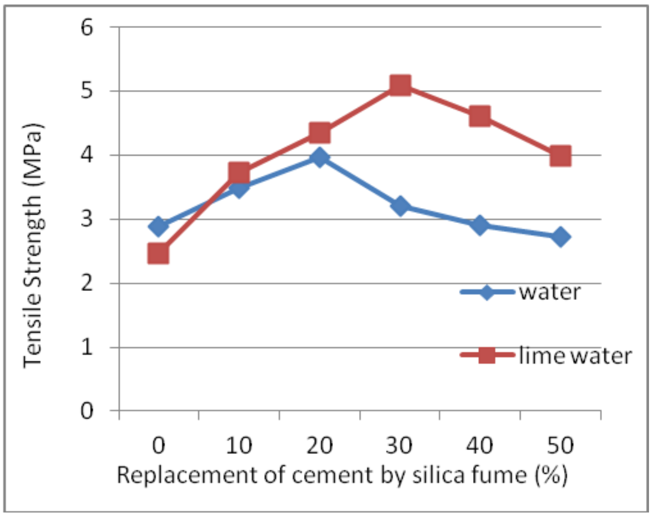

Chart -4: Split tensile strength for various Percentage of silica fume with and without lime water at 28th day test

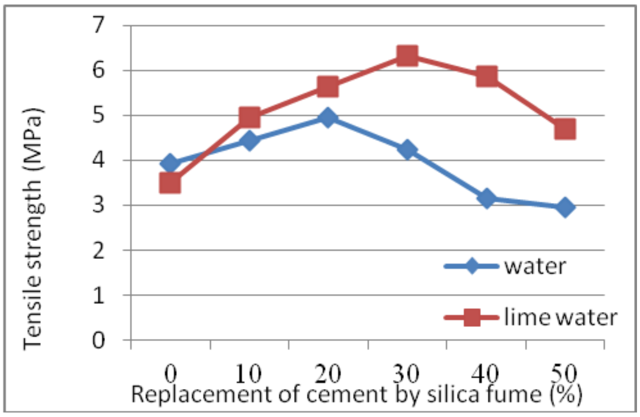

Chart -5: Split tensile strength for various Percentage of silica fume with and without lime water at 50th day test

The maximum enhancement in tensile strength was achieved at 20% SF for mix M20W as 26.53% over the control mix M0W at 50 days age when using normal water.

The maximum enhancement was recorded at 30% SF for mix M30LW as 60.96 % over the control mix M0W. In contrary and for the mix without SF M0LW a reduction of the compressive strength was noticed at all ages when using lime water.

4.4 Flexural strength

Table -7: Test results of mortar mixes flexural strength

Identification	SF (%)	Flexural Strength at 28th day (MPa)
M0W	0	18.14
M10W	10	20.45
M20W	20	20.80
M30W	30	17.32
M40W	40	16.83
M50W	50	15.66
M0LW	0	18.10
M10LW	10	20.82
M20LW	20	22.11
M30LW	30	24.05
M40LW	40	23.60
M50LW	50	22.35

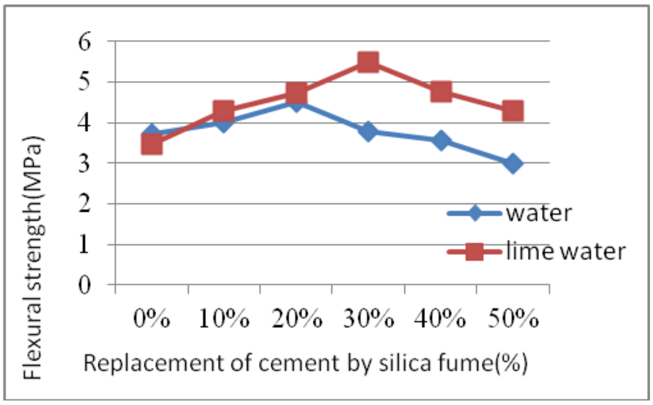

Chart -6: Flexural strength for various Percentage of silica fume with and without lime water at 28th day test

The maximum enhancement in flexural strength was achieved at 20% SF for mix M20W as 20.64% over the control mix M0W at 28th age when using normal water.

The maximum enhancement was recorded at 30% SF for mix M30LW as 46.91 % over the control mix M0W. In contrary and for the mix without SF M0LW a reduction of the compressive strength was noticed at all ages when using lime water.

5. CONCLUSION

Based on the test results and discussions, the following conclusions could be drawn for the current study as follows:

Using Lime Water as a mixing solution delays both initial and final setting times for Portland cement based materials as well as mixes containing SF. The maximum delay was recorded for cement paste as 88 and 110 min for initial and final setting times for mixes P20LW and P30LW over the control mix P0W, respectively.

34.71% increase of the compressive strength was recorded for mix M30LW at 28th and 50 days age over the control mix which means 30% SF replacement instead of cement weight could be achieved and gives better enhancement in compressive strength when replacing tap water by LW in mixing.

60.96% increase of the tensile strength was recorded for mix M30LW at 28th and 50 days age over the control mix which means 30% SF replacement instead of cement weight could be achieved and gives better enhancement in compressive strength when replacing tap water by LW in mixing.

46.91% increase of the flexural strength was recorded for mix M30LW at 28th day age over the control mix which means 30% SF replacement instead of cement weight could be achieved and gives better enhancement in flexural strength when replacing tap water by LW in mixing.

REFERENCES

[1] Jahren, p. (1983). " Use of Silica Fume in Concrete," Fly Ash, Silica Fume, Slag, and other mineral By-Products in Concrete, Proceedings of the First CANMET/ACI International Conference, SP-79, V. M. Malhotra, ed., American Concrete Institute, Farmington Hills, Mich., pp. 625-642.

[2] Lam L, Wong Y.L. and Poon C.S.(1988). "Effect of Fly Ash and Silica Fume on compressive and fracture behaviors of concrete", Cement and Concrete research, volume 28, no. 2, pages. 271-283.

[3] Bayasi, Zing, Zhou, Jing, (1993) "Properties of Silica Fume Concrete and Mortar", ACI Materials Journal, 90 (4) 349 - 356.

[4] Halit Yazici (2008). 'The Effect of Silica Fume and High-Volume Class C Fly Ash on mechanical Properties, Chloride Penetration And Freeze–Thaw Resistance Of Self-Compacting Concrete", Construction and Building Materials, Volume 22, Issue 4, Pages 456-462.

[5] Thanongsak, N., Watcharapong, W., and Chaipanich. A., (2009), "Utilization of Fly Ash with Silica Fume and properties of Portland Cement–Fly Ash–Silica Fume concrete". Fuel, Volume 89, Issue 3, March 2010, Pages 768-774.

[6] Barbhuiya S.A., Gbagbo, J.K., Russeli, M.I., Basheer, P.A.M. (2009) "Properties of Fly Ash concrete modified with hydrated lime and Silica Fume", a Centre for Built Environment Research, School of Planning, Architecture and Civil Engineering, Queen's University Belfast, Northern Ireland BT7 1NN, United Kingdom Received 28 January 2009; revised 1 June 2009; accepted 3 June 2009. Available online 15 July 2009.

[7] Solikin et al (2011) "The Influence of Lime Water as Mixing Water on The Compressive Strength Development of High Volume Ultra Fine Fly Ash Mortar".

[8] Des King, (2012) "The Effect Of Silica Fume On The Properties Of Concrete", As Defined In Concrete Society Report 74, Cementitious Materials, Singapore Concrete institute.