iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: IV Month of publication: April 2018

DOI: http://doi.org/10.22214/ijraset.2018.4721

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

Effect of Field Latex on Mechanical Properties of Silica Fume Blended High Performance Concrete

Gokul Krishnan[1], Swethamol Shaji[2]
[1]PG Scholar, Department of Civil Engineering, SVNCE
[2]Asst.Professor, Department of Civil Engineering, SVNCE

Abstract: Repair and restoration work of reinforced concrete structure is increasing because of the deterioration of aging infrastructures worldwide. The inclusion of Natural Rubber Latex (NRL) improves the workability of concrete through ball bearing actions and imparts good bond between cement and aggregates. Silica fume (SF) in concrete reduces the porosity in concrete due to its pozzolanic actions and thereby produces a High-Performance Concrete (HPC). The experimental program consists of two parts. In part I, the effect of SF on mechanical properties of concrete is analysed and the optimum content for the best performance was evaluated. Part II of the experimental program is designed in which the combined effect of SF and NRL on the mechanical properties of the modified mix is evaluated. The various results which indicate the effect of NRL and SF on the workability and strength characteristics of HPC are presented in this paper to arrive at useful conclusions.

Keywords: Silica fume, Natural Rubber Latex, High Performance Concrete, Compressive strength, Split tensile strength, Flexural strength

I. INTRODUCTION

Nowadays the concrete properties are upgraded regarding the fresh and hardened properties by inclusion of new material other than ingredients of concrete, from reducing porosity by compaction, improves the strength of the concrete. The porosity is due to the air voids or water voids or due to the inherent porosity of gel structure itself. On account of the porosity the strength of concrete is naturally reduced [8]. It is conceived by many research workers that reduction of porosity results in increase of strength of concrete. It is the material of choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required. In recent years there is very much essential for the concrete which possess high mechanical properties as well as durability characteristics [1], [2], [9]. This is only possible by the production of a type of concrete, which requires sufficient compaction, good paste characteristics, proper bondage, and good strength and durability characteristics. This can be achieved by the production of High Performance Concrete.

Natural rubber latex is one of the natural polymers, which is obtained from the Heave tree that is abundantly found in the parts of India and countries like Malaysia, Thailand, and South America etc. Natural rubber consists of suitable polymers of organic matter Isoprene, minor impurities and water. Natural rubber latex is elastomers since they comprise of poly isoprene has chemical structure as "cis 1, 4 poly isoprene" and chemical formulas as C_5H_8.Hence these types of polymers are made use in concrete mixing. Natural rubber latex (NRL) imparts excellent bondage with aggregates of the concrete, good mechanical and durability characteristics also it could improve the quality of construction extend service life of the buildings, pavements etc. and thus minimizing the maintenance cost of the constructions. In India, natural rubber latex is grown abundantly in Kerala and few parts in Karnataka. Natural rubber latex is obtained from trees naturally; hence, it can be made use in concrete rather than artificial polymers. The continuous research by the concrete technologists to improve the properties of concrete has resulted in finding the new type of concrete known as polymer concrete. Using NRL becomes eco-friendly due its zero-energy consumption when compared to synthesized rubbers and plastics [6]. In the polymer (NRL) modified mortar and concrete structures, aggregates are bound by co-matrix phase with superior properties of latex modified concrete compared to conventional concrete.

II. METHODOLOGY

The experimental program consists of two parts. In part I, the effect of SF on mechanical properties of concrete is analysed and the optimum content for the best performance was evaluated. For that the silica fume is replaced at 5%, 10%, 15%, and 20% by the weight of cement. The replacement of silica fume to achieve maximum strength properties such as compressive strength, Split tensile strength and Flexural strength is taken as optimum. Part II of the experimental program is designed in which the combined effect of SF and NRL on the mechanical properties of the modified mix is evaluated. In this part, NRL is added as an additive at 2%,

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

4%, 6% and 8% keeping the optimum silica fume content constant. The replacement of materials for the experimental program for Parts I and II is shown in Table I.

Mix design is the process of selection of suitable ingredients of concrete and to determine their properties with object of producing concrete of certain maximum strength and durability, as economical as possible. The mix proportion for M30 grade concrete was used in this investigation in accordance with IS 10262-2009.

TABLE I DESIGNATION OF MIX

Sl. No.	Material	S0L0	S5L0	S10L 0	S15L 0	S20L 0	S10L 2	S10L 4	S10L 6	S10L 8
1	Silica fume, %	0	5	10	15	20	10	10	10	10
2	Natural rubber latex, %	0	0	0	0	0	2	4	6	8

III.MATERIALS

The important constituent materials used for the preparation of specimens and their properties are as follows.

A. OPC 53 Grade

By conducting tests like fineness of cement, specific gravity of cement, consistency of standard cement pastes and initial and final setting time of cement, the properties of cement were obtained and are presented in Table II.

TABLE III PROPERTIES OF ORDINARY PORTLAND CEMENT

Sl. No.	Particulars	Test Values
1	Fineness	4%
2	Specific Gravity	3.13
3	Consistency	30.30 %
4	Initial Setting Time	90 minutes
5	Final Setting Time	290 minutes
6	Compressive strength at 3 days	28.9 N/mm^2
7	Compressive strength at 7 days	39.2 N/mm^2
8	Compressive strength at 28 days	57 N/mm^2

B. Aggregates

M-sand bought from a local vendor was used as fine aggregate and 20 mm broken stone as coarse aggregate. Tests were conducted in accordance with IS 383-1970 to determine the properties of aggregates. A sieve analysis was conducted showing all the particles for coarse aggregate as well as fine aggregate. The properties of fine aggregate and coarse aggregates were obtained and are presented in Table III.

TABLE IIIII PROPERTIES OF FINE AGGREGATE

Sl No.	Particulars	Fine aggregate	Coarse aggregate
1	Fineness Modulus	3.22	7.0
2	Specific Gravity	2.61	2.73
3	Bulk Density (kg/m^3)	1.62	1.57
4	Void Ratio	0.69	0.72
5	Porosity (%)	0.41	0.60
6	Grade	Zone II	Zone II

C. Silica Fume

It also referred to as micro silica or condensed silica fume. The silica fume is obtained by reduction of high purity quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloys. When the silica is condensed, it attains non-crystalline state with ultra-fine particle size [5]. The properties of the silica fume were listed in Table IV.

TABLE IV PROPERTIES OF SILICA FUME

Sl. No.	Particulars	Values
1	Appearance	White powdered form
2	Specific gravity	2.22
3	Uncompacted unit weight, kg/m^3	250-300
4	Residue on 45 µ IS sieve, %	10
5	Chemical analysis: Silicon dioxide, %	>85%
6	Specific surface, m^2/kg	15,000-30,000

D. Natural Rubber Latex (Styrene Butadiene)

Natural rubber latex is an alkaline material with a pH of 11. In the fresh state, latex particles repel each other due to negative charge. On exposure to atmosphere, lactic acid bacteria will attack the latex, thereby reducing the pH value to 4. This results in the drastic reduction in repulsion with the tendency for coagulation. In order to retain the latex in a stable state as well as to prevent premature coagulation, the alkaline environment is essential. To realise this environment, ammonia is generally used [4].

TABLE V PROPERTIES OF LATEX

Sl No.	Parameters	Value
1	DRC (Dry Rubber Content), %	33.6
2	pH	10.9
3	NH_3 , %	1.25
4	TSC (Total Solid Content), %	37.1
5	VFA (Volatile Fatty Acid)	0.04
6	Sludge, %	0.05
7	Coagulum , %	0.0002

IV. RESULTS AND DISCUSSIONS

A. Workability of concrete

1) Slump value: Slump cone test was done to check the workability of concrete. True slump was obtained and it was observed that workability decreases as the silica fume content increases and it increases as the latex content increases. Figure I represents the slump variation of fresh concrete with silica fume and latex content in normal concrete.

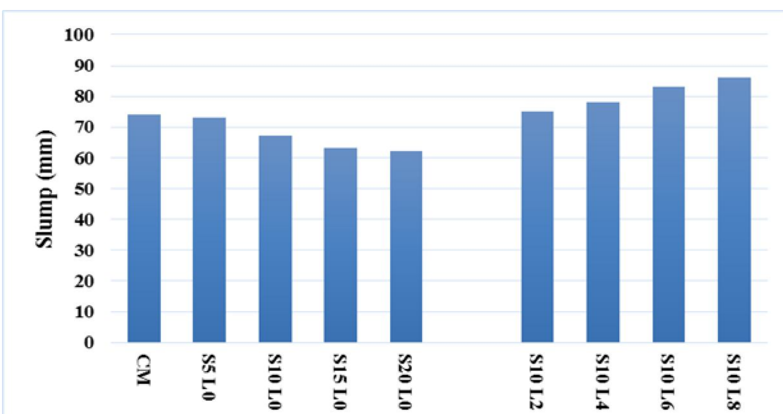

Fig. 1 Variation in slump value with different percentages of SF and NRL

Increase in percentages of Silica fume reduces the flow ability of concrete, thereby affecting the concrete workability. When natural rubber latex is added to concrete, the mix becomes stiff and sticky which in turn reduces the workability of concrete mix. Also, the direct addition of rubber latex into the concrete mix leads to the certain amount of coagulation of latex and the concrete mix becomes harsh and less workable. To overcome this premature coagulation, latex is mixed first with a water reducing super plasticiser and then water is added. Hence the slump value of latex modified concrete is found to be increased on addition of higher percentages of NRL. This shows that Natural rubber latex together with the super plasticiser has a plasticising effect.

2) *Compaction Factor:* The compaction factor test is more precise and sensitive than the slump test and is particularly useful for concrete mixes of low workability. Variation in compaction factor with different percentages of silica fume and latex is shown in Fig. 2.

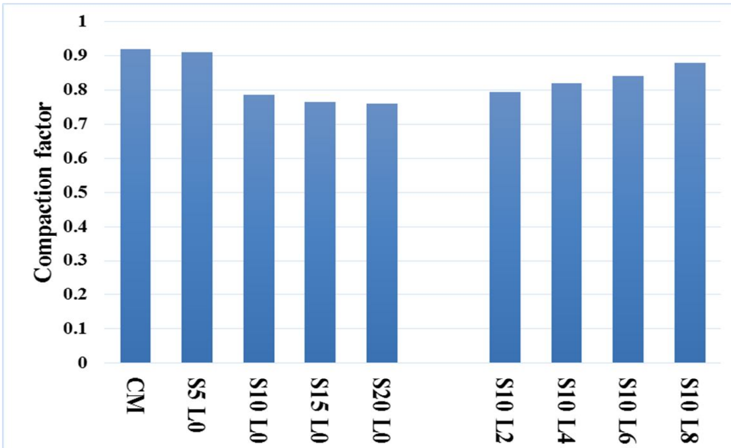

Fig. 2 Variation in compaction factor with different percentages of SF and NRL

The normal concrete mix exhibited a higher compaction factor of 0.92. A linear reduction in compaction factor was observed in micro silica addition, the compaction factor reached 0.76by the addition of 20% Silica fume and compaction factor values was increased and gives satisfactory results, since the compaction factor value was nearer to the controlled mix, when the natural rubber latex was added to the concrete at 2% to 8% by the weight of cement.

B. Mechanical Properties

1) *Compressive Strength:* Compression test on the cubes was conducted on the 2000 kN motorized compression testing machine. The pressure gauge of the machine indicating the load has a least count of 1 kN. The results of cube compressive strength tests are presented in Fig. 3 and Fig.4.

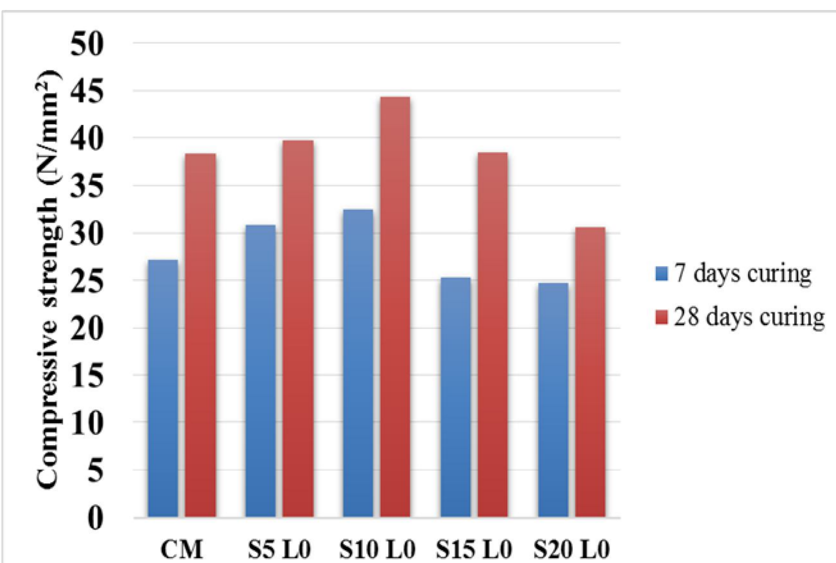

Fig. 3 Effect on compressive strength for different SF dosage

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

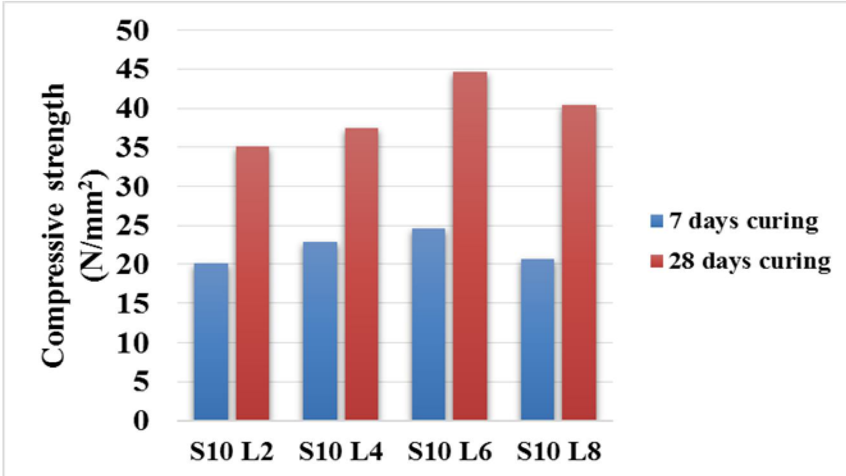

Fig. 4 Effect on compressive strength for different NRL dosage

In polymer-cement ratio of 6%, the compressive strength reaches its maximum value and slightly higher than that with 10% silica fume. The filling effect of polymer may be a cause of increasing a little compressive strength. The compressive strength is mostly influenced by the bonding forces generated by hydration reaction of cement also the continuity of polymer film is only present through small tiny bridges on a limited number of spots. Although, structure between the polymer film and cement hydrates is developed in the polymer cement ratio of 6%, but compressive strength of concrete is decreased on comparison with silica fume concrete on further adding the latex polymer. Polymer film formation and the permeation and reinforcing effect of polymer particles in micro pores in concrete/ mortar might be responsible for such improved compressive strength.

2) *Split tensile Strength*: The split tensile strength test is an indirect test used for determining the tensile strength of cylindrical specimens of concrete, by applying diametric compressive force along the length of a cylindrical specimen (150mm diameter and 300mm long). The results of split tensile strength tests are presented in Fig. 5 and Fig.6.

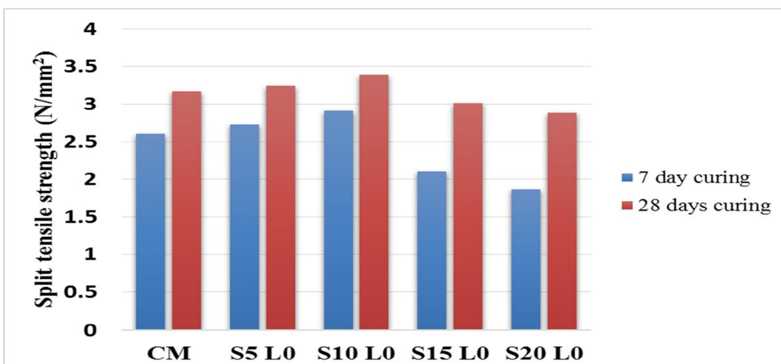

Fig. 5 Effect on split tensile strength for different SF dosage

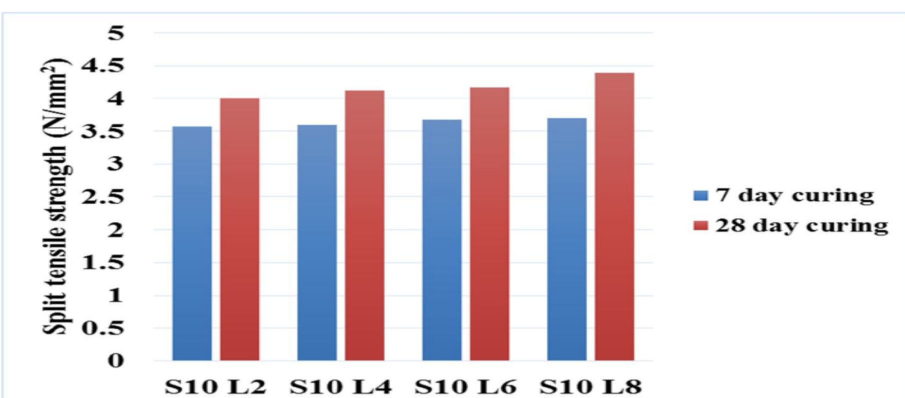

Fig. 6 Effect on split tensile strength for different NRL dosage

Split tensile strength is observed to be increasing as the NRL dosage increases. The test results shows an increment of 26.49%, 29.96%, 31.55% and 38.48% for the NRL dosages of 2%, 4%, 6% and 8% by the weight of cement respectively. In making of these samples percentage of super plasticizer is kept constant. The percentage of NRL that attains maximum split tensile strength is 8%. The graph obtained as a result of split tensile strength of various latex addictions shows a linear increment which reveals that the natural rubber latex imparts some sort of tensile strength to the hardened concrete.

3) Flexural Strength

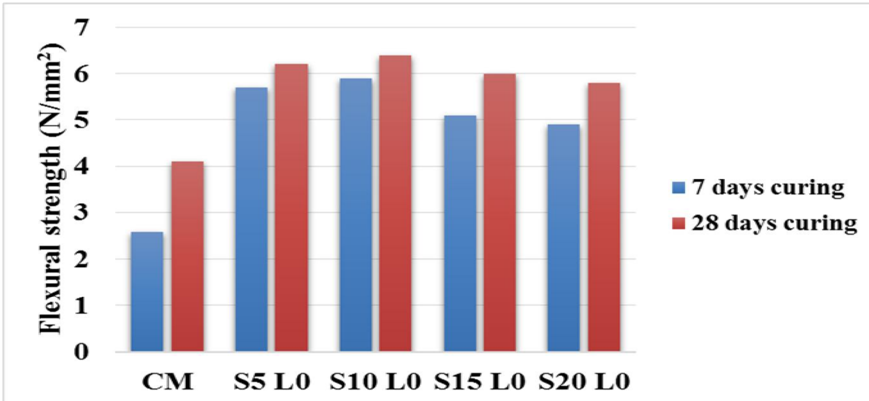

Fig. 7 Effect on flexural strength for different SF dosage

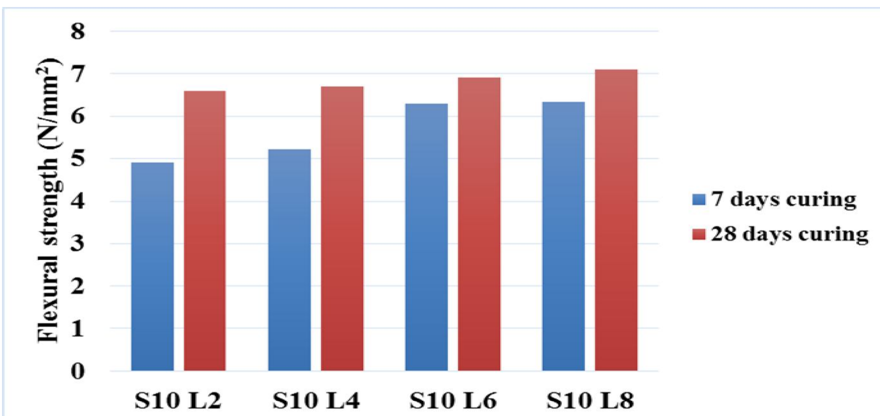

Fig. 8 Effect on Flexural strength for different NRL dosage

This shows that the addition of latex polymer to concrete has more influence on flexural strength of concrete than on the compressive strength. The presence of the latex polymer increases the binding force between the materials when the concrete is subjected to flexural or tensile stresses. Therefore, the flexural strength was sufficiently large to satisfy the standards for emergency concrete repair. When the ratio of silica fume to cement is certain (10%), the amount of natural rubber latex affects the flexural strength of concrete (Fig. 7). In all samples taken, there is an increase in flexural strength is observed when polymer is added (Fig. 8). Addition of 2%, 4%, 6% and 8% NRL increases flexural strength of 61.36%, 63.81%, 68.70%, and 73.59% respectively with respect to the control mix. In making of these samples percentage of super plasticizer is kept constant.

V. CONCLUSIONS

This research had concentrated on the effective utilisation of silica fume as mineral admixture as a replacement for cement in concrete along with natural rubber latex as polymer additive. Based on the results and observations of the experimental investigation presented in this study, the following conclusions could be drawn:

A. Pozzolana materials can be used with cement in concrete. This contributes strength to the concrete. The addition of silica fume increases the strength when compared with conventional concrete.
B. By adding silica fume to the concrete, the workability of concrete gets decreased while the natural rubber latex addition increases workability.

C. The optimum dosage of silica fume is 10% by the weight of cement which shows an increase in compressive strength, split tensile strength and flexural strength of 15.4%, 6.62%, 56.47% respectively.

D. Latex addition up to 6% by the weight of cement leads to an increase in compressive strength of 16.1% and addition of 8% latex leads to increase in split tensile strength and flexural strength of 38.48% and 73.59 % respectively. Higher the latex content, higher will be the tensile property.

REFERENCES

[1] A. S Ali, Jawad, H. S and I.S. Majeed, "Improvement the properties of cement mortar by using styrene butadiene rubber polymer," Journal of Engineering and Development, Vol. 16, pp. 61-71, 2012.

[2] Artelt, C and Garcia, F, "Impact of super plasticiser concentration and of ultra-fine particles on the rheological behaviour of dense mortar suspension," Cement and concrete research, Vol. 38, pp. 633-642, 2008.

[3] Fu, X and D.D.L Chung, "Combined use of silica fume and methylcellulose as admixtures in concrete for increasing the bond strength between concrete and steel rebar," Cement and concrete research, Vol. 28, pp. 487-492, 1997.

[4] P. Khamput and K. Suweero, "Properties of mortar mixing with medium ammonia concentrated latex," 9th Eco-Energy and Materials Science and Engineering Symposium, Energy Procedia, 9, pp.559-567, 2011.

[5] V. M. Malhotra G. G Carette, "Silica fume concrete- Properties, applications and limitations," Concrete international, 2, pp. 40- 46, 1983.

[6] T. S. Nagaraj, K. T. S. R Iyengar, and Rao, B.K. "Super Plasticized Natural Rubber Latex Modified Concretes," Cement and concrete research, Vol. 18, pp. 138-144, 1988.

[7] Y. Ohama, "Polymer-modified mortars and concretes," in: V.S. Ramachandran (Ed.), Concrete Admixtures Handbook: Properties, Science and Technology, pp. 337– 342, 1984.

[8] V. G. Papadakis and S. Tsimas, "Supplementary Cementing Materials in Concrete Part I: Efficiency and Design," Cement and Concrete Research, Vol. 32, pp. 1525–1532, 2002.

[9] Shobha, M.S. "Mechanical properties of latex modified high performance concrete," IOSR Journal of Mechanical and Civil Engineering, Vol. 1, pp.13-19, 2014.

[10] K. Soni, and Y. P. Joshi, "Performance Analysis of Styrene Butadiene Rubber-Latex on Cement Concrete Mixes," International Journal of Engineering Research and Applications, Vol. 4, pp. 838-844, 2014.