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Effects Of Varying Steel Fiber Dosages On The Characteristics Of Fresh And Hardened Concrete

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Abstract:
The most often utilized building material worldwide is cement concrete. Because of its good workability and ability to be shaped into any shape, it is widely used. Cement concrete has extremely little resistance to crack, and a relatively low tensile strength. Concrete's durability and toughness can be altered by appropriately adjusting its constituents, such as the cementitious materials such fly ash, rice husk ash and silica fumes etc and different fibers as steel, coir, synthetic fibers etc. When compared to glass and polypropylene fibers, steel fibers have the highest strength, according to numerous research studies In this study, the effects of adding three different volume fractions of steel fiber in conventional concrete and its fresh and hardened properties were examined after curing of 14 days and 28 days. When compared to conventional concrete, it was found that SFRC specimens show improved qualities. The optimum mix from this study in terms compressive strength, split tensile strength, flexural strength and workability is having the volume fraction 3%.

Keywords – Compressive strength, tensile strength, flexural strength, Steel fibers, Steel fiber reinforced concrete.

I. INTRODUCTION

With over seven billion tonnes produced annually concrete is the most commonly used structural material worldwide. Concrete cracking can be caused by structural, environmental, or economic issues, although the majority of fractures are caused by the material's intrinsic inability to withstand tensile pressures. By making concrete more durable and ductile, steel fibres reinforcement is provided a solution to cracking issue. Numerous studied and field test conducted on over the previous research have also confirmed that adding steel fibres to plain, reinforced and pre-stressed concrete member during mixing improves a number of concrete characteristics, especially those regarding to strength, performance and durability. Fibre reinforced concrete is a composite building material made of fibres that are typically short, irregular, and dispersed at random throughout the concrete part. When fibres are evenly dispersed throughout the entire mss of the concrete, the weak matrix more durable and behave like composite material with characteristics very different form conventional concrete. The composite will sustain increasing loads after the initial crack in the matrix if the pullout resistance of the fibres at the initial crack is greater than the load at the initial crack. At the fracture location, where the concrete can't sustain ant strain, the fibres support the entire load of the composite. The fibres will usually transfer the additional stress to concrete matrix through bond stress when the load on the composite concrete increased. In advanced concrete technology, steel bars and fibres serve distinct purposes, and both types of reinforcement are appropriate for a variety of applications. Steel fibres significance and appeal for use in reinforced concrete can be seen by their capacity to control cracks, especially within concrete.

II. EXPERIMENTAL PROGRAMME

2.1 Materials Specifications

Cement, fine aggregates, coarse aggregates, portable water and both end hooked steel fiber are utilized for this experimental investigation. The mechanical properties of concrete mix are depending upon the each ingredients property of materials. The main objective is to develop strength is to create a strong strength property.

2.1.1 Cement

Cement used in the experimental work was Portland pozzolana cement (Table 1). It was conformed to relevant Indian standards specification IS (1489-1991). When water is added cement, which is often inform of powder, can be turned into paste that solidifies when moulded.

Table 1 Physical properties of PPC

Standard consistency	35%
Initial setting time	55min
Final setting time	310 min
Specific gravity	2.90

2.1.2 Aggregates

Fine aggregates are the natural sand which is washed and sieved to remove the large particle and lumps in the sand. The sand passed through 4.75 mm IS sieve was used. Locally available crushed stone coarse aggregates of maximum size 12.5 mm were used throughout the investigation. The physical properties of the fine aggregates and coarse aggregates are listed below in table 2 and 3.

Table 2 Physical properties of fine aggregates

Fineness Modulus	2.53
Specific Gravity	2.65
Water Absorption (%)	1.3
Moisture Content (%)	0.48

Table 3 Physical properties of coarse aggregates

Fineness Modulus	6.55
Specific Gravity	2.70
Flakiness Index (%)	11
Water Absorption (%)	0.3
Moisture Content (%)	0.5

2.1.3 Water

Water is generally regards as suitable for concrete and safe to drink. Oil, acids and organic matter should not present in water. Basically water serves two purposes in concrete mix. First it creates Cement paste through a chemical reaction with cement, which keeps insert aggregates suspended until the paste solidifies. Second, it serves as lubricants in cement and fine aggregate combination.

2.1.4 Steel fiber

Steel fibre, which has hooked ends of high low carbon steel wire and has great tensile strength, good toughn ess, and low cost was used to strengthen concrete. Fiber content by weight was added in concrete and varied from 0%-5%.Steel fiber (SF) of length 50mm with diameter of 0.7mm and aspect ratio is 72 as shown in figure 1.

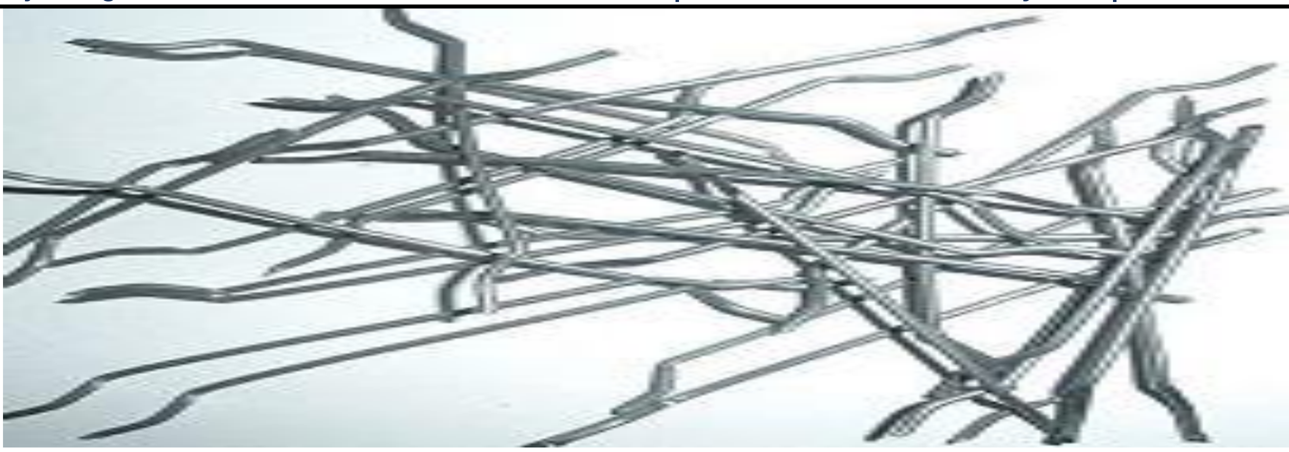

Fig.1 Steel Fibres both ends hooked 50mm long

III. MIX PROPORTIONS.

Depending on the characteristics of the constituent material, the mix design considers the quantity of cement , fine and coarse aggregate, as well as other relevant requirements. The mix design is carried out as per IS 10262:2009. Strength at a certain age, fresh concrete workability, and durability criteria are all fulfilled by the proportioning. The proportions for normal mix of M30 (1:1.26:2.44) as shown in table 4.

Table 4 Quantity of materials per cubic meter of concrete mix

Cement	Fine aggregates	Coarse aggregates	w/c ratio	Steel Fiber (SF) % age	Concrete Mix	Mix Identification
460	580	1120	0.45	0%	Plain Concrete (PC)	PC
				1.0%	PC + 1% SF	PC1SF
				3.0%	PC+ 3% SF	PC3SF
				5.0%	PC+ 5% SF	PC5SF

IV. CASTING OF SPECIMENS.

For measuring all the dimensions of concrete cubes (150 mm X 150 mm X 150 mm), cylinders (100 mm dia, 200 mm long), and beam moulds (100 mm X 100 mm X 500 mm) filled with three layers fully compacted concrete poured in the moulds as give in figure 2. After 24hours specimen are de-molded and placed in curing tank for 14 and 28 days. For compressive strength 24 cubes, 24 cylinders for split tensile strength and 24 beams were castes and tested for flexural strength test.

Fig.2 Specimen casting

V. FRESH CONCRETE TEST AND RESULTS

5.1 Slump Cone test

The slump cone test is employed to determine how easily it can be handled, carried, placed, compacted, and then finished without separate. The test is carried out to ensure proper finishing and to ignore any bleeding indicators in the final mixing and compacting stages. The results of slump test are given in table 5.

Table 5 Slump cone test results

Mix Combination	Slump Value (mm)
PC	120
PC1SF	97
PC3SF	81
PC5SF	53

The workability of concrete is reduced as the dosage of steel fiber increased. At addition of 1% steel fibers workability will be reduced 20% with reference to plain concrete mix as shown in figure 3. The increase in the fiber content from 3% to 5% the workability is further decreased 32% and 56% respectively addition of steel fiber respectively. The steel fibers reduced the workability due to its length, but at 5% volume fraction the balling effect of steel fibers observed which leads to dropped workability very significantly.

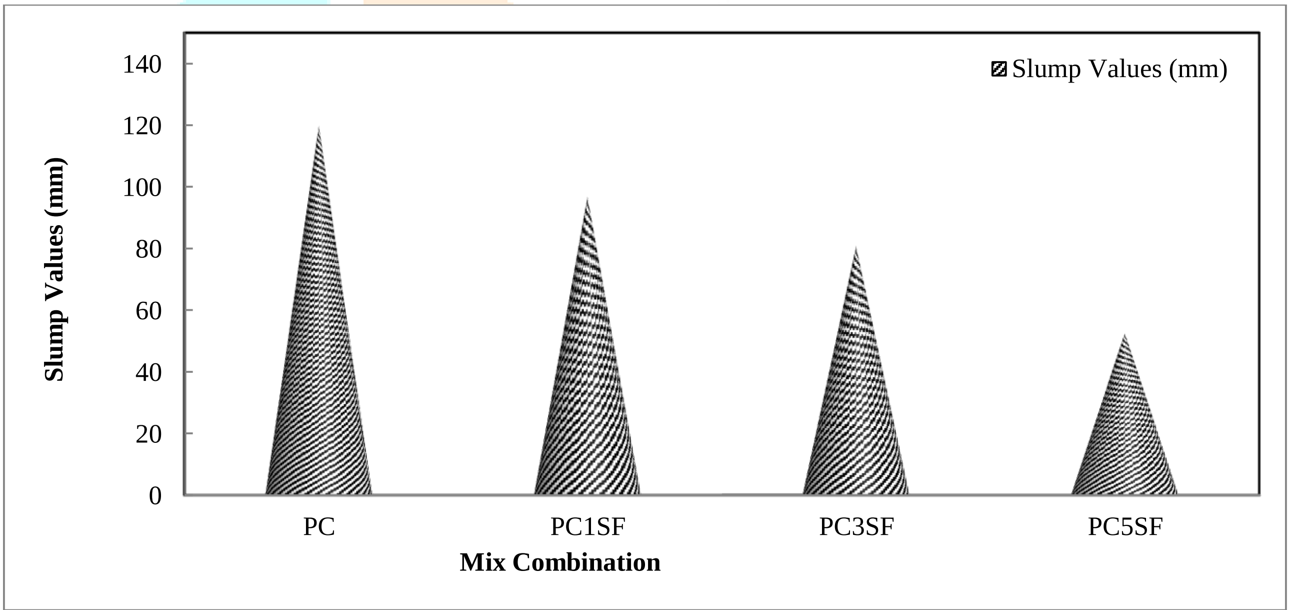

Fig3. Slump cone test results

VI. HARDENED CONCRETE TEST AND RESULTS.

Compressive strength and split tensile strength tests were conducted on cube and cylinder specimens after 14 and 28days of curing. These tests were carried out in accordance with IS: 516-1959 on a 2000 KN Compression Testing Machine. The load was applied at a rate of 14 $N/mm^2/min$.

6.1 Compressive strength.

Table 7 and figure 4 presents the results of compressive strength for 14 days and 28 days for all mixes. For clearly the results of 28^{th} days are discussed and compared with plain concrete mix here.

Table 7 Compressive strength test results.

Mix Combination	Compressive strength (MPA)	
	14 days	28 days
PC	26.50	35.40
PC1SF	30.10	39.40
PC3SF	32.80	43.60
PC5SF	27.50	32.10

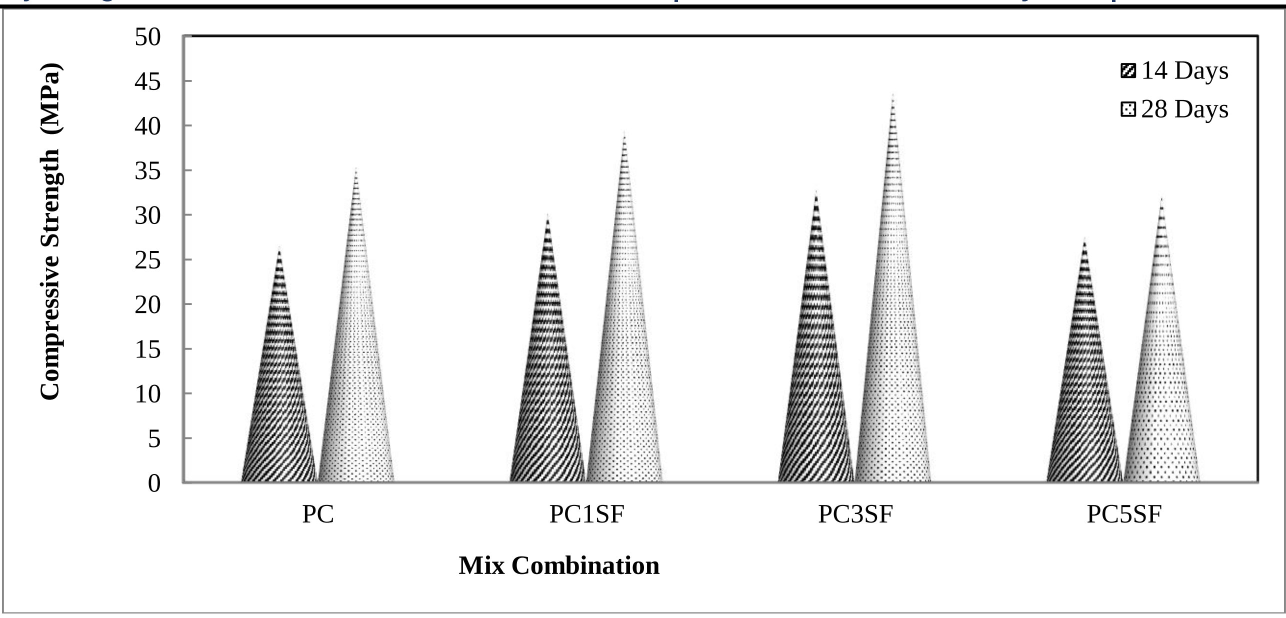

Fig.4 Compressive strength results

On addition of 1% volume fraction of steel fibers the compressive strength increased by 11% as compared to plain concrete at 28th day of curing. The similar trend further observed by 23% increase on addition of 3% volume fraction of steel fibers. When the dose of steel fibers increased to 5% volume fraction of steel fibers the 10% drop in compressive strength was observed.

At volume fraction of 1% and 3% the steel fiber provide the bridging effect due to its length which contributed in the higher compressive strength results. As the volume fraction of steel fibers increased to 5% then the compressive strength dropped drastically due to balling effect caused by cling of fibers and results in the small honeycombing patches developed in harden concrete which leads to lower compressive strength at high volume fraction of steel fibres. The mix combination with 3% volume fraction of steel fibers plays good role in compressive strength.

6.2 Split tensile strength

The split tensile strength results presented in table 8 and figure 5 for 14 days and 28 days for all mixes. For clearly the results of 28th days are discussed and compared with plain concrete mix here. The split tensile strength increased by 28% on addition of 1% steel fibers as compared to the plain concrete mix at 28th day of curing. On addition of 3% volume fraction of steel fibers the split tensile strength increased by 61% as compared to plain concrete at 28th day of curing. The significant drop in split tensile strength by 23% was observed on addition of 5% volume fraction of steel fibers at 28th day of curing as compares to plain concrete mix. The steel fibers at 1% and 3% volume fraction plays positive contribution, however at 5% volume fraction the strength results dropped due to the clinging effect of the steel fibers. The mix combination with 3% volume fraction of steel fibers plays good role in split tensile strength.

Table 8 Split strength test results.

Mix Combination	Split tensile strength (MPA)	
	14 days	28 days
PC	3.18	4.60
PC1SF	4.21	5.91
PC3SF	4.26	7.41
PC5SF	3.03	3.53

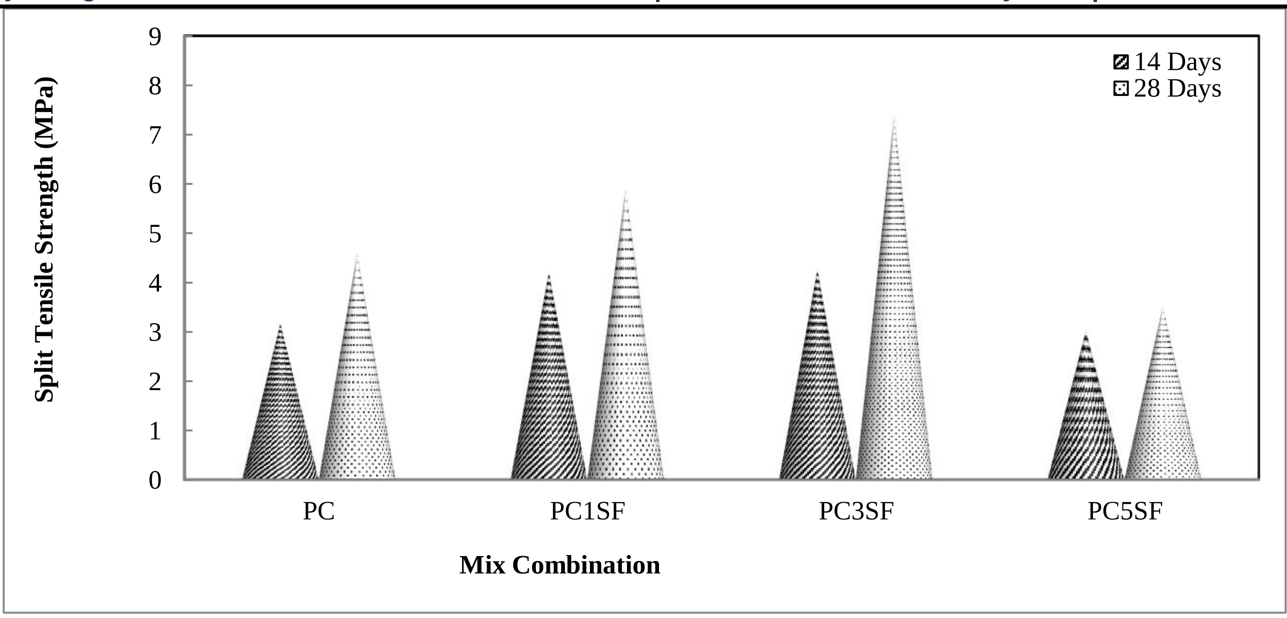

Fig.5 Tensile strength results

6.3 Flexural Strength.

Table 8 and figure 6 presents the results of flexural strength for 14 days and 28 days for all mixes. For clearly the results of 28th days are discussed and compared with plain concrete mix here The flexural strength increased by 21% on addition of 1% steel fibers as compared to the plain concrete mix at 28th day of curing. Further on addition of 3% volume fraction of steel fibers the flexural strength increased by 57% as compared to plain concrete at 28th day of curing. The significant drop in flexural strength by 30% was observed on addition of 5% volume fraction of steel fibers at 28th day of curing as compares to plain concrete mix. The steel fibers at 1% and 3% volume fraction acting constructive contribution; however at 5% volume fraction the strength results dropped due to the fit tightly due to balling effect of the steel fibers. The mix combination with 3% volume fraction of steel fibres provides best results in flexural strength.

Table 8 Flexural strength test results.

Mix Combination	**Flexural strength (MPA)**	
	14 days	**28 days**
PC	3.12	3.89
PC1SF	4.02	4.73
PC3SF	5.01	6.10
PC5SF	2.18	2.73

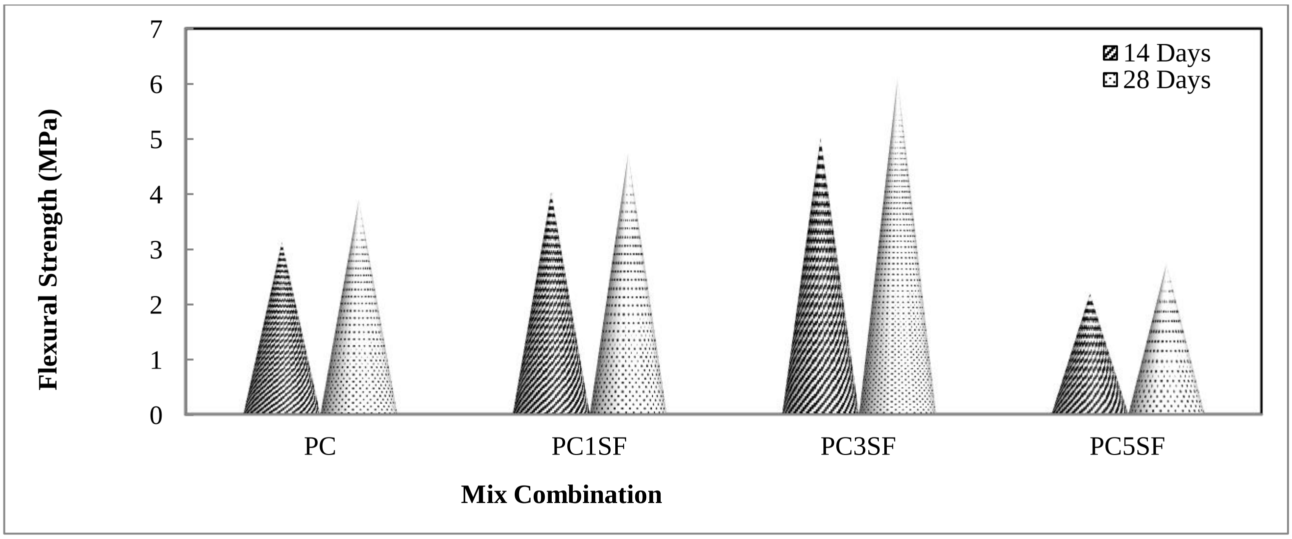

Fig.6 Flexural strength results

VII. Conclusion

The compressive strength, split tensile strength and flexural strength results increased significantly on addition of steel fibers at 1% and 3% volume fraction. However significant drop in compressive strength, split tensile strength and flexural strength at addition of 5% volume fraction of steel fibers. At higher volume fraction 5% the balling effect of steel fibers due to clinging of the fibers was responsible; the workability results also prop up this tendency in this study. In terms of strength parameters the most optimum mix adjudged the mix containing 3% volume fraction.

References

[1] Mukesh Shukla, October 2011 Behavior of Reinforced Concrete Beams with Steel Fibres under Flexural Loading. International Journal of Earth Sciences and Engineering, volume 04: pp 843-846.

[2] Dr. N. Ganesan & Dr. P.V. Indira, 2007. Behaviour of steel fibre reinforced high performance concrete members under flexure. Behaviour of steel fibre reinforced high performance concrete members under flexure, vol88: pp20-23.

[3] Nataraja M.C, Dhang N. and Gupta A.P, 1998. Steel fiber reinforced under compression: The Indian concrete journal: pp 353-356.

[4] Shah Surendra and Rangan. 1994, Effect of Fiber addition on concrete strength. Indian Concrete Journal.

[5] Falah A. Almottiri (2011), Physical Properties of Steel Fiber Reinforced Cement Composites Made with Fly Ash: Jordan Journal of Civil Engineering, 5(2).

[6] B. Krishna Rao, V. Ravindra , 2010, Steel Fiber Reinforced Self compacting Concrete Incorporating Class F Fly Ash, International Journal of Engineering Science and Technology, Vol. 2(9): 4936-4943.

[7] Arnon Bentur & Sidney Mindess, 1990. Fiber reinforced cementations composites, Elsevier applied science London and Newyork.

[8] S. A. Mahadik, S. K. Kamane, A. C. Lande. October 2014, International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347 Vol. 03

[9] S. Jemin Joel, S. Varatharajan, D. Maruthachalam & S. Antony Jeyendran. January 2014, Influence of Fibers on Fresh and Hardened Properties of Self-Curing Concrete. International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03.

[10] Vikrant S. Vairagade and Kavita S. Kene, 2012. Introduction to Steel Fiber Reinforced Concrete on Engineering Performance of Concrete. International Journal of Scientific & Technology Research, 1(4), ISSN 2277-8616.

[11] B. Krishna Rao & V. Ravindra ,2010.Steel Fiber Reinforced Self compacting Concrete Incorporating Class F Fly Ash, International Journal of Engineering Science and Technology Vol. 2(9):4936-4943.

[12] Sarvesh Pastay & Mahaboobali Nadaf, 2022. Experimentation on sustainable concrete by addition of steel fibers and industrial wastes. International Research Journal of Engineering and Technology, vol. 09: issue 09.

[13] Uygunoglu.T, 2011.Effect of fiber type and content on bleeding of steel fiber reinforced concrete.Construction and building materials,Vol.22: pp.766-772.

[14] Mohammadi. Y, Carkon-Azad. R, Singh. SP & Kaushik. SK, 2009.Impact resistance of steel fibrous concrete containing fibres of mixed aspect ratio. Construction and Building Materials, vol. 23: pp. 183-189.

[15] I.S. 5816-1999.Methods of test for splitting tensile strength of concrete," Bureau of Indian standard, New Delhi 1999.

[16] I.S 10262-2009.Recommended guidelines for concrete mix design," 2009.

[17] I.S 383-1970.Specifications for coarse and fine aggregates.