EXPERIMENTAL STUDY ON EFFECT SILICAFUME ON STEEL SLAG AGGREGATE CONCRETE USING FIBERS

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Abstract- The aim of this study is to evaluate the performance of Silica Fume on steel slag aggregate concrete when fibres (glass) were added. Concrete over the past few years suggest that cement replacement materials can improve the strength, workability and durability characteristics of concrete. This study investigates the performance of concrete mixture in terms of Compressive strength and split tensile strength for 7 and 28 days respectively of M40 grade concrete. Here this project deals with the replacement levels of fine aggregate with steel slag in 10%, 20% , 30%and 40%.To this obtained optimum resultant mix glass fibres were added in percentage of 0.5,1,1.5 and 2. Where replacement levels of OPC by Silica Fume were 10%, 20%, 30% and 40%.

Keywords – M40 Grade Concrete using Steel slag, Fibres, Silica fume

I. INTRODUCTION

Concrete is the most widely used material for construction all over the globe because of its superior specialty of being mould to any desirable shape. Concrete is the most versatile construction material because it can be designed to withstand the harshest environments while taking on the most inspirational forms. Engineers are continually pushing the limits to improve its performance with the help of innovative chemical admixtures and supplementary cementitious materials (SCM's). Nowadays, most concrete mixture contains supplementary cementitious material which forms part of the cementitious component. These materials are majority by products from other processes. The main benefits of SCMs are their ability to replace certain amount of cement and still able to display cementitious property, thus reducing the cost of using Portland cement. The fast growth in industrialization has resulted in tons and tons of by product or waste materials, which can be used as SCMs such as fly ash, silica fume, ground granulated blast furnace slag, steel slag etc. The use of these byproducts not only helps to utilize thesewaste materials but also enhances the properties of concrete in fresh and hydrated states. The present work includes various series of tests to determine the strength by replacing fine aggregate with steel slag by 10%, 20%, 30% and 40%. To these optimum fibres were added in 0.5, 1, 1.5 and 2% and finally optimum is obtained and to this silica fume is added as various percentage of mix in replacement of cement.

II. MATERIAL

In this research work various materials like Cement, Fine Aggregate, Coarse Aggregate, water and Glass fibres were used and their properties are examined by taking the help of IS [INDIAN STANDARD] codes.

Cement:

Cement, though different from the refined product found nowadays, has been used in many forms since the advent of human civilization. From volcanic ashes, crushed pottery, burnt gypsum and hydrated lime to the first hydraulic cement used by the Romans in the middle ages, the development of cement continued to the 18th century, when James Parker patented Roman cement, which gained popularity but was replaced by Portland cement in the 1850s. Ordinary Portland cement of 53 Grade was preferred for this study. The physical properties of cement are categorized as per IS 456-2000.

Fine aggregate:

Locally available river sand was preferred as fine aggregate for entire experimental work. The physical properties of sand were carried out by taking the help of IS 383- 1970.

Coarse aggregate:

Crushed Granite stone of sizes 20mm were selected for this work. Taking the reference of IS code IS 2386-1963 the properties of coarse aggregate have been tested.

Steel Salg:

Steel slag, a by-product of steel making, is produced during the separation of the molten steel from impurities in steel-making furnaces. The slag occurs as a molten liquid melt and is a complex solution of silicates and oxides that solidifies upon cooling.

FIGURE I: STEEL SLAG

Fibers:

Glass fibers: The type glass fibers used is s- glass type fibers. The properties are given below. The length of glass fibers is 6mm and diameter is 10 microns. As per MORTH Section 600.

Silica Fume:

Silica fume is a by-product of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its physical properties and chemical composition, it is a very reactive pozzolano. Concrete containing silica fume can have very high strength and can be very durable.

FIGURE 2: SILICA FUME

III. MIX DESIGN

The mix design for M30 has carried out by following the specifications and limitations of Indian Standard Code (IS 10262-2009). The water to cement ratio is taken as 0.45. The mix proportion for M40 grade concrete is 1:1.92:2.86

TABLE 1: MIX PROPORTION RATIO FOR M40 GRADE

Cement Kg/m^3	Fine Aggregate Kg/m^3	Coarse Aggregate Kg/m^3	Wate r l/m^3
400	770.74	1146.85	160
1	1.92	2.86	0.4

IV. TESTS DONE ON CONCRETE FOR STRENGTH AND DURABILITY

A number of tests were conducted on concrete determine the design mix properties of concrete in the laboratory. The strength criterion includes measurement of following parameters:

Compressive Test:
Compressive strength is obtained by applying crushing load on the cube surface. So it is also called as Crushing strength. Compressive strength of concrete is calculated by casting 150mm x 150mm x 150mm cubes. The test results are presented here for the Compressive strength of 7 days, 28 days testing.
Split tensile Test:
Split tensile was performed on cylinders 150mm dia. and 300mm height on compression testing machine. The failure load was recorded to find out split tensile strength. After testing the concrete (split tensile strength) for M40 grade concrete separately for replacement of sand with steel slag to this optimum, fibers were added in 0.5,1, 1.5, 2% where optimum is obtained at 1% and finally to this silica fume is used in replacement with cement and final strength is obtained.
Flexural Test:
Flexural test was performed on beams by placing them on universal find out the flexural strength. After testing the concrete (flexural strength) for M40 grade concrete separately for replacement of sand with steel slag to this optimum fibers were added in 0.5,1, 1.5, 2% where optimum is obtained at 1% and finally to this silica fume is used in replacement with cement and final strength is obtained.

V. RESULTS AND GRAPHS

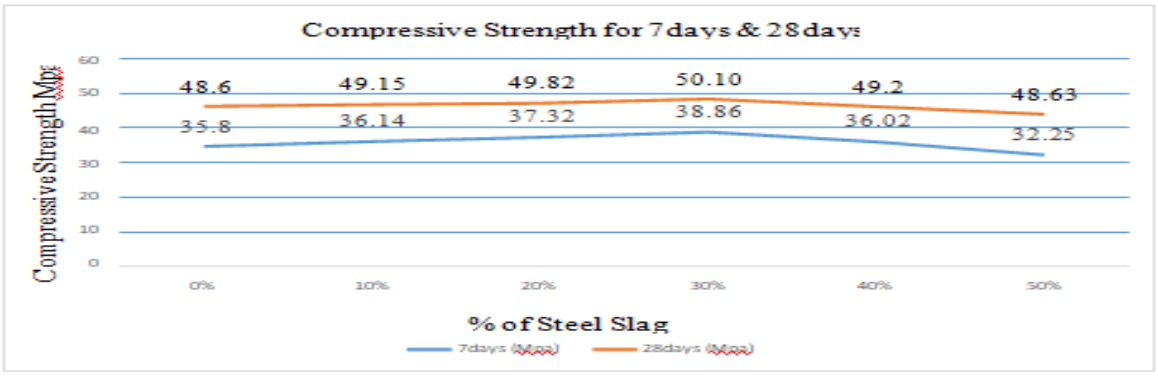
TABLE 2: RESULTS (CONVENTIONAL CONCRETE + % OF STEEL SLAG)

% Of Steel Slag	Compressive strength		Split tensile strength		Flexural tensile strength	
	7 days	28 days	7 days	28days	7 days	28 days
0%	35.80	48.60	2.05	3.19	3.64	4.78
10%	36.14	49.15	2.18	3.26	3.86	4.85
20%	37.32	49.82	2.23	3.35	4.02	4.93
30%	**38.86**	**50.10**	**2.40**	**3.41**	**4.20**	**5.03**
40%	36.02	49.28	2.29	3.32	3.82	4.85
50%	32.25	48.63	2.17	3.25	2.87	3.96

From the above results Replacement of fine aggregate with % of Steel Slag to the conventional concrete. Up to 30% the Strength of the concrete is Gradually Increasing and then its strength is reduced in all the 3 tests.

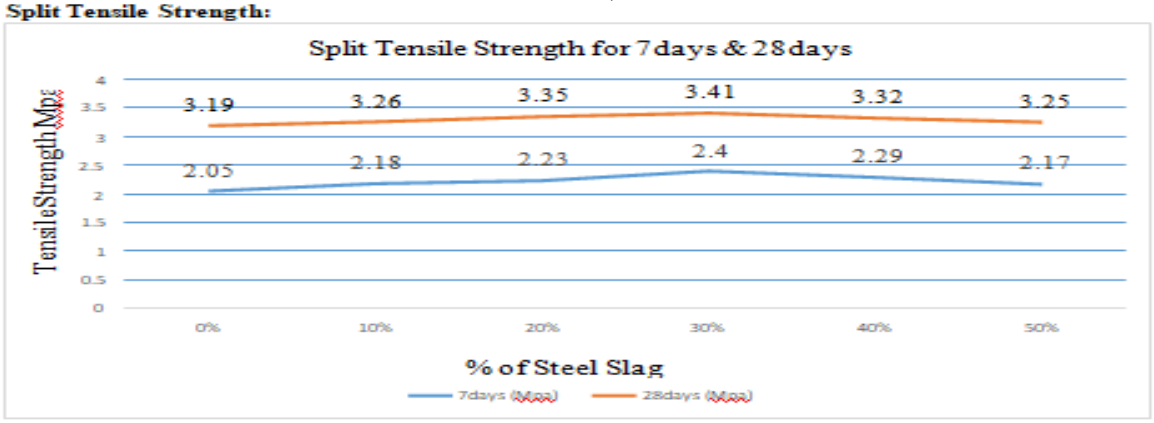
Graphs:

Compressive Strength:



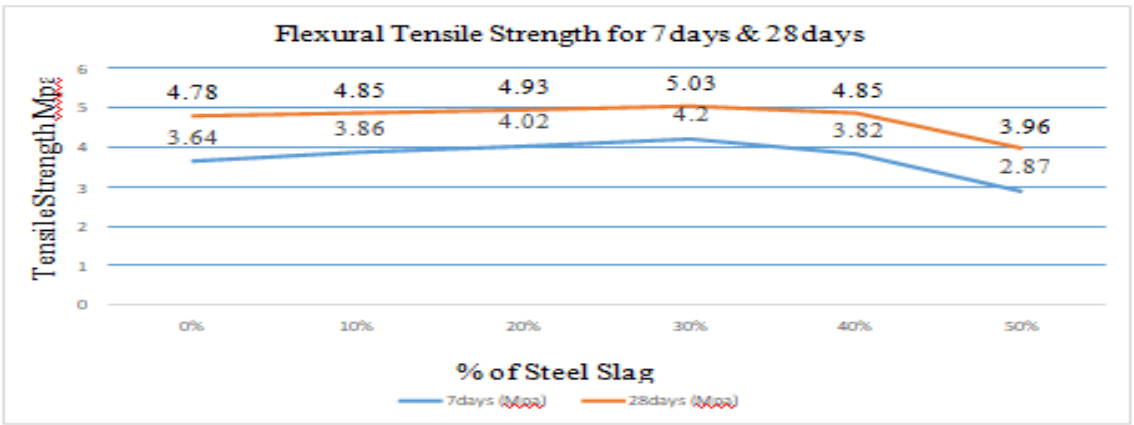
GRAPH I: GRAPH FOR COMPRESSIVE STRENGTH OF (CONVENTIONAL CONCRETE + % OF STEEL SLAG)

Split Tensile Strength:



GRAPH II: GRAPH FOR SPLIT TENSILE STRENGTH (CONVENTIONAL CONCRETE + % OF STEEL SLAG)

Flexural Tensile Strength:



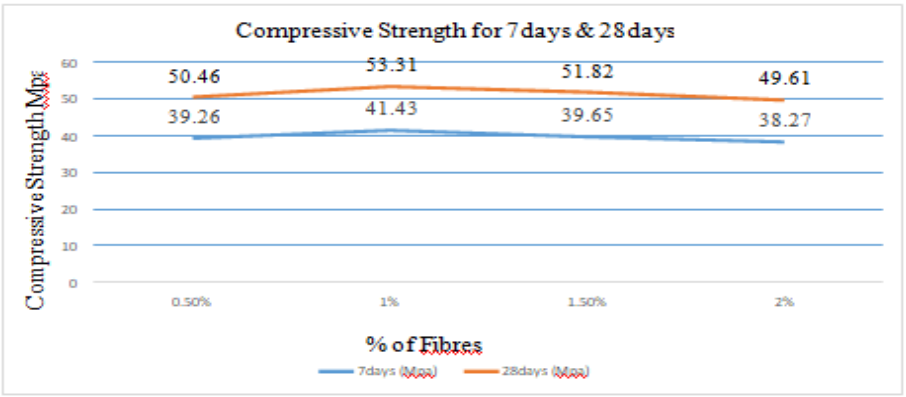
GRAPH III: GRAPH FOR FLEXURAL TENSILE STRENGTH (CONVENTIONAL CONCRETE + % OF STEEL SLAG)

TABLE 3: RESULTS (CONVENTIONAL CONCRETE + 30% OF STEEL SLAG CONSTANT + % OF FIBRES)

% of Fibres added	Compressive strength		Split tensile strength		Flexural strength	
	7 days	28 days	7 days	28 days	7 days	28 days
0.5%	39.26	50.46	2.53	3.53	4.87	5.16
1%	**41.43**	**53.31**	**2.71**	**3.65**	**4.99**	**5.32**
1.5%	39.65	51.82	2.61	3.50	4.68	5.25
2%	38.27	49.61	2.56	3.43	4.41	5.11

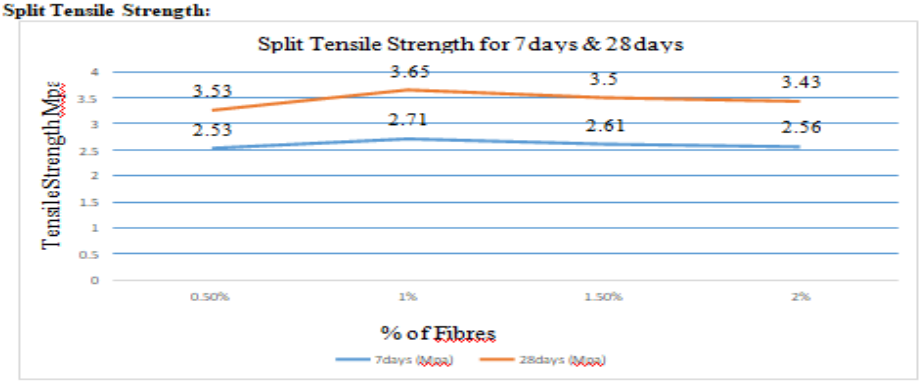
From the above results Replacement of fine aggregate with 30 % of Steel Slag and addition to the glass fibres to the conventional concrete. Up to 1% the Strength of the concrete is Gradually Increasing and then its strength is reduced in all the 3 tests.

Compressive Strength:



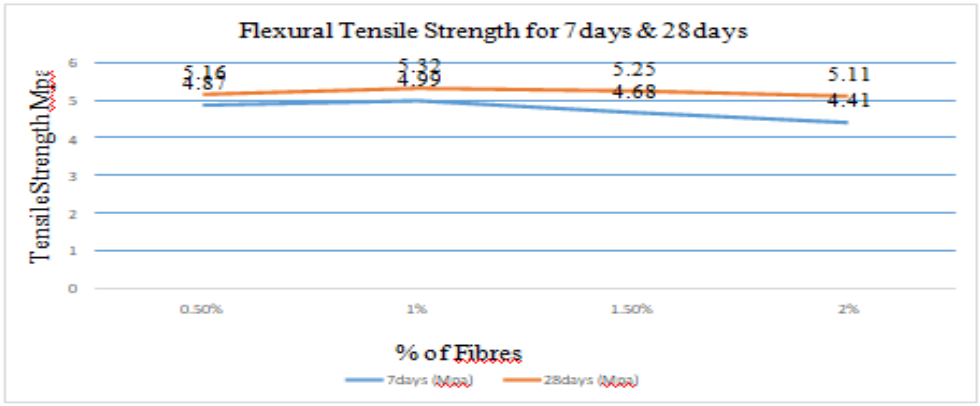
GRAPH IV: GRAPH COMPRESSIVE STRENGTH FOR (CONVENTIONAL CONCRETE + 30% OF STEEL SLAG CONSTANT + % OF FIBRES)

Split Tensile Strength:



GRAPH V: GRAPH SPLIT TENSILE STRENGTH FOR (CONVENTIONAL CONCRETE + 30% OF STEEL SLAG CONSTANT + % OF FIBRES)

Flexural Tensile Strength:

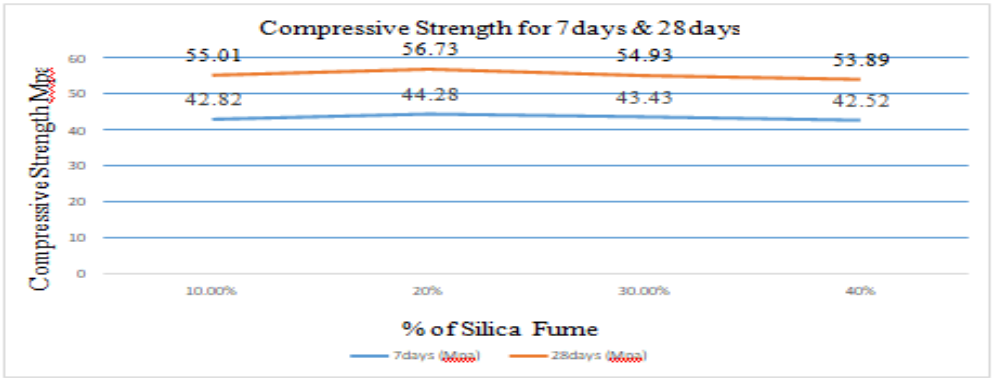


GRAPH VI: GRAPH SPLIT TENSILE STRENGTH FOR (CONVENTIONAL CONCRETE + 30% OF STEEL SLAG CONSTANT + % OF FIBRES)

TABLE 4: RESULTS (CONVENTIONAL CONCRETE + 30% OF STEEL SLAG CONSTANT + 1% OF FIBRES CONSTANT + % OF SILICA FUME)

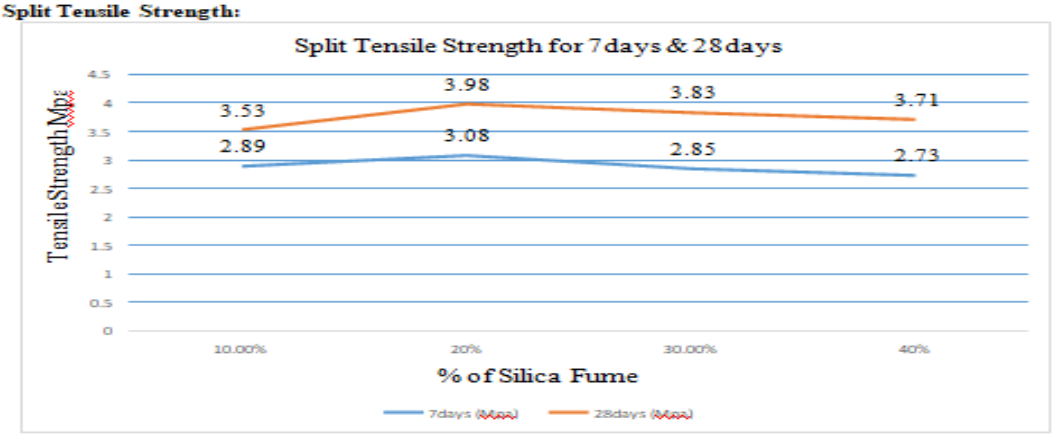
% of Silica fume added	Compressive strength		Split tensile strength		Flexural strength	
	7 days	28 days	7 days	28 days	7 days	28 days
10%	42.82	55.01	2.89	3.79	5.09	5.45
20%	**44.28**	**56.73**	**3.08**	**3.98**	**5.22**	**5.62**
30%	43.43	54.93	2.85	3.83	4.99	5.53
40%	42.52	53.89	2.73	3.71	4.85	5.35

Compressive Strength:



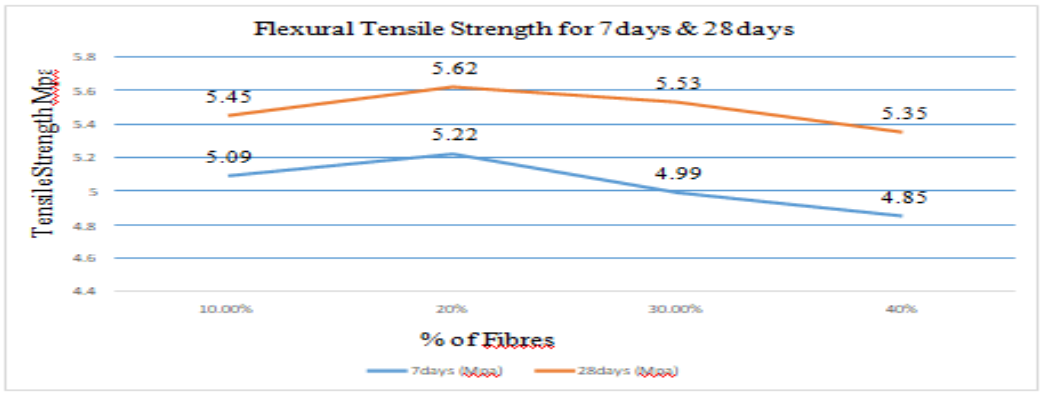
GRAPH VII: GRAPH FOR COMPRESSIVE STRENGTH FOR REPLACEMENT OF CEMENT WITH SILICAFUME (30%STEELSLAG+1%GLASSFIBERS+SILICAFUME)

Split Tensile Strength:



GRAPH VIII: GRAPH FOR SPLIT TENSILE STRENGTH FOR REPLACEMENT OF CEMENT WITH SILICAFUME (30%STEELSLAG+1%GLASSFIBERS+SILICAFUME)

Flexural Tensile Strength:



GRAPH IX: GRAPH FOR FLEXURAL TENSILE STRENGTH FOR REPLACEMENT OF CEMENT WITH SILICAFUME (30%STEELSLAG+1%GLASSFIBERS+SILICAFUME)

VI. CONCLUSIONS

In present study of 30% replacement of fine aggregate with steel slag, 1% of fibres and 20% of replacement of cement with silica fume the increase in compressive strength for 7days and 28days was observed, Later for more than 30% replacement of fine aggregate with steel slag, 1% of fibres and 20% of replacement of cement with silica fume the decreasing strength was observed, when compared to the design mix with 100% conventional concrete

1. The optimum strength (of 50.10KN/m^3 for compressive strength, 3.41 KN/m^3 for split tensile, and 5.03 KN/m^3 for flexural strength) was obtained at Conventional concrete and fine aggregate is replaced with 30% of steel slag.
2. The optimum strength (of 53.31KN/m^3 for compressive strength, 3.65 KN/m^3 for split tensile, and 5.32 KN/m^3 for flexural strength) was obtained at Conventional concrete, fine aggregate is replaced with 30% of steel slag after addition of 1% of fibres.
3. The optimum strength (of 56.73KN/m^3 for compressive strength, 3.98 KN/m^3 for split tensile, 5.62 KN/m^3 for flexural strength) was obtained at Conventional concrete, fine aggregate is replaced with 30% of steel slag, addition of 1% of fibres after replacing cement with 30% of silica fume.
4. The increased in strength after replacing with 30% steel slag was found to be 15.14% of compressive strength, 14.42% of split tensile strength, and 11.29% of flexural strength.
5. The observed increase in strength (Conventional concrete, fine aggregate is replaced with 30% of steel slag after addition of 1% of fibres) is 8.39% of compressive strength, 21.09% of split tensile strength, 12.79% of flexural strength.

6. The increase in strength (Conventional concrete, fine aggregate is replaced with 30% of steel slag, addition of 1% of fibres after replacing cement with 30% of silica fume) is 22.52% of compressive strength, 24.76% of split tensile strength, 17.57% of flexural strength.
7. The optimum obtained for the concrete by replacing fine Aggregate with Steel slag is obtained at 30%.
8. Concrete with 1% of glass fibers in concrete has highest value in strength.
9. Concrete with 20% of silica fume in replacement in concrete has highest value in strength.

VII. REFERENCES

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[7]. Fine Aggregate for entire experimental work. The physical properties of sand were carried out by taking the help of IS 383- 1970.
[8]. Coarse Aggregate Crushed Granite stone of sizes 20mm were selected for this work. Taking the reference of IS code IS 2386-1963.
[9]. Glass Fibres and its properties are taken with the reference of MORTH Section 600.
[10]. For Calculating Target mean strength the standard deviation 's' Value taken from TABLE NO 1 FROM IS:10262-2009.
[11]. The Water Cement ratio value was taken from TABLE NO 5 FROM IS: 456-2000.