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"A Study on Properties of Concrete Containing Ceramic Waste Powder with Steel Fiber"

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Abstract - *An A use of industrial waste materials in concrete compensate lack of natural resources, providing solution for disposal problem of waste and find alternative techniques for sustainable development. There are a number of industrial waste used as fully or partial renewal of coarse aggregates or fine aggregates. Some of the industrial waste are just like¬¬ waste sand, steel slag, copper slag, blast furnace slag, coal bottom ash, plastic etc. Different kind of physical & mechanical properties of industrial waste as well as industrial waste concrete, by which natural sand is substituted has been researched.*

In present the construction cost as lack of sand is enhancing day by day in order to counteract this problem, sand is partially replace in form of ceramic wastes material. Also this techniques proved to be highly cost effective than ordinary method. The objective of this dissertation is replacement of cement with ceramic waste has been kept constant that is 10% by weight and the proportion of steel fiber are varied in the percentage of 0%, 0.5%, 1.0%, 1.5% and 2.0% and test it for compressive strength, tensile strength, flexure strength and durability.

Keywords: *Concrete, ceramic, recycle, steel fibers, strength.*

1. INTRODUCTION

Concrete is a most habitually used construction material which is a mixture of cement and filler mix along with water in desired proportion the term called concrete. It is used for construction of multi-story buildings, dams, road pavement, tanks, offshore structures, canal lining. The method of selecting appropriate ingredients of concrete and determining their comparative amount with the purpose of producing a concrete of the required strength durability and workability as efficiently as possible is termed the concrete mix design.

2. LITERATURE SURVEY

- **A.Sathesh Kanna, G.Sangara Pitchai Raj(2019)**, performed test with marble powder with concluding M15 mix gave greater, M 5 mix gave lower compressive strength & split tensile strength test with M 15 mix gave greater, M20 results lower split tensile strength.

- **B.Senthil, S.Selvarani, M.Saranya, D.Suganya(2018)** reported that 30% replacement of fine aggregate by industrial waste give maximum result in strength and quality aspects than the conventional concrete and prepared the concrete containing 10, 20, 30, 40, 50% waste of quarry dust, and granite slurry with sand compared to the total quantity of normal concrete with studied in terms of their properties both in fresh and in hardened states.

- **Chandraprabha Sahu(2018)** reported that the inclusion of Marble powder the strength of concrete gradually increases up to a certain limit but then gradually decreases with Partial Replacement of Cement with Marble Dust Powder and tested at 3, 7, 28 days with taking five types of fly ash cement bricks specimens. In first three types sand percentage is taken as 30%, while the percentages of cement and fly ash have been changed by 5%. And in others percentage of fly ash is taken 60% with cement and sand having variation in their percentage by weight of the brick.

- **Lokesh Kumar, Gautam Bhadoriya(2017)** concluded compressive strength of 7th days cube is maximum for concrete mix M3 with addition of 25% fly ash as compared to other diverse concrete mixes & Increase in water cement ratio with addition of 25% fly ash.

3. METHODOLOGY

For this study the following raw materials are being used:

1. Coarse aggregate- The aggregates of nominal size of 20mm were used. The aggregates were purchased locally and tested for specific gravity and gradation using sieve analysis as per the Indian Standards.

2. Fine aggregate/sand- River sand was obtained from local sources. On this sand, Sieve Analysis and specific gravity tests were carried out.

3. Cement- Ordinary Portland Cement of grade 43 (OPC 43) was obtained locally

4. Ceramic waste- Ceramic waste is one of the most active research areas that encompass a number of disciplines including civil engineering and construction materials. Ceramic waste powder is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health.

5. Steel fibres- Steel fibres is a metal reinforcement. Steel fibres for reinforcing concrete is defined as short, discrete lengths of steel fibres with an aspect ratio (ratio of length to diameter) from about 20 to 100, with different cross-sections, and that are sufficiently small to be randomly dispersed in an unhardened concrete mixture using the usual mixing procedures

4. RESULT AND DISCUSSION

4.1 Workability of Concrete

4.1.1 Slump Test

Table No. 4.1 Slump for Control mix of M25 & M30 Grade

S. No.	Control Mix	Slump (mm)
1	M25	75
2	M30	90

Table No. 4.2 Slump with 10% MDP and Steel Fiber

S. No.	Steel fibre %	Slump (mm)	
		M25	M30
1	0.0	70	80
2	0.5	68	78
3	1.0	64	75
4	1.5	61	72
5	2.0	59	70

4.2 Compressive Strength Test

Compressive strength of concrete is utmost property of concrete. Cubes of dimensions 150×150×150 mm were cast and testes for compressive strength on compression testing machine.

Table 4.3 Compressive Strength of M25 grade

Steel Fibre %	Compressive Strength (N/mm²)		
	7 Days	14 Days	28 Days
0.0	16.09	21.46	26.82
0.5	17.95	23.78	29.93
1.0	20.52	26.94	33.64
1.5	21.24	27.85	34.82
2.0	18.17	22.24	27.70

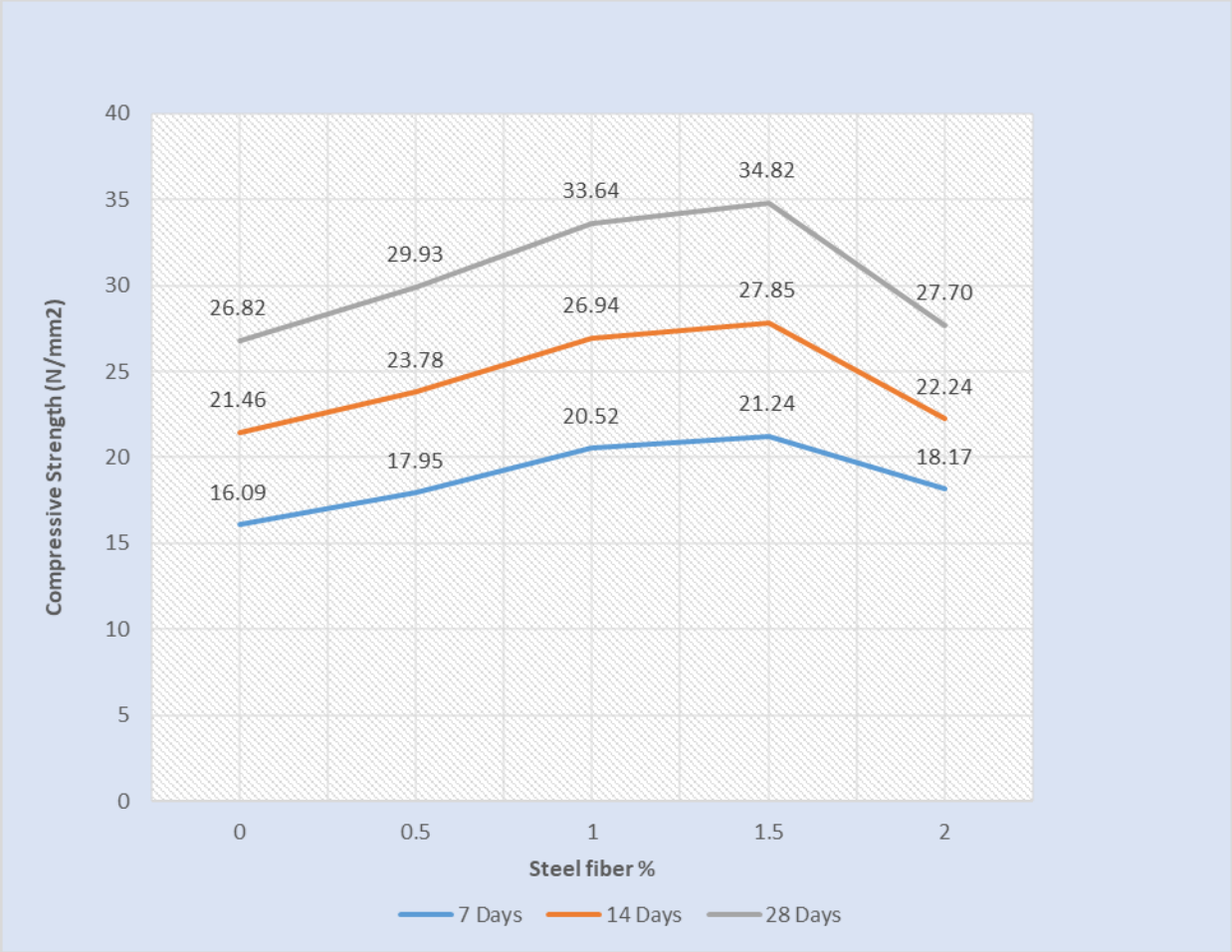

Fig 4.1 Comparative Compressive Strength of M25 Grade

Table 4.4 Compressive strength of M30 grade

Steel Fiber %	Compressive Strength (N/mm²)		
	7 Days	14 Days	28 Days
0.0	19.60	26.50	32.67
0.5	20.41	26.12	33.47
1.0	21.50	28.46	35.84
1.5	22.80	29.47	36.79
2.0	21.71	28.76	35.60

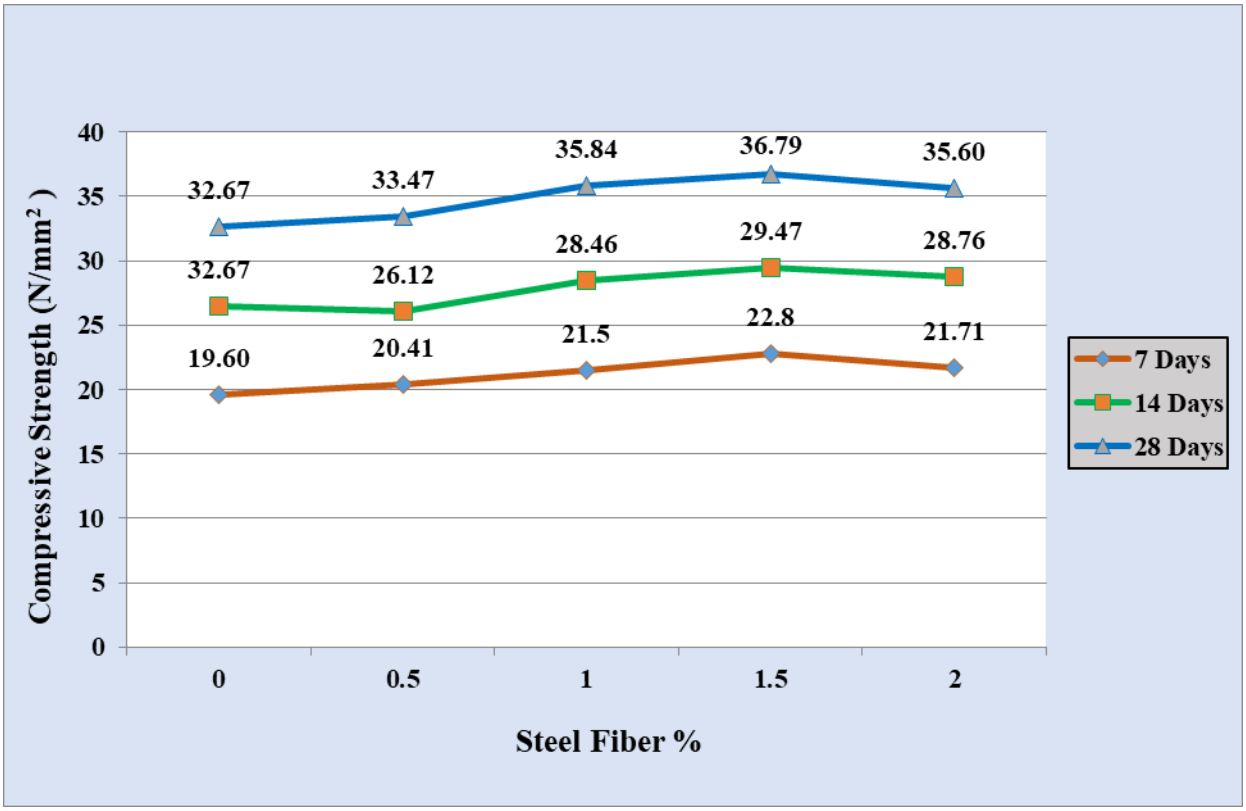

Fig 4.2 Comparative Compressive Strength of M30 Grade

4.3 Split Tensile Strength of Concrete

Concrete is weak in tension so the testing of cylinder specimen for tensile strength is required. Cylinders of dimension 150mm (dia.) and 300mm (length) were cast and tested for split tensile strength on universal testing machine.

Table 4.5 Splitting Tensile Strength of M25 grade

Steel Fiber %	Splitting Tensile Strength (N/mm²)		
	7 Days	14 Days	28 Days
0.0	1.38	1.79	2.24
0.5	1.49	1.94	2.41
1.0	1.66	2.18	2.73
1.5	2.02	2.58	3.26
2.0	1.39	1.77	2.27

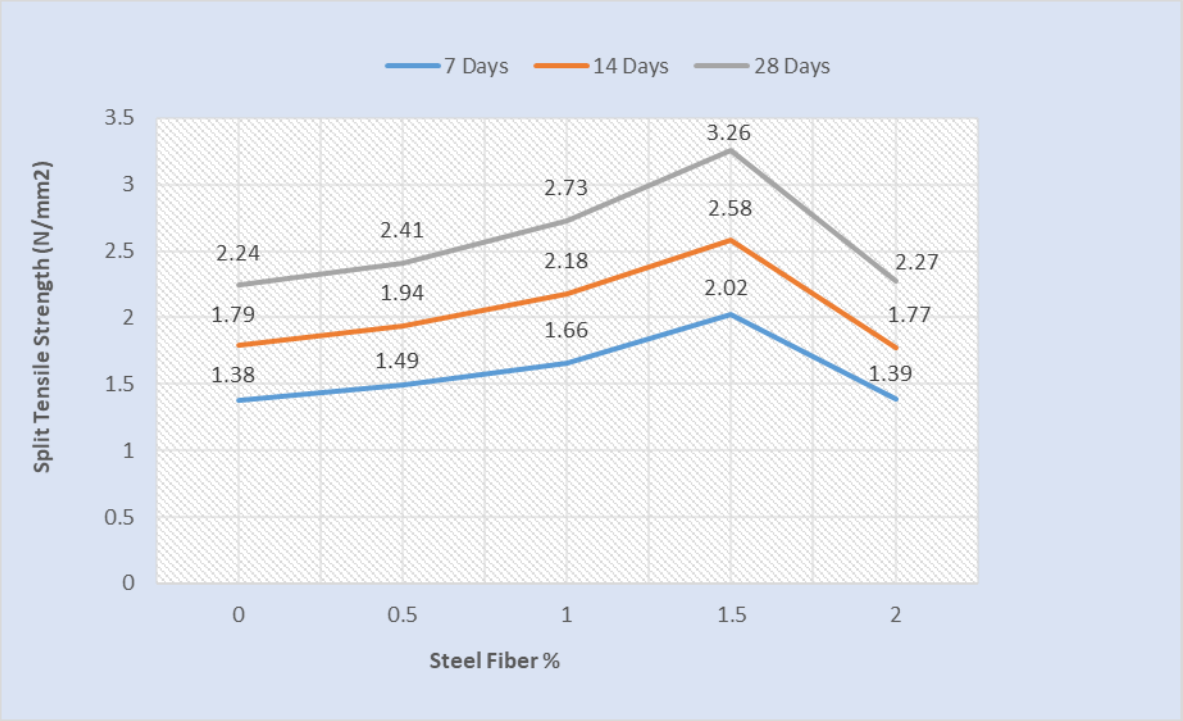

Fig 4.3 Comparative Splitting Tensile Strength of M25 Grade

Table 4.6 Splitting Tensile Strength of M30 grade

Steel Fiber %	Splitting Tensile Strength (N/mm²)		
	7 Days	14 Days	28 Days
0.0	1.99	2.97	3.33
0.5	2.42	3.33	3.97
1.0	2.51	3.48	4.12
1.5	2.22	3.29	3.64
2.0	2.04	3.06	3.41

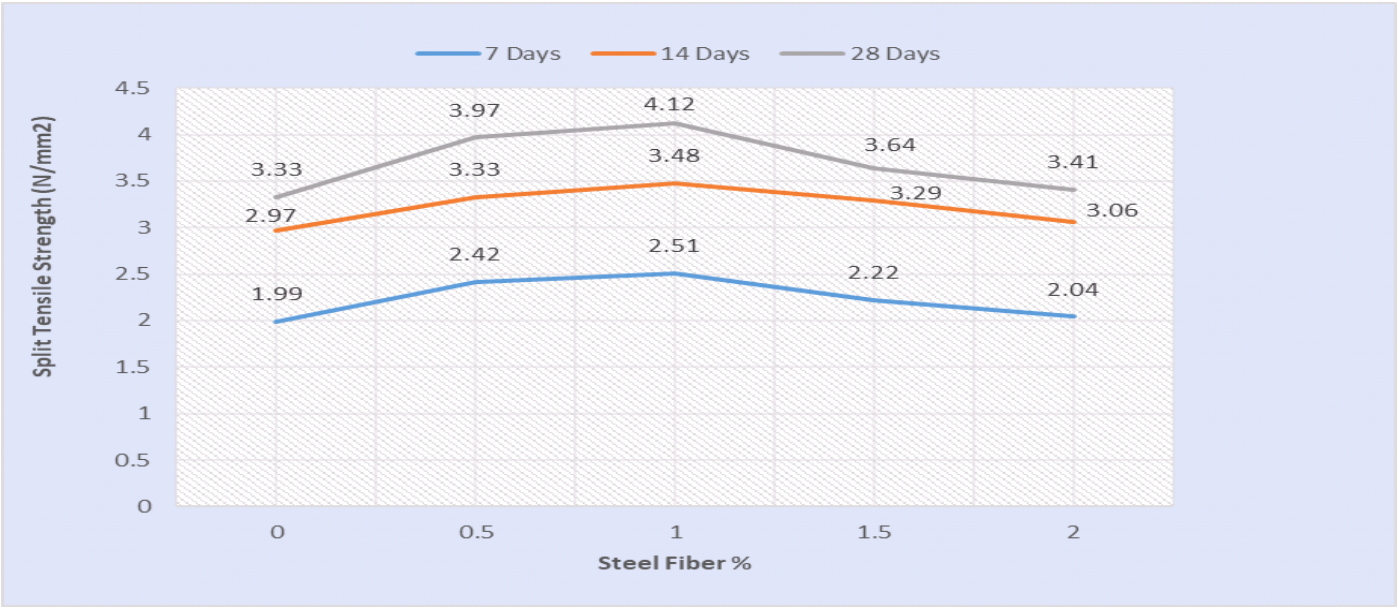

Fig 4.4 Comparative Splitting Tensile Strength of M30 Grade

4.4 Flexural Strength of Concrete

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. For flexural strength test beams of dimensions 150×150×500 mm were cast and tested on flexural testing machine.

Table 4.7 Flexural Strength of M25 grade

Steel Fiber %	Flexural Strength (N/mm²)	
	7 Days	28 Days
0.0	1.58	2.6
0.5	1.76	2.9
1.0	2.01	3.3
1.5	2.07	3.4
2.0	1.67	2.7

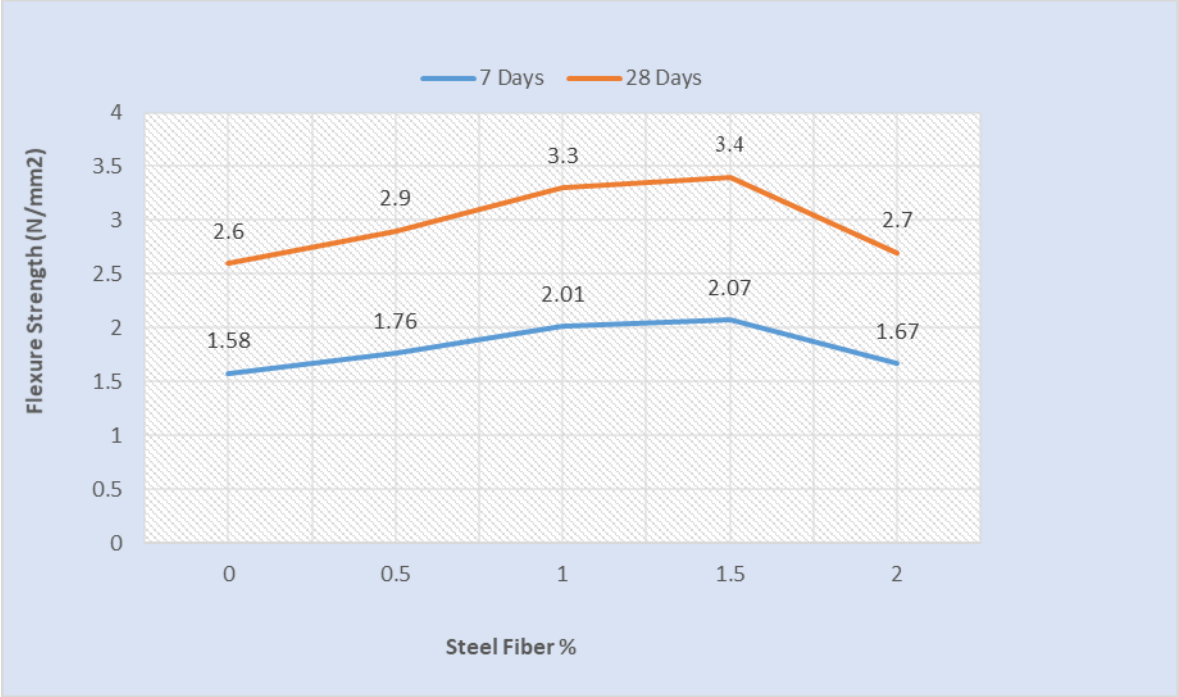

Fig 4.5 Comparative Flexural Strength of M25 Grade

Table 4.8 Flexural Strength of M30 grade

Steel Fiber %	Flexural Strength (N/mm²)	
	7 Days	28 Days
0.0	1.64	2.70
0.5	1.81`	2.97
1.0	2.06	3.38
1.5	1.98	3.26
2.0	1.93	3.12

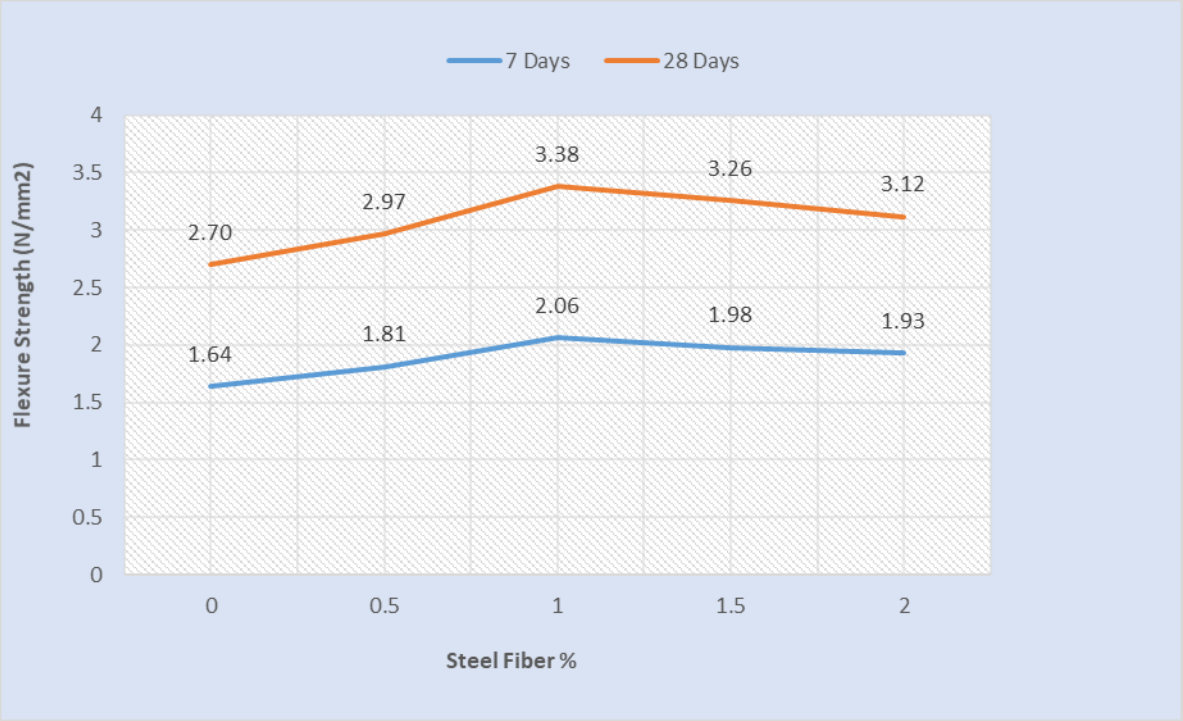

Fig 4.6 Comparative Flexural Strength of M30 Grade

CONCLUSIONS

5.1 General Experimentation Result

In the project work these Experimental Scenarios were considered during experimentation.

• Accomplish Compressive strength test, split tensile test and flexural strength on concrete of grade M25 & M30 having different Percentage (0%, 0.5%, 1.0%, 1.5% and 2.0%) of Steel Fiber and 10% of Ceramic waste powder.

• To determine durability of concrete in terms of moisture loss in percentage for both M25 & M30.

Results: In this experiment, Mix-Design of M25 & M-30 grade concrete; reference IS 10262: 2009, having water-cement ratio 0.45 is considered. Percentage of steel fiber (0% to 2%) is added in concrete along with Ceramic waste powder which was partial replacement of cement by 10%. Total 60 specimens of Steel Fiber Reinforced Concrete were cast with great precision and were cured for 7, 14 days and 28 days. During concreting/casting of cubes, slump test on fresh concrete was conducted for verification of workability with above percentage (%) addition of steel fiber i.e. (0% to 2%). After completion of maturity period of concrete Compressive strength test, split tensile test and flexural strength test and durability tests were conducted on all the specimens with respective date of casting. From the study following observations were made with respect to above stated tests conducted –

A. FOR M25

1. **Compressive Strength**:

The compressive strength increased as increase the percentage (%) of steel fiber (0% to 1.5%) after 1.5% of SF compressive strength decreases for both 14 days & 28 days cube strength.

It was concluded that optimum percentage increment in compressive strength of concrete was 29.82% at 28 days of curing respectively.

2. **Split Tensile Strength:**

The minimum split tensile strength was obtained at 0% addition of steel fiber while optimum split tensile strength was obtained at 1.5% addition of steel fiber at 14 and 28 days curing of cubes.

It was concluded that optimum percentage increment in split tensile strength of concrete was 45.53% at 28 days of curing respectively.

3. **Flexure Strength:**

It was noted that flexural strength of concrete increase gradually with addition of steel fiber and minimum flexural strength was obtained at 0% while optimum flexural strength was obtained at 1.5% addition of steel fiber at 14 and 28 days of curing respectively.

It was concluded that optimum percentage increment in flexural strength of concrete was 30.76% at 28 days curing respectively.

4. **Durability:**

It was concluded that the percent loss of weight of cube specimens for resistance against acid attack was found to be -

- For CWP 10% at 90 days - 0.92 %
- For CWP 10% and SF 0.5% to 2.0% at 90 days found increasing - 0.95 to 1.73 %

The results revealed that the percent loss of weight of cube specimens for resistance against alkali attack was found to be -

- For CWP 10% at 90 days - 0.26%
- For CWP 10% and SF 0.5% to 2.0% at 90 days found increasing - 0.31 to 0.51 %

B. FOR M30

1. Compressive Strength:

The results revealed that minimum compressive strength was obtained at 0% addition of steel fiber while optimum compressive strength was obtained at 1.5% addition of steel fiber for both 14 days and 28 days curing period of cubes.

It was concluded that optimum percentage increment in compressive strength of concrete was 12.61% at 28 days of curing respectively.

2. Split Tensile Strength:

The results revealed that minimum split tensile strength was obtained at 0% addition of steel fiber while optimum split tensile strength was obtained at 1.0% addition of steel fiber at 14 and 28 days curing of cubes.

It was concluded that optimum percentage increment in split tensile strength of concrete was 23.72% at 28 days of curing respectively.

3. Flexure Strength:

It was noted that minimum flexural strength was obtained at 0% while optimum flexural strength was obtained at 1.0% addition of steel fiber at 14 and 28 days or curing respectively.

It was observed that optimum percentage increment in flexural strength of concrete was 25.18 % at 28 days curing.

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