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Experimental Investigations on Cement Concrete by using Waste Steel as a Fibre in Concrete

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ABSTRACT

As the technology is getting advanced day by day bringing the enhancement in comfort level of the human beings for example use of plastic containers. The use of plastic and metal containers has became very popular for carrying any liquid or semi liquid content. But if we see as per the rule of nature every action has a reaction likewise after looking at the advantages there are many disadvantages for example the plastic material used for making is not decomposible naturally and has to be taken care of artificially.

So the researchers today are finding the way out for processing, recycling or reusing such material for some other purpose. In today scenario the constructions globally are increasing rapidly so there is a need of the construction industry to find out the cost effective materials for increasing the strength of concrete structures. Keeping this in mind the researcher has decided to study the influence of addition of waste materials like lathe waste, soft drink bottle caps, empty waste tin, waste steel powder as a mixing material with the concrete in the percentage of maximum 1 to 1.2 % of total weight of concrete.

All the scrap material mentioned above was collected and processed in to strips of approximately size of 15 to 25 mm. Today due to Global warming there is a need of using maximum quantity of such recyled material by which we can conserve the natural resources and reduce the amount of materials going to our landfills. Large quantities of metal waste are generated from empty metal cans and bottle caps of juices and soft drinks. This is an environmental issue as metal waste is difficult to biodegrade and involves processes either to recycle or reuse. Today the construction industry is in need of finding effective materials for increasing the strength of concrete structures with low cost, and with less environmental damage. In this study the researcher has tried his level best for the positive results by using the waste or scraped metal material as a partial substitute for coarse aggregate with the help of orange leaves powder as a plasticizer. The parameters like slump, demoulded density, split tensile strength, compressive strength, flexural strength properties at different percentages replacement of coarse aggregate with waste bottle caps were investigated in the laboratory. In this investigation, after conducting certain laboratory tests the researcher has done the comparison between plain cement concrete and the metal fiber reinforced cement concrete in various proportions by weight. The metal fibers used in this study were irregular in shape and varying aspect ratio. Analytical comparison of both the samples was done for the parameters like compressive strength, tensile strength and flexural strength. After the completion of 28 days the strength of metal fiber reinforced material concrete was found increased when compared with the strength of plain cement concrete. This study was conducted with M30 cement.

Keywords: *concrete, fiber, FLEXURAL STRENGTH*

1. INTRODUCTION

In the current scenario a human being is running after the construction of very challenging and difficult civil engineering structures. Concrete is the only commonly used and important material in the contruction there is a need of manufacturing of concrete with the characteristics like high strength, sufficient workability. For fulfilling these requirements the scientists are taking lot of efforts in the field of concrete technology with the help of mixing fibers and other admixtures in the concrete up to certain proportions.

As per the studies available using or mixing of waste steel or metal fibers in the cement for manufacturing concrete provide improvements in the tensile strength, toughness, ductility, post cracking resistance, fatigue characteristics, durability, shrinkage characteristics, impact, cavitations, erosion resistance and serviceability of concrete. In each lathe industry the remains of metal wastes are available which were normally dumped in the barren soil resulting in contamination of the soil and ground water. Now a day's this scrap material is used by many innovative construction industries. The term fiber reinforced concrete means the concrete mixed with metal fibers in it. Normal concrete is weak in tensile strength and strong in compressive strength. For increasing the tensile strength of the concrete the researchers conducted lot of experiments and finally reached to a conclusion of adding metal fibers as a partial substitute.

Concrete has an extensive role to play in the construction and improvement of our civil engineering and infrastructure development. Its great strength, durability and veracity are the properties that are utilized in construction of Roads, Bridges, Airports, Railways, and Tunnels, Port, Harbours, and many other infrastructural projects.

The practice of mixing of admixtures to concrete was first carried out in 1900 at that time the asbestos fibres were used as an admixture to the concrete . After further studies by 1960 steel, glass and synthetic fibres such as polypropylene fibres were used as an admixture in concrete. But further as the meatl waste is not degradadble or decomposible it has become a need of today of recycling and reusing it in the manufacturing of concrete.

In this study the mineral admixture used is the metallic waste obtained from various locally available things such as mild steel lathe waste, empty beverage tins, soft drink bottle caps. All the above said things procurred were transformed into the rectangular pieces with an approximate size of 10mm to 15mm. These metal pieces or fibers were added in the concrete in the proportion of 0.6%, 0.8%, 1.0% and 1.2% respectively as per the weight of concrete.

Ordinary Portland Cement (OPC) 43 grade and fine aggregate with less amount of clay and silt with sand size is pass through 1.19mm sieve and retained on 900micron sieve. The coarse aggregate used in 20mm & 10mm size. It is well graded and potable water, free from impurities such as oil, alkalies, acids, salts, sugar, and organic materials were used

a. Bottle Caps Fibre b. Lathe Waste

c. Steel Canes d. Mix of All Fibres

Fig.No.1 Various Waste Materials

2. MATERIALS AND THEIR PROPERTIES

A. Cement

Portlan cements are hydraulic cements, meaning they react and harden chemically with the addition of water. Cement contains limestone, clay, cement rock and iron ore blended and heated to 1200 to 1500 C°. The resulting product "clinker" is then ground to the consistency of powder. Gypsum is added to control setting time.

Sr. No.	Characteristics	Experimental value	Specified value as per IS:8112-1989
1.	Consistency of cement (%)	34%	**---**
2.	Specific gravity	2.99	**3.15**
3.	Initial setting time (minutes)	36	**>30 As Per IS 4031-1968**
4.	Final setting time (minutes)	284	**<600 As per IS 4031-1968**
5.	Compressive strength (N/mm^2) (i) 3 days (ii) 7 days (iii)28days	 25.77 40.42 47.50	 **>23** **>33** **>43**
6.	Soundness (mm)	1.00	**10**
7.	**Fineness of Cement**	**5%**	**10% As Per IS 269-1976.**

Table No.-2.1 Characteristics Properties of Cement

B. Fine aggregate:

Aggregate smaller than (5 or 4.75 mm) in diameter is Classified as fine aggregate or sand.

C. Course aggregate:

Aggregate larger than (5 or 4.75mm) in diameter is classified as coarse aggregate.

D. Water:

The water used in the concreting work was the potable water as supplied in the PG Structures lab of our college. Water used for mixing and curing was clean and free from injurious amounts of oils, acids, alkalis, salts and sugar, organic substances that may be deleterious to concrete. As per IS 456- 2000 Potable water is generally considered satisfactory for mixing and curing of concrete. Accordingly potable tap water was used for the preparation of all concrete specimens.

Sr. No.	Properties	Values
1.	Specific Gravity of Fine Aggregates	2.65
2.	Specific Gravity of Coarse Aggregates	2.87
3.	Free Moisture Content	2%
4.	Water Absorption	1.82%

Table No.-2.2 Physical Properties of Aggregates

3. EXPERIMENTAL INVESTIGATION

3.1. CASTING OF SPECIMEN

Standard cubical moulds of size 150mm×150mm×150mm and cylinder mould of depth 150mm ,height 300mm and dia. of 100mm and beam mould of 150mm×150mm×700mm made of cast iron were used to cast concrete specimens to test compressive strength ,split tensile strength and flexural strength respectively. The quantities of cement, fine aggregates, coarse aggregates, and water for each batch were weighted to an accuracy of 1kg separately. Sand and steel waste is added to this mixture in dry form. Finally, coarse aggregates were added and thoroughly mixed to get a uniform mixture throughout the batch. Required dosage of water was added in the course of mixing. Through mixing was done until concrete appeared to be homogeneous and of desired consistency. Concrete mix so prepared was tested for slump flow and reading of slump carefully recorded. The inner surfaces of moulds were oiled so as to avoid the sticking of concrete. Concrete was then filled in previously prepared moulds with controlled vibration to the concrete. Surface of concrete was finished level using a trowel and date along with batch number was marked properly on it. Finished specimens were left to harden and removed from moulds approximate after 24 hours of casting. They were then placed in water tank containing portable water and were left for curing.

Fig. No. 3.1: Fibres added concrete mix before adding water

3.2. TESTING OF CONCRETE

Fig 3.2 Test Set up for Split Tensile Strength

S. N	Mix Designation	Percentage of Steel Waste	Load (KN)	Compressive Strength (N/mm²)	Average Compressive Strength (N/mm²)	% increase in strength at 7 days
1.	MX0	0%	515 510 520	22.88 22.67 23.11	22.88	....
2.	MX1	0.4%	525 525 520	23.33 23.33 23.11	23.25	1.61
3.	MX2	0.8%	540 530 545	24.00 23.55 24.22	23.92	4.54
4.	MX3	1.2	555 540 560	24.67 24.00 24.89	24.52	7.16
5.	MX4	1.6	560 570 550	24.89 25.33 24.44	24.88	8.74

Table 3.1 Compressive Strength after 7 Days

S. N	Mix Designation	Percentage of Waste steel	Load (KN)	Compressive Strength (N/mm²)	Average Compressive strength (N/mm²)	% increase in strength at 28 days
1.	MX0	0%	860 855 870	38.22 38.00 38.66	38.29	.....
2.	MX1	0.6%	870 875 880	38.66 38.88 39.11	38.88	1.54
3.	MX2	0.8%	892 880 885	39.64 39.11 39.33	39.36	2.79
4.	MX3	1.0%	890 907 897	39.55 40.31 39.86	39.90	4.20
5.	MX4	1.2%	913 925 920	40.57 41.11 40.88	40.85	6.68

Table 3.2 Compressive Strength after 28 Days

S. N	Mix Designation	Percentage of Steel waste	Split Tensile Strength (Tonnes)	Split Tensile Strength (N/mm²)	Average strength (N/mm²)	% increase in strength at 7days
1.	MX0	0	120 116 128	1.69 1.64 1.81	1.71	....
2.	MX1	0.6%	130 140 138	1.84 1.98 1.95	1.92	12.28
3.	MX2	0.8%	155 142 150	2.19 2.00 2.12	2.10	22.80
4.	MX3	1.0%	155 160 166	2.19 2.26 2.34	2.26	32.16
5.	MX4	1.2%	168 160 170	2.37 2.26 2.40	2.34	36.84

Table3.3 Split Tensile Strength after 7 Days

Sr. No.	Mix Designation	Percentage of steel waste	Split Tensile Strength (Tonnes)	Split Tensile Strength (N/mm²)	Average strength (N/mm²)	% increase in strength at 28 days
1.	MX0	0%	205 215 201	3.90 3.04 2.84	2.92	.....
2.	MX1	0.6%	220 225 218	3.11 3.18 3.08	3.12	6.84
3.	MX2	0.8%	245 238 230	3.46 3.37 3.25	3.36	15.06
4.	MX3	1.0%	248 250 260	3.51 3.49 3.64	3.54	21.23
5.	MX4	1.2%	265 275 260	3.75 3.89 3.64	3.76	28.76

Table 3.4 Split Tensile Strength after 28 Days

Sr. No.	Mix Designation	Percentage of Waste steel	Flexural Strength (KN)	Flexural Strength (N/mm²)	Average strength (N/mm²)	% increase in strength at 7 days
1.	MX0	0%	19.2 19.7 18.9	3.41 3.50 3.36	3.42	....
2.	MX1	0.6%	20.6 20.0 21.2	3.66 3.55 3.76	3.65	6.72
3.	MX2	0.8%	21.4 21.9 22.2	3.80 3.89 3.95	3.88	13.4
4.	MX3	1.0%	22.3 22.7 23.2	3.96 4.03 4.12	4.03	17.83
5.	MX4	1.2%	23.1 23.5 23.9	4.10 4.17 4.24	4.17	21.92

Fig.No. 3.5 Flexure Strength after 7 Days

Sr. No.	Mix Designation	Percentage of steel waste	Flexural Strength (KN)	Flexural Strength (N/mm^2)	Average strength (N/mm^2)	% increase in strength at 28 days
1.	MX0	0%	29.7 30.3 30.9	5.28 5.38 5.49	5.38	....
2.	MX1	0.6%	31.1 31.6 32.0	5.52 5.61 5.68	5.60	4.08
3.	MX2	0.8%	32.5 32.8 33.3	5.77 5.83 5.90	5.83	8.36
4.	MX3	1.0%	33.3 33.9 34.3	5.92 6.02 6.09	6.01	11.76
5.	MX4	1.2%	34.2 34.6 34.0	6.08 6.15 6.04	6.09	13.19

Table 3.6 Flexure Strength after 28 Days

4. INTERPRETATION OF TEST RESULTS

4.1. Compressive Strength

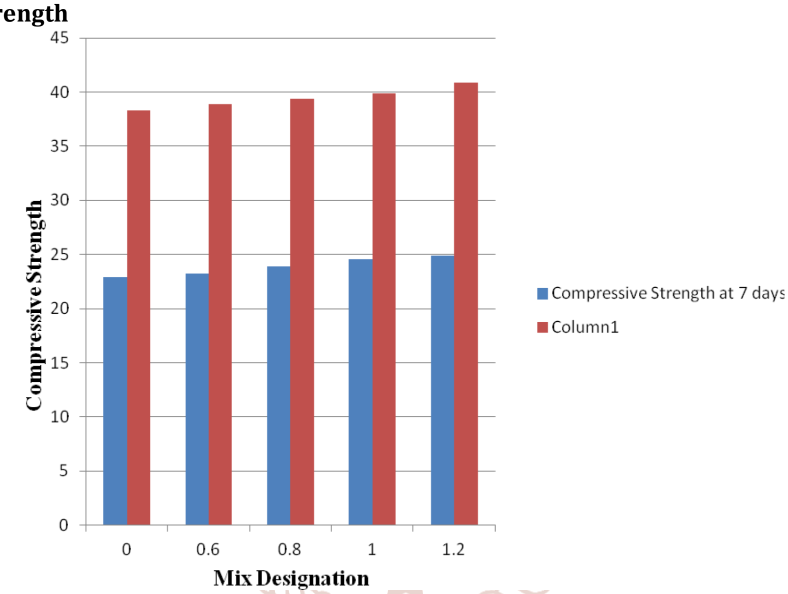

Fig.No. 4.1: Graph comparing compressive strength for 7 and 28 days

4.2. Split Tensile Strength

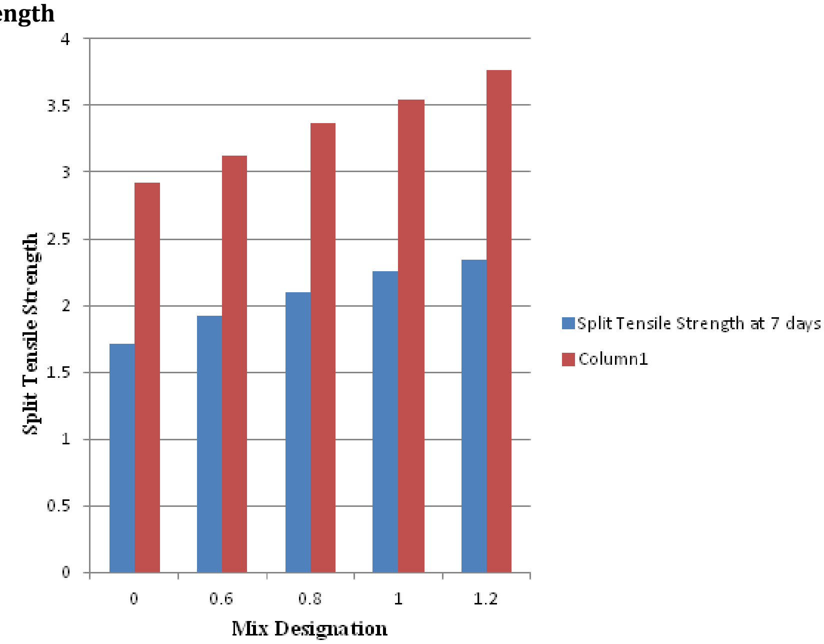

Fig. No. 4.2: Graph comparing Split Tensile Strength for 7 and 28 days

4.3. Flexure Strength

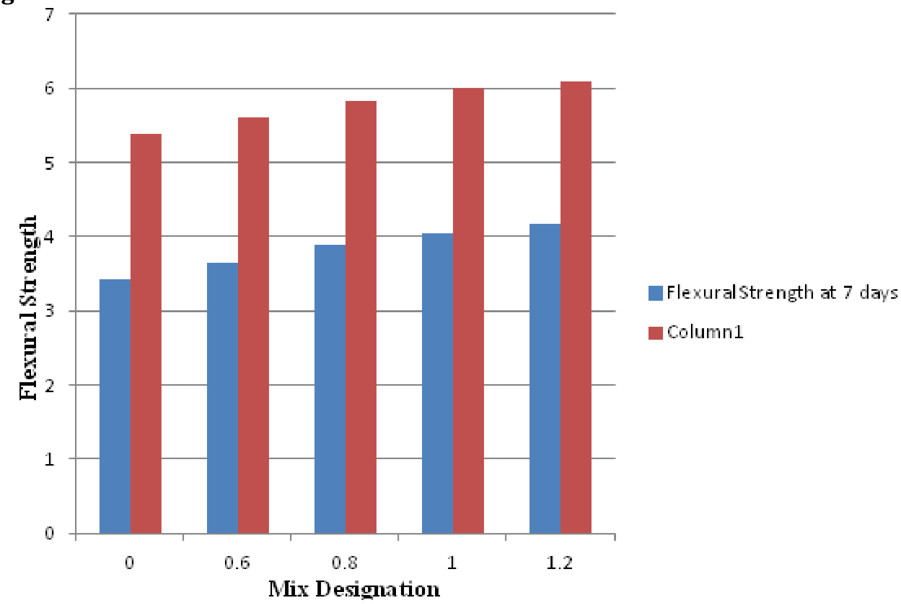

Fig.No.4.3: Graph comparing Flexural Strength for 7 and 28 days

5. CONCLUSIONS

Based on the results obtained in the present investigation, the following conclusion can be drawn-

A. The results obtained in the present study indicates that it is feasible to add the steel waste as a fibre for improving the strength characteristics of concrete, thus the WSF can be used as an additive material for the production of concrete to address the waste disposal problems and to maximize the strength of concrete with usages of WSF which is most cheaply available.
B. With the addition of the waste steel fibre
C. Addition of waste steel fibres helps in increasing ductility of concrete.
D. Addition of waste steel fibres in high strength concrete adds more advantage compared to its addition in normal strength concrete. High strength concrete has a compact structure, low water cement ratio. As the temperature increases more internal stresses are induced causing bursting or explosive spalling. Waste steel fibres helps in decreasing the internal pressures and also helps in improved flexural and split strengths.
E. The geometry of waste steel fibres helps in better bonding of concrete, it also helps the fibres to act more efficiently as abridge in reducing the fracture of concrete. It also helps using attaining fibre free surface.
F. Fiber addition improves ductility of concrete & its post-cracking load carrying capacity.
G. Increases the cube compressive strength of concrete in 7 days to an extent of 8.74%
H. The increase in the various mechanical properties of the concrete mixes with polythene fiber is not in same league as that of the steel fiber.
I. Increases the cube compressive strength of concrete in 28 days to an extent of 6.68% at the dosage of 1.2% of addition of waste steel fibre.
J. Increases the split tensile strength of concrete in 28 days up to 28.76 % at the 1.2% of fibre addition. It is much higher strength increment at last specimen in our study .it shows that as per our objective we can gain better tensile strength.
K. In this the flexural strength of concrete at 1.2% of waste steel fibre addition in concrete at 28 days at a percentage of 13.19.

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