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Experimental Examination of Fiber Reinforced Concrete Incorporation with Lathe Steel Scrap

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Abstract*: Food and shelter are the basic needs of every human being, as the population of the world is increasing there is an emerging need of mass constructions or multi storied constructions which can accommodate a greater number of people. In this aspect high strength concrete is required which is eco-friendly i.e. it must be more sustainable and effort worthy. To accelerate the properties of concrete we can add fibrous material to the concrete which are evenly distributed and randomly oriented and helps to increase the compressive strength, shear resistance, crack résistance, modulus of elasticity, toughness and reduction of shrinkage of concrete. And also, by keeping sustainability in mind we have used Lathe steel scrap as a fibrous material in the concrete, which is non-bio-degradable solid waste produced by Lathe machinery in manufacturing industries, land filling by these materials causes land pollution and also affect the quality of ground water at such places. In consideration of environmental pollution and vast availability of these scrap material we have used Lathe steel scrap as partial addition to concrete at 1%, 1.5%, 2% by volume proportions for M30 grade concrete and the properties like compressive, split tensile, bending, flexural beam strength, modules of elasticity are tested for 7 and 28 days and compared with noramal M30 concrete

Keywords* : *Compressive Strength, Split Tensile Strength, Bending Strength, Flexural Strength, Modulus of elasticity and Lathe Steel scrap.

I. INTRODUCTION

Conventional concrete

Plain cement concrete has a very low tensile strength, less resistance to cracking and low ductility and also it undergoes shrinkage and small internal micro cracks are found due to high carbon emission. These micro cracks and shrinkage are responsible for the inelastic deformations in concrete, so we need reinforcement in all directions which can arrest the cracks.

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The only possible way is to introduce fibers in them so that concrete can be more conventional in usage. But the PCC have a high compressive strength in comparison to other building materials so it is a advantage using concrete as building material.

Fiber reinforced concrete

FRC contains uniformly distributed and unevenly oriented fibers which are responsible for the increase in ductility, increase in flexural strength and it helps to increase all the properties in which the concrete is lagging. The fibers are categorized into synthetic, natural, glass, and steel fibers in this study we are using steel fibers which are obtained from lathe machinery, again these steel fibers can be classified as Carbon steel (mild, medium carbon, and high carbon), Alloy steel, Stainless steel, Tool steel. We have used mild steel scrap as an addition to the concrete.The concrete prepared with the lathe steel scrap are used to produce self compacting concrete as the specific gravity of lathe steel scrap is more in comparision with all the materials in the concrete so these fibers can reach all the corners and also to the bottom of the concrete members. As the tension zone of the member will be at the bottom for vertically loaded members usage of these type of self compacting concrete can help in the acceleration of settling of concrete. And while using with lathe steel scrap it also gives additional strength to the concrete which is almost 1.5 times the original strength of the designed target mean strength. This addition doesn't show much effect on the flow properties like slump value when designed for the true slump.

Nithi M.et al. The work is carried out by using 1%, 2%, 3% addition of lathe steel scrap into the concrete of M30 grade. In this experiment 24 specimens are casted where 12 beams are with shear reinforcement and others are with shear reinforcement. They observed for both bending and shear that the ultimate strength of the beam increases at an optimal addition.

Dinesh W. Gawatre et al. The work is carried out by using 0 to 2% addition of lathe steel scrap at an interval of 0.4% in the concrete of grade M30. In this study 36 cubes are casted to find out the compression strength of the concrete. They conclude that the strength keeps on increasing up to the optimum addition of lathe steel scrap in comparison with the controlled mix.

Sheetal Chinnu James et al. The work is carried out by using 0 to 3% addition of lathe steel scrap at an interval of 0.5% in the concrete of grade M30. The concrete cubes are casted and tested under compression for 7, 14 and 28 days and found the compression strength.

They concludes that the optimum percentage of steel scrap is 1% which gives maximum strength when compared to normal concrete.

Abdul Rahman et al. In this work they have used M-sand in place of natural river sand. And also added lathe steel scrap 0 to 10% at an interval of 2.5%. In the concrete of grade M30. Specimens are tested for compressive and tensile strength. It was concluded that the maximum strength is attained at 10% addition of lathe steel scrap.

Jasis Joyand Rajesh Rajeev. in this work 0.5%,1% and 2% addition of scrap like steel nails, Binding wire, lathe steel scrap is used in the concrete of M25, and they have casted a total number of 162 specimens for compression strength, flexural strength, split tensile strength and tested for 3,7,28 days. In which the results of tensile stress and flexural strength is maximum at 1.5% additions and compression strength is found to be maximum at 1% addition of steel scrap.

Poorva Haldkar and Ashwini Salunke. This paper is a comparison between plain cement concrete and fiber reinforced concrete. Lathe steel is used as an fiber material in this the fibers are added to the concrete of grade M25at an interval of 0.4% within the limits of 0 to 2%.and different specimens are caste to test compression, flexure and tension. After the tests the results are found to be maximum at 1.2% addition of lathe steel fiber to the concrete in compared to the controlled mix of the concrete.

Aravind N et al. In this study the lathe steel scrap is used as an addition to the concrete of grade M30 and the specimens are tested for compressive strength to know corrosion in the concrete due to the steel lathe steel scrap used in the concrete using phenolphthalein indicator. In this study 1%,2% and 3% addition of lathe steel scrap is used and the study concludes that the optimum percentage if addition is 2% and when the damaged surface of the specimen is applied by phenolphthalein indicator it turns into pink i.e. it effects in the corrosion of the concrete.

Babu et alworked on Comparative study on compressive and flexural strength of steel fibre reinforced concrete (SFRC) using fly ash. Suneel et al. has done Study on strength parameters in concrete with partial replacement of cement using hypo sludge by adding fibers. Suresh et al. Strength and behaviour of concrete by using natural and artificial fibre combinations. Pasala and Lalitha worked on Experimental study on mechanical properties of concrete (M30) by adding natural fibers (Jute Fiber).Aravind et al., Experimental study on partial replacement of cement by bagasse ash in concrete mix with glass fibre as admixture.

Materials & Mix Design

Cement: OPC of 53 grade of specific gravity 3.15 and bulk density 1.14 (1140 kg/m^3) is used in the casting of specimens

Coarse aggregate: The aggregate used in this project having specific gravity 2.7 and bulk density 1550 kg/m^3. In this project 50% of aggregates are of 10-12 mm size and remaining 50% are of 20mm size.

Fine aggregate: Natural river sand which is easily available in market which confirms as per IS 383-1970 zone-II whose size is less than 4.75mm and of specific gravity 2.67, bulk density of 1500 (kg/m^3**).**

Lathe steel scrap: lathe steel scrap is the material which is obtained from lathe machinery used for shaping metal. The scrap used is of mild steel of density 7850(kg/m^3), the thickness is of 0.25mm, young's modulus 2x10^5 (N/mm^2) and length is in range of 10mm-20mm is been used these can be seen in fig.1

Fig.1 Lathe steel scrap

Chemical Admixture: ECMAS HP 902 (Hyper plasticizer) was used to retain workability of concrete as fibers are used in the concrete the workability value will decrease so we have used poly carboxylic ethers as hyper plasticizer.

Concrete mix design: In this present study, all the properties are tested for M30 concrete as per IS 456-2000. The design mix is prepared as per the specifications of the materials mentioned above. And the quantities of the materials is shown in table.1

Table 1: Material quantities

Material	M0	M1	M2	M3
% Addition of steel scrap	0	1	1.5	2
Cement (kg)	359	359	359	359
Coarse aggregate (kg)	1233.75	1216.66	1208.12	1200.01
Fine aggregate (kg)	688.78	679.24	674.78	669.72
Steel scrap weight (kg)	0	78.5	117.75	157
Chemical admixture (litre)	2.154	2.154	2.154	2.154
Water (litre)	158	158	158	158

II. RESULTS AND DISCUSSION

In this present work strength studies like compressive, split tensile and bending strength are determined.

Workability

Workability of concrete is known by slump cone test for all mixes (M0 – M3). The slump values are measured and represented in the Fig: 2. the figure is showing Mix ID's along X-axis and Slump value along Y-axis

Fig.2 Workability

Compressive Strength of mixes is measured from cubes with sizes 150×150×150 mm. Average of three specimens is casted for each curing period and tested under compressive testing machine. The responses are plotted in Fig: 3. The fig:3 is representing the Curing period in X-axis and strength in Y-axis.

Bending strength

Bending strength is determined by casting specimens of size 500 mm x 100 mm x 100 mm and kept for 28 days curing. Average of three specimens is taken by testing under 4 point bending. The responses are plotted in the Fig: 4 for all the mixes and curing ages. The Fig: 4 is representing the curing ages in X-axis and bending strength in Y-axis.

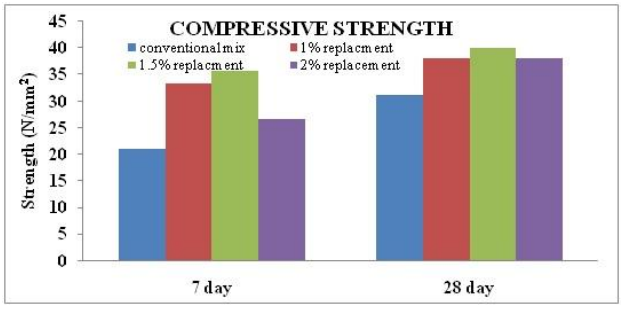

Fig.3 Compression strength

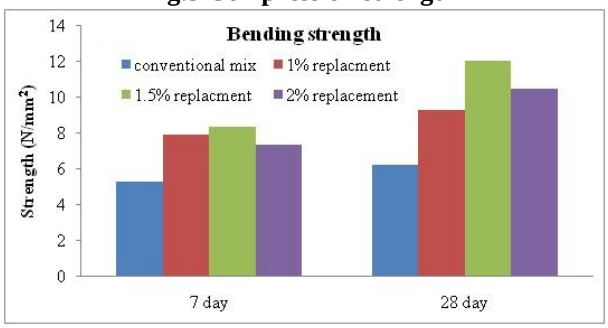

Fig.4 Bending strength

Split tensile strength:

Split tensile strength is determined by casting specimens of size 150 mm diameters and 300mm length and are tested under compression along the length. The responses are plotted in the Fig: 5.

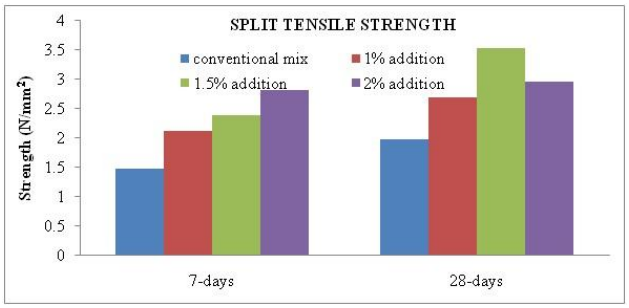

Fig.5 Split tensile strength test analysis

Modulus of elasticity

The Same specimens of Split tensile strength are tested under compression along the height and deflections are noted for corresponding load increment. The responses are plotted in the Fig.6.

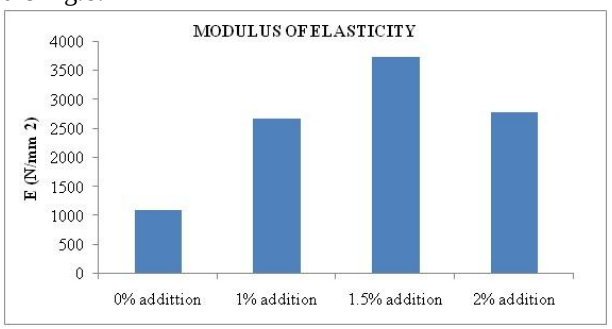

Fig.6 Modulus of elasticity

Flexural Strength

To know the flexural strength of the fiber reinforced concrete beams by incorporating with lathe steel scrap having dimensions 700 x 150 x 150 mm are casted with Reinforcement (A_{st} - 2 bars of 10 mm dia and A_{sc} -2 bars of 10 mm dia) both compression and tension. The beam detailing is showing in Fig: 7.

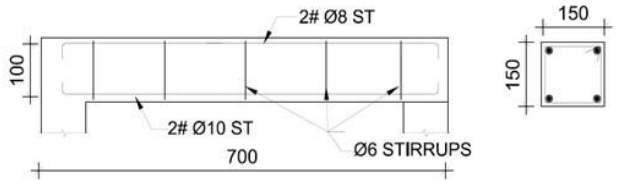

Fig: 7 Beam Detailing

The casted beams are cured in normal water for 28 days. Specimens are tested under four point bending. The beam deflections are recorded under load increment. The responses like Load Vs Deflection and Stress Vs Stain are plotted in fig: 7 and 8 for all four (M0 – M3) concrete Mixes.

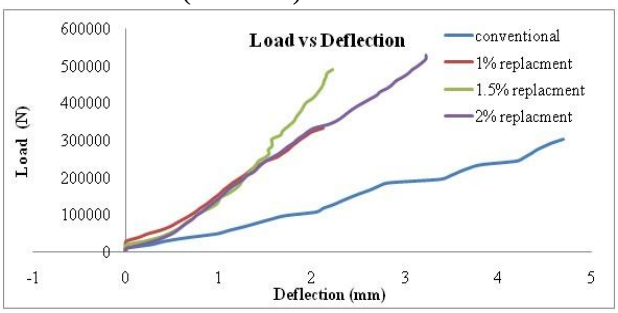

Fig.7 Load vs. Deflection curve

From the various test results it was observed added lathe steel scrap in concrete in different proportions the properties are being varying i.e. increasing linearly up to the optimum content from there the workability is being reduced as the steel scrap fibers are unevenly distributed and has more specific area leads to decrease in workability and also tends to decrease in compressive strength, tensile strength and all other durability properties of the concrete. The following applications are invented from the test results.

- This concrete can be implemented in load bearing structures as the fibres helps the concrete to eliminate the micro cracks internally such that it can take more load without failure.
- It can be used in construction of pressurized chambers because due to its internal resistance offered by fibres can give more warnings before failure i.e. it has high modulus of elasticity.
- It can give more desired strength so it is safer for construction of public places where there is a chance overcrowding such that accidents can be avoided

From the investigations studied from various tests it was observed decrease in all the strength properties for 2% lathe steel scrap addition. So we observed that 1.5% addition of lathe steel scrap shows a comparatively affect in increasing the properties. So from the study we say that 1.5% is the optimum addition of lathe steel scrap in which concrete has more workability i.e. slump value of 75

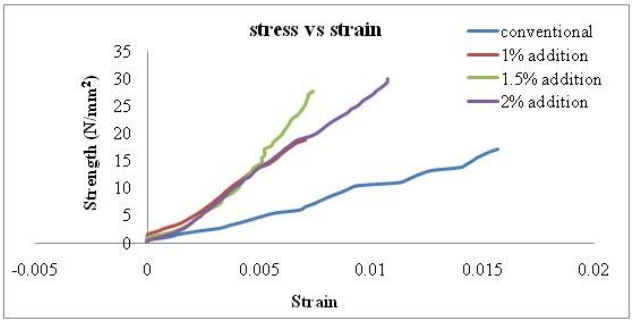

Fig.8 Stress-Strain curve

III. CONCLUSION

The study concludes that the mechanical properties such as compressive, split tensile, bending strength and modulus of elasticity of concrete are increased rapidly at an optimum content of 1.5%. Increase in compressive strength by 10.2%, Increase in bending strength by 45%, Increase in split tensile strength by 30% and modulus of elasticity increases by 250%. Apart from all these properties the usage scrap material in the construction leads to a huge boon to the environment so that it can enhance the properties of concrete same as by using manufactured fibrous material so that we can decrease the cost of construction innovatively. And can save the mother earth from being polluted.

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