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The structural behaviour of scrap reinforced concrete using waste metal

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***Abstract*- Scrap which is a waste can be used as reinforcing material in concrete to enhance the various properties of concrete. Scrap from lathe machine act in a same way as steel fiber. In every lathe industry, wastes are available in form of steel scraps which are produced in different manufacturing processes of lathe machine works and dumping of these wastes in the barren land causes the contamination of soil and ground water which builds an unhealthy environment. In this paper, M40 concrete is used and lathe scrap fiber is added with different proportions (0.5%, 1.0%, 1.5%, and 1.75%) to check the strength variations in concrete. In this experiment, three different types of waste metal have been compared with commercial 40, 60 and 72 graded steel reinforcement bar. The fiber used is irregular in shape and with varying aspect ratio.The main idea of this research work is to use waste scrap steel fiber in concrete which provides cost-effective and eco-friendly sustainable development.**

Keywords: lathe scrap, compressive strength, split tensile strength, flexural strength.

I. INTRODUCTION

Waste utilization is an attractive alternative to disposal in that disposal cost and potential pollution problems are reduced or even eliminated along with the achievement of resource conservation. Nevertheless, the utilization strategy must be coupled with environmental and energy considerations to use available materials most efficiently. Steel slag, the by-product of steel and iron producing processes, started to be used in civil engineering projects during the past 12 years. The second waste from steel is the iron filing, which is produced locally in great amounts from steel workshops and factories. This product has a negative impact on the environment when disposed from this reason the research project started. Most of the previous researches were concerned with steel slag where a rare of it was concerned with iron filing.

Scrap from lathe machine is produced from different manufacturing processes which are carried out by lathe machine. Scrap which is a waste can be used as an reinforcing material in concrete to enhance the various properties of concrete. Scrap from machine can act in a same way as steel fiber. Steel scrap which is a lathe waste generated by each lathe industry and dumping of such wastes in barren soil causes contamination of soil and ground water, which creates unhealthy environment. In addition to get sustainable development and environmental benefits, lathe scrap can be used as recycled fiber with concrete. With increase in population and industrial activities, the quantity of waste fibers generated will increase in coming years.

These industrial waste fibers can be effectively used for making high-strength low cost FRC after exploring their suitability. Plain reinforced concrete is brittle material due to addition of steel fibers in concrete considerably increases the tensile strength, static flexural strength, durability ,impact strength and shock resistance. Concrete is a material which is weak in tension and fails in brittle manner when subjected to tension and flexure. When steel scrap is added to concrete, the behavior of composite material is superior to plane concrete. A good waste solid management is to find a way to make use of it. In this paper an experimental investigation was carried out to study the feasibility of using steel scrap obtained from lathe machine in concrete by checking the compressive strength, splitting tensile strength and flexural strength of M20 concrete and thus optimizing the fiber proportions. Lathe steel scrap reinforced concrete (LSSRC) is a cost effective replacement for fiber reinforced concrete.

Benefits of using steel scrap in concrete

Steel scrap can.

- Improve structural strength.
- Reduce steel reinforcements.
- Improve ductility
- Reduce cracks width thus improving durability.
- Improve impact and abrasion resistance.

II. MATERIALS USED

2.1 Cement

53 grade ordinary Portland cement from Deccan cement Ltd. conforming to IS: 12269-1987 having specific gravity 3.15 is used.

2.2Fine Aggregate

Locally available river sand conforming to Indian standard passing from 4.75 mm, having Specific gravity 2.60, Fineness Modulus 2.78 is used for this study.

2.3 Coarse aggregate

The crushed coarse aggregate of 12.5 mm is used and tested as per the IS 2386-1963. The coarse aggregate is tested for its specific gravity is 2.70.

2.4 Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Ordinary potable water available in the laboratory is used.

2.5. Lathe waste

Lathe waste is a material from lathe machines and that can be used as steel fibers. But the aspect ratio was not constant. Here manually processed lathe waste aspect ratio varying from 50 to 110 is used. The thickness varies from 0.45 to 1mm and length from 15mm to 50mm.

Figure 1.Processed Lathe Waste.

2.6Super plasticizers

MasterGleniumSKY8233 from BASF Company is used as Super plasticizer. It complies with IS: 9103– 1999and IS: 265-2003.

Table 2.1 Fresh Concrete Tests

Property	**Value**
Aspect	Light brown liquid
Relative Density	1.08 ± 0.01 at 25°C
PH	>6
Chloride ion content	<0.2%

Table 2.2 reinforcing steel bar

ASTM (A615)-reinforcing bars	Minimum yield strength (Mpa)	Minimum tensile strength (Mpa)
Grade 40	**275**	**420**
Grade 60	**415**	**620**
Grade 72	**500**	**690**

III. EXPERIMENTAL INVESTIGATION

A. Compressive Strength Test

Compression test is the Most Common test Conducted on hardened concrete; partly it is easy because most of the desirable characteristic properties of concrete are qualitatively related to its compressive Strength. The Compression test is carried out on Specimens Cubical or Cylindrical in Shape. The size of the Cube specimens used for finding out the Compressive Strength is 150xa50x150mm.

B. Split Tensile Strength Test

The test is carried out by placing cylinder specimen of dimension 150mm diameter and 300mm length. The failure load of tensile strength of cylinder is calculated by using the formula

$$\textbf{Tensile strength} = 2P / 3.14\,DL$$

C. Flexural Strength Test

The test is carried out to find the flexural strength of the prism of dimension 100 x 100 x 500 mm. The load is applied until the failure of the prism. By using the failure load of prism.

$$\textbf{Flexural strength} = PL/bd^2$$

D. Non-Destructive Testing

Non-Destructive Testing System is used for assess the Quality of concrete in its damaged State without any disturbance to the Surrounding Concrete**.** There are different types of destructive testing are available. They are

- Rebound Hammer test
- Ultrasonic Pulse Velocity Test

Table 3.1 Quality of Cover Concrete from Rebound Number

Average Rebound Number	**Quality of Concrete**
Greater than 40	Very Good Hard layer
30 to 40	Good layer
20 to 30	Fair
Less than 20	Poor Concrete
0	Delaminated

Figure 2.Casting of specimens

E. Mix design

There are many procedures available in literature for proportioning Ordinary Portland Cement. Here the mix design procedure has been carried out in reference with that of the EFNARC code. Here the three number of trial mixes have been done for nominal LSSRC mix of M_{40}

Table 3.2 Quantities For Conventional Concrete

Materials	Weight(Kg/m^3)	Proportions
Cement	492.5	1
Fine aggregate	639.236	1.3
Coarse aggregate	1083.078	2.2
Water	197	0.4

Table 3.3 Fresh concrete test

S. No	Tests Done	Limits	Results
1.	Slump flow	600-800mm	694mm
2.	T50 cm Slump flow	2-5cm	3
3.	V-funnel test	6-12sec	7

Figure.3. Slump flow on fresh concrete

IV. EXPERIMENTAL RESULTS

Table 4.1 Test Results of Conventional Concrete

Age of concrete (days)	Average compressive strength (N/mm^2)	Average split tensile strength(N/mm^2)	Average flexural strength(N/mm^2)
7	21.88	2.02	2.32
14	30.68	2.58	3.16
28	36.80	2.85	3.89

Table 4.2 Results of Compressive Strength, Split Tensile Strength and Flexural Strength at 7 days

Lathe scrap %	Average compressive strength at 7 days (N/mm^2)	Average split tensile strength at 7 days (N/mm^2)	Average flexural strength at 7 days (N/mm^2)
0.5	23.33	2.21	2.87
1.0	25.6	2.37	2.92
1.5	26.8	2.42	2.97
1.75	27.2	2.57	3.02

Table 4.3 Results of Compressive Strength, Split Tensile Strength and Flexural Strength At 14 days

Lathe scrap %	Average compressive strength at 14 days (N/mm^2)	Average split tensile strength at 14 days (N/mm^2)	Average flexural strength at 14 days (N/mm^2)
0.5	33.27	2.71	3.22
1.0	34.34	2.81	3.47
1.5	35.69	2.87	3.68
1.75	35.75	2.91	3.86

Table 4.4 Results of Compressive Strength, Split Tensile Strength and Flexural Strength at 28 days

Lathe scrap %	Average compressive strength at 28 days (N/mm^2)	Average split tensile strength at 28 days (N/mm^2)	Average flexural strength at 28 days (N/mm^2)
0.5	40.08	3.05	4.07
1.0	41.28	3.48	4.42
1.5	43.22	3.62	4.67
1.75	43.44	3.82	4.85

A. Hardened Properties of Concrete

Results of Compressive strength, split tensile strength and flexural strength for M_{40} grade of concrete on specimen are shown in table and graph below.

Fig.4Comparison of Compressive Strength

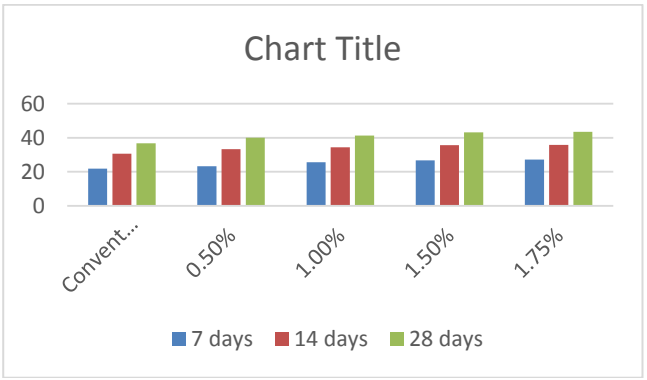


Fig 5Comparison of Split Tensile strength

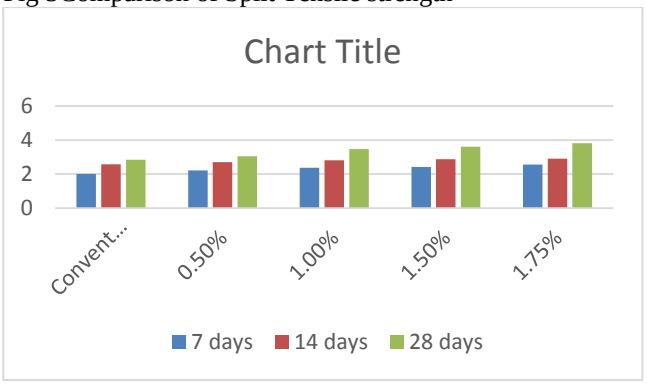
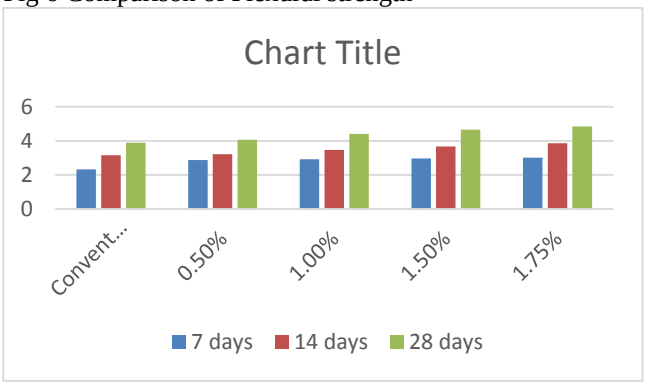


Fig 6 Comparison of Flexural strength



V. CONCLUSIONS

This experimental work shows the various results

- The study proves that mechanical properties of concrete are increased by adding steel scrap up to certain proportions.
- The experimental work shows that the compressive strength, flexural strength and split tensile strength appear to increase gradually till 1.75% of lathe scrap added in concrete. The compressive strength is increased by 11%. The flexural strength is increased by 19% - 32.3%. The split tensile strength is increased by 25.7%.

Future scope

The effect of rusting of the steel lathe scrap on the strengths of concrete can be determined. Also, the effect of addition of lathe scrap on the reinforcement provided in R.C.C structure can be determined.

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