STRENGTHENING OF CONCRETE USING LATHE SCRAP WASTE

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Abstract – *Due to rapid growth of industries and use of steel at large scale in industries, waste production of steel without management has become a major problem. This report presents a research to utilization of steel waste (CNC lathe waste) by partial replacement (by weight of natural coarse aggregate) with coarse aggregate. Aim of this investigation was to study the effect of lathe scrap waste replacement in concrete at different percentage so that we can achieve an improved, better composite and more durable concrete comparative to conventional concrete. The tests performed are COMPRESSIVE STRENGTH TEST, SPLIT TENSILE TEST and REBOUND HAMMER TEST and experiments are conducted by replacing the Lathe waste at 3%, 4%, and 5% of coarse aggregate by weight and calculating their strengths at 7 days, 14 days and 28 days for M25 grade concrete. All the test results showed an increase in compressive strength as well as flexural strength in early-age at 7 days and 14 days as well as better results on 28 days when compared to normal M25 grade concrete. The Results from Rebound Hammer Test showed similar results.*

Keywords – Lathe scrap waste, Compressive strength, Split Tensile Strength, Fibre Reinforced Concrete (FRC), Flexural Strength.

1. INTRODUCTION

Concrete is considered as the backbone of a modern day structures. Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space between the aggregate particles and glues them together.

Concrete is widely used for making architectural structures, foundations, pavements, bridges or overpasses, motorways, runways, parking structures, dams, pools/reservoirs etc. Being strong in compression and weak in tension, concrete is required to be reinforced by materials having higher tensile strength. To overcome this weakness various researches are done by using different materials in concrete; one of them is Fibre reinforced concrete (FRC). Lathe Machine Scrap which is a machine waste can be used as a reinforcing material in concrete to enhance the various properties of concrete. We have used mild steel scrap in concrete. FRC contains uniformly distributed and unevenly oriented fibres which are responsible for increase in ductility, flexural strength and other improved properties.

2. Literature Review

Irwan Lie Keng Wong et al studied the utilization of lathe waste and its use to increase the compressive and tensile strength of concrete. The results showed for the compressive strength test on day 28 obtained the following results: normal concrete -296.354 kg/cm^2, the addition of 0.5% waste lathe is 309.825 kg/cm^2, the addition of 1.0% waste lathe is 321.371 kg/cm^2 and the addition of 2.0% waste lathe is 354.086 kg/cm^2. And for tensile strength test on day 28 obtained the following results: normal concrete: 93.660 kg/cm^2, the addition of 0.5% waste lathe is - 95.170 kg/cm^2.

Dr. Y.P. Joshi and Pooja Srivastava worked on the study of the workability and mechanical strength properties of the concrete reinforced with industrialized waste fibre. Different experimental studies were done on that concrete and various properties were found increased due to the addition of steel scrap in concrete but up to 0.5- 2% scrap content.

S.C. James et al did an experimental study on fibre reinforced concrete using lathe waste. The tests conducted were slump test, compressive strength test, split tensile strength test and flexural strength test. For this concrete cubes, beams and cylinders were casted and cured and tests were done at 7th day and 28th day. The Results showed that an optimum of 1% of lathe scrap as an addition can be used to improve the strength of fibre reinforced concrete. Compressive strength increased up to 20.171 % at 7 days when compared to control specimen and 16.904 % at 28 days when compared to control specimen.

3. Objective of the Study

The idea behind the study is the utilization of steel scrap in improvement in the strength of concrete and use of waste for saviour of earth. This report aims to have a comparative study between CNC scrap concrete at 3%, 4% and 5% replacement with coarse aggregates and conventional concrete in M25 concrete.

4. Experimental Investigation

Material Used:
For M25 grade mix design

1. Cement:
   Portland Pozzolana Cement of grade 53 is used for making specimens. The specific gravity of cement is found 3.10. The initial and final setting time is found to be 40 minutes and 7 hours 50 minutes respectively. And the standard consistency is found to be 28%.

2. Coarse Aggregate:
   Locally available crushed coarse aggregate of 20mm in size and angular in shape is used. Fineness modulus and sp. gravity of aggregate are 6.3 and 2.64 respectively.

3. Fine Aggregate:
   Natural river sand which is easily available in market which confirms IS-383-1970 zone-II whose size is less than 4.75mm and of specific gravity 2.6 with fineness modulus of 2.91 is used in experiment.

4. Water:
   Portable water is used in experiment. Ph value of water is greater than 6; recommended by IS code.

5. Lathe machine scrap:
   Lathe scrap is waste material produced by working on the lathe machine when used for shaping metals. We have used mild carbon steel scrap in specimens.

5. Methodology:

For finding the compressive strength, cubes of size 15cm × 15cm × 15cm are casted. The fine aggregate and cement are mixed & blended then coarse aggregate is added and mixed until it is uniformly distributed. Add water and mix it until concrete appears to be homogeneous & of desired consistency. Now concrete is casted into moulds and compaction is done. The concrete specimens are de-moulded after 24 hours and are kept in water until taken out for testing.

Mix design calculations (as per IS 10262-2019) are given below:

1. Cement = 433 kg/m^3
2. Water = 186 kg/m^3
3. Coarse aggregate = 1164 kg/m^3
4. Fine aggregate = 606 kg/m^3

The following tests were conducted as per the Indian codal provisions:

1. Rebound hammer test: Rebound hammer testing is done as per IS 13311 (Part 2):1992. Rebound hammer test is a non destructive test and it can be used for assessing the compressive strength or quality of concrete from various graphical co-relations. The plunger of the rebound hammer is pressed against the surface of the specimens and the impact gives a reading noted as rebound number. A number of readings are taken and through graphs and co-relations compressive strength is worked out.

2. Compression test: The compression testing is done afterwards which gives more accurate values. The samples are placed in the universal testing machine. The load is applied gradually at the rate of 140 kg/cm^2/minute until the specimens fails. The maximum load at which it fails is recorded and compressive strength is determined.

3. Split tensile test: It is an indirect method of testing tensile strength of concrete using a cylinder which splits across the vertical diameter. The length of the specimen shall not be less than the diameter and not more than twice the diameter. We prepared specimen of specifications:
   Diameter of specimen **d =** 15 cm
   Length of specimen **l =** 30 cm

6. Results and Discussions

In this section we will study the results of the tests that have been conducted on the concrete specimens.

COMPARISION OF COMPRESSIVE STRENGTH BY REBOUND HAMMER TEST:

Table 1 Comparison of Equivalent Compressive Strength at 7 Day:

S.NO	Type of sample	Equivalent Compressive Strength (MPa)	Increase in Strength (%)
1	Control Sample	23.65	-
2	With 3% Lathe scrap	21.72	-
3	With 4% Lathe scrap	28.27	19.53%
4	With 5% Lathe scrap	23.07	-

Table 2 Compressive Equivalent Strength at 14 Days:

S.NO	Type of sample	Equivalent Compressive Strength (MPa)	Increase in Strength (%)
1	Control Sample	24.80	-
2	With 3% Lathe scrap	27.31	10.12%
3	With 4% Lathe scrap	36.73	48.10%
4	With 5% Lathe scrap	36.54	47.33%

Table3 Compressive Equivalent Strength at 28 Days:

S.NO	Type of sample	Equivalent Compressive Strength (MPa)	Increase in Strength (%)
1	Control Sample	35.77	-
2	With 3% Lathe scrap	30.38	-
3	With 4% Lathe scrap	34.04	-
4	With 5% Lathe scrap	40.08	12.04%

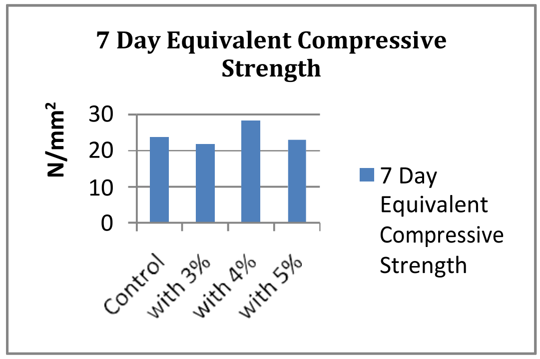

Fig.1 Equivalent Compressive Strength of Control sample & with 3%, 4% and 5% lathe waste at 7 days with RHT.

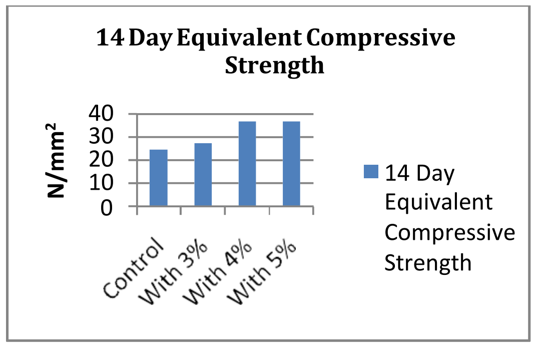

Fig2. Equivalent Compressive Strength of Control sample & with 3%, 4% and 5% lathe waste at 14 day with RHT.

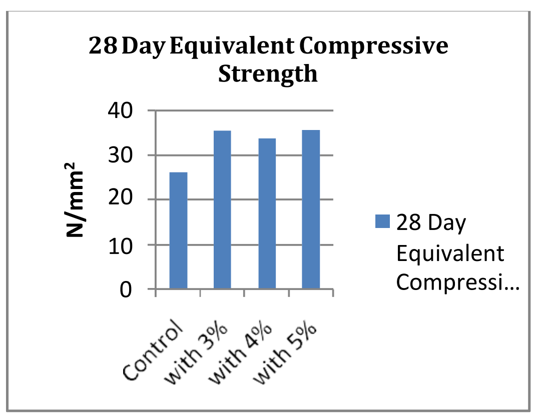

Fig3. Equivalent Compressive Strength of Control sample & with 3%, 4% and 5% lathe waste at 28 day with RHT.

COMPARISION OF COMPRESSIVE STRENGTH BY UNIVERSAL TESTING MACHINE:

Table 4 Comparison of compressive strength at 7 day:

S.NO	Type of sample	Equivalent Compressive Strength (MPa)	Increase in Strength (%)
1	Control Sample	17.79	-
2	With 3% Lathe scrap	14.92	-
3	With 4% Lathe scrap	18.13	1.91%
4	With 5% Lathe scrap	20.05	12.70%

Table 5 Comparison of compressive strength at 14 day:

S.NO	Type of sample	Equivalent Compressive Strength (MPa)	Increase in Strength (%)
1	Control Sample	20.36	-
2	With 3% Lathe scrap	22.52	10.60%
3	With 4% Lathe scrap	27.43	34.72%
4	With 5% Lathe scrap	29.43	44.54%

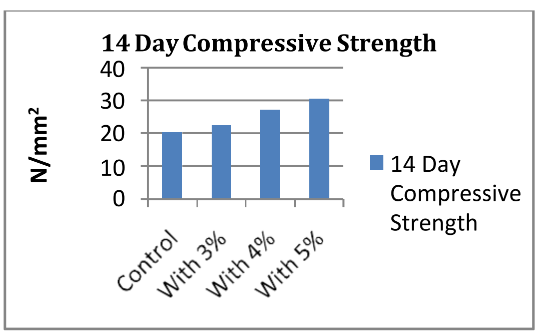

Fig5. Compressive Strength of Control sample & with 3%, 4% and 5% lathe waste at 14 days by UTM

Table 6 Comparison of compressive strength at 28 day:

S.NO	Type of sample	Equivalent Compressive Strength (MPa)	Increase in Strength (%)
1	Control Sample	25.29	-
2	With 3% Lathe scrap	34.22	35.31%
3	With 4% Lathe scrap	32.48	28.43%
4	With 5% Lathe scrap	34.37	35.90%

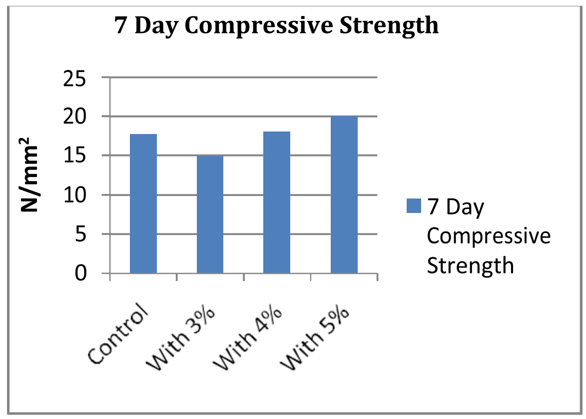

Fig4. Compressive Strength of Control sample & with 3%, 4% and 5% lathe waste at 7 days by UTM

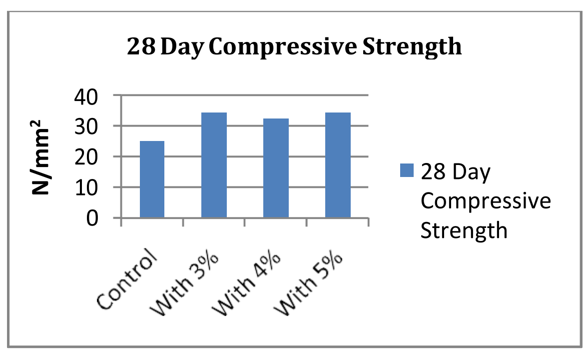

Fig6. Compressive Strength of Control sample & with 3%, 4% and 5% lathe waste at 28 days by UTM

Table 7 RELATIVE COMPRESSIVE STRENGTH

S. No.	Type of sample	Compressive Strength (MPa)					
		7 day strength		14 day strength		28 day strength	
		R H T	C T	R H T	C T	R H T	C T
1	Normal Concrete	23.65	17.79	24.80	20.36	35.77	25.29
2	With 3% Lathe Waste	21.72	14.92	27.31	22.52	30.38	34.22
3	With 4% Lathe Waste	28.27	18.13	36.73	27.43	34.04	32.48
4	With 5% Lathe Waste	23.07	20.05	36.54	29.43	40.08	34.37

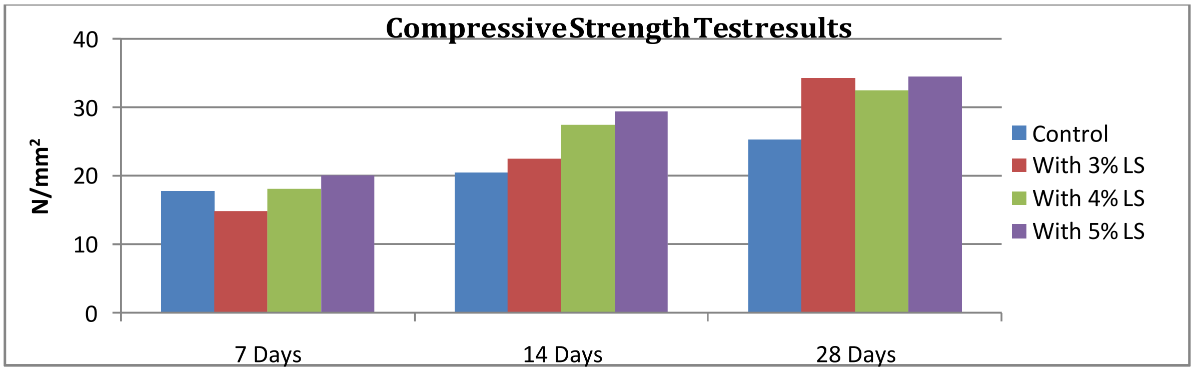

Fig7 Test Results from Rebound Hammer Test

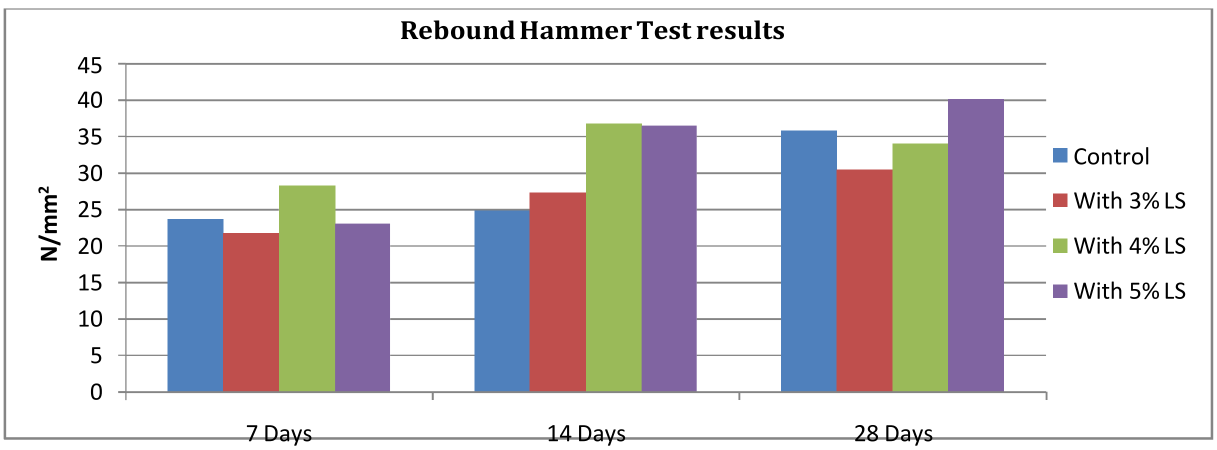

Fig8 Test Results from Compression Test

Table 8 Comparison of split tensile strength

S. No.	Specimen Age.	Normal Concrete		Concrete with 4 % Lathe Waste		% increase in strength
		Compression Load at failure (kg)	Split Tensile Strength (kg/sqcm)	Compressive Load at failure (kg)	Split Tensile Strength (kg/sqcm)	
1	7 days	10000	14.14	9800	13.86	-
2	14 days	11000	15.55	14000	19.80	27.33 %
3	28 days	15000	21.21	15300	21.64	2.03 %

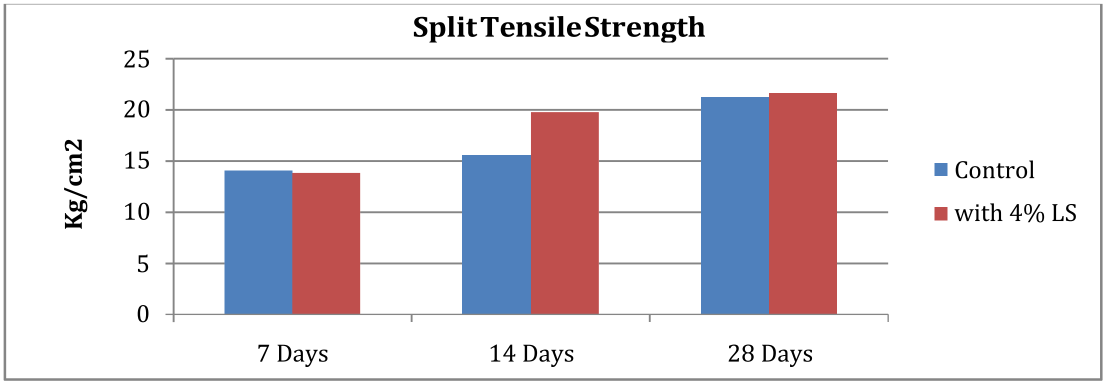

Fig9 Split Tensile Strength for Normal and modified concrete

7. Conclusions

The Results from the test show that the addition of CNC lathe waste remarkably increases the strength of concrete. Since, concrete is weak in tension, it is seen that the tensile Strength of Concrete also shows astonishing patterns.

Following are the Conclusions that can be derived from the research.

1. At 7 days, initially the concrete sample which contained 3% lathe waste doesn't show expected results as compared to the control sample as there is a 17% decrease in the Compressive Strength of the concrete. However at 4% and 5%, there was an increase in the strength of Concrete by 1.92% and 12.70% respectively when compared to Control Sample.
2. There was a massive increase in the Compressive strength of Concrete at the 14 days testing period. When Compared to Control Sample, the 3%, 4%, and 5% lathe waste samples showed an increase in the compressive strength by 10.64%, 34.76% and 44.54%.
3. Similarly for 28 days Compressive Strength, there was a remarkable increase in the compressive strength of concrete. The 3% lathe waste containing sample increased its strength by 35.31%, the sample with 4% lathe waste showed an increase in strength by 28.43% and the sample with 5% lathe waste showed an increase in strength by 35.90%, when compared to control sample.
4. However, the 28 days Compressive strength when checked with Rebound Hammer Test showed peculiar results as only the sample containing 5% of lathe waste aggregate replacement showed satisfying results with the increase in strength by 12.04%. The Samples with 3% and 4% lathe waste didn't give the strength as expected from the Compression test.
5. As for the Split Tensile Test, only one sample with 4% aggregate replacement by lathe waste was used in addition to the control sample. The 14 days Split tensile Strength showed an increase by 27.33% whereas for 28 days split tensile strength, there was very little increase in strength of 2.03%.
6. The use of Lathe waste can prove very economical as it is non usable waste and is available almost free of cost.

8. Acknowledgment

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10. Biographies

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