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STUDY OF PROPERTIES OF MIX DESIGN CONCRETE USING LATHE SCRAP

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Abstract : The proliferation of industries and extensive steel usage has given rise to a pressing issue – the mismanagement of steel waste, specifically CNC lathe waste. This research report investigates the potential of using CNC lathe waste as a partial replacement for natural coarse aggregate in concrete. The primary objective is to evaluate the impact of lathe scrap waste incorporation on the concrete's properties, aiming to produce a more robust, durable, and sustainable composite in comparison to traditional concrete. The study encompasses a range of mechanical tests, including Compressive Strength, Split Tensile Strength. Various percentages of lathe waste replacement (3%, 4%, and 5% by weight of coarse aggregate) are explored at different curing durations (7 days, 14 days, and 28 days) for M25 grade concrete. The results consistently indicate enhanced compressive strength and flexural strength, especially in the early stages at 7 and 14 days, with further improvements observed at the 28-day mark, outperforming the conventional M25 grade concrete.

***IndexTerms* – Lathe scrap waste, Mix design, Compressive Strength, Split Tensile Strength, Fibre Reinforced Concrete.**

I. INTRODUCTION

Concrete serves as the essential structural foundation for contemporary buildings. It is a composite substance comprising a sturdy matrix of material (known as the cement or binder) that envelopes and adheres to the coarse granular material (the aggregate or filler), effectively binding and consolidating the aggregate particles. This amalgamation forms the solid structure that underpins modern architectural achievements.

Concrete is a versatile construction material widely utilized in a variety of architectural and infrastructure applications, including buildings, foundations, roads, bridges, and more. However, its inherent weakness in tension necessitates the incorporation of materials with higher tensile strength to reinforce it. To address this issue, researchers have explored various methods, and one promising approach is the use of Fiber Reinforced Concrete (FRC).

FRC involves the integration of fibers, such as lathe machine scrap, which is a waste material from machining processes. These fibers are strategically dispersed within the concrete mixture to enhance its mechanical properties and overall performance. In particular, the incorporation of these fibers results in improved ductility and flexural strength, among other beneficial enhancements. This technique leads to a more robust and resilient concrete material, making it better suited for demanding structural and construction applications.

II. Literature Review

G Vijayakumar et al delved into the investigation of how the incorporation of lathe scrap enhances the impact resistance and energy absorption qualities of concrete. This project is dedicated to exploring the use of lathe scrap as a reinforcing agent in concrete, bringing innovation to the construction industry.
The experiments followed the established Indian standard procedures to assess the mechanical properties of this lathe scrap-reinforced concrete. Various tests were carried out, including those for flexural strength, split tensile strength, compressive strength, and impact resistance, all of which were then compared with traditional Plain Cement Concrete (PCC).
The results revealed that the compressive strength of lathe scrap-reinforced concrete at 7 days exceeded that of PCC, and after 28 days of normal curing, it nearly equaled PCC's strength. This addition of lathe scrap significantly improved the flexural performance of concrete beams, demonstrating a remarkable 40% increase when compared to PCC.

Irwan Lie Keng Wong et al studied and investigated the potential use of lathe waste as a supplementary material to enhance the compressive and tensile strength of concrete. The research findings, particularly the results from the compressive strength test conducted on day 28, revealed the following outcomes: For the compressive strength test on day 28, the normal concrete achieved a strength of 296.354 kg/cm². When 0.5% waste lathe was added, the strength increased to 309.825 kg/cm². With 1.0% waste lathe addition, the strength reached 321.371 kg/cm², and when 2.0% waste lathe was added, the compressive strength rose to 354.086 kg/cm².

In the tensile strength test on day 28, the normal concrete had a strength of 93.660 kg/cm². When 0.5% waste lathe was incorporated, the tensile strength increased to 95.170 kg/cm².

Dr. Y.P. Joshi and Pooja Srivastava has done Extensive research to investigate the influence of incorporating industrial waste fibers into concrete on its workability and mechanical strength characteristics. This research involved a series of experiments, which revealed significant improvements in several properties of the concrete when steel scrap was added. Notably, the enhancement in these properties was observed within the range of 0.5% to 2% steel scrap content in the concrete mixture.

S.C. James et al has carried out an experiment to investigate the use of lathe waste as a reinforcement material in concrete. The study encompassed several key tests, including the slump test, compressive strength test, split tensile strength test and flexural strength test. To evaluate the effects of this reinforcement, concrete cubes, beams and cylinders were manufactured and subjected to curing, followed by testing at two different time intervals: 7 days and 28 days.
The results of the study indicate that incorporating 1% lathe scrap as an additive in fiber-reinforced concrete yielded optimal results in terms of strength enhancement. Specifically, the compressive strength exhibited a notable increase, with a significant boost of 20.171% observed at the 7-day mark compared to the control specimen. This improvement was sustained at 16.904% when compared to the control specimen after 28 days. In summary, the findings of this experiment suggest that adding 1% lathe waste as a reinforcement material can effectively enhance the strength of fiber-reinforced concrete, with substantial improvements in compressive strength demonstrated at both 7 and 28 days of testing.

III. Objective of study

This research project centers around the innovative application of steel scrap to bolster the structural integrity of concrete, while simultaneously contributing to the preservation of our planet by repurposing waste materials. The primary objective of this study is to conduct a comparative analysis between concrete containing CNC scrap, with varying replacement percentages of 3%, 4%, and 5%, in lieu of traditional coarse aggregates within the M25 concrete mix.

IV. EXPERIMENTAL INVESTIGATION

Material Used:

For M25 grade mix design:

1.**Cement:**

Portland Pozzolana Cement (PPC) is utilized for specimen preparation. The cement has a specific gravity of 2.86. The initial setting time is determined to be 40 minutes, while the final setting time is found to be 7 hours and 50 minutes. The standard consistency of the cement is established to be 28%.

2.**Coarse Aggregate:**

The coarse aggregate used in this locality is angular in shape and has a size of 20mm. It has a fineness modulus of 6.3 and a gravity of 2.82, making it suitable for various construction applications.

3. **Fine Aggregate:**

In our experiment, we utilized readily accessible natural river sand that complies with the IS-383-1970 standard, specifically falling within Zone-III classification. This river sand has a particle size less than 4.75mm and exhibits a specific gravity of 2.65. Its fineness modulus stands at 2.9, making it a suitable material for our research.

4.**Water:**

The water used in the experiment should have a pH value exceeding 6, as per the guidelines set by the IS code.

5.**Lathe Machine Scrap:**

Lathe scrap refers to the residual material generated during the machining process on a lathe machine, typically used for shaping metal. In our experiments, we utilized scrap material derived from mild carbon steel as specimens.

6. **Admixture:**

It is used to improve the properties and performance of concrete in various ways. They are typically added in small quantities and are an essential part of modern concrete technology.

V. METHODOLOGY:

To assess the compressive strength of concrete, the procedure involves thoroughly blending fine aggregate and cement, adding coarse aggregate and ensuring even distribution, followed by the addition of water to achieve the desired consistency, casting the concrete into 15cm × 15cm × 15cm molds, compacting to eliminate air voids, demolding after 24 hours, curing in water, and ultimately subjecting the specimens to testing to determine their compressive strength, thus ensuring the concrete meets the required quality standards for construction.

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

1. Cement = 325 kg/m3
2. Water = 156 kg/m3
3. Coarse aggregate = 1176 kg/m3
4. Fine aggregate = 802 kg/m3
5. Admixture = 3.9 kg/m3

The following tests were carried out as per the Indian codal provisions:

1. Compression test: Compression testing is conducted subsequently to obtain more precise results. Samples are inserted into a universal testing machine, and a gradual load is applied at a rate of 140 kg/cm2 per minute until the specimens ultimately fail. The maximum load at which failure occurs is noted, and this value is used to determine the compressive strength.
2. Split tensile test: This testing technique involves indirectly assessing the tensile strength of concrete by subjecting a cylindrical specimen to a splitting force along its vertical diameter. The length of the specimen must adhere to the requirement that it is neither smaller than the diameter nor greater than double the diameter. We prepared specimen of following dimensions: Diameter of specimen **d =** 15 cm, Length of specimen **l =** 30 cm

Fig.1 Compressive Strength test

Fig.2 Split Tensile Strength test

VI. RESULTS AND DISCUSSIONS:

This section will delve into the examination of the outcomes derived from the tests carried out on the concrete specimens.

Comparing Compressive Strength Using Universal Testing Machine

Table 1 Comparing 7-Day Compressive Strength

S. NO	Type of sample	Equivalent compressive strength (MPa)	Increase in strength (%)
1	Control sample	17.68	-
2	With 3% Lathe scrap	15.62	-
3	With 4% Lathe scrap	18.42	4.18 %
4	With 5% Lathe scrap	20.81	17.70 %

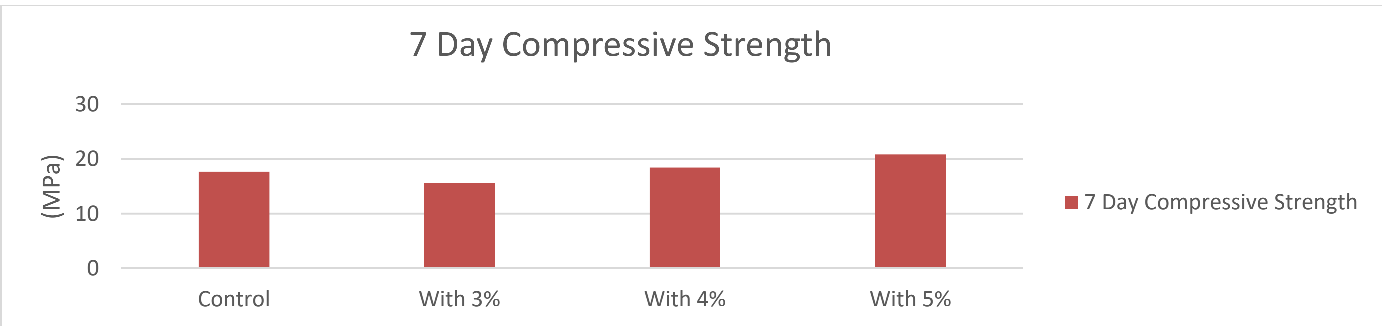

Fig.3 Compressive Strength of control sample and with 3%,4% & 5% lathe waste at 7 days.

Table 2 Comparing 14-Day Compressive Strength

S.NO	Type of sample	Equivalent Compressive Strength (MPa)	Increase in Strength (%)
1	Control Sample	21.31	-
2	With 3% Lathe scrap	22.87	7.32 %
3	With 4% Lathe scrap	28.34	33.00 %
4	With 5% Lathe scrap	29.41	38.01 %

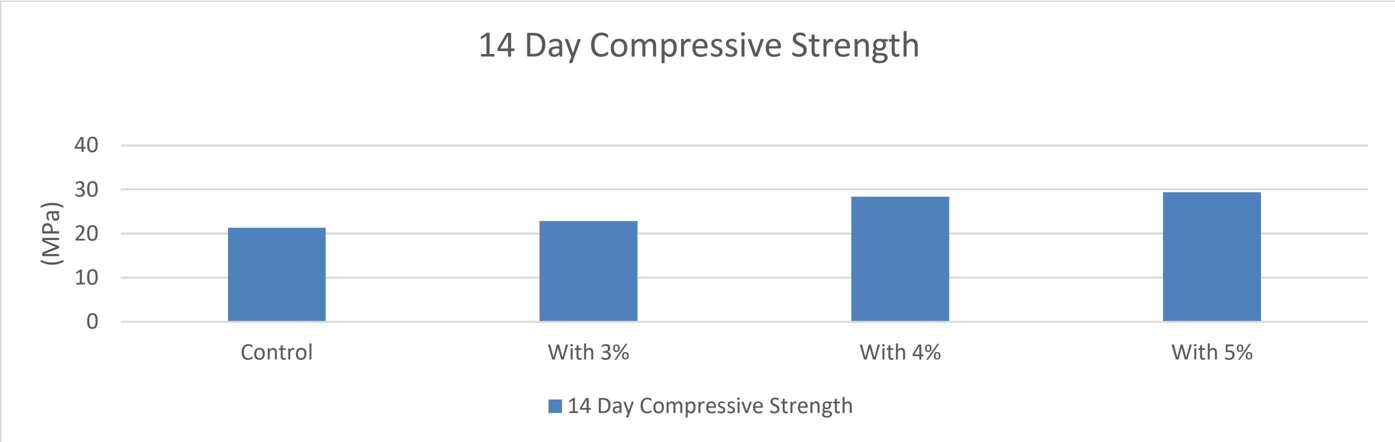

Fig.4 Compressive Strength of control sample and with 3%,4% & 5% lathe waste at 14 days.

Table 3 Comparing 28-Day Compressive Strength

S. NO	Type of sample	Equivalent Compressive strength (MPa)	Increase in Strength (%)
1	Control Sample	25.86	-
2	With 3% Lathe scrap	33.24	28.54 %
3	With 4% Lathe scrap	33.74	30.47 %
4	With 5% Lathe scrap	34.23	32.37 %

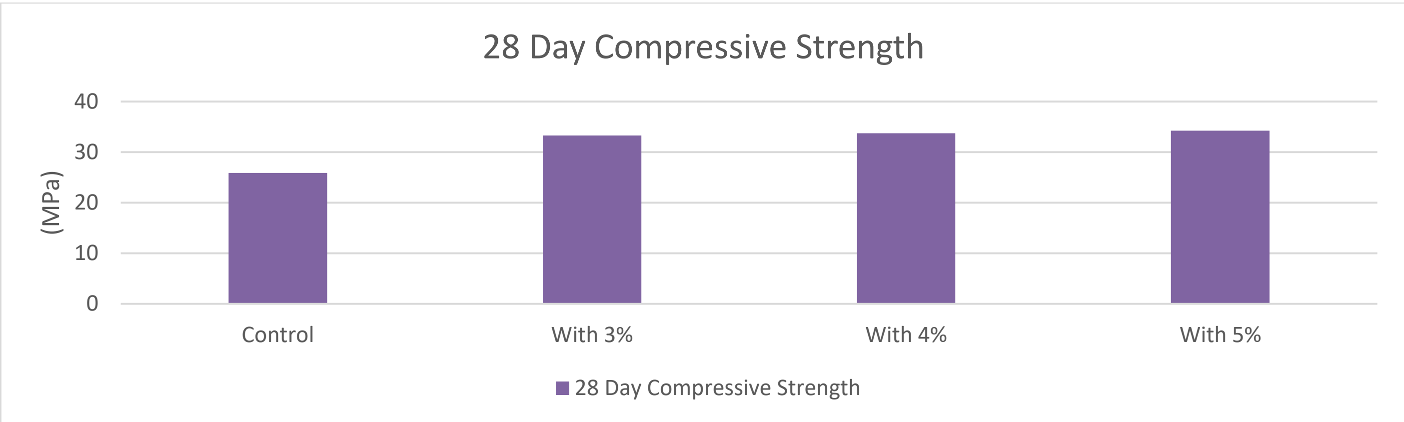

Fig.5 Compressive Strength of control sample and with 3%,4% & 5% lathe waste at 28 days.

Table 4 Comparing Relative Compressive Strength

S. No	Type of Sample	Compressive Strength (MPa)		
		7 Day strength	14 Day strength	28 Day strength
1	Control	17.68	21.31	25.86
2	With 3% Lathe scrap	15.62	22.87	33.24
3	With 4% Lathe scrap	18.42	28.34	33.74
4	With 5% Lathe scrap	20.81	29.41	34.23

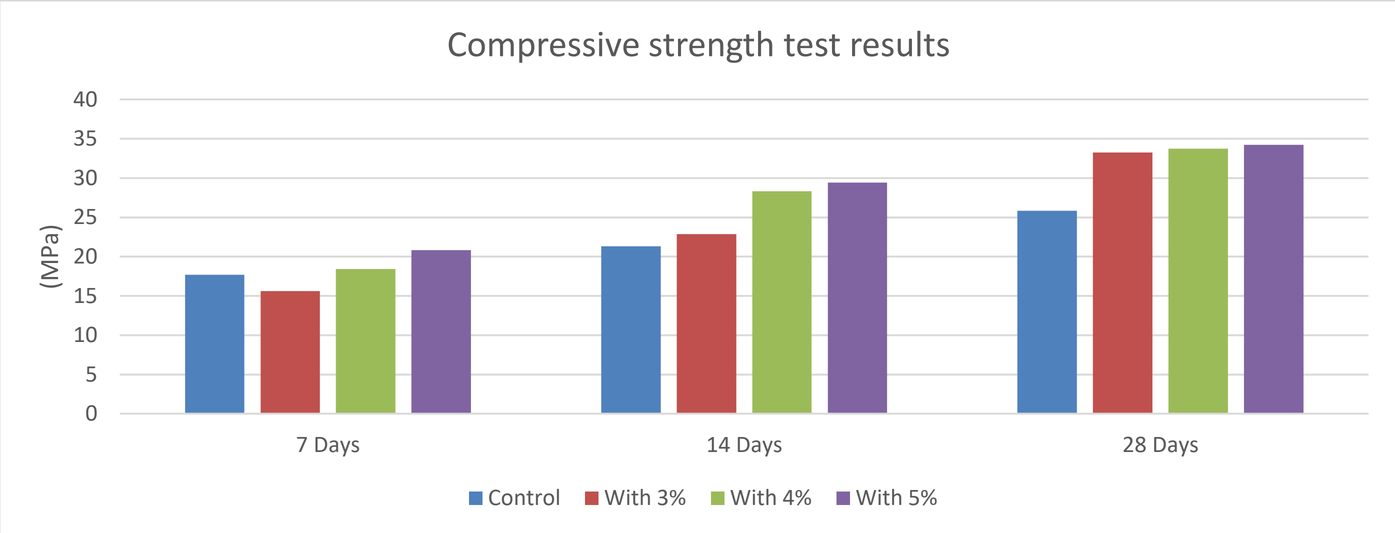

Fig.6 Compressive Strength of control sample & with 3%,4% and 5% lathe waste at 7 days, 14 days & 28 days.

Table 5 Comparing Split Tensile Strength

S. No	Specimen Age.	Normal Concrete		Concrete with 5% Lathe scrap		Increase in strength (%)
		Collapse Load (KN)	Split Tensile Strength (MPa)	Collapse Load (KN)	Split Tensile Strength (MPa)	
1	7 days	98	1.40	96	1.36	-
2	14 days	100	1.42	130	1.84	29.60 %
3	28 days	150	2.12	160	2.26	6.60 %

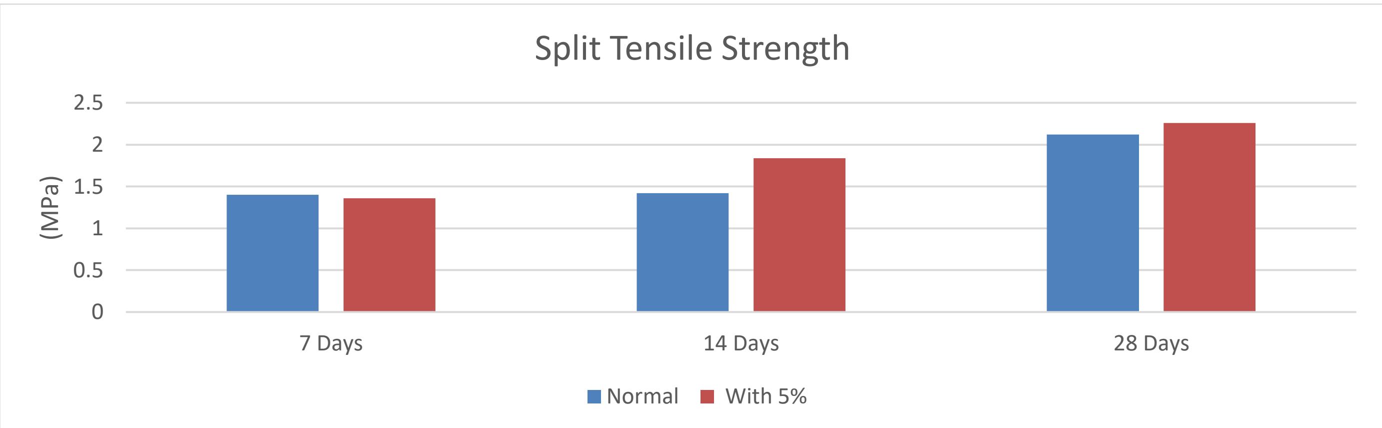

Fig.7 Split Tensile Strength for normal and modified concrete.

VII. CONCLUSIONS

The test results indicate a significant enhancement in the strength of concrete when CNC lathe waste is incorporated. Concrete is inherently weaker in tension, but this study has unveiled remarkable and intriguing patterns in the tensile strength of concrete when this waste material is added.
The research yields the following key conclusions:

1. After 7 days, the concrete sample initially containing 3% lathe waste exhibited ` reduction in Compressive Strength compared to the control sample, which was not as expected. In contrast, when the lathe waste content was increased to 4% and 5%, the concrete strength showed improvements, with a 4.18% and 17.70% increase, respectively, when compared to the control sample.
2. During the 14-day testing period, the compressive strength of concrete exhibited a significant enhancement when compared to the control sample. Specifically, the inclusion of lathe waste at concentrations of 3%, 4%, and 5% resulted in substantial improvements in compressive strength. The compressive strength increased by 7.32%, 33.0%, and 38.01% for the 3%, 4%, and 5% lathe waste samples, respectively.
3. The compressive strength of concrete displayed significant improvements over a 28-day period. When 3% lathe waste was incorporated into the samples, it resulted in a remarkable strength increase of 28.54%. In a similar fashion, the addition of 4% lathe waste led to a substantial strength gain of 30.47%, while the inclusion of 5% lathe waste boosted the strength by an impressive 32.37%, as compared to the control sample.
4. In the Split Tensile Test, two samples were examined: one with 5% aggregate replacement by lathe waste (the experimental sample) and a control sample. After 14 days, the split tensile strength of the experimental sample increased by 29.6%, while the 28-day test showed a strength increase of only 6.6%.
5. Utilizing lathe waste is a highly cost-effective strategy due to it's abundant availability at little to no cost. This waste, typically considered unusable, offers a valuable resource that can be repurposed in a sustainable and economically efficient manner.

VIII. ACKNOWLEDGEMENT

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