IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 7, October 2026
Impact Factor: 8.2

Experimental Study On the Partial Replacement of Fine Aggregate with Steel Lathe Turning Chips in Concrete

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Abstract: *The increasing demand for natural fine aggregate in concrete has created a need for alternative materials in construction. Steel lathe turning chips are industrial waste materials produced during machining operations, which can be effectively utilized in concrete. This study investigates the feasibility of partially replacing fine aggregate with steel lathe turning chips in concrete. Concrete specimens are prepared with different replacement percentages and tested to evaluate their workability, density, compressive strength and split tensile strength. The experimental results are used to understand the influence of steel lathe turning chips on the properties of concrete and to identify a suitable replacement level. This study helps in reducing industrial waste disposal problems and minimizing the consumption of natural fine aggregate. The utilization of steel lathe turning chips can contribute to sustainable and eco-friendly construction practices.*

Keywords: Steel Lathe Turning Chips, Fine Aggregate Replacement, Concrete, Compressive Strength, Split Tensile Strength, Workability, Sustainable Construction, Industrial Waste

I. INTRODUCTION

As the construction industry continues to grow, the demand for natural fine aggregate, particularly river sand, is increasing rapidly, leading to the depletion of natural resources and environmental concerns. At the same time, machining industries generate a considerable amount of steel lathe turning chips as industrial waste. Improper disposal of these waste materials may cause environmental problems. Reusing steel lathe turning chips in concrete provides a possible solution for reducing industrial waste and conserving natural sand. Steel lathe turning chips are small metallic particles produced during machining operations. Due to their physical characteristics and metallic composition, they can be investigated as a partial replacement for fine aggregate in concrete. In this study, M20 grade concrete is prepared using a nominal mix proportion of 1:1.5:3, with steel lathe turning chips replacing fine aggregate at 5%, 10% and 15%. Concrete cubes of size 150 mm × 150 mm × 150 mm are cast and cured for 7, 14 and 28 days. The compressive strength of the specimens is evaluated to understand the influence of different replacement percentages. This study aims to identify a suitable replacement level while promoting sustainable construction practices, reducing the consumption of natural sand and encouraging the effective utilization of industrial waste materials.

II. OBJECTIVE

The main objective of this study is to investigate the feasibility of using steel lathe turning chips as a partial replacement for fine aggregate in concrete. The study aims to prepare M20 grade concrete with different replacement percentages of 5%, 10% and 15% while maintaining a nominal mix proportion of 1:1.5:3. Concrete cubes measuring 150 mm × 150 mm × 150 mm are cast and subjected to curing periods of 7, 14 and 28 days to evaluate their strength development. The compressive strength test is conducted to determine the load-carrying capacity of the concrete

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specimens and to compare the performance of conventional concrete with steel lathe turning chip concrete. Furthermore, the study focuses on identifying the suitable replacement percentage based on the experimental results. It also aims to reduce the consumption of natural fine aggregate, utilize industrial waste effectively and contribute towards sustainable and eco-friendly concrete production.

III. METHODOLOGY

- Collection and Preparation of Materials
- Mix Design
- Batching and Mixing
- Curing
- Compressive Strength Testing
- Analysis of Results

IV. LITREATURE REVIEW

1. Bhagyawati et al. (2018) — "Experimental Study on Properties of Concrete by Partial Replacement of Fine Aggregates with Waste Steel Chips"

Waste steel chips were used as a partial replacement for fine aggregate in concrete.

The study reported improvement in concrete strength at selected replacement levels.

2. Alwaeli (2016) — "The Implementation of Scale and Steel Chips Waste as a Replacement for Raw Sand in Concrete Manufacturing"

Steel chips and scale waste were investigated as partial replacements for natural sand in concrete.

The study indicated that steel waste may improve concrete performance at suitable replacement levels.

3. Keshavarz and Mostofinejad (2019) — "Study on Concrete Containing Steel Chips and Porcelain Ceramic Waste"

Steel chips and porcelain ceramic waste were incorporated into concrete as alternative materials.

The study reported changes in concrete mechanical properties depending on the replacement materials and their proportions.

4. Padmanabhan (2020) — "Replacement of Fine Aggregate by Using Construction Demolition Waste Steel Powder in Concrete"

Steel powder obtained from construction and demolition waste was used as a partial replacement for fine aggregate.

Strength improvement was reported in some mixes, while workability decreased.

5. Prabu (2020) — "Experimental Study on Concrete in Partial Replacement of Fine Aggregate with Lathe Waste"

Lathe waste was used as a partial replacement for fine aggregate in concrete.

The study explored the potential reuse of lathe waste and evaluated its influence on concrete strength and workability.

6. Kaliskiego (2021) — "Effect of Metal Lathe Waste Addition on the Mechanical and Thermal Properties of Concrete"

Metal lathe waste was added to concrete at different proportions to investigate its mechanical and thermal properties.

The study reported variations in compressive, flexural and split tensile strength depending on the quantity of lathe waste.

7. Asfar (2023) — "Determination of Hardened Properties of High-Strength Concrete with Partial Replacement of Fine Aggregate Using Lathe Scraps"

Lathe scraps were used as a partial replacement for fine aggregate in high-strength concrete.

The study investigated hardened concrete properties and the influence of lathe scraps on concrete strength.

8. Indurkar (2022) — "Experimental Study on Partial Replacement of Fine Aggregate by Lathe Steel Scrap in Concrete"

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Lathe steel scrap was used as an alternative material for partial replacement of fine aggregate.
The study evaluated workability and strength by comparing replacement mixes with conventional concrete.

9. Kumar (2022) — "Influence of Waste Steel Scraps on Concrete Strength"

Different quantities of waste steel scraps were incorporated into concrete to investigate their effect on strength.
The study evaluated compressive, split tensile and flexural strength of concrete.

10. Thihk Kumar (2023) — "Mechanical Performance of Geopolymer Concrete with Microsilica Fume and Waste Steel Lathe Scraps"

Waste steel lathe scraps and microsilica fume were incorporated into geopolymer concrete.
The study reported that the quantity of steel lathe scraps influenced the mechanical performance of concrete.

V. MATERIAL USED

- Cement
- Fine Aggregate (M Sand)
- Coarse Aggregate
- Steel Lathe Turning Chips
- Water

Mix Design for M20 Grade Concrete Cube (150 mm)
Mix Proportion = 1 : 1.5 : 3
Water-Cement Ratio = 0.50
Cement = 1.36 kg
Water = 0.68 L
Fine Aggregate = 2.04 kg
Coarse Aggregate = 4.08 kg

Modified Mix:

5% Steel Lathe Chips = 0.102 kg
10% Steel Lathe Chips = 0.204 kg
15% Steel Lathe Chips = 0.306 kg

VI. BATCHING AND MIXING

M20 concrete was prepared using a mix ratio of 1:1.5:3 and a water-cement ratio of 0.50. Materials were measured by weight batching. Steel lathe turning chips were cleaned, cut into uniform sizes and sieved using a 4.75 mm sieve.
Fine aggregate was replaced with steel lathe turning chips at 5%, 10%, and 15%. All materials were mixed thoroughly with water to obtain a uniform concrete mix. The fresh concrete was placed in 150 mm × 150 mm × 150 mm cube moulds and compacted using a tamping rod. The specimens were demoulded after 24 hours.

Mix ID	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Steel Chips (kg)
CC (0%)	1.36	2.040	4.08	0.000
S1 (5%)	1.36	1.938	4.08	0.102
S2 (10%)	1.36	1.836	4.08	0.204
S3 (15%)	1.36	1.734	4.08	0.306

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VII. CURING

After 24 hours, the concrete specimens were demoulded and immersed in clean water at room temperature (27 ± 2°C). Curing was carried out for 7, 14, and 28 days. After curing, the specimens were removed, surface-dried and tested to determine their strength. Proper curing helped in cement hydration and strength development.

VIII. COMPRESSIVE STRENGTH

The compressive strength of conventional concrete and steel lathe turning chip concrete was determined using a compression testing machine (CTM). The cube size used for testing was 150 mm × 150 mm × 150 mm, with a cross-sectional area of 22,500 mm². The maximum load at failure was recorded, and the compressive strength was calculated using the following formula:

$$f_c = \frac{P}{A}$$

Where P is the load at failure (N) and A is the cross-sectional area (mm²).

Compressive Strength of Steel Lathe Turning Chips Concrete

The compressive strength of concrete containing 5%, 10%, and 15% steel lathe turning chips as partial replacement of fine aggregate was determined using the same relation

IX. RESULTS AND DISCUSSION

The compressive strength of conventional concrete and concrete containing steel lathe turning chips at 5%, 10%, and 15% replacement levels was studied.

The concrete specimens were tested after 7, 14, and 28 days of curing to evaluate the strength development.

The results were compared to understand the effect of steel lathe turning chips on the compressive strength of M20 grade concrete.

The variation in strength at different replacement levels helps to identify the suitable percentage of steel lathe turning chips.

The addition of steel lathe turning chips may influence the bonding, density, and strength properties of concrete.

The study also highlights the reuse of industrial steel waste as an alternative construction material and its contribution to sustainable development.

X. CONCLUSION

•This experimental study investigates the partial replacement of fine aggregate with steel lathe turning chips in M20 grade concrete.

• Fine aggregate was replaced with steel lathe turning chips at 5%, 10%, and 15% by weight.

• Concrete specimens were prepared and cured for 7, 14, and 28 days to evaluate their strength characteristics.

• Compressive strength testing was carried out to compare conventional concrete with modified concrete.

• The experimental study helps to identify the suitable replacement percentage based on the test results.

• The use of steel lathe turning chips provides an effective way to reuse industrial waste and reduce the consumption of natural fine aggregate.

• Overall, this study explores the possibility of using steel lathe turning chips in concrete and promoting sustainable construction practices.

XI. ACKNOWLEDGMENT

The authors express their sincere gratitude to the management and faculty members of the Department of Civil Engineering for their valuable guidance and support throughout this project. Special thanks are extended to the project supervisor for continuous encouragement, technical suggestions and support. The authors also thank the laboratory staff

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for their assistance during material preparation, casting, curing and testing of concrete specimens. Finally, the authors express their gratitude to all those who directly or indirectly contributed to the successful completion of this project.

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