IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Investigation On Concrete With Partial Replacement Of Fine Aggregate Using Foundry Sand

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Abstract: In this project, to make concrete a sustainable material, fine aggregate was replaced partially with foundry sand because our resources are limited. Tests were performed on concrete samples at different percentage replacements (10%, 15%, 20%) for compressive strength, tensile strength, and flexural strength. They also have the purpose of finding a suitable replacement percentage, ensuring the balance between mechanical resistance and workability together to encourage the recycling of industrial waste. This paper also helps reduce the environmental impact of construction activities and promoting sustainable materials.

Index Terms –Fine aggregate, Tensile Strength, Compressive Strength ,Flexural Strength, Industrial Waste, Sustainable materials

I.INTRODUCTION

1.1 GENERAL

Concrete is a widely used construction material known for its strength, durability, and versatility. The growing demand for natural sand in concrete has led to environmental concerns such as resource depletion and ecological imbalance. Foundry sand, an industrial byproduct from the metal casting process, offers a sustainable alternative to natural sand. This project investigates the feasibility of partially replacing fine aggregate with foundry sand in concrete. The study focuses on evaluating the effects on mechanical properties like compressive strength, tensile strength, and flexural strength. By identifying the optimal replacement percentage, the project promotes recycling of industrial waste and supports sustainable construction practices.

1.2 CONCRETE

Concrete is a composite medium in which an inert particle of well-graded fine and coarse concrete is bonded together by a binding material mixed in water and solidified.

1.3 CLASSIFICATION OF CONCRETE

Concrete are classified into different types:

According to binding materials used in concrete

According to design of concrete

1.3.1 CLASSIFICATION ACCORDING TO BINDING MATERIAL

According to binding material used concrete are two types

i) Cement concrete

ii) Lime concrete

1.4 .OBJECTIVES:

- To study the feasibility of using foundry sand as a partial replacement for fine aggregate in concrete.
- To evaluate the mechanical properties such as compressive strength, tensile strength, and workability of concrete.
- To analyze the environmental benefits of recycling industrial waste.

1.5 SCOPE:

This project focuses on replacing fine aggregate in concrete with varying percentages of foundry sand (0%, 10%, 20%,

30%, and 40%).

It aims to identify the optimal replacement level for achieving the best strength and workability

II. METHODOLGY

2.1 Material Collection and Testing

- Collect materials: Cement, coarse aggregate, fine aggregate, and foundry sand.
- Perform tests to determine properties of materials:
- Cement: Specific gravity, consistency, and initial setting time.
- Fine Aggregate and Foundry Sand: Sieve analysis, specific gravity, and fineness modulus.
- Coarse Aggregate: Sieve analysis and specific gravity.

III. MIX DESIGN

Design a concrete mix (M20 grade as a reference).

Replace fine aggregate with foundry sand at 0%, 15%, 25%, 35%.

3.1 Preparation of Concrete Specimens

Cast cubes, cylinders, and beams for each mix proportion.

Standard sizes:

Cubes: 150mm x 150mm x 150mm

Cylinders: 150mm diameter and 300mm height

Beams: 100mm x 100mm x 500mm

3.2 Testing of Specimens

Conduct the following tests after curing (7, 14, and 28 days):

Workability Test: Slump cone test.

Compressive Strength: Cube testing in a compression testing machine.

3.3 Data Analysis

Compare results for different replacement levels.

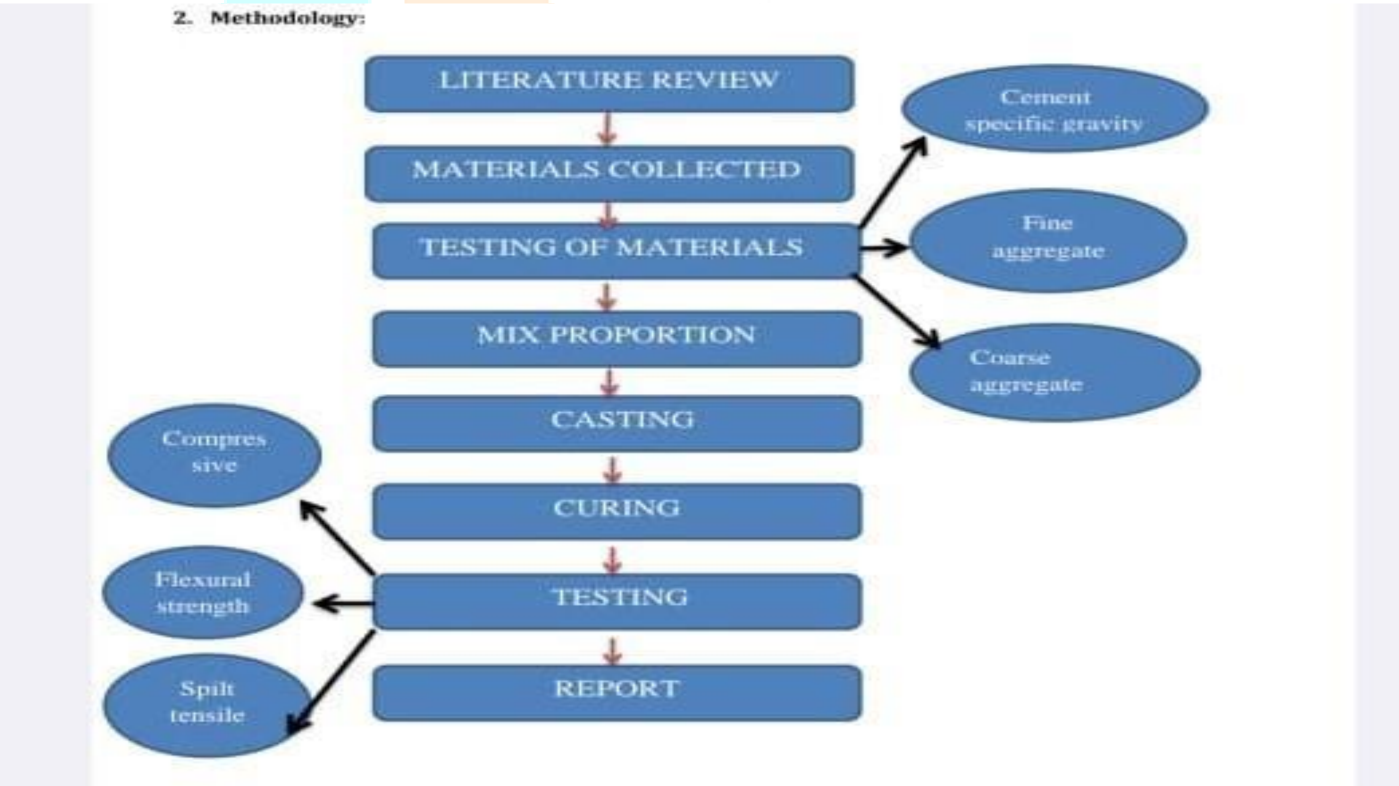
Determine the optimal percentage of foundry sand replacement.

3.4 Conclusion and Recommendations

Conclude based on experimental results.

Suggest applications and potential environmental benefits.

Materials Required:



3.5 Mix Proportions

The concrete mix design follows IS 10262:2019. The control mix is prepared without foundry sand, while experimental mixes are designed with 15%, 25%, and 35% replacement of fine aggregate by weight.

Mix ID	Cement (kg/m³)	Fine Aggregate (kg/m³)	Coarse Aggregate (kg/m³)	Foundry Sand (%)	Water (kg/m³)
M0	380	660	1200	0	190
M15	380	561	1200	15	190
M25	380	495	1200	25	190
M35	380	429	1200	35	190

IV. Experimental Procedure

4.1 Material Characterization:

Foundry Sand: Conduct sieve analysis, specific gravity test, and chemical analysis.

Fine Aggregate: Test for particle size distribution and fineness modulus.

4.2 Concrete Preparation:

Batch and mix materials as per the specified mix proportions.

Cast standard specimens for compressive strength (150 mm cubes), split tensile strength (150 mm × 300 mm cylinders), and flexural strength (100 mm × 100 mm × 500 mm beams).

Figure 4.1 Mixing of Concrete

4.3 Curing:

Cure specimens in water for 7, 14, and 28 days.

4.4 Testing:

Compressive Strength: Test cubes using a compression testing machine.

Tensile Strength: Conduct split tensile tests on cylinders.

Flexural Strength: Perform flexural tests on beams

4.5 Specific Calculations for 15% Replacement (M15)

4.5.1 .Mix Calculation:

Total fine aggregate weight: 660 kg/m³.

Foundry sand (15% of fine aggregate):

Remaining fine aggregate.

4.5.2 Water cement ratio:

Water content: 190 kg/m³.

Cement content: 380 kg/m³.

4.5.3 Workability Test:

Slump height measured: 75 mm (within medium workability range).

4.5.4 Parameters for M20 Grade Concrete

Target Strength (fck): 20 MPa

Water-Cement Ratio: 0.50 (assumed, adjust based on actual conditions).

Mix Ratio (by weight): 1:1.5:3 (Cement: Fine Aggregate: Coarse Aggregate).

Density of Concrete: 2400 kg/m³ (assumed).

V. Results and Discussion Compressive Strength

Results indicate an increase in strength at 15% replacement, followed by a decline at higher percentages. Optimal performance observed at 15% replacement.

Replacement (%)	7-day Strength (MPa)	14-day Strength (MPa)	28-day Strength (MPa)
0 (M0)	25.5	33.2	41.0
15 (M15)	27.8	36.5	44.7

5.1 Tensile Strength

Tensile strength improved at 15% replacement, showing compatibility of foundry sand in enhancing tensile properties.

5.2 Flexural Strength

Flexural performance followed a similar trend, with the highest strength observed at 15% replacement.

5.3 Discussion

Foundry sand exhibits good binding properties at lower replacement levels.

Excessive replacement leads to a reduction in workability and strength due to higher fineness and weaker particle bonds.

VI. Conclusion

- 15% Replacement: Achieves the best results with enhanced compressive, tensile, and flexural strengths. Maintains medium workability without adjustments, making it ideal for structural applications.
- 25% Replacement: Shows slightly reduced strength compared to 15% but remains comparable to the control mix. Moderate workability is achieved with minor adjustments, suitable for cost-efficient projects.
- 35% Replacement: Significant strength reduction due to poor bonding and increased porosity. Workability decreases, requiring major adjustments, making it unsuitable for structural applications.
- Recommendation: 15% is optimal for strength and workability, while 25% is viable for moderate performance. Avoid 35% for structural uses.
- Self-curing concrete is the alternative where there is a larger scarcity of sand.
- For curing in the study, cast, cubes, rods, prism were kept at room temperature.

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