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EXPERIMENTAL STUDY ON ENGINEERED CEMENTITIOUS COMPOSITES USING GRANITE STONE DUST AND ALCOFINE

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ABSTRACT

This study investigates the use of granite stone dust and Alcofine as partial replacements in engineered cementitious composites (ECC) to enhance mechanical and durability properties while promoting sustainability. Cement production contributes significantly to global CO_2 emissions, necessitating alternative materials to reduce environmental impact. Granite stone dust, a byproduct of stone processing, and Alcofine, a highly reactive supplementary cementitious material, were incorporated in varying proportions.

Concrete mixes were prepared using M25 grade with replacement levels of 15% and 20% Alcofine and 20% and 30% granite stone dust. The specimens were tested for compressive strength, split tensile strength, and flexural strength at curing periods of 7, 14, and 28 days. Experimental results revealed that the combined use of granite dust and Alcofine significantly enhances strength properties due to improved particle packing and matrix densification.

The optimum mix (20% Alcofine and 30% granite dust) showed maximum compressive strength of 183.6 N/mm² at 28 days, outperforming conventional concrete. The study concludes that the use of these materials not only improves performance but also supports eco-friendly construction by reducing cement consumption and utilizing industrial waste.

KEYWORDS: Engineered Cementitious Composites, Granite Stone Dust, Alcofine, Sustainable Concrete, Mechanical Strength

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1. INTRODUCTION

Concrete is the most widely used construction material due to its strength, durability, and versatility. However, cement production is responsible for nearly 8% of global CO_2 emissions, making it environmentally unsustainable. The depletion of natural resources such as river sand further intensifies the need for alternative materials.

Engineered Cementitious Composites (ECC) are advanced materials known for their high ductility, crack resistance, and improved durability compared to conventional concrete. The use of supplementary cementitious materials such as Alcofine and industrial byproducts like granite stone dust offers a promising solution to improve both sustainability and performance.

Granite stone dust is a waste material obtained during stone crushing operations and can serve as a partial replacement for fine aggregates. Alcofine, a microfine material derived from slag, enhances early strength and improves durability due to its pozzolanic properties.

This study aims to evaluate the mechanical performance of ECC by incorporating

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granite stone dust and Alcofine and to identify an optimum mix that enhances strength while reducing environmental impact.

2. MATERIALS AND METHODS

2.1 Materials Used

The following materials were used in this study:

- Cement (PPC)
- Fine aggregate (natural sand)
- Coarse aggregate (20 mm size)
- Granite stone dust
- Alcofine
- Water

The specific gravity values were:

- Cement: 3.31
- Fine aggregate: 2.46
- Coarse aggregate: 2.71
- Alcofine: 3.12
- Granite stone dust: 2.72

2.2 Mix Design

Concrete of M25 grade was designed as per IS 10262:2019 guidelines.

- Water-cement ratio: 0.40
- Mix proportion: 1 : 1 : 2
- Alcofine replacement: 15%, 20% (cement)
- Granite dust replacement: 20%, 30% (fine aggregate)

2.3 Specimen Preparation

The specimens prepared were:

- Cubes (150×150×150 mm) for compressive strength
- Cylinders (150 mm × 300 mm) for split tensile strength
- Beams (100×100×500 mm) for flexural strength

All specimens were cured for 7, 14, and 28 days before testing.

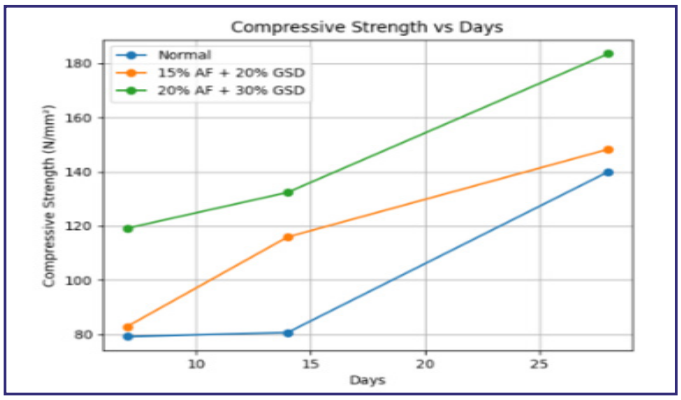
2.4 Testing Procedure

- Compressive strength test was conducted using a compression testing machine.
- Split tensile strength was measured on cylindrical specimens.
- Flexural strength was tested using beam specimens under loading conditions.

3. RESULTS

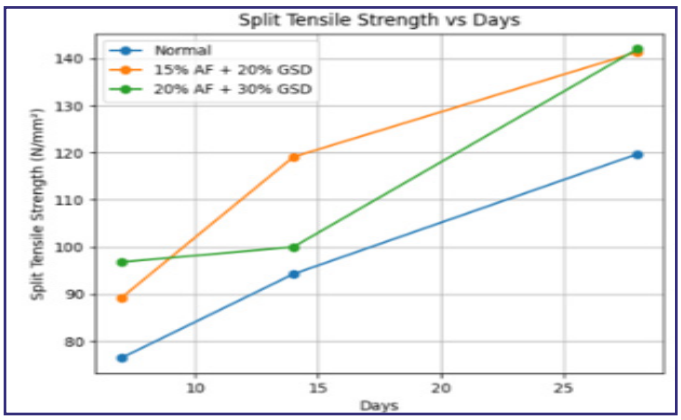
3.1 Compressive Strength

Mix Type	7 Days	14 Days	28 Days
Normal Concrete	79.12	80.59	140
15% AF + 20% GSD	82.82	115.88	148.3
20% AF + 30% GSD	119.12	132.35	183.6



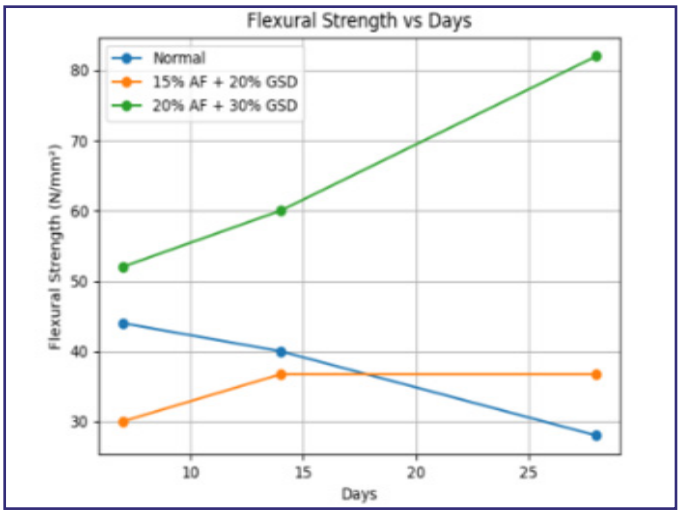
3.2 Split Tensile Strength

Mix Type	7 Days	14 Days	28 Days
Normal	76.43	94.26	119.74
15% AF + 20% GSD	89.17	119.10	141.40
20% AF + 30% GSD	96.81	100	142.03



3.3 Flexural Strength

Mix Type	7 Days	14 Days	28 Days
Normal	44	40	28
15% AF + 20% GSD	30	36.72	36.72
20% AF + 30% GSD	52	60	82



4. DISCUSSION

The experimental results clearly indicate that the addition of granite stone dust and Alcofine improves the mechanical properties of ECC.

The increase in compressive strength is mainly due to:

- Improved particle packing
- Reduced voids
- Enhanced hydration process

Alcofine contributes to early strength gain due to its fine particle size and high reactivity, while granite dust enhances the density and reduces permeability of concrete.

The combination of 20% Alcofine and 30% granite dust yielded the best results across all tests. However, excessive replacement beyond this level may negatively affect workability.

5. CONCLUSIONS

- Partial replacement of cement and fine aggregate improves strength characteristics.
- Optimum mix (20% Alcofine + 30% granite dust) showed highest performance.
- Compressive, tensile, and flexural strengths increased significantly.
- Use of industrial byproducts reduces environmental impact.
- ECC with these materials is suitable for sustainable construction applications.

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