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Experimental Investigation on Concrete with Quarry Dust and Marble Powder

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ABSTRACT: The demand for sustainable construction materials has led to a surge in research aimed at enhancing the properties of concrete while reducing its environmental footprint. This study investigates the feasibility of utilizing quarry dust and marble powder as partial replacements for fine aggregate in concrete production. Quarry dust, a by-product of stone crushing operations, and marble powder, a waste material from marble processing, are abundant and often underutilized resources. In this experimental study, varying proportions of quarry dust and maintaining constant 15% marble powder were substituted for fine aggregate in concrete mixes. To evaluate compressive and split tensile strengths for 7 and 28 days.

KEY WORDS: Marble Powder, Quarry Dust, Sustainable, Compressive Strength, Split Tensile Strength.

I. INTRODUCTION

Concrete is a versatile and widely used construction material composed primarily of cement, aggregates (such as sand and gravel), and water. It has been a cornerstone of modern construction for centuries, owing to its strength, durability, and versatility. Concrete plays a crucial role in various construction applications, including buildings, bridges, roads, dams, and infrastructure projects.

Quarry dust, also known as stone dust or crusher dust, is a by-product of stone crushing operations in quarries. It consists of particles ranging from fine dust to gravel-sized stones, generated during the process of crushing rocks to produce aggregates for construction purposes. While quarry dust is traditionally considered a waste material, it possesses several properties that make it a potentially valuable resource in various applications, including construction. Marble powder, a by-product of marble processing industries, is generated during the cutting, grinding, and polishing of marble blocks into various shapes and sizes for architectural and decorative purposes. This fine powder consists of finely ground particles of calcium carbonate and other minerals present in marble. While traditionally considered a waste material, marble powder possesses unique properties that make it an attractive candidate for various applications, particularly in the construction sector.

II. OBJECTIVES

1. To assess the usage of quarry dust and marble powder in fine aggregate.
2. To determine the compressive and split tensile strength of concrete.

III. MATERIALS

3.1 Cement: In construction, cement is a substance that acts as a binding agent to keep the other building materials together. The majority of the material in concrete is composed of coarse aggregate, with fine aggregate filling in the spaces left by the coarse aggregate. Mortar is only regular cement combined with water and fine aggregate, whereas concrete is just cement mixed with coarse material.

3.2 Fine Aggregate: Fine aggregates are naturally occurring sand particles extracted from the ground during mining. Crushed stone particles $\frac{1}{4}$ " or smaller can be used, in any size. For this reason, this product is frequently described as $\frac{1}{4}$ ' minus due to the size, or grade, of the aggregate. Matter that passes through an IS Sieve with a 4.75 mm opening is referred to as fine aggregate. Sand in the River Grade II Grading Zone. Grain size: medium.

3.3 Coarse Aggregate: Aggregate preserved above IS Sieve 4.75 mm is referred to as coarse aggregate. Although self-compacting concrete has been found to use particle sizes of up to 40 mm or more, the usual maximum size is progressively 10–20 mm.

3.4 Marble Powder: Marble powder is primarily composed of calcium carbonate along with traces of other minerals present in marble. Due to its composition, marble powder exhibits pozzolanic properties, meaning it can react with calcium hydroxide ($\text{Ca}(\text{OH})_2$) in cementitious systems to form additional cementitious compounds. This characteristic makes marble powder suitable for use as a supplementary material in construction, particularly in the production of concrete and mortar.

3.5 Quarry dust: Quarry dust is typically composed of finely crushed stone particles with angular shapes and rough surfaces. It is a form of crushed stone aggregate that is often considered a waste material in the quarrying industry. However, quarry dust possesses several properties that make it suitable for various construction applications.

IV. EXPERIMENTAL INVESTIGATIONS

4.1 Compressive Strength Results: compressive strength of concrete is determined through standardized laboratory tests, usually conducted on cylindrical or cubic specimens that are subjected to gradually increasing compressive loads until failure occurs.

Table 1: Compressive Strength of Concrete with Quarry dust and maintaining Constant Percent of Marble Powder as Partial Replacement of Cement.

S.No	% of Quarry dust+ 15%Marblepowder	Compressive strength (N/mm^2)	
		7 days	28 days
1	0%	33.82	49.83
2	15%+10%	41.61	60.39
3	15%+20%	44.96	64.33
4	15%+30%	47.43	67.78
5	15%+40%	45.69	66.32

4.2 Split Tensile Strength Test: In a split tensile strength test for concrete, a cylindrical specimen is placed horizontally between two compressive platens of a testing machine. A compressive force is applied diametrically to the specimen, causing it to crack and separate along its length. The tensile stress developed perpendicular to the applied force is known as split tensile stress.

Table 2: Split tensile Strength of Concrete with Quarry dust and maintaining Constant Percent of Marble Powder as Partial Replacement of Cement.

S.No	% of Quarry dust+ 15%Marblepowder	Split tensile strength (N/mm^2)	
		7 days	28 days
1	0%	3.24	4.87
2	15%+10%	4.05	5.94
3	15%+20%	4.51	6.56
4	15%+30%	4.85	6.91
5	15%+40%	4.64	6.62

V. CONCLUSIONS

1. The compressive strength results for 7 and 28 days of normal concrete are 33.82 and 49.83 N/mm^2 .
2. The split tensile strength results for 7 and 28 days of normal concrete are 3.24 and 4.87 N/mm^2 .

3. By maintaining 15% of marble powder constant and incorporating 30% of quarry dust, the compressive strength results for 7 and 28 days is 47.43 and 67.78 N/mm².
4. By maintaining 15% of marble powder constant and incorporating 30% of quarry dust, the split tensile strength results for 7 and 28 days is 4.85 and 6.91 N/mm².

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