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STRENGTH STUDIES ON CONCRETE WITH DUNITE POWDER AS CEMENT REPLACEMENT AND M-SAND AS FINE AGGREGATE

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ABSTRACT

This research explores the mechanical properties of concrete incorporating Dunite powder as a partial cement replacement and Manufactured Sand (M-Sand) as a replacement for fine aggregate. The study aims to enhance the sustainability and performance of concrete by using these alternative materials. Dunite powder, rich in magnesium silicate, is substituted for cement in varying proportions 20%,40% and 60%. M-Sand, a manufactured alternative to natural sand, is used partial replacement of fine aggregate by varying proportions 15%,30% and 45%. The concrete mixes are subjected to rigorous testing to evaluate compressive strength test, split tensile strength at 7 and 28days of curing and ultrasonic pulse velocity test carried at 28days.The integration of Dunite powder aims to reduce the carbon footprint of cement production, while M-Sand addresses the depletion and environmental impact of natural sand resources. Preliminary results indicate that the modified concrete mixes achieve comparable or improved mechanical properties relative to traditional concrete. This study demonstrates the viability of using Dunite powder and M-Sand in concrete production, offering an eco-friendly and sustainable solution without compromising on structural performance. The findings contribute to the development of optimized concrete mix designs that support sustainable construction practices.

***KEYWORDS**: M-Sand, Dunite Powder, Compressive Strength, Split Tensile Strength and Ultrasonic pulse Velocity.*

1. INTRODUCTION:

One significant method of getting rid of solid waste from other sectors is by using waste components in concrete mixtures. The composite material known as concrete is made up of coarse gravel and a cement that is fluid initially and solidifies over time. The majority of concretes that are used, like Portland cement concrete or concretes that are created with several hydraulic cements, include a base of lime. Cement is currently the most significant building material and is likely to remain so for some time to come. The standards for the materials used in engineering and construction are always getting higher. In terms of quality, economy, productivity, and the environment, they have alternatives to wood, steel, and plastic in constructing.

The use of natural river sand as a fine aggregate in concrete production has been a standard practice for decades. However, the depletion of natural sand reserves and the environmental impact of sand mining have led to a growing demand for sustainable alternatives. Manufactured sand, commonly known as M-Sand, has emerged as a viable solution. Produced by crushing hard granite stones, M-Sand mimics the properties of natural sand while offering additional benefits in terms of quality and consistency. Its controlled manufacturing process ensures that M-Sand is free from impurities such as clay, silt, and organic matter, which can adversely affect the properties of concrete.

Dunite, an ultramafic igneous rock primarily composed of olivine, is gaining attention as a sustainable material in the construction industry. The fine powder derived from dunite, known as dunite powder, has emerged as a potential partial replacement for cement in concrete. The interest in dunite powder stems from its mineral composition and the potential benefits it offers in terms of both mechanical performance and environmental impact. Utilizing dunite powder can help reduce the reliance on traditional Portland cement, whose production is associated with significant carbon dioxide emissions.

2. OBJECTIVES

1. To investigate the use of Dunite powder as a partial replacement for cement to optimize cement content in concrete.

2. To evaluate the effectiveness of using Manufactured Sand (M-Sand) as a complete replacement for natural fine aggregate in concrete.

3. To determine the compressive strength, split tensile strength, and flexural strength of concrete mixes incorporating Dunite powder and M-Sand at various curing periods (7 and 28 56 days).

3. MATERIALS

3.1 Cement: Cement manufacture and use have a substantial negative influence on the environment, especially when it comes to carbon dioxide emissions. The industry has been investigating several supplemental cementitious materials (SCMs) such fly ash, slag, and natural pozzolans like zeolite to solve these environmental concerns. These ingredients improve the performance qualities of concrete while also lessening the carbon footprint associated with cement manufacture.

3.2 Fine Aggregate: The cumulative percentages of weights passing a specific IS sieve are the definition of grading. Four ranges, or zones, are specified for the grading of fine aggregate in IS 383-1970.Sand is coarsest in

Zone I, finest in Zone IV, and intermediate in Zones II and III. For reinforced concrete, it is advised to utilize fine particles that satisfy grading zones II or III.

3.3 Coarse Aggregate: An essential component of concrete, coarse aggregate greatly enhances the overall strength, longevity, and structural integrity of the material. Coarse aggregate gives the concrete mix the bulk and stability it needs. It can be made of materials like crushed stone, gravel, or recycled concrete. The coarse aggregate particle size and form, which normally vary from 4.75 mm to 20 mm, are important factors in defining the concrete's workability, strength, and longevity.

3.4 M-SAND: Manufactured sand, often known as M-Sand, is a type of fine aggregate that is created by pulverizing bigger aggregates such as rocks into particles the size of sand. It is treated to remove organic debris, silt, and clay in order to comply with building codes.

3.5 Dunite powder: Dunite powder is a finely ground form of dunite rock, primarily composed of olivine minerals (magnesium iron silicates). It is produced by crushing and grinding dunite ore into a powder form, typically with particle sizes ranging from fine to very fine.

3.6 Water: It is commonly accepted that using potable water is sufficient for mixing and curing concrete. H2O makes up water, and its pH range is 6 to 8.

4. Experimental Investigations:

4.1**Compressive Strength Results:**Test specimens are either 15-cm cubes or 15-cm diameter, and the concrete to be tested shall not have nominal maximum aggregate sizes greater than 20 mm. Usually, the concrete specimens are tested when they are 7 and 28 days.

Table 1: Compressive Strength Results of Concrete with Partial Replacement of Fine aggregate by M-Sand.

S.No	% of M-Sand	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	33.56	49.86
2	15%	38.64	55.79
3	30%	43.07	61.45
4	45%	41.31	59.11

Table 2: Compressive Strength Results of Concrete with Partial Replacement of Cement by Dunite Powder.

S.No	% of Dunite powder	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	33.56	49.86
2	20%	34.98	51.53
3	40%	37.73	54.78
4	60%	36.87	52.91

Table 3: Combined compressive strength results for the partial replacement of fine aggregate with M-Sand and cement with dunite powder.

S.No	% of M-Sand+Dunite Powder	Compressive strength results, N/mm^2	
		7 days	28 days
1	0%	33.56	49.86
2	30% M-Sand+40% Dunite Powder	44.06	63.96

4.2 Split Tensile Strength Test: The loading surfaces of the compression testing machine are divided horizontally by a standard concrete specimen test cylinder of 300 mm by 150 mm in diameter. Throughout the cylinder's length, the compression force is applied steadily and symmetrically until the cylinder breaks at its vertical diameter.

Table 4: Split tensile Strength Results of Concrete with Partial Replacement of Fine aggregate by M-Sand.

S.No	% of M-Sand	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	3.34	4.89
2	15%	3.85	5.51
3	30%	4.26	6.08
4	45%	4.08	5.84

Table 5: Split tensile Strength Results of Concrete with Partial Replacement of Cement by Dunite Powder.

S.No	% of Dunite powder	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	3.34	4.89
2	20%	3.51	5.08
3	40%	4.07	5.75
4	60%	3.69	5.28

Table 6: Combined Split tensile strength results for the partial replacement of fine aggregate with M-Sand and cement with dunite powder.

S.No	% of M-Sand+Dunite Powder	Split tensile strength results, N/mm^2	
		7 days	28 days
1	0%	3.34	4.89
2	30% M-Sand+40% Dunite Powder	4.69	6.71

4.3 Ultrasonic pulse Velocity Test: Ultrasonic Wave Pulse The density and elastic modulus of concrete are the main factors that determine its velocity.

Table 7: Ultra Pulse Velocity Results of Concrete with Partial Replacement of Fine aggregate by M-Sand.

S.No	% of M-Sand	Ultra Pulse Velocity results, m/s	
		28 days	Quality of Concrete
1	0%	4456	Good
2	15%	4629	Excellent
3	30%	4843	Excellent
4	45%	4763	Excellent

Table8: Ultra Pulse Velocity Results of Concrete with Partial Replacement of Cement by Dunite Powder.

S.No	% of Dunite powder	Ultra Pulse Velocity results, m/s	
		28 days	Quality of Concrete
1	0%	4456	Good
2	20%	4511	Excellent
3	40%	4601	Excellent
4	60%	4584	Excellent

Table 9: Combined Ultra Pulse Velocity strength results for the partial replacement of fine aggregate with M-Sand and cement with dunite powder.

S.No	% of M-Sand+Dunite Powder	Ultra Pulse Velocity results, m/s	
		28 days	Quality of Concrete
1	0%	4456	Good
2	30% M-Sand+40% Dunite Powder	4903	Excellent

5. CONCLUSIONS:-

1. The compressive strength results of normal concrete at 7 days and 28 days are 33.56 N/mm² and 49.86 N/mm², respectively.

2. The optimum compressive strength results for concrete with fine aggregate partially replaced by 30% M-Sand at 7 days and 28 days are 43.07 N/mm² and 61.45 N/mm², respectively.

3. The optimum compressive strength results for concrete with cement partially replaced by 40% dunite powder at 7 days and 28 days are 37.73 N/mm² and 54.78 N/mm², respectively.

4. The combined compressive strength results for concrete with 30% M-Sand replacing fine aggregate and 40% dunite powder replacing cement at 7 days and 28 days are 44.06 N/mm² and 63.96 N/mm², respectively.

5. The Split tensile strength results of normal concrete at 7 days and 28 days are 3.34 N/mm² and 4.89 N/mm², respectively.

6. The optimum Split tensile strength results for concrete with fine aggregate partially replaced by 30% M-Sand at 7 days and 28 days are 4.26 N/mm² and 6.08 N/mm², respectively.
7. The optimum Split tensile strength results for concrete with cement partially replaced by 40% dunite powder at 7 days and 28 days are 4.07 N/mm² and 5.75 N/mm², respectively.

8. The combined Split tensile strength results for concrete with 30% M-Sand replacing fine aggregate and 40% dunite powder replacing cement at 7 days and 28 days are 4.69 N/mm² and 6.71 N/mm², respectively.

9. The Ultra pulse velocity results of normal concrete at 28 days is 4456 m/s respectively.

10. The optimum Ultra pulse velocity results for concrete with fine aggregate partially replaced by 30 % M-Sand at at 28 days is 4843 m/s respectively.
11. The optimum Ultra pulse velocity results for concrete with cement partially replaced by 40% dunite powder at at 28 days is 4601 m/s respectively.

12. The combined Ultra pulse velocity results for concrete with 30% M-Sand replacing fine aggregate and 40% dunite powder replacing cement at at 28 days is 4903 m/s respectively.

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