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EXPERIMENTAL INVESTIGATION ON CONCRETE WITHTITANIUM DIOXIDEAND QUARRY DUST

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ABSTRACT

Concrete, a fundamental construction material, faces inherent limitations such as low tensile strength, susceptibility to cracking, and a significant environmental footprint. To address these challenges, material science explores innovative modifications. The incorporation of nano-titanium dioxide (TiO2) as a partial cement replacement offers a dual benefit: it refines the concrete's microstructure by acting as a filler and accelerating cement hydration, thereby enhancing mechanical properties. Quarry dust, a waste material, is abundantly available and can reduce the demand for natural sand. Results show improved strength and durability with quarry dust replacement up to a certain percentage. Quarry dust can be a sustainable alternative to fine aggregate in concrete construction. The optimal replacement percentage is determined through compressive strength tests and split tensile strength for 7 and 28days.

KEYWORDS: ***Quarry Dust, Titanium dioxide, Sustainable ,Compressive strength and Split tensile strength***

1. INTRODUCTION

Concrete, the world's most ubiquitous building material, is an indispensable and versatile composite forming the backbone of modern infrastructure. Composed primarily of cement, aggregates, and water, it transforms into a durable, stone-like material through hydration. Its widespread adoption is driven by exceptional strength, adaptability, and cost-effectiveness, though ongoing research continually seeks to enhance its sustainability and properties in response to environmental concerns stemming from cement production. Consequently, concrete remains fundamental to global development, constantly evolving to meet contemporary demands.

Quarry dust, a significant by-product of the stone crushing industry, is increasingly recognized as a valuable resource in civil engineering. Generated in vast quantities, its disposal often poses environmental and economic challenges. However, its physical and chemical properties make it a viable alternative to natural fine aggregate in

concrete production.Utilizing quarry dust helps mitigate the environmental impact of excessive sand mining while addressing waste management concerns. Its angular particles can enhance concrete's packing density and contribute to improved mechanical properties. This sustainable approach offers a dual benefit: conserving natural resources and fostering greener construction practices.

Titanium dioxide (TiO2) is a naturally occurring inorganic compound, renowned for its exceptional brightness and high refractive index. Beyond its widespread use as a brilliant white pigment in paints, plastics, and paper, TiO2 possesses remarkable photocatalytic properties. This enables it to act as a self-cleaning agent and an air purifier, effectively breaking down pollutants when exposed to light. In civil engineering, its integration into concrete and other building materials enhances durability, aesthetic appeal, and environmental performance.

2. OBJECTIVES

To investigate the combined influence of partial cement replacement with titanium dioxide and partial fine aggregate replacement with quarry dust on the mechanical properties of compressive strength and split tensile strength of concrete.

3. MATERIALS

3.1 Cement: Cement is a fine, powdery binding material that, when mixed with water, forms a paste. This paste then hardens through hydration, acting as an adhesive to bind aggregates together. It is a crucial component in concrete, enabling it to achieve its strength and structural integrity.

3.2 Fineaggregate: Fine aggregate consists of small granular materials, typically sand, with particle sizes generally passing a 4.75 mm sieve. It plays a crucial role in concrete mixes by filling voids between coarse aggregates, contributing to workability, and ensuring a dense, cohesive mixture. This component is essential for achieving the desired strength and finish in concrete structures.

3.3 Coarse aggregate: Coarse aggregate refers to granular materials, such as gravel or crushed stone, that are larger than 4.75 mm. They form the main structural framework in concrete, providing strength, durability, and volume. These aggregates are essential for various construction applications, including concrete, asphalt, and road bases.

3.4 Water: Water plays two vital roles in concrete: it hydrates the cement to create a hardened binding paste and lubricates the mix for easier placement and finishing.

3.5Quarry Dust: Quarry dust as fine aggregate replacement refers to using this byproduct of stone crushing, typically sized under 4.75 mm, to partially or fully substitute natural sand in concrete and mortar mixes. This practice helps conserve natural sand resources, addresses environmental concerns related to waste disposal, and can often improve the strength and durability of the concrete. It offers an economical and sustainable alternative for construction materials.

3.6 Titanium Dioxide: Titanium dioxide (TiO2) as a partial replacement for cement offers concrete enhanced functionalities beyond traditional properties. Additionally, TiO2 can refine the concrete's microstructure, potentially enhancing its strength and durability.

4. EXPERIMENTAL RESULTS

4.1 Compressive strength

The compressive strength test determines the maximum load a material, such as concrete, can bear under compression before failure. This is commonly performed by applying gradual force to a standardized cube specimen in a testing machine, typically at 7 and 28 days to assess its strength development.

Table 1: Compressive strength results of concrete with Quarry Dust used as a partial replacement of Fine aggregate.

Sl.no	% of Quarry dust	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	21.95	32.58
2	10%	23.51	34.76
3	20%	25.55	37.31
4	30%	27.82	39.65
5	40%	27.19	38.91

Table 2: Compressive strength results of concrete with Titanium dioxide used as a partial replacement of Cement

Sl.no	% of Titanium dioxide	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	21.95	32.58
2	0.5%	26.04	38.42
3	1%	28.16	40.06
4	1.5%	26.38	37.74

Table 3: Combined Compressive strength of concrete with 30%QD+1%Tio_2

Sl.no	30%QD+1%Tio_2	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	21.95	32.58
2	30%QD+1%Tio_2	30.49	43.62

4.2 Split tensile strength

Split tensile strength is an indirect method for determining the tensile strength of concrete, which is typically very weak in direct tension. The test involves placing a cylindrical concrete specimen horizontally and applying a compressive load along its diameter plane until it splits into two halves, typically at **7 and 28 days** to assess its

strength development.

Table 4: Split tensile strength results of concrete with Quarry Dust used as a partial replacement of Fine *aggregate.*

Sl.no	% of Quarry dust	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	2.24	3.17
2	10%	2.31	3.39
3	20%	2.59	3.67
4	30%	2.86	4.04
5	40%	2.68	3.85

Table 5: Split tensile strength results of concrete with Titanium dioxide used as a partial replacement of Cement

Sl.no	% of Titanium dioxide	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	2.24	3.17
2	0.5%	2.56	3.78
3	1%	2.91	4.23
4	1.5%	2.47	3.69

Table 6: Combined Split tensile strength of concrete with 30%QD+1%Tio_2

Sl.no	30%QD+1%Tio_2	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	2.24	3.17
2	30%QD+1%Tio_2	3.04	4.42

5. CONCLUSION

1. The normal concrete compressive strength results for 7 and 28days is 21.95 and 32.56N/mm^2.
2. At 30% partial replacement of fine aggregate with Quarry dust which gives compressive strength result for 7 and 28days is 27.82 and 39.65 N/mm^2.
3. At 1% partial replacement of cement with Titanium dioxide which gives compressive strength result for 7 and 28days is 28.16 and 40.06 N/mm^2.
4. Compressive strength result for combined replacement of 30% partial replacement of fine aggregate with Quarry dust and 1% partial replacement of cement with Titanium dioxide which gives compressive strength result for 7 and 28days is 30.49 and 43.62 N/mm^2.
5. The normal concrete split tensile strength results for 7 and 28days is 2.24 and 3.17 N/mm^2.
6. At 30% partial replacement of fine aggregate with Quarry dust which gives split tensile strength result for 7 and 28days is 2.86 and 4.04 N/mm^2.
7. At 1% partial replacement of cement with Titanium dioxide which gives split tensile strength result for 7 and 28days is 2.91 and 4.42 N/mm^2.

8. Split tensile strength result for combined replacement of 30% partial replacement of fine aggregate with Quarry dust and 1% partial replacement of cement with Titanium dioxide which gives compressive strength result for 7 and 28days is 3.04 and 4.42 N/mm^2.

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