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EXPERIMENTAL INVESTIGATION ON CONCRETE WITHTITANIUM DIOXIDEAND QUARRY DUST

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ABSTRACT

Concrete, a vital construction material, has drawbacks like *low tensile strength****, proneness to*** *cracking****, and a substantial*** *environmental impact****. Material science is tackling these issues with innovations like*** *titanium dioxide(TiO2)****, which, when partially replacing cement, improves the concrete's*** *microstructure* ***and*** *mechanical properties* ***by acting as a filler and speeding up hydration. Additionally, abundant*** *quarry dust****, a waste product, can*** *sustainably replace natural sand* ***as a fine aggregate, leading to*** *improved strength and durability* ***within certain replacement percentages.The optimal replacement percentage is determined through compressive strength tests and split tensile strength for 28,56 and 90 days.***

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

1. INTRODUCTION

Concrete stands as the most ubiquitous and indispensable building material globally, forming the very foundation of modern infrastructure. This versatile composite, primarily made of cement, aggregates, and water, transforms into a durable, stone-like material through a process called hydration. Its widespread use is due to its exceptional strength, adaptability, and cost-effectiveness. However, with growing environmental concerns from cement production, ongoing research consistently aims to enhance its sustainability and properties.

Quarry dust**,** a significant byproduct of the stone crushing industry, is gaining recognition as a valuable resource in civil engineering. The vast quantities generated typically present environmental and economic disposal 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 and addresses waste management concerns. Its angular particles can enhance concrete's packing density, contributing to improved mechanical properties.

Titanium dioxide (TiO_2**),** a naturally occurring inorganic compound, is well-known for its exceptional brightness and high refractive index. Beyond its widespread application as a brilliant white pigment in paints, plastics, and paper, TiO_2 boasts remarkable photocatalytic properties. This characteristic allows it to act as a self-cleaning agent and an air purifier, effectively breaking down pollutants when exposed to light. In civil engineering, integrating TiO_2 into concrete and other building materials enhances durability, aesthetic appeal, and environmental performance.

2. OBJECTIVES

This research aims to investigate the combined influence of partially replacing cement with titanium dioxide and fine aggregate with quarry duston the compressive strength and split tensile strength of concrete.

3. MATERIALS

3.1 Cement: Cement is a fine, powdery binder that forms a hardening paste when mixed with water through hydration. This paste acts as an adhesive, binding aggregates together to give concrete its strength and structural integrity.

3.2 Fineaggregate: **Fine aggregate,** typically sand with particles smaller than 4.75 mm, fills the voids between coarse aggregates in concrete. It's crucial for workability and creating a dense, cohesive mixture, ensuring desired strength and finish.

3.3 Coarse aggregate: **Coarse aggregate** consists of granular materials like gravel or crushed stone, larger than 4.75 mm. These form concrete's main structural framework, providing essential strength, durability, and volume for various construction applications.

3.4 Water: Water plays two vital roles in concrete: it triggers cement hydration to form the binding paste and lubricates the mix for easier placement and finishing.

3.5Quarry Dust: Quarry dust can replace natural sand in concrete and mortar mixes. This byproduct of stone crushing, typically under 4.75 mm, helps conserve natural resources, tackles waste disposal issues, and often improves concrete's strength and durability, offering an economical and sustainable construction alternative.

3.6 Titanium Dioxide: Titanium dioxide (TiO_2), when partially replacing cement, enhances concrete's functionality beyond traditional properties. It refines the concrete's microstructure, potentially boosting 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 28,56 and 90 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		
		28 days	56 days	90 days
1	0%	32.58	35.33	37.88
2	10%	34.76	37.74	40.51
3	20%	37.31	40.65	43.63
4	30%	39.65	43.37	46.42
5	40%	38.91	42.39	45.27

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		
		28 days	56 days	90 days
1	0%	32.58	35.33	37.88
2	0.5%	38.42	41.75	44.86
3	1%	40.06	43.52	46.68
4	1.5%	37.74	41.09	43.92

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

Sl.no	30%QD+1%Tio_2	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	32.58	35.33	37.88
2	30%QD+1%Tio_2	43.62	47.86	51.27

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		
		28 days	56 days	90 days
1	0%	3.17	3.44	3.68
2	10%	3.39	3.73	3.97
3	20%	3.67	3.99	4.28
4	30%	4.04	4.41	4.72
5	40%	3.85	4.19	4.55

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		
		28 days	56 days	90 days
1	0%	3.17	3.44	3.68
2	0.5%	3.78	4.09	4.46
3	1%	4.23	4.62	4.94
4	1.5%	3.69	4.01	4.29

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		
		28 days	56 days	90 days
1	0%	3.17	3.44	3.68
2	30%QD+1%Tio_2	4.42	4.83	5.16

5. CONCLUSION

1. The normal concrete compressive strength results for 28,56 and 90 days is 32.58, 35.33 and 37.88N/mm^2.
2. At 30% partial replacement of fine aggregate with Quarry dust which gives compressive strength result for 28,56 and 90 days is 39.65, 43.37 and 46.42 N/mm^2.
3. At 1% partial replacement of cement with Titanium dioxide which gives compressive strength result for for 28,56 and 90 days is 40.06, 43.52 and 46.68 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 28,56 and 90 days is 43.62, 47.86 and 51.27 N/mm^2.
5. The normal concrete split tensile strength results for 28,56 and 90 days is 3.17, 3.44 and 3.68 N/mm^2.
6. At 30% partial replacement of fine aggregate with Quarry dust which gives split tensile strength result for 28,56 and 90 days is 4.04, 4.41 and 4.72 N/mm^2.
7. At 1% partial replacement of cement with Titanium dioxide which gives split tensile strength result for 28,56 and 90 days is 4.23, 4.62 and 4.94 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 28,56 and 90 days is 4.42, 4.83 and 5.16 N/mm^2.

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