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EXPERIMENTAL INVESTIGATION ON CONCRETE WITH TITANIUM DIOXIDE AND QUARTZ POWDER

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Abstract

Concrete, as the most widely used construction material globally, poses significant environmental challenges due to its high carbon footprint associated with cement production. In recent years, researchers and engineers have been exploring alternative materials and additives to reduce cement content in concrete mixes while maintaining or even enhancing performance. This study investigates the feasibility of incorporating titanium dioxide (TiO2) and quartz powder (QP) as partial replacements for cement in concrete, aiming to improve sustainability and mitigate environmental impact. To calculate the compressive strength and split tensile strength for 7 and 28 days.

Keywords

Quartz powder, Titanium dioxide, Environmental Impact, Compressive Strength and Split Tensile Strength.

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1. INTRODUCTION

Concrete, renowned for its versatility and durability, is the cornerstone of modern construction. However, the high environmental footprint associated with cement production, a key ingredient in concrete, necessitates the exploration of sustainable alternatives to reduce its usage while maintaining or enhancing concrete performance. In this context, the integration of supplementary materials such as titanium dioxide (TiO2) and quartz powder (QP) has emerged as a promising strategy to improve the sustainability and performance of concrete.

Titanium dioxide as a partial replacement for cement in concrete offers a sustainable solution to enhance durability, reduce environmental impact, improve aesthetics, and mitigate urban heat island effects. Further research and development efforts are needed to optimize TiO2-based concrete formulations and validate their performance in various applications, paving the way for greener and more resilient infrastructure in the future.

utilizing quartz powder as a partial replacement for cement in concrete offers significant benefits in terms of sustainability, durability, and performance. Through careful formulation and optimization, quartz powder-based concrete mixes can contribute to the development of more resilient, environmentally friendly, and cost-effective infrastructure solutions. Continued research and innovation in this area are essential to unlocking the full potential of quartz powder in cement replacement and advancing sustainable construction practices.

2. OBJECTIVES

(a) Investigate the influence of TiO2 and quartz powder dosage on concrete properties and determine the optimal replacement levels for different applications and environmental conditions.

(b) The workability and setting time of concrete mixes containing TiO2 and quartz powder to ensure that they meet construction requirements and can be effectively placed and finished

(c) To determine the Compressive strength and Split tensile Strength.

3. MATERIALS

1. Cement:- A common binding element in construction, cement is the main component of mortar, grout, and concrete. Typically, a mixture of limestone, clay, shale, iron ore, and other elements are burnt to high temperatures in a kiln to generate clinker, which is then ground into a fine powder.

2. Fine aggregate:- Sand, or fine aggregate, is a granular substance that is usually made up of particles with diameters between 0.075 and 4.75 millimeters (mm). Together with cement and coarse aggregate (such crushed stone or gravel), it is one of the main ingredients of mortar and concrete mixtures.

3. Coarse aggregate:- Granular materials with a typical size range of 4.75 millimeters (mm) to 75 mm in diameter are referred to as coarse aggregate, though the maximum limit may change based on local norms and requirements. It is one of the primary ingredients of concrete, along with cement and fine aggregate, or sand.

4.Titanium dioxide:- When added to concrete, titanium dioxide, a white-colored naturally occurring mineral, acts as a cleaning agent by absorbing toxic pollution. In porcelain enamels, titanium dioxide has been employed as an opacifying and bleaching chemical to give the materials their brightness, hardness, and acid resistance.When exposed to ultraviolet light, titanium dioxide's photocatalytic activity produces thin coatings with self-cleaning and disinfecting qualities. Titanium dioxide is frequently employed and well-known in nanoscience and nanotechnology due to its special qualities.

5.Quartz Powder:- Almost always, quartz is inert when used as aggregate in concrete instead than as a fine powder to replace cement. It means it is unable to respond in normal situations. less reaction and a more manageable real problem. That, together with its hardness, is what makes concrete desirable.

6. Water:- Water is a key component of concrete mixtures, affecting the hardened material's strength, durability, workability, and other characteristics. To produce durable and high-quality concrete structures, it is imperative to control the water-cement ratio and implement suitable mix design and curing procedures.

4. TEST RESULTS

(a) Compressive Strength: The greatest load or force that a material can bear under compression (pressing or squeezing) before failing or breaking is known as its compressive strength. To determine for 7 and 28 days.

Table 1: Compressive Strength Results of Partial Replacement of Cement with Quartz Powder

Sl.no	%Quartz powder	Compressive Strength Results,(N/mm^2)	
		7 days	28 days
1	0%	18.96	27.81
2	5%	20.67	30.01
3	10%	21.78	31.16
4	15%	22.06	33.68
5	20%	22.84	32.76

Table 2: Compressive Strength Results of Partial Replacement of Cement With Titanium dioxide

Sl.no	% Titanium dioxide	Compressive Strength Results,(N/mm^2)	
		7 days	28 days
1	0%	18.96	27.81
2	0.5%	22.02	31.97
3	1.0%	23.38	33.41
4	1.5%	21.75	31.13

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Table 3: Combined Replacements of Compressive Strength Results of Quartz Powder and Titanium dioxide

Sl.no	% of QP+ TiO_2	Compressive Strength Results,(N/mm^2)	
		7 days	28 days
1	0%	18.96	27.81
2	10 % QP+1.0% TiO_2	25.29	36.39

Split Tensile Strength: A crucial characteristic of concrete is split tensile strength, which indicates how resistant the material is to tensile stresses and breaking. In applications where tensile pressures are anticipated to be applied to the concrete, it is especially important. To determine for 7 and 28 days.

Table 4 : Split Tensile Strength Results of Partial Replacement of Cement With Quartz Powder

Sl.no	% Quartz powder	Split Tensile Strength Results,(N/mm^2)	
		7 days	28 days
1	0%	1.91	2.75
2	5%	2.04	2.97
3	10%	2.19	3.14
4	15%	2.56	3.43
5	20%	2.01	2.99

Table 5: Split Tensile Strength Results of Partial Replacement of Cement With Titanium dioxide

Sl.no	% Titanium dioxide	Split Tensile Strength Results,(N/mm^2)	
		7 days	28 days
1	0%	1.91	2.75
2	0.5%	2.15	3.09
3	1.0%	2.38	3.32
4	1.5%	2.24	3.16

Table 6: Combined Replacements of Split Tensile Strength Results of Quartz Powder and Titanium dioxide

Sl.no	% of QP+ TiO_2	Split Tensile Strength Results,(N/mm^2)	
		7 days	28 days
1	0%	1.91	2.75
2	10 % QP+1.0% TiO_2	2.53	3.59

5. CONCLUSIONS

1. The Normal Concrete of Compressive Strength results for 7 and 28 days is 18.96 and 27.81 N/mm^2.
2. The Normal Concrete of Split tensile Strength results for 7 and 28 days is 1.91 and 2.75 N/mm^2.

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3. By 15% of quartz powder as partial replacement with cement the Compressive Strength results for 7 and 28 days is 22.06 and 33.68 N/mm^2.
4. By 15% of quartz powder as partial replacement with cement the Split tensile Strength results for 7 and 28 days is 2.56 and 3.43 N/mm^2.
5. By 1.0% of titanium dioxide as partial replacement with cement the Compressive Strength results for 7 and 28 days is 23.38 and 33.41 N/mm^2.
6. By 1.0% of titanium dioxide as partial replacement with cement the Split tensile Strength results for 7 and 28 days is 2.38 and 3.32 N/mm^2
7. By the combination of 15% of quartz powder +1.0% of titanium dioxide the Compressive Strength results for 7 and 28 days is 25.29 and 36.39 N/mm^2.
8. By the combination of 15% of quartz powder +1.0% of titanium dioxide the Split tensile Strength results for 7 and 28 days is 2.53 and 3.59 N/mm^2.

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