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STRENGTH STUDIES ON CONCRETE WITH TITANIUM DIOXIDE AND QUARTZ POWDER

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Abstract:

The most popular building material in the world, concrete presents serious environmental problems because of the large carbon footprint that comes with cement manufacture. In order to lower the cement percentage of concrete mixes without sacrificing or even improving performance, scientists and engineers have been investigating substitute materials and additives in recent years. In an effort to increase sustainability and lessen environmental effect, this study explores the viability of partially replacing cement in concrete with titanium dioxide (TiO2) and quartz powder (QP).To assess compressive strength and split tensile strength for 28,56 and 90 days.

Keywords:

Titanium dioxide, Quartz powder, Sustainability, Compressive Strength and Split Tensile Strength.

1. INTRODUCTION

The incorporation of TiO2 and QP in concrete offers multifaceted benefits, including improved mechanical properties, enhanced durability, and reduced environmental impact. By partially replacing cement with TiO2 and QP, it is possible to achieve concrete mixes with optimized performance and reduced carbon footprint. Moreover, TiO2-containing concrete exhibits self-cleaning properties, contributing to the maintenance of aesthetic appeal and environmental quality in urban environments.

Adding titanium dioxide to concrete in place of some of the cement provides a sustainable way to increase its longevity, lessen its impact on the environment, improve its appearance, and lessen the impacts of urban heat islands. In order to confirm the performance of TiO2-based concrete formulations in a range of applications and optimise them, additional research and development work is required. This will pave the way for future infrastructure that is more durable and environmentally friendly.

There are several advantages to using quartz powder in place of some of the cement in concrete when it comes to performance, durability, and sustainability. Concrete mixes including quartz powder can help create more durable, eco-friendly, and economically viable infrastructure solutions by carefully formulating and optimising the mix. To fully realise the benefits of quartz powder as a cement substitute and to promote environmentally friendly building techniques, more research and innovation in this field are imperative.

2. OBJECTIVES

(a) Examine how the dosage of quartz powder and TiO2 affects the characteristics of concrete; establish the ideal replacement amounts for various applications and environmental circumstances.

(b) The concrete mixes including TiO2 and quartz powder's workability and setting time, in order to guarantee that they can be put and finished successfully and that they fulfill building standards.

(c) To calculate the split tensile strength and compressive strength.

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3. MATERIALS

1. Cement:- Cement is the primary ingredient of mortar, grout, and concrete and is a frequent binding material in construction. Clinker is often produced by burning a mixture of limestone, clay, shale, iron ore, and other materials at high temperatures in a kiln. Clinker is then pulverized into a fine powder.

2. Fine aggregate:- Fine aggregate, sometimes referred to as sand, is a granular substance that is usually made up of particles with diameters between 0.075 and 4.75 millimetres (mm). It is one of the main ingredients in mortar and concrete mixtures, along with cement and coarse aggregate (such crushed stone or gravel).

3. Coarse aggregate:- Granular materials that normally range in size from 4.75 millimetres (mm) to 75 mm in diameter are referred to as coarse aggregate, though the maximum limit may change according on local regulations and specifications. It is one of the primary ingredients in concrete, along with cement and fine aggregate, or sand.

4.Titanium dioxide:- The naturally occurring white mineral titanium dioxide serves as a cleaning agent in concrete by absorbing toxic pollution. Porcelain enamels have been given brightness, hardness, and acid resistance by the use of titanium dioxide as an opacifying and bleaching agent. When exposed to ultraviolet light, thin coatings with titanium dioxide's photocatalytic activity demonstrate self-cleaning and disinfecting qualities. In nanoscience and nanotechnology, titanium dioxide is frequently employed and well-known due to its special qualities.

5. QuartzPowder:- Quartz is nearly always inert when used as aggregate in concrete as opposed to a fine powder to replace cement. It implies that it is incapable of responding in normal situations. less reaction and a genuine problem that is simpler to control. That's why concrete is attractive in addition to its hardness.

6. Water:- Water has a significant impact on the workability, strength, durability, and other characteristics of the hardened material in concrete mixtures. Ensuring the right mix design, curing procedures, and water-cement ratio control are crucial for creating durable and high-quality concrete structures.

4. TEST RESULTS

(a) Compressive Strength: A material's compressive strength is the highest load or force it can bear under compression (pressing or squeezing) before failing or breaking. To determine for 28,56 and 90 days.

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

Sl.no	%Quartz powder	Compressive Strength Results,(N/mm^2)		
		28 days	56 days	90 days
1	0%	27.81	30.29	32.36
2	5%	30.01	32.67	35.06
3	10%	31.16	33.93	36.47
4	15%	33.68	36.72	40.05
5	20%	32.76	35.69	38.32

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

Sl.no	% Titanium dioxide	Compressive Strength Results,(N/mm^2)		
		28 days	56 days	90 days
1	0%	27.81	30.29	32.36
2	0.5%	31.97	34.83	37.21

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3	1.0%	33.41	36.47	39.12
4	1.5%	31.13	33.91	36.43

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)		
		28 days	56 days	90 days
1	0%	27.81	30.29	32.36
2	10 % QP+1.0% Tio_2	36.39	39.75	42.86

Split Tensile Strength: Concrete's split tensile strength is a crucial characteristic since it shows how resistant the material is to tensile stresses and breaking. It is especially important in situations when concrete is anticipated to experience tensile pressures. To determine for 28,56 and 90 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)		
		28 days	56 days	90 days
1	0%	2.75	3.02	3.27
2	5%	2.97	3.23	3.51
3	10%	3.14	3.42	3.68
4	15%	3.43	3.74	4.02
5	20%	2.99	3.25	3.49

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)		
		28 days	56 days	90 days
1	0%	2.75	3.02	3.27
2	0.5%	3.09	3.36	3.66
3	1.0%	3.32	3.69	3.92
4	1.5%	3.16	3.48	3.75

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)		
		28 days	56 days	90 days
1	0%	2.75	3.02	3.27
2	10 % QP+1.0% Tio_2	3.59	3.94	4.23

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5. CONCLUSIONS

1. The Normal Concrete of Compressive Strength results for 28,56 and 90 days is 27.81,30.29 and32.36 N/mm^2.
2. The Normal Concrete of Split tensile Strength results for 28,56 and 90 days is 2.75, 3.02 and 3.27 N/mm^2.
3. By 15% of quartz powder as partial replacement with cement the Compressive Strength results for 28,56 and 90 days is 33.68, 36.72 and 40.05 N/mm^2.
4. By 15% of quartz powder as partial replacement with cement the Split tensile Strength results for 28,56 and 90 days is 3.43, 3.74 and 4.02 N/mm^2.
5. By 1.0% of titanium dioxide as partial replacement with cement the Compressive Strength results for 28,56 and 90 days is 33.41, 36.47 and 39.12 N/mm^2.
6. By 1.0% of titanium dioxide as partial replacement with cement the Split tensile Strength results for 28,56 and 90 days is 3.32, 3.69 and 3.92 N/mm^2.
7. By the combination of 15% of quartz powder +1.0% of titanium dioxide the Compressive Strength results for 28,56 and 90 days is 36.39, 39.75 and 42.86 N/mm^2.
8. By the combination of 15% of quartz powder +1.0% of titanium dioxide the Split tensile Strength results 28,56 and 90 days is 3.59, 3.94 and 4.23 N/mm^2.

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