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EXPERIMENTAL INVESTIGATION ON CONCRETE WITH TITANIUM DIOXIDE AND TAMARIND KERNEL SHELL POWDER

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ABSTRACT

This study examines the effects of partially replacing cement with titanium dioxide (TiO_2) and tamarind kernel shell (TKS) on the mechanical and durability properties of concrete. Titanium dioxide, known for its photo catalytic and self-cleaning properties, and tamarind kernel shell ash, a sustainable pozzolanic material derived from agricultural waste, are evaluated for their potential to enhance the performance and sustainability of concrete. Concrete mixtures are prepared with TiO_2 replacing 0.5%, 1%, and 1.5% of the cement weight, and TKSAddition to cement by weight is 0.25%, 0.5%, and 0.75%. The experimental program includes tests for compressive strength, tensile strength, and Ultrasonic pulse velocity. These tests are conducted at various curing periods to assess both short-term and long-term performance.

***KEYWORDS**: Titanium dioxide, Tamarind Kernel Shell Ash, Pozzolanic, Compressive Strength, Split Tensile Strength and Ultrasonic pulse velocity.*

1. INTRODUCTION:

One of the most widely used building materials in the modern world is concrete, this could be due to a variety of factors, not just the extensive range of applications it offers; its behavior, strength, affordability, durability, and adaptability are all significant factors. Thus, concrete is regarded by construction projects as a simple, reliable, and secure material. It is utilized in a variety of constructions, such as infrastructure (roads, bridges, etc.) and residential and multistory office buildings. Slabs, beams, columns, and other load-bearing components are built with concrete.

The possible uses of titanium dioxide (TiO2) have been investigated. These include its use as a white pigment, in hydrolysis and power production, and as an addition in building materials including cement, concrete, tiles, and windows because of its antifouling, deodorizing, and sterilizing qualities.

The plant Tamarindus indica is the source of powdered tamarind kernels. The tamarind tree is an evergreen. In tamarind seeds, the cotyledon or kernel is regarded as a waste. According to biotechnological research, the kernel includes starch and gum, which are processed through many stages to become powder. As a binding agent, it is also utilized in the textile, printing, and sizing industries. Approximately,97,000 metric tons of tamarind seed wastes are produced annually, primarily in India. The use of tamarind seed to enhance concrete will be a tremendous advance in the absence of waste disposal.

2. OBJECTIVES

1. This objective focuses on determining the optimal replacement levels of TiO_2 and TKS to achieve maximum strength enhancement.

2.It aims to understand how these additives contribute to a denser, more refined microstructure, reduced porosity, and improved interfacial bonding, while also promoting environmental sustainability by utilizing industrial and agricultural byproducts.

3. Investigate the potential of Titanium dioxide and Tamarind kernel shell ash to improve the compressive, tensile, and flexural strengths of concrete.

3. MATERIALS

3.1 Cement: Cement is one of the most important elements in the built environment; it'ssometimes called the "glue" that ties modern architecture together. As the foundation ofmortar, concrete, and other building materials, cement is essential to the construction ofthe buildingsweliveinanddependoneveryday.The fine powder that cement produces during its precise production process,which unites aggregates into a cohesive mass, is obtained from a finely ground mixtureof limestone, clay, and other minerals. Building materials get stability, strength, andresilience from the chemical reaction that cement and water undergo when they mix, aprocess called as hydration.

3.2Fine Aggregate: Avital component of construction, fine aggregate is crucial to the longevity and structural integrity of many civil engineering projects. The foundation of concrete mixes, mortar, and asphalt is fine aggregate, which is often made out of sand, crushed stone, orgravel with particles smaller than 4.75 mm.

3.3 Coarse Aggregate: Coarse aggregate is rock that has been broken into small and irregularly shapedpieces. Construction works use aggregates such as limestone and granite or river gravel and the coarse aggregate gives higher resistance to cracking and crushing. The ideal size of coarse aggregates should be such that it passes the IS 63mm sieve and remains on the IS 4.75mm sieve.

3.4 Titanium dioxide: Titanium dioxide has photocatalytic properties, meaning it can accelerate certainchemical reactions in the presence of light. When used in concrete, TiO2 can contribute to the self-cleaning properties of surfaces. It helps break down organic pollutants and dirt when exposed to sunlight, keeping the concrete surface cleaner over time and this can indirectly improve the overall performance and life span of the concrete.

3.5 Tamarind Kernel shell Powder: Tamarind kernel shell powder (TKSP) is a fine, powdered material obtained from the outer shells of tamarind seeds. Tamarind (Tamarindus indica) is a tropical fruit-bearing tree, and its seeds are encased in hard, fibrous shells. The kernel inside the shell is commonly used for various industrial applications, whiles the shell itself, once processed, yields the powder.

3.6 Water: Water that is suitable for human consumption, or potable water, can generally be used as mixing water. Non-potable water sources, however, can also be utilized as long as they don't adversely affect the characteristics of concrete. Concrete can be mixed and cured with potable water.Water has a PH of 6 to 8.

4. EXPERIMENTAL INVESTIGATIONS:

4.1**Compressive Strength Results:** The concrete to be tested must not have nominal maximum aggregate sizes larger than 20 mm, and test specimens must measure 15 by 15 by 15 cm. The concrete specimens are typically evaluated after seven and twenty-eight days.

Table 1: - Compressive Strength Results of Concrete with Partial Replacement of Cement by Titanium dioxide.

S.No	% of Titanium dioxide	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	34.21	49.67
2	0.5%	39.44	57.08
3	1%	41.53	59.12
4	1.5%	40.14	57.43

Table 2: - Compressive strength of concrete with the addition of tamarind kernel shell Powder by cement.

S.No	% of Tamarind Kernel Shell Powder	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	34.21	49.67
2	0.25%	39.43	57.24
3	0.5%	43.95	65.58
4	0.75%	39.02	55.83

Table 3: - Combined Replacement of compressive strength results of concrete with a partial replacement of cement by 1% Titanium Dioxide and the addition of 0.5% Tamarind Kernel Shell.

S.No	0.5% of Tio2 +0.5% of Tks	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	34.21	49.67
2	0.5% of Tio2 +0.5% of Tks	48.45	70.33

4.2 Split Tensile Strength Test: A standard test cylinder of concrete specimen (300 mm x 150 mm in diameter) is used to separate the loading surfaces of the compression testing machine horizontally. The compression force is applied uniformly and symmetrically along the cylinder's length until the cylinder fails at its vertical diameter.

Table 4: - Split tensile Strength Results of Concrete with Partial Replacement of Cement by Titanium dioxide.

S.No	% of Titanium dioxide	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	3.97	4.91
2	0.5%	3.89	5.65
3	1%	4.07	5.83
4	1.5%	4.02	5.68

Table 5: - Split tensile strength of concrete with the addition of tamarind kernel shell Powder as a partial replacement for cement.

S.No	% of Tamarind Kernel Shell Powder	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	3.97	4.91
2	0.25%	4.08	5.64
3	0.5%	4.59	6.55
4	0.75%	3.82	5.52

Table 6: - Combined Replacement of split tensile strength results of concrete with a partial replacement of cement by 1% Titanium Dioxide and the addition of 0.5% Tamarind Kernel Shell.

S.No	0.5% of Tio2 +0.5% of Tks	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	3.97	4.91
2	0.5% of Tio2 +0.5% of Tks	4.94	6.95

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: - Ultrasonic Pulse Velocity Results of Concrete with Partial Replacement of Cement by

Titanium dioxide.

S.No	% of Titanium dioxide	Ultrasonic Pulse Velocity Results, m/s	
		28 days	Quality of Concrete
1	0%	4347	Good
2	0.5%	4804	Excellent
3	1%	5026	Excellent
4	1.5%	4911	Excellent

Table 8: - Ultrasonic Pulse Velocity Results of concrete with the addition of tamarind kernel shell Powder as a partial replacement for cement.

S.No	% of Tamarind Kernel Shell Powder	Ultrasonic Pulse Velocity Results, m/s	
		28 days	Quality of Concrete
1	0%	4347	Good
2	0.25%	4876	Excellent
3	0.5%	5236	Excellent
4	0.75%	5010	Excellent

Table 9: - Combined Replacement of Ultrasonic Pulse Velocity strength results of concrete with a partial replacement of cement by 1% Titanium Dioxide and the addition of 0.5% Tamarind Kernel Shell.

S.No	0.5% of Tio2 +0.5% of Tks	Ultrasonic Pulse Velocity Results, m/s	
		28 days	Quality of Concrete
1	0%	4347	Good
2	0.5% of Tio2 +0.5% of Tks	5531	Excellent

5. CONCLUSIONS:

1. The Normal Concrete Compressive Strength Results for 7 and 28 days is 34.21 and 49.67 N/mm^2.
2. The optimum compressive strength results of concrete with partial replacement of cement by 1% Tio2 at 7 and 28 days 41.53 and 59.12 N/mm^2.
3. The optimum compressive strength results of concrete addition of Tamarind Kernel shell powder by cement at 7 and 28 days is 43.95 and 65.58 N/mm^2.

4. **By Combined Replacement of compressive strength results of concrete with a partial replacement of cement by 1% Titanium Dioxide and the addition of 0.5% Tamarind Kernel Shell at 7 and 28 days is 48.45 and 70.33N/mm^2.**

5. The Normal Concrete Split tensile Strength Results for 7 and 28 days is 3.97 and 4.91 N/mm^2.

6. The optimum Split tensile strength results of concrete with partial replacement of cement by 1% Tio2 at 7 and 28 days 4.07 and 5.83 N/mm^2.

7. The optimum Split tensile strength results of concrete addition of Tamarind Kernel shell powder by cement at 7 and 28 days is 4.59 and 6.55N/mm^2.

8. **By Combined Replacement of Split tensile strength results of concrete with a partial replacement of cement by 1% Titanium Dioxide and the addition of 0.5% Tamarind Kernel Shell at 7 and 28 days is 4.94 and 6.95 N/mm^2.**

9. The Normal Concrete Ultrasonic pulse Velocity results for 28 days is 4347 m/s.

10. The optimum Ultrasonic pulse Velocity results of concrete with partial replacement of cement by 1% Tio2 at 28 days 5026 m/s.

11. The optimum Ultrasonic pulse Velocity results of concrete addition of Tamarind Kernel shell powder by cement at 28 days 5236 m/s.

12. **By Combined Replacement of Ultrasonic pulse Velocity strength results of concrete with a partial replacement of cement by 1% Titanium Dioxide and the addition of 0.5% Tamarind Kernel Shell at 28 days 5531 m/s.**

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