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INVESTIGATION OF JUTE FIBER-REINFORCED CONCRETE ENHANCED WITH TITANIUM DIOXIDE

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Abstract:

A possible strategy for improving the sustainability and performance of concrete is to reinforce it with jute fiber and use titanium dioxide in place of some of the cement. Better living and working conditions could be achieved by this creative combination, which could provide stronger, more resilient, and ecologically friendly buildings and structures. Concrete is a durable, environmentally beneficial building material that may be made more sustainable and structurally sound with the help of jute fiber reinforcement. The weight of the concrete, several percentages of jute fiber were added (0, 0.5%, 1%, 1.5%), and the content of titanium dioxide was changed by 0%, 0.6%, 0.8%, 1%, and 1.2%. To determine compressive strength and split tensile strength for 28, 56 and days.

Key words: Jute Fibre, Titaniumdioxide, Durable, Reinforcing, Compressive strength, Split tensile strength

1. INTRODUCTION

Numerous considerations outside its wide range of applications have made concrete one of the most popular building materials in the modern world. Its appeal can be attributed to its strength, affordability, durability, and versatility. Concrete is therefore thought of as a straightforward, dependable, and safe material for building projects. It is utilized in many different kinds of constructions, including as residential and multistory office buildings, as well as infrastructure like highways and bridges. When building load-bearing elements like slabs, beams, and columns, concrete is necessary. Cement, water, aggregates (such sand and gravel), and occasionally admixtures or additives to improve performance are its main components.

Titanium dioxide (TiO_2) has gained recognition as a valuable material for partially replacing cement in concrete, offering notable advantages in performance and sustainability. Renowned for its photocatalytic properties, TiO_2 enhances concrete durability by mitigating environmental impacts such as pollution and microbial growth. Its addition boosts resistance to wear and weathering, extending the lifespan of structures. Moreover, TiO_2 improves energy efficiency by reflecting heat, aiding in temperature regulation within buildings. By reducing dependence on traditional cement, incorporating TiO_2 not only cuts carbon emissions but also supports greener and more environmentally friendly construction practices.

Integrating jute fiber into concrete offers a novel solution for enhancing structural performance and promoting sustainability in construction materials. As a natural, renewable fiber, jute increases tensile strength, toughness, and crack resistance, making concrete more resilient under stress. Its biodegradability and affordability position it as an eco-friendly alternative to synthetic reinforcement fibers. Furthermore, jute fiber minimizes shrinkage and enhances the durability of concrete structures. By incorporating jute fiber, the construction industry can adopt more sustainable, cost-efficient, and environmentally responsible building practices.

2. OBJECTIVES

1. Enhance the durability of concrete by incorporating titanium dioxide, which provides superior resistance to environmental challenges like pollution, weathering, and microbial growth.

2. Improve the mechanical properties of concrete, including tensile and compressive strength, by adding jute fiber to create more robust and resilient structures.

3. Reduce shrinkage and cracking in concrete structures through the integration of jute fiber, ensuring better long-term structural integrity.

3. MATERIALS

3.1 Cement: Cement is a finely powdered binding material widely used in construction to create concrete and mortar. When mixed with water, it hardens, binding aggregates such as sand and gravel to form sturdy, long-lasting structures. Produced from limestone, clay, and various minerals, cement plays a crucial role in ensuring the strength and stability of buildings and infrastructure.

3.2Fineaggregate:Fine aggregate is a construction material composed of small particles, such as sand or crushed stone, that pass through a 4.75 mm sieve. It is used in concrete and mortar to fill voids between coarse aggregates, enhancing workability and strength. Fine aggregate is essential for creating a smooth, dense mixture in construction applications.

3.3 Coarse aggregate: Coarse aggregate is a construction material consisting of larger particles, such as gravel or crushed stone, ranging in size from 4.75 mm to 50 mm. It is incorporated into concrete to add bulk, strength, and durability, forming the structural framework of the mix. Coarse aggregate improves load-bearing capacity and ensures the overall stability of structures.

3.4 Water: Water is a critical construction material, indispensable for tasks like mixing cement, preparing mortar, and curing. The quality of water used significantly impacts the strength and durability of mortar and concrete, directly affecting the overall performance of the structure.

3.5 Titaniumdioxide: Titanium dioxide (TiO_2) is gaining popularity as a partial cement replacement in concrete, offering improved properties and greater sustainability. Its inclusion enhances concrete's strength and durability while lowering the carbon footprint of conventional cement production. Moreover, TiO_2's photocatalytic properties enable self-cleaning capabilities and contribute to pollution reduction.

3.6 Jute Fiber: Jute fiber, a natural and biodegradable material, can be incorporated into concrete to enhance its performance. Adding jute fiber increases tensile strength, ductility, and durability while reducing the likelihood of cracking. Furthermore, it supports sustainability by leveraging a renewable resource and reducing environmental impact.

4. EXPERIMENTAL RESULTS

4.1 Compressive strength: The minimum compressive strength of a cube is determined using a standard cube specimen (15 cm x 15 cm x 15 cm). Concrete specimens are typically evaluated at 28, 56, and 90 days to assess their compressive strength.

Table 1: Compressive strength results of concrete with Titanium Dioxide (TiO_2) used as a partial replacement for cement.

Sl.no	% of Tio_2	Compressive Strength Results, N/mm²		
		28 days	56 days	90 days
1	0%	27.05	29.28	31.54
2	0.6%	30.85	33.61	36.06
3	0.8%	31.37	34.25	36.72
4	1%	32.19	35.13	37.69
5	1.2%	31.46	34.53	36.48

Table 2: Compressive strength results of concrete with the addition of Jute fiber.

Sl.no	% of Jute fiber	Compressive Strength Results, N/mm²		
		28 days	56 days	90 days
1	0%	27.05	29.28	31.54
2	0.5%	31.42	34.08	36.56
3	1%	32.85	35.82	38.54
4	1.5%	31.92	34.73	37.31

Table 3 : Combined Compressive strength of concrete with partial replacement of cement using Titanium Dioxide and addition of Jute fiber.

Sl.no	Combined Replacement(s)	Compressive Strength Results, N/mm²		
		28 days	56 days	90 days
1	0%	27.05	29.28	31.54
2	1 % $Ti0_2$+1% JF	35.42	38.62	42.03

4.2 Split tensile strength : Split tensile strength is a measure of a material's ability to resist tension, determined by applying a load along a horizontal cylindrical specimen until failure occurs. This test is essential for evaluating the tensile properties of concrete, as it simulates the tensile stresses that occur in structural elements. Higher split tensile strength at 28, 56, and 90 days indicates improved durability and resistance to cracking in concrete structures.

Table 4: Split tensile strength results of concrete with Titanium Dioxide (TiO_2) used as a partial replacement for cement.

Sl.no	% of Tio_2	Split Tensile Strength Results, N/mm²		
		28 days	56 days	90 days
1	0%	2.64	2.86	3.07
2	0.6%	3.01	3.26	3.51
3	0.8%	3.15	3.43	3.78
4	1%	3.21	3.53	3.82
5	1.2%	3.16	3.44	3.75

Table 5: Split tensile strength results of concrete with the addition of Jute fiber.

Sl.no	% of Jute fiber	Split Tensile Strength Results, N/mm²		
		28 days	56 days	90 days
1	0%	2.64	2.86	3.07
2	0.5%	3.12	3.38	3.63
3	1%	3.31	3.61	3.87
4	1.5%	3.17	3.45	3.72

Table 6: Combined Split tensile strength of concrete with partial replacement of cement using Titanium Dioxide and addition of Jute fiber.

Sl.no	Combined Replacement(s)	Split Tensile Strength Results, N/mm²		
		28 days	56 days	90 days
1	0%	2.64	2.86	3.07
2	1 % $Ti0_2$+1% JF	3.59	4.28	4.56

5. CONCLUSION

1.The normal concrete compressive strength results for 28,56 and 90 days is 27.05, 29.28 and 31.54 N/mm².

2.At 1% partial replacement of cement with Titanium Dioxide which gives compressive strength result for 28,56 and 90 days is 32.19, 35.13 and 37.69 N/mm².

3. At 1% addition of Jute Fibre to concrete then the compressive strength result for 28,56 and 90 days is 32.85, 35.82 and 38.54 N/mm².

4.Compressive strength result for combined replacement of 1% Tio2 for cement and 1% JF is addition to concrete for 28,56 and 90 days is 35.42, 38.62 and 42.03 N/mm².

5.The normal concrete split tensile strength result for 28,56and 90 days is 2.64, 2.86 and 3.07 N/mm².

6. At 1% partial replacement of cement with Titanium dioxide which gives split tensile strength result for 28,56 and 90 days is 3.21, 3.53 and 3.82 N/mm².

7.At 1% addition of Jute to concrete then the split tensile strength result for 28,56 and 90 days 3.31, 3.61 and 3.87 N/mm².

8.Split tensile strength result for combined replacement of 1% Tio2 for cement and 1% JF is addition to concrete for 28,56 and 90 days is 3.59, 4.28 and 4.56 N/mm².

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