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INVESTIGATION ON UTILIZATION OF HYPOSLUDGE AND JUTE FIBRE IN THE PRODUCTION OF HIGH-PERFORMANCE CONCRETE

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Abstract: **Concrete is the world second most utilized and popular material after water, used as a core ingredient in the construction industry. It is a combination of cement, sand, aggregate, water, and some admixture which makes it adopt any shape and size and then after hardening it become rock-like structure. Concrete has good compressive strength but very less tensile strength that's why some technical enhancement required for improving their properties. In this research work; jute fiber is used as reinforcement material along with Hypo-Sludge (waste of Paper Industry). Both the material is mixed in concrete in different percentage and combinations. For the investigation purpose several physical tests like compressive strength test, flexural and split tensile strength test performed on the samples and a comparative study conducted between the results.**

Keywords: **High-Performance Concrete, Jute Fiber "Saan", Hypo Sludge.**

1. INTRODUCTION

Concrete is a stronger, versatile, easily moldable and chemically inert construction material made by cement, sand, and aggregate. This mixed proportion allowed to cure, harden like rock type mass which has high compressive strength but low tensile strength. For any construction and engineering material strength, durability and serviceability depend on the properties of its ingredients, mixed proportion, methods of placing, and their characteristic. For considering concrete cement, sand and aggregate is core ingredient but for manufacturing of strong, durable and uniform concrete that is also known as high-performance concrete careful, control and proper processing required with some special ingredient like fiber, chemicals, fly ash, and admixture which helps to improve the physical and crystalline properties of concrete. In the time of technical enhancement and innovation, many researchers have performed their study to evaluate the properties of concrete. In this study combination of jute fiber as a reinforcing material and hypo-sludge as partial replacement of cement is used for high-performance concrete. In our study, the following ingredient is used such as

1) Cement- In our proposed study, M43 grade cement is adopted.

2) Aggregate- These are primarily naturally available granular material like sand, gravel, or crushed stone. For this research work locally available sand and aggregate are used for manufacturing concrete.

3) Water – Pure and clean fresh water whose pH is not less than 6 is used for the manufacturing the samples.

4) Hypo-Sludge – It is an industrial waste collected from the paper recycles industry having the following properties.

5) Jute Fiber- Jute fiber is purchased from the local market it was kept in mind that high-quality jute fiber is used for the research work that's why the best available jute fiber locally is known as "Saan" is purchased which have high strength because of low processing and treatment.

TABLE- 1 CHEMICAL COMPOSITION OF HYPO- SLUDGE

Chemical composition	Silicon dioxide (SiO2)	Aluminum oxide (Al2O3)	Iron oxide (Fe2O3)	Calcium Oxide (CaO)	Magnesium Oxide (MgO)	Loss on Ignition
Hypo Sludge (%)	9.27%	1.45%	1.68%	29.83%	4.28%	49.24%

2. LITERATURE REVIEW

[1] Danish Ansari et, al (2016) Carried out investigation, on the properties of concrete is tested which made by partial replacement of cement with fly ash at 10%, 20% & 30% along with addition of jute fiber at 1%, 2% & 3% and superplasticizer 0.1% and results show 20% of fly ash content shows optimum results along with 2% of jute fiber.

[2] Rahul R. Kshatriya et, al (2016) was taking a quantity of jute as 1% of cement and observed that when the raw jute fibers were added in concrete by 1% weight of cement then the compressive strength of concrete cube increased by 17.5% and by adding modified jute compressive strength increase by 26.5%.

[3] Mohammad Zakaria et, al (2015) carried out an experimental investigation of the compressive, flexural and tensile strengths of Jute Yarn Reinforced Concrete composites (JYRCC). For the sample jute fiber of length 10, 15, 20 and 25 mm and volume content 0.1, 0.25, 0.5 and 0.75 % is used. The maximum increment in flexural, split tensile and compressive strength, observed in results is 33, 23 and 38%, respectively with concrete without jute yarn.

[4] Abdullah Shahbaz Khan et al. (2014) carried out an investigation on the waste from paper industries termed as hypo sludge and present M20 & M30 grade concrete with W/c ratio of 0.55 & 0.45 respectively as a control specimen and hypo sludge is used different percentages such as 10%, 20%, and 30% by weight of cement. The test was conducted on 3, 7 and 28 days and results show that 10% and 20% replacement of cement hypo sludge sample show increment in strength then 0% control mixed design but optimum is obtained at 10% of replacements.

[5] Priya R. Hepzibah et al. (2017) carried out analysis work, and tests were carried out to evaluate compressive strength and spilled tensile strength for 7, and 28 days of curing. In this research work, M30 grade concrete was used and replacing cement 10%,15%,20%,25% and 30% by hypo sludge. Test researcher got maximum compressive strength both for 7 days and 28days 25.6 MPa and 38.5 MPa respectively with 15% hypo sludge content.

[6] Vinai Kant Singh et al. (2016) carried out a study on 43 grade Cement with hypo sludge from the nearest paper industry having 63.25% moisture content. After properly dry the hypo sludge, it's mixed in cement concrete with a variation of 5% from 0% to 50% in total 10 different proportions. In the compressive strength test, it was observed that the value of compressive strength increased to 15% of hypo sludge content after that it reduces.

3. METHODOLOGY

For this research work 0 to 25% hypo sludge is added in place of cement and jute fiber in addition of 0.5% to 1.5% by weight of cement and samples was prepared for a different test to investigate the properties of concrete as well as strength.

4. RESULTS AND DISCUSSION

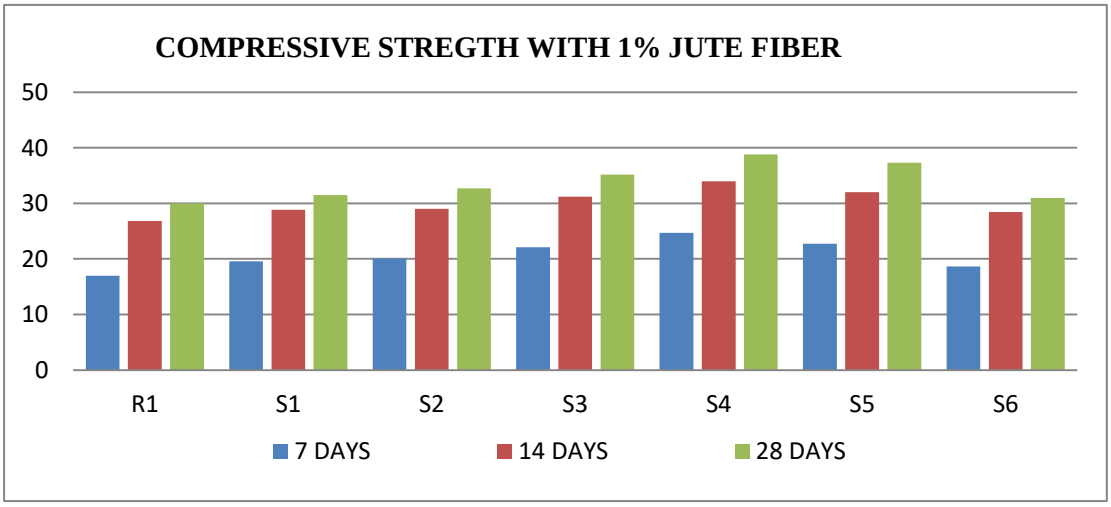
Determination of Compressive Strength (IS 516: (1959))

The compressive strength measurement of the concrete samples was done as per IS 516: (1959) standard practice. The test was conducted on the three samples of each composition and the average value of all is evaluated by a sample of each composition as the result of compressive strength.

TABLE-2 COMPRESSIVE STRENGTH OF DIFFERENT HYPO SLUDGE MIXED FOR 7, 14 AND 28 DAYS SAMPLE

S. no	Sample name	Compressive strength N/mm^2 (7 Days)	Compressive strength N/mm^2 (14 Days)	Compressive strength N/mm^2 (28 Days)
1	R1	16.99	26.80	30.10
	S1	17.99	27.50	30.80
2		19.54	28.85	31.5

		18.54	27.80	30.20
	S2	18.68	27.50	30.90
		20.09	29.00	32.70
3		19.89	29.80	32.40
	S3	20.85	30.60	33.45
		22.13	31.20	35.20
4		21.89	30.80	33.70
	S4	23.92	32.20	36.70
		24.71	34.00	38.80
5		22.30	33.80	38.40
	S5	22.06	31.50	35.20
		22.75	32.00	37.30
6		21.57	32.00	36.20
	S6	17.71	26.50	29.80
		18.64	28.45	31.00
7		16.47	25.70	28.70



GRAPH-1 COMPRESSIVE STRENGTH WITH 1% JUTE FIBER

The table shows that the maximum compressive strength of HPC is achieved at 15% hypo sludge content and 1% of jute fiber content with 38.80 Mpa and minimum compressive strength gain by the concrete with the combination of 25% Hypo-sludge and 1.5% jute fiber which is 28.70 Mpa for 28 days.

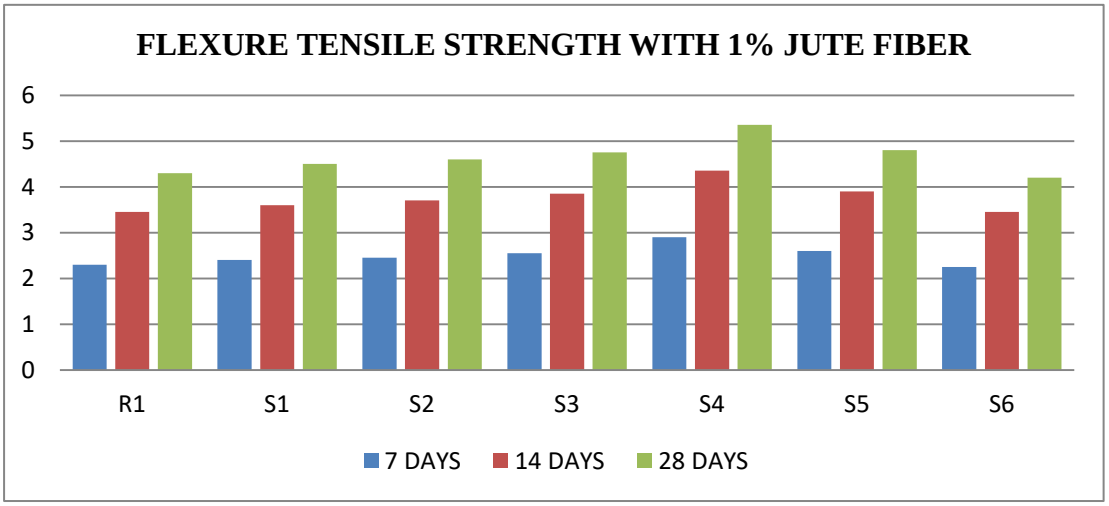
Flexural tensile strength tests (IS: 516 (1959))

The flexural strength is expressed as modulus of rupture and it is measured by ASTM machine.

TABLE-3 FLEXURAL TENSILE STRENGTH VALUES OF DIFFERENT HYPO SLUDGE MIXED FOR 7, 14 AND 28 DAYS SAMPLE

S. no	Sample name	Flexural tensile strength N/mm^2 (7 Days)	Flexural tensile strength N/mm^2 (14 Days)	Flexural tensile strength N/mm^2 (28 Days)
1	R1	2.30	3.45	4.30
	S1	2.35	3.55	4.40
		2.40	3.60	4.50
2		2.35	3.55	4.40
	S2	2.40	3.60	4.50
		2.45	3.70	4.60
3		2.40	3.60	4.55
4	S3	2.50	3.80	4.65

		2.55	3.85	4.75
		2.50	3.75	4.50
	S4	2.75	4.10	5.10
		2.90	4.35	5.35
5		2.80	4.25	5.15
	S5	2.50	3.75	4.70
		2.60	3.90	4.80
6		2.55	3.85	4.75
	S6	2.10	3.30	4.00
		2.25	3.40	4.25
7		2.25	3.45	4.20



GRAPH-2 FLEXURAL TENSILE STRENGTH WITH 1% JUTE FIBER

The table shows that maximum flexural strength gain by concrete is 2.90 MPa which having 15% hypo-sludge and 1.0% jute fiber but minimum flexural strength got with 25% Hypo- sludge and 0.5%, 1.0% jute fiber with a value of 2.10 MPa at 28 days.

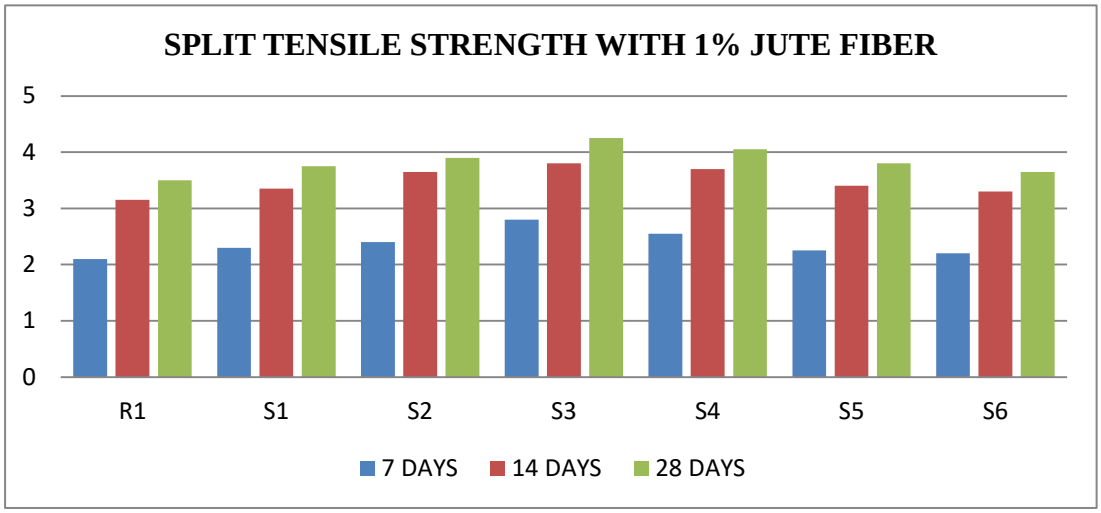
Split Tensile Strength Test (IS: 5816 (1999))

Table 4.5.1, 4.5.2 and 4.5.3 show the results of split tensile strength test perform on high perform hypo sludge jute fiber concrete.

TABLE-4 SPLIT TENSILE STRENGTH VALUES OF DIFFERENT HYPO SLUDGE MIX FOR 7, 14 AND 28 DAYS SAMPLE

S. no	Sample name	Split tensile strength N/mm^2 (7 Days)	Split tensile strength N/mm^2 (14 Days)	Split tensile strength N/mm^2 (28 Days)
1	R1	2.10	3.15	3.50
	S1	2.35	3.20	3.55
		2.30	3.35	3.75
2		2.20	3.25	3.60
	S2	2.30	3.40	3.80
		2.40	3.65	3.90
3		2.35	3.40	3.75
	S3	2.50	3.60	4.00
		2.80	3.80	4.25
4		2.60	3.65	4.05
	S4	2.45	3.45	3.85
5		2.55	3.70	4.05

		2.40	3.60	4.00
	S5	2.35	3.30	3.65
		2.25	3.40	3.80
6		2.20	3.35	3.70
	S6	2.15	3.20	3.55
		2.20	3.30	3.65
7		1.85	3.05	3.45



GRAPH-3 SPLIT TENSILE STRENGTH WITH 1% JUTE FIBER

The table shows that maximum split tensile strength gain by composite concrete is 4.25 MPa in 28 days with 10% hypo sludge content and 1.0% jute fiber.

5. CONCLUSION

1) The maximum compressive strength value Is 38.80 MPa on 1.0% jute fiber and 15% hypo sludge content while the minimum compressive strength value is 28.70 MPa on 1.5% jute fiber and 25% hypo sludge content.

2) The maximum gain in compressive strength is 29.33% with compared to standard concrete.

3) The maximum flexural tensile strength value is 5.35 MPa on 1.0% jute fiber and 15% hypo sludge content while the minimum tensile strength value is 4.20 MPa on 1.5% jute fiber and 25% hypo sludge content.

4) The maximum gain in flexural strength is 24.42% with compared to standard concrete.

5) The maximum split strength value is 4.25 MPa on 1.0% jute fiber and 10% hypo sludge content while the minimum split strength value is 3.45 MPa on 1.5% jute fiber and 25% hypo sludge content.

6) The maximum gain in compressive strength is 21.42% with compared to standard concrete.

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