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"Mechanical Performance Of Jute Fibre Reinforced Concrete With Partial Replacement Of Cement By Wollastonic Powder"

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Abstract: Concrete is a commonly employed construction material for a wide range of structures because of its robust structural integrity and strength. Ordinary portland cement is a crucial component in the manufacturing of concrete and is irreplaceable in the civil construction sector. By utilizing industrial by-products as a substitute for cement, sustainable energy and cost savings can be achieved. Wollastonite enhances the functionality of various products, including polymers, plastics, paints and coatings, construction materials, friction devices, ceramics, and more. It has also been utilized in metallurgical applications. Wollastonite powder is utilized in various mixtures that can be substituted for 0% to 18% of cement's weight in concrete, while maintaining a constant percentage of jute fiber. After a curing period of 28 days, the concrete is examined for its compressive strength, flexural strength, and durability. These are in comparison with a standard mixture that contains 0% wollastonite powder and a constant percentage of jute fiber, which determines the optimal combination for replacing the material.

Keywords: Wollastonite Powder, OPC, Concrete, Compressive Strength, Flexural Strength.

I. INTRODUCTION

Concrete is a commonly employed construction material for a wide range of structures because of its robust structural integrity and strength. The usage, behavior as well as the durability of concrete structure, built during the last first half of the century with ordinary portland cement and plane round bar of mild steel, the ease of procuring the constituents material (whatever may be their qualities) of concrete and the knowledge that almost any combination of the constituents leads to a mass of concrete have bred contempt. The importance of strength was emphasized without considering the durability of the structure. As a consequence of the liberty station, the durability of concrete and concrete structures is on southward journey, a journey that seems to have gained momentum on its path to self-destruction. Ordinary portland cement is a crucial component in the manufacturing of concrete and is irreplaceable in the civil construction sector. Unfortunately, the production of cement releases a significant amount of carbon dioxide gas into the atmosphere, which is a major contributor to the greenhouse effect and global warming. As a result, it is either necessary to find an alternative material or partially substitute it with another material. The search for any material that can be used as a substitute or addition to cement should contribute to global sustainable development and have the least negative impact on the environment. By utilizing industrial by-products as a substitute for cement, sustainable energy and cost savings can be achieved. Fly ash, ground granulated blast furnace slag, rice husk ash, and silica fume are some of the pozzolanic materials that can be used in concrete as a partial substitute for cement.

Objectives

1. To examine the strength characteristics of the wollastonite powder and jute fiber mixed specimens and to compare them with conventional specimens.
2. To study the behavior of beams with varying percentages of wollastonite as cement, ranging from 0% to 18%, and jute fiber with a constant percentage of 1%. The compressive and flexural strength properties have been examined for each mix.

II. METHODOLOGY

Data Collection:

Gather pertinent information from scholarly sources and previous research concerning the utilization of wollastonite and its impact on concrete. Collect information on the material characteristics, such as cement, wollastonite powder, aggregates, and fibers, as well as the mix design, curing techniques, and test outcomes from previous studies.

Material Used:

Cement: ordinary portland cement (opc) of standard grade (e.g., 53-grade cement) will be used as the base material.

Wollastonite Powder: A naturally occurring mineral used as a partial replacement for cement.the wollastonite powder will be obtained regionally.

Coarse Aggregate: crushed stone aggregates with a size range from 10 mm to 20 mm.

Fine Aggregate: natural river sand with a specific fineness modulus (e.g., 2.5-3.0).

Jute Fibre: natural fibers added to the concrete mix to enhance mechanical properties, used at constant proportion 1%.

Water: Clean, potable water, free from impurities, to ensure proper hydration of cement and to maintain workability of the mix.

Table 1. Mix Proportion for casting Cube

Wollastonite Powder %	Cement (kg)	Wollastonite Powder (kg)	Jute Fiber %	Jute Fiber (Kg)	Sand (kg)	Aggregates (kg)	Water lit
0%	2.27	0	0	0	3.91	5.74	1.02
10%	2.04	0.23	1%	0.22	3.91	5.74	1.02
13%	1.97	0.30	1%	0.22	3.91	5.74	1.02
16%	1.91	0.36	1%	0.22	3.91	5.74	1.02
18%	1.86	0.41	1%	0.22	3.91	5.74	1.02

Table 2. Mix Proportion for casting Beam

Wollastonite Powder %	Cement (Kg)	Wollastonite Powder (Kg)	Jute Fiber %	Jute Fiber (Kg)	Sand (Kg)	Aggregates (Kg)	Water
0%	10.57	0	0	0	17.78	26.74	4.75
10%	9.51	1.06	1%	0.105	17.78	26.74	4.75
13%	9.20	1.37	1%	0.105	17.78	26.74	4.75
16%	8.88	1.69	1%	0.105	17.78	26.74	4.75
18%	8.67	1.90	1%	0.105	17.78	26.74	4.75

III. RESULT AND DISCUSSION

Table 3 Compressive Strength (Wollastonic powder)

Compressive Strength (Wollastonic powder)										
%	0%		10%		13%		16%		18%	
	Load	Strain	Load	Strain	Load	Strain	Load	Strain	Load	Strain
7 days	406.2	18.05	448.1	19.92	478.2	21.253	532.3	23.66	453.9	20.17
	412.9	18.35	441.4	19.62	451.6	20.071	551.1	24.49	458.7	20.39
	409.5	18.20	448.7	19.94	465.2	20.676	548.2	24.36	448.2	19.92
14 days	582.9	25.907	598.9	26.62	652.9	29.018	693.7	30.83	614.7	27.32
	578.1	25.693	607.5	27.00	641.9	28.53	696.1	30.94	625.3	27.79
	602.8	26.791	603.2	26.81	650.4	28.907	691.9	30.75	631.0	28.044
28 days	698.2	31.031	720.1	32.00	778.6	34.60	832.4	37.00	751.9	33.42
	679.4	30.196	709.4	31.53	798.4	35.484	828.3	36.81	721.4	32.062
	701.8	31.191	716.0	31.82	790.7	35.142	829.1	36.85	738.1	32.804

Table 4 Compressive Strength (Wollastonic powder + Jute fiber)

Compressive Strength (Wollastonic powder + Jute fiber)										
%	0%		10%		13%		16%		18%	
	Load	Strain	Load	Strain	Load	Strain	Load	Strain	Load	Strain
7 days	492.80	21.90	563.60	25.05	601.20	26.72	663.20	29.48	597.40	26.55
	503.40	22.37	569.00	25.29	625.40	27.80	687.10	30.54	586.50	26.07
	498.50	22.16	558.10	24.80	613.70	27.28	648.90	28.84	572.90	25.46
14 days	597.70	26.56	654.20	29.08	689.60	30.65	823.50	36.60	677.10	30.09
	612.20	27.21	643.10	28.58	694.40	30.86	832.40	37.00	665.70	29.59
	608.40	27.04	660.80	29.37	701.10	31.16	824.10	36.63	678.40	30.15
28 days	732.30	32.55	746.50	33.18	798.80	35.50	899.20	39.96	768.10	34.14
	749.30	33.30	750.60	33.36	793.10	35.25	905.10	40.23	775.20	34.45
	732.90	32.57	750.10	33.34	814.60	36.20	903.70	40.16	761.70	33.85

Table 5 Flexural Strength (Wollastonic powder)

Flexural Strength (Wollastonic powder)					
%	0%	10%	13%	16%	18%
3 days	3.31	3.71	3.86	4.23	3.75
	3.47	3.72	3.89	4.18	3.79
	3.39	3.78	3.86	4.25	3.71
7 days	3.75	3.81	4.25	4.71	4.01
	3.73	3.83	4.44	4.78	3.99
	3.81	3.8	4.37	4.68	4.07
28 days	4.55	4.71	4.98	5.2	4.83
	4.51	4.69	4.91	5.18	4.86
	4.59	4.66	4.95	5.24	4.88

Table 6 Flexural Strength (Wollastonic powder + Jute fiber)

Flexural Strength (Wollastonic powder + Jute fiber)					
%	**0%**	**10%**	**13%**	**16%**	**18%**
3 days	2.47	2.58	2.68	2.97	2.66
	2.36	2.68	2.71	2.95	2.71
	2.38	2.41	2.68	2.99	2.69
7 days	3.07	3.61	3.81	4.01	3.81
	3.09	3.58	3.79	3.97	3.77
	3.01	3.52	3.83	3.99	3.77
28 days	3.99	4.06	4.35	4.48	4.34
	4.01	4.03	4.28	4.51	4.38
	3.94	4.11	4.32	4.56	4.36

IV. CONCLUSION

- There is a marginal increase in Compressive strength in replacement of Wollastonic powder up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%.
- There is a marginal increase in Flexural Strength in replacement of Wollastonic powder up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%.
- There is a marginal increase in Compressive strength in replacement of Wollastonic powder + Jute fiber up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%.
- That there is a marginal increase in Flexural Strength in replacement of Wollastonic powder + Jute fiber up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%
- There is a marginal decrease in Compressive strength after acid attack test on specimen of replacement of Wollastonic powder + Jute fiber. jute fibre can affect the performance of concrete in acid attack tests, Jute is less resistant to acids compared to other properties like heat and fire resistance.

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