Performance on Jute Fiber Reinforced Concrete with Admixtures and the Replacement of Fine Aggregate by Moorum Soil

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Abstract

As is generally known, the globe is rapidly developing, and building construction plays a crucial role in this development. If we go into further detail, the increased use of concrete results in a depletion of natural resources. We considered substituting the following measurements for part of the concrete's proportions in order to conserve our natural resources. To preserve natural resources like fine aggregate, we are employing metakaolin as an additive in partial substitution of cement at the following percentages: 0%, 5%, 7.5%, 10% and 12.5%. In fine aggregate, we are substituting moorum soil to varying degrees (0, 5, 10, 15 and 20%). To improve the concrete's mechanical and lasting qualities, we use several types of fibres. Concrete is good at compression and weak attention. We are incorporating jute fibres into the volume of concrete with a 25 mm length in various percentages, such as 0%, 0.5%, 1%, 1.5% and 2%, to enhance the tensile qualities of the concrete because we are aware that it is strong in compression but weak in tension. The largest 28-day strength improvement of concrete can be anticipated at partial replacements in the 10-15% range, according to the test results obtained with compressive strength and split tensile strength tests in this instance. The strength parameters are increasing as a result of the combined use of metakaolin.

Keywords: Jute Fiber, Metakaolin, Moorum Soil, Compressive Strength, Split Tensile Strength

1. Introduction

After water, concrete is the most commonly used material, and more than six billion tons of cement are produced annually. Solid structure segments in various sizes and shapes include divider boards, doorsills, bar, columns, and that's just the tip of the iceberg. Post-tensioned chunks are the preferred technique for the construction of mechanical, commercial, and residential floor pieces. Concrete is specifically suited to various applications such as new developments, fixes, recoveries, and retrofitting. It is advantageous to categories the use of cement depending on where and how it is produced as well as its method of application because these have different requirements and properties. With the technological advancement and the enlarged field of cement and mortar use, the demand for concrete has increased to rank second only to that of water. As a result, many qualities of ordinary cement needed to be modified to make it more sensible, wise, and environmentally friendly. This has led to the use of cementitious materials. The use of moorum soil and metakaolin in part as a substitute for the fine total concrete results in a reduction in the amount of concrete used, a reduction in carbon dioxide (CO2) emissions, the preservation of existing assets, and an improvement in the quality and strength attributes of concrete. Fast condition deterioration is being caused by the uncertainty of infrastructure development. The development of common fibre composites has recently started. Sisal strands, bamboo fibre, coir fibre, and jute fibre are particularly fascinating among the several common filaments.

2. Objectives

(1) To use cement with kaolin as efficiently as possible.
(2) To use fine aggregate with moorum soil as efficiently as possible.
(3) To calculate the concrete's split and compressive tensile strengths.

3. Material

3.1. Metakaolin

The cementitious substance metakaolin is used as an additive to produce high-quality cement. Metakaolin is made by drying kaolin at a suitable temperature (700°-900° C) to produce a white powder of A2Si. When kaolin is heated in air, it undergoes a few basic modifications, and when heated to roughly 600° C, the layered structure of the material is affected due to a lack of hydration, resulting in a temporary stage with weak crystalline. Metakaolin can be used to make cementitious materials and combine high-quality elite cement because of its high mobility.

3.2. Moorum Soil

Soils from the moist tropical and central zones are known as Moorum or Moram. A deep endured layer from which silica has been drained is used to describe it. It's a sort of rock that's high in iron and aluminium, and it's thought to have formed in hot, humid tropical climates. Because of the high iron oxide content, almost all laterites have a tarnished redtinge.

3.3. Jute Fibers

Jute is along, soft, lustrous vegetable fiber that may be spun into strong, coarse threads. It comes mostly from the Corchorus genus of plants. Jute is a long, soft, and lustrous fiber with a diameter of 17 to 20 microns and a length of 1 to 4 meters. Jute fibers with lengths of 25 mm.

3.4. Cement

The locally available 43 grade OPC cement utilized for the activities and presented in Table 1.

Table 1: Physical Properties of Ordinary Portland Cement - 43 Grade

Sr. No.	Properties	Values Observed
1	Specific Gravity	3.15
2	Normal Consistency	33%
3	Initial Setting Time	33 min
4	Final Setting Time	510 min

3.5. Fine Aggregate

The properties of fine aggregate from local source are presented in Table 2.

Table 2: Properties of Fine Aggregate

Sr. No.	Property	Result
1	Fineness Modulus	2.72
2	Specific Gravity	2.65
3	Bulk Density	1670 kg/m^3
4	Zone	III

3.6. Coarse Aggregate

The properties of coarse aggregate are presented in Table 3.

Table 3: Physical Properties of Coarse Aggregates

Sr. No.	Property	Result
1	Fineness Modulus	7.68
2	Specific Gravity	2.74
3	Bulk Density	1680 kg/m^3

4. Mix Proportion for M30 Concrete

The design mix achieved in the laboratory for M40 grade of concrete with controlled temperature and satisfying IS 10262-2019 and tabulated in Table 4.

Table 4: Mix Ratio for M30 Grade of Concrete

Cement	Fine Aggregate	Coarse Aggregate	Water
492.0	803.57	943.32	197
1	1.63	1.91	0.40

5. Results

5.1. Compressive Strength Test

The tests were performed on the cube size of 150 mm cast, and demoulded after 24 hours. After demoulding, the specimens are cured for 28, 56 and 90 days. The results are furnished in Table 5.

Table 5: Compressive Strength of Concrete with Moorum Soil of Partial Replacement of FA

Mix No.	% of Moorum Soil	Compressive Strength, N/mm^2		
		28 Days	56 Days	90 Days
1	0%	37.50	40.83	43.83
2	5%	38.19	41.54	44.43
3	10%	39.50	43.03	46.11

4	15%	41.29	44.98	48.26
5	20%	38.41	41.48	44.93

Table 6: Compressive Strength of Concrete 15% of Moorum Soil with Different % of Partial Replacement of Cement with Metakaolin

Mix No.	% of Metakaolin with 15% of Moorum Soil	Compressive Strength, N/mm^2		
		28 Days	56 Days	90 Days
0	Normal Concrete	37.50	40.83	43.83
1	0%	41.29	44.98	48.29
2	2.5%	42.18	45.75	49..24
3	5%	42.74	46.26	49.73
4	7.5%	43.11	46.97	50.32
5	10%	45.34	49.35	52.80
6	12.5%	44.33	48.29	51.75

Table 7: Compressive Strength of Concrete 15% of Moorum Soil with 10% of Metakaolin with Different % of Jute Fibre in Concrete

Mix No.	15% of Moorum Soil + 10% of Metakaolin with Different % of Fibers	Compressive Strength, N/mm^2		
		28 Days	56 Days	90 Days
0	Normal Concrete	37.50	40.83	43.83
1	0%	45.34	49.37	53.03
2	0.50%	45.84	49.62	53.62
3	1%	46.30	50.11	54.05
4	1.50%	47.23	51.24	55.24
5	2%	46.68	50.50	54.36

5.2. Split Tensile Strength Test

A standard test cylinder of concrete specimen (300 mm × 150 mm diameter) is placed horizontally between the loading surfaces of Compression Testing Machine and tabulated in Table 8.

Table 8: Split Tensile Strength of Concrete with Moorum Soil of Partial Replacement of FA

Mix No.	% of Moorum Soil	Split Tensile Strength, N/mm^2		
		28 Days	56 Days	90 Days
1	0%	3.69	4.01	4.31
2	5%	3.76	4.09	4.37
3	10%	3.90	4.22	4.55
4	15%	4.08	4.46	4.75
5	20%	3.78	4.10	4.40

Table 9: Split Tensile Strength of Concrete 15% of Moorum Soil with Different % of Partial Replacement of Cement with Metakaolin

Mix No.	% of Metakaolin with 15% of Moorum Soil	Split Tensile Strength, N/mm^2		
		28 Days	56 Days	90 Days
0	Normal Concrete	3.69	4.01	4.31
1	0%	4.08	4.44	4.78
2	2.5%	4.43	4.80	5.15
3	5%	4.51	4.91	5.28
4	7.5%	4.79	5.21	5.59
5	10%	4.90	5.33	5.71
6	12.5%	4.70	5.11	5.46

Table 10: Split Tensile Strength of Concrete 15% of Moorum Soil with 10% of Metakaolin with Different % of Jute Fibre in Concrete

Mix No.	15% of Moorum Soil + 10% of Metakaolin with Different % of Fibers	Split Tensile Strength, N/mm^2		
		28 Days	56 Days	90 Days
0	Normal concrete	3.69	4.01	4.31
1	0%	4.90	5.46	5.74
2	0.50%	4.88	5.19	5.59
3	1%	4.83	5.25	5.61
4	1.50%	4.98	5.38	5.82
5	2%	4.48	4.87	5.22

6. Conclusion

(1) The compressive strength of Normal Concrete at 28, 56 and 90 days are 37.50, 40.83 and 43.83 N/mm^2.
(2) The split tensile strength of Normal Concrete at 28, 56 and 90 days are 3.69, 4.01 and 4.31 N/mm^2.
(3) At 15% partially replacement of FA with moorum soil, the compressive strength is 41.29, 44.98 and 48.26 N/mm^2 for 28, 56 and 90 days.
(4) At 15% partially replacement of FA with moorum soil, the split tensile strength is 4.08, 4.46 and 4.75 N/mm^2 for 28, 56 and 90 days.
(5) At 15% partially replaced of FA with moorum soil + 10% Metakaolin partial replacement of cement, the compressive strength is 45.34, 49.35 and 52.80 N/mm^2 for 28, 56 and 90 days.
(6) At 15% partially replaced of FA with moorum soil + 10% Metakaolin partial replacement of cement, the split tensile strength is 4.90, 5.33 and 5.71 N/mm^2 for 28, 56 and 90 days.
(7) At 15% partially replaced of FA with moorum soil + 10% Metakaolin partial replacement of cement + 1.5% JF partial replacement in concrete, the compressive strength is 47.23, 51.24 and 55.24 N/mm^2 for 28, 56 and 90 days.

(8) At 15% partially replaced of FA with moorum soil + 10% Metakaolin partial replacement of cement + 1.5% JF partial replacement in concrete, the split tensile strength is 4.98, 5.38 and 5.82 N/mm^2 for 28, 56 and 90 days.

7. References

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