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Experimental Study On The Durability And Sustainability Of Basalt Fiber Reinforced Plaster

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Abstract:
This study investigates the use of basalt fiber as a reinforcement material in plastering applications to enhance durability and sustainability. Basalt fiber, a natural and eco-friendly material, is recognized for its high strength, thermal stability, and resistance to chemical and environmental degradation. In this research, basalt fiber-reinforced plaster (BFRP) was developed and evaluated for its mechanical properties and long-term performance. Experimental results demonstrated not able improvements in compressive strength, flexural strength, and impact resistance compared to conventional plaster. Furthermore, BFRP exhibited superior durability against weathering, thermal fluctuations, and chemical exposure, making it a viable alternative for enhancing the longevity of plaster structures. The incorporation of basalt fiber also contributes to sustainability by reducing dependence on synthetic reinforcement materials, therebyminimizing the environmental footprint of construction practices. Overall, this study highlights the potential of BFRP as a high-performance also durable and sustainable solution for modern plastering applications. The main objective of our project is to evaluate the mechanical properties and durability of plaster reinforced with (0.1%,0.2%,0.3%,0.4%,0.5%,0.7%) basalt fiber. The experimental investigation is carried out by adding basalt fiber by different percentages.

Key Word: *Basalt Fiber- reinforced plaster, Sustainability, Mechanical properties, Durability.*

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I. Introduction

Cement mortar is a crucial building material used for bonding masonry units, plastering surfaces, and repairing structures. It is a mixture of cement, sand, and water, sometimes with additives to enhance workability and strength. The cement acts as a binder, while sand provides bulk and reduces shrinkage. When mixed with water, the cement undergoes hydration, leading to hardening and strength development over time. Depending on the cement-to-sand ratio, mortar can be categorized as rich, medium, or lean, each serving different construction purposes. It is known for its strong adhesive properties, durability, and resistance to environmental conditions. The river sand is used in combination as fine aggregate conforming to the requirements of IS:383. The river sand is cleaned by washing, so as to clear any foreign matter. In concrete water plays an important role which is responsible in the formation of cement gel, so the quality of water is to be tested initially. Basalt fiber is a high-performance non-metallic material made up of very fine fibers of basalt. Its composition consists of mineral plagioclase, pyroxene and olivine. These continuous basalt fibers have some proven technical characteristics and performance specifications.

Fig. 1. Basalt Fibre

II. Preparation Of Specimen

For testing, standard specimen molds are prepared in accordance with ASTM guidelines. Cubes of size 70.6 mm × 70.6 mm × 70.6 mm are used for compressive strength tests, The molds are cleaned and lightly oiled to prevent the mortar from sticking. Freshly prepared mortar is poured in layers into the molds and each layer is tamped 25 times with a tamping rod to remove entrapped air and ensure uniform compaction. The top surface is leveled using a trowel. After molding, the specimens are kept in a controlled environment for 24 hours before demolding. After demolding, all samples are transferred to a curing tank filled with clean water and stored for 7, 14, and 28 days depending on the type of test to be performed.

Table: 2.1 mix proportions of mortar different proportion (by weight)

Mix id	Fiber (%)	Cement (kg)	Sand(kg)	Water (liters)	Basalt fiber (g)
M01	0.1	1	3	0.5	1.88
M02	0.2	1	3	0.5	3.75
M03	0.3	1	3	0.5	5.63
M04	0.4	1	3	0.5	7.5
M05	0.5	1	3	0.5	9.38
M06	0.7	1	3	0.5	13.13

III. Tests And Results

Compression Strength Test

The compression strength test was performed to evaluate the mechanical strength of basalt fiber-reinforced plaster. The objective was to determine how the addition of basalt fibers affects the ability of plaster to withstand compressive loads. The compression strength test was conducted to assess the load-bearing capacity of basalt fiber- reinforced plaster. Cube specimens of size 70.6 mm were prepared with varying fiber content: 0% (control),0.1%,0.2%,0.3%,0.4%, 0.5%, 0.6%, and 0.7%. after 7and 14 days of water curing, the samples were tested using a Compression Testing Machine (CTM) to determine their maximum compressive strength. The results showed that the addition of basalt fibers significantly enhanced the compressive strength of the plaster. The 0.3% fiber mix demonstrated noticeable improvement over the control, while the 0.5% mix exhibited the highest strength, indicating that basalt fibers contribute to better internal bonding and resistance to cracking. This suggests that incorporating basalt fibers makes the plaster more suitable for structural applications requiring higher durability and strength.

Table 3.1 Compression Values for 1:4 test on 7,14 days

S.No.	% (fiber)	7 days	14 days
1	0	7.83	8.33
2	0.1	9.03	11.16
3	0.2	9.15	11.86
4	0.3	10.76	12.18
5	0.4	10.07	11.76
6	0.5	9.42	10.47
7	0.7	8.47	9.93

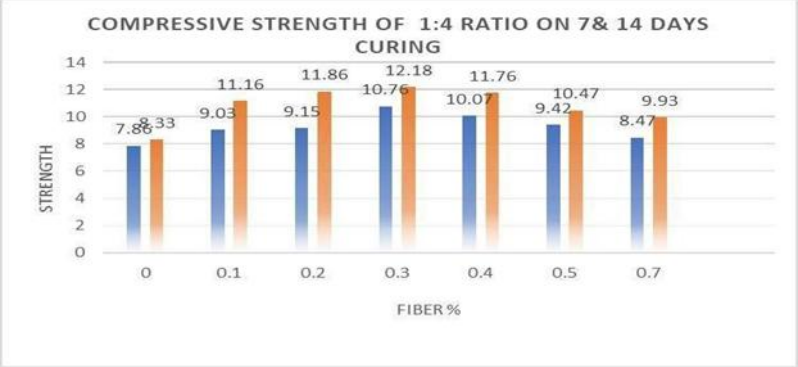

Fig. 2. Compression Test Graph

Table 3.2. Compression Values for 1:6 test on 7,14 days

S. No.	% (fiber)	7 days	14 days
1	0	4.12	5.85
2	0.1	5.99	7.16

3	0.2	10.23	12.13
4	0.3	13.95	14.36
5	0.4	12.33	14.66
6	0.5	11.95	14.93
7	0.7	5.83	6.35

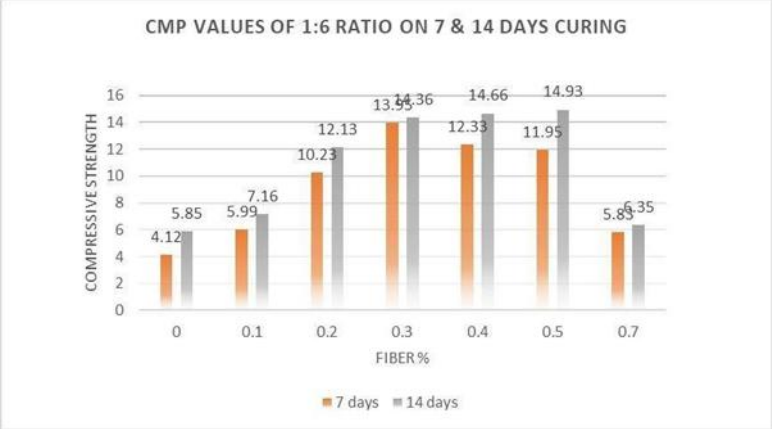

Fig. 3. Compression Test Graph

Study on Durability of mortar

Table 3.3. Durability test on 1:4 ratio 14 days

S. No.	%(fiber)	Before curing	After curing
1	0	750	712
2	0.1	730	692
3	0.2	720	698
4	0.3	760	746
5	0.4	730	678
6	0.5	720	693
7	0.7	740	720

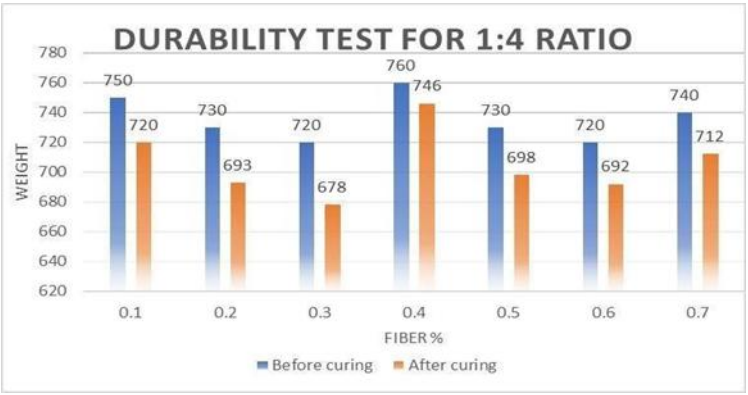

Fig. 4. Durability Test Graph

Table 3.4. Durability test on 1:6 ratio 14 days

S. No.	**%(fiber)**	**Before curing**	**After curing**
1	0	688	652
2	0.1	642	622
3	0.2	666	643
4	0.3	640	617
5	0.4	675	648
6	0.5	693	666
7	0.7	687	664

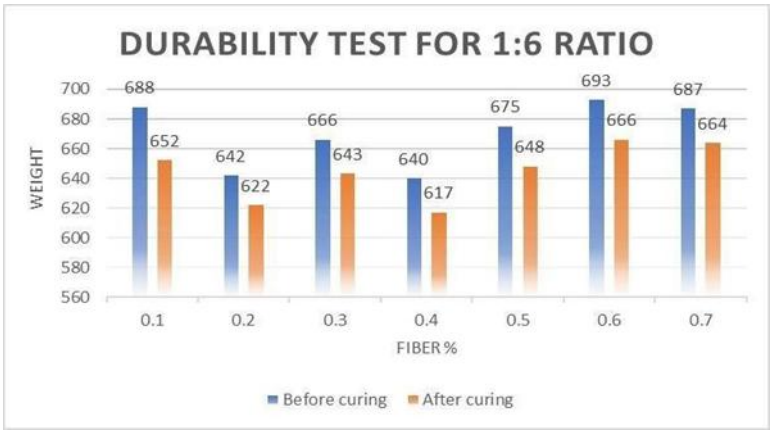

Fig. 5. Durability Test Graph

Muffle Furnace Test

To determine the weight loss of a sample (such as plaster) after heating at high temperature, indicating the presence of combustible materials or inorganic content. The main objective of the Muffle Furnace Test is to determine the amount of volatile (combustible) matter or organic content in a material by measuring the weight loss after heating at high temperatures.

Fig.6. Muffle Furnace

IV. Conclusion

Compression Strength Test

The addition of basalt fibers significantly improved the compressive strength of plaster. The compressive strength is increased for mortar having 0%, 0.1%, 0.2%, 0.3%. Reduction in 0.4%, 0.5%, 0.7% Basalt content for interior walls.

The compressive strength is increased for mortar having 0% ,0.1%, 0.2%, 0.3%, 0.4%, 0.5% Reduction in 0.7% Basalt content for Exterior walls. An optimum fiber content of 0.3% (interior) and 0.5% (exterior) showed the best results in terms of strength and workability.

Durability Test

BFRP exhibited better resistance to environmental conditions compared to conventional plaster. The fiber enhanced the long-term performance and reduced degradation over time.

Muffle Furnace Test

Basalt fiber reinforced plaster maintained structural integrity even after exposure to high temperatures. It showed improved thermal stability, indicating better fire resistance

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