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Performance Evaluation of Gypsum Board Partition Walls Reinforced With Natural Fibers

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Abstract - *This study evaluates the use of natural fibers as sustainable alternatives to glass fibers in gypsum boards. Coir, jute, and bamboo fibers were incorporated in varying proportions, and their effects on compressive strength and water absorption were experimentally analyzed. The results show that natural fiber reinforcement improves the mechanical performance of gypsum boards, with some combinations achieving results comparable to or better than glass fiber-reinforced boards. Additionally, natural fibers provide benefits such as low cost, biodegradability, and environmental sustainability. Therefore, natural fiber-reinforced gypsum boards present a viable eco-friendly alternative for construction applications.*

Key Words: **(Gypsum board, Natural fiber, Coir fiber, Jute fiber, Bamboo fiber, Compressive strength, Water absorption, Fiber reinforcement)**

1. INTRODUCTION

Gypsum boards are widely used in residential, industrial, and commercial construction for applications such as façade panels, internal partitions, and drywall systems. Their popularity is due to advantages such as low cost, lightweight nature, thermal and acoustic insulation, and fire resistance.

Despite these benefits, gypsum plasters have certain limitations, particularly its low tensile strength and poor impact resistance. To overcome these drawbacks, fiber reinforcement has been introduced to improve its mechanical performance. While synthetic fibers have been commonly used, there is a growing interest in natural fibers as sustainable and eco-friendly alternative.

Natural fibers such as coir, jute, and bamboo have gained attention due to their availability, biodegradability, and favorable mechanical properties. Coir fiber, obtained from the outer husk of coconut, is known for its durability and resistance to moisture, making it suitable for building materials. Jute fiber offers good tensile strength and cost-effectiveness, while bamboo fiber provides a high strength-to-weight ratio and flexibility.

In this study, gypsum composites reinforced with coir, jute, and bamboo fibers in various combinations are investigated. The mechanical properties such as compressive strength and water absorption are evaluated and compared with those of glass fiber reinforced gypsum boards.

2. OBJECTIVES

The primary objectives of this study are:

1. To evaluate the performance of fibre-reinforced gypsum boards using experimental work.
2. To compare the test results of fibre-reinforced boards with conventional gypsum boards.

3. METHODOLOGY

3.1 Materials Used

The following materials were used in the experimental study:

Gypsum: Gypsum, commercially known as Plaster of Paris (POP), is a soft sulfate mineral composed of calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$). It is widely used in various industries due to its versatility, inexpensiveness, ease of workability, and good moldability.

Glass Fiber: Fiberglass is made from extremely fine glass fibers and is commonly used as a composite reinforcement material due to its strength, lightweight, and versatility.

Coir Fiber: Coir fiber is a natural fiber obtained from coconut husk, known for its durability and moisture resistance. It is used as a reinforcement material due to its toughness and eco-friendly nature.

Jute Fiber: Jute is a natural fiber derived from plant stems, valued for its good tensile strength and low cost. It is commonly used in composites for its biodegradability and flexibility.

Bamboo Fiber: Bamboo fiber is extracted from bamboo, known for its high strength-to-weight ratio. It is used as reinforcement due to its strength and sustainability.

Water: Ordinary pipe water was used to mix all the composites in this study

Table -1: Optimization of Fiber Content in Gypsum Board

Mix No.	Coir	Jute	Bamboo	Glass
1	1%	0.5%	-	-
2	1%	-	0.5%	-
3	0.5%	1%	-	-
4	-	1%	0.5%	-
5	-	0.5%	1%	-
6	0.5%	-	1%	-
7	0.5%	0.5%	0.5%	-
8	-	-	-	1.5%

3.2 Casting of Specimen

Specimens were cast for different tests as per IS 8272-1984 for water absorption test and compressive strength test. Specimens of 50mm cube mould conforming to IS 10086-1982 were prepared.

Fig -1: Casting of cube specimens in moulds

3.3 Mixing and Casting Procedure

Mixing: All mixing was done manually to control the workability of the mix. Gypsum powder and fibres were mixed thoroughly and then combined with water until a uniform mix was formed.

Casting: After mixing, the material was introduced into the mould with proper compaction. The surface of the gypsum was smoothened and specimens were demoulded 1 day after casting.

3.4 Tests on Specimens

The tests conducted on specimens include Water Absorption Test (IS 2542) and Compression Test (IS 8272-1984).

3.4.1 Water Absorption Test

The specimens were completely immersed in water at 27 ± 2°C for a period of 24 hours, with at least 30 mm height of water over the top of the specimen. These were taken out and weighed (W_1) after removing surplus moisture with a damp cloth.

The specimens were then placed in an air oven maintained at 105°C and dried until constant mass (within ±0.1 percent) was attained, and the mass (W_2) was recorded for each specimen.

Percentage absorption = $(W_1 - W_2) / W_2 \times 100$

Where, W_1 = Mass of specimen after absorption; W_2 = Mass of specimen after heating.

Fig -2: Water absorption test setup

3.4.2 Compressive Strength Test

The specimen was placed centrally in a compression testing machine (CTM) so that the load was applied uniformly on opposite faces. A gradual and continuous load was applied without shock until the specimen failed, and the maximum load at failure was recorded.

Compressive strength = Failure Load / Cross-sectional Area (N/mm^2)

Fig -3: Compressive strength testing on CTM

3. RESULTS AND DISCUSSION

Water Absorption:

The water absorption results show variation across different fiber combinations. Mix 1 (Coir 1% + Bamboo 0.5%) showed the lowest average water absorption of 9.251%, while Mix 8 (Glass fiber 1.5%) showed the highest at 14.999%. Natural fiber mixes 1, 2, and 6 showed competitive performance compared to the glass fiber mix.

Table -2: Water Absorption Results (%)

Mix	A	B	C	D	E	Avg (%)
1	10.325	7.131	6.368	15.959	10.632	10.083
2	9.688	8.299	8.813	9.504	9.954	9.251
3	9.999	12.995	10.000	12.998	11.327	11.464
4	10.001	10.614	12.399	9.422	13.653	11.218
5	6.169	15.002	14.999	15.000	14.997	13.234
6	8.997	11.689	9.594	11.356	10.550	10.437
7	9.998	13.048	10.388	9.844	10.964	10.848
8	15.001	14.999	15.003	14.999	14.997	14.999

Compressive Strength:

Mix 1 (Coir 1% + Jute 0.5%) achieved an average compressive strength of 10.55 N/mm^2, while Mix 5 (Jute 0.5% + Bamboo 1%) achieved 9.73 N/mm^2, comparable to the glass fiber reference (Mix 8 = 10.47 N/mm^2). All mixes satisfied the minimum requirements specified in IS 8272-1984.

Table -3: Compressive Strength Results (N/mm^2)

Mix	A	B	C	D	E	Avg
1	9.78	12.30	10.90	8.46	11.30	10.55
2	6.84	12.70	7.08	2.82	9.06	7.70
3	11.50	9.78	2.88	10.20	8.22	8.52
4	7.38	5.94	6.12	7.38	7.20	6.80
5	12.30	10.50	9.72	10.60	5.52	9.73
6	9.54	10.30	6.42	7.62	4.50	7.68
7	7.56	4.68	8.34	8.58	11.40	8.11
8	13.40	12.40	11.70	6.23	8.64	10.47

The results indicate that specific combinations of natural fibers can achieve mechanical performance comparable to glass fiber-reinforced boards. The coir-jute combination demonstrated particularly promising results in terms of both compressive strength and water resistance.

5. CONCLUSIONS

The present study demonstrates that natural fiber reinforcement significantly influences the performance of gypsum boards. The inclusion of coir, jute, and bamboo fibers improved compressive strength and modified water absorption behavior, depending on the fiber type and proportion.

Results from the experimental analysis show that certain fiber combinations yield performance comparable to or better than conventional gypsum composites. Furthermore, all test results satisfy the requirements specified in IS 8272, confirming the adequacy and reliability of the developed composites for practical applications.

Moreover, natural fibers offer additional benefits such as biodegradability, low cost, and environmental sustainability. Therefore, natural fiber-reinforced gypsum boards can be considered a viable alternative to glass fiber-reinforced boards in construction applications.

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