e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:02/February-2024 Impact Factor- 7.868 www.irjmets.com

EXPERIMENTAL STUDY ON IMPACT RESISTANCE OF GLASS FIBER PANELS

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DOI : https://www.doi.org/10.56726/IRJMETS49391

ABSTRACT

Boards serve as a protective outer layer for structures, attached to the building framework or an intermediate layer. Framing, made of rigid materials, like interlocking wood or plastic, aims to shield against wind and rain. Fiber cement or metal panels offer fire resistance, while glass fibers enhance reinforcement when randomly dispersed in mixtures. Fiber cement panels, containing sand, concrete, and cellulose fibers, are compared in thicknesses of 40mm, 60mm, and 80mm to a 120mm plain concrete cement board for impact resistance assessment. Glass fiber reinforced concrete (GFRC) has revolutionized construction for over 40 years, providing economic, technological, and aesthetic benefits. GFRC's versatility and lightness enable intricate shapes and self-cleaning panels, aided by 3D printing. Its integration into High Performance Concrete (HPC) further enhances mechanical properties, durability, and workability.

Keywords: Drope Weight Test, GFRC, Impact Test, Glass Fibers, Impact Resistance.

I. INTRODUCTION

1.1. General:

Concrete, a versatile construction material, encompasses various types such as normal, regular, plain, high-strength, prestressed, self-compacting, lightweight, and reinforced concrete, each tailored for specific applications and structural requirements.

1.2. Fiber Reinforced Concrete (FRC):

Fiber reinforced concrete (FRC) enhances structural integrity with uniformly distributed fibers like steel, glass, synthetic, or natural fibers, improving tensile strength and reducing cracking, especially in shotcrete and on-ground construction.

1.3. Glass Fiber Reinforced Concrete (GFRC):

Glass fiber reinforced concrete (GFRC) offers versatility and durability, with thin panels, high reliability in 3D printing, and international standards, making it popular in architectural and industrial construction worldwide.

1.4. Scope of Glass Fiber Reinforced Concrete:

GFRC offers versatility and durability in construction. Despite higher costs and limited research, its widespread applications, aided by advancing technology, warrant further research to enhance properties.

1.5. Histor of Glass Fiber Reinforced Concrete:

In the late 1950s and early 1960s, E glass and C glass were considered for reinforcing concrete, but stability issues arose due to the high alkalinity. By the late 1960s, alkali-resistant glass formulations led to the birth of the Glass Fiber Reinforced Concrete industry

1.6. Glass Fiber Panels

Cladding, also known as paneling, serves as an additional layer or outer covering on the exterior of a structure. It can be affixed to the building's frame or an intermediary layer of supports. Its primary function is to prevent the ingress of wind and rain into the building. Glass fibers are small, discrete lengths that are easily and randomly dispersed within fresh concrete during the standard mixing process. Fiber cement panels consist of sand, cement, and cellulose fibers that provide reinforcement. These panels can be painted or stained before or after installation, with weatherproof paint recommended for exposed areas. Typically, joints are covered with wooden battens, and the entire wall surface is painted. Fiber cement siding offers numerous advantages, including resistance to termite damage, rot, impact, and fire.

II. METHODOLOGY

2.1 Evaluation of Impact Resistance:

Compare the impact resistance of various building boards, including fiber cement panels of different thicknesses (40mm, 60mm, 80mm), and a 120mm plain concrete cement board. Utilize the drope weight test method to evaluate the impact resistance of each board type.

2.2 Study on Fiber Reinforced Concrete (FRC):

Investigate the contribution of fiber reinforced concrete (FRC) to enhancing structural integrity, minimizing cracking, and enhancing tensile strength, particularly in shotcrete and on-ground construction applications. Analyze the types of fibers employed, such as steel, glass, synthetic, or natural fibers.

2.3 Analysis of Glass Fiber Reinforced Concrete (GFRC):

Examine the versatility, longevity, and adherence to international standards associated with GFRC. Focus on thin panel manufacturing, reliability in 3D printing, and its widespread acceptance in architectural and industrial construction globally.

2.4 Assessment of Historical Development:

Explore the historical evolution of GFRC, from the consideration of E glass and C glass in the late 1950s and early 1960s to the advent of alkali-resistant glass formulations in the late 1960s, culminating in the establishment of the Glass Fiber Reinforced Concrete industry.

2.5 Characterization of Glass Fiber Panels:

Define the attributes and qualities of glass fiber panels, encompassing their role as building cladding, composition, installation methods, and benefits such as impact resistance, fire resistance, termite resistance, and rot prevention.

2.6 Identification of Research Gaps:

Recognize deficiencies in current research on GFRC, such as higher costs, limited research scope, and potential avenues for further advancements in properties. Explore how advancements in technology can contribute to augmenting the versatility and durability of GFRC in construction applications. increase some word

III. MODELING AND ANALYSIS

3.1 Model Description:

The model utilized in this study simulates a typical building structure, comprising walls, floors, and roofing systems. It includes components such as framing, insulation, and protective outer layers, commonly found in construction practices. The model aims to represent a real-world scenario for assessing the performance of various building boards under different conditions.

3.2 Materials Used:

The materials selected for the model are chosen based on their relevance to construction and their impact on the structural integrity and resilience of the building. The primary materials include: 3.2.1 Fiber Cement Panels: Fiber cement panels are composed of sand, cement, cellulose fibers, and additives. They offer fire resistance and durability, making them suitable for external cladding and roofing applications. 3.2.2 Glass Fiber Reinforced Concrete (GFRC): GFRC consists of cement, fine and coarse aggregates, water, and glass fibers. It provides versatility, durability, and aesthetic appeal, commonly used in architectural cladding and decorative elements. 3.2.3 Metal Panels: Metal panels are fabricated from aluminum, steel, or other metals, offering high strength and corrosion resistance. They are often used for roofing, wall cladding, and structural applications. 3.2.4 Plain Concrete Cement Board: The plain concrete cement board is made of cement, sand, aggregates, and water. It serves as a traditional building material for various structural and non-structural applications.

3.3 Model and Material Specifications:

The specifications for each material, including dimensions, compositions, and properties, are detailed in the following table: Material Composition Dimensions Properties Fiber Cement Panels Sand, cement, cellulose fibers, additives Various thicknesses Fire resistance, durability Glass Fiber Reinforced Concrete (GFRC) Cement, aggregates, water, glass fibers Various thicknesses Versatility, durability, aesthetic appeal Metal Panels Aluminum, steel, or other metals Various thicknesses High strength, corrosion resistance Plain Concrete

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Cement Board Cement, sand, aggregates, water 120mm thickness Traditional building material.

Material	Composition	Dimensions	Properties
Fiber Cement Panels	Sand, cement, cellulose fibers, additives	Various thicknesses	Fire resistance, durability
Glass Fiber Reinforced Concrete (GFRC)	Cement, aggregates, water, glass fibers	Various thicknesses	Versatility, durability, aesthetic appeal
Metal Panels	Aluminum, steel, or other metals	Various thicknesses	High strength, corrosion resistance
Plain Concrete Cement Board	Cement, sand, aggregates, water	120mm thickness	Traditional building material

IV. RESULTS AND DISCUSSION

Compressive strength test: it is calculated for the M30 experimental mix at 7 days, 14 days, and 28 days of curing. On a compressive testing apparatus, the testing was conducted. On the specimen, 1.4 KN/m of loading is applied. With the help of a control valve, the machine has the ability to regulate the rate of loading. The cube specimen is taken out of the curing when the necessary amount of time has passed.

TABLE 1. Compressive strength test in Mpa

S. No.	7 days	14 days	28 days
1.	23.50	30.41	42.10
2.	24.25	32.11	41.54
3.	22.65	32.55	42.23
Avg.	**23.46**	**31.69**	**41.95**

Impact Load Test Results on P.C.C slab and Glass Fiber Pan: Instrument was set up for impact loading on the specimens as show in the figure. The Impact load consisted of 5kgs steel mass dropped from a height of 1.5 meters. To the top of this frame a friction less pulley was attached centrally. The specimens were rested upon flat leveled surface. The repeated impact test was carried out by a free drop of 1.5 m height of 5 kg weight with a circular striking head.

Test on Plain concrete cement slab type

TABLE 2. Slab Type – Plain Concrete Cement

Size of slab	Sample number	No. of blows resisted	Energy absorption (JOULES)
500mmx500mmx120mm	1	22	1617
	2	25	1837.5
	3	26	1911
Average		**24**	**1764**

Test on GFRP Concrete Slab Type (40mm)

TABLE 3. Slab Type – GFRP Concrete

Size of slab	Sample number	No. of blows resisted	Energy absorption (JOULES)
500mmx500mmx40mm	1	18	1323.0
	2	17	1249.5
	3	18	1323.0
Average		**18**	**1298.5**

Test on GFRP Concrete Slab Type (80 mm)

TABLE 4. Slab Type – GFRP Concrete

Slab type	Sample number	No. of blows resisted	Energy absorption (JOULES)
500mmx500mmx80mm	1	55	4042.5
	2	48	3528.0
	3	51	3748.5
Average		**51.33**	**3773.0**

V. CONCLUSION

The following conclusions are drawn from the investigation into the impact loading on slabs measuring 120mm thick and panels of varying thicknesses, including 40mm, 60mm, and 80mm

- Glass Fiber Panels with a thickness of 40mm exhibit the lowest ultimate impact energy compared to all other slabs.
- A 120mm thick Plain Cement Concrete (PCC) slab demonstrates 33% higher Energy Absorption than a 40mm thick panel
- Glass fiber reinforced panels with a thickness of 60mm absorb 116.67% more Impact Energy than 40mm thick panels and 62.5% more than PCC slabs.
- Panels with an 80mm thickness absorb 183.33% more Energy than 40mm thick panels, 112.5% more than PCC slabs, and 30.77% more than 60mm thick panels.
- Initial cracks tend to appear at the bottom of slabs and panels, becoming visible on the sides and panels, and progressing upward with an increase in the number of blows.
- Glass Fiber Reinforced panels demonstrate higher energy absorption compared to conventional plain cement concrete mixtures, with maximum energy absorption observed in specimens with increased thickness.

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