

# Properties and Applicability's of Glass Fibre Reinforced Gypsum (GFRG) Panels

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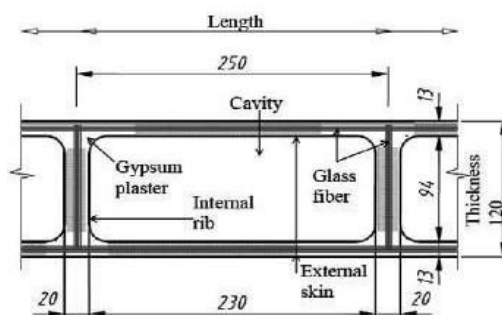
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**Abstract:**The construction industry is growing at very fast rate in India. India also faces the challenges of affordable housing. To overcome the need of housing in India and to achieve the Housing For all Mission 2020, Affordable construction materials should be studied. Affordability in construction can be achieved through Innovative, Alternative, Energy efficient material and long lasting material. Gypsum is a durable as well an industrial waste product. Glass fibre reinforced gypsum panels are composite material comprising of calcined gypsum mortar and glass fibre. GFRG panels can be used for rapid construction and as well to achieve affordability in construction. GFRG panels are prefabricated panels which are widely used for partition walls and can be used as load bearing walling system in construction. GFRG panels are light weight, high compressive strength, shearing, flexural strength etc. GFRG panels are also fire, water and heat resistance. This paper mainly focuses on the properties and applicability's of GFRG panels in construction industry.

**Index terms:** Affordable, Residential building, Panels, housing.

## INTRODUCTION

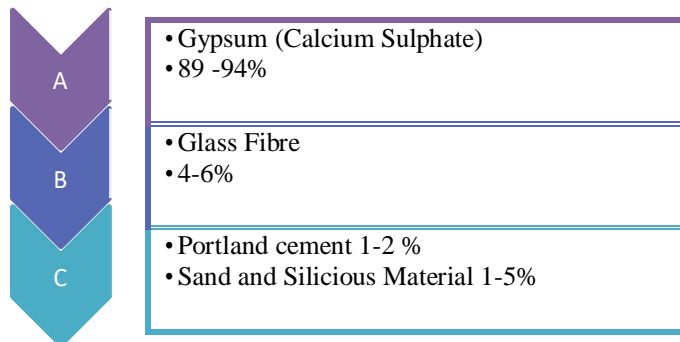
Beams, Columns, Bricks and plastering etc are comprises of conventional building designs which have many inefficiencies during the construction. Brick require lot of labor and manufacturing of bricks is mainly involves a lot of pollution, resource and energy. There are additionally imperatives in hiding and directing M&E (Mechanical and Electrical) administrations. Aside from utilizing increasingly serious labor and longer development durations, there are some innate challenges in accomplishing high caliber. To study and implement some new alternative material and techniques for building construction is the only way for cost effective, time effective and energy effective construction. Government of India has a mission of Housing for all till 2022 under PMAY (PradhanMantriAwasYojana) scheme for this there would be a great demand of affordable housing andfor affordable housing we must study the alternative, cost effective and rapid construction materials techniques. GFRG Panels (Glass Fibre reinforced Gypsum), also known as RAPIDWALL in commercial market. These panels were introduced in 1990 in Australia, basically they were introduced for rapid construction and an alternative to load bearing walls. In India RCF (Rashtriya Chemicals and Fertilizers) Mumbai and FACT (Fertilizers and Chemicals Travancore) Kochi are those who manufacture GFRG panels. (MENON, 2014) These boards contain cavities among ribs and rib which can be loaded up with RCC for extra quality. Pipe Gypsum, Phosphor Gypsum, Mineral gypsum or marine gypsum can be used for manufacturing GFRG panels. About 4 cells and 48 cavities are in each panel. The dimension of one cavity is about 124mm x 94mm x 3mm. The panels are light in weight due to these cavities. About 10-12% of weight is reduced in comparison of Brick or concrete masonry. (Shukla, 2016)



**Table No: 1**

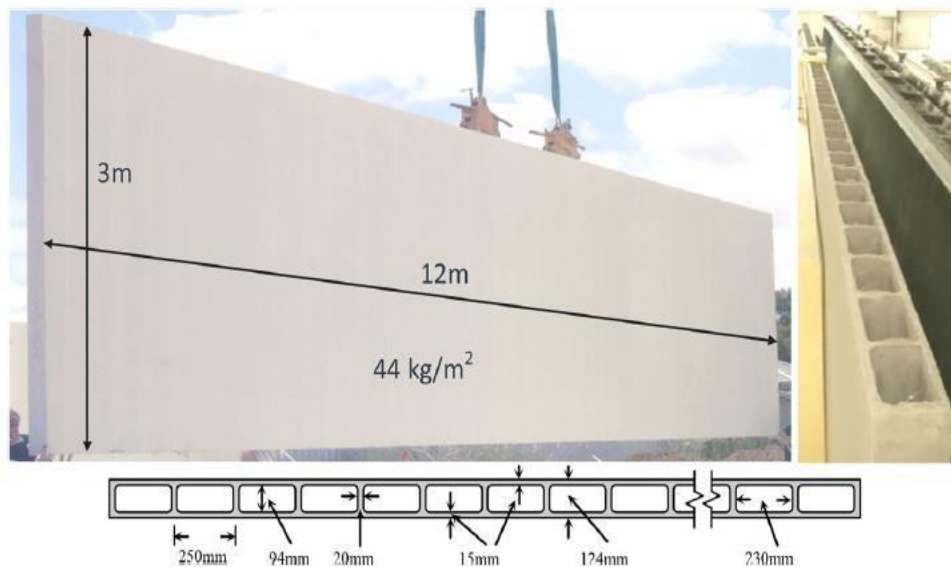
GFRG Panel Specification	
Length	12000 MM
Height	3000 MM
Thickness	124 MM

**CONSTITUENTS OF GFRG PANELS**



**Table No: 2**

Tensile Strength	35 KN/m
Ductility	4
Thermal Resistance R	0.36 K/W
Thermal conductivity	0.617
Sound Transmission	40
Axial Load capacity	16 tons/m
Unit Shear Strength	50.90 kN/m
Fire Resistance	700-1000°C (up to 140min)
“U” Value	2.85 W/M2K
Elastic Modulus	3000-6000 Mpa
Water Absorption	<5%



**Properties of GFRG Panels**

**Table No: 3**

GFRG panels unit weight	1440 kg
Compressive Strength	73.2 kg/cm2
Flexural Strength	21.25 kg/cm2

**Manufacturing of GFRG Panels**

The manufacturing procedure of a GFRG Panel is completed in a self-loader plant by combining the constituent fixings in satisfactory extents. The waste result of the compost/ fertilizers is reprocessed to make gypsum mortar that fills in as the crude material for creating the GFRG boards. The assembling procedure is essentially done in three extraordinary and progressive stages.

The calcined gypsum and other compound added substances are poured on an uncommon table made for the assembling procedure of the boards. At that point the glass filaments are spread uniformly on the blend in with the assistance of a screening and moving procedure. When a layer of blend is finished, aluminum plugs are embedded having a hole of 20mm between them. These aluminum plugs are acquainted with empty holes inside the boards. The second layer of blend is then poured on the aluminum plugs alongside the cut glass filaments. Packing is done to frame ribs on the empty boards. In the last stage, a similar procedure as the principal stage is rehashed to finish the top layer of the boards. (PACS, 2011)

This course of action is left for setting, which is around 25 minutes. At that point the throwing table is turned to arrive at a vertical position so the board can be taken out. It is then saved for drying by methods for an exceptional forklift. The drying is completed in a dry chamber, where sight-seeing is ceaselessly circled to dry the board equitably for roughly 20 minutes.



Source: (Atull, 2017)

**Flow Chart of Manufacturing Process of GFRG Panels**

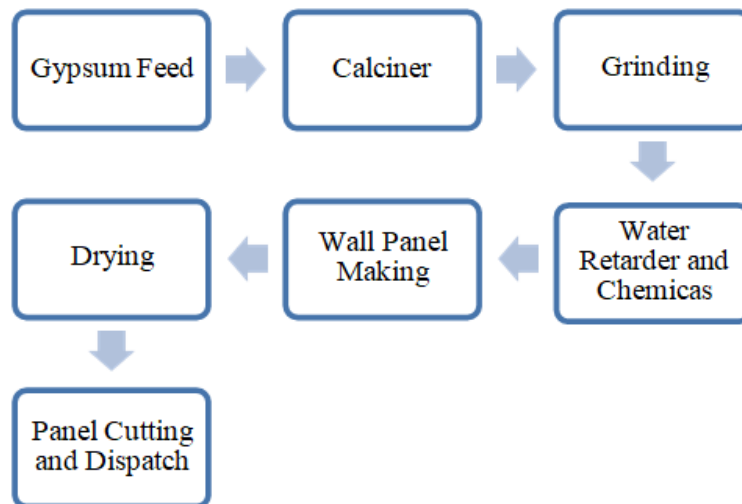


Table No: 4

**PROPERTIES OF GFRG PANELS**

**Seismic performance-** About 10 Storey’s buildings can be build using these panels in moderate seismic zones. The panels have intensity to resist lateral loads without any joint failures.

**Sustainable Development**–The panels are light weight and are also applicable for construction high rise buildings, residential complexes, commercial complexes and industrial buildings. Pre-Cut of Windows and door openings is done in factory and is delivered to the site. So the cost is reduced, thus saving of time is

maintained, the panels are recyclable, fire and water resistant as well as rot resistance, panels can help for sustainable development in construction industries

**Cost effectiveness** - Compared to traditional products, panels achieve far better results, at considerably reduced cost. The speedy construction represents additional savings and about 50% of energy embodied cost can be achieved due to its thermal properties

**Rapid installation** - The construction experiences using the system show marked reduction in construction time compared to traditional building methods.

**Lightness, ease of transport & handling** - Being light weight and rigid, panels are both easy to handle and transport even in the most adverse conditions.

**Versatility** - The building system gives full design flexibility as it offers a complete range of building elements such as load-bearing walls, curtain walls, floors, stairs etc. **Wide choice of finishes** - Buildings constructed using panels can be completed in a variety of finishes, or can be painted traditionally on smoothed plaster.

**Cyclone resistance** - Laboratory tests conducted on buildings, to determine the resistance of cyclone impact and damage caused by wind-borne debris confirm the strength of the building System against such loads.

## APPLICATIONS OF GFRG PANELS

### Load Bearing Walls

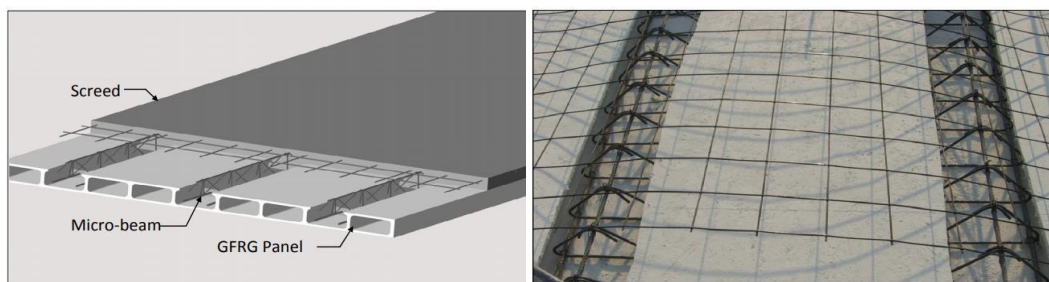
The panel can resist vertical and lateral loads when filled with reinforced concrete by which multi storeyed construction can be achieved. For single or two storeyed buildings the cavities can be kept unfilled.

Partition walls

Compound walls can also be done with panels.

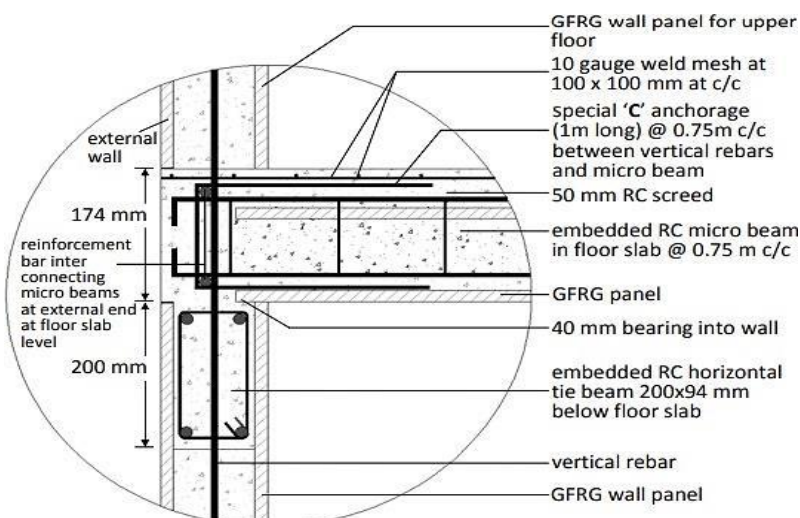
As horizontal floor slabs / roof slabs can be done with Screed.

Micro beams and reinforced concrete.



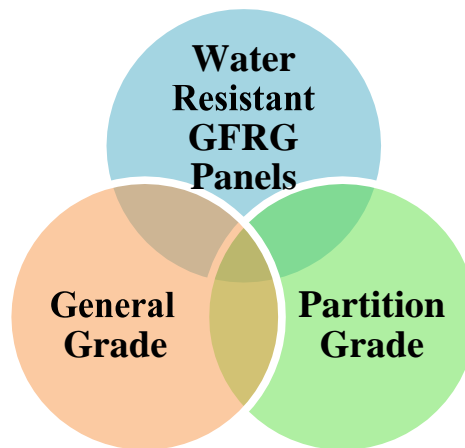
### Use as Roof Slabs and Floor Slabs

Gfrg panels can be utilized for slabs with the use of reinforced concrete. The strength can be achieved by improvised by inserting reinforced concrete in micro beams.



Source : (Singh P. , 2020)

### Classification of GFRG Panels



**Water Resistant GFRG Panels** also known as Class One Panels these panels are used for external walls were especially to resist water or dampness is a prime factor, also for form work these panels are used.

**General Grade Panels** also known as Class two panels are mainly used for structural as well as non structural walls. These panels are not used for external walls.

**Partition Grade** panels are also known as Class Three Panels are mainly used for purpose of constructing partition walls and mainly in dry areas.

#### Construction of houses by using GFRG Panels. Excavation and Foundation

Excavation / Uncovering of soil is completed a similar method to establish the framework. Initial step is the Foundation. The three most normally utilized sorts of establishment are Strip Footing, Isolated footing, and Raft footing. Raft Footing is commonly utilized for multistoried structures or on the off chance that if the dirt is distinguished as powerless. Isolated Footing is commonly utilized for houses which are small.

When the foundation is laid, the waterproofing of the foundation is done by splashing the fitting synthetic compounds or chemicals.

#### Placement of Panels

Casting of Reinforced concrete is done for the plinth beams. to place the gfrg panels the starters bars are fixed inside the casting of concrete. Transportation of panels is done from manufacturing site to the site. They are set on the starter bars as indicated by the measurements and the positions marked out to them. When they are done the placing of panels, waterproofing is done to keep the joints secured.



Source : (Falak, 2019)

#### Concrete Mixture pouring

Subsequent to fixing the GFRG boards, they should be held set up until the concrete mixture is poured onto them. The help to these boards is given by the support bars. At that point the concrete mixture is filled into every one of the holes of boards from the top.



### Placements of Slabs

On Completion of Walls, Slabs are done by placing the panels on top. Concrete mix is poured on to the slabs, Provision of reinforced cage for the implanted beams is done. Roof slab is concreted and finishing with plastering is done for completion.



**Comparative analysis of a Construction in 150 mm Brick wall, 150mm R.C.C wall and GFRG PANEL**  
*Consider a construction Room of size 3.00m x 4.5m x 3.25m room is having a door 0.9m x 2.10m and a window of size 1.50m x 1.2m as shown in below plan*



Plan



Source :(<https://www.rapidwall.com.au/>)

Examples of Buildings Constructed with GFRG Panels



Source :(Kudumbashree)

Criterion	150 mm Brick WALL	150 mm RCC WALL	124mm GFRG Panel
Construction Cost Approx Cost	Total Const. Cost = 85,555 /-	Total Const. Cost = 723900 /-	Total Const. Cost = 65800 /-
Sound Insulation	0.05	0.02	0.28
Durability	10 years	20 years	20 years
Time	15 Days	12 Days	2-3 Days
Heat Transmission	50%	38%	28%
<b>Remarks</b> <ul style="list-style-type: none"> <li>• Value for money Material.</li> <li>• More durable then brick wall and RCC wall.</li> <li>• Speedy and Easy to construct, less labour required for Construction.</li> <li>• Provides Good Sound Insulation.</li> <li>• Less Heat Transmission.</li> <li>• Eco Friendly Material.</li> </ul> <p><i>Savings in Time and Labour upto 40%, Savings In Steel, Savings in Cement, (Plastering, bed Mortar, Joints), savings in Space upto 20%. Hence Cost Effective Material</i></p>			

### Advantages of GFRG Panels

- Innovative and Alternative construction Material
- Cost effective and affordable material.
- Green Environmentally friendly and sustainable material
- Economical and Speedy construction is achieved
- Good Sound and Thermal Insulation is Achieved
- Durability and Strength are similar to conventional construction is an advantage of material.
- Minimal and Reduced CO2 emissions.
- Minimal use of cement, sand, steel and water.
- No requirement of extra plastering as it has good finishes.
- Multi storied buildings up to 10 floors construction can be done without the columns and beams.
- Resistant to earthquake and Fire are additional pros of GFRG panels.

### Disadvantages of GFRG Panels

- Skilled Labour and Experienced workman are required for the construction.
- Handling of Panels must be done carefully.
- Use of Specific machinery to cut the panels is required on site.
- Buildings with Curve designs and Circular Forms cannot be constructed with GFRG panels.
- Use of crane and large space during the construction is needed.
- Buildings with similar plans can only be constructed in the GFRG panels.

### *Facilitation Complex in Kochi for CSEZ*



### *School Building at Thrissur, Kerala*



### *Administrative building at Kollam*





Academic Block at Malayalam University (G+1) Building having Classrooms and Library Block



## CONCLUSION

GFRG panels can be a boon to housing construction industry, speedy construction, economical and sustainable material is need of the developing countries and especially India. To achieve the Housing for all mission 2020. This material can play a important role. Use of GFRG panels and awareness in the construction industry must be done. Besides some minor disadvantages this material has many benefits for the growth of the construction industry. Use of Cement, sand, steel and water can be minimized. The simple design, efficient production, easy transportation and quick erection of the building unit reduce time lines of projects of all sizes. The monolithic structure created by the panel in conjunction with concrete enables it to withstand earthquakes, hurricanes and high winds. Specifically, on the cost of production and time of construction, GFRG Panels has an edge over conventional building materials.

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