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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Study on Glass Fiber Reinforced Gypsum (GFRG) Panels

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A B S T R A C T

The comprehensive planning, coordinating, and oversight of a construction process from start to finish constitutes construction management. A qualified service is provided by uses specific project management methods to supervise the project's whole planning, design, and construction process. Controlling the time, cost, and quality of a project is the goal of construction management. Time, quality, and cost all play important roles in how well a project is managed. This triangle has formed the foundation of several construction systems. One of these systems was developed in Australia and is called GFRG. It is essentially a wall panel made from Phospo gypsum, which is readily available as a waste product from many different chemicals and fertilizer plants in large quantities. It aims to promote sustainable growth.The purpose of this research is to study GFRG panels in depth for construction management.

OBJECTIVE

To study different methods of construction to successfully achieve the structural design with recommended specifications.

Keywords: GFRG, Time, Quality.

1. INTRODUCTION

Glass Fiber Reinforced Gypsum (GFRG) Panel, also known as Rapid wall, is a mass-scale building construction material comprised of calcined gypsum plaster and reinforced with glass fibers. It was first produced and utilized in Australia in 1990. The panel has cavities that may be left empty, partially filled, or completely filled with reinforced concrete depending on the structural requirement. It is manufactured to a thickness of 124mm under carefully monitored circumstances and has a length of 12 m and a height of 3 m.It has been demonstrated through experimental studies and research in Australia, China, and India that GFRG panels filled with plain reinforced concrete have sufficient strength to serve as both load-bearing elements and shear walls that can withstand lateral loads brought on by earthquakes and wind. Without any limitations on the number of stories, micro-beams and RCC screed (acting on T-beam) can be employed to good effect as in-fills (Non-load bearing) in combination with RCC framed columns and beams in traditional framed construction of multi-story buildings.

Grade and Type: The three grades listed below may be used to supply GFRG panels:

Class 1 - Water Resistant grade: Panels that may be used for external walls, in wet regions, and/or as floor and wall formwork for concrete filling.

Class 2 - General grade: Panels that may be used structurally or non-structurally in dry spaces.

Class 3 - Partition grade: Panels that may only be used as non-4 structural interior partition walls in dry locations. These panels are generally inappropriate for use as wall or floor formwork.

1.1. Properties of GFRG panels

Mechanical property	Characteristics value	Remarks
Unit weight	40 Kg/m^2 ($1/8^{th}$ of concrete)	Unfilled single leaf GFRG panel
Uni-axial compressive strength	160 Kn/m	
Uni-axial tensile strength	35 Kn/m	
Elastic modulus	3000-6000 MPA	
Co-efficient of thermal expansion	$12X10^{-6}$ mm/mm/^{0}c	
Water absorption	<5%	By weight after 24 hrs. of immersion
Thermal resistance	0.36m^2 K/W	Unfilled panel
Sound transmission	28 45	Unfilled panel Concrete filled panel
Fire resistance	>3 hours	For structural adequacy

2. MATERIALS USED FOR MANUFACTURING OF GFRG PANEL OR WALL

There are different types of materials are used in the manufacturing of GFRG panel or wall). They are:

- Photo-gypsum
- Glass fiber roving's
- Water
- White cement
- D 50 (retarder)
- BS 94 (water repellent)

2.1. Gypsum handling

Around 2000 tons of raw gypsum are dumped at a specific phosphoric acid factory daily, therefore in the first stage, raw gypsum is collected using a truck from there and transported to the storage shed, where it is thinly ground into powder using a JCB as shown in Figure.

Fig 1Gypser handling

2.2. Calciner plant

Gypsum from the storage building is crushed and fed into the calciner for calcination. Gypsum raw material is heated throughout the calcination process to temperatures between 1800°F and 200°F with a 15 tons per hour output. Next, using a calciner to dehydrate gypsum, the calcium sulphate hemihydrate is produced, as shown in fig-2.

Fig 2 Calciner plant

2.3. Plaster handling

As seen in Fig. 3, the calcined gypsum is being kept in product silos with a 250-megaton capacity.

Fig 3 Plaster handling

2.4. Wall panel plant

The glass fibers should finally be distributed throughout the mixture using a screening and rolling procedure after the initial plaster layer has been applied. Then, over the completed first layer with a 20mm gap between them, special aluminum plugs are added to create hollow chambers in the panels. Then the second layer with glass fibers is poured on top of it, and after that the tapping procedure is carried out to produce the ribs of the hollow panel.To create the finished top layer of the panel, the first layer of the same procedure is repeated in the final step of the process. After that, setting it up takes about 25 minutes. Plugs are removed from the casting table once the setting period is complete, and the casting table is then turned into the vertical position depicted in Figure 4. The panel is then removed using specialized flock lifts, and acrobatics are utilized to lift it from one location to another.

Fig 4 Wall panel plant

2.5. Wall panel drier

The wet panel is moved employing an acrobatic technique from the casting table to the drying chamber. The wet wall panels are dried for roughly 90 minutes in a dryer chamber (illustrated in fig. 4.8), where hot air is circulated. The cured panel is put into the racks for drying, as indicated in figure 6. After the drying process the panels are been brought to the cutting plant where the panels are been cutted to the required dimension.

2.6. Utilities

The panels are placed onto the truck using a crane at the cutting factory, as illustrated in fig. Loaded trucks are then sent to the designated locations.

3. INSTALLATION PROCESS

There are several stages which is been involved in the construction of GFRG system.

Stage-1: up to plinth level the construction is done as per conventional building (GFRG Panels are does not require any special foundation).
Stage-2: Than, the panels are lifted with cranes and special hooks and are placed in the proper position.
Stage-3: once the panels are placed properly, the cutting of doors, windows, sanitary fittings etc., is done.
Stage-4: Reinforcement bars are inserted where the in-fillment is to be done.
Stage-5: Concrete pouring is done. Concrete is poured in different levels of 1 m each at the interval of 1 hour.
Stage-6: Now, the panels are placed for the slab and triangular reinforcement is done for the slab and placed as per structural design than the concreting is done.
Stage-7: Finally, the water proofing is done on the roof.

4. STRENGTH OF GFRG PANELS

1. Compressive strength
   a. Empty panel------73.10 Kg/cm^2
   b. Concrete infill----180.70 Kg/cm^2

2. Flexural strength
   a. Empty panel----21.25 Kg/cm^2
   b. Concrete infill----20.80 Kg/cm^2

3. Net density------1140 Kg/m^3

4. Earthquake resistance------ Up to Ritcher scale-8

5. Fire resistance (rating 700^0C to 1000^0C)----4 hours

5. COMPARISON OF GFRG WALL BUILDING vs CONVENTIONAL BUILDING (for 1500 Sq. ft)

Materials/items	GFRG wall building	Conventional building	Saving in %
Cement	16 tons	s32.55 tons	50.8
Steel	1800 kg	2779 kg	35.2
River sand	20 cum	83.37 cum	76
Granite metal	38 cum	52.46 cum	27.56
Water	50000ltr	2000000ltr	75
Built area	143 sqm	154.45sqm	8
Labor	389-man days	1200-man days	67.59
Construction time	21 days	120 days	82%
Total wt. of Superstructure	170 tons	490 tons	65
Construction cost	Rs 13.25 lakhs approx.	Rs 18.27 lakhs approx.	27.47%

6. CONCLUSION

- It took 21 days for the GFRG building system and 120 days for the traditional building system.
- By contrasting the two, we may conclude that the GFRG building system saves 42 percent more time than the conventional building method.
- Each day, construction is completed on 143 square meters of GFRG buildings and 154.45 square meters of conventional buildings.
- When compared to a conventional building system, the cost for a GFRG building system was Rs 13.25 lakhs approx. and Rs 18.27 lakhs approx.
- By contrasting the two, it can be determined that using a GFRG system will result in a 27% cost savings compared to using a traditional construction.

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