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GFRG Panel Method for Low Cost Construction

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ABSTRACT: Economical plan and development of structures, utilizing green material is an option in contrast to exhaustion of totals and increment in cost of concrete. Glass fiber reinforced gypsum panel (GFRG) is a green material, which is a rapid wall construction method and a cost-effective construction process. With the end goal to enhance the productivity, and decrease of waste, the lean the development has been presented as another administration rule for better execution. In India, the usage of lean administration in the development industry is a noteworthy errand. Because of the absence of consideration and uneducated towards the lean administration guideline the proprietor, contractual worker, engineers and so on are as yet creating a stage to actualize this standard in their task. This venture primarily centers on to recognize the potential outcomes of execution of lean administration in the development industry. This paper shows the probabilities of compelling usage of lean administration guideline in the development industry, which can definitely diminish the use of time, increment the nature of work, and benefit rate by wiping out the wastage of materials. It finally, points in giving lodging to all classes of people, in this way enhancing the economy of India.

KEYWORDS: Glass Fibre Reinforced Gypsum, Gypsum, GFRG, bracing, Deflection, AutoCAD

I. INTRODUCTION

GFRG (Glass Fibre Reinforced Gypsum) panels are building panels suitable for affordable mass housing construction, originally introduced in Australia in 1990 (as 'Rapidwall'). These are large load bearing building panels manufactured out of calcined gypsum, glass fiber rovings and special additives. In India, phosphogypsum (a by-product waste from the fertiliser industry) is used for the manufacturing. Currently, Rashtriya Chemicals and Fertilisers (RCF), Mumbai and FACT – RCF Building Products Ltd (FRBL), Kochi produce GFRG panels in India, in technological collaboration with Rapid Building Systems (RBS) Pty. Ltd., Australia. GFRG panels are manufactured to a size of 12m length, 3m height and 124 mm thickness with hollow cavities as shown in Figure 1.1. The cross-section of the panel is shown in Figure 1.2.

A. *Durability/ Life of GFRG Buildings:*

In GFRG buildings, GFRG panels are used as walls, floor / roof slabs, staircases, etc., with many (if not all) cavities infilled with plain or reinforced concrete of M20 / M25 grade, as per the requirements of IS 456 : 2000. The reinforced concrete cores in the cavities are not directly exposed to the environment and are protected by the presence of the GFRG skin (15 mm thick) on either side in the case of wall panels and on the underside in the case of slabs. Further application of mandatory primer on all exposed GFRG panel surfaces and prescribed waterproofing treatment (specified in the 'Manual of Waterproofing of GFRG / Rapidwall Buildings') provides additional protection. Hence, if all the components of the GFRG building system are properly designed (as per the 'GFRG / Rapidwall Building Structural Design Manual' *3+) and constructed and finished (as per good practice, prescribed in this Manual), there is good reason to believe that the durability and life of the GFRG buildings will certainly not be less than that of conventional well-maintained buildings. The excellent performance of the oldest GFRG buildings in existence, presently located in Australia (close to 30 years), supports this assertion.



Fig.1.1 Panels in stillages

A. Preparation of Drawing and Obtaining Building Permit from Authorities

An architect / structural engineer who is familiar with GFRG technology and its application shall prepare the drawings, keeping in mind the limitations of the technology (as stated in Chapter 1). By following the guidelines given in the structural design manual [3], a proper structural design shall be carried out. Any additional beams, cantilevered projections, balconies, etc., as provided by the architect in the building plan, shall be structurally designed, as done for conventional buildings. The conveyance facilities available in India, allows transportation of panels to a maximum length of only 6m. Based on this constraint and the plan dimensions, panels shall be cut in the factory before transporting to site

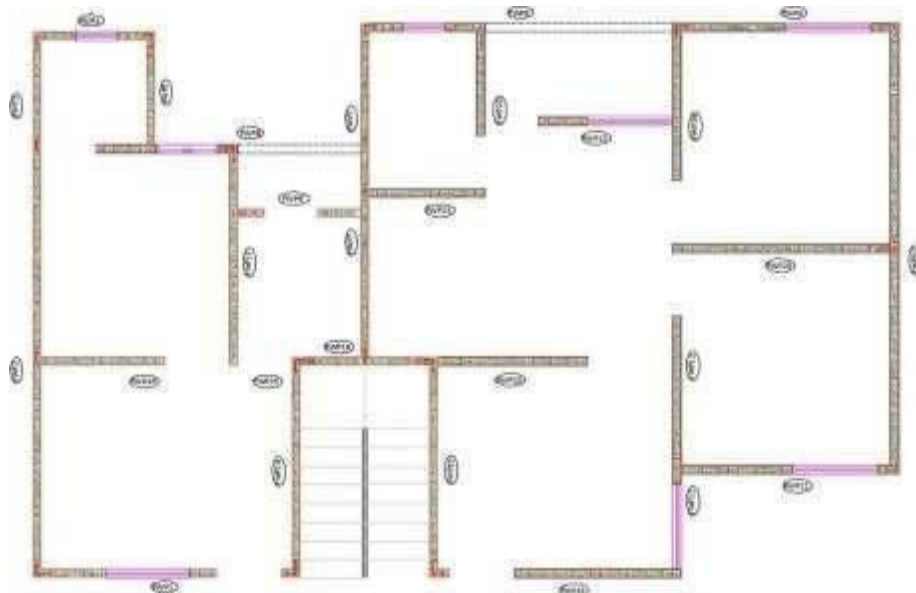


Fig. 1.2 Typical Floor Plan of a GFRG Building Showing Wall Panel Notations

II. RELATED WORK

Devdas Menon [2014] discussed a construction of building made in IIT Madras. The building is constructed victimization of GFRG Panels that have made out of mineral, mostly accessible in style of Phosphogypsum, a waste by- product of fertilizer trade and glass fiber as a reinforcing agent, which boosts the strength of the panels. The building panels are appropriate for reasonable mass housing, with the benefits of value effectiveness and fast construction.

Eldhose M Manjummekudiyil et al. [2015] studied regarding GFRG Panel strengthening victimization of very different concrete mixes crammed within the cavities. They used three very different concrete mixtures within the panels for testing. The concrete is a Nominal mix M25, Fly-ash concrete and Recycled Aggregate concrete. The main objective of victimization ash in most of the cement concrete applications is to urge sturdy concrete at a reduced value. The addition of fly ash as additional ingredients at the concrete mixing stage as part replacement of OPC and fine aggregates is a method that is more flexible.

Aishwary Shukla, Mohd. Afaq Khan (2016) researched on wall panel building system. This paper surveys about advancements in the field of building frameworks utilizing glass fiber strengthened gypsum boards. GFRG boards, made in institutionalized parts or segments prepared for quick gathering and erection as structures are instant gypsum boards with empty depressions. This Rapid divider is used in private and business built abodes. At the point when the empty depressions of GFRG boards are loaded up with strengthened self-compacting concrete, the security between the solid and the GFRG boards yields another composite.

Mohamed Said MeselhyElsaeed (2016) Studies about the GFRG framework and configuration cost model to examine coordinate expense for the framework amid the planning stage. The market cost for this framework is separated into two fundamental perspectives; cost and increase. The increase viewpoint is separated into the possibility, which is principally identified with hazard investigation and it contrasts regarding the site, proprietor and venture. The other angle is net revenue, which relies upon market status and plausibility examine for the undertaking. Cost viewpoint is partitioned into two stages, which are the immediate cost and roundabout expense. Increase and circuitous cost perspectives cannot be broke down in this exploration, as they are venture-arranged viewpoints.

Sk. Subhan Alisha et al. [2016] discovered gypsum is a tough material, The establishment cost comes to around 10 to 15% of the aggregate building. It is recommended to receive as curve establishment in common soil for affecting a decrease in development cost up to 40%. The conventional R.C.C. lintels, which are expensive, can be substituted by block curves for little ranges and spare development cost up to 30 to 40% over the conventional technique for development

III. METHODOLOGY

The GFRG (Glass Fiber Reinforced Gypsum) panels, also known as Rapidwall or Rapid Building System, are a construction material made of a composite of gypsum plaster reinforced with glass fibers. The panels are used in building construction to create walls, partitions, and other structural elements. Here's a general overview of the methodology involved in the production and installation of GFRG panels:

3.1 Design and Engineering:

The design and engineering of the GFRG panels are typically carried out by architects, engineers, and designers. The dimensions, layout, and structural requirements of the panels are determined based on the specific project needs.

3.2 Material Preparation:

Gypsum plaster and glass fiber reinforcement are the primary materials used for manufacturing GFRG panels. The gypsum plaster is mixed with water to create a slurry-like consistency. Glass fibers are added to the slurry to enhance the strength and durability of the panels.

3.3 Panel Manufacturing:

The prepared mixture of gypsum plaster and glass fibers is poured into pre-designed molds or formwork. The mixture is carefully compacted within the molds to eliminate air voids and ensure uniform distribution.

The panels are left to cure and harden within the molds for a specific period, allowing the gypsum to set and achieve its desired strength.

3.4 Panel Finishing:

After the panels have sufficiently cured, they are removed from the molds. Any necessary finishing work, such as sanding or trimming, may be done to achieve the desired surface quality and dimensions. Openings for windows, doors, electrical fixtures, and plumbing conduits can be cut or molded into the panels during this stage.

3.5 Transportation and Installation:

The finished GFRG panels are transported to the construction site using appropriate vehicles and handling equipment. On-site, the panels are lifted and installed in their designated positions according to the construction plans and specifications.

The panels are securely attached to the building's structural frame using suitable techniques, such as adhesive bonding, mechanical fasteners, or a combination of both.

3.6 Jointing and Finishing:

Once the panels are installed, jointing materials, such as gypsum-based joint compounds, are used to fill and smoothen the gaps between adjacent panels. The jointing compounds are applied and finished to achieve a seamless appearance. After the jointing is complete, the surface of the panels can be further finished with paint, texture, or other decorative treatments as desired.

It's important to note that the specific methodologies and techniques may vary depending on the manufacturer, construction practices, and local building codes and regulations. Therefore, it's recommended to consult the manufacturer's guidelines and work with qualified professionals when working with GFRG panels.

IV. RESULT ESTIMATE & COST ANALYSIS

At present, more than 600 GFRG buildings have been constructed across the country, mostly individual houses. The first of the group housing projects carried out has 36 units of 2 storeyed houses with single (32 nos.) and duplex (4 nos.) units each of built-up areas 43 sq.m. and 38 sq.m. respectively at Nellore. This is the first mass housing project in the country, which is a huge project for the EWS (Economically Weaker Section) and LIG (Low Income Group) class. The first GFRG building in India was constructed inside the campus of Rashtriya Chemicals and Fertilisers Ltd., Mumbai, using panels exported from Australia. Some of the GFRG buildings constructed so far in our country are mentioned in this section.

A. *Estimate:*

In the given context a case of 2 BHK HOUSE has been taken to make a comparison between the construction duration in both cases; BRICK WALL and GFRG panel. On the bases of days of different construction and their respective schedule rates of work, a final estimate is calculated in case of GFRG Panel.

Type of Building: PRIVATE Building (2 BHK HOUSE)..

Type of Construction: Rapid wall construction with GFRG

panels Area: 880 Sq.ft/ 81.75 Sq.m

No of Rooms:

2 Bedrooms 1

common hall

3 WC

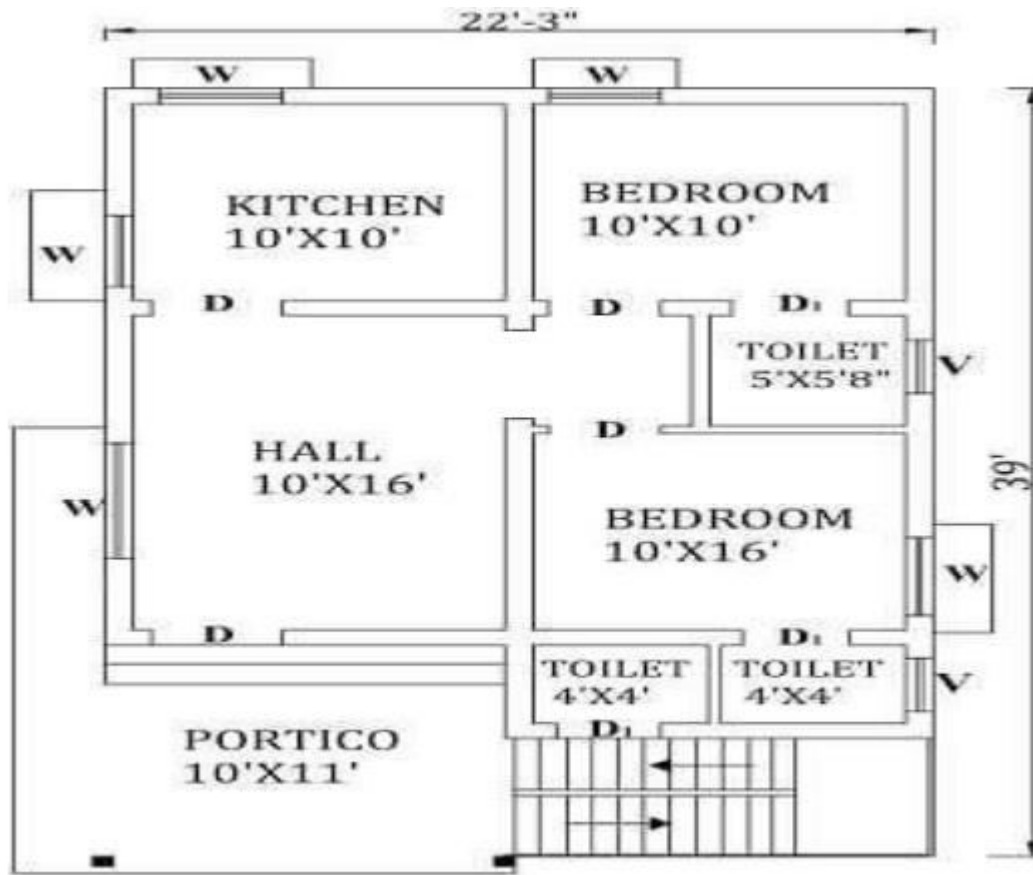


Fig.4.1 NORTH FACING HOUSE (2BHK)

Table 4.1 House Description

S.No.	DESCRIPTION	DETAILS
1	PLOTSIZE	20*44
2	BUILDINGSIZE	18*42
3	FACING	NORTH
4	No.OFFLOORS	GROUND
5	TYPE	RESIDENTIAL

Table 4.2 Construction Duration

S.no.	ItemOfwork	RCC (Duration in Days)	GFRG (Duration in Days)
1	EarthWorkExcavation	2-4	2-4

2	C.CBed1:4:8	2-3	2-3
3	Brickwork in Foundation	5-7	5-7
4	Plinth Beam with DPC	2-4	2-4
5	Columns	9-10	-
6	Walls	10-15	2-4
7	Beams	15-18	-
8	Lintels	4-5	2-3
9	Slab	28	14
10	Plastering	10-12	-
11	White Wash	3-4	-
12	Color Wash	2-3	2-3
13	Flooring	3	3
Total Duration		98-115	34-44

GFRG Panel cost is around Rs. 999 per Sq. m. While introduced in India in the year 2018 but now after adding the GST of 12%, its current price is Rs 1120 per sq. m.. Price may vary from state to state. Whereas the brick work cost is Rs 1200 per sq. m.

1) Preliminary Estimate

Table 4.3 Preliminary Estimate

Materials/items	Rapid wall Building by GFRG	Conventional Building	Saving in %
Cement	9.3 tons	19.09 tons	105.26
Steel	1056 kg	1631 kg	54.45



Sand	11.7cum	48.91cum	318.03
Granite	22.29cum	30.77cum	38.04
Bricks	-	33560	-
GFRGpanel	293.35sqm	-	-
Water	29335ltr	117340ltr	300
Labour	228man/days	704man/days	67.59
Constructiontime	13days	71days	208.77
Wt. of Superstructure	99.74tons	287.48tons	188.22
Construction Cost	Rs9.86lakhs	Rs13.58lakhs	37.83

A) Cost Analysis

SrNo.	ItemDescription	Quantity	Unit	Rate	Amount(Rs)
1	Earthworkinexcavationinfooting:	54	cum	75	4050
2	P.C.Cinfoundation:	2.704	cum	2500	6760
3	column(300mm×300mm)	4	cum	7090	28360
4	PlinthBeam	6.97	cum	3000	20910
5	Earthfillinginplinth	47.61	cum	40	1905
6	Dampproofcourse(DPC)	22.47	sqm	330	7416
7	GFRGPanelWalls	198.5	sqm	1120	222320
8	GFRGPanelSlab	37.18	cum	1120	41641
9	Flooring	100.3	sqm	1120	112336
10	Dado	198.95	sqm	1500	298425



11	Skirting	107.22	perm	457	49007
12	FixingofDoors	32.34	sqm	3192	103230
13	FixingofWindows	28.08	sqm	3192	89632
				Totalcost	986000
	RecapitulationSheet:				
	Add8%Electrification Charges	78880	Rs		
	Add 5%PlumbingCharges	49300	Rs		
	Add5%ContingenciesCharges	49300	Rs		
	Add2.5%ofWorkChargesEstablishment	24650	Rs		
	TotalCost	1188130	Rs		

V. CONCLUSION

A detailed study, appraisal and analysis of the GFRG Panel based building System was carried out during this study which leads to the following are the conclusions:

- GFRG Panel based construction is a new approach to building construction.
- This construction method takes a giant leap towards sustainable living reducing the adverse impact on the environment which is generally attributed to the conventional construction technologies that have been followed.
- Although theoretically there are advantages of using this technology, a few practical issues do arise as to its disadvantages (Ex. Crane movement, expertise, and storage of panels)
- Even though GFRG panel technology is widely accepted and used in the southern part of India (mostly in Tamil Nadu, Andhra Pradesh and Kerala), it is not used in the northern part of the country. The main reason is the transportation cost of these panels which makes the use of these panels non-viable.
- There is a lack of awareness pertaining to this technology among the people including developers, contractors and end-users.
- This technology can be suitable to the affordable housing or EWS or where Rapid construction is required. It can be a good choice for Rehabilitation Housing, temporary housing (in case of natural calamity or disaster, etc.) or when there is a huge demand of housing in a short time. (subjected to the availability of the panels)
- GFRG technology is comparable to conventional construction systems with few limitations. Example: Poor performance of un-fill panels in case of fire resistance and acoustics. Whereas both these

parameters are up to the mark when panels are infilled. (Filling of panels leads to extra cost and reduction in savings)

- While looking at the completion of overall project including the infrastructure and external development which are required for a project to become operational it is observed that- even if the dwelling units are ready (in short time) in isolation, the whole project cannot be operational in the absence of external ancillary and supporting services (drainage, electrical supply, water supply, storm water, roads, etc.). Hence, extensive planning is required if this technology is to be used in mass housing projects where external development is of considerable importance.
- The savings percentage in costing between CONVENTIONAL BUILDING & GFRG BUILDING, for a 880 sq. ft., 2BHK house comes out to be 37.83 %.

REFERENCES

- [1] Devdas Menon (2014) "Rapid Affordable Mass Housing using Glass Fibre Reinforced Gypsum (GFRG) Panels" International Journal of Scientific & Engineering Research.
- [2] Eldhose M Manjummekudiyil, Basil P Alias, Biji K Eldhose, Sarath Rajan, Thasneem Hussain (2015) "Study of GFRG panel and its Strengthening" International Journal of Civil and Structural Engineering Research.
- [3] Mohamed Said Meselhy Elsaeed (2016) "Cost Model for using Glass Fibre Reinforced Gypsum System (GFRG)" International Journal of Development and Economic Sustainability.
- [4] Aishwary Shukla, Mohd. Afaq Khan, Abhishek Kumar (2016) "A Review of Research on Building System Using Glass Fiber Reinforced Gypsum Wall Panels" International Research Journal of Engineering and Technology (IRJET).
- [5] Sk. Subhan Alisha, Sajja. Neeraja, Sk. Akber, G. Sai Manoj (2016) "Low Cost Housing by Using GFRG Panels" International Journal of Scientific Research in Science, Engineering and Technology.
- [6] Usama Hamed Issa (2013), "Implementation of Lean Construction Techniques for Minimizing the Risks Effect on Project Construction Time"
- [7] Lianying Zhang^a, Xi Chen^b, "Role of Lean Tools in Supporting Knowledge Creation and Performance in Lean Construction"



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