

# Towards Achieving Economical, Efficient and Environment Friendly Housing by GFRG

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**Abstract :-** There is a rapid increase in the requirement of building materials in India due to the existing condition of transformation from temporary housing to a permanent housing causing shortage of housing material . But construction industry is still using old methods, techniques and conventional technologies. The real focus is to provide a cheap housing which is not that durable and thus innovatively thinking is never kept in focus and so it compromises with cheap material which affects durability and performance of building ultimately reducing the life cycle of structure and so the fact is that the proper path to achieving economy goes through proper technique and innovative thinking. Low-cost and affordable housing is a better way to provide the shelter to the lower middle class and poor families which can be reached through the use of proper techniques. To achieve effective and affordable housing a material known as GFRG(Glass fiber reinforced gypsum) has been studied . Glass fiber reinforced gypsum (GFRG) wall panel consist of gypsum in its plaster form and glass fiber which are bonded together to form a composite material in form of a panel. This panel's are hollow from inside and so can be used as load bearing walls. The hollow cores inside the walls is filled with reinforced concrete or in-situ plain .There are various other material which can be used for affordable housing but in this study the main focus is kept on GFRG .

**Keywords:** - Affordable housing, GFRG, in-situ plain.

## I. INTRODUCTION

To achieve the aim of reduction in the use of high resource and energy demanding construction materials and for fast delivery of houses and which should be economical are the key challenges faced in the field of affordable housing today. There is huge demand for various construction materials such as coarse aggregate, fine aggregate, cement, bricks in order to achieve the large demand for housing. As all of this products are either mined or manufactured which causes tremendous amount of environmental pollution and due to scarcity of material available the prices of this material are increasing and thus there is immediate demands for a innovative solution but which should be also affordable,

which will help to achieve the goal of affordable and efficient housing needs for the Lower middle Income Group and Economically poor group.

GFRG panel which is also called Rapidwall panel. This rapidwall panel is an economical and energy efficient building material also known as green building material with tremendous possibility for use of this panel in load bearing and non load bearing wall. As we are constructing for affordable housing, so the both internal and external wall panels should be load bearing panels. This panels are having the modular cavities which can be filled by various binding materials (Nominal Mix of M25 grade concrete, Recycled aggregate concrete and the fly ash concrete) according to environmental factors, which provide the required load bearing strength and thus making the structure stable .This can further be used for slab of house roof with a composite material usually Reinforced cement concrete (RCC) and the same is applied for intermediary floor .

For filling the cavities of the panels there are various options such as Nominal Mix of M25 grade concrete , Recycled aggregate concrete and the fly ash concrete. When various test were conducted to determine the compressive strength of various fillers .Results are shown in Table -1 .

Table- 1: Compressive Strength of GFRG Panel With Filler Material

Filler Material	Compressive Strength(N/mm <sup>2</sup> )
Nominal Mix of M25	13.97
Recycled Aggregate Concrete	8.12
Fly ash Concrete	9.62

In future with more R&D on Rapidwall panel it can been used for various sizes of building such as single storied to medium size buildings. With current technology this panels have large shearing strength, flexural strength high

compressive strength, ductility , high level of resistance to rot and corrosion, heat, water, termites, so in future the

properties will definitely enhance the quality of panels.

## II. DIMENSIONS OF GRFG PANELS

Table –2. Dimensions of GRFG Panels

Size of Panel	12m x 3m x 124mm	L x B x H
Each Panel	48 cavities	
Size of Cavities	230mm x 94mm x 3m	
Weight of Panel	1440 Kg or 40kg/sqm	
Density	1.14g/cu. cm	Approx 9.5-13% wt of comparable concrete

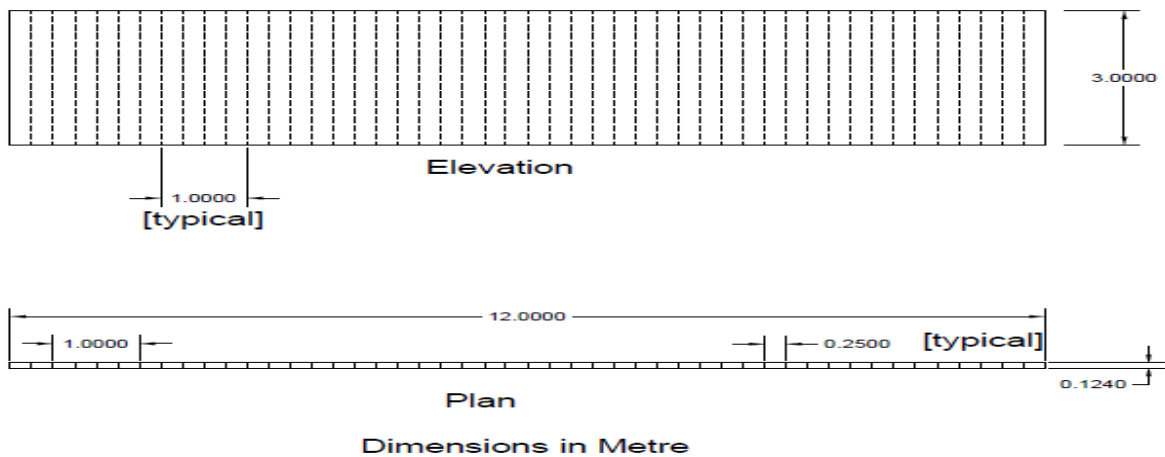


Figure 1: Plan and Elevation of GRFG panel

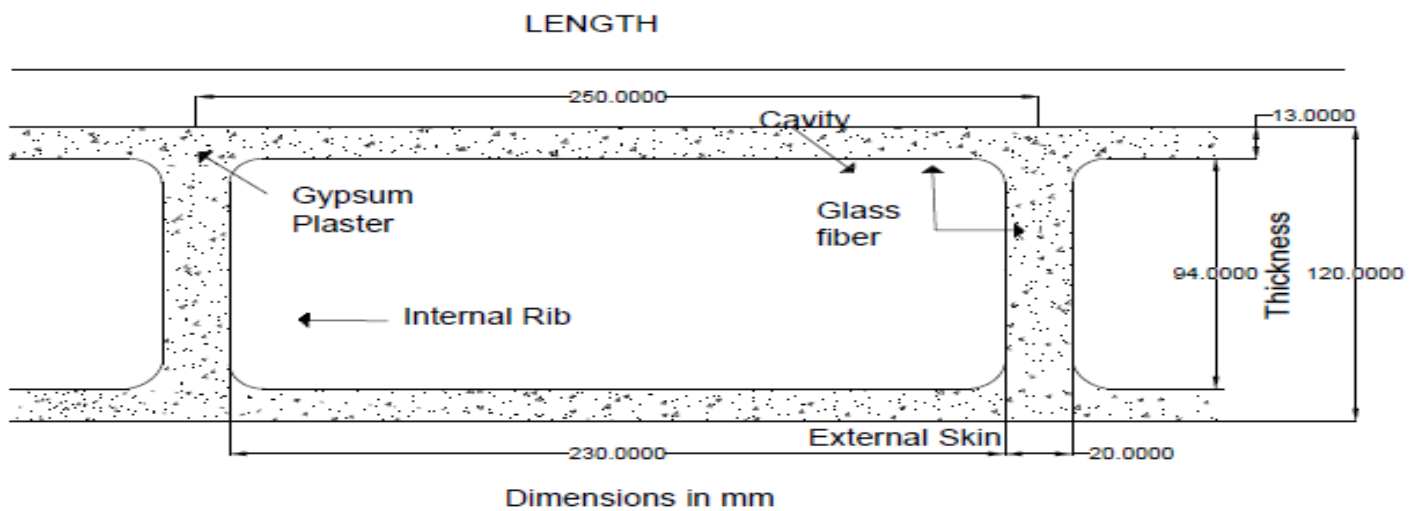


Figure 2: GRFG panel Plan

**III. CONSTRUCTION OF MASS HOUSING USING GRFG PANELS**

Foundation of a structure is decided on the basis of geographical terrain that is where the structure is to be built. Now for any conventional (RCC) structure or our GRFG structure the foundation is totally dependent on the terrain on which it has to be built. The foundation is generally provided as per the conventional method keeping in mind the geographical terrain.

For a single storied building structure a simple spread footing can work well. For this low-rise structure simple masonry spread footings is given which is connected with a network of reinforced concrete tie (plinth) beams on top, on which the GRFG wall is kept and then placed. The panels are connected with the bars which are embedded in the tie beam.

In case of deep foundation, the tie (plinth) beams are framed to pedestals with are usually casted with RCC or Reinforced cement. These pedestals are provided with small isolated footings which have to be properly designed.

GRFG wall panels can be easily placed and fixed with the help of mechanical tools such as a mobile Hydra or a fixed

Crane. While providing the plinth beam, a special attention should be given for the placement and spacing of the starter bars as this bars will only get connected with panels cavities and thus act like a rigid wall structure

When the casting of slab is done using GFRG slabs, then every 3<sup>rd</sup> or 4<sup>th</sup> panel depending on strength required, the cavity is reinforced with a hidden RCC beam and the entire system should have a covering of at least 75mm screed concrete on top. As this slab combines with the beam it act as a T-beam and thus increasing its strength quite significantly. Thus it can be designed as a one-way slab to achieve the required strength for a given span and live loading. The GFRG slab can cover a length up to 5m but as in this study we are suggesting construction of small affordable housing thus it covers our purpose and fulfilling our requirement.

**IV. ENVIRONMENTAL FACTORS**

When we compare the construction of a building using a conventional method and a modern technique we find a significant difference in the way the methodology affects the environment.

Table 3: Environmental Factor

Material	Conventional Method	Modern technique (GFRG panels)
	<p style="text-align: center;"><b>Cement</b></p> <p>Making cement results in high levels of CO<sub>2</sub> output</p> <p>It results in 5-7% of total worldwide pollution</p> <p>Production of one ton of cement results in 780 kg of CO<sub>2</sub></p> <p>Of the total CO<sub>2</sub> output, 30 derives from the use of energy and 70% results from decarbonation</p> <p>It is non-recyclable</p>	<p style="text-align: center;"><b>Gypsum</b></p> <p>It is a naturally occurring substance and can be also produce synthetically</p> <p>It is non toxic in use.</p> <p>Gypsum can regulate humidity through moisture absorption</p> <p>Can enable quicker and cheaper construction</p> <p>It is recyclable</p>
	<p style="text-align: center;"><b>Aggregates</b></p> <p>Energy Consumption and production of Carbon dioxide</p> <p>Causes pollution both air pollution and noise pollution</p> <p>Loss of agriculture land</p>	<p style="text-align: center;"><b>Glass Fibers</b></p> <p>This is a composite material thus it has high tensile strength</p> <p>This make the panels water &amp; fire resistant</p>

<b>Transportation of material</b>	As in conventional method there are various material which are required but as our country is not uniformly distributed with the resources thus different material are needed to be transported from other parts and thus consumes lots of time and also takes lot of resources and fuel.	This are just panels which can be easily manufactured at a plant , so can be Manufactured at local level and thus can be easily transported and thus save time ,fuel and other resources.
<b>Storage</b>	There are various material which are required for the process of construction and thus the building material requires lot of space and a proper attention is needed from the climatic condition such as cement and steel need to be kept away from water.	This are simple panel which are casted with GFRG and thus we just have to store this panels properly, other material which is required is not of that large quantity and thus it doesn't require a lot of space for the purpose of storage.

## V. ECONOMICAL FACTOR

When we compare both the conventional and modern GFRG panel method in construction of a structure we will be easily able to tell which method is more beneficial for the purpose of construction.

Table 4: When compare the cost of building a 2 floor storey house using conventional and GFRG panels.

Work	Conventional Method	GFRG Panels
Plinth area	1288 sq feet	1256 sq feet
Cement require	20.4 tonn	8.62 tonn
Steel require	1.42 tonn	3.78 tonn
Brick require	54500	Nil
Aggregate	40.85 cu m	16 cu m
Water require	168000 liter	59000 liter
Dead load	201 tonn	54.5 tonn
Time for completion	150-185 days	63-69 days
Labor require	Rs 450 / day	Rs.300/day
Cost of construction	Rs. 814000	Rs. 585000
Rate of construction	Rs. 716/ sq feet	Rs. 512 /sq feet

Embodied energy of 1 sqm brick wall using the convention technique : 186.3 kWh

Embodied energy of 1 sqm using the GFRG panel: 39.4 kWh

## VI. ADVANTAGES OF GFRG PANELS

There are various advantages of GFRG panels over the conventional method

- Strong and quality construction is achieved.
- Reduce hassle of construction as less material is required.
- Rapid / Fast construction using this method.
- Less cost in transportation of material as compare to conventional method.
- Less number of workers are needed for .construction.
- No problem of disposal of waste from construction.
- This panel are resistant to earthquake, fire and other disasters and thus more safety is achieved.
- Without additional cost.
- As there is no brickwork thus it save 8-10% of space hence more carpet area can be achieved.
- This buildings can regulate the temperature thus save the cost of cooling or heating inside the structure.

- Less cost for maintenance of the structure.
- No or less wastage of the material as every piece can be used for other purpose.
- Fast construction can help in rapid transformation for people from temporary housing to a permanent house.
- This panel is reusable and can be used after demolition of the old structure.
- This structure is more durable as they are corrosion free and thus can be used in coastal area.

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## VII. CONCLUSION

As the demand of affordable housing is growing at a rapid rate it will be very difficult for the builders to fulfill such demands if they will still use the conventional technique and thus construction using the GFRG panels should be promoted as it provides fast track building construction method as it utilizes the advantage of light weight large panels which is having cavities and also this panels are prefabricated so they can be easily placed. This help in cut down the construction time as well as the its cost and also reduces the labour needed and so achieving the Economy.

When we are using the GFRG panels to requirement of scarce natural resources like mined aggregate , river sand, water is reduced and thus saving the nature , due to this method the requirement of cement is also reduced which helps in production of less carbon dioxide . Rapid wall panels have also reduced embodied energy & it also take less energy for thermo-regulation of interiors. This helps us to achieve a eco-friendly housing at no additional cost and so achieving the goal to protect Environment.

It is a well know relation that the efficiency is directly proportional to economy and environment as so when we are able to save both the economy and environment and so making the project efficient and thus helps to achieve the goal of Efficiency.

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