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Review on GFRG Panels in Low Cost Rural Infrastructure Housing

Shrirang D. Borkar[1], Atul S. Verulkar *[2], Anshul Limje*[2], Chaitanya K. Raut*[2], Kunal V. Wankar*[2], Nilayam R. Margamwar*[2], Sarang K. Wakharkar*[2]

[1]Project Guide, Assistant Professor Civil Engineering Department, DBACER, Nagpur, Maharashtra, India

[2]Students of Civil Engineering Department, DBACER, Nagpur, Maharashtra, India

ABSTRACT

The main motive of this literature survey is to provide the basic information of GFRG panels in construction of low cost houses. GFRG (Glass Fiber Reinforced Gypsum) is a new building material which is also known as "Rapid wall Building Panel". The main reason for using these panels in construction is to overcome the unavailability of natural resources like river sand, water, gravel, etc. The gypsum is industrial by-product waste. GFRG panels are made up of calcined gypsum plaster and glass fiber. The panel contains cavities that may be filled with concrete and reinforced with steel bars to impart additional strength and provide ductility. It has light weight, high compressive strength, shearing strength, flexural strength, stiffness and ductility. The rapid wall buildings are also resistant to fire, heat, water and corrosion. The paper carried out some of the literature study in different samples of GFRG panel`s performance in experimental wise.

Keywords: GFRG, Rapid wall panels, Low Cost.

I. INTRODUCTION

The GFRG panel was originally developed by GFRG Building System Australia and used since 1990 in Australia for mass scale building construction. These panels are manufactured under carefully controlled conditions. The panels are manufactured with the dimensions as 12m x 3m in length x height provided with 124 mm thickness contains cavities which may be unfilled, partially filled or completely filled with concrete and reinforcing steel bars as per the structural requirement.

Experimental studies conducted in Australia, China, and India shows that the GFRG panels suitably filled with plain reinforced concrete possess the substantial strength to act as a load bearing structure as well as shear walls capable of resisting lateral loads due to earthquake and wind.

II. CLASSIFICATION

1) Class 1 : Water Resistant Grade
   GFRG panel for extended walls, in wet areas and as floor and wall formwork for concrete filling.

2) Class 2 : General Grade
   GFRG panels for structural application or non-structural application in dry areas.

3) Class 3 : Partition Grade
   GFRG panel used as non-structural internal partition walls in dry areas.

III. APPLICATION OF GFRG PANELS

GFRG panels are generally used in following ways:

A. As load bearing walls:

Panels with cavities filled with reinforced concrete are suitable for multi-storeyed housing. The cavities

can remain unfilled or suitably filled with non-structural core filling such as insulation, sand, quarry dust, polyurethane or light weight concrete for the single or two storey constructions.

B.As partition walls in multi-storeyed frame buildings.

C.As compound walls/security walls.

D.As horizontal floor slabs/roofs slab with reinforced concrete micro beams and screed (T-beam section).

Typical dimension of a GFRG panel cell

The regular dimension of GFRG panel is 12.0 m x 3.0 m x 0.124 m .

Detailed diagram of GFRG panel cell

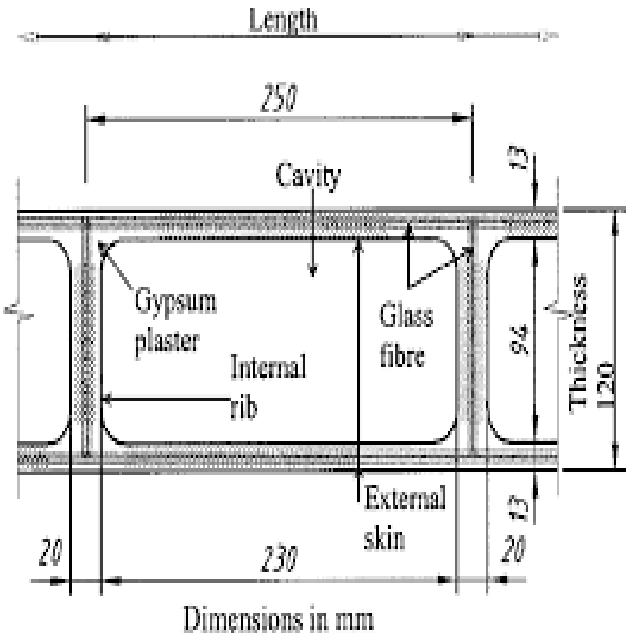

Figure 1. cross section of GFRG panel unit cell

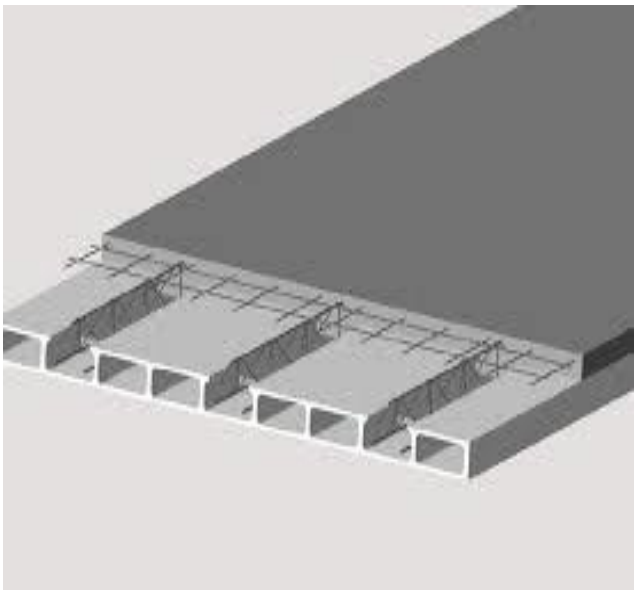

Figure 2. Roof/Floor slab of GFRG panel

Mechanical properties of GFRG panels:

*ISO10140-3:210-Acoustics–laboratory measurements of sound insulation of building elements-part 3: measurement of impact sound insulation

Table 1. Mechanical properties of GFRG panels

Sr no.	Mechanical properties	Nominal value
1	Unit weight	0.433KN/sq.m
2	Modulus of elasticity E	750N/sq. mm
3	Uni-axial compressive strength P	160KN/m (4.77mPa)
4	Uni-axial shear strength T	34-37KN/m
5	Ultimate shear strength V	21.6KN/m
6	Mohr`s hardness	1.6
7	Coefficient of thermal expansion Cm	12 $x10^{-6}$ mm/^{0}C
8	Water absorption	1.0%:1 hr 3.85%:24 hr
9	Sound transmission class (STC)	4dB
10	Fire resistance:	140/140/140

	Structural adequacy/integrity /insulation	minutes

Why GFRG is superior to conventional construction?

Gypsum which is a waste product of fertiliser industry is used to make the panels economical and eco-friendly. Glass fibre is used as reinforcing agent which enhances the strength of the panels. Eventually the usage of cement is reduced.

One cement industry alone accounts for 5% increase in CO^2 emission. By using GFRG panels cement use is reduced and thereby reducing environmental pollution.

In site they are just erected by cranes. Those hollow cavities inside the panels are filled with concrete and steel. Concrete is poured in every third cavity of the panel and other cavities can be filled with waste materials like quarry dust hence it becomes more economical than conventional methods.

GFRG houses are:

- Fire resistant up to 1000 ^{0}C
- Earthquake resistant
- Naturally cooler up to 4^{0}C
- Eco-friendly
- Water resistant
- Economical

IV. ADVANTAGES OF GFRG PANELS

- **GREEN TECHNOLOGY:** It makes use of industrial waste gypsum. Does not need any plastering. It consumes much less embodied energy and less carbon footprint.
- **REDUCED BUILT-UP AREA:** Panels being only 124 mm thick, for the same carpet area, the built up area and the building footprint is much less than conventional buildings.
- **VERSATILITY:** Panels can be used not only as walls but also as floors, roofs and staircase.
- **SPEED OF CONSTRUCTION:** Using the system, the construction of a building can be very fast compared to the conventional building.
- **LIGHTNESS OF STRUCTURES:** These panels are very light weight only 43 kg/m^2. Even after filling some of cavities with concrete, the overall building weight is much less, contributing to significant reduction in design earthquake forces and savings in foundation and overall buildings cost especially in multistoried buildings.

LIMITATION OF USE OF GFRG PANELS

- The shorter span of slab (floor/roof) should be restricted to 5 m.
- Is ideal for if the same floor/roof is replicated for all floors in multistoried structures. For any variations, structural designer needs to be consulted.
- Curved walls or domes should be avoided. In any case it is essential, use masonry/concrete for that particular area.
- The electrical/plumbing drawing should be such that most of the pipes go through the cavities (in order to facilitate minimum cutting of panel).

V. CONCLUSION

GFRG building performs well in terms of least storey displacement, storey drift and base shear when compared to conventional building. The storey displacement and storey drift of both GFRG and conventional buildings are within permissible limits. Static analysis is not sufficient for high rise building and it is necessary to do dynamic analysis.

The building constructed using RW panel comes under Green building categories as after constructing it energy requirement for heat insulation, sound

insulation, humidity and temperature inside is less than conventional building. It is very effective technology to beat the current rising cost of construction. And the most important, this new technology is having potential to provide the low cost shelter to the “Homeless Citizens”.

VI. PREVIOUS STUDIES

- **COMPARISON BETWEEN RAPID WALL PANEL CONSTRUCTION OVER CONVENTIONAL CONSTRUCTION WITH RESPECT TO COST AND TIME OF CONSTRUCTION (Kadam Sagar .P , Darade Milind . M) (2016) :**
  Rapid wall panel is world`s largest load bearing light weight panels. This method of construction takes a massive leap towards sustainable living creating a positive effect on environment. It is more affordable housing to low income groups. After detailed study and analysis of building it is observed that rapid wall construction saves 67% in construction time and 27% in construction cost compare with conventional building.
- **LOW COST HOUSING BY USINGGFRG PANELS (Sk. Subhan Alisha) (2016):**
  Experts forecast that a building made of GFRG panels can have a life span of 60 years. The foundation cost comes about 10-15% of the total building. It is suggested to adopt arch foundation in ordinary soil for effecting construction cost up to 40%. The conventional R.C.C. lintels which are costly can be replaced by brick arches for small spans and saves construction cost up to 30-40%.
- **RAPID AFFORDABLE MASS HOUSING USING GLASS FIBER REINFORCED GYPSUM (GFRG) PANELS (Devdas Menon) (2014):**
  I n order to express this technology, a two storey GFRG demo building was built inside the IIT Madras campus. This building, constructed within a span of 30 days housing a total area of1981 sq. ft., has 4 flats, two having carpet area of 269 sq. ft. meant for EWS (economically weak section), and the other two with 497 sq. ft. carpet area each meant for LIG. The saving in cost was almost 35% when compared to conventional construction.

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