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STUDY ON GLASS FIBRE REINFORCED GYPSUM PANEL SYSTEM USED IN BUILDING CONSTRUCTION

Huzefa Bombaywala[1], Samidha Raut[2], Aakanksha Chaudhari[3], Abhijit Giri[4]

[1]*UG Student, Civil Engineering Department, J.D.I.E.T, Yavatmal, Maharashtra, India,* **huzefabombaywala@gmail.com**
[2]*UG Student, Civil Engineering Department, J.D.I.E.T, Yavatmal, Maharashtra, India,***raut07s@gmail.com**
[1]*UG Student, Civil Engineering Department, J.D.I.E.T, Yavatmal, Maharashtra, India,* **aakanksha21.4.95@gmail.com**
[4]*Assistant Professor, Civil Engineering Department, J.D.I.E.T, Yavatmal, Maharashtra, India,* **giriabhijit17@gmail.com**

Abstract

India is on a path to superfast growth as a Nation. While there are actions being taken in almost every aspect, some areas like housing remain key focus areas in making a significant difference in the life of a common man. One of the milestones for the success of construction projects is the project management triangle (time, quality and cost). So one needs to adopt cost effective construction methods either by upgradation of traditional technologies using modern construction materials and techniques with efficient inputs leading to economic solutions. GFRG panels are of much relevance in India where there is a tremendous need for cost effective mass scale and rapid housing. GFRG panel is finding a key role in affordable mass housing construction in India. GFRG panels are hollow composite panels that can conveniently be filled with any structural material like concrete, and RC (reinforced concrete) if required in order to improve its load carrying capacity.

Keywords: *GFRG panel, construction*

1. INTRODUCTION

Housing is the basic needs of society and is an essential component of the built environment. One of the milestone for the success of the construction project is the management of the project in particular time. India being a developing country, the economy plays an important role. Time and cost are the two main concerns in construction. A material is considered smart only when it contributes something to upgrade the quality of building. With all those advancements in construction techniques and also with the demand of end users for the smart buildings we as constructors and designers are ought to introduce something new and smart to fulfil their demands and needs. Many countries have initiated adopting innovative yet cost efficient construction techniques. Adopting traditional methods of construction for housing and other building requires more time and adds significant construction cost, materials and labour. In today's fast paced world, many processes have been modernised in order to increase efficiency and drive down costs. The goal of low cost housing is to save money while also maintaining the building quality.

Fig-1: GFRG Panel

2. OVERVIEW OF GFRG PANEL

GFRG (Glass Fiber Reinforced Gypsum) also known as Rapid wall is a technology that is being poised as a revolution in construction technology that could bring down construction cost by 50% or more. GFRG panel essentially replaces the blocks/bricks. The Australian technological breakthrough of combining glass fibre strandswith Gypsum Plaster produced in an energy efficient fluidized bed calcining process resulted in GFRG panels, which have desired properties of strength and water resistance. The panel was originally developed by GFRG building system Australia and used since 1990 in Australia for mass scale building construction. The GFRG panel are manufactured with size 12 m Long, 3m high and 0.124 m thickness. Each segment of panel contains four cells, thus each panel (12m long) having 48 modular cavities of dimension 230mm x 94mm x 3mm. The cellular cavities are formed between two outer skins. This makes the panels very

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light and weight of these panels is 10-12% of weight of comparable concrete or brick masonry. GFRG panels are hollow composite panels that can conveniently be filled with any structural material like concrete, and RC (reinforced concrete) if required in order to improve its load carrying capacity. The various cells are inter- connected by solid ribs (20 mm thick) and 'flanges' (15 mm thick) comprising gypsum plaster , reinforced with 300- 350 mm glass fibre roving , located randomly but centrally. The skin thickness is 15 mm and rib thickness is 20 mm.

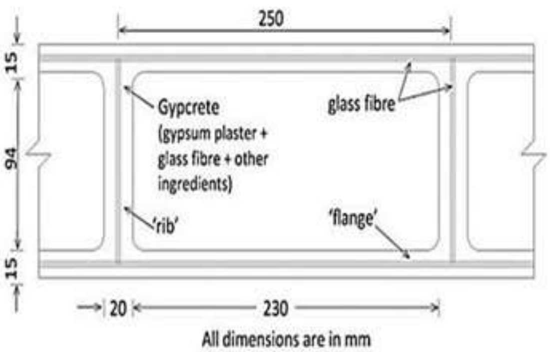

Fig-2: Cross-section of GFRG Panel

2.1 Why is GFRG superior than conventional construction?

The main component that goes into the construction of GFRG panel is a powder that is residual of many fertilizer industries and is available at very cheap rate. Gypsum which is a waste of many fertilizer industries is used in manufacturing of these panels. As gypsum is available in many industries as there waste product makes the manufacturing of GFRG panel more economical and Eco – friendly. Glass fiber is used as reinforcing agent which enhances the property and develops strength in the panel. As gypsum is used instead of cement therefore there is a reduction in carbon footprint which evolves during the processing of cement. One cement industry alone accounts for 5% increase in the CO_2 emission. By using the GFRG panel cement usage is reduced and thereby reducing environment pollution. On the site they are just erected using cranes and hence take much less time as compared to conventional construction. The hollow cavities in the panel can be filled either by concrete or any other waste material like quarry dust hence making it more economical than conventional method of construction.

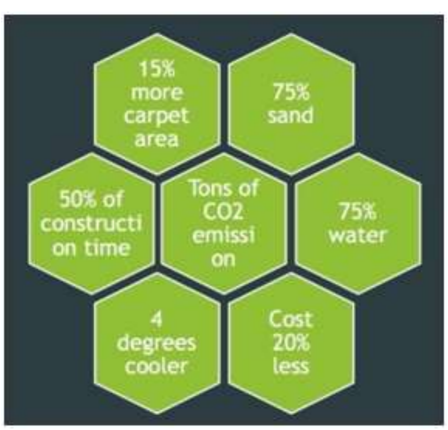

Fig-3: Benefits of GFRG panel

2.2 Applications of GFRG Panel

The GFRG Panels can be used for following purposes

i. As partition infill wall in multi-storey framed building.
ii. As lightweight load bearing walls in buildings upto two storey construction, the panel may be used with or without non- structural core filling such as insulation, sand or light weight concrete.
iii. As vertical and shear load bearing structural walling in multi-storey construction, the panel core shall be filled with reinforced concrete suitably designed to resist the combined effect of lateral and gravity loading.
iv. As cladding for industrial building.
v. As compound wall.
vi. As floor/ roof slabs with reinforced concrete micro beams and screed concrete.

2.3 Manufacturing process of GFRG panel

1. Raw gypsum is first collected from the gypsum deposition at phosphoric acid plant.
2. Raw gypsum is crushed in the storage shed.
3. It is then fed to calciner for the calcinations process.
4. In the calciner the raw gypsum is then heated at 180^{o}C to 200^{o}C with the efficiency of 15ton/ hr.
5. This Calcined gypsum is then stored in the silos.
6. From silos the plaster is mixed with water, white cement and chemicals.
7. One layer of slurry is poured followed by a layer of glass roving.
8. Then the aluminium plugs are inserted for forming hollow cavities in the panel. After this the process of spreading slurry (1 layer) and glass fibre (2 layer) is repeated.
9. After 20 minutes the aluminium plugs are removed and then panels is kept as it is for 20 minutes.
10. Then the panels are lifted by acrobat and taken to the drying process. The wall panel is dried at a temperature of 200^{o}C for 60 minutes.
11. After drying the panel is shifted to the storage facility.
12. The wall panel is cut in the required dimension as per the structural requirement.

2.4 Stages for constructing GFRG building

1. Prior to the delivery of the panels the surveyors establish and mark all main grid lines on the plinth or the concrete floor on which GFRG panel is to be positioned.
2. Upto the plinth level the construction is done as per conventional building.
3. Using the architectural layout drawings the erection crew marks out the wall positions in reference to these grid lines.
4. Holes are drilled in the concrete foundation, starter bars inserted and waterproof membrane applied.

5. Then, the panels are lifted with cranes and special hooks and are placed in the proper position.
6. Check the plumb and line of the wall.
7. Once the panels are properly placed, the cutting of doors, windows, sanitary fittings, etc is done.
8. Fill the holdfast gap with concrete.
9. Finish the joints of two panels by fixing fibre tape with stucco by making a slot of 8mm wide and 2mm deep at the joint and then fix the jointing fibre tape and finish the surface with stucco.
10. Joints of Rapidwall with RCC column and beams shall be finished by stucco with reinforcing fibre of used cement bags.
11. Reinforcement bars are inserted where the infillment is to be done.
12. Concrete pouring is done. Concrete is poured in different levels of 1m each at the interval of 1 hour.
13. Now, the panels are placed for the slab. Triangular micro beam reinforcement is done and placed as per structural design. Then the concreting is done.
14. Finally the water proofing is done on the roof.

Fig-4: Concrete filling in GFRG panel

2.5 Supply of Panels

Depending upon the grade and type GFRG Panel may be supplied in any of the form:

Class I - (Water Resistant Grade)
Panels that may be used for external walls, in wet areas and/or as floor and wall formwork for concrete filling.

Class II - (General Grade)
Panels that may be used structurally or non-structurally in dry areas. These panels are generally unsuitable for used as wall or floor formwork.

Class III - (Partition Grade)
Panels that may only be used as non-structural internal partition walls in dry areas only.

2.6 Manufacturing plants

Presently two plants are working in India:

i. Rashtriya Chemicals and Fertilizers Limited, “Priyadarshini”, Eastern Express Highway, Sion, Mumbai.
ii. FACT – RCF Building Products Ltd, FACT Cochin Division Campus, Ambalamedu, Kochi (Kerala).

The panels are manufactured at the plants are based on the technology transferred through collaboration with GFRG Building System, Australia.

2.7 Benefits of GFRG panel

1. Very fast construction with less no of workers.
2. Less overhead cost and less project cost.
3. Increase in the carpet area (8-10%) for the same built up area.
4. Less embodied energy and carbon footprint significant reduction in use of steel, sand, cement and water.
5. Saving in the transport cost of sand, bricks, cement, steel, scaffolding and shuttering material.
6. Less building weight and thereby reduction in the design of seismic forces and saving in the foundation, especially in multi-storied buildings.
7. GFRG construction will help in rehabilitation scheme/rebuilding projects of unsafe buildings and displaced families during any calamities.
8. Better thermal comfort inside GFRG building compared to conventional building.
9. The movement of moisture through concrete is the big problem in conventional buildings but in GFRG there is no dampness problem.
10. Lightweight and rapid construction will help to put up additional storey over the existing buildings within no time and hence opportunity for builders/customer.

2.8 Disadvantages

i. Lack of expertise in the existing contractor
Handling, fixing and equipment required for these panels is fairly different from the conventional system. So we need some expertise in order to do construction by this technology. It is not very difficult to learn the right technique but it will eventually take some time.

ii. Extensive planning during design phase
The panels are customized as per the design and drawings of the building therefore it becomes difficult make any sudden changes at the stage of fixing. Hence it needs proper planning. Also the position of doors and windows are to fixed prior from fixing, as they need to be cut before the placing.

iii. Requirement of free space and equipment during construction.
Nowadays if you are looking for the construction in the populated area it is more likely that our plot is already surrounded by built houses. In such cases it becomes very

difficult to install the panels as they require machines for lifting purpose and a sufficient space. Also the panel needs special care while lifting which is difficult job in populated areas.

2.9 Use as a Roof Slab

GFRG panels can be also used as a intermediate floor/ roof slabs in the combination with RCC. GFRG slabs are provided without any need of RCC beams. The strength of GFRG slabs can be enhanced by embedding reinforced concrete micro beams. For embedded micro beams every 3rd cavity in the GFRG panel is cut open and then reinforced. After this a RCC screed concrete of a minimum thickness of 50mm is provided above the GFRG floor panel which is reinforced with the weld mesh. This RCC screed and micro beams act together as a series of embedded T-beam. The thickness of the screed depends on the purpose for which the structure is built. The connectivity between the horizontal tie beam, embedded RCC micro beam, concrete screed and vertical reinforcement in GFRG wall panel ensures the perfect connection between the floor slab and walling system.

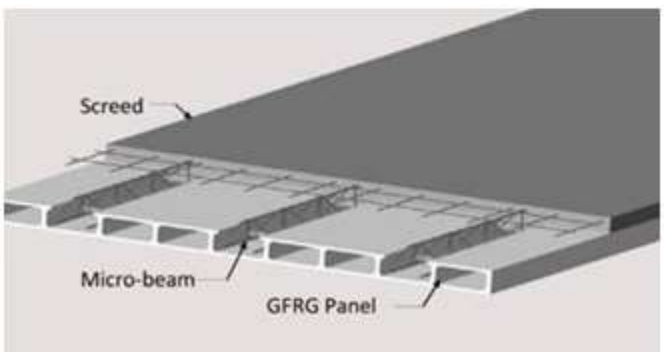

Fig-5: GFRG slab with screed and micro beam

2.10 Staircase

The staircase can also be constructed using GFRG panel. The staircase waist slab and mid-landing slabs were constructed using GFRG panel. GFRG panels should be cut open from the top and were reinforced by no of micro beams in all cavities. Landing beams were provided at both the floor slab and mid landing level. These were also constructed using GFRG panels. The waist slab of the staircase is constructed using GFRG panel. After this concreting of the panel is done.

Fig-6: Reinforcement for concealed beams in waist slab

3. CONCLUSION

From this we conclude that the conventional buildings are more costlier when compare to the GFRG panel system. GFRG panel provides a new method of building construction in fast track, fully utilising the benefit of prefabricated and light weight panel with modular cavities. By the use of this system man power, cost and time of construction is reduced. GFRG can be effectively used for the entire superstructure of buildings, including all walls, slabs, staircase and parapet. GFRG buildings have the potential to meet the challenge of providing rapid affordable mass housing. GFRG panel have reduced embodied energy and require less energy for thermo-regulation of interiors. GFRG building thereby reduces burdening of the environment and helps to reduce global warming. From this we can create some awareness about the construction of panel systems about the cost, time management, resource allocation and quality and quantity of GFRG panel.

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