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STUDY OF CONSTRUCTION MANAGEMENT ASPECTS OF BUILDING USING GFRG PANELS

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Abstract - *Construction management is the overall planning, coordination, and control of a construction process from beginning to completion. It is a professional service that uses specialized, project management techniques to oversee the planning, design, and construction of a project, from its beginning to its end. The purpose of construction management is to control a project's time, cost and quality. Success of a project management is a triangle which include time, quality, and cost. Lots of construction system has been developed from this triangle. GFRG system was one of these system established in Australia. It is basically a wall panel developed from phospo gypsum which is available as a waste product from various chemicals, fertilizer plant in huge quantity. It is set towards sustainable development. Aim of this project is to conduct the detail study of GFRG panels in construction management aspect in terms of cost and time by detail scheduling of activities and also to compare with the conventional building in terms of these aspect by implementing in the real case environment.*

Key Words: Glass fibre reinforced gypsum panel, Rapid wall, low income groups

1. INTRODUCTION

In a developing country like India , there is a huge shortage of houses due to the increasing population and specially it is been found among low income people due to the huge growing demand of building materials. So India is on the path to superfast the growth of building construction. Constructing a house is a life time worth of saving and even now there are more than 200 million people who are still living in "kacha houses" or slums and these "kacha houses" will get flushed away easily when it is exposed to bad weather.

Gfrg panels were originally developed and used since 1990s in Australia and now presently the technology has been exported to India with the aim of developing cost effective, easy to assemble and economical building technology. Gfrg panels is been used to replace the conventional walling system. Experts predict that a building made of gfrg panels can have a life span of 100 years. Experimental studies and research have shown that gfrg panels, suitably filled with reinforced concrete, possess substantial strength to act not only as load bearing elements, but also as shear wall, capable of resisting lateral loads due to earthquake and wind. It is possible to design such buildings up to 10 storeys in low seismic zone and to lesser height in high seismic zone. However, the structure needs to be properly designed by a qualified structural engineer. A gfrg building does not require beams and columns. The material has been approved as green building material by the United Nations framework convention on climate change (unfccc). The main limitation of gfrg panels is it cannot be used for wall with circular or higher curvature and the clear span is limited to 5m or residential buildings.

GFRG Panels, made out of gypsum board reinforced with glass fibres is an emerging alternative building material. FRBL Kochi is the leading manufacturers of GFRG panels in Kerala. The GFRG panel manufactured by FRBL using advanced Australian building technology is the World's largest load bearing building panels. GFRG panels replace the conventional walling system. The panels are manufactured to the fixed size of 12m length, 3m height and 124mm thickness, with hollow cavities in it and each 1m segment of the panel has four cells and each cell has 250mm wide and 124mm thick, containing a cavity 230mm x 94mm. These cells are interconnected by solids ribs of 20mm thick and flanges of 15mm thick comprising gypsum reinforced with 300mm x 350mm glass fiber roving, located randomly but centrally. The skin thickness is 15mm and rib thickness is 20mm. The glass fibres about 300 – 350 mm long are randomly distributed inside the panel skins and ribs in the manufacturing process. The fiber content is 0.8 kg/m^2. The 120 mm thick panels are hollow and can be filled with in-situ plain or reinforced concrete to increase the strength.

1.1 Manufacturing process

There are mainly six steps which is been involved in the manufacturing of gypsum panels which is been done in FACT Cochin Division Campus, Ambalamedu, Kochi.

1.1.1 Gypsum Handling

In the first step the raw gypsum is been collected using truck from certain phosphoric acid plant where around 2000 tons of gypsum is been deposited every day, so from there raw gypsum is been collected and brought to the storage shed where the raw gypsum is been made thin powdered with the help of jcb as shown in Fig: 1

Fig - 1: Gypsum handling

1.1.2 Calciner Plant

The crushed gypsum from the storage shed is been feeded in to the calciner for calcination process. In calcination process the raw gypsum is been heated to 180^{0}C to 200^{o}C with the efficiency of 15 tons / hr. then the calcium sulphate hemihydrate is been obtained by dehydration of gypsum by calciner which is shown in fig: 2

Fig- 2 : Calciner Plant

1.1.3 Plaster Handling

Here the calcined gypsum is been stored in product silos which is having the capacity of 250 megaton as shown in Fig 3

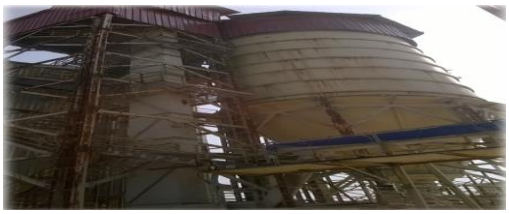

Fig - 3: Plaster Handling

1.1.4 Wall Panel Plant

From the silos it's been mixed with water to get the required water plaster ratio, white cement and chemicals like D50 (retarders) and BS94 (water repellent) in the mixer and is been poured into the casting table which is been shown in fig 4

Fig- 4: Casting table in Wall Panel Plant

As the first layer of plaster is been poured then the glass fibres should be eventually spread throughout the mix using a screening and rolling process. Then special aluminimum plugs is been inserted on top of the finished first layer which is having 20mm gap in between to form hollow cavities in the panels. Then on top of that the second layer is been poured on top of it with glass fibers is been poured and then tapping process is been done so that the ribs of the hollow panel is been formed. In the last stage of the process the first layer of the same process is been repeated to form the cpmplete top layer of the panel. Then it takes around 25 minutes to get it set.

After the setting time is over the plugs is been removed from the casting table and then the casting table is been rotated in its vertical position which is been shown in fig 5 Then the panel is been taken out using special flock lifts and acroba is been used for lifting the panel from one place to other.

Fig- 5: Casting table rotated by 90 degree

1.1.5 Wall panel drier

From the casting table the wet panel is been brought to the drying chamber using acroba. The wet wall panels is been dried in a dryer chamber (shown in fig: 4.8) where the hotter is been circulated to dry the panel for about 90 minutes. The dried panel is been stacked into the drying racks which is been shown in fig: 6

Fig- 6 : Dryer chamber

After the drying process the panels are been brought to the cutting plant where the panels are been cutted to the required dimension which is been shown in fig 7

Fig - 7: Cutting plant

1.1.5 Utilities

From the cutting plant the panels are been loaded to the truck using crane which is been shown in fig and loaded trucks are been dispatched to the respective sites as shown in fig 8

Fig - 8: Utilities

1.2 INSTALLATION PROCESS

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

Stage I: The foundation is been build up with the help of construction Manual. Soil report is been prepared and based on that foundation is been designed. There is no change in case of constructing foundation while comparing with the conventional building and from the plinth beam starter bars are been provided upwards which is been shown in fig:9

Fig- 9 : Starter bars in foundation

Stage II: Installation process of the panels are been placed on top of the starter bars which is been shown in fig:10 the panel erection is been done only with the help of crane. Now for the panel erection which is been done by using crane which is been attached to a special locking system i.e. lifting bar which is been attached to two lifting jaw which holds the panel as shown in fig: 10

Fig- 10: Installation process

As the panels is been placed vertical it is been provided with support which is been shown in fig 11 and the cuttings of the doors and windows is been removed.

Fig- 11: supports provided for GFRG panel

Stage III: All door and window frame fixing is need to be done and also need to mark out all the plug points and all electrical work is need to be done.

Stage IV: The cavities present in the panels are been filled with concrete that is every third cavity is need to be filled and others cavities should be left vacant which is shown in fig: 12 But as per the requirement what actually happens in site is that every third cavity and corners are been placed by concrete with appropriate mix and other cavities are also been filled with some inert materials with 2 percentage of cement mix. Concrete filling is been shown in fig and above all doors and windows reinforcement for lintel is been placed and rest of the concrete filling is been done. The concrete should be prepared in such a way that it should have required strength and specified slum and expected volume of concrete. Filling should not be done if there is rain. First of all, fill panels to 0.75 m checking continuously below to ensure over filling. Then fill the balance of the panel to full height with the third pour and fill it completely. Connections between the panels should be provided for the support i.e. L-joint , T-joint then the last one is the star joint and after all that plumbing work is been done.

Fig - 12: Concrete filling

Stage V: The roofing work which can also be done using GFRG panel. Now here what they does is that they mark out the places were panels is been placed vertically with the help of crane (attached to lifting bar and lifting jaw) which is been shown in fig 13 which shows how the panel is been hold by the crane and placed and before placing the panels we need to provide acro span which is been supported using Jacky span toward downwards.

Fig- 13: Roof placing

Then the skin cutting is been done that is the upper skin i.e. the panel is been cutted i.e. the upper skin of every third cavity is been cutted and then micro beams and cross beams is been provided and on top of that 20mm weld mesh is been placed and then concreting is been done on top of it as shown in fig14

Fig - 14 : Reinforcement on slab

Then after two days marking for the panel erection for second floor is been done and the process is been repeated.

2. CASE STUDIES

Five houses within Kerala, built using GFRG panels have been chosen as case studies which is been shown in table1. Detailed time schedule and project cost for the case studies were prepared using the scheduling software, ASTA POWERPROJECT. Details of the case studies have been summarized in the following sections.

Table - 1: Project site of all five GFRG building

SL.NO	PROJECT SITE
1	MUVATTUPUZHA PROJECT
2	KOLLAM PROJECT
3	ALUVA PROJECT
4	AROOR PROJECT
5	KOLENCHERY PROJECT

The Muvatupuzha project is a sinle story residential building where the wall and roofing is been done using GFRG system. The purlin and roof tile is been placed. For foundation RR masonary is been used. It has an area of 2590 sq.ft.

The second project is Kollam project which also a single story, where the walls are done using GFRG panels but roofing is done conventionally. For foundation column footing is been provided. It has an area of 2100 sq.ft.

The third one is Aluva project which is a two story residential building where all the walls and roofing is done using GFRG panels. Foundation is done using RR masonary. It has an area of 1990 Sq.ft. with the ground floor area of 1127 sq.ft and first floor of area of 770 sq.ft.

The fouth one is Aroor project which is also a two story project in which walls and roofing are done using GFRG panels. And column footing is been used. It has an area of 3600 Sq.ft. and ground floor of 1756 sq.ft and the first floor of size 1740sq.ft

The fifth one is a Kolenchery site where all walls and roofing is done using GFRG panels and RR masonry is used in foundation. It has an area of 2600 Sq.ft. The ground floor of 1456 sq.ft. And the first floor of size 1144 sq.ft

The schedule is been prepared using ASTA power project using time and cost and from the detail time study of all the five cases the result is been illustrated in table 2

Table - 2: Summary of time schedule

SL.NO	PROJECT SITE	AREA	DAYS	Sq.ft/day
1	MUVATTUPUZHA PROJECT	2590	92	28.15
2	KOLLAM PROJECT	2100	109	19.27
3	ALUVA PROJECT	1990	134	14.85
4	AROOR PROJECT	3600	154	23.4
5	KOLENCHERY PROJECT	2600	143	18.18

A detail cost schedule is been prepared using ASTA power project which is scheduling software and the summary is been illustrated in table 3 and the corresponding result is been illustrated below.

Table – 4: Summary of cost with corresponding project.

PROJECT SITE	AREA	DAYS	RS/SQ.FT	TOTAL COST
MUVATTUPUZHA PROJECT	2590	92	Rs 1700	Rs45.12 lakhs
KOLLAM PROJECT	2100	109	Rs 1700	Rs36.26 lakhs
ALUVA PROJECT	1990	138	Rs 1800	Rs36.44 lakhs
AROOR PROJECT	3600	154	Rs 1500	Rs52.05 lakhs
KOLENCHERY PROJECT	2600	143	Rs 1700	Rs44.63 lakhs

These are the practical cases which is required in the site for the completion of that particular project and GFRG is best suited for large areas construction since larger the size the time and cost is been reduced

3. IMPLEMENTING IN A CONVENTIONAL BUILDING

Now a conventional building which is been situated in karukachal, kottayam, Kerala is been taken for studying and comparing the GFRG and conventional building system by detail study about the cost and time of both type of construction building system. It has an area of 2770 Sq.ft. where the ground floor of area 1647sq.ft and first floor of area 1115 sq.ft. The main activity involved in GFRG system and conventional builds is been illustrated in table 5 after the detail time and cost study results is been concluded in the table 6

Table - 5: Major activities of both type of building system

Sl.no.	GFRG building	Conventional building
1	Preliminary documentation preparation	Preliminary documentation preparation
2	Applying for permits	Applying for permits
3	Foundation including plinth beam casting	Foundation including plinth beam casting
4	GFRG walls	Block work
5	GFRG panel roofing	Conventional roofing
6	Electrical work	Electrical work
7	Plumbing work	Plumbing work
8	Plastering work	Waterproofing
9	Putty and primer	Putty and primer
10	Two coat plastic emulsion	Two coat plastic emulsion

Table - 6 : Summary of kottayam project

BUILDING SYSTEM	DAYS	COST
GFRG SYSTEM	133	Rs 41.69 lakhs
CONVENTIONAL BUILDING	236	Rs 49.04 lakhs
PERCENTAGE SAVEING	42%	15%

4. CONCLUSION

- GFRG building system it took 133 days and for conventional building system it took 236 days
- By comparing the two we can say that there is 42 percentage of time saving when we compare GFRG building system with respect to conventional building system.
- In case of GFRG building per day 20.87 sq.ft work and for conventional building per day 11.73 sq.ft work is been done.
- In case of for GFRG building system it took Rs41.69 lakhs and when it is compared with the conventional it took Rs 49.04 lakhs
- By comparing both it can be conclude that there is 15 percentage of saving in terms of cost for GFRG system when it is compared with the conventional building
- The rate of construction for GFRG system is Rs 1480 per sq.ft and for conventional building it costs Rs 1775 per sq.ft.
- GFRG system is best in all aspects especially in case of time and cost.

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