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''RAPID WALL TECHNOLOGY''

(CONTRUCTION USING GFRG WALL PANELS)

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Abstract: Housing is one of the basic needs of society and is an essential component of the built environment. The Ministry of Rural Development estimated that the rural housing shortage in India stands at 44 million dwelling units. India's urban housing shortage is 18.78 million units, of which 96% pertains to Economically Weaker Section (EWS) and Low Income Group (LIG) type, as per the estimate of the Ministry of Housing and Urban Poverty Alleviation [1, 2]. The demand for conventional building materials used in the housing sector such as burnt clay bricks, cement and steel is growing every year. Reduction in the use of these energy intensive construction materials and speedy delivery of housing units at affordable cost are the key challenges faced in the mass housing sector today. Buildings using Glass Fibre Reinforced Gypsum (GFRG) panels (infilled with reinforced concrete) hold promise as a rapid, affordable and sustainable mass housing solution. GFRG panels were introduced in Australia in 1990 and are now manufactured in India, making reuse of waste gypsum from the fertiliser industry.

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I INTRODUCTION

The panels are made of calcined gypsum, reinforced with glass fibres. They are prefabricated to a size of 12 m length, 3 m height and 124 mm overall thickness (with cavities), and are relatively light-weight (44 kg/m2). Figure 1 shows typical details of the GFRG panels. Some of the advantages of the GFRG system over conventional buildings are: high speed of construction involving less labour, increased carpet area for the same built-up area, reduction in the use of cement, sand, steel and water, excellent finish of the panels with no need for plastering, lesser building weight contributing to reduction in earthquake forces, etc. Buildings constructed of GFRG also have the advantages of cost effectiveness and energy efficiency, in terms of reduced use of energy intensive building materials, and recycled use of industrial waste. Tests have established that the panels have the required resistance to water and fire.

Objectives

1.To study what is rapid wall technology and what its benefits, features and characteristics.

2. To study how rapid wall is manufactured and what are the materials used in the process

3.To study how rapid wall is erected and why it's preferred against other technologies

4. Make a comparison between the conventional building materials & rapid wall technology at different areas.

II LITERATURE REVIEW

* optimization of affordable housing – by prof.Sri V.K.JAH (LAM) ,DR S. & S.S. GHANDHY COLLEGEOF ENGG.& TECH. SURAT

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*Innovative technology for construction glass fibre reinforce technology for construction – an approved technology by BMTPC (Building materials and technological promotion council)

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*Use of glass fibre reinforced gypsum panels with reinforced concrete infills for construction of walls and slabs – Article in Indian concrete journal – December 2016 by prof. Philip cherian and prof. devdas menon , Indian institute of technology Madras,

*Mass Housing Using GFRG Panels: A Sustainable, Rapid and Affordable Solution - Article *in* Journal of The Institution of Engineers (India) Series A · June 2017 – Prof. Shinto paul , Prof. Gauri Krishna SR , prof. Philip cherian and prof. devdas menon , Indian institute of technology Madras

*'Rapid wall technology' researchgate article Jan. 2019 – prof. Mayur yeole, Pimpri Chinchwad College Of Engineering & Research,Ravet

III RAPIDWALL PRODUCTION AND MANUFACTURING PROCESS

Material Survey:-

Rapidwall manufacturing process

(1) Gypsum : (CaSo4·1/2 H2O) Navin Flooring, Udhana, Surat.

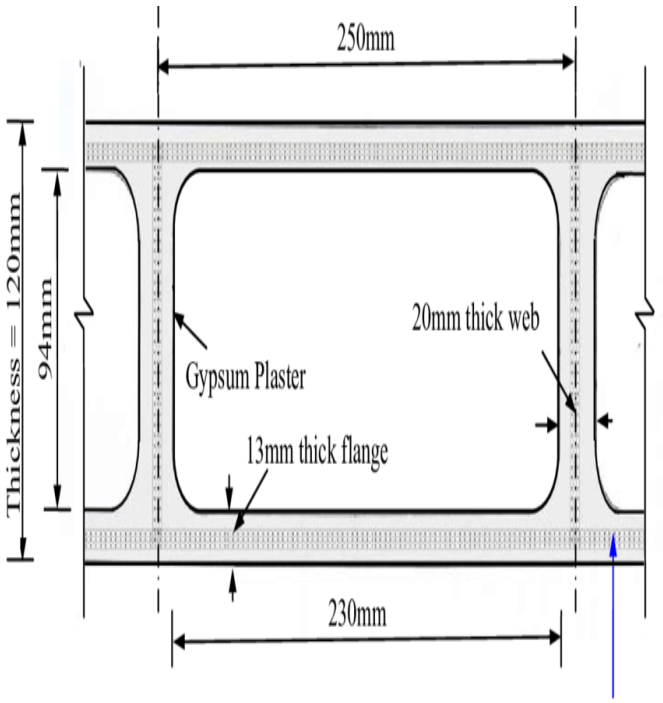
(2) Glass fibre : (E-type glass fibre) Kallapam Chemicals, surat.

(3) Additives : (Hydraprooph-AR & other chemical) Kallapam chemicals, surat.

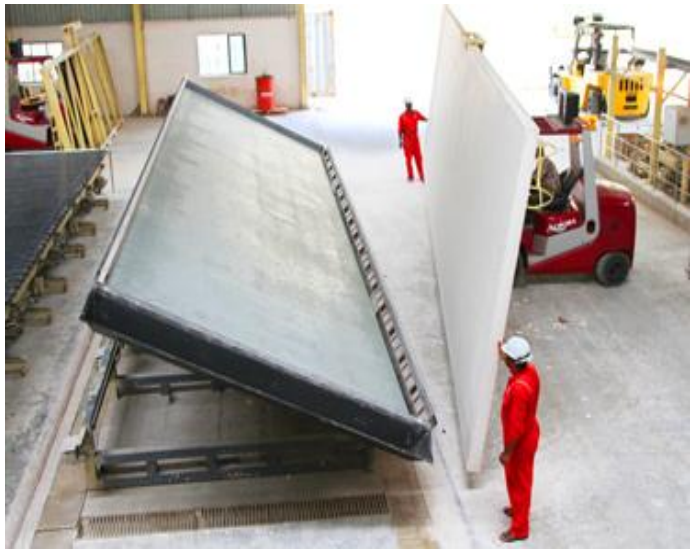
RAPID WALL MANUFACTURING PROCEDURE.

Glass fiber reinforced gypsum (GFRG) walls,known as Rapidwall in the building industry, are new building materials developed in Australia in the early1990s. GFRG walls are machine-made panels with hollow cores and are made of modified gypsum plaster and reinforced with cut glass fibers. Glass fiber reinforced gypsum (GFRG) wall is a green product which can erect a building fast in prefabricated method. Substantial research and practices on GFRG walls have been carried in Australia and a few Asian countries such as China, Malaysia and India. GFRG walls can be used in low buildings as load-bearing walls and in low-rise buildings or as upper storey walls in high-rise building when filled with concrete in the hollow cores. The application of GFRG wall is limited for its poor lateral stiffness even though it is filled concrete in its hollow cores.

Finding a new way to enhance this disadvantage (its lateral stiffness) to make it suitable for small high-rise residential building is a valuable choice for researchers.



Cross sectional details



Transporting rapidwalls with stillage

3.1 Physical and Material Characteristics:-

A typical cross-section of a standard panel is shown in Fig. 1.During the Manufacturing process, glass fibers of about 300–350 mm in length are randomly Distributed inside the panel skins and in the ribs. The fiber volume in the panel is 0.8 kg per square meter of wall surface area. The physical properties of the current standard GFRG panels are listed in Table 1.In building construction, the standard large panels are cut in the factory into building components that may have window and door openings.

These components are then transported to the construction site and erected in a similar way to the construction of precast concrete panels. The cavities (hollow cores) inside the panel can be filled with various materials, such as concrete or insulation materials, to serve different purposes, such as to increase the strength or improve the thermal and sound insulation of the walls. In a Rapidwall building, most or all the building components are constructed with GFRG panels. Therefore, the GFRG walls serve as both architectural partitions and structural walls.

3.2 Standard details of GFRG panel

Physical properties of GFRG panels

Weight- light weight - 40 Kg/ sqm

Axial load capacity - 160 kN/m{ 16 tons/ m}

Compressive strength - 73.2 Kg/cm2

Unit Shear strength -50.90 kN/m

Flexural strength - 21.25 kg/cm2

Tensile Strength - 35 KN/ m

Ductility - 4

Fire resistance 4 hr rating withstood -700-10000 C

Thermal Resistance R - 0.36 K/W

“U “Value - 2.85W/M2K

Thermal conductivity - 0.617

Elastic Modulus - 3000-6000Mpa

Sound transmission{STC} -40

Water absorption - < 5%

3.3 Construction mechanism :-

Introduction

Rapidwall enables fast track method of construction. Conventional building construction involves various cumbersome and time consuming processes, like) masonry wall construction ii) cement plastering requiring curing, iii) casting of RCC slabs requiring cantering and scaffolding and curing iv) removal of cantering and scaffolding and v) plastering of ceilings and so on. It also contributes to pollution and environmental degradation due to debris left on the site. In contrast, Rapidwall construction is much faster and easier. There will be no debris left at site. Construction time is minimized to 15-20%. Instead of brick by brick construction, Rapidwall enables wall by wall construction. Rapidwall also does not require cement plastering as both surfaces are smooth and even and ready for application of special primer and finishing coat of paint.

Foundation

For Rapidwall buildings/ Housing a conventional foundation like spread footing, RCC column footing, raft or pile foundation is used as per the soil condition and load factors. All around the building RCC plinth beam is provided at basement plinth level. For erection of panel as wall, 12 mm dia vertical reinforcement of 0.75m long of which 0.45m protrudes up and remaining portion with0.15m angle is placed into the RCC plinth beams before casting. Start up rods are at 1m centre to centre.

Rapid Construction Method

As per the building plan, each wall panel will be cut at the factory with millimetre precision using an automated cutting saw. Door/window/ventilator, openings for AC unit etc will also be cut and panels for every floor is marked relating to building drawing. Panels are vertically loaded at the factory on stillages for transport to the construction sites on trucks.Each stillage olds 5 or 8 pre-cut panels. The stillages are placed at the construction site close to the foundation for erection using vehicle mounted crane or other type of crane with required boom length for construction of low, medium and high rise buildings. Special lifting jaws suitable to lift the pane l are used by inserting into the cavities and pierced into webs, so that lifting/handling of panels will be safe. Panels are erected over the RCC plinth beam and concrete is infilled from top. Protruded start up rods go inside cavities as can be seen from Fig. .All the panels are erected as per the building plan by following the notation. Each panel is erected level and plumb and will be supported by lateral props to keep the panel in level, plumb and secure in position. Once wall panels are erected, door and window frames are fixed in position using conventional clamps with concrete infill of cavities on either side. Embedded RCC lintels are to be provided wherever required by cutting open external flange. Reinforcement for lintels and RCC sunshades can be provided with required shuttering and support.

3.4 Concrete infill

After inserting vertical reinforcement rods as per the structural design and clamps for wall corners are in place to keep the wall panels in perfect position, concrete of 12mm size aggregate will be poured from top into the cavities using a small hose to go

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down at least 1.5 to 2 m into the cavities for directly pumping the concrete from ready mix concrete truck. For small building construction, concrete can be poured manually using a funnel.

Filling the panels with concrete is to be done in three layers of 1m height with an interval of 1 hr between each layer. There is no need to use vibrator because gravitational pressure acts to self compact the concrete inside the water tight cavities.

Cutting of top flange

Embedded RCC tie beam all around at each level floor/roof slab:

An embedded RCC tie beam to floor slab is to be provided at each floor slab level, as an essential requirement of national building code against earth quakes. For this,web portion to required beam depth at top is to be cut and removed for placing horizontal reinforcement with stirrups and concreted.

Rapidwall for floor/ roof slab in combination with RCC

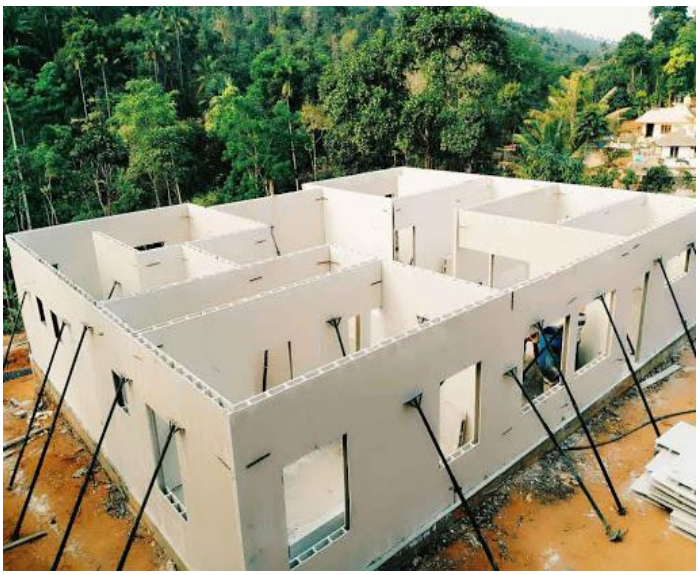
Rapidwall for floor/roof slab will also be cut to required size and marked with notation.

First the wall joints and other cavities and horizontal RCC tie beams are in- filled with concrete ; then wooden plank of 0.3 to 0.45 m wide is provided to room span between the wall with support wherever embedded micro beams are there; finally roof panels will be lifted by crane using strong sling tied at mid-diagonal point, so that panel will float perfectly horizontal Each roof panel is placed over the wall in such a way that there will be at least a gap of 40 mm. This is to enable vertical rods to be placed continuously from floor to floor and provide monolithic RCC frame within Rapidwall. Wherever embedded micro-beams are there, top flanges of roof panel are cut leaving at least 25mmprojection. Reinforcement for micro-beams is placed and weld mesh as reinforcement is placed(Fig). Concrete is poured for micro-beams and RCC slab. This results in the embedded RCC micro beams and 50 mm thickness screed concrete becoming a series of "T" beams.

Erection of wall panel and floor slab for upper floor

Roof panel installation

The following day, erection of wall panels for the upper floor can be arranged Vertical reinforcement of floor below is provided with extra length so as to protrude to0.45 m to serve as start up rods and lap length for upper floor. (See Fig.)Once the wall panels are erected on the upper floor, vertical reinforcement rods are provided, door/window frames fixed and RCC lintel cast. Then concrete is filled where required and joints are filled.Then RCC tie beam all around are concreted. Roof panel for upper floor is repeated same as ground floor. For every upper floor the same method is repeated.



Installed rapidwall panels (building construction at Kerala)

3.5 FINISHING WORK

Once concreting of ground floor roof slab is completed, on the 4th day, wooden planks with support props in ground floor can be removed. Finishing of internal wall corners and ceiling corners etc can be done using wall putty or special plaster by experienced POP plasterers. Simultaneously, electrical work, water supply and sanitary work, floor tiling, mosaic or marble works, staircase work etc can also be carried out. Every upper floor can be finished in the same way.

IV CONCLUSION -

The application of Glass Fibre Reinforced Gypsum panels as a low-energy and sustainable building technology is gaining momentum in India. Currently, there are more than 1600 GFRG The total weight of the GFRG and the conventional brick masonry building are found to be 2074 and 2767 kg/sq. m. respectively, con- sidering the entire building. About ¼ reduction in the structural weight of the GFRG building is advantageous for earthquake- resistant design, facilitating reduced forces in design.

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