



Rapid Wall Technology

Shreya. N

Student

Department of Civil Engineering
Rural Engineering College, Hulkoti, Karnataka, India**Abstract:**

Housing is a basic need which is most difficult to fulfill considering the rising costs and shortage of building materials. Urban & Rural India has shortage of 90 million housing units by 2015 also the projected population in India by 2026 will be 1,400 million. With the rapid urban migration, the poor have to settle for a life in the streets or in slums in cities. Offering hope in this dismal scene are cheaper alternative building materials. An example is the gypsum wall panels. Recently, Gypsum based wall panels are in the market which are capable of replacing brick walls. The panels are available in 12x3 metre and 6x2.8 meter size with a thickness of 124 mm. They can be cut to the requirements of the customers. The lightweight panels conform to the green building concept with savings in energy. Along with this other parameter like construction technique of building using rapid wall panels, its advantages over conventional building, benefits to builders and also feasibility w.r.t. environmental aspect, thermal insulation, fire resistance, water proofing studied. Conclusions are drawn based on above mentioned points.

Keywords: Housing, Rapid wall, Solid waste, Environmental pollution, Building materials

I. INTRODUCTION

Traditionally materials like clay, sand, stone, gravels, cement, brick, block, tiles, distemper, paint, timber and steel are being used as major building components in construction sector. All these materials have been produced from the existing natural resources and will have intrinsic distinctiveness for damaging the environment due to their continuous exploitation. The cost of construction materials is increasing incrementally. Rapidwall panels are manufactured, in moulding process, from high grade gypsum plaster and glass-fibre rovings to a size of 12 metres by 3 metres by 123 millimetres thick. The hollow sections, or voids, have 250 millimetre centres. The panels are cut in the factory to design specifications to a maximum tolerance of 5 millimetres. After cutting, the panels are loaded

onto collapsible frames called stillages ready for transport to the building site. Up to 500 m² of Rapidwall can be transported on one truck. The panels are lowered into position using a small crane and supported by props until the structure is completed. The formed cells can be filled with insulation for increased thermal performance or with concrete for increased load-bearing structural capacity. Rapidwall is a load bearing building panel with a multitude of uses for the construction industry. It is ideal for just about any construction in which current building practices are used and is suitable for single, double or multi-storey housing and for commercial and industrial development. Rapidwall eliminates the need for bricks, timber wall frames and plasterboard as it serves as both the internal and external load bearing wall.

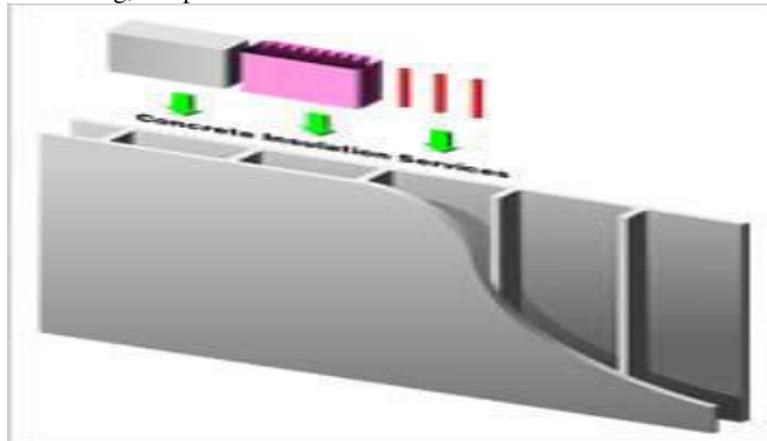


Figure.1. Example

Because of its low energy and environmental credentials, Rapidwall is particularly suitable in areas where traditional building materials, that have high energy usage, high carbon emissions or cause degradation to the environment, are no longer sustainable. Its Superior building material that is Rapidwall is a revolutionary, low cost, prefabricated, load bearing walling product suitable for use in high-rise residential, commercial and industrial building construction. Rapid wall is Economical. Compared with conventional building, Rapidwall has an installed cost considerably less than

that of an equivalent standard precast concrete wall. Rapidwall is quicker and easier to erect, projects are finished faster and development funds are tied up for shorter periods. Rapidwall can eliminate the need for bricks, blocks, timber wall frames and plasterboard linings. Load-bearing wall, Rapidwall panels enables it to be used to provide sufficient axial strength and lateral rigidity to support buildings up to 15 storeys. When used structurally Rapidwall eliminates the need for beam and column framework. Rapid wall provides Superior finish. The finish of Rapidwall is smoother and flatter than an equivalent

precast concrete, insitu-concrete or rendered masonry walls Earthquake resistant building material. When used as load-bearing shear walls Rapidwall exhibits superior ductile qualities that make it safer and effectively stronger than unreinforced masonry. Water resistant material. In an unsealed and uncoated state and after full immersion in water for 24 hours, the moisture uptake of Rapidwall is less than 5% [by weight].

Figure.2. Example

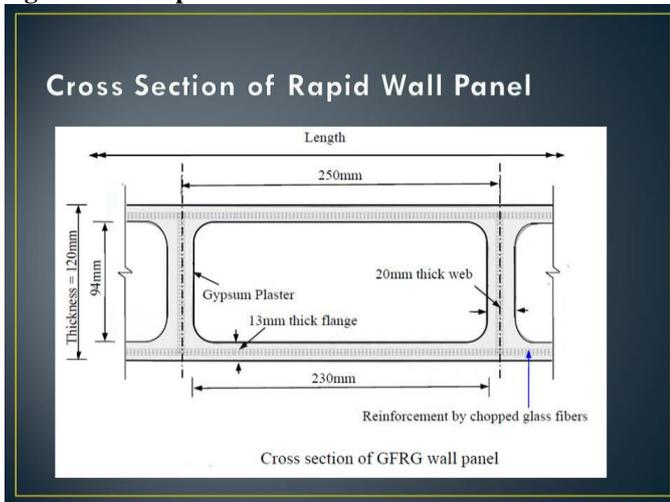


Figure.2. Cross section

II. PRODUCT DETAILS

Gypsum is the primary raw material for the manufacture of Rapidwall. Throughout the world, natural gypsum as well as synthetic gypsum is used for Rapidwall. Natural gypsum is an inert, naturally occurring, material and available in vast quantities all over the world. In all countries gypsum is used as a clay breaker to enhance the yield of farming land. Many millions of tonnes of flue gas gypsum and phospho gypsum are produced annually as by-products of coal fired power stations and chemical fertilizer industries and in many cases this waste is itself becoming an environmental problem. By utilising Rapid Building Systems' Rapidflow calcination equipment, phospho gypsum, flue gas gypsum and other industrial gypsums can be turned into plaster and subsequently into Rapidwall buildings that are environmentally friendly, non polluting, energy efficient and aesthetically pleasing; thereby cleaning up the environment. In formulating Rapidwall building panels, the main ingredients are plaster and water supplemented with relatively small amounts of other materials to obtain excellent water resistant and strength properties. The other raw materials consist of retarder, a water proofing agent, polymers, consistency modifiers, release agents and fibre glass rovings. These ingredients are sourced through the petrochemical, mineral and vegetable oil industries and are all supplied with comprehensive Material Safety Data Sheets for safe and environmentally responsible use. There are no animal products required or used. Rapidwall is continuing with research and development on raw materials and additives to obtain even better performances within strict ecological guidelines, whilst maintaining quality and recycling status as top priorities. In a diverse range of countries and communities where Rapidwall is active, traditional customs, beliefs and religions are treated with the highest respect, before and during the life cycle of the respective projects. Building panel, presently manufactured as a Rapid wall, for the typical dimensions and material properties described in this manual. Typical dimensions of rapid wall panel 12.0m x 3.0m x

124mm as shown in fig. Each 1.0m segment of the panel has four cells. Each cell is 250mm wide and 124mm thick, containing a cavity of 230mm x 94mm as shown in fig. The various cells are inter connected by ribs of 20 mm 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.

III. DESIGN

The designs are based on limit state design procedures, as per relevant Indian Standards, The design should be such that the structures should withstand safety against all loads likely to act on the structure during its lifetime. the ultimate limit state for strength design considered, treating the 3.0 m high GFRG building panel as the unit material and considering the strength capacity as obtained from the test results. It shall also satisfy the serviceability requirements, such as limitations of deflection and cracking. In general the structure shall be designed on the basis of the most critical limit state and shall be checked for other limit states. Detailed design Guidelines are given in "Use of Glass Fiber Reinforced Gypsum (GFRG) Panels in Buildings -Structural Design Manual" prepared by IIT Madras and published by BMTPC (Building Materials and Technology Promotion Council). It may be obtained on request from BMTPC. 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 storey's 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. Manufacture of GFRG Panels with increased thickness (150 mm – 200 mm) with suitable flange thickness can facilitate design and construction of taller buildings. These panels need some equipments like forklift, crane, v-shaped funnel, adjustable m.s. props and angles, required for construction of RAPID WALL Structure.

ENVIRONMENTAL BENEFITS OF RAPID WALL:

Eliminate in environmental damage

UseChina outlawed the use of clay bricks in 2002 because of the damage caused by the mining of clay and because of the pollution caused by firing the many thousands of kilns. So important does China view this issue, they now operate in Beijing, a "Ministry of Walling" with the sole responsibility of finding and introducing new types of energy efficient and environmentally friendly walling products. The Government of India has arrived at a similar conclusion in regard to the use of Rapidwall, and production started two years ago. The single panel Rapidwall system serves as both the internal and external wall and eliminates the need for bricks, blocks, timber and steel wall frames and plasterboard linings. The lowest energy embodied building product *Rapidwall panels are the lowest embodied energy building material available on the world market.* Embodied energy is the energy consumed by all of the processes associated with the production of a building, from the acquisition of natural resources to product delivery, including mining, manufacturing of materials and equipment, transport and administrative functions. Adding all the energy components together from gypsum mining, manufacturing panels, transporting to site and constructing a building, Rapidwall buildings are low energy consumers. Even when concrete and insulation are used to fill cavities in the panels to provide

insulation for single storeys, and strength for multi storeys, the embodied energy of Rapidwall buildings is substantially less than other buildings. Studies have been carried out on a series of alternative building products and Rapidwall is less than 50% of these materials.

- **Eligible for Carbon Credits:** Rapidwall has been acknowledged by the World Bank to be eligible for carbon credits, which we understand, to be the first building material to achieve such recognition.

- **Air drying:** In many countries in the world Rapidwall building panels can be air dried in open air racks thereby alleviating the need for kiln drying process and saving on energy.

- **100% recyclable:** With Rapidwall, door and window openings are cut in the factory according to building design requirements. The partial off-cuts can be used in other parts of the building project, or returned to the plaster manufacturer for recycling. If not recycled, off-cuts and miscellaneous remnants of panels remaining after installation are biodegradable after pulverising.

- **CO₂:** Carbon dioxide emissions are substantially less for Rapidwall than comparable building materials. One square metre of clay brickwork emits over 70kg of carbon dioxide compared with 7kg for the equivalent “Rapidwall” panel. The CO₂emissions include production, transportation and installation of the respective products. When panels are airdried, natural water vapour is the only emission into the atmosphere, and there are no other emissions.

- **Environment Impact:** Environmental impact clearances have so far been obtained with each plant approval in Australia, China and India and completely comply with Environmental guidelines set by the local Environment Protection Boards.

- **Air Quality-exterior:** Where gypsum is calcined the emissions are kept well below any Countries legal limits. Plaster conveying is a minimal dust operation and any dust generated is encapsulated within the silos. Exhaust air from the dust collectors is filtered through bin vents mounted on the top of the silos and bins, then recycled. Mobile equipment such as fork lift trucks operating outside the factory are equipped and fully maintained with exhausts and silencers as specified by the suppliers and local regulations. Access roads surrounding the factory are either made from concrete or asphalt, minimizing airborne dust caused by traffic movement.

Air Quality-interior: The factory is ventilated via natural air

- flows and there are no airborne emissions from the production process of producing Rapidwall. Efficient dust collection removes potential dust emissions at each stage of the processing. Mobile equipment operating within the factory site is fitted with approved exhaust systems. Operators are provided with masks when handling some raw materials as specified by the Supplier’s MSDS.

C.Water Supply, Underground Tanks and Rain water Harvesing :potable water is used in the process for making Rapidwall building panels.Process water is sourced from local water services to the nominated industrial area. Additional water is sourced from recycling process water stored in underground tanks, and by harvesting rain water.

Recycled Plaster :

In the final stages of moulding and forming Rapidwall building panels, excess plaster slurry is screeded from the surface of the panels. This material is collected by the operators, placed in containers and recycled by the plaster manufacturer and/or supplier for reuse in the process. The wet mixer is washed after each panel is mixed and formed, and the wash water is recycled and used again.

Environmentally Friendly Raw Materials:

All raw materials are carefully selected to avoid toxic and hazardous substances in the process. Plaster (CaSO₄, 0.5H₂O) is the main raw material which is made from naturally occurring or industrial gypsum. It is a fully biodegradable material when pulverised finely and water is added, forming gypsum Sourcing Raw Materials: All raw materials are derived from natural minerals natural gypsum rock or industrial waste gypsum with the chemical name of calcium sulphatedihydrate (CaSO₄, 2H₂O).Natural gypsum is mined, transported from a local source and converted into plaster by local manufacturers. The chemical name for plaster is calcium sulphate hemihydrate (CaSO₄, 0.5H₂O). Gypsum and plaster are both slightly soluble in water and are considered non hazardous substances.

G.Glass Fibre Rovings (E glass):

Glass Fibre rovings are used for reinforcing Rapidwall building panels. The rovings are cut into lengths during panel production and are wetted directly into the plaster slurry during moulding operations. Fibre glass handling and cutting are considered non hazardous activities. The fibre glass is non-respirable.

MATERIAMLS USED	RAPIDWALL BUILDING	CONVENTIONAL BUILDING	SAVING IN %
CEMENT	16 tonnes	32.55 tonnes	50.8
STEEL	1800 kg	2779 kg	35.2
RIVER SAND	20 m ³	83.37m ³	76
GRANITE METAL	38m ³	52.46m ³	27.56
BRICKS		57200	
RAPID WALL	500 m ²		
WATER	50000lt	200000lt	75
BUILT AREA	143 m ²	154.45m ²	8
LABOUR	389 MAN DAYS	1200 man days	67.59
CONSTRUCTION TIME	21 DAYS	120days	82
TOTAL WEIGHT OF SUPER STRUCTURE	170 tonnes	490 tonnes	65
CONSTRUCTION COST	US 26,800	\$us 36.980	27.5
EMBODIED ENERGY IN kwh	82921	215400	61.5

Retarders are classed as food grade quality:

Further information regarding raw materials used in the production and manufacture of Rapidwall or Rapidflow plasters

and material safety data sheets (MSDS) are available on request from Rapid Building Systems

Respect for Local Customs and Religious Beliefs :

Rapidwall building panels are manufactured in a number of countries throughout the world and the respective customs and religions are high priorities for consideration before, during and after building new plants. In this regard great care has been taken to remain sensitive towards these important items Where appropriate the following important items are addressed:

- As the process is a batch operation, prayer times are available for personnel during normal production cycles.
- Care has been taken to ensure that all raw materials used in the process are of non animal origin.
- Any other requirements not mentioned here but required by local laws and regulations are implemented for disadvantaged peoples.

The following chart is based on the construction of a 130m² demonstration house in Mumbai, India.

Materials/ items	Rapidwall Building	Conventional building	Saving in %
Bricks	-	965327	-
GFRG Panel	2044	-	-
Water	160000 ltr	666000 ltr	75.98
Construction Time	66 days	200 days	67
Construction Cost	32.73 lakh	44.80 lakh	26.94
Accuracy	MORE	LESS	-
Transportation	MORE	LESS	-

ADVANTAGES OVER CONVENTIONAL BUILDINGS:

1. Less built-up area for the same carpet area, the wall panels are only 124mm thick.
2. Less embodied energy and carbon footprint: significant reduction in use of cement, sand, steel and water; recycling of industrial waste gypsum.
3. Lower cost of structure. Due to that we can save the materials.
4. Lower building weight (panels weigh only 43 kg/m²), contributing to savings in foundation and reduction in design for earthquake forces, particularly in multi-storied construction.
5. Buildings up to 8-10 storeys’ can be designed using this load-bearing system, without the need for beams and columns.
6. Excellent finishes of prefabricated GFRG panels – used for all the walls, floors and staircases, with minimal embedded concrete: no need for additional plastering.
7. The use of prefabricated light-weight GFRG panels not only implies faster overall construction time but also a safer working environment.
8. The structure is Light weight and accurate. The whole construction is Economical.
9. The construction using this panel is Load-bearing
10. Rapid wall panel is environmentally positive of environment friendly.

11. The structure is Fire proof.
12. This construction is Earthquake resistant.
13. The structure has good sound attenuation quality
14. Protection from all the elements-Fire, hurricanes and cyclones and temperature.

Produced from inert gypsum plaster, Rapidwall has a 1 hour fire rating when unfilled or a 4 hour fire rating when filled with concrete. By using a simple tie down system, the roof is secured through the cavity of the wall to the foundation giving it significant protection against high winds. Further, Rapidwall has a high thermal insulation and when the hollows are filled with insulation even greater thermal properties are achieved.

Saves energy & the environment: In his thesis, Ecologically Sustainable Development - Approaches in the Construction Industry, Robert Omahen, University of Regensburg concludes that: Rapidwall offers huge savings in embodied energy- 66% for domestic buildings 40% for commercial buildings. Rapidwall uses fewer raw materials but doesn’t compromise on load bearing capability and the total CO₂ saving of Rapidwall, for residential dwellings in Australia would be about 63% or 3.91 million tonnes compared to brick. High quality finish: The manner in which Rapidwall is manufactured means that both sides, the internal and external surfaces, are finished to a very high quality thereby dramatically reducing construction and finishing time.

IV. CONCLUSIONS

Rapid wall construction is more economical. Rapid wall Panel provides a new method of building construction in fast track. Using rapid wall construction we can reduce man power, cost and time of construction. The use of natural resources which are now-a-day not easily available like river sand, water and agricultural land is reduced. It reduces adverse effects on environment. 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.

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