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Review on Structural Behavior of Glass Fiber Reinforced Gypsum (GFRG) Panel for Building System

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ABSTRACT

Currently country showing housing shortage problem, especially among the low-income group and It is necessary to fulfill their shelter needs, so that there is introduction of GFRG (Glass fibre reinforced gypsum) panels in India. Glass fiber reinforced gypsum (GFRG) walls are prefabricated large gypsum panels with hollow cores. Developed in Australia in the early 1990s and now all over adopted by other countries, These are light-weight, Efficient load-bearing panels which can resist the loads and various studies are conducted worldwide for the establishment and suitability of the panel for the construction of walls and slabs. It has now found large utilization, even without use of sophisticated codes of structural design, to a great extent because of their environmental friendly behavior. When the hollow cavities of GFRG panels are filled with reinforced self-compacting concrete, the bond between the concrete and the GFRG panels are maintain properly. As a result, the structural performance of Rapidwall and the building systems are more efficient than that of other conventional building systems. GFRG buildings consist of GFRG walls and slabs alone and can be constructed up to 5-8 storeys for low to moderate seismic zones, and lesser height can be taken in higher seismic zones.These research Studies were carried out in India and other countries to understand various properties of GFRG panels and this paper presents review on the structural behaviour of GFRG panels. In this paper, we review the important research and issues of the GFRG Panels.

Keywords: GFRG (Glass fibre reinforced gypsum),Prefabricated, load-bearing panels, seismic zones, Rapidwall, environmental friendly.

1. INTRODUCTION

Glass fiber reinforced gypsum (GFRG) walls, also known as Rapidwall in the construction industry,which is a new building materials in construction industry. firstly manufactured in Australia in 1990s. GFRG panels/Rapidwall are ready-made prefabricated gypsum panels with hollow cavities and are made of calcined gypsum plaster and reinforced with cut glass fibers which is (a slender filament). GFRG walls are hollow machined panels made of modified gypsum plaster and reinforced with cut glass fiber.Glass fiber reinforced gypsum (GFRG) panel is a green and Sustainable product which is quick to assemble and erection in buildings.Fundamental analysis and utilization of GFRG panels has been carried in India, Australia, and China. Rapidwall could be used in low height buildings as load-bearing walls in low -rise buildings or as upper storey walls building- rise building when filled with self-compacting concrete in the hollow cavities. The Glass fibre reinforced gypsum (GFRG) panels are light-weight, load-bearing walls used for rapid construction of affordable and eco-friendly houses and are being used in India for more than a decade. GFRG panel is an alternative building material to replace bricks or concrete blocks. panel is an energy efficient green building material for use as load bearing and non-load bearing wall panels. Rapid wall is a large load bearing panel with modular cavities suitable for both external and internal walls. These are prefabricated in controlled-conditions in factories, from gypsum plaster reinforced with glass fibres (chopped) along with certain special additives and are available in a fixed size of 12 m length, 3 m height and 124 mm thickness. The panels are hollow, with cavities of size, 230 × 94 mm (formed between 20 mm thick ribs and 15 mm thick flanges), aligned along the height as in Fig. 1.

The structural behaviour of the GFRG walls and the buildings are very much complicated than the conventional system. This is happeen due to the development of a composite action as a result of the interaction between GFRG and the concrete when the cavities of the panel are filled with reinforced concrete [Wu, Y. F. 2009]. Therefore, the conventional structural theories and design procedure do not apply to the GFRG buildings. This paper discusses various studies conducted on GFRG wall and slab panels.

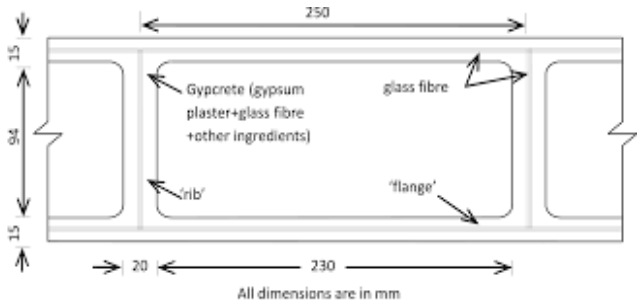

Fig. 1. GFRG panel : Cross-section

2. LITERATURE REVIEW:

[1] Aishwarya Shaji, S. R. Gouri Krishna, A. Meher Prasad and Devdas Menon (December 2022), The current housing shortage problem in the country, especially among the low-income groups and the necessity to address their shelter needs, led to the introduction of Glass fibre reinforced gypsum (GFRG) panels in India. These panels were originally developed in Australia in 1990 and later introduced in India, China, Hong Kong and other countries. They are light-weight, load-bearing walls used for rapid construction of affordable and eco-friendly houses (individual units to multi-storeyed buildings) and are being used in India for more than a decade. These are prefabricated in controlled-conditions in factories, from gypsum plaster reinforced with glass fibres along with certain special additives and are available in a fixed size of 12 m length, 3 m height and 124 mm thickness. The panels are hollow, with cavities of size, 230 × 94 mm, aligned along the height. These panels can resist axial, in-plane and out-of-plane loads and various studies conducted worldwide established the suitability of the panel for the construction of walls, slabs, staircases and parapet walls. GFRG buildings consist of GFRG panels as walls and slabs (without any beams and columns) and can be constructed up to 5-8 storeys in low to moderate seismic zones, and lesser height in higher seismic zones. Thus to properly understand the structural behaviour of the GFRG building system and to develop a proper design guideline, comprehensive research works were undertaken in India and other countries which includes the study to determine the various material and structural properties of the panel and this paper presents a critical review of the experimental and theoretical investigations on the structural behaviour of GFRG wall panels.

[2] A Meher Prasad (January 2019), The study focused on new building panel product, made of gypsum plaster reinforced with glass fibres. A similar study conducted on the evaluation of embodied energy on a conventional reinforced concrete framed building shows that the embodied energy per unit area is 10.8 GJ/m2.For the GFRG demo building, the embodied energy works out to be only 5.24 GJ/m2 , which shows that GFRG has almost 50% lesser embodied energy when compared to conventional building system. This makes GFRG a competent alternative to conventional building materials and systems.This reveals that the use of GFRG panels in building construction improves the sustainability of the building sector.

[3] Eldhose M manjummekudiyil et al. (March 2015), The typical shear failure mode observed was longitudinal shear in the gypsum plaster. Based on the experimental results a design procedure for the building system has been proposed. The lengthwise reinforcement has no significant effect on shear response of concrete filled GFRG panels. Axial load has a similar effect on the shear strength of the walls.

[4] Anjana R, Silambarasan.G, P.Balamurugan (April 2018), Nowadays there is a need for quick period construction for our society. By comparing the commercial concrete construction, the Rapid wall construction gives good result for our construction needs in the society. Glass Fibre Reinforced Gypsum (GFRG) is a new building material and it is also known as Rapidwall building panel. It is mainly used to overcome the lack of natural resources like River sand, water, gravel, etc., The product gypsum is abundantly available as an industrial by-product waste. GFRG panels are a composite material consisting of calcined gypsum plaster and glass fibre. The panel contains cavities that may be filled with concrete and reinforced with steel bars to impart additional strength and provide ductility and also it can be used for the construction of walls, floor and roof slabs. It has light weight, high compressive strength, shearing strength, flexural strength, stiffness and ductility. It has high level of resistance to fire, heat, water and corrosion. Concrete infill with vertical reinforcement rods enhances its vertical and lateral load capacities. The rapid wall buildings are also resistant to earthquakes, cyclones and fire. The paper carried out some of the literature study in the different samples of GFRG panels performance in experimental wise.

[5] S. Vishnu1, R. Shanmuga Priyan (November 2018)- Economical plan and development of structures, utilizing green material is an option in contrast to exhaustion of totals and increment in cost of concrete. Glass fiber reinforced gypsum panel (GFRG) is a green material, which is a rapid wall construction method and a cost effective construction process. With the end goal to enhance the productivity, and decrease of waste, the lean the development has been presented as another administration rule for better execution. In India, the usage of lean

administration in the development industry is a noteworthy errand. Because of the absence of consideration and uneducated towards the lean administration guideline the proprietor, contractual worker, engineers and so on are as yet creating a stage to actualize this standard in their task. This venture primarily centers on to recognize the potential outcomes of execution of lean administration in the development industry. This paper shows the probabilities of compelling usage of lean administration guideline in the development industry, which can definitely diminish the use of time, increment the nature of work, and benefit rate by wiping out the wastage of materials. It finally, points in giving lodging to all classes of people, in this way enhancing the economy of India.

3. AIM & OBJECTIVE -

AIM: To Study The Concept Of GFRG Panel: Structural Behavior & Application.
Objectives:
To understand the concept of GFRG Panel
To understand the Structural Behavior of GFRG Panel.
To study the application of GFRG Panel in construction industry

3.1 MATERIAL PROPERTIES-

The physical and mechanical properties of the GFRG panel were obtained based on Compression test on GFRG blocks (520×250×120 mm) and tension test on GFRG flanges (as the tension failure is more likely on flanges) were performed. and thus the stress-strain curve under axial tension and compression were determined. The ultimate shear stress was obtained by performing four-point loading test on a specimen of size 1100 ×270×120 mm.

3.2 BEHAVIOUR OF GFRG PANEL-

The GFRG panels can be used as walls, where the cavities are either left unfilled or filled with plain or reinforced concrete to improve its load-carrying capacity and ductility. GFRG, as a load-bearing structural member is capable of resisting axial load (P), lateral shear (V).

3.3 ADVANTAGES OF GFRG WALL PANELS-

- It is used in light-weight construction and advantageous in earthquake-resistant design.
- It is sustainable construction reduced use of steel and concrete.
- It increased carpet area.
- Thin wall panels, improved thermal comfort - saving in operational energy.
- These panels can be used for the construction of walls, slabs, staircases and parapet walls.

3.4 PROPERTIES OF GFRG WALL PANELS

- The material is light in weight which has general flexible strength for the design plans and industrial complexes.
- It has a wonderful load-bearing capability and they are eco-friendly.
- Panels made of GFRG can resist earthquakes up to 8 Richter scale.
- These panels are also fire-resistant and water-resistant.
- They decrease the structural weight of the construction.
- It is comparatively simple to construct and also saves time compared to the usual building process

4. FACTORS AFFECTING THE SHEAR STRENGTH OF THE GFRG WALL PANELS ARE FOLLOWING-

- 1. Concrete strength-
- 2. Reinforcement bar-
- 3. Axial load-
- 4. Internal frame action-

5. CONCLUSION –

1.In Australia, the GFRG panels were used as load-bearing walls for resisting gravity loads and the slabs were made up of reinforced concrete.
2.This paper has introduced GFRG walls and the associated building system.From the studies conducted in India, an earthquake-resistant design procedure for the use of GFRG panels for buildings in different seismic zones of the country was developed.
3.GFRG panels with embedded micro-beams and RC screed can be used as floor/roof slabs and so that It is suitable for constructing walls, slabs, staircases, and parapet walls.

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