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EXPERIMENTAL STUDY ON EMPTY GLASS FIBRE REINFORCED GYPSUM PANEL

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Abstract - There is an extensive seeding stipulation of dwelling provisions in India due to the prevailing housing defalcation of 24.7 million units (2007) essentially for the under exact tribute huddles in metropolitan India. Approximated housing units in 2012 are 26.53 million, while the housing shortage of rural India in 2012 is 42 million units. Thus total estimated housing shortage for the urban and rural India in 2012 is 68.53 million units. To meet this challenge, India requires innovative, energy efficient building material for strong and durable housing is fast track method of construction at affordable cost. It is also important that housing and buildings are disaster resist to product the live and properties of people! All these concern are involved in sustainable and inclusive development. Rapid wall panels provide fast or accelerated improvisation and contribute to environmental protection, providing a elucidation to multitude of the exceeding issues and concern, So the requirement is full-filled by the GLASS FIBRE REINFORCED GYPSUM (GFRG) PANEL. This project describes the experimental investigation of the GFRG panel. Various experiments were conducted on the physical and mechanical characteristic of GFRG empty panel. From the result, the compressive strength was noted. This paper concludes with the physical and mechanical properties with the strength of the empty panel

Keywords - Glass Fibre Reinforced Gypsum (GFRG) Panel, Load Bearing Capacity, Strength, Nominal, Empty Pane

I. Introduction

GFRG is used as panels for construction of building at low cost. These panels are composite materials consisting of based gypsum plaster and glass fibers. When the cavities are filled with reinforcement, the composition is between the concrete and panel [1]. GFRG can be used wherever a light, strong and fire retardant material is required (casinos, hotels, theaters, residential, etc.). They can be used for the construction of various building components like Lintels, roof slabs, stair case, tie beam and can be provided as openings for doors, windows etc. They are considered to be more economic than other conventional materials. Our main aim is to study the properties and strength of GFRG panels in an economic way in construction of various structures. Generally, conventional materials require high cost and strength is less when compared with GFRG panels.

A. Economic Analysis of Using GFRG Panels

The conventional materials require more time and the rate of is more compared to GFRG panels. Generally, the construction of building using modular brick requires more cost than GFRG panels. The main advantage of using GFRG panel is it withstands the moisture and dampness in and around the walls. It can be used in cold places. Unlike the conventional materials it will not collapse due to excessive dampness and the crack in the wall can be prevented by using GFRG Panels. This type of wall depends on structural design, self-weight, construction, easiness in transportation, types of materials and its specification so, study or analysis of different materials which are suitable for the constructions of non-load bearing wall are necessary [4].

B. Advantages of GFRG Panels

These can be given as follows: Very fast construction, reduced hassles of construction with less material, saving in transport cost of sand, bricks/concrete blocks, granite metal, cement, steel, water, scaffolding and shuttering materials, fire proof, strong and quality construction, earthquake resistant building at no extra cost. less maintenance cost, less recurring cost for cooling or heating of indoor space. However, in terms of the application of GFRG wall is limited for its poor lateral stiffness even though it is filled concrete in its hollow cores, its lateral stiffness to be suitable for small high-rise residential building is a valuable choice for researchers [2].

II. Physical Properties of Empty Panel

A. Appearance

The two external faces of GFRG panels should be free from defects such as corrugations, ripples, pockmarks, stains, loose corners, cracks which undesirably affected the painted attractive surface finishes

B. Dimensional Tolerances

The manufactured dimensional tolerances for a full sized GFRG panel are given in Tables 1 & 2.

TABLE I. Overall Dimensions Tolerances

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Length	Height	Thickness
Nominal Length ±3mm	Nominal Height ±3mm	Nominal Thickness ±3mm

TABLE II. Cross Sectional Tolerances

Panel Classification	External Skin Thickness	Internal Rib Thickness	Cavity Width	Cavity Depth
General Grade & Water Resistant Grade	Nominal Thickness ±3mm	Nominal Thickness ±2mm	Nominal Width ±4mm	Nominal Depth ±3mm
Partition Grade	Minimum 8mm	Nominal Thickness ±5mm	Nominal Width ±7mm	Nominal Depth ±7mm

C. Panel Weight

The weight of the empty hollow core GFRG panel satisfaction is shown in Table III.

Table – III : Empty Panel Weight

Panel Classification	Nominal Weight	Tolerance %
Class 1, 124mm thick	40	6
Class 2, 124mm thick	40	6
Class 3, 124mm thick	40	15

1) Dimension of the Specimens

Figure 1 indicates that the panels are manufactured with size of Length = 12m.

Height = 3m.

Thickness = 124 mm.

Each panel = 48 modular cavities

Dimension of the cavity is 230 mm x 94 mm x 3m.

Dimension of the specimen is 300*250*15mm

Fig. 1 Specimen of Empty GFRG Panel

III. Procedure and Result of Physical Properties

A. Measurement of Water Content

The specimens were taken in a drying oven whose space should not be less than 200x300x360. They were dried at temperature of 40±2°C and humidity was at 50±2%. The capacity of 5 Kg and accuracy of 0.5g each specimen was weighed and the weights were recorded. The specimens were taken at constant weights with 0.1% of dried weight at temperature of 40±2°C. This can be achieved by drying the specimen for 24 hrs and weighted. After the specimen was dried for 24hrs, the same specimen was further dried for another 4 hours and then weighted until the difference of the two consecutive weights of the specimen was with 0.1% of the dried weight and the readings are exhibited in Table IV. To determine the water content of the panel is in the equation (1) was employed.

TABLE IV. Observation of the water content of the panel

Description	Ranges
Temperature	30°C
Dimension of the specimen	300*250*15mm
Weight of the dried specimen (W_2)	2.865kg
Weight of the specimen before oven dry (W_1)	2.88kg

$$\text{Water Content} = \frac{(W_2 - W_1)}{W_1} * 100 \quad (1)$$

Water absorption = ((2.88-2.865)/2.865)*100 = 0.535%

The value of water content of panels is measured after the drying process (without moisture intake after drying) and found as water content shall be less than 1% and 0.535%.

B. Measurement of Water Absorption Rate

The specimen tested for the water content was immediately taken for water absorption rate and the apparatus used for the experiment were balance with a capacity of 5kg and an accuracy of 0.5g using water bath or container with enough room to immerse the three specimens and keep them separated and elevated from the bottom of the bath with minimum spaces of 25mm. The specimen was immersed in a flat water bath at temperature of 21±0.5°C with 25mm head of water over the top of sample. The sample was placed in the water bath elevated above its base, and removed after 24hrs, excess water from the surfaces and edges of the specimens was wiped and weighed immediately to within 0.5g.The % of weight gained in water with respect to the dried weight of each specimen were determined the water absorption rate was calculated by the formula 2. Table V shows the observation over water absorption of the panel

TABLE V. Observation over the water absorption of the panel

Description	Ranges
Temperature	21°C
Dimension of the specimen	300*250*15mm
Weight of the specimen (W_2)	2.865kg
Weight of the specimen immersed in water (W_1)	2.902kg

$$Water\ Absorption = \frac{W_2 - W_1}{W_1} * 100 \quad (2)$$

Water absorption = ((2.902-2.865)/2.865)*100 = 1.29%

The specimen tested for the water content is immediately used for water absorption rate is 1.29%.

C. Measurement of Vertical Load Bearing Capacity

The measurement shall be taken on both front and back faces of the specimen and an average value used. Placing of Specimen: that of the specimen shall be placed at the centre of the platen on the test machine. The strength of the plaster lower than the test specimen at the time of testing. Loading: the compression load gradually in a rate not greater than 10KN per minute until it reach the peak load and then dropped at least 20%off peak load. The recorded values were noted. For the first sample the first crack appeared 80kN and the total destruction of specimen occurred at 170kN. The compressive strength can be calculated by dividing the total destruction by first crack. Table VI gives the result of compressive strength of the empty panel sample (the size of the panel is 250mm*520mm*124mm).

Fig. 3 Compression test Setup on GFRG Panel

Fig. 2 Crack in the Empty GFRG Panel

TABLE VI. Result of Compressive Strength of the were Empty Panel

Sample	Weight of the Specimen (kg)	First Crack (kN)	Total Destruction (kN)	Compressive Strength (N/mm^2)
1	7.65	80	170	1.24
2	7.58	83	160	1.29
3	7.68	92	180	1.42

Average compressive strength value of empty panels is 1.30 N/mm^2

D. Flexural Strength of the Empty Panel

Generally, the flexural strength of panel is determined by applying a thick layer of plaster on steel plates. Then, the specimen is fixed between two steel plates and the centre line position of roller bar is marked on the bottom of the specimen. At mid span, the transducer is placed under the bottom of test specimen after the plaster is set. To prevent cracks in the specimen, a small piece of plate is placed at the tip of transducer. If the cracks appear then the weight blocks are placed on surface area by rows and columns. In the meantime of teat data is recorded between the load vs displacement curve. The Moment Carrying Capacity of the Specimen is given by the equation (3).

$$Mu = 1/8\ (w + f)L^2 \quad (3)$$

Where,

W is the unit weight of the panel which is typically 0.4kN/m^2.

f is F/L,

F in kN is the First Peak load from the Load vs. Displacement curve

L is the Span which is 2.5m.

The Graph is plotted between the Loads vs. Displacement of the Sample 1 (Figure 2)

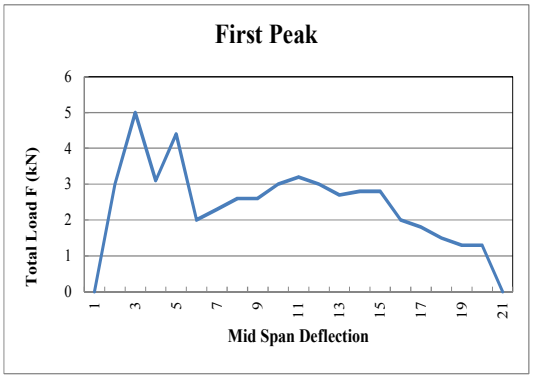

Fig. 4 Load vs. Displacement for Sample 1

Mu= (1/8)*(0.4+2)*2.5^2=1.87kNm

The Graph is plotted between the Loads vs. Displacement of the Sample 2 (Figure 3)

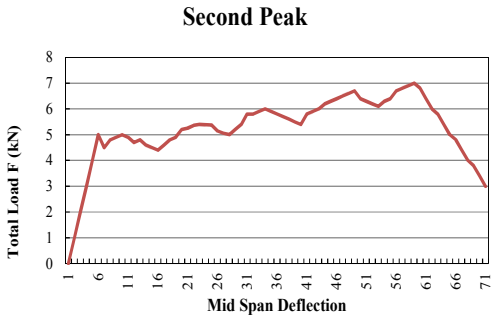

Fig. 5 Load vs. Displacement for Sample 2

Mu= (1/8)*(0.4+2.32)*2.5^2=2.125kNm

Table 7 presents the Flexural strength of the empty panel.

Table VI : First Value of the Load vs. Displacement

Sample	First Peak Load (kN)	F (kN/m)	Flexural Strength (kNm)
1	5	2	1.87
2	5.8	2.32	2.125

Average flexural strength value of empty panels is 2.02 kNm.

E. Fire Resistance Test

Dimension of test specimen is 300mm *300mm *124mm. The fire resistance test on GFRG panel shall be conducted using a blow torch. The blue flame temperature shall be measured and be in the range of 700^{O}C to 1000^{O}C. The blower tip of the blow torch shall be kept at a distance of about 50 mm from one face of the panel, so that the blue flame shall directly hit the panel continuously. The panel shall be exposed continuously 4 hours duration. The other face of the panel shall be pasted with a thermocouple to monitor the temperature continuously. Recording the value of the temperature at the interval of in 4 hours of the GFRG panel. At the end of the test no damage or cracks was observed beyond the spot where the flame was directly hitting the face of the panel. Instead empty cavity is filled with concrete mix in that also no cracks and damage was observed. Thermal conductivity is very less.

IV. Conclusion

GFRG panel were collected and various physical properties of the panel were tested.

- GFRG panels are light weight building material which can be used as wall and roof slab
- Compressive strength of GFRG panel was obtained as 1.31 N/mm^2
- Water absorption value was obtained as 1.29 %
- The flexural value of empty panel was 2.02kNm.
- GFRG panels were used replacing various bricks used for walls.
- GFRG panels can be used as both load bearing walls and non-load bearing walls.
- They can be used in the areas which have been struck with calamities and for restoring the lifeline of the area rapidly.

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