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Study of GFRG Panel and Its Strengthening

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Abstract: **There is a huge growing requirement of building materials in India due to the existing housing shortage. To meet this challenge, India requires innovative, energy efficient building materials for strong and durable housing in fast track method of construction at affordable cost. Rapid wall is an alternative building material to replace bricks or concrete blocks. This study deals with the physical properties of GFRG Panel and finding out the suitable filler materials to strengthen it. Various experiments were conducted on the physical characteristics of GFRG panels. From the results obtained, variations in the compressive strength with different filler materials were noted. This paper concludes with selection of the filler materials to improve the strength of GFRG panels in a cost effective way. Besides this, certain methods to overcome its drawbacks are also discussed.**

Keywords**: GFRG Panel, Remedies.**

I. INTRODUCTION

Rapidwall, also called gypcrete panel is an energy efficient green building material with huge potential for use as load bearing and non load bearing wall panels. Rapidwall is a large load bearing panel with modular cavities suitable for both external and internal walls. It can also be used as intermediary floor slab/roof slab in combination with RCC as a composite material. Since the advent of innovative Rapidwall panel in1990 in Australia, it has been used for buildings ranging from single storey to medium - high rise buildings. Light weighted Rapidwall has high compressive strength, shearing strength, flexural strength and ductility. It has very high level of resistance to fire, heat, water, termites, rot and corrosion. Concrete infill with vertical reinforcement rods enhances its vertical and lateral load capabilities. Rapidwall buildings are resistant to earthquakes, cyclones and fire.

Rapidwall panel is world's largest loadbearing lightweight panels. The panels are manufactured with size 12m length, 3m height and 124 mm thickness. Each panel has 48 modular cavities of 230 mm x 94 mm x 3m dimension. The weight of one panel is 1440 kg or 40 kg/sqm. The density is 1.14g/cm^3, being only 10-12% of the weight of comparable concrete /brick masonry. The other relevant physical and material properties of the Panel are given in the table 1.

TABLE 1: DETERMINATION OF OPTIMUM FLOW RATE

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 ^oC
Thermal conductivity	0.617
Thermal Resistance R	0.36 K/W
"U "Value	2.85W/M2K
Elastic Modulus	3000-6000Mpa
Sound transmission{STC}	40
Water absorption	< 5%

II. PRELIMINARY TESTS

2.1 TESTS DONE ON GYPSUM PLASTER:

A. Initial Setting Time:

Collect a sample of gypsum plaster from casting table. Place it into a standard mould and remove the mould. The gypsum plaster spreads into a circle on the table. Use the tool called as Initial hilmor (200g) and place the tip of it on the sample. Note the time at which the impression just disappears.

B. Final Setting Time:

Now use the tool called as Final hilmor (4800g) and places the tip of it on the sample. Note the time at which the impression just disappears is noted.

C. Cube Test:

Prepare a test specimen of standard size (50 cm^2 face area). Remove the mould after 24 hours. Place the cube on Compression testing machine. Apply the load gradually and note the load at which the specimen fails.

2.2 TESTS DONE ON PANEL:

A. Water Absorption:

The size of specimen for Water Absorption is specified as 250mm X 300mm. The Test procedure adopted is as follows:-

Weigh each original specimen and record their weights. Condition the specimen to constant weight by keeping it in an oven at a temperature of 40+ 20C. This can be done drying the specimen for 24 hours initially and weighing the specimen; when drying for another 4 hours each time and weighing the specimen until the difference of the two consecutive weights of the specimen is with 0.1% of dried weight. Weighed the dried W1 of each specimen to within 0.5 gram. Immersed the specimen in water for 24 hours and weighed it. (W2).Water Absorption =(W2-W1)x100/ W1.

B. Compression Testing:

Measurement of dimension - The width of the test specimen is measured at the waist of the specimen as shown in fig.1. The measurement shall be taken on both the front face and back face of the specimen and an average value used. The test specimen shall be placed at the center of the platen on the test machine. Under no circumstance should any part of the specimen be placed outside the perimeter of the platen of the test machine. Capping is done on the top and bottom faces of the test specimen capped with a thin layer of quick setting plaster to ensure firm and uniform contact with platen. The strength of the applied plaster shall not be lower than that of the test specimen at the time of testing. Apply the compression load gradually in a rate not greater than 10 KN/min until it reaches the peak load and then drops at least 20% of the peak load. The maximum applied load (peak load) indicated by the testing machine was recorded.

C. Flexural strength:

Mark the positions of support line (centerline position of the roller bar) on the bottom of the specimen, and load line (centerline position of the secondary distribution beam) on the top of the test specimen. Set up the pin and roller supports. Apply a thin layer of quick setting plaster on top of the supporting steel plates and then place the test specimen on top of the two supports. Wait a few minutes for the plaster to set. Apply a layer quick setting plaster on top of the test specimen at the position of the secondary distribution beam in position. Allow the plaster to set .Set up the rest of the loading system (main distribution beam and its support) and loading jack. Place the displacement transducer under the test specimen at the midspan. A piece of small plate (about 20mm X 20mm X 2mm thick) shall be glued on to the tip of the transducer to prevent it from going into a crack if the crack happens to occur at the position of the displacement machine point. Load the jack under displacement control in a strain rate of not greater than 5mm/min until the load passes the peak and drops atleast 50% of its peak load. In the mean time of applying loading, record the test data at sufficient number of test points to produce a load v/s displacement curve.

III. IMPORTANCE OF SELECTED FILLER MATERIALS

3.1. Nominal mix-M25:

The nominal mix was prepared so that a comparison can be made amongst the other special types of filler materials. The exposures of Indian Construction sites at most places are Moderate for which IS: 456-2000 specified that minimum grade of concrete for reinforced concrete should be M25. Accordingly for durability consideration the structural concrete must not be below M-25 grade. The high strength benefits obtained should be taken into account in the design consideration of the concrete structures. The below nominal mixes are worked out for Zone II fine aggregate. The coarse aggregates used were of 20mm and 12mm size.

Fig.1. Modular cavity of panel filled with nominal M25 mix concrete

3.2. Flyash concrete:

Use of fly ash in concrete imparts several environmental benefits and thus it is ecofriendly.It saves the cement requirement for the same strength thus saving of raw materials such as limestone, coal etc required for manufacture of cement. Manufacture of cement is high-energy intensive industry. In the manufacturing of one ton of cement, about 1 ton of CO2 is emitted and goes to atmosphere. Less requirement of cement means less emission of result in reduction in green house gas emission. The main objective of using fly ash in most of the cement concrete applications is to get durable concrete at reduced cost. The addition of fly ash as an additional ingredients at concrete mixing stage as part replacement of OPC and fine aggregates is more flexible method. It allows for maximum utilization of the quality fly ash as an important component (cementatious and as fine aggregates) of concrete. Hence , here 30% of cement is replaced by flyash.

Fig.2. Modular cavity of panel is filled with flyash concrete

3.3. Recycled aggregate concrete:

One of the major challenges of our present society is the protection of environment. Some of the important elements in this respect are the reduction of the consumption of energy and natural raw materials and consumption of waste materials. In India the total quantum of waste from the construction industry estimated to be between 12 million to 14.7 million tonnes per annum,out of which 7 to 8 million tonnes are concrete and brick waste.50% of construction and demolition waste is being reused and recycled, while the remainder is mostly landfilled.

Fig.3. Modular cavity of panel is filled with recycled aggregate concrete

The use of recycled aggregates from construction and demolition wastes is showing prospective application in construction as alternative to primary (natural) aggregates. Therefore, there is a need to study about recycled aggregate concrete and it's characteristics in the areas of workability, strength, durability while using it for higher grade concrete applications.

IV. RESULTS AND DISCUSSION

Various tests were conducted on the GFRG panels to determine its physical properties.

TABLE 2: PHYSICAL PROPERTIES OF GFRG PANEL

SL.NO	Test	Result
1	Water Absorption	1 .225%
2	Compressive Strength	1.25 N/mm^2
3	Flexural Strength	2.12KNm

TABLE 3: COMPRESSIVE STRENGTH OF GFRG PANEL WITH FILLER MATERIAL

SL.NO	FILLER MATERIAL	COMPRESSIVE STRENGTH(N/mm^2)
1	Nominal mix-M25	14.56
2	Flyash concrete	9.81
3	Recycled aggregate concrete	7.44

V. CONCLUSIONS

GFRG Panels were collected and tested for compression after filling it with selected filler materials. The fillers selected were Nominal mix-M25, Flyash concrete and Recycled aggregate concrete. A comparison was made between the panels tested based on strength and economy. Following are the conclusions drawn from the study.

5.1.Study of properties of GFRG Panel:

- GFRG Panels are light weight building material which can be used as walls and roof slab.
- Phospho-Gypsum, which is bi-product of fertilizer industry, can be effectively used in the production of panel.
- Compressive strength of GFRG Panel was obtained as 1.25 N/mm^2
- Water absorption value is obtained as 1.225%

5.2.Strengthening of Panel:

- From the results obtained from various tests conducted on GFRG panel, it is clear that the compressive strength gets increased with the inclusion of filler materials.

- Nominal- M25 mix gave maximum strength when used in panels.
- Recycled aggregate concrete filler also gave satisfactory strength in compression, and inturn it leads to an economic method of construction.
- Flyash being a bi-product of fertilizer industry can be effectively used along with the filler material in GFRG Panel.

5.3. Remedies to overcome the limitations of GFRG Panel:

- During dry season, it is advisable to add a curing compound in the filler inorder to ensure proper curing at site.
- Leakage in joints can be rectified by the use of proper sealing compounds and water proofing agents.
- Number of storeys of buildings constructed using GFRG Panel can be increased by using light weight concrete fillers in the higher storey's.
- In order to reduce the cost of construction recycled aggregate concrete and flyash concrete can be used.

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