iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** III **Month of publication:** March 2019

DOI: http://doi.org/10.22214/ijraset.2019.3423

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue III, Mar 2019- Available at www.ijraset.com

Low Cost Housing by using Glass Fibre Reinforced Gypsum Panels

Gaurav Saini[1], Kshitij Pant[2], Deepanshu Soni[3], Dipesh Jangid[4], Jitendra B. Jangid[5]
[1, 2, 3 ,4]*B.Tech. Final Year Students, Department of Civil Engineering, SKIT, M&G, Jaipur.*
[5]*Assistant Professor, Department of Civil Engineering, SKIT, M&G, Jaipur.*

Abstract: ***The urban housing requirement in India is growing at a very fast rate. To fulfil the requirements, India require energy efficient and energy innovative building material for stronger and long lasting housing at affordable cost. Our research has found that gypsum is a durable material. Experts predict that a building made of GFRG panels is expected to have a life span of 60 years. That's why GFRG panels are heavily in use as partition walls. A GFRG building does not require beams and columns. Also United Nations Framework Convention on Climate Change (UNFCCC) has also approved the material as a green building material. An additional strength can also be provided by filling the cavities in the panels partially or completely with reinforced concrete. These panels also overcome the drawback of the Load Bearing Structures. Using the panels multiple storeys can be constructed in Load Bearing Structures upto 8-10 Storey's in low seismic zones. So in this paper we are doing overall comparison of a conventionally constructed building and a building constructed with GFRG panels.***
Keywords: ***Low cost housing, GFRG panel, Cost comparison.***

I. INTRODUCTION

According to the 2011 census, the housing stock in urban India stood at 78.48 million for 78.86 million urban households [1]. Due to the continuous urbanisation, the economically weaker sections are forced to live in the slums which is continuously deteriorating their living standards.

The group further estimated that 88% of this shortage pertains to houses for Economically Weaker Sections (EWS) and another 11% for Lower-Income Groups (LIG). For Middle- and High-Income Groups (MIG and HIG), the estimated shortage is only 0.04 million [1].

Hence GFRG panels can be used as Glass Fibre Reinforced Gypsum (GFRG) panels is a new building materials which is suitable for rapid mass-scale building construction. GFRG panels are made essentially of high quality gypsum plaster (beta plaster), reinforced with glass fibre roving's and special additives [2]. During the manufacturing process, glass fibers of about 300–350 mm in length are randomly distributed inside the panel skins and in the ribs [3].

The design and construction of each structural component of the GFRG building system is briefly discussed in this paper. So it is observed that lower cost of construction GFRG panel step-back set-back and step-back structures has also higher lateral stiffness, rigidness against lateral load minimizing the maximum lateral deformation then Brick infill step-back set-back and step-back structures [4].

GFRG panels can be unfilled when used as partition walls, but when used as load bearing walls, it is filled with M20 grade concrete (reinforced concrete filling) in order to resist the gravity and lateral loads [5].

This product was originally developed in 1990 and is in use since then in Australia in Rapid wall Building Systems. Presently, these panels are manufactured in few Asian countries like India, China, Saudi Arabia and Oman. In Australia, several buildings had been built using the Rapid wall technology, but the use of the panels was restricted to walls, transferring the gravity loads [6].

A. Need of Low Cost Houses

Following are the needs of LCH

1) Growing population day by day.
2) Affordable housing for BPL peoples.
3) We need a solution that is fast.
4) Easy to build.
5) Fulfils the needs of conventional houses.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue III, Mar 2019- Available at www.ijraset.com

II. LITERATURE REVIEW

Following are the research journals, referred in the study of this project:

A. Low Cost Housing by Using GFRG Panels, Sk. Subhan Alisha, Sajja. Neeraja, Sk. Akber, G. Sai Manoj.

Experts predict that a building made of GFRG panels can have a life span of 60 years. The panel cavities can be partially or fully filled with reinforced concrete to provide additional strength. Buildings with load-bearing systems made of reinforced GFRG panels can go as high as 8- 10 Storey's in low seismic zones. The panel cavities can also be used for electrical wiring and piping work.

This paper is about GFRG panel details, properties and tests on the GFRG panels and the procedure of estimating the quantity of materials for different building components, and thereby evaluating the total cost of the project.

B. Sustainable, Rapid and Affordable Mass Housing using 'GFRG' Panels, Shinto Paul, Devdas Menon, Meher Prasad, Gopinathan.

Based on extensive research carried out at IIT Madras for more than a decade, this technology has been demonstrated by constructing around 300 buildings in India. Design and construction aspects of GFRG buildings are presented in this paper.

In this paper it is found that, this building system has many advantages over conventional buildings. GFRG buildings have the potential to meet the challenge of providing rapid affordable mass housing. This is an eco-friendly and sustainable building system, making use of recycled industrial waste gypsum or natural gypsum and minimising the use of cement, steel, sand, water and labour input.

C. The Structural Behaviour and Design Methodology for a new Building System Consisting of Glass Fibre Reinforced Gypsum Panels, y.-f. Wu.

GFRG walls are hollow machined panels made of modified gypsum plaster and reinforced with cut glass fibers. 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 about 0.8 kg per square meter of wall surface area.

In this paper it is found that the Indian shake table tests on full-scale two-story houses demonstrated the excellent seismic performance of the GFRG structural system. In this 6 models were tested. It was found that minor cracks were developed in one of the 6 models in an earthquake excitations of 0.36g. Also no structural distress found in any of the cases. In a destructive test on a five-story building, under a cyclic horizontal force of a magnitude of 100 tons no visible structural cracks or other distresses were observed, which is equivalent to a zone 8 earthquake as per the Chinese seismic code of practice.

D. Seismic Evaluation of GFRG Panel and Brick Infill Step-Back Set-Back and Step-Back Building, Arun Deshwali, Dr. Raghvendra Singh.

The present research work is to analyse a 3D step-back set-back building constructed on a sloping ground and performed the analysis by using software SAP 2000 (ver.16.0) using static nonlinear method for comparing and investigating the changes in structural behaviour subjected to seismic load.

In this paper it is found that, GFRG panel step back set back structure shows 0.043m displacement and GFRG panel step back structure shows 0.020m displacement and this is very less in comparison to Brick infill step back structure, which shows 0.29m displacement, so it is observed that lower cost of construction GFRG panel step-back set-back and step-back structures has also higher lateral stiffness, rigidness against lateral load minimizing the maximum lateral deformation then Brick infill step-back set-back and step-back structures.

E. Experimental Study on Glass Fibre Reinforced Gypsum (GFRG) Panels Filled with Alternate Concrete Mix Using Shredded Thermocol and Phosphogypsum, NithyaNandan A, Renjith R.

GFRG panels can be unfilled when used as partition walls, but when used as load bearing walls, it is filled with M20 grade concrete (reinforced concrete filling) in order to resist the gravity and lateral loads.

In this paper it is found that, the optimum combination of phosphogypsum and shredded thermocol which can be used as an alternative to M20 mix which can be filled in GFRG panels was found to be 10% and 15% respectively. The reduction in density of GFRG test specimens filled with alternate mix was about 4.08% when compared to that filled with M20 grade concrete.

F. Selection framework for evaluating housing technologies, VPS Nihar Nanyam, Riddha Basu, Anil Sawhney, J.K Prasad.

This paper highlights the evaluation framework consisting of mandatory attributes and preferred attributes, based on which the emerging housing technologies are selected for adoption. This framework is analyzed for two case studies to check the applicability. Glass fibre reinforced gypsum (GFRG) panel more popularly known as Rapid-wall is a building panel made up of calcined gypsum plaster and reinforced with glass fibre.

G. Study of GFRG Panel and Its Strengthening, Eldhose M Manjummekudiyil, Basil P Alias, Biji K Eldhose,Sarath Rajan, Thasneem Hussain.

In this paper, it is found that 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/mm2. Water absorption value is obtained as 1.225%. 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. Number of storeys of buildings constructed using GFRG Panel can be increased by using light weight concrete fillers in the higher storeys.

III. GFRG PANELS

Glass Fibre Reinforced Gypsum (GFRG) Panel also known as Rapid wall is a building panel made-up of calcined gypsum plaster, reinforced with glass fibers. This product was originally developed in 1990 and is in use since then in Australia for mass scale building construction. Now, these panels are also being produced in India. Also the technology is adopted in India.

GFRG panel are manufactured to a standard size of 12.0 m length, 3.0 m height and 124 mm thick, with modular cavities, as shown in Fig.1. These cellular cavities are formed between outer skins (flanges), 15 mm thick, and interconnecting ribs, 20 mm thick, at 250 mm spacing [7]. Each one metre length of GFRG panel has four such cavities of size 230 mm length and 94 mm wide as shown in Fig. 2. GFRG panel can also be used efficiently as in-fills (non- load bearing) in combination with RCC framed columns and beams (conventional framed) without any restriction on number of stories.

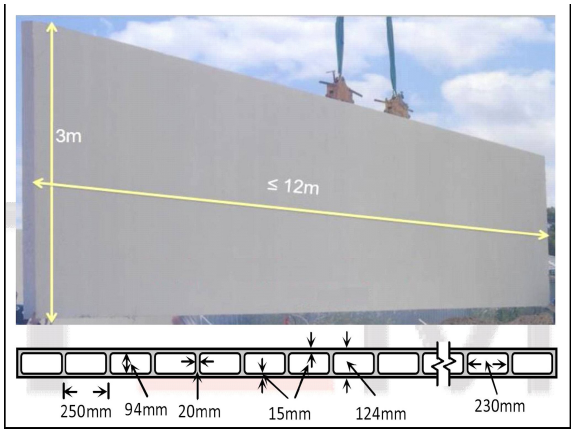


Fig. 1 Cross section of GFRG panel

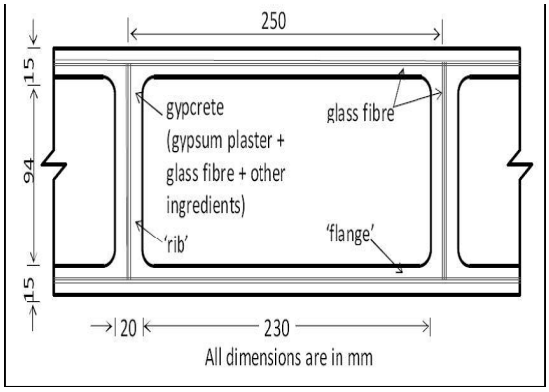


Fig. 2 Enlarged view of a typical cell

A. Grade and Type

GFRG panel may be supplied in any of the following three grades:

1) *Class 1:* Water Resistant grade – these panels cab be used for external walls, in wet areas and as floor and wall formwork for concrete filling
2) *Class 2:* General grade – these panels can be used structurally or non-structurally in dry areas. The panels are generally unsuitable for use as wall formwork as well as floor formwork.
3) *Class 3:* Partition grade – these panels can only be used as non- structural internal partition walls in dry areas only.

B. Manufacturing Process Of GFRG Panels

For manufacturing the GFRG panels the following procedure is used:

1) Phosphors gypsum is a by-product of phosphoric acid plant is calcined in calciner at 140-150°C at the rate of 15MT/hr. of calcined plaster. This calcined plaster is stored in product silos with a capacity of 250MT.
2) The plaster is then transferred to batch hopper by screw conveyors in wall panel manufacturing area.
3) The area consists of 6 casting tables with dimensions of 3m x 12m, one crab having mixer and glass roving delivery system is used for delivering slurry and glass roving for three tables. The chemicals are then added in water & mixed and then plaster is added & mixed to form slurry.
4) One layer of slurry is laid on the table by the crab followed by a layer of glass roving. The glass roving is embedded in to the slurry with the help of screen rollers.
5) Another layer of slurry is then poured followed by a layer of glass roving. Then this layer is pushed inside the ribs with the help of temping bar. Finally a layer of glass roving is placed for the top face of the wall panel.
6) After getting final Gilmore wall panel is then lifted from the casting table to ACROBA frame and shifted to drier for drying. The wall panel is dried at a temperature of 275°C for 60minutes.
7) After drying, the wall panel is either shifted to storage area or on the cutting table. The wall panels is cut as per desired dimensions and the cut pieces are transferred to stillage's which are specially made for transporting wall panel.

C. Properties of GFRG Panels

The mechanical properties of GFRG panels, for both empty panels and panels filled with M20 concrete in all cavities are given in Table I, based on tests conducted at IIT Madras [2].

Table I: GFRG Panels: Mechanical properties

S. no	Mechanical Property	Characteristic Value
1.	Unit weight	0.43 kN/m^2
2.	Uni-axial compressive Strength	160kN/m^2(empty panel) 1310kN/m^2(filled panel)
3.	Ultimate shear strength	21.6kN/m^2(empty panel) 61.0 kN/m^2 (filled panel)
4.	Water absorption	1% in 1 hour, 3.85% in 24 hours
5.	Fire resistance	2.30hours rating (empty panel) 4.0 hour rating (filled panel)-withstood 900-1000°C
6.	Coefficient of thermal expansion	12 x 10-6 mm/mm/°C

IV. COMPARISON OF ESTIMATION BETWEEN COVENTIONAL BUILDING AND GFRG BUILDING

In this research work a 2BHK house compared with a building made with GFRG panels. The plan of 2BHK house as shown in fig-3.

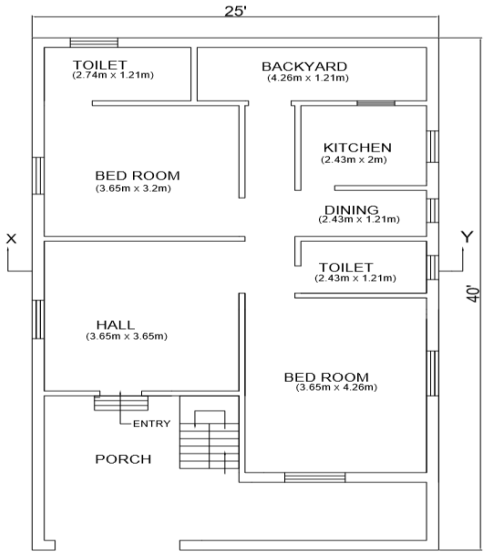


Fig.3 (a) Plan of a House (2BHK)

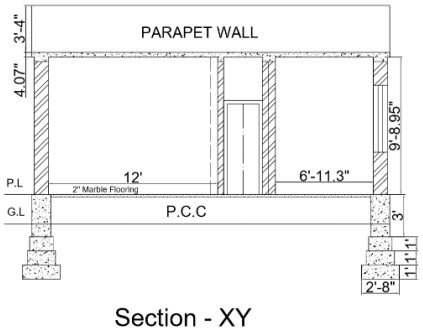


Fig.3 (b) Section of House (2BHK)

A. Abstract Sheet Of Gfrg Building

1) Rate of GFRG wall panels (Per Square Meter)-Rs.1000
2) Size of a panel (standard) -12 x 3 m
3) Quantity of Panels Required:
a) For Wall – 165 sq.m
b) For Slab – 92.6 sq.m
4) Total Panels required - 258.6 sq.m
5) Cost for Panels- 2.586 Lakhs
6) Concrete Work Estimation-4.78 Lakhs
7) Total- 7.36 Lakhs
8) Electrical work 8% of civil work- Rs. 58,800
9) Plumbing Work 5%- Rs. 36,800
10) For steel work 6% of civil work- Rs.36,800
Total – Rs. 8, 75,760/-

B. Rate Analtsis For Coventional Building

S.NO	ITEM DESCRIPTION	QUANTITY	RATE	UNITS	AMOUNT
1	Earthwork in excavation for foundation	65.532	236	CUBIC METER	15465.55
2	PCC in foundation	16.38	3231	CUBIC METER	52923.78
3	Footing Concrete (1:15:3)	44.1	4468	CUBIC METER	197038.8
4	Earth filling in plinth	28.69	172.3	CUBIC METER	4943.287
5	Brick masnory above plinth level	46.9	4200	CUBIC METER	196980
6	Smooth plaster inside rooms and ceiling	231.85	106	Square M	24576.1
7	RCC work in column (1:1.5:3)	5.07	5300	CUBIC METER	26871
8	rcc work in beam	8.12	5300	CUBIC METER	43036
9	rcc work in slab	50.3	5300	CUBIC METER	266590
10	Plinth Beam	6.242	5300	Square M	33082.6
11	PCC in flooring (1:4:8)	13.654	3750	CUBIC METER	51202.5
12	Parapet Wall	11.27	4200	CUBIC METER	47334
13	Outer Plaster	156.3	135	Square M	21100.5
14	Flooring Tiles	62	2012	Square M	124744
15	Woodwork	100	1200	Square M	120000
	Total				**1225888**

Civil Work Total	1225890
Electrical Work 8%	98072
Plumbing Work 6%	73555
Steel Work 6%	73555
General Work 6%	73555
Total	1544627

C. Comparison Of Construction Time Between Rcc And Gfrg Construction

Sn.	Item of Work	RCC (Duration in Days)	GFRG (Duration in Days)
1	Earth work Excavation	2-4	2-4
2	C.C Bed 1:4:8	2-3	2-3
3	Brickwork in Foundation	5-7	5-7
4	Plinth Beam with DPC	2-4	2-4
5	Columns	9-10	-
6	Walls (Brick / GFRG)	10-15	2-4
7	Beams	15-18	-
8	Lintels and Sunshades	4-5	2-3
9	Slab	28	14
10	Plastering	10-12	-
11	White Wash	3-4	-
12	Colour Wash	2-3	2-3
13	Flooring	3	3
Total Duration		98-115	34-44

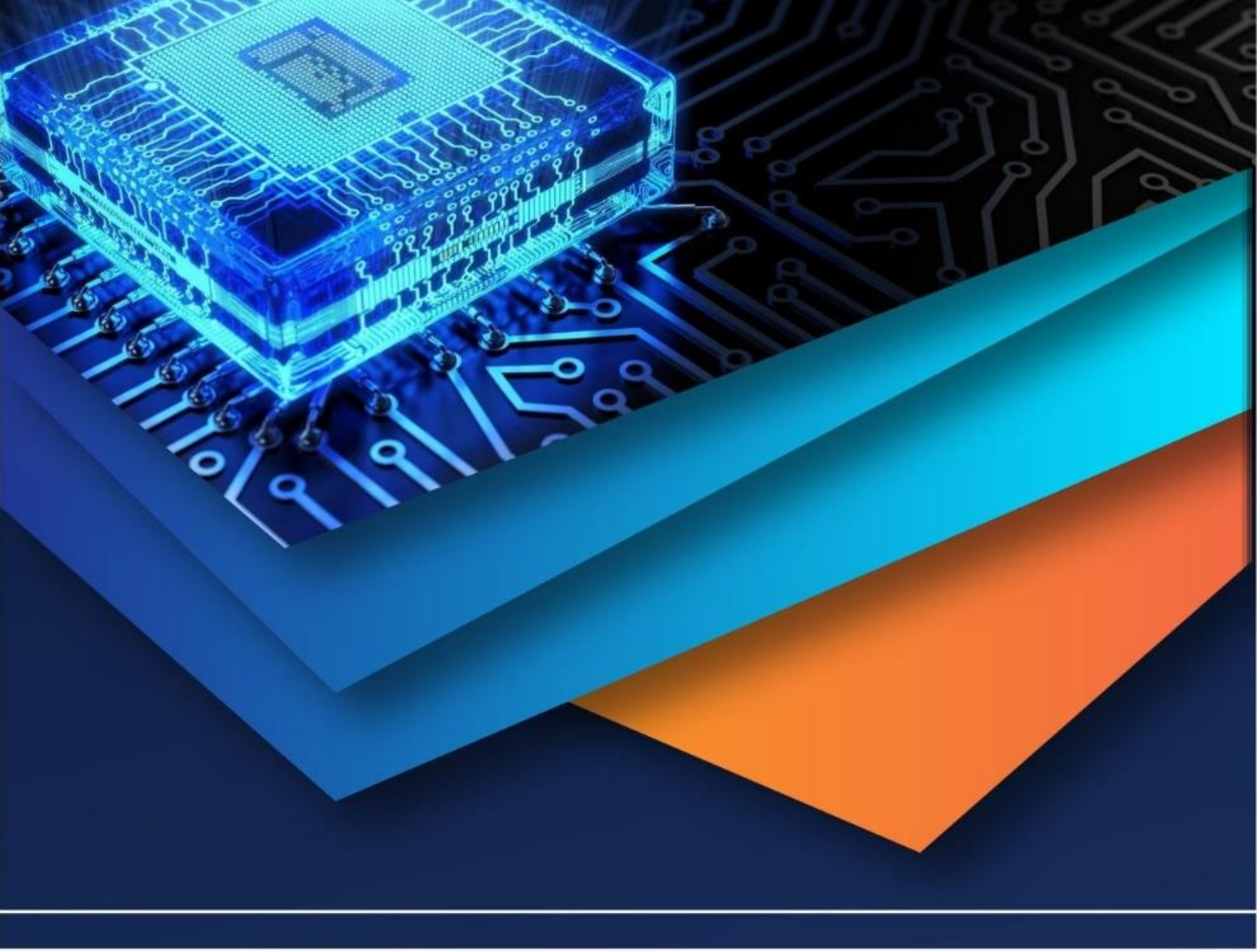
V. CONCLUSION

From the above research study, following conclusions may be made:

A. In this project we have learnt about GFRG panel details, properties and tests on the GFRG panels.
B. We have learnt about the step by step procedure of a GFRG panel construction.
C. We have learnt the procedure of estimating the quantity of materials for different building components, and thereby evaluating the total cost of the project.
D. We have learnt how to design slabs, beams, columns based on the local conditions of the site.
E. In this project, we are comparing the estimation cost between conventional and GFRG building.
F. By using above calculation we can save about 43.30% cost using GFRG Panels.

REFERENCES

[1] Low Cost Housing by Using GFRG Panels, Sk. Subhan Alisha, Sajja. Neeraja, Sk. Akber, G. Sai Manoj, IJSRSET, 2016, 939-946.
[2] Sustainable, Rapid and Affordable Mass Housing using 'GFRG' Panels, Shinto Paul, Devdas Menon, Meher Prasad, Gopinathan, International Journal of Advances in Mechanical and Civil Engineering,2017,135-139.
[3] The structural behavior and design methodology for a new building system consisting of glass fiber reinforced gypsum panels, Y.-F. Wu, Elsevier (Science Direct), 23 (2009) 2905–2913.
[4] Seismic Evaluation of GFRG Panel and Brick Infill Step-Back Set-Back and Step-Back Building, Arun Deshwali, Dr. Raghvendra Singh, IJSRSET, 2017,614-618.
[5] Experimental Study on Glass Fiber Reinforced Gypsum (GFRG) Panels Filled with Alternate Concrete Mix Using Shredded Thermocol and Phosphogypsum, Nithya Nandan A, Renjith R, International Journal of Scientific & Engineering Research,2016,225-227.
[6] Selection framework for evaluating housing technologies, VPS Nihar Nanyam, Riddha Basu, Anil Sawhney, J.K Prasad, Elsevier(Science Direct), 2015 , 333 – 341.
[7] Study of GFRG Panel and Its Strengthening, Eldhose M Manjummekudiyil, Basil P Alias, Biji K Eldhose,Sarath Rajan, Thasneem Hussain, International Journal of Civil and Structural Engineering Research,2014-15,161-165.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY