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Low Cost Housing

Prof. A. L. Shimpi[1], Mr. Rokade Kiran Sanjay[2], Mr. Rathod Ankush Babu[3], Miss. Gunjal Nikita Sanjay[4], Miss. Bhoye Paneri Raghunath[5]
Department of Civil Engineering, Sandip Institute Of Engineering & Management, Nashik, Pune University.

Abstract: Housing is the major sector of urban infrastructure. Government of India has launched the scheme "Housing for All by 2022" for urban areas. To achieve this goal Government is providing subsidy to the urban poor up to Rs. 1 lakh per house which causes huge burden over the country's economy. Despite urban houses are not affordable to the poor due to escalating land & construction cost. This scenario can be improved if the land or construction cost can be reduced to some extent without compromising with the quality of structure. Low cost housing offers the use of various low cost material & technique which reduces the overall cost of construction. In this paper an attempt is made to review the various researches on low cost housing material & techniques which can be used for both rural and urban areas according to their suitability in different conditions.
Keywords: Low Cost Housing, Affordable Housing, Strategies, Finance, Challenges, Building Materials, Sustainability.

I. INTRODUCTION

House or shelter is one of the basic necessities for a human being. Evolution of houses from huts and mud brick houses to G+1,cement plastered, multi-storey housing colonies has witnessed a great change in lifestyle and housing needs of individual. The housing scenario in India has changed a lot during past few decades since independence. Nearly 31% of India's current population lives in urban areas and with increasing urbanization, urban areas expected to house 40% of India's population by 2030.(CE & CR, MAY 2017). Housing availability and various difficulties arising due to it is more critical in urban areas as compare to rural areas. This can be understood from the data given by NSSO (National sample survey organization from the 69 round conducted on July 12 to December 12 which revealed that 61.1% of the urban population resided in their own houses and the other 35.4% in rented homes whereas in rural areas 93.3% of the population had own houses and near 5.1% where residing on a rental basis. At a rough estimate India's overall housing shortage as of today stands at about 22 million homes and in this the shortage of affordable housing has a sizable share. Provision of low cost houses can be the solution for this problem. Low cost housing can be defined as a concept which deals with effective budgeting and following of techniques which help in reducing the cost of construction through the use of locally available materials along with improved skills and technology without sacrificing the strength performance and life of the structure. It is deemed affordable to those with low income as rated by governing authorities.

II. LITERATURE SURVEY

The study of literature includes deep investigation of the research done in past decades aiming to provide low cost housing and studies the results of the study done by various authors and ultimately provides the future scope of their study. B.V.V. Reddy (2011) had studied the suitability of manufactured sand as fine aggregate material. In this study the characteristics of concrete and mortar using M-sand as fine aggregate were determined and compared with that of concrete with river sand. The mortar made with M-sand showed better engineering properties (compressive strength, better workability, bulk density etc.) as compared to that with river sand. The concrete sample was of M20 & M30 grade which gave very satisfactory results when M sand was used in place of river sand. Hence the test program gave a positive aspect on the suitability of M-sand as an alternative to river sand and also helps in the cost reduction for constructional activities. M.M. Eldhose et. al (October 2014) investigated the physical properties of GFRG Panel and the suitability of various suitable filler materials with the help of various experiments. The Physical properties of GFRG panels such as water absorption, compressive strength and flexural strength were investigated and results were obtained. The compressive strength was also tested by using 3 types of filler materials (Nominal mix-M25, Flyash concrete and Recycled aggregate concrete) which provide d with 3 different values. The results from various tests implied that filler materials increases the compressive strength of GFRG panels and Recycled aggregate concrete as a filler material gave satisfactory results. Hence, it can be concluded that GFRG panels with suitable filler material can be used efficiently as a low cost construction technique. R.K. Watile et. al (May 2014) had obtained result of the various properties of interlocking blocks through an experimental effort.

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The effect of GFRP with maximum percentage of fly ash in interlocking bricks is studied. Materials used for the casting of brick were cement, fly ash, stone-dust, GFRP, fine aggregate and water which were mixed in varying proportions and blocks of size 230 x 100 x 75mm are obtained and were tested for different values of compressive strength and it was noted that the compressive strength of any individual block shouldn't fall under the minimum average compressive strength by more than 20%. The study showed that the water absorption of the bricks is directly proportional to the fly ash content used and the strength of interlocking bricks increases with increasing fly ash time to time. Interlocking bricks have sufficient strength and are extremely suitable for low cost housing and non-load bearing structures. 8 Alone and Sawant (2014) used scorecard approach to assess the factors causing concrete waste in building construction and found that in India concrete waste makes around 4.7% part of total material (year-2012). Based on site observations, interviews & questionnaire survey a complete set of 50 factors, grouped in 5 categories was done. The value of waste index was calculated for each category and they found that project management, planning and methodology was the highest rated factor with waste index 227 followed by materials, machinery and equipment. This concluded that project management, planning and methodology is the factor causing highest influence to the generation of concrete waste and hence increasing construction costs. Rinku Taur and Vidya Devi T. (2009) studied different aspects of low cost housing including prefabricated elements, use of locally available materials and use of new techniques for improving durability of conventional low cost materials which makes them useful to be used for today's housing requirements. Their research included use, advantages and limitations of prefabricated materials for various works. Implementation of any alternative technology for mass housing on large scale may subject to economy and effectiveness of the material and ultimately its acceptance by market. So, the methodology for low cost housing can be suggested as of intermediate type instead of adopting an alternative technology for entire construction. A.D. Chougule et. al (Nov. 2014) discusses the use of filler slab as an alternative construction technique to the modern conventional methods. The materials to be used as filler materials should be light weight, inert and inexpensive with a particular size which so as to be can be accommodated within the spacing reinforcement. According to a study conducted by Central building research institute a filler slab with non-autoclaved cellular concrete blocks can be used for sustainable construction. A comparison was made between the filler slab and conventional RC slab which proves that the strength of conventional slab and filler slab is almost equal and hence do not have any strength deformities and can be adopted in place of conventional slab. The filler slab technique is a cost effective method and saves up to 30% of concrete hence justifying its role as a efficient low cost construction technique.

III. OBJECTIVE

The objectives of low cost housing are

1) To study the housing requirements of people.
2) To study various Construction techniques which can be used to reduce the cost of construction.
3) Study of alternative materials which can be used for Low cost housing.
4) Cost estimation of normal building and the identifying the percentage reduction in cost for low cost building.

IV. MATERIALS FOR LOW COST HOUSING

A. Hollow Concrete Blocks

Concrete blocks having core void area larger than 25% of the gross area is termed as hollow concrete blocks. the hollow space in the blocks enables the masonry to have good insulating properties against sound, heat, and moisture.

1) Advantages

a) The hollow block will give a different look as it reduces the energy bill to create an environmentally friendly environment in the building.
b) Solid hollow blocks require less maintenance and provide insulation from sound, heat, and fire-resistant.
c) The joints in these blocks require less cement mortar, little or no plastering thus speeding up the construction process.
d) High dimensional accuracy and consistent finish make it an ideal building material for building load-bearing structures and building partition walls.
e) These hollow concrete blocks have high-stress bearing capacity hence widely used in building construction practices.
f) Concrete hollow blocks are lightweight hence used in the construction of homes in earthquake-prone areas.
g) These blocks are more cost-effective than other traditional wall systems or wall construction systems.
h) It is high quality, high strength, uniform size, and shape.

2) Standard Sizes of Hollow Block

a) 39 cm x 19 cm 30 cm: Standard size of hollow concrete blocks.

b) 39 cm x 19 cm x 20 cm: Hollow building tiles.

c) 39 cm x 19 cm x 10 cm: Absorption of water will be less than 10% in hollow solid block blocks for partitioning 12

B. Flyash Gypsum Bricks

Is a building material, specifically masonry units, containing class C or class F fly ash and water. Compressed at 28 MPa (272 atm) and cured for 24 hours in a 66 °C steam bath, then toughened with an air entrainment agent, the bricks can last for more than 100 freezethaw cycles. Owing to the high concentration of calcium oxide in class C fly ash, the brick is described as "self-cementing". The manufacturing method saves energy, reduces mercury pollution in the environment, and often costs 20% less than traditional clay brick manufacturing.

1) The Raw Materials

Material	Mass
Fly ash	60%
Sand/ Stone dust	30%
Portland Cement or Lime	10%



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C. Stabilized And Compacted Mud Blocks

These are made of mud stabilized with 5% cement/lime etc. and compacted in block making machine with no burning. • They are economical, energy saving, and are easy to manufacture.

1) Advantages

a) Minimal or no need for mortar, thus reducing both the labor and materials costs.

b) Transport cost: Suitable soils are often available at or near the construction site.

c) Strengths might exceed the ASTM standard for concrete blocks (1900 psi) in some instances. In India, the observed compressive strength and flexural strength of CSEB at 28 days of aging with 9% cement stabilization has been observed to be 3.2 MPa and 1 MPa respectively.

d) Non-toxic: like bricks, materials are completely natural, non-toxic, and do not out-gas.

e) Sound resistant: an important feature in high-density neighbour hoods, residential areas adjacent to industrial zones.

f) Fire resistant: like bricks, earthen walls do not burn



D. Light Weight Concrete Panels

These lightweight panels are created by sandwiching two calcium silicate panels with polystyrene beads and cement or ceramsite. They form a non-load bearing light weight composite panel that can be used in walls, flooring and roofing**.**

1) Advantages

a) Since these panels are lightweight, the installation process is extremely easy and can be done with simple construction tools.

b) They are highly durable and have a long life span.

c) They are earthquake proof, soundproof and also fireproof.

d) Since they are lightweight, these panels can be easily assembled and reassembled at another location thus making it an economical and environmentally-friendly solution.



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V. USE OF THE GFRG PANELS

Glass Fiber Reinforced Gypsum (GFRG) Panel branded as Rapid wall is a building panel product, made of calcined gypsum plaster, reinforced with glass fibres, for Mass-scale building construction, was originally developed and used since 1990 in Australia. As lightweight load bearing walling in building (single or double storey construction) up to two storey construction: the panel may be used with or without non-structural core filling such as insulation, sand polyurethane or light weight concrete.

A. Manufacturing Process

1) Phosphors gypsum which is a by product of phosphoric acid plant is calcined in calciner at 140-1500 C at the rate of 15MT/hr. of calcined plaster. This calcined plaster is stored in product silo having capacity of250MT.
2) The plaster is then transferred to batch hopper by screw conveyors and through Entoleter in wall panel manufacturing area.
3) This area consists of 6 casting tables having dimensions of 3m x 12m, one crab having mixer and glass roving delivery system is for delivering slurry and glass roving for three tables. The chemicals are 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. This glass roving is embedded in to the slurry with the help of screen roller.
5) Another layer of slurry is poured followed by a layer of glass roving this layer is pushed inside the ribs with the help of temping bar. Finally a layer of glass roving is laid for the top face of the wall panel.
6) After getting final Gilmore wall panel is lifted from the casting table to ACROBA frame and shifted to dryer for drying. The wall panel is dried at a temperature of 275OC for 60minutes.
7) After drying, the wall panel is either shifted to storage area or on the cutting table. The wall panel is cut as per dimensions supplied by the consumer and the cut 16 pieces are transferred to stillage's which are specially made for transporting wall panel.
8) The liquid effluent generated during manufacturing process is recycled back in the system for manufacturing of new wall panels.
9) The solid waste which is generated while manufacturing wall panels is recycled back to the calciner after crushing and separating plaster & glass roving in recycle plant.
10) The above system is a batch process. Six wall panels can be manufactured in eight hour shift per table. Similarly, 36 wall panels can be manufactured in eight hour shift with 6tables.
11) Flow diagram of the system showing the manufacturing process is attached herewith.
12) The manufacturing machine is as shown in figure.

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B. GFRG Panel Manufacturing

Fig yeil

GFRG Panel Dimensions:

- Thickness – 124mm
- Height – 3m
- Length – 12m

C. Comparison of Construction Time between RCC and GFRG Construction

Sr.no	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 Day's	34-44 Day's

D. Properties of GFRG Panels

1) Axial load capacity - 160 KN/m (16 Tons/m)
2) Compressive strength - 73.2 Kg/cm2
3) Unit Shear strength - 50.90 N/m2
4) Flexural strength - 21.25 Kg/cm2
5) Tensile Strength - 35 KN/m
6) Ductility - 4
7) Fire resistance - 700-10000°C
8) Thermal Resistance (R) - 0.36 K.W
9) "U" Value - 2.85W/M2K
10) Thermal conductivity - 0.617
11) Elastic Modulus (E) - 3000-6000Mpa
12) Sound transmission (STC) - 40
13) Water absorption - < 5%
14) Coefficient of thermal expansion- 12×10-6mm/°C

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E. Advantages of Using GFRG Panels

1) *Quicker Construction:* Conventional buildings with G+1that are usually constructed in a span of 6-8 months can be constructed in a month with GFRG panels.
2) *Economical:* GFRG reduces the consumption of cement by almost 50%,steel by 35% and sand by an astonishing76%.
3) *Fire Resistant:* In an event of fire, GFRG panels release 15-20% moisture of its own weight which largely reduces the surface temperature and fire damage.
4) *Earthquake Resistant:* GFRG panels have been found to be successful at resisting the impacts of earthquakes in the fifth seismic zone as their panels can be turned into shear walls as well.
5) *Water Resistant:* Certain chemicals are added to the mix during the manufacture of GFRG panels which make the mim pervious to the attack of water.
6) *Strength and Durability:* The strength and durability of GFRG panels is five times that of the conventional construction materials. Besides, gypsum is known for its strength and offers excellent dimensional stability and durability.

F. Limitations of GFRG Panels

1) The panels are required to be handled with extreme care and specific machinery is needed for their movements.
2) The panels cannot be used for wall with circular or higher curvature.
3) The panels need to be neatly stacked in order to avoid abrasion.
4) The clear span is limited to 5mfor residential buildings.







VI. ADVANTAGES OF LOW COST HOUSING

1) Use of cheap & locally available materials
2) Job opportunity for local people
3) Biodegradable materials
4) Energy efficiency and eco friendliness 5 – 15 times less energy consumed than fired brick and around 3 – 8 times less emission
5) Transferable technology
6) Import Reduction
7) Cost effectiveness
8) Minimum mortar required
9) Keys that interlock with each other provides better integrity
10) Hollow provisions for laying vertical and horizontal reinforcements to improve the lateral load resisting capacity
11) Ease and Fastness in construction
12) Fire resistant

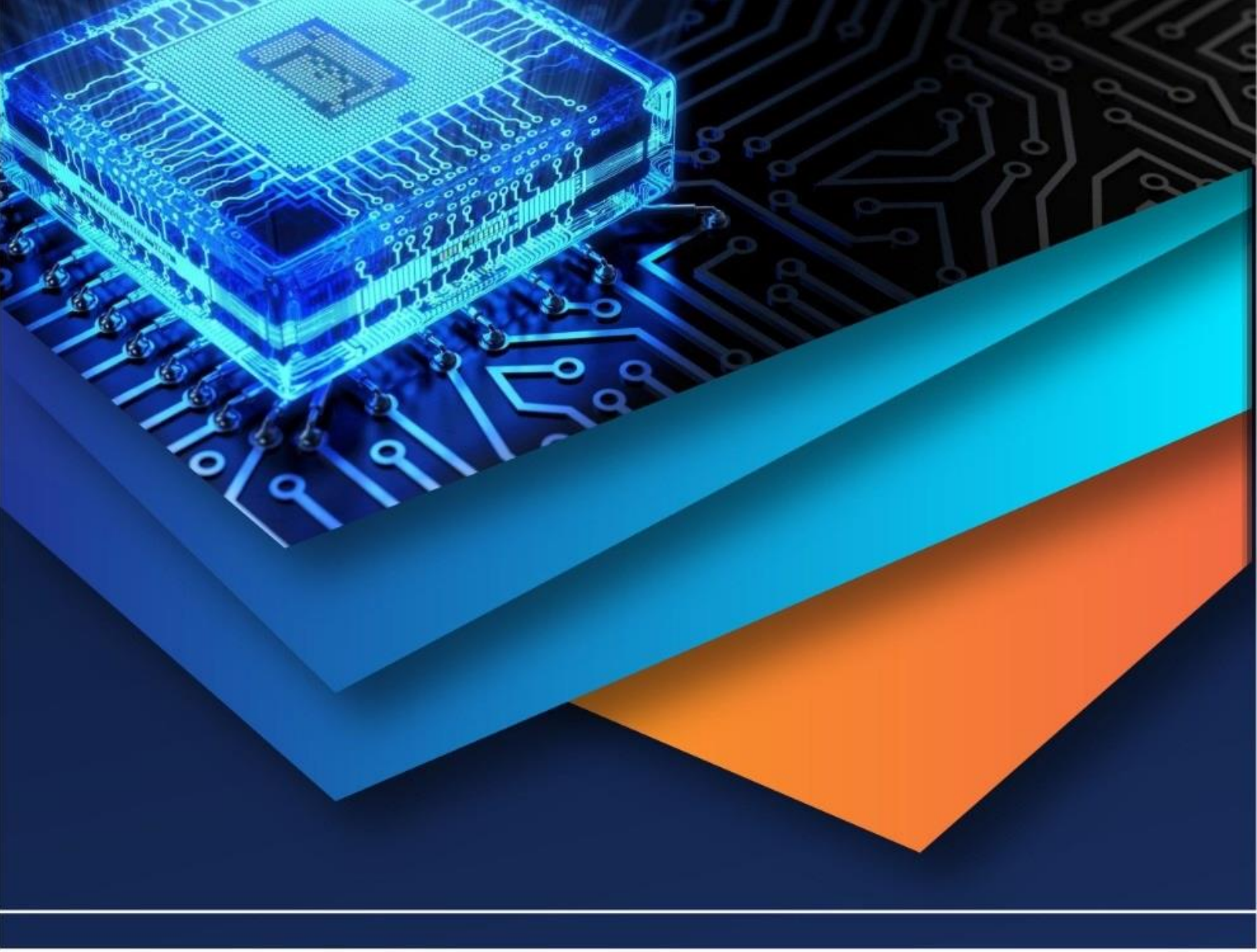
VII. CONCLUSIONS

It is now possible to built Speedy and Low Cost Housing for rural and urban areas without any compromises with the strengths or materials being used. All the above stated techniques and method also help in saving energy . The affordability of a Residential building can be brought to the range of Low and Medium class income people through adopting to Improved Building Technologies and proper usage of Natural resources. The cost of a building can be reduced up to 25-30% The strength of the building is not compromised in Low cost Housing and in fact the buildings are made more effective.The low income people wish to have their house through Government schemes and the remaining through Loans and Own sources.

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