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Affordable Housing – A Much Needed Solution for the current scenario.

G.VINAY KUMAR[1], M.ASHWIN KUMAR[2].
ASST.PROFESSOR, CIVIL ENGG, VIDYA JYOTHI INSTITUTE OF TECHNOLOGY[1]
SENIOR ASST.PROFESSOR, CIVIL ENGG, VIDYA JYOTHI INSTITUTE OF TECHNOLOGY[2]
Email: vinaykumarrohini@gmail.com[1] ashwin@vjit.ac.in[2].

ABSTRACT: It is very important to have a shelter of our own. The major population of our country is below lower income group. Affordable housing projects for an affordable living are a major concern for the government. The Indian government has started affordable housing scheme as a pilot project collaborating with a public & private partnership in states of Maharashtra, Rajasthan, Kerala, Andhra Pradesh & Telangana. In this state of the art literature review; construction of Affordable housing in India is studied. In this case study; a prototype model is proposed. Construction of affordable housing by using the low-cost building materials increases the access to buildings by low-income group people. Affordable housing can be achieved by efficient planning and project management, locally available materials, economical construction technologies and use of alternate construction methods available. The profit gained by usage of such methods can decrease the cost of construction and make the affordable housing accessible to all. In this concept; locally available materials were used like coarse rubble masonry for basement, locally available good soil for filling & fly ash, bottom ash as a substitute of cement & fine aggregate by replacing cement with fly ash up to 35% we achieve more smoothness in walls which will completely avoid the plastering & pointing of walls, moreover the whole construction above the ground level like columns, beams & slabs are casted at a time with special type of form work which will enormously decrease the construction time which will reduce the cost of duplication works & other factors The use of local materials reduces cost of transportation whose contribution to the building material cost is high for long distance. A use of locally available building materials not only reduces the construction cost but also is suitable for the local environmental

1. Introduction

It is very important to have a shelter of your own. The housing market has undergone constant change over the years. And it has changed for the better. There are innumerable housing projects coming up in different countries of the but are they catering to the needs of the people with low income? Several residential projects are undoubtedly coming up but there are very few which help.So, the need of the hour is low-cost homes. Construction of affordable housing by using the low-cost building materials increases the access to buildings by low-income group peoples. Affordable housing can be achieved by use of efficient planning and project management, low-cost materials, economical construction technologies and use of alternate construction methods available. The profit gained from the use of such methods can decrease the cost of construction and make the affordable housing accessible to all. The use of low-cost alternate building materials also prevents the rise of construction cost due to use of scarce building materials which eventually increase the cost of the project.

2. Materials Selection for Affordable housing:

The first step to affordable housing material selection is to select eco-friendly building materials. This also enhances the sustainable design principle. The life cycle of the building is Pre-building, building and post-building stages. Each stage of the building should be such that they help conserve the energy. These three stages indicate the flow of building materials through different stages of a building. Pre-building stage mainly consists of manufacture which is subdivided in processing, packing, and transport. The building phase mainly consists of construction, operation, and maintenance whilst as the last stage would be disposal where the material can be recycled or reused. In Manufacturing of low-cost building materials

Pollution prevention: Manufacturing of building materials should be environment-friendly. Efforts should be made to study and revise the technologies for producing good quality, efficient building materials.

Reducing Energy Consumption and use of Natural materials: The total energy required to produce a material is called embodied energy. The greater a materials embodied energy; it requires a greater usage of non-renewable sources. It is therefore advantageous to use materials or composite materials prepared from the wastages. The natural materials such as stones, wood, lime, sand, and bamboo can be used in ample where ever possible. The natural materials impact more sustainability to structures as well as they are friendlier to the environment.

Recycling of wastes in Manufacturing: The wastes which can be recycled can and used in masonries whilst as wooden wastes can be used in the manufacture of plywood or soft boards. (Courtesy-BMTPC)

Use of Local material: The use of local materials reduces the dependence on transportation whose contribution to the building material cost is high for long distance. A use of locally available building materials not only reduces the construction cost but also is suitable for the local environmental conditions.

Energy Efficiency: Energy efficiently of a building material can be measured through various factors as its R-value, shading coefficient, luminous efficiency or fuel efficiency. Energy efficient materials must reduce the amount of generated energy.

Use of non-toxic building materials: Use of toxic building materials can significantly impact the health of construction people and the occupants of the building. Thus it is advisable to use the non-toxic building materials for construction. There are several chemicals including formaldehyde, benzene, ammonia, resins, chemicals in insulations, ply boards which are present in furnishings and building material. The effect on the health of these toxic materials must be considered while their selection and they should be used only where-ever required. Higher air cycling is recommended while installation of materials having volatile organic compound such as several adhesives, paints, sealants, cleaners and so on.

Longitivity, durability, and maintenance of building material: The use of durable construction materials does not only enhance the life of the building but also reduces the cost of maintenance. The lower maintenance costs naturally save a lot of building operating cost. The materials used in buildings determine the long-term costs of an operating.

Recyclability and reusability of building material: A material should be available in a form which can be recyclable or reusable. Ex –the plastics waste can be used for recycling and producing newer materials. The scrap from steel can be used to manufacture the RCC bars, binding covers and other miscellaneous steel products in building construction.

Biodegradability: A material should be able to decompose naturally when discarded. Natural materials or organic materials would decompose very easily. It is also a very important consideration whether a material decomposes naturally or produces some toxic gases.

3. The scope of Project:

Affordable housing is a term used to describe dwelling units whose total housing cost are deemed "Affordable" to a group of people within a specified income range. In India, the technology to be adopted for housing components should be such that the production and erection technology be adjusted to suite the level of skills and handling facilities available under metropolitan, urban and rural conditions.

Logical approach for optimizing housing solutions: There should be a logical approach for providing appropriate technology based on the availability of options, considering its technical and economic analysis.

1. There should be optimal space in the design considering the efficiency of space, minimum circulation space.
2. The economy should be considered in the design of individual buildings, layouts, clusters etc.
3. While preparing the specifications it should be kept in mind that, cost-effective construction systems are adopted.
4. Energy efficiency has gained considerable importance due to the energy crisis, especially in developing countries. Orientation, built–form, openings & materials play a vital role besides landscaping / outdoor environment.
5. To develop an effective mechanism for providing appropriate technology based shelter particularly to the vulnerable group and economically weaker section.

4. LITERATURE REVIEW

1. Vidya Devi, RinkiTaur (Oct 2009)
This paper aims at varied aspects of prefab building methodologies for low-value housing by lightness the various manufacture techniques to scale back the price of construction. Since there's continuous and recurrent production of same varieties of parts informed construction, therefore, it ends up in quicker execution, a lot of productivity and economy. In prefab construction, the work on the website is reduced to a minimum, thereby, enhancing the standard of labor, irresponsibleness, and cleanliness.

2. Jones Lang LaSalle (2011)
The paper offers the concept concerning Urbanization and Housing shortage in Bharat as per EWS, LIG, MIG, and HIG as per the technical cluster report on Estimation of Urban Housing.In this paper below the Policy Framework and rules for Low price Housing the Central level Schemes likewise as State-sponsored initiatives area unit mentioned. Central level schemes like. statesman National Renewal Mission (JNNURM) and Maharashtra Housing and Space Development Authority (MHADA)

3. Swaptik Chowdhury, Sangeeta Roy (Jan21, 2013)
The paper grants work on inexpensive having blessings in areas such as the Asian nation wherever concrete or steel is dear. This paper aims to means the varied aspects of prefab building ways for low price housing by light the various fabrication techniques, and therefore the efficient blessings achieved by its adoption which might be studied one by one supported the requirements so, raising the speed of construction and reducing the development price. the foremost gift ways of construction systems thought of here square measure particularly, structural, precast.

5. Construction Methodology:

This project is work developed to reduce the cost of a 2-bedroom house by adopting the following three methods.

Reduce the time of construction two weeks whereby certain establishment costs like watchmen salary, power consumption, and supervision etc could be limited to that two week period only.
Reduce the labor component by using special shuttering and going in for a complete concrete shell i.e., the footings, walls, and slabs are made in concrete and the whole structure is concreted in one day at a stretch. Special care is taken to use smooth surfaced shuttering, perfectly aligned to line and plumb. All the pipes of sanitary and electrical are laid to plan before concreting and ensured that they stay in their position at the time of concreting.

The materials used will be the locally available materials like fly ash, which we have used to reduce cement component by 30% locally available sand retrieved from riverbeds Tandur blue stones and CRS masonry using granite stones for wall foundation and basement, locally available morrum soils for filling in the basement and developing all around the building.

The site is cleared and the type of foundation like load bearing CRS wall or RCC footing is decided based on the no of floors, SBC and water table etc.

The foundation is done as per the plan. Then if it is a load bearing wall type the wall foundation is taken as shown in the figure and shuttering for walls and slab is erected. The shuttering for walls will be big panels of 8'x4'size and the mechanism is developed to make it convenient for shuttering,de-shuttering and transport so that any non - technical labor can erect it and remove it.

The shuttering ensure verticality of walls and smooth surface of walls. Special care is taken for this keeping in mind that the surface need not be plastered which will contribute to reducing the cost of plastering. Moreover the window frames and door frames will be provided in the shuttering itself before concreting along with pipes for wiring and sanitary lines.This will also reduce the time of chasing walls and to fix them and make good the chased walls.

After the completion of foundation and basement, it will take two days for shuttering and one day for concreting .the following day the shuttering for walls will be removed and after ten days the slab shuttering can be removed. After de-shuttering walls and ceiling, the structure is ready for flooring, wiring, and plumbing.

With this method of construction, we can gain a lot of time which in turn reduces the labor work. Moreover by ensuring a smooth surface and encasing all electrical and plumbing pipes lot of savings can be achieved by avoiding plastering to internal and external walls. For a good building, we need good building materials which should sustain for longer period of time at the same time all the construction materials should be economical the following are tests which are performed on the materials

6. Tests on materials

Cement

- Fineness test
- Consistency test
- Soundness test
- Strength test

Fineness test - fineness test on cement is conducted to know the fineness of cement & percentage passing through 90 microns sieve

Consistency test - consistency test on cement is conducted to find the initial & final setting time of cement we conduct this test by Vicat apparatus.

Strength test – strength test is performed to know the compressive test of cement by casting cubes of length preparing 3 cubes for 3 days, 7 days, & 28 days.

Coarse aggregate

- Crushing value
- Impact test
- Abrasion test
- Specific gravity test & Water absorption
- Flakiness index

Crushing value – aggregate crushing value is performed to find out the crushing strength of the coarse aggregate

Specific gravity test & Water absorption – specific gravity test is performed to know the specific gravity & water absorption of coarse aggregate using pycnometer test apparatus

Fine aggregate

- Sieve analysis
- Bulking of sand
- Specific gravity test & Water absorption

Sieve analysis – sieve analysis is performed on aggregates to know whether the given sample is coarse or fine by passing them through a set of sieves starting from 4.75mm to 60 microns.

Bulking of sand – bulking of sand test is performed to know the bulking ratio & swelling of sand by adding water in required percentages

Specific gravity & water absorption – specific gravity test is performed to know the specific gravity & water absorption of fine aggregate using pycnometer test apparatus

Tests performed on concrete

- Compressive test
- Slump cone test
- Rebound hammer test

Compressive test – cubes of concrete are cast the cubes are cast on 150mm X 150mm 150 mm by mixing the proper proportions of cement, fine aggregate, coarse aggregate with required amount of water – cement ratio
This process involves

- Mixing
- Casting
- Curing

Mixing – concrete mortar is prepared by taking appropriate quantities of cement, coarse aggregate, fine aggregate, fly ash & water as per mix design suitable for the type of work.

Casting – the mixed concrete is placed in cast iron cubes of size 300mmX300mmX300mm cubes by greasing the sides of the cube for easy removal of the molds.

Curing – casted cubes are left for setting then after concrete casting is opened after 12hrs cubes are kept for drying in sun then after the concrete cubes are placed in water bath for

curing. Curing period is kept for 3days, 7days, 14days, & 28days.

Compressive test on concrete blocks is performed by compression testing machine (C.T.M) by placing our concrete cube after curing period of 3days, 7days, 14days, & 28days in between two load acting members and an appropriate load of 500N, 1000N or 2000N is applied based upon the curing period of the cube.

Slump cone test – slump cone test is performed to find the workability of the concrete by adding required percentage of water-cement ratio this test is performed on slump cone apparatus filling concrete in slump cone and tampering it at regular intervals with tampering rod for 24 blows finally cone is filled with concrete and cone is removed from base plate then we can find the slumped shape based on shape of slump we can know the workability of concrete.

Rebound hammer test – rebound hammer test is a method of Non-Destructive test the concrete block is kept under pressure and it's tested with help of rebound hammer apparatus to find the strength of the concrete block.

7. RESULTS, DISCUSSION & GRAPHS:

We have performed various tests for different materials we majorly concentrated on the compressive test of the concrete for various mixes of concrete by substituting various percentages of fly ash instead of cement

SNO	MIX DESIGN	% OF REPLACEMENT	CEMENT (Kgs)	F.A (Kgs)	C.A (Kgs)	FLY ASH (Kgs)	WATER (ml)	W/C RATIO
1	M20	25%	1.125	3	6	0.375	0.675	0.45
		30%	1.05	3	6	0.45	0.675	0.45
		35%	0.975	3	6	0.525	0.675	0.45
2	M20	25%	1.125	3	6	0.375	0.75	0.5
		30%	1.05	3	6	0.45	0.75	0.5
		35%	0.975	3	6	0.525	0.75	0.5
3	M25	25%	1.5	2	4	0.5	900	0.45
		30%	1.4	2	4	0.6	900	0.5
		35%	1.3	2	4	0.7	900	0.5
4	M25	25%	1.5	2	4	0.5	1000	0.5
		30%	1.4	2	4	0.6	1000	0.5
		35%	1.3	2	4	0.7	1000	0.5

Table 1. Batching of materials for mix design by replacing cement with fly ash with 0.45 & 0.5 w/c ratios

SNO	Mix Design	Material	% Fly Ash	Compressive Strength [fck]	Mix Design	Material	% Fly Ash	Compressive Strength [fck]	W/C Ratio
1	M20	OC	0%	13.5	M20	FC	25%	13.11	0.45
2	M20	OC	0%	13.5	M20	FC	30%	13.4	0.45
3	M20	OC	0%	13.5	M20	FC	35%	12.22	0.45
4	M20	OC	0%	12.7	M20	FC	25%	12.93	0.5
5	M20	OC	0%	12.7	M20	FC	30%	12.6	0.5
6	M20	OC	0%	12.7	M20	FC	35%	12.03	0.5
7	M25	OC	0%	17	M25	FC	25%	12.22	0.45
8	M25	OC	0%	17	M25	FC	30%	13.2	0.45
9	M25	OC	0%	17	M25	FC	35%	11.33	0.45
10	M25	OC	0%	11.91	M25	FC	25%	11.7	0.5
11	M25	OC	0%	11.91	M25	FC	30%	11.5	0.5
12	M25	OC	0%	11.91	M25	FC	35%	11	0.5

Table 2. Compression test values for 7 days curing of ordinary concrete [OC] & fly ash concrete [FC] with 0.45 & 0.5 w/c ratios.

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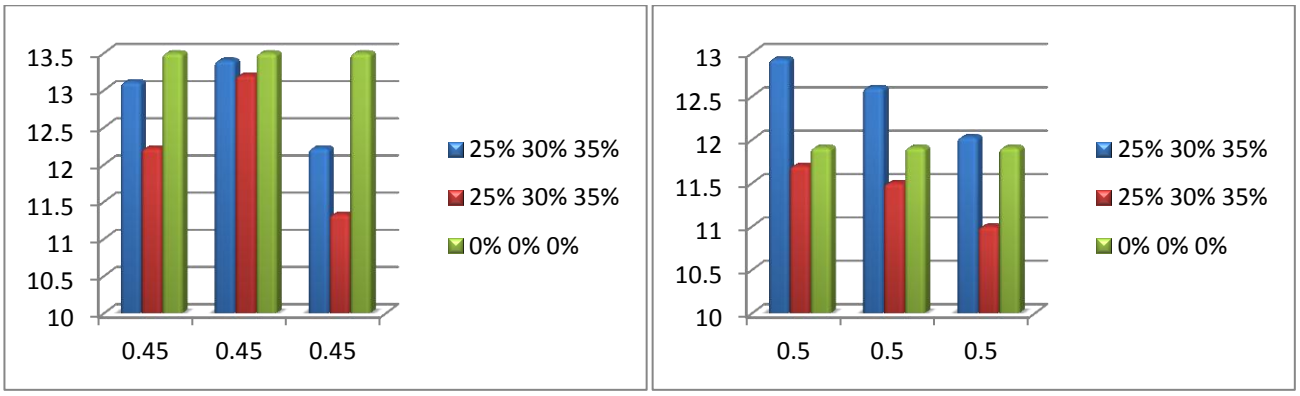
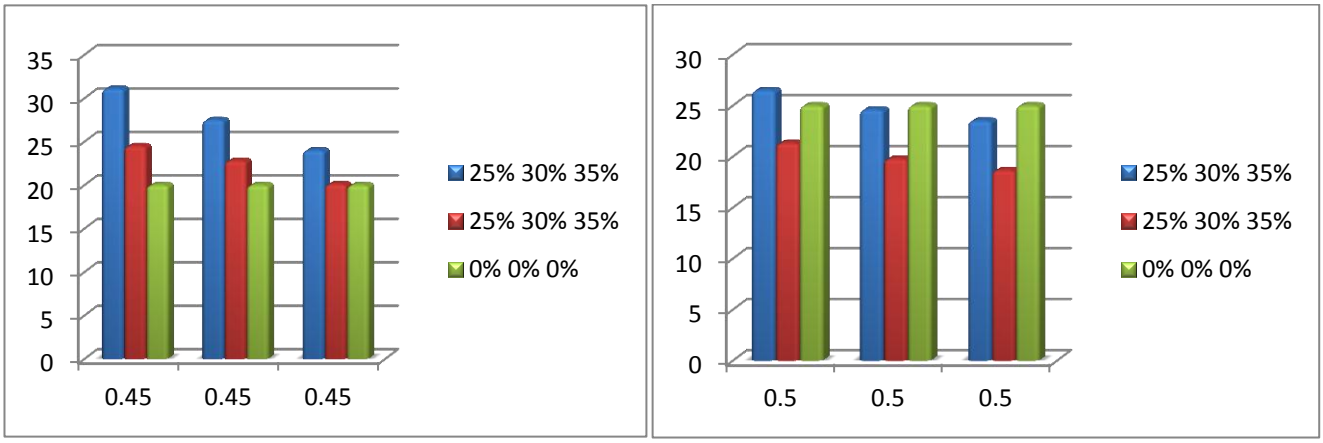
SNO	Mix Design	Material	% Fly Ash	Compressive Strength [fck]	Mix Design	Material	% Fly Ash	Compressive Strength [fck]	W/C Ratio
1	M20	OC	0%	20	M20	FC	25%	31.1	0.45
2	M20	OC	0%	20	M20	FC	30%	27.5	0.45
3	M20	OC	0%	20	M20	FC	35%	24	0.45
4	M20	OC	0%	20	M20	FC	25%	26.5	0.5
5	M20	OC	0%	20	M20	FC	30%	24.6	0.5
6	M20	OC	0%	20	M20	FC	35%	23.5	0.5
7	M25	OC	0%	25	M25	FC	25%	24.5	0.45
8	M25	OC	0%	25	M25	FC	30%	22.8	0.45
9	M25	OC	0%	25	M25	FC	35%	20.11	0.45
10	M25	OC	0%	25	M25	FC	25%	21.32	0.5
11	M25	OC	0%	25	M25	FC	30%	19.77	0.5
12	M25	OC	0%	25	M25	FC	35%	18.65	0.5

Table 3. Compression test values for 28 days curing of ordinary concrete [OC] & fly ash concrete [FC] with 0.45 & 0.5 w/c ratios.



Graph 1. Graph showing compression test values for 7 days of fly ash concrete with varying percentages and ordinary concrete with different water-cement ratios



Graph 2. Graph showing compression test values for 28 days of fly ash concrete with varying percentages and ordinary concrete with different water-cement ratios

8. CONCLUSION:

From the above study, we conclude that

- Replacement of fly ash in 25% & 30% gives more compressive strength compared to ordinary concrete and more smoothness in walls need not require any plastering.
- Usage of supplementary cementitious materials not only used for eco-friendly constructions but also it can be used as cost reduction techniques.
- Affordable housing schemes will not only reduce poverty but also it fulfills the dreams of a common man of having an own shelter
- Fly ash is used as a natural admixture which develops the workability and strength of the concrete for a longer run.
- In this study, we noticed that the excess usage of fly ash will give a smooth finishing to the walls which will reduce the plastering cost of a building.

Figure 1. images of proto type made up of ply wood.

Figure 2. image of special type of form work used for construction made of aluminum.

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