© 2018 IJSRSET | Volume 4 | Issue 1 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology

Affordable Housing Materials and Techniques

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ABSTRACT

Affordable housing is the near future of the modern world. With the over increasing population the tendency to have a home at reduced and sustainable rate is increasing day by day. So to have a solution at the major growing issue of the population in addition with the growth in poverty, and the need of the population for a growth in standard housing the techniques and materials of affordable housing is having a great impact on the market.With the 30% reduction in the construction costs of the homes with affordable housing this method is proving to be gaining success in the market. The tendancy and the mentality of the people towards affordable housing has be increased for having a well home at a reduced price with all accomodities of a normal house built with non-afforadable techniques and materials.This paper elaborates about the need and the various materials and techniques which are used for affordable housing.

Keywords : Affordable, Materials, Techniques, Construction.

I. INTRODUCTION

Affordable housing refers to housing units that are affordable by that section of society whose income is below the median household income.The Pradhan Mantri Awas Yojana (2015) envisages to provide housing to all by 2022. The mission seeks to provide 20 million housing units and take up slum rehabilitation projects. According to the mission guidelines, an 'affordable housing project' shall have a minimum of 35% of the houses for the Economically Weaker Section (EWS) category. EWS households are those having an annual income up to Rs. 3,00,000 and a dwelling with a carpet area of up to 30 sq.m. Low Income Group (LIG) is defined as having an annual income between Rs. 300,001 up to Rs. 600,000 and a dwelling unit having carpet area up to 60 sq.m. Slum is defined as a compact area of at least 300 population or about 60-70 households of poorly built, congested tenements in unhygienic environment, usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities. It means **'A HOME TO ALL'**. The success of this project depends upon the least cost and effective materials and techniques for providing a shelter to all.

II. METHODOLOGY

The methodology for screening and rating sustainable housing technologies consisted of three primary steps: data collection, data processing, and technology screening.[1]

2.1. Data collection procedures

Motivated by the diversity of building technologies and the absence of a common exchange platform, the aim was to develop a database with a wide range of data sources. Three major data sources consulted were: international development organizations; the private sector; and research institutions. Data for the present research was collected from the published literature about existing technologies and concepts; the databases of organizations involved in affordable housing projects; and personal interviews with representatives of the companies producing affordable housing technologies. A format using the 18 levels of information shown in Table 1 was developed to standardize the collected data. This format enables the systematic study of different technologies and formed the basis for the grading and ranking process.

2.2. Data processing

The total sample encompasses approximately 75 building technologies, from which 46 were selected for the assessment. A database was developed with 2–4 pages of information for each technology. The first pre-requisite on the screening process was an economic filter that excluded any technologies with initial construction costs above 200USD/m2 from further study.

2.3. Technology assessment

The indicators for assessing the construction technologies are based on the key challenges identified in the first section of this paper. Furthermore, through in depth study of affordable housing programs, as explained in Section 1.4 and interviews with experts, from organizations working on the development of affordable housing programs, the ten most commonly used and accepted indicators were selected. The concept of sustainabilitywasbased on widely accepted definition, developed by the Brundtland Commission in 1987, that is: “to meet the needs of the present generation without compromising the ability of future generations to meet their own needs” (W.C.o.E.a.D., 1987). Based on this definition and the present research used a triple-bottom-line approach that considers the economic, ecological and social aspects of each technology. It is important to remark that most of the selected indicators are measures of dimensions of economic, social or environmental unsustainability which must be minimized to keep on a sustainable trajectory. And as described by Lyon, they are guides to management future decision and action, but they cannot guarantee sustainability. Furthermore, this approach allows the rankings to use a flexible weighting scheme between indicators or clusters of indicators that can help identify the weaknesses and strengths of technologies through a sensitivity analysis. In the following sections, the assessment indicators are briefly described, and a table is presented that contains the values used to grade each technology.

2.3.1. Initial construction costs per m²

The initial construction costs are a key determinant of the successful implementation of a technology on the market. This indicator addresses the key challenge “lack of sufficient funds”. The amount listed under [USD/m2] in the ranking matrix includes all direct and indirect costs of the superstructure including standard equipment, such as windows, doors, inner walls and kitchen/sanitation facilities. Furthermore, labour costs for construction are included. When only the total project cost was given, a scientific estimate of the margin was made using a ratio work cost to material cost of 20:80. This ratio was based on the literature (Bhaskara, 1994; Mathur, 1993) and discussion with experts from the Hilti foundation (Burmann, 2010) working on this field. The proposed ratio considers that most of the studied technologies are meant to produce single family housing units; to use limited unskilled labour (mainly future inhabitants); and to maximize the initial investment. The price of land and infrastructure costs for water, sewage, roads and electricity are not included in the initial construction costs of the ranking matrix. It should be noted that the initials costs refer to the value provided by the company referred in the fact sheet. Labour and material costs might vary according to country, and this must be taken into account when considering transferring technologies (see Table 1).

Table 1. Indicator values – initial construction costs.

Initial construction costs [USD/m2]	Rating
<40USD	10
<60USD	8
<100USD	6
<140USD	4
>180USD	2
N/A	0

2.3.2. Requirements of the production and construction processes

Housing construction can create a significant number of jobs. It is important to define the skill level associated with these jobs. This indicator focuses on skill and equipment requirements in the development, production, and construction phases. This indicator tackles the key challenge “shortage of skilled labour” by reducing the rating of technologies that require high skill levels (see Table 2).

Table 2. Indicator values – requirement of the production and construction processes.

Requirements production|construction process	Rating
Unskilled labour with no training or local skills traditionallyavailable, low-tech tools	**10**
Unskilled labour with short training (<2 weeks) or local skills available	**8**
Unskilled labour with intensive training (several weeks) or skilled workers	**6**
Advanced skills or tools required	**4**
Very advanced skill level or tools required	**2**
Information not available	**0**

2.3.3. Time schedule, prefabrication degree

This indicator evaluates the importance of prefabrication, supply chains, and management, each of which are indirectly linked to the costs (see Table 3).

Table 3. Indicator values – time schedule, degree of prefabrication.

Time schedule, prefabrication degree	Rating
Erection of one unit <1 day	10
Erection of one unit 1–3 days	8
Erection of one unit <1 week	6
Erection of one unit <2 weeks	4
Erection of one unit >2 weeks	2
Information not available	0

2.3.4. Economy of scale, prefabrication degree

The scalability of the technology plays an important role on this indicator, as it is indirectly linked to the initial construction costs. As the demand for houses grows, programs that utilize economies of scale have significant potential to reduce costs through mass production (see Table 4).

Table 4. Indicator values – economy of scale, mass production.

Economy of scale, mass production	Rating
Immense price reduction potential	10
Significant large price reduction potential or only possible with large scale approach.	8
Decisive price reduction potential through mass production or large scale approach of advantage.	6
Minor price reduction potential through mass production.	4
No significant price reduction potential through mass Production.	2
Information not available.	0

2.3.5. Durability

The service lifespan of the house plays a major role in the creation of local value as well as in resource consumption. Good indicators to assess the durability of building technology include resistance against insects and against natural deterioration, such as high humidity, earthquakes, flooding and wind loads (see Table 5).

Table 5. Indicator values – durability.

Durability	Rating
>40 years	10
>30 years	8
>20 years	6
>10 years	4
<10 years	2
Information not available	0

2.3.6. Maintenance requirements

The integration of maintenance requirements is relevant when taking a holistic view of a building's life cycle. Costs (as well as resources) can be saved by reducing maintenance requirements. This key indicator complements the initial construction costs by accounting for the maintenance requirements over a building's lifecycle (see Table 6).

Table 6. Indicator values – maintenance costs.

Maintenance costs – interaction costs for corrective and preventive maintenance	Rating
Seldom interventions	10
Interventions of low skill and cost level	8
Average interventions of medium skill and cost level	6
Very frequent interventions	4
Intervention of advanced skill and cost	2
Information not available	0

2.3.7. Modularization and flexibility

This indicator captures a technology's capacity to be delivered in ready-engineered modules and kits as well as its flexibility to floor plan changes. Housing design needs to be flexible to adapt to the different needs of each location and cultures. This mainly aiming at a future the expansion of a building unit to better satisfy the family unit's space needs (see Table 7).

Table 7. Indicator values – modularization and flexibility.

Modularization and flexibility	Rating
High flexibility in case of change of use	10
High modularization	8
Medium modularization or medium flexibility in case of change of use	6
Low modularization	4
Low flexibility in case of change of use	2
Information not available	0

2.3.8. Local value creation

This indicator evaluates integrated design features that include communities on both design and production process of socially accepted architecture. Moreover, housing schemes that fulfil mixed functions and provide broad socio-economic to the locals are preferred (see Table 8).

Table 8. Indicator values – local value creation.

Local value creation B material availability	Rating
Available in the country own open market with high npotential for large scale use.	10
Available in the country own open market with medium potential for large scale use	8
Available in the country potential market (not currently commercial)	6
Large degree of import	4
Not available on the local market	2
Information not available	0

2.3.9. Interface to basic utilities

This indicator accounts for how each specific technology can be connected with existing infrastructure such as drinking water, sewage, waste disposal and housing amenities (e.g. ventilation, lighting, heating, and energy) (see Table 9).

Table 9. Indicator values – interface to basic services.

Intersection to infrastructure and housing techniques	Rating
Integrated within construction process, reduced efforts	10
Minimal effort for integration	8
Additional processes required such as wall chasing	6
Large effort for integration	4
Only exposed possible	2
Information not available	0

2.3.10. Recycling and demolition ability

This indicator considers the potential and required effort for demolishing and recycling the main construction components of a building (see Table 10).

Table 10. Indicator values – recycling and demolition ability.

Recycling and demolition ability	Rating
High degree of recycling	10
Low demolition effort	8
Medium degree of recycling and demolition effort	6
High demolition effort	4
Low degree of recycling	2
Information not available	0

III. MATERIALS USED

3.1 Structural Materials

3.1.1 Pozzolona Material (fly ash/slag/calcined clay) as Blending Material with Cement

Up to 35% of suitable fly ash can directly be substituted for cement as blending material keeping the structural considerations. Addition of fly ash significantly improves the quality & durability characteristics of the resulting concrete. Use of blended cement has now become quite popular world over, from durability and environmental benefits point of view. The advantages achieved with the use of blended cement in concrete are quite well documented: Reduced heat of hydration, improved workability & ease of pumping, superior microstructure leading to lower permeability, higher long term strength, better performance in aggressive environment (Sulphates, Chlorides etc.), reduced risk of alkali silica reaction and higher electrical resistance leading to lesser chances of reinforcement corrosion are some of the benefits of pozzolona material blends. While Portland pozzolona cement saves energy by 20%, lime pozzolona mixture shows up to 70% savings in energy.[2]

3.1.2 Recycled Steel Reinforcement

Steel reinforcement can be made entirely of recycled scrap iron. This material is salvaged from automobiles, appliances, and steel-reinforced structures, which include reinforced concrete pavements, bridges, and buildings. In general, steel reinforcement bars can be rolled out from either of the following: used scrap rails, automobile scrap or defense scrap, defectives from steel plants, scrap generated from ship breaking or discarded structures, ingots from induction furnaces, tested billets from mini steel plants and main producers. The primary criterion to be satisfied by steel reinforcement bars is mass per meter run. The IS 1786 specifies batch rolling tolerances in the range of +/- 7 to 3 percent, depending on the diameter of the bar. It is very well possible to control the weight of the reinforcement bars within these limits and if it is specified that steel should be supplied in the minus tolerance range only then substantial savings in the weight of steel could be achieved. Though a premium of 1to 2 percent may be charged for this, it is possible to save up to 7 percent of the cost of steel. Specified lengths but when minimum lengths are specified than minus tolerance is reduced to zero.

Figure 1. Recycled Steel Reinforcement

3.1.3 Ferro Cement and Precast Components

Precast Components are 85% recyclable, have low carbon dioxide generation and are energy efficient. They are ecofriendly, cost effective and easy to install. With use of precast components, wastes during operations are minimal, curing is not required, and structures are waterproof due to less water cement ratio, plastering is not required from the inner side of slabs and the components are corrosion proof. The components are also stronger than cast-in-situ structures, have longer life and have better load bearing capacity. Precast aerated/cellular concrete walling blocks and roofing slabs when used in multi-storied structures reduce weight, resulting in more economic design of structure, can be worked and handled easily, have high fire resistance rating and provide better insulation. Precast spacers designed as per I.S. code give benefits of improved performance of RCC due to exact position of reinforcements and larger life.

Figure 2. Ferro cement and various precast components

3.1.4 Precast R.C.C. / Ferro-cement Frames

Precast R.C.C. frames are concrete doorframes with welded reinforcement. These are manufactured according to Indian Standards. These are economical, environment friendly and durable. They are termite proof, fire resistant and corrosion proof. There is no bending or twisting, no warping, no shrinkage and no cracks. They are maintenance free and easy to install at site, provided with in-built high quality aldrop hold protector, stronger than other door frame material available in the market and are provided with two different types of hinge fixing arrangements to suite specific requirements.

Figure 3. Precast RCC

3.2 Bricks & blocks

Need for building materials is growing at an alarming rate and in order to meet the demand for new buildings, new ways and techniques must be evolved. Manufacturing of building materials like bricks/blocks, cement, steel, aggregates, etc. Consumed in bulk quantities, puts great pressure on natural resources (raw materials) and energy requirements. The use of alternative materials for bricks should be encouraged in order to preserve precious fertile top soil. Described below are a few examples of alternative materials for bricks/blocks.

3.2.1 Fly ash – sand – lime bricks

To bridge the huge shortfall of bricks and to maximize reuse of fly ash waste, these fly ash- sand lime bricks should be used. These bricks provide the advantage of being available in several load bearing grades, savings in mortar plastering, and in giving smart looking brickwork.

Figure 4. Fly ash-sand-lime bricks

3.2.2 Bricks from Coal Washery Rejects

Freshly mined coal is washed to remove impurities prior to its use or processing. This residual waste from the coal washery plants is a hazard to the environment and needs to be disposed or utilized in a manner which lessens its harmful effects on the natural surroundings. With a suitable binder such as cement or lime, bricks and blocks similar to those made using fly ash can be made using this coal washery reject material. These bricks are eco-friendly and waste utilizing. They reduce air, land and water pollution, are energy efficient and cost effective.

Figure 5. Bricks from Coal Washery Rejects

3.2.3 Building Blocks from Mine Waste and Industrial Waste

It is eco-friendly, utilizes waste and reduces air, land and water pollution. It is energy efficient and also cost effective. Majority of the large-scale industries and thermal power plants generate solid wastes in bulk quantities. Red-mud, coal ash, slag, fly ash, etc. Represent such wastes unutilized for several decades. For example, more than 100 tones fly ash is produced annually in India (from thermal power plants) and only 2–3% is being utilized. Similarly millions of tones of red-mud is stored near 1005 abours 1005 s manufacturing units (~ 20 × 106 tones of red-mud is heaped into hillocks at the 1005 abours 1005 s manufacturing unit at Belgaum in Karnataka state). Such huge heaps of wastes concentrated in certain specific localities cause environmental and pollution hazards. Such wastes can be utilized for the manufacture of bricks/blocks, substitute for fine aggregates in concrete, partial replacement of cement in concrete, lime–pozzolona cements, etc.

3.2.4 C-Brick

These are bricks manufactured using the C- brick Machine developed by CBRI. The machine is available with BMTPC and is used for production of quality bricks using fly ash – sand –lime, fly ash –sand –cement and cement-sand aggregate. The bricks manufactured have properties such as compressive strength of 40-80 kg/sq.cm, water absorption less than 20%, and efflorescence free product.

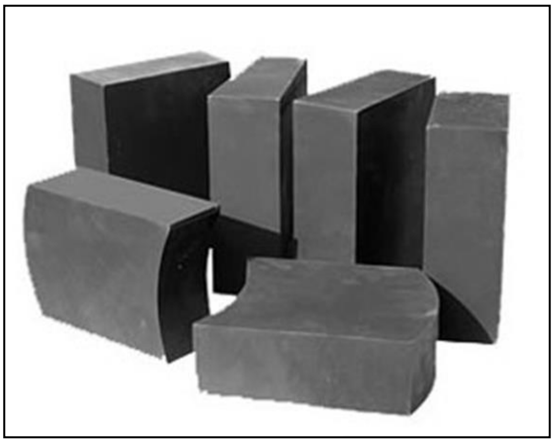


Figure 6. C- Bricks

3.3 Plaster

3.3.1 Calcium Silicate Plaster

Calcium silicate refractories are usually derived from calcium silicate or silicate bearing minerals such as hornblende, epidotic and diopside, often with calcite or dolomite or wollastonite. Wollastonite is a naturally occurring form of calcium silicate commonly used as filler. Portland cements are also based on calcium silicate. Calcium silicate plasters are economic, eco-friendly, produce less wastage, have wide usage, give a smart finish, are less energy consuming, do not emit VOC and other toxic fumes and gases after application and are recyclable. They are safe in handling and usage, do not need skilled man power, are fast drying, durable, and have less water consumption.

Figure 7. Calcium Silicate Plaster

3.3.2 Fiber reinforced clay plaster

Clay Plaster can achieve better sticking properties by reinforcing it with fibers. These fibers can be natural plant (cellulose) fiber or artificial fibers of polypropylene. Plant fibers in fiber reinforced plaster act as reinforcement and create voids thus controlling cracking due to drying shrinkage and thermal movements. The dried plaster is less brittle than conventional plasters and can withstand small movements of the substrate. Fibers made from 100% virgin polypropylene fibers are also available and can be used to achieve the similar properties. Use of these fibers can reduce plastic shrinkage, reduce permeability, and provide increased impact and abrasion resistance.

Figure 8. Fiber reinforced clay plaster

3.4 Roofing's

3.4.1 Bamboo matt corrugated roofing sheets

Roofing is an essential ingredient of any house and in India several roof cladding materials are in use including burnt clay / Mangalore tiles, thatch, corrugated sheets of galvanized iron, 1006abours1006s and asbestos cement, etc. Of these, for semi permanent structures corrugated sheets are preferred. However, one of the major roofing materials, viz., ACCS is being replaced with other alternative materials in many countries. Considering the need for developing alternate eco-friendly, energy efficient and cost effective roofing sheets, Building Materials & Technology Promotion Council (BMTPC) and Indian Plywood Industries Research & Training Institute (IPIRTI) have jointly developed a technology for manufacturing Bamboo Mat Corrugated Sheets (BMCSs).

Figure 9. Bamboo matt corrugated roofing sheets

3.4.2 Micro concrete roofing tiles

Micro Concrete Roofing (MCR) tiles are a durable, aesthetic and inexpensive alternative for sloping roofs. Micro Concrete Roofing (MCR) tiles are made from a carefully controlled mix of cement, sand, fine stone aggregate and water. MCR tiles undergo stringent quality control at every step. They are put through rigorous tests for water tightness, strength, shape and size. MCR technology is a result of global research and development effort. In India, TARA, Development Alternatives in association with SKAT of Switzerland, promotes MCR technology. MCR tiles offer many advantages over other sloping roof materials such as G.I. sheets, Mangalore tiles, wooden shingles, slate and asbestos. MCR tiles are: highly cost effective, durable-they have the life of concrete, lighter than other roofing tiles-they require lessunderstructure, easily installed, can be colouredto specification, reduce heat gain, do not make noise during rains.Cost of roof varies according to span and roof form. A variety of roof designs for farm and country houses, bunglows verandas and pavilions are possible with MCR tiles. They have also been used on industrial sheds, workshops and restaurants. The average value of braking load is 104.80 kg. 10 mm thickness tiles are 10% stronger and the life span of MCR tiles is about 25 years.

Figure 10. Micro concrete roofing tiles

3.4.3 Clay tiles

These tiles are uniform, more durable, fire resistant, environment friendly, energy efficient and low cost. Due to their low self-weight, the dead loading on the super structure reduces significantly, thus indirectly reducing costs. Tiles m made using locally available clay should be encouraged rather than insisting only on the Mangalore pattern clay tile for the purpose of roofing. Fiber reinforced clay tile is a good alternative material, displaying high aesthetic performance and durability. The fibers could be any locally available agro waste.

IV. TECHNIQUES USED

4.1 Technique no - 1

These two sketches in figure no 3.1 typify the small "Modern house" at the top and an old fashioned one below. The modern house is "cubist" in design and use a lot of cement plaster & paint. The roof does not protect the walls from rain and sun with the result that it is not very comfortable or convenient to live in. The "Old fashioned" house ha as a sloping roof which quickly sheds heavy rain protects walls from getting damp and from absorbing he eat from the sun. Some of the windows have been replaced with 1007abou, which are cheaper and give permanent – ventilation and light and protection or security building is near the edge of the terrace.

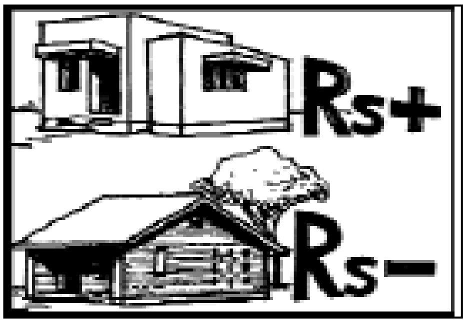


Figure 11. "Comparison of modern & old house"

4.2 Technique no -2

To build the house on a terraced site, it is less expensive to place it in the middle of the terrace. The lower picture in figure no 3.2 shows the extra and more costly foundation and basement wall hat has to be built if the

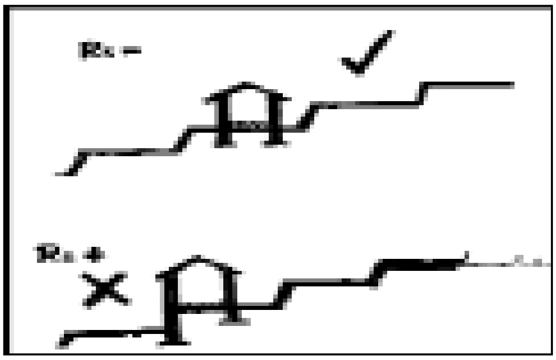


Figure 12. "extra and more costly foundation terrace site"

4.3 Technique no -3

If the site is a sloping one, less excavation and less filling up is needed if it has to place the building parallel to the contours, as in the upper picture, and not cutting across the contours, as shown in the picture. Figure no 3.3

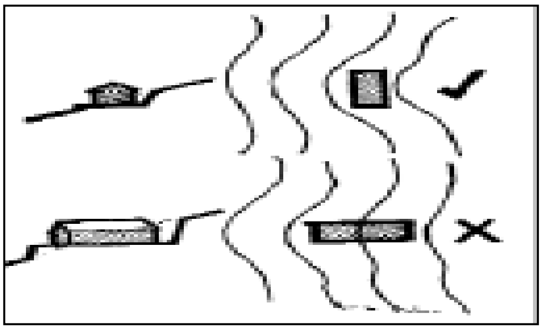


Figure 13. "site on a sloping ground"

4.4 Technique no-4

Exchanging the trenches for the house foundations, 1007abours1007s dig out the soil and throw it in all directions, especially outwards. After the basement walls have been completed they then shovel all the soil back again as infilling. If they shovel the soil inwards it will already be where it is wanted fo or infilling and some of the expense of excavation and infilling will have been saved. See in figure no 3.4

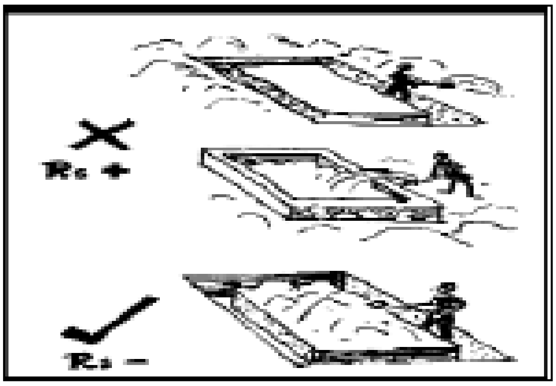


Figure 14. “Exchanging the trenches for the house foundations”

4.5 Technique no 5

A common practice is to have the main walls of a house in 0.23m thick burnt bricks, sitting on the top of a 0.45m random rubble (roughly shaped stones) basement and foundation. This means that there is a step where the 0.23m wall sits on the 0.45 wall below, and rainwater tends to seep in and weaken the lower stonewall, as shown in the upper picture in figure no 3.5. For single and double storey houses it is better to put the outer side of 0.23m brick wall flush with the outer side of the 0.45m stone wall so that rain water running down the wall does not soak in to the wall. This is also less costly because it will give additional useful area inside the room.[2]

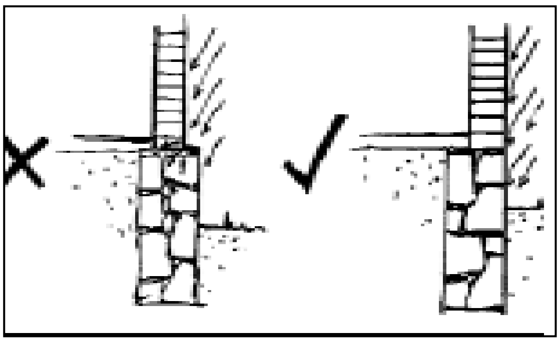


Figure 15. “Flushing of water with comparison”

V. MODELS USED FOR URBAN POOR

5.1 Selection of materials for the project work

After study of different housing materials it is observed that concrete is versatile material and its ingredients are easily available in India and all over the world, for the project work major material is consider as wire mesh concrete, which is used in prefabricated concrete product as cement concrete door and windows frames, prefabricated concrete ventilators, wall panels which is majority used in khandesh are. For this work precast concrete product factories in khandesh area are observed and from that observation one technique which is use in precast concrete compound wall panels is selected as the cost efficient technique for this project work, it is made up of wire mesh concrete techniques, wire mesh of 2-3 mm diameter is used as reinforcement and the thickness of the panels of 5 to 10 cm depending upon its use in different situations, generally 5cm thick wall panels are used in precast compound walls ,use of wire mesh is reduce the cost of normal steel used concrete works. Following figures shows the casting and fixing of precast concrete wall panel pro ducts which are easily available in the khandesh area.

5.2. Development of three dimensional models for the project work

For development of three dimensional model the concept of compound wall panels are studied in detail and from this concept wall panels and slab panels of project work that is affordable house for urban poor’s is developed . Different stages of project house for LIG group peoples are shown and describe in detail, for this work one room kitchen plan is take en in to consideration which has nearly same area of MHADA hosing constructed for LIG group at Dhule town on Chalisgaon road. Estimate of MHADA house of same area and estimate of precast house has show the different in cost and time required for construction .This house is assumed to use at soil bear ring strata which is generally available at maximum depth 0.9 m from ground level. This house is consider red as ground floor house.

5.2.1 Footing stage

Footing for the house consider in this project is isolated column footing, which is pre cast concrete product has size 0.3m x 0.3m x 0.9 m (maximum), 6mm steel 4 bars are used as main steel & stirrups for column and 4 bars of 16 mm diameter are placed 0.18m c-c from bottom as anchoring purpose after placement of a particular column footing, cement concrete is poured in pit as anchoring purpose and p.c.c for a level plain surface for the footing, footing has top grove (0.1mx0.1m mx0.3m) for connection of ground beam and column above it.

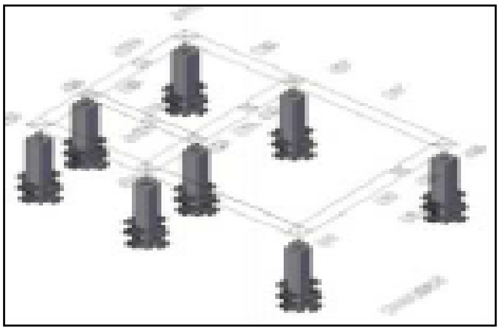


Figure 16. "A footing level"

5.2.2 Footing and ground beam stage

Footing and ground beams are connected by columns, size of ground beam is 0.23m x 0.23m in cross-section

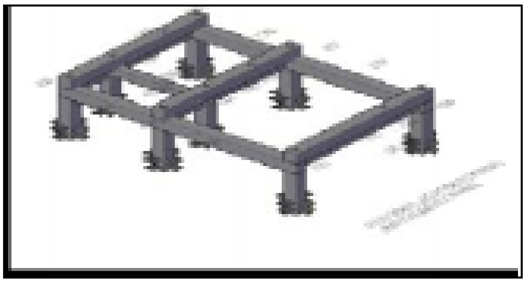


Figure 17. "Connections of ground beam & footing"

5.2.3 Footing, ground beams, plinth beams, columns connections

This stage shows the detail connections of footings, ground beams, plinth beams, columns and the columns shows groves for fixing wall panels at different levels.

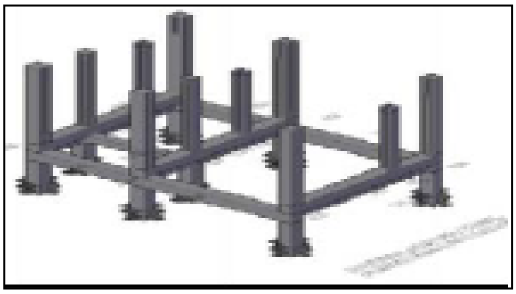


Figure 18. "connection ns of footings, ground & plinth beams, and columns"

5 .2.4 Footing, ground beams, plinth beams, columns & wall panels connections

This stage shows how the footings, ground beams, plinth beams, columns, different wall panels are connected to each other at different levels.

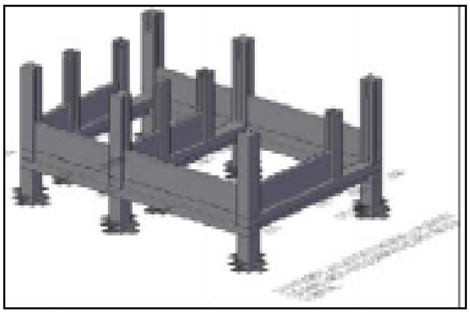


Figure 19. "Connections of footings, ground & plinth"

5 .2.5 Footing, ground beams, plinth beams, columns, wall panels, windows, doors & ventilators connections

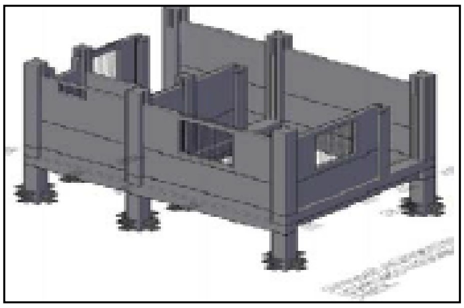


Figure 20. "Doors, window & ventilators connections"

5.2.6 Footing, ground beams , plinth beam ms, columns, wall panels, windows, doors ventilators weather shade roof beam connections

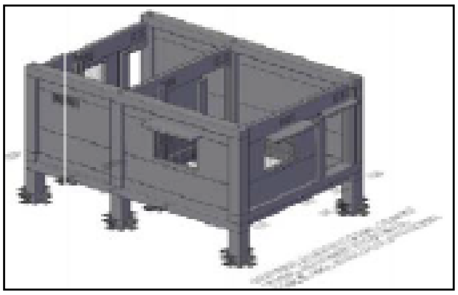


Figure 21. "Connections of roof beams & weather shades"

5.2.7 Roof beams connections

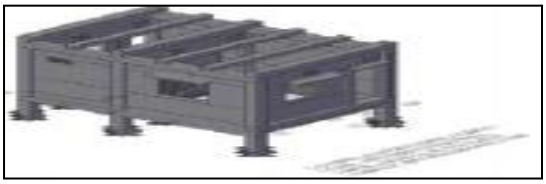


Figure 22. "Positions of roof beams for fixings slab panels"

5.2.8 Complete view of roof beams & slab

The complete view show the slab panels connected with roof beams; this is the final complete view for this project. Beams, columns & wall panels"[3]

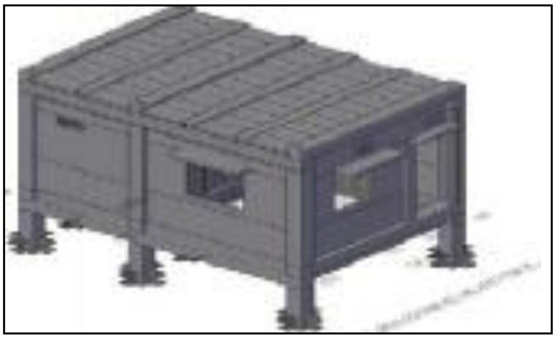


Figure 23. "Final completed view of the project"

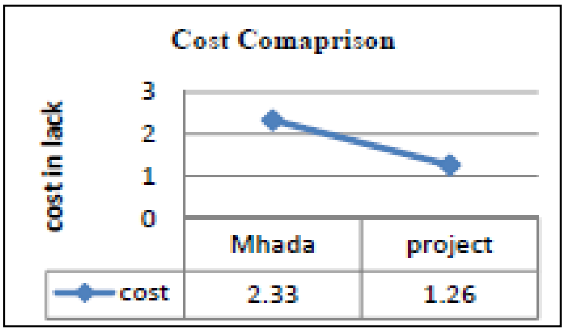
VI. CONCLUSION

Shelter is a basic human need next only to food and clothing. At the end of the 10th Five Year Plan, the housing shortage is estimated to be 24.7 million. However, urban areas in our country are also characterized by severe shortage of basic services like potable water, well laid out drainage system, sewerage network, sanitation facilities, electricity, roads and appropriate solid waste disposal. This is model developed in this dissertation would be helpful for construction of LIG group housing with in shorter time at affordable cost, normal traditional housing techniques are time consuming they will required minimum 4 to 6 months to construct small ground storied house again workmanship and quality is another aspect, but this factory made product will be of a particular expected quality and will required 2-3 days maximum to assemble at site .this fast casting and assembling techniques are helpful to reduce the construction time and cost of housing for urban poor's, planning of similar types of projects will reduce the cost of manufacturing and cost of assembling, because to manufacture similar components of factory products mold required to be same and design parameters and materials are also same ,this will helpful give the order of different materials on mass quantity will reduce the purchasing cost of materials. Labors are main persons who are involved in construction activity and now a days there is big shortage of 1010 abours in all types of industries, construction industry is the big industry in all over the world and, it has almost big potential to provide all type of jobs to the labor , but due shortage of 1010 abours the completion time and cost of construction is going on increasing ,replacement of 1010 abours in the form of machinery is very important , that's why factory made products will used to replaced labor. In the comparison of cost of two estimates, it is found that the estimated cost of the project work is 1.26 lacks and the cost of MHADA project is 2.33 lacks, hence the proposed project work is beneficial as compare to the MHADA project.[4]

VII. DISCUSSION

Comparison of final cost project build ding with MHADA project building for same area.

Detail estimate of Project Building is carried out , (for this building area similar to MHADA building is consider for LIG housing) the project's cost is 121756 Rs and cost of MHADA project is 233178 Rs, for this estimate PWD DSR (2005- 2006) is used . The figures shows that the estimate cost of project building is one lack twenty-one thousand seven hundred fifty-six and MHADA project building is two lack thirty three thousand one seventy eight, it is near about twice the cost of project building , hence from the cost of MHADA project , two houses for proposed project building would be possible to construct .



VIII. AKNOWLEDGEMENT

We the authors of this paper Mr. Santosh Kshirsagar, Mr. Jayanath Patil, Ms. Shaila Chaudhari would like to offer our deep gratitude to our principal sir **Dr. Ajay. S. Radke**and project guide **Prof. Sachin Kumbhar** for providing timely assistant to our query and guidance that he gave owing to his experience in this field for past many year. He had indeed been a lighthouse for us in this journey. We would also take this opportunity to thank our project co-coordinator **Prof. Samruddhi Shelavle** for his guidance in selecting this project and also for providing us all this details on proper presentation of this project. We extend our sincerity appreciation to all our Professors from **VISHWATMAK OM GURUDEV, COLLEGE OF ENGINEERING** for their valuable inside and tip during the designing of the project. Their contributions have been valuable in so many ways that we find it difficult to acknowledge of them individual.We also great full to our **H.O.D. Prof. Ashok Chavan** for extending his help directly and indirectly through various channel in our project work.

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