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# Low-Cost Housing and Cost Analysis

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## ABSTRACT

Inexpensive housing is another concept that deals with effective cost accounting and following techniques that help reduce construction costs using widely available materials alongside improved technology without losing the performance, performance, and lifespan of the structure. There is a great misconception that cheap housing is only suitable for sub-standard work and that it is built from cheap, low-quality building materials. The fact is that low-cost housing is achieved through proper resource management. Savings are also achieved by postponing final work or doing it in phases. The cost reduction is achieved through the selection of a more efficient material or through an improved design. The construction of low-cost housing using low-cost building materials increases access to construction for low-income populations. Advantages of low-cost building material are pollution prevention, reduction of energy consumption and use of natural materials, as well as the reusability of building materials. The overview of various low-cost building design management is presented in this paper.

Keywords: Low cost, Building Materials, Construction.

# CHAPTER 1
# INTRODUCTION

## 1.1 General

Low-cost housing for low- and middle-income earners can now be considered affordable if the household can purchase a housing unit for an amount up to 30% of its household income [miles, 2000]. In developing countries like India, only 20% of the total population has high incomes and can afford normal housing units. The low-income groups in developing countries generally have no access to the housing market. Inexpensive housing is a relative concept and has more to do with budgeting, trying to reduce construction costs through better management and the appropriate use of materials, skills and technology, but without sacrificing the performance and lifespan of the structure. It should be noted that cheap apartments are not houses built from low-quality materials. An inexpensive home is designed and built like any other home in terms of foundation and structural strength. Cost reduction is achieved through the effective use of locally available building materials and techniques that are permanently economical, user-acceptable and do not require costly maintenance. Economy is also achieved by moving, completing and implementing inexpensive building services in transitions.

If current housing overhang growth continues, at least 30 million additional homes will be needed by 2020. In India, private developers mainly target luxury, high-end and upper-mid housing segments as they command a premium over budget. income housing. This leads to a sustainable supply of this segment and increases the competitiveness of developers in the market. On the other hand, the housing for the poor and the EWS are mainly provided by the government for welfare purposes. However, compared to the existing shortage in the segment, this is insufficient. Thus, the housing needs of the lower-middle and lower-income groups are severely neglected and there is a severe shortage of affordable housing, which is mainly demanded by this income group in India.

### 1.1.1. Affordable Housing –

Low-Cost Housing is a new concept that addresses effective budgeting and following techniques that help reduce construction costs through the use of locally available materials along with improved skills and technology without sacrificing the strength, performance and lifespan of the structure sacrifice (Kumar, 1999; Civil Engineering Portal, 2008).

Like any other developing country, India is currently going through a phase of acute housing shortage. According to estimates by the National Buildings Organization (NBO), in 2015 the country was missing 31 million housing units, of which 10.4 million units were missing in the urban sector and the remaining 20.6 million units were missing in the rural sector. By the turn of the century, the housing surplus is expected to rise to 41 million. At the bottom of the economic ladder, the picture is abysmal. According to a UN estimate, over 33 percent of the population in developing countries are homeless. A recent study by UNCHS shows that over 100 million people live in a state of absolute homelessness, while more than a billion people are forced by circumstances to live in severely inadequate housing that threaten their health, safety and security.

To overcome such difficulties, management is looking for new alternative building materials and techniques, and one such approach is the use of low-cost construction. With this approach, the phases of the project are carried out in parallel rather than sequentially. The complexities that arise in the management of projects are addressed through an appropriate restructuring of the project organization; Commitment of upgrade management, selection of the right materials 3 and planning of activities, ensuring project quality, dealing fairly with project risks. and managing the cost-cutting techniques employed in housing construction (Baker, 1986). The Council for Works and Housing (CWHR) is an R&D organization under the auspices of the Department of Science and Technology. The main task of this council is to promote scientific research on problems related to various types of civil engineering structures such as buildings, roads, bridges, dams, ports, sewage treatment plants, etc.

For the state of Maharashtra, the gap between the total demand for housing and the total supply of housing is of great importance. This leads to a high housing shortage in the country. Due to the escalating price of building materials, housing has become completely inaccessible for many. Today, the price of building materials alone accounts for 60-70 percent of the construction costs. The predominant use of conventional building materials such as steel, cement, fired clay bricks and wood clearly shows that construction costs have increased over the years. Building costs are increasing at 13-15 percent each year, even when inflation is less than double digits. Therefore, the main topic of immediate interest is reducing construction costs. Low-cost, eco-friendly technology makes sustained efforts to implement predictive programming and architectural planning, rational and structural design, organization, execution and management of work, and the use of new materials and construction devices.

### 1.2 Aims and Objective:

House is one of the greatest needs and cheap housing gives people houses at reasonable prices. Accordingly, the following objectives are proposed in the present study. Defining appropriate proportions and mix designs for M30

concrete required for the experimental work.

- Investigation of different types of building materials used to reduce construction costs.
- Alternative and inexpensive building materials used for sustainable development.
- To determine the total cost required to complete a project using conventional and inexpensive material.
- Comparison of cost reduction by using different materials for a small house.

### 1.3 Scope of Work:

- In view of the aforementioned problems, as they emerge from the literature research, the following scope for the present study is outlined.
- The object of investigation is the consumption of building materials, which changes both quantitatively and qualitatively in the various phases of house construction. Accordingly, the construction costs also fluctuate between conventional and inexpensive technologies.
- Overall, this study will be very useful for past, ongoing and upcoming future large scale construction projects to minimize cost, time and waste and structural improvement.

### 1.4 Definitions:

Low-Cost Housing is a new concept that deals with effective budgeting and following techniques that help reduce construction costs using locally available materials along with improved skills and technology without increasing the strength, performance and lifespan of the structure sacrifice. There is a big misconception that low-cost housing is only suitable for low-quality work and that it is built using cheap, low-quality building materials. The fact is that low-cost housing is achieved through proper resource management. Savings are also achieved by postponing or phasing expansion work.

### 1.5 Parameters For Material Selection:

The existing pattern of the structure consists of pre-build, build, and post-build phases. Each phase of the structure should be with the end goal that they help save energy. These three phases show the progression of building materials through different phases of a structure. The pre-construction stage essentially includes the assembly, which is divided into preparation, pressing and transport. The construction phase essentially includes construction, operation, maintenance, and dismantling.

**1.5.1 Environmentally friendly –**

The assembly of building materials should be condition compatible. Efforts should be made to study and revise the innovations to deliver a quality assembly. effective structural materials and should improve waste generated during manufacture.

**1.5.2 Recycled Waste –**

The reusable wastes can be used in masonry while wooden wastes can be used in assembling compressed wood or delicate panels.

**1.5.3 Using Natural Low Cost –**

The absolute energy required to produce material is called the typified energy. The more pronounced the energy encapsulated in a material, the more it requires a significant use of non-inexhaustible sources. Accordingly, it is favorable to use materials assembled from scraps or composite materials.

**1.5.4 Locally available building materials –**

The use of neighborhood materials reduces the dependency on transportation, the obligation of which to the material expenditures for the structure is high over significant distances. The use of locally accessible building materials reduces development costs and is appropriate to the ecological conditions in the area.

**1.5.5 Energy-efficient building materials –**

The energy efficiency of building materials can be estimated using various elements such as R-value, concealment coefficient and luminous productivity. Energy efficient materials must reduce the amount of energy generated.

**1.5.6 Non-toxic building materials –**

The use of harmful building materials can significantly affect the development security of the individual and the occupants of the structure. In this way, it is ammonia, pitch resin chemicals for protection, barrier boards available in decorations, and building materials. The impact on strength of these toxic materials must be considered when choosing them, and they should be used exactly where they are needed.

**1.5.7 Longevity, Durability and Maintenance –**

The use of robust building materials not only extends the lifespan of the building but also reduces maintenance costs. Lower maintenance costs usually save a lot of construction costs. The materials used in construction determine the long service life.

**1.5.8 Recyclability & Reusability –**

The material should be accessible in a structure that is recyclable or reusable. For example – plastic waste can be used to recycle and create fresher materials. The piece of steel can be used to craft the RCC rods, constrain spreads, and other by-products in building development.

**1.5.9 Biodegradability –**

The material should be allowed to decompose normally upon disposal. Ordinary materials or natural materials would deteriorate a lot. It is also an important consideration whether a material decomposes normally or produces toxic gases.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Applications of Inexpensive Materials

**Harry et al.** A new ductile hybrid FRP rod was shown to have been developed. This new reinforcement has a bilinear stress-strain characteristic that devices in concrete structures use. It has high strength, low weight and no corrosion properties. An approximate specimen beam, each 50 x 100 mm in cross section and 1.2 m in length with 5 mm diameter hybrid reinforcement 3 such beams was prepared and tested in a 44.5 KN capacity displacement-controlled bench-type universal testing machine. The test result showed that ductile behavior was obtained with good reproducibility and failure of the beam occurs after significant inelastic deformation.

**Tam.**Explained the cost-effectiveness of using low-cost casing technology in construction. It was found that 26.11% and 22.68% of construction costs can be saved by using low-cost housing technologies in the evaluation with traditional construction.

Fei and Dale. Elaborated that fiberglass reinforcement is a new technology that is prefabricated. For glass fiber reinforced cavity wall panels with or without concrete reinforcement, this wall type is widely used in Australia and when tested shows high axial and shear resistance.

**Chowdhury et al**. Regarding the prospect of low-cost housing in India, it is noted that this paper has explored alternative building materials mainly natural materials like bamboo, straw, bagasse, artificial materials like fly ash and air conditioning panels and the potential of these materials can be used as an alternative building material released.

**Najjar et al**. Investigate the use of natural hemp fiber in improved compacted clay load response. A total of 6 specimens of an unconsolidated undrained specimen measuring 7.1 cm in diameter and 14.2 cm in length were

prepared with hemp fiber reinforcement of 0, 0.15, 0.3, 0.4, 0.5 and 1 % manufactured. The sample was compacted and cut in a PVC tube and tested in a triaxial testing machine. The result showed that the inclusion of hemp fibers has a positive influence on the ductility and the shear strength increased from 0.15% to 1% when the effective fiber content (0.5 to 1%).

**Mangesch et al.** Explained that SBA, which is otherwise landfilled, was used in a building material. SBA has been tested and proven to be a pozzolanic and cementitious material with a thermal stability of 650 degrees. SBA brick was manufactured with constant boundary composition and tested for physico-chemical properties. The test result showed that bricks were lighter, more durable and more energy efficient.

**Taurus et al.** Low-cost housing explained. It is noted that this paper aims to argue the various aspects of prefabricated construction methods for low-cost housing by highlighting different prefabrication techniques and economic benefits achieved through their introduction. In the construction of foundation wall, flooring, column, slab are important components. Namely, the main construction methods here are structural log walls, mortar less log walls, precast RC planks, precast concrete/iron cement panels are considered.

**Huma Yun et al.** Investigated over sun-dried fly ash brick, the aggregate to binder ratio used for fly ash brick was reported to be 1:4. The average fly ash brick size was 230 x 110 x 75 mm and a 10 to 12 mm mortar joint was used. And has been tested using a uniaxial monotonic compression displacement load with an actuator of 250KN. The result showed that WA was 18.3% higher, the failure modes in masonry showed that good adhesion can be achieved with higher mortar quality.

**Caponetto et al.** Explains ecological materials and technologies in a low-cost construction system, it is observed that a high recyclability of natural materials that can be used in a low-cost construction, combined with a construction technique capable of exploiting the principle of bioclimatic architecture for living needs , allows us to create buildings environmentally conscious and responsible. At the same time, the project of a special block was developed to meet the requirements of sustainability and ease of construction.

**Zami et al.** Having reported that the economic benefits of contemporary adobe construction lie in low-cost urban housing, stabilized adobe is observed to be an alternative building material on every continent and in every age. This article reviews and argues the economic benefits of using earth as a building material and describes the related construction techniques for the provision of urban housing in developing countries. Hutcheson. Studies the project management of low-cost housing in developing countries, it is found that the study of this paper includes designs, cost control systems, communications, contract law and planning. An appreciation of the evidence arising from the issues outlined throughout the paper leads to decisions on the need for design simplifications, the implications of insufficient local support and therefore the need for detailed and complete advance planning. In addition, the conclusions emphasize the need for careful assembly of self-sustaining teams

of multidisciplinary professionals and sub-professionals.

**Ugochukwu.** Explaining the local building materials, the paper is observed to recognize the problem of inadequate housing as a critical challenge for sustainable urban growth and development. The extensive use of recycled materials contributes to the conservation of the restorations and preserves the ecosystem. Green Buildings Waste Management ensures resource and energy efficiency. The proximity of the material saves costs and reduces fuel contamination during transport.

**Jasvi et al.** Studies on the sustainable use of low-cost building materials in rural areas showed that the main challenge is to use the materials in structural components for low-cost housing and their adaptation to influences such as - technical, social, ecological, physical - through different products. It meets the idea about the need of rural dwelling in India and explains different uses of materials and techniques of building for LIG people, urban poor in different aspects of building. It covers the use of local materials in the building to reduce costs and makes affordable homes for low-income people. Bredenoord. Sustainable housing and building materials for low-income households explained, it is observed that sustainable goals for low-cost housing and applications are achievable. Measures for the spatial development of districts such as urban density and networking are just as important as measures for community development. The latter include support for community-based organisations, small housing cooperatives (or similar forms of cooperation) and individual households or small groups that gradually build and expand their homes. Appropriate design and social organization and support are prerequisites for achieving sustainability in incremental housing.

**Tapkir et al.** Explained the study and analysis of low-cost housing based on building techniques. It is found that there are three factors that affect the cost of project time, materials used and techniques. Various methods for cost control and reduction have been discussed in this post.

**Pachecotorgal et al**. Explains earth building and building materials, it can be observed that in this paper earth building has a great expression in less developed countries, on the other hand the mimetic temptations near more poisonous construction techniques based on reinforced concrete and fired bricks are likely to favor a change nearby of a clearly unsustainable design. In order to disclose and highlight the importance of earth building, this article describes some environmental benefits such as consumption of non-renewable resources, waste generation, energy consumption, carbon emissions and indoor air quality. Sale. Reinforced concrete has been shown to be a very common building material. However, these steels are subject to oxidation when exposed to marine environments. Therefore, a new material is being produced, which is a fiber-reinforced polymer composite made from resin fibers that has the potential to bridge performance and cost gaps. The properties compared to traditional steel bars are used in various bridge construction.

**Mrs. Harshleen Kaur.** It has been researched that housing is a boon to the home buyer and developer as it offers

them subsidized loans, service tax exemption, tax exemptions and possible stamp duty exemptions, but at the same time does not give the developer enough leeway needed to make a project successful complete and deliver. If the state governments successfully implement the measures proposed by the central government for affordable housing projects, such as help them to complete the projects on time, without unnecessary delays caused by multiple permits.

**Urmi Sengupta.** The aim was to capture the contradictions and paradoxes and the ways in which the concept of affordability and home design is embedded in both the discourse and practice surrounding the affordable housing banner. Its ubiquitous influence has been seen in design and architecture as well as in developers' marketing campaigns. For many developers, they are the ideal target audience that can be tapped with the same design, construction, and marketing templates as luxury homes. On the other hand, poor households facing serious affordability problems are being pressured to embrace the "dream" of middle-class housing that simply isn't for them. Your choices are limited. In fact, the concept of affordable housing is articulated through multiple identities and definitions. The concept as such is promising, but in the meantime it also points to a fairly elemental confluence of priorities and policies that may produce a range of alternative scenarios that may not necessarily be fully aligned with the goals of 'affordable housing for all' '.

**G Vinay Kumar.** They studied that replacing fly ash in 25% and 30% results in higher compressive strength compared to ordinary concrete and more smoothness in the walls requiring no plastering. Use of additional cementitious materials, which are not only used for green construction, but can also be used as cost reduction techniques. Affordable forms of housing not only reduce poverty, but also fulfill the dream of a simple man of his own accommodation. Fly ash is used as a natural admixture that develops the workability and strength of the concrete for longer service life. In this study, they found that excessive use of fly ash gives walls a smooth finish, which reduces a building's plastering costs.

**Jean Bosco Harelimana.** Balancing affordable housing needs with household income requires several things to be done. In fact, affordable home rental or ownership prices are extremely high compared to wages and other household incomes. In addition, the high interest rates on loans and mortgages in Rwanda do not favor people to own their affordable homes. Few educated people with good jobs and household incomes (business people) are able to gain a foothold in affordable rented housing. Still, low-cost, affordable housing is possible when both the public and private sectors work together to minimize all of these barriers to affordable housing. The main challenge in obtaining affordable housing is high interest rates and a large gap between house prices and household income levels. To offset this, the government must intervene with a special affordable housing fund that can serve as both a subsidy; to make the project more financially viable and as a guarantee enabling a housing association with a limited credit standing to borrow against that amount. On the other hand, the fund will adjust

the interest rate to attract more borrowers to invest in affordable housing.

**Prof. Trymbak et al.** Identify the critical areas impacting project performance and plan carefully to overcome such risks. With the help of the identified factors, the project manager can apply a special control according to their criticality. The study helps parties working on housing projects to use their skills and resources in the most effective way. **Ms. Deepti Pande Rana et al.** Current models for creating affordable housing focus on people's purchasing power. These models require a variety of public and private sector agencies working together to create affordable housing. The private sector, which includes housing developers, develops affordable housing projects and sells them on the open market. Government agencies such as Urban Local Bodies (ULBs) and Urban Development Departments (UDDs) are responsible for setting policies and bylaws for affordable housing. Certain restrictions imposed by the Department of Environment and Forests limit the use of land in urban areas for housing, leading to a shortage of land and hence higher prices.

**Khalifa Alteneiji et al.** Notes that despite the large-scale global implementation of public infrastructure projects using PPPs, the implementation of social infrastructure through PPPs remains limited. The affordable housing sector is not considered attractive to private investors due to the high risk associated with lending to low-income people, as well as many failed experiences with the public sector in this area, especially in developing countries.

**Michael Atafo Adabre et al**.Due to income inequality, not every household will be able to compete in the same housing market to meet their housing needs. Households with fewer resources will, of course, consume relatively little housing, which takes up a larger part of their meager income. As a result, poorer households may have insufficient funds to purchase other necessities. Although governments and other policy makers have recognized that society's well-being improves when all households meet minimum housing standards, there is controversy over the effectiveness of policies to achieve sustainable, affordable housing. To MA Adabre and A.P.C. Chan Building and Environment 156 (2019) 203–214 212 to ensure sustainable affordable housing, this study aimed to examine the CSFs to help policy makers in their decision making. Through a thorough and critical review of the literature, 30 SFs were identified. The research results have several implications in practice and theory. The results of the study suggest that the CSFs are among the many success factors that could be the key interventions for sustainable, affordable housing in both developing and developed countries. Also, the classification of these factors informs policy makers about the underlying groupings of CSF that could be implemented at the same time. Furthermore, the successful implementation of these CSFs will ensure a holistic, sustainable and affordable housing market. For example, economic sustainability could be achieved by implementing "developer-enabling NSFs" while social sustainability could be achieved through the execution of "household demand-enabling NSFs" and "land-use planning NSFs". The implementation of the underlying component "Mixed Land Use CSF" ultimately leads to environmental sustainability.

**N.S.R.K. Prasad Kethineni et al**. In the MDSH model, they cracked challenges in the implementation of affordable housing. a. Clear definitions: In 2017, the Indian government announced that the GST for low-cost housing would be reduced by 8%. However, the Circular does not define affordable housing and the Government has stated that the GST will be reduced for affordable housing. b. Facilitate land availability: By providing a subsidy to private landowners for the use of land for housing. c. Relaxed zoning norms: Floor area ratios and density norms are crucial for affordable housing. The government should regularly review master plans. i.e. Invest in infrastructure modernization: Involvement of private actors in state infrastructure. e. Special Approval Window for Affordable Housing: Government agencies should provide a separate open window system for quick approval of projects. f. Strengthen microfinance. G. Use of advanced technologies.The MDSH model will be helpful to crack the risk link in PPP. a. In this model, public authorities must actively involve the project life cycle and oversee the construction work. b. In this model, an authority will provide clear information about the project itself during the tendering phase. c. Establish coordination and support between public and private authorities.

**Dipti Parashar**. Explained that the government's role is largely limited to formulating policies with little emphasis on turning them into workable projects. Free approaches such as TDR programs, FSI incentives and housing reservation policies for the poor are attractive as they do not impose any financial burden on government and as such are "free" but in return require a larger role with greater managerial savvy -how at the city level. Without these, there would be deficiencies and burdens on the existing urban infrastructure. The dominant stance of governments to encourage condominiums is not a sustainable model as it poses greater challenges in terms of land availability and identifying beneficiaries. Rental housing models on PPP need to be explored and implemented as ownership models are not viable in urban areas where land is a scarce resource.

With the need for formal housing for the poor growing at a required rate of 4 percent per year, there is a need to establish policies and programs that would allow the policies to be translated into services on a large scale. Institutional arrangements need to be strengthened to ensure that projects reach the intended beneficiaries, and projects need to be identified and targeted for contexts that are consistent with the nature of poor housing. The government must be proactive, beyond policy making, focusing on large-scale bulk deliveries and facilitating the increase in the number of residential PPPs.

**Renita D'souza.** The following point stated. a. The housing strategy must be sustainable. b. The strategy is underpinned by efficient allocation and use of available and accessible resources. The conversation does not end with government-owned resources, but includes private sector and philanthropic resources. c. The diverse efforts that are being made in the housing sector must be bundled and expanded. i.e. The emerging fintech sector must be incentivized to engage in real estate strategy to innovate for the financial needs of the lower end of the EWS and LIG population. e. The focus must be on correcting market distortions and other anomalies that adversely

affect the incentive structure underlying the affordable housing segment in India.

**Maulik G Gangani et al.** The scale of the housing problem in India is too great for any single entity to make an impact. The HFH model gives us a sustainable model that is a good starting point. Based on our understanding of the HFH model, we believe that a collective system that combines the benefits of each entity with clearly defined roles and responsibilities is the most likely solution. 3. It will require collective efforts and efficient coordination between these different entities to build a scalable and sustainable model that can attempt to address the burgeoning housing problem in India.

**Ganesh Kumar Nidugala et al**.Given the location constraints and basic infrastructure issues, difficulties might arise in the near future, but these will be resolved later with the increase in housing demand and infrastructure development. Valuation based on the collector guideline rate for commercial use at a running rate of Rs 4,650/m2 appears to be a profitable business for both MPIDB and private developers. Scenario IV gives a reasonable 12.6% plus land for EWS and LIG units (617 number of EWS and LIG residential units) and the remaining 87.4% of the land is given to the private developer who continues to develop for residential or Commercial purposes can be used for purposes.

**S. Ping Ho et al.**They identify three main sources of transaction costs in PPPs, namely principal-principal issues, renegotiation and delay issues, and soft budget constraints. In particular, the earnings structure of private project sponsors in PPP projects is analyzed in order to show the internal conflicts of interest of various stakeholders. A process framework based on game theory perspective is further proposed to study the interaction dynamics between government and promoters under asymmetric information. Since the high transaction costs undermine competition and prevent value creation, the policy decisions related to the ex-ante tendering process and the ex-post management mechanism should take into account the interaction dynamics of the public and private sectors.

**Brizal Chaudhari, et al.**It is not possible to completely eliminate the urban housing shortage as market forces combined with migration and population growth will always leave a certain percentage of the population with inadequate or unaffordable housing. However, it is possible to ensure the formulation of systems and practices that are aware of and adaptable to the diversity of this housing demand. One way to do this is to ensure, as much as possible, proper site selection for the construction of new housing units. To mitigate negative externalities, proposed locations for affordable housing projects should not be on land.

**Neema Kavishe, et al**. The study used semi-structured interviews to firstly identify and rank the necessary CSFs for PPP implementation in AHS delivery projects and secondly to conduct a "mapping exercise" of the identified CSFs over the project lifecycle of PPP-AHS. The "mapping exercise" builds on the proposed PPP framework for housing projects as previously developed by the authors on the challenges associated with the implementation process. Contributions of this study include the identification of an ordered set of CSFs and their mapping across

the project life cycle for PPP implementation in AHS in developing countries like Tanzania. Second, the results shed light and provide insights into understanding the CSFs required for the implementation of PPP in the Tanzanian housing and construction sector. This is a hitherto little explored area. Third, by identifying the CSFs for the Tanzanian context, this present study contributes to the PPP research agenda by responding to and addressing the knowledge gap related to the drivers identified in the study, which have been conceptualized as CSFs for PPPs.

**Vinit Muchiya.**The events in the case study point to the need for a more cautious, prudent and multi-faceted policy approach, as market-driven, actor-centred enablement strategies can lead to highly uncertain outcomes. Due to the imprecise results, planners and politicians have to be careful. However, the main focus of this case study is not whether markets should be activated, but how market actors can be activated. Furthermore, the focus is not on enabling long-term institutional development, but rather on short-term and transitional strategies that can form the basis for regulatory reforms and more robust policies.

**Urmi Sengupta.** The paper discussed the implementation of PPPs in response to the increasing severity of the housing shortage and the failure of public utilities to keep up with demand over the past 30 years of Kolkata's state housing programs. The empowerment path taken by the government has resulted in a kind of partnership that is growing strangely, despite the socialist institutional context.

# CHAPTER 3

# MATERIALS AND SITE DETAILS

## 3.1 MATERIALS:

### 3.1.1 Bamboo Reinforcement –

#### 3.1.1.1 What is Bamboo Reinforcement –

- The bamboo reinforced concrete structure follows the same design, mix ratios and construction techniques used for steel reinforced structures. Only the steel reinforcement is replaced with bamboo reinforcement. This article discusses the properties of bamboo reinforcement, the mix proportion of concrete, the design, and the construction technique using bamboo concrete. Nature's material, bamboo, has been widely used for many purposes.
- Mainly as a strength-bearing material. It is used to build shelters from earlier times. Bamboo has been used for scaffolding, formwork props and many structural works in building construction.
- These are limited to medium-sized projects. Although the existence of bamboo has been known for centuries, bamboo as a reinforcing material is an innovation in the field of civil engineering. This innovation was based on Clemson's study conducted at Clemson Agricultural College.
- Bamboo is biodegradable and naturally renewable. It is energy efficient as it is of natural origin and environmentally friendly. These properties have forced them to be used in the construction sector for centuries.
- Steel as a reinforcing material is a daily increasing demand in most developing countries. There are situations when production is insufficient to meet demand for steel.
- It is therefore important to have an alternative that is valuable compared to steel. Bamboo is plentiful; They are tough and can therefore meet demand as a reinforcement material and become an ideal replacement for steel.
- The tensile strength property, which is the main requirement for a reinforcement material, is considered significant for bamboo compared to other materials, including steel.

- The structure of the bamboo from its origin gives this property. The hollow tubular structure has a high resistance to wind forces when placed in a natural habitat. Working on the weak points of bamboo and developing an innovation using bamboo as a replacement for structural steel would be a great alternative.

**Fig. 3.1.** Bamboo Reinforcement

**3.1.1.2. Benefits of Recycled Steel –**

- The natural fibers of bamboo are extremely strong.
- It has high tensile strength.
- It is extremely flexible due to its hollow nature.
- Light weight compared to steel.
- Cost effective and environmentally friendly.
- It has great potential for shock absorption.

**3.1.3. Disadvantages of Recycled Steel –**

- Unlike steel, it does not last longer.
- Because bamboo is less durable than steel, it cannot be used for permanent construction.
- Shrinkage problems. With bamboo, the moisture content varies depending on altitude, location and ripening time. It is one of the essential aspects when evaluating the life of bamboo. Use treated bamboo if you want your structure to last longer than 2 to 3 years.
- More susceptible to environmental degradation and insect infestation.

### 3.1.4. Environmental Impact of Recycled Steel –

- Bamboo plays an important role in the environment. Bamboo helps reduce light intensity and protects against ultraviolet rays.
- The rate of deforestation has also been reduced as trees are felled year after year, however this will reduce the rate of wood consumption.
- The development of bamboo reduces pollution; His plants reduce up to 35% carbon dioxide in the climate and provide more oxygen.
- Bamboo roots help control erosion as they form a water barrier; Developed countries use bamboo as a defense component for their crops and villages from incessant washing.
- Bamboo absorbs large amounts of nitrogen, which helps reduce water pollution. Bamboo can be harvested and replenished without destroying the natural forest.
- Environmentally friendly Bamboo reduces the use of wood in construction, as mentioned earlier, it has a naturally waxy surface that requires no painting and is therefore free from painting health hazards.
- Because of its quality and strength, studies have shown that bamboo can be used as reinforcement for concrete, which will reduce pollution from steel factories

### 3.1.5. Cost of Bamboo Reinforcement –

**Table 3.1.** Cost of bamboo reinforcement

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | BAMBOO REINFORCEMENT | 4.5 | 27,000 | M.T | 1,21,500 |

## 3.2. Fly Ash Bricks –

### 3.2.1. What are fly ash Bricks –

Fly ash brick (FAB) is a building material, particularly masonry, containing class C or F fly ash and water. Compacted at 28 MPa (272 atm) and cured for 24 hours in a 66°C steam bath, then toughened with an air entraining agent, the bricks can withstand more than 100 freeze-thaw cycles. Due to the high concentration of calcium oxide in the class C fly ash, the brick is said to be "self-cementing". The production method saves energy, reduces mercury pollution in the environment and often costs 20% less than traditional brick production.

**Table 3.2.** Fly ash composition

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

**Fig. 3.2**. fly ash brick

**3.2.2. Benefits of fly ash bricks –**

- It reduces dead load on structures due to its low weight (2.6 kg, dimensions: 230 mm x 110 mm x 70 mm). The same number of bricks cover more area than clay bricks.
- High fire insulation.
- Virtually no breakage during transport and use due to high strength. This is because the joints of the bricks are thick.
- Due to the uniform brick size, the mortar required for joints and plaster is reduced by almost 50%. Since they are of a uniform size, the need for mortar and plaster is reduced by around 40%.
- Reduced water penetration significantly reduces water seepage through brick.

- Gypsum plasters can be applied directly to these bricks without back plastering with lime plaster. Once you use them, you'll be happy to see that they're organic and crack-free.
- These stones do not need to be soaked in water for 24 hours. Spraying with water before use is sufficient.
- The heat capacity of fly ash blocks is between 0.90 and 1.05 W/m². So they absorb less heat.

**3.2.3. Disadvantages Of Fly Ash Bricks –**

- Depending on the mixture, the mechanical strength can be low. This can be partially remedied by placing scraps of marble or mortar between the blocks.
- For large sizes, there may be more breaks depending on the mix of materials.
- It has high thermal conductivity.
- Additional insulation is required in colder regions.

**3.2.4. Environmental Compatibility Of Fly Ash Bricks –**

- The use of fly ash bricks in construction has brought a number of environmental benefits. As the world moves towards the development of green buildings, the manufacture and increasing use of fly ash bricks in construction has the potential to bring about significant environmental change.
- The basic ideology of fly ash brick technology is to produce climate friendly bricks without using coal in the process. Traditional brick making burns large amounts of coal and emits tons of carbon dioxide every year. In addition, valuable topsoil is used for the production of clay bricks.
- If the use of fly ash bricks is introduced globally, it has the potential to eliminate CO2 emissions from the brick industry.

**3.2.5. Cost Of Fly Ash Bricks –**

**Table 3.3.** Cost for Fly Ash Bricks

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | FLY ASH BRICK IN FOUNDATION & PLINTH | 10 | 2,100 | Cum | 21,000 |
| 2 | FLY ASH BRICK | 30 | 2,100 | Cum | 63,000 |

| | | | | | |
|---|---|---|---|---|---|
| | IN SUPERSTRUCTURE | | | | |

## 3.3. Ceramic tiles –

### 3.3.1. What Are Ceramic Tiles –

- Ceramic tiles are made from clay as well as other natural resources including sand, quartz, and water. They are mainly used in homes, restaurants, offices, shops, etc. as bathroom wall and kitchen floor. They are easy to assemble, easy to clean, easy to maintain and available at great prices.
- Ceramics have good strength and can withstand high temperatures and acidic materials but are brittle and weak in stress and shear. Applications include floor tile, pipe, brick, cookware, tableware, sanitary ware, ceramic products, gas and fire emitters, furnace liners, glass and steel crucibles, knife blades, automotive disc brakes, watch cases and biomedical implants.
- Global ceramic tile demand was estimated at around US$72.0 billion in 2014 and is expected to reach around US$120.0 billion in 2020, at a CAGR of just over 9.0%. In terms of volume, the global ceramic tile market was 13.0 billion square meters in 2014.
- The demand for ceramic tiles is mainly driven by the growing construction and infrastructure industry. The strong growth of construction industry in emerging markets like India, China, Brazil and South Asian countries is expected to drive the growth of ceramic tile market in the future. Increasing industrialization and urbanization has led to increasing demand for commercial and residential buildings in emerging markets. Technological advancement in ceramic tile manufacturing and availability of abundant raw materials are also contributing to the growth of ceramic tile market.
- Ceramic tiles are used in a wide variety of applications across different industries, e.g. B. Residential replacement, commercial, new residential, and others (facades, countertops, etc.). Home replacement was the largest application in 2014, accounting for over 45% of total consumption. Demand for ceramic tile, used as a replacement for residential buildings, has increased due to its potential as a substitute for paint and other products. New residential areas are also expected to grow rapidly.
- Asia Pacific was the largest market in 2014, accounting for over 50% of total consumption. Europe was the second largest market, followed by Latin America, the Middle East, Asia and Africa, and North America. China, India and Brazil are also major drivers of global ceramic tile market growth.

**Fig. 3.3**. Ceramic Tiles

**3.3.2. Benefits of Ceramic Tiles –**

- These tiles have high strength and are very durable.
- It is fire resistant.
- The surface of tiles is non-slip.
- Easy to install.
- Repairs and maintenance are relatively easier.
- Relatively cheaper compared to other tiles.
- They are available in a variety of sizes, colors and designs.
- Ceramic tiles are lightweight.
- Improved aesthetics due to the wide range of colors and designs.

**3.3.3. Disadvantages of Ceramic Tiles –**

- These tiles are hard and brittle. So there is a possibility of breaking.
- Large format tiles are sometimes difficult to handle and complex to install.
- Sometimes the tiles are bent during their manufacture or during transport.
- Ceramic is a cold material. It does not retain heat for a long period of time. So in winter these tiles get very cold.
- It has a hard surface that makes it uncomfortable to stand for long periods of time. In addition, the tiles can not be softened with padded underlay.

**3.3.4. Environmental Compatibility Of Ceramic Tiles –**

- Ceramic tile is a clean disposal material. That means if you decide to remodel your home and ditch the old ceramic

tile, the Environmental Protection Agency (EPA) has deemed it the perfect material for a clean fill. This is because ceramic tile cannot decompose, does not leach corrosive liquids and is not water soluble. Therefore, although the tile occupies landfill space, it occupies it in a positive way.

#### 3.3.5. Cost Comparison with Ceramic Tiles –

**Table 3.4**. Cost For Ceramic Flooring

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | CERAMIC FLOORING | 180 | 500 | Sq.m. | 90,000 |

## 3.4. White Gypsum Plaster –

### 3.4.1. What Is White Gypsum Plaster –

- Plastering is one of the most common and oldest finishing techniques. It is applied to give a visually pleasing smooth finish to block or brick masonry. Plastering not only enhances beauty, but also serves as a protective cover for bricks and stones, protecting them from rain and wind. Depending on the desired finish, ingredients, popularity and the required proportion, different types of plaster are used in different works. Various plasters available on the market are cement plaster, lime plaster, clay plaster, mud plaster, gypsum plaster, etc. In recent decades, gypsum plaster has gained popularity and has largely replaced lime and cement plaster. Here we discuss the properties, application, advantages and disadvantages of gypsum plaster.
- Gypsum plaster uses gypsum as a binder instead of Portland cement. Gypsum plaster is a white putty material made by the partial or complete dehydration of the mineral gypsum. When dry gypsum powder is mixed with water, it hardens. This material can be applied to block, brick or concrete surfaces to form a smooth finish. It is available ready to use and does not require sand. Only the addition of water is required. It offers excellent acoustic and thermal properties and gives the best finish to leveled walls.
- Gypsum plaster ensures a smooth interior finish and is an ideal base for high-quality paintwork and wallpaper. It can be applied to both smooth and rough wall surfaces. Gypsum plaster is easy to apply and requires less skilled labor than traditional cement mortar. Surface preparation and application of gypsum plaster should be appropriate to avoid cracking and delamination.
- Gypsum is a soft sulphate mineral containing calcium sulphate dihydrate (CaSO4:2H20). It occurs in nature in the form of rocks with a white color. It is widely used in fertilizers, molds, sculptures, and as a gypsum material.


**Fig. 3.4.** White gypsum plaster

### 3.4.2. Benefits of White Gypsum Plaster –

- The benefits of gypsum plaster is a time-saving process, reducing the cost of the project.
- Amount of waste in application is negligible.
- Easy to work with for an excellent finish.
- Gypsum plaster does not need to harden, which saves both water and time during construction.
- Gypsum has binding properties. Therefore, just one coat of paint on RCC ceilings, bare brick interior walls, AAC blocks and concrete columns would be sufficient.
- The room looks big and beautiful because the gypsum plaster is pure white.
- Gypsum plaster is a pre-mixed material and is available in handy packs.
- It is easy to apply and mold into different shapes for decorative purposes, the setting time of the gypsum plaster can be controlled and the time interval required between two successive coats is also reduced.
- Gives the surface a smooth finish to accommodate all types of paint.
- Various surface textures and surface hardnesses can be achieved.
- Gypsum plaster is not attacked by insects and does not encourage fungal growth.

### 3.4.3. Disadvantages Of White Gypsum Plaster –

- Gypsum plaster is more expensive than cement plaster for the same thickness. But in areas where river sand is hard to come by, gypsum plaster would be economical.
- Gypsum plaster is undesirable on exterior walls that are prone to moisture and in permanently damp areas such as bathrooms, toilets, laundry rooms, kitchens, etc.

- According to “R. Chudley' (author of Building Construction Handbook) warns against using gypsum plaster at temperatures above 43°C and on frozen substrates.

**3.4.4. Environmental Impact of White Gypsum Plaster–**

- First of all, gypsum plaster is one of the most commonly used plaster materials in construction. It has good environmental impact. It also means a durable and eco-friendly product. Gypsum plaster is now an essential part of building construction and repair work. This is especially true for eco-friendly homes. In reality, sustainable living is trying to create healthier homes that are environmentally friendly and energy efficient.
- Similarly, gypsum generates less carbon dioxide throughout the manufacturing process. It also has a lower impact on the environment. This will make your building initiatives more sustainable. In other words, gypsum has a low carbon footprint compared to brick and concrete blocks.
- Moisture and moisture tend to enter homes, particularly in coastal or tropical environments, or in older buildings with exterior penetrations. Although impossible to prevent, ventilation and air quality can be maintained. Gypsum plaster offers another layer of protection and resistance to ceiling moisture. In a place like Kerala with a tropical climate, gypsum plaster is safe to use and best for reducing your construction costs.
- Gypsum plaster can prevent fire hazards from latticework and wire. In such conditions, fireproof can provide enough resistance. They are excellent for securely installing smoke detectors, water sprinklers and heat detectors to warn of and respond to fire hazards. When a fire comes into contact with plaster, the first thing that escapes is water in the form of steam. Even after the water has evaporated, the gypsum can withstand heat. Gypsum has high heat resistance.
- Gypsum is a lightweight plaster. It can be used for manual or machine application on interior surfaces. It dries to a brilliant white, smooth, smooth finish with high impact resistance. Gypsum is a lightweight material with high strength and low density. This reduces the weight of the plaster by 30% and increases the structural strength of high-rise buildings.
- Compared to the more conventional plastering method, the use of gypsum plaster saves time and money and reduces project costs. Since sand has become scarce and cement expensive, cement plaster is more expensive than gypsum plaster. Also, applying cement plaster is a time-consuming technique that increases project costs. With a single application and time savings during application, the percentage of waste is minimal. Using gypsum plaster saves time and reduces overall project costs.

### 3.4.5. White Gypsum Plaster Cost –

**Table 3.5.** Cost For White Gypsum Plaster

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | INTERNAL PLASTER TO WALL | 550 | 240 | Sq.m. | 1,32,000 |
| 2 | OUTER SAND FACE PLASTER | 430 | 310 | Sq.m. | 1,33,300 |

## 3.5.PVC Wall Panels –

### 3.5.1. What are PVC Wall Panels –

- When it comes to our interior design, many people try to be trendy, with the current interior design trend making them stand out visually. With this common interior wall covering trend, it has inherited the other wall finishes such as paint, tile trim, wallpaper, etc. Among most of the wall panels, the "PVC Wall Panels" are more common to improve the look of interiors of your home including furnishings and flooring.
- The Germans were the first in the 1970s to use the PVC panels in Walls as decorative interior finishes. It was quite a unique and smooth finish compared to the other wall coverings of the time.
- PVC sheets are such eco-friendly products that are trending due to its multiple properties such as impact resistance, durability and flexibility. These are lightweight boards that are easily available in the market at an affordable price.
- The panels with thickness more than 6mm are mainly used as exterior wall cladding material. They become an extra layer of protection. The layer protects the wall from rain, snow, hail and sunlight. They are also used to isolate the space inside, reducing the intensity of external noise penetrating the walls.
- We can also have such boards CNC cut to create decorative patterns on the wall paneling.
- These are PVC foils that are embedded between the longitudinal PVC grid. This grid provides the strength of the panel and makes the panel light, hence also known as lightweight panel.
- PVC wall panels have edges with a locking system so that water cannot get through the joint. Some designs have grooves that give a stripe shape to a wall. In such patterns, the joints are not visible at all, since they merge into the grooves.
- The most commonly available PVC wall panel size in India is 10 inches wide and 10 feet long, with a thickness of 8mm.

**Fig. 3.5**. PVC wall panels

**3.5.2. Benefits of PVC Wall Panels –**

- When there is moisture in the wall, PVC wall panels are most useful as they resist moisture very well.
- We know that PVC is environmentally friendly and many medical devices and food packaging are also made from PVC material as it does not pollute the environment. Therefore, such material is useful in hospitals, sports arenas, schools.
- PVC has good resistance to moisture. The surface has no pores or cracks, preventing the growth of bacteria. They have a polyurethane layer that gives the panel a smooth and even surface. So it will be easy to clean such boards. Dirt does not accumulate on the surface, and such wall covering is easy to care for. Therefore, such panels are suitable for the kitchen and toilets, among other rooms.
- They will not rust when used on outside surfaces of the house.
- The ignition temperature is 60 C degrees, so they don't burn that easily. In the event of a fire, they emit less smoke than wood and the by-products of combustion are less toxic in nature.
- Because these are lightweight panels, the installation process is short. These panels can be easily cut and installed without grout.
- Many panels have a locking or tongue and groove system that speeds up the fastening process. It also helps to replace a single panel if it becomes damaged.
- The PVC wall panels are good for insulation.
- The PVC panels are recyclable and old ones can be taken to a plastic recycling facility.
- The PVC panels are available in many colours, designs and shapes. Thus, it offers a designer many opportunities to create a decorative wall surface.

- The PVC panels are finished surface panels. They do not require any additional post-processing such as painting or polishing etc.

**3.5.3. Disadvantages of PVC Wall Panels –**

- These are finished panels; care must be taken not to hit it with a sharp object that may scratch it, as such scratches will be difficult to remove, hide or treat.
- Nailing/screwing such boards can sometimes be difficult. If the screw goes wrong, the same hole cannot be used to screw the plate.

**3.5.4. Environmental Sustainability PVC Wall Panels –**

- An estimated 75% of drywall ends up in landfills, where it accounts for 25% to 40% of the national solid waste stream. Once it reaches the landfill, drywall decomposes, producing smelly and potentially deadly hydrogen sulfide gas. It can also leach dangerous sulfates into groundwater.
- PVC wall panels that are durable and have a lower manufacturing carbon footprint than glass or metal. Unlike drywall, they are 100% recyclable at the end of their life, and waste products can be reground and reused to create new materials. Wherever possible, we use recycled materials to offset the amount of virgin materials used.
- Offering custom product sizes is another way we strive to reduce material waste. This reduces waste during assembly. However, because PVC is fully recyclable, it can be broken down into its original chemical components, which can be used to make new PVC or as raw materials for other manufacturing processes.
- Maintaining the value of new and existing buildings by selecting materials that enhance their durability and performance is a critical consideration. The lifespan and benefits derived from the use of a construction product not only affect the sustainability of a building, but also the aesthetics and functionality of the spaces built within it.
- The superior performance and extended lifespan of PVC wall panels results in a 55% lower total cost of ownership compared to alternatives such as drywall, resulting from less labor and lower maintenance and operating costs.

3**.5.5. PVC Wall Panel Cost –**

**Table 3.6.** Cost for PVC Wall Panels

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | PVC WALL PANELS | 20 | 600 | Sq.m. | 12,000 |

## 3.6. Stainless Steel Glass Railing –

**3.6.1. What is SS Glass Railing –**

- Glass railings are a strong option for modern and contemporary homes and buildings. Adding a glass railing to your project can add that extra something to make it stand out.
- In residential interiors, it is common to use 36 inch tall glass on stairs and 39 inch or 42 inch on balconies or other planar applications. When using your glass railing as pool protection, the code often calls for 48 inch high railings.
- Glass railings have been used for decades and you will often see them in shopping malls, stadiums, airports and other high traffic environments. This is because it is one of the strongest, most durable and safest railing options available. There are gaps or moving parts to worry about. The tempering process that all panels undergo strengthens the glass. When installed correctly, these panels far exceed the legal requirements for railing strength.
- Many people have had experiences with glass that make them nervous about the safety of glass railings. Everyone has probably broken a glass cup or maybe even a window at some point. But the glass used for these types of applications is very different from what is used for glass railings. All glass railing systems are manufactured with modified glass for improved tensile strength and chip resistance - the technical terms for tempered and laminated glass.


**Fig. 3.6**. SS glass railing

**3.6.2. Advantages Of Stainless-Steel Glass Railings –**

- Constructed from extremely durable material that withstands harsh weather.
- Clear glass allows an unobstructed view of the outside, even from low vantage points such as deck chairs.
- More coverage accounts for young children and pet safety considerations.
- A quarter inch thick tempered glass provides good security.
- Available in a range of decoration options and color tones.

**3.6.3. Disadvantages of SS Glass Railings –**

- Requires thorough and frequent cleaning.

- Susceptible to dirt and mineral stains if not properly cared for.
- Transparent panels may pose a hazard to flying birds.
- Tend to be more expensive than most other deck rail materials.

**3.6.4. Environmental Sustainability SS Glass Railings –**

- Perhaps you've never thought about the environmental benefits of investing in glass railings over metal or ceramic railings. The World Life Fund for Nature has spoken about the environmental benefits of using glass, particularly recycled glass.
- One of the biggest environmental benefits of using glass is that it is much easier to recycle. It doesn't need to be heated nearly as much to melt as metal. It also tends to have more uniform material properties, eliminating the need to separate different materials as would be possible when recycling metal.
- Therefore, the use of glass railings (and other glass fixtures) makes a lot of ecological sense.

**3.6.5. SS Glass Railing Cost –**

**Table 3.7** Cost for SS Glass Railing

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | SS & GLASS RAILING | 20 | 1,350 | Sq.m. | 27,000 |

## 3.7. PVC Doors –

**3.7.1. What are PVC doors –**

- UPVC doors are manufactured by encasing an insulated steel frame in unplasticized polyvinyl chloride (UPVC) to create a closed unit that is strong and thermally efficient. UPVC doors may have a plastic finish, but they're an affordable and effective solution for securing any home in style.
- These doors were created to prevent temperature changes from moving through them. When it's hot outside, the heat doesn't get through the door, and when it's cold it doesn't get through either.
- The uPVC helps keep your heating or air conditioning where it belongs, meaning you pay less to heat or cool your home. That means a smaller carbon footprint, which is better for the environment, and energy cost savings.
- The fact that these doors are so energy efficient means you'll probably want them on every door frame in your home to ensure the entire room is properly decorated.
- uPVC doors are stronger and more durable than most other doors. If you look at a wooden door or frame, you will see that moisture and the regular changes in weather and temperature can cause them to warp or even begin to rot. PVC does not do this.
- In fact, it's temperature independent, so you can count on it to be good for years to come. Technically, metal

frames are the safest in the industry, but PVC frames are a close second.

- They provide the strength needed to make it difficult for anyone to break in and are not easy to manipulate. If you want solidity, a plastic front door is a good choice. If someone tries to get through a solid PVC door, they will find it quite difficult.
- This also applies to window frames, which tend to be a weak point with wood. Given the lower cost of producing PVC, it makes sense that the doors would be significantly cheaper than doors made from expensive hardwoods or even metal doors.

**Fig. 3.7**. PVC doors

**3.7.2. Advantages of PVC doors –**

- UPVC doors are very difficult to break, ie your property, and will be better protected. The polyvinyl chloride of UPVC doors and windows will not degrade over time.
- UPVC is also a relatively inexpensive material and is much more resistant to fire, again making it a safer option whether in the home or in the workplace.
- Some UPVC doors are fitted with a thick reinforced UPVC sheet as an extra security measure.
- One of the main advantages of UPVC doors is the wide range of door designs available on the market. UPVC doors are available for a variety of architectures.
- Not many are aware that plastic doors have a high energy saving potential. The plastic frames play an important role in promoting energy efficient thermal insulation.
- In this respect, plastic doors score top marks compared to aluminum or wooden doors.

**3.7.3. Disadvantage of PVC doors –**

- Despite their robustness, PVC doors are prone to sagging and leafing due to their light weight and because they are not as structurally strong as wood/aluminium doors. Too much heat can even cause their frames to crack.

- Wooden doors add an air of soft sophistication and sophistication while adding a rustic touch that gives your home a far more tasteful look than PVC.
- Aesthetically pleasing wooden doors help maintain the charm and character of your home. UPVC often lacks character and can look out of place in traditional homes.
- Additionally, timber and aluminum doors are manufactured to precisely match your frames to give them a nice, snug look. PVC, on the other hand, is mass-produced and you will easily see the distinct difference in grades.

**3.6.4. Environmental compatibility of PVC doors –**

- PVC doors have heat insulating properties, which means you use less energy to keep your home comfortable by cooling and heating.
- These doors are made from materials that are fully recyclable, making them virtually waste-free.
- The uPVC doors are extremely durable and will not warp, meaning they do not need to be replaced frequently. In addition, less energy is used to manufacture the windows and doors.
- Recycled materials are reused in the production of new doors.
- The material PVC is a good alternative to timber/wood. Logging increases the rate of deforestation but will slow down significantly as more people start using these uPVC doors.
- Calcium-zinc ingredients are used instead of lead-based ingredients, which is better for both people and the environment.

**3.7.5. Cost of PVC Doors –**

**Table 3.8.** Cost for uPVC Door

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | uPVC DOOR | 16 | 3,880 | Sq.m. | 62,080 |
| 2 | uPVC DOOR FRAMES | 15 | 1,610 | Sq.m. | 24,150 |

## 3.8. Precast Concrete Windows –

**3.8.1. What are precast concrete windows –**

- Precast concrete is manufactured by pouring concrete into reusable molds or 'molds' which are then treated in a controlled environment, transported to the construction site and lifted into place.
- The properties of precast concrete such as economy, durability, adaptability, ease of use and maintenance have attracted a lot of attention worldwide and are slowly becoming the preference of many construction companies.
- One of the many components of precast concrete are window frames. Shape, dimensions, casting process, curing, installation and fastening of the prefabricated window frames.
- Prefabricated reinforced concrete door and window frames have been proposed in the region. As an alternative

to wooden and steel door window frames.

- RCC frames are much more durable than wood and steel frames. Timber frames are prone to termites and cracking in high humidity, even steel is prone to corrosion in regions of high rainfall. In this case, RCC frames offer a lifetime alternative material that is durable in all weather conditions.
- Precast concrete window frames consist of separate RCC elements that correspond to the sides of the opening.
- The bars are minimally reinforced with wire reinforcement. Being reinforced concrete, the upper element of the frame can also serve as a lintel over a window. The profile of the frames is like wooden frames with the possibility of single and double folds.

**Fig. 3.8**. Prefabricated concrete windows

**3.8.2. Benefits of Precast Concrete Windows –**

- Precast concrete construction saves time, the risk of a project delay is also lower. The precast concrete casting can be carried out at the same time as other work on the construction site such as earthworks, surveying, etc., thus saving time.
- The key factors that regulate construction quality, such as: B. Curing, temperature, mix design, formwork, etc. can be monitored for precast concrete elements. Thus, construction with improved quality can be performed.
- By using prestressed precast elements, structural materials with high strength and load-bearing capacity can be achieved, which can lead to larger spans, reduced cross-sectional size of structural members, etc.
- The simplified construction process reduces time, increases productivity, quality and safety and thus reduces costs.
- Precast concrete structures have a longer service life and minimal maintenance. The high density precast concrete is more resistant to acid attack, corrosion, impact, reduces surface voids and resists dust accumulation.
- Because the structures are prefabricated in a controlled factory environment, multiple combinations of colors and

textures can be used. A wide range of shapes and sizes with a smooth surface are available to choose from, increasing the aesthetic value of the products.

- No raw materials need to be stored on site for the construction of precast concrete elements. It reduces the need for traditional formwork and supports, waste, manpower, etc., thus providing a safe working platform.
- More than 40% cost savings compared to the high-quality wooden frame.
- Creates local jobs through an enterprise mode production unit - easily replicated by a group of trained individuals.
- Resistance to all weather conditions, easy and lifelong fixing of the panels.
- Easy to assemble, offers dimensional accuracy, excellent surface finish allows for polishing and easy painting, and is resistant to vermin and white ants.

**3.8.3. Disadvantages of Precast Concrete Windows –**

- Installing a precast concrete plant requires heavy and sophisticated machinery that requires a high initial investment. In order to make sufficient profit, a large number of precast construction projects must be available.
- The construction site may be far away from the precast plant. In this case, the prefabricated parts have to be transported to the construction site with trailers. In many cases, the reduced cost of precast concrete is offset by the cost of transportation.
- Reasonable care and caution should be exercised when handling precast concrete. Typically, finished parts are heavy and large, making them difficult to handle without damage. Generally, portable cranes or tower cranes are used to handle finished parts.
- Limitation With prefabricated structures, it is difficult to modify the structure. For example, if a load-bearing wall has to be dismantled for modification, this will affect the overall stability of the structure.
- The assembly of the precast elements is one of the key points to ensure a strong structural performance. Connections between multiple components must be monitored and properly executed to ensure the intended behavior of the connection, e.g. B. simple, semi-rigid or rigid connections. In addition, improper connections can lead to water leakage and soundproofing failure.

**3.8.4. Environmental compatibility of precast concrete windows –**

- Saves materials, no need for additional framing and drywall.
- Saves material and energy; eliminates channels and charges the thermal mass of the board.
- Thermal mass with insulation offers energy benefits that exceed the benefits of bulk or insulation alone in most

climates. saves material; extends the life of the panels.

- Long life, low maintenance materials require fewer replacements and maintenance over the life of the building.
- Reduces waste transportation and disposal costs. Fewer virgin materials are used when construction waste is recycled for another project.

### 3.8.5. Cost of Precast Concrete Windows –

**Table 3.9.** Cost for Precast Concrete Windows

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | ALUMINIUM WINDOWS AND M.S GRILL | 12 | 1,070 | Sq.m. | 12,840 |

## 3.9. Primer -

### 3.9.1. What Is Primer Paint –

- Primer is a paint product that allows the topcoat to adhere much better than if used alone. It is intended to adhere to surfaces and form a binding layer that is better prepared to absorb the paint.
- Compared to paint, a primer is not intended to be used as the ultimate permanent coating, but can instead be engineered to have enhanced filling and bonding properties with the underlying material. Sometimes this is accomplished through chemistry, as in the case of the aluminum primer, but more commonly this is accomplished by controlling the physical properties of the primer such as porosity, tack, and hygroscopicity.
- In practice, when painting porous materials, including concrete and wood, a primer is often used. The use of a primer is considered mandatory if the material is not waterproof and will be exposed to the elements.
- The priming of plasterboard (drywall) is also common in new buildings, as it seals the wall against moisture and can prevent mold growth. Primers can also be used on soiled surfaces that cannot be cleaned or before painting light colors over a dark surface.
- Primers are also used to cover joints and seams to give a finished look.


**Fig. 3.9.** Primer

### 3.9.2. Benefits of Primer Paint –

- Oil-based primers are superior to temperature changes and provide a resilient surface that prevents paint layers from expanding or contracting due to temperature changes.
- Oil based primers are fine for high hand contact areas as they help control stains.
- Any porous wood surface can be sealed with oil based primers and these types of primers are used to prevent tannins from seeping through the paint product.
- Oil-based primer is suitable for untreated wood, formerly varnished wood and heavily weathered wood.

### 3.9.3. Disadvantages Of Primer Paint –

- Oil-based primers require a well-ventilated work area and protective kits during application as they produce significant VOCs (volatile organic compounds).
- The drying time is too long; They last about or longer than a full day.
- Cleaning oil-based primers is tough on painting tools.
- It is not common to use oil based primers directly on masonry. Raw wood, raw drywall, and patched surfaces, as well as rough or stained surfaces, are numerous ideal for this type of primer.

### 3.9.4 Cost of priming –

**Table 3.10.** Cost for Primer Paint

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | PRIMER PAINT | 320 | 210 | Sq.m. | 67,200 |

## 3.11. Prefabricated Lintels –

### 3.11.1. What Are Prefabricated Lintels–

- A lintel is a secondary structural element used to support a wall that spans an opening in a masonry wall.
- They are normally classified as elements of minor structural importance unless the span of the opening is very large.
- Lintels are usually horizontal structures with a rectangular cross-section and are often made of reinforced concrete or steel.
- Other materials such as stone, brick, reinforced brick and wood can also be used. Lintels are important in a building and the details can be included in the structural drawing in the form of a lintel plan to show the reinforcement specification based on the size of the openings.
- Such a schedule can help the surveyor record the cost of the falls in the bill of quantities.
- Prefabricated lintels are always practical for residential buildings and are mostly used by value engineers.
- Key benefits include cost and time savings for the project or contractors.

**Fig. 3.10.** Prefab Lintel

### 3.11.2. Advantages of Prefabricated Lintel –

- Significant savings in reinforcement are achieved by using offcuts from other elements
- It is more sustainable due to the reduced need for cement and aggregates
- The quality control in the production of the lintel is improved
- In addition, formwork costs are saved or reduced
- It reduces labor costs.
- It is relatively easy to construct
- Saves time on the build program as it can be created ahead of time and stored.

### 3.11.3. Disadvantages Of Precast Lintels –

- A lifting mechanism may be required to attach the lintel.
- The robustness of the wall/element is reduced
- The bond strength of wall and lintel is weaker compared to in-situ concrete.

### 3.11.4. Environmental Impact of Prefabricated Lintels –

- Long life, low maintenance materials require fewer replacements and maintenance over the life of the building.
- Reduces waste transportation and disposal costs. Fewer virgin materials are used when construction waste is recycled for another project.
- It also saves material.

### 3.11.5. Prefabricated lintel cost –

**Table 3.12.** Cost for Precast Lintel

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | PRECAST LINTELS | 10 | 500 | RM | 5,000 |

## 3.12. FRP Chajja –

### 3.12.1. What are FRP Chajja –

- With ever-increasing and rapid technological change in building construction, the concept of construction is rapidly changing from conventional labor-intensive advances to prefabricated and modular concepts in building construction that are less time-consuming and environmentally friendly, including better, resistance to frequent earthquakes.
- Conventional RCC chajjas are less durable, prone to cracking and difficult to maintain, which is why there is a need for durable and prefabricated chajjas that are easy and simple to install and maintain over a long period of use.
- FRP is a wonderful composite material and is well known for its very high strength, durability, resistance to high temperatures and extreme weather conditions, resistance to environmental corrosion and light weight, hence due to the above inherent properties, prefabricated chajjas of FRP are in a single piece the most preferred and suitable material for said application.
- Prefabricated FRP Chajja in a single piece are lightweight and can therefore be easily lifted and fixed at a suitable height on site with minimal preparation. The installation details below will further define the easy handling and installation of FRP Chajja on site.

**Fig. 3.11**. FRP Chajja

**3.12.2. Benefits of FRP Chajja –**

- FRP Chajja are light.
- FRP Chajja has high strength compared to Rcc Chajja.
- It has higher modulus of elasticity than RCC Chajja.
- It also has high resistance to fatigue failure.
- And has good corrosion resistance.

**3.12.3. Disadvantages of FRP Chajja –**

- The strength of FRP in a direction perpendicular to the fibers is extremely low (up to 5%) compared to the strength along the fiber length.
- The construction of GRP components is complex.
- The manufacture and testing of FRP components is highly specialized.

**3.12.4. Environmental sustainability of FRP Chajja –**

- Light weight – reduces transportation costs, less need for heavy lifting on site.
- Less dead weight Less construction material is required, reducing resource consumption.
- Long life - resists environmental degradation.
- Resistance – corrosion, rot, mildew, mildew, insects; reduces replacement costs and the use of toxic chemicals used in maintenance.
- Maximizes energy efficiency.
- Environmentally conscious choice of materials - LEED recognized.

### 3.11.5. Cost of FRP Chajja –

**Table 3.12.** Cost for FRP Chajja

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | FRP CHAJJA | 12 | 2,500 | Sq.m. | 30,000 |

## 3.13. Filler Slab–

### 3.13.1. What is Filler Slab –

- The infill panel is based on the principle that in simply supported roofs the upper part of the panel is subject to compressive forces and the lower part of the panel to tensile forces. Concrete withstands compressive forces very well and steel bears the stress of tensile forces.
- Thus, the lower tension area of the slab requires no concrete other than to hold the steel reinforcement together.
- Therefore, with a conventional RCC slab, a lot of concrete is wasted and additional reinforcement must be used due to the additional load on the concrete, which can otherwise be replaced by inexpensive and light-weight filling materials, which reduce both the dead weight and the cost of the slab 25% (due to the use of 40% less steel and 30% less concrete).
- Less loads are also transferred to the load-bearing walls and foundations due to the infill panels. The air gap between the tiles makes them a good heat insulator and the ceiling also looks attractive.
- The Mechanism The infill plate is a mechanism to replace the concrete in the tension zone. The filling material is thus not a structural part of the panel. By reducing the amount of material and weight, the roof becomes less expensive but retains the strength of the traditional panel.
- Thermal insulation The air pocket created by the contours of the tiles creates an excellent thermal insulation layer. The design integrity of a filler panel requires careful planning, taking into account negative zones and areas of reinforcement.

**Fig. 3.12.** filling plate

### 3.12.2. Benefits of the infill panel–

- Consumes less concrete and steel due to reduced slab weight through the introduction of a lighter, less expensive fill material such as two layers of fired clay bricks. Plate thickness at least 112.5 mm.
- Improves the thermal comfort inside the building due to the heat-resistant properties of the filling materials and the gap between two fired clay bricks.
- Approximately 23% cost savings with this panel compared to traditional panels.
- Reduces concrete consumption and saves about 40% cement and steel.

### 3.12.3. Disadvantages Of The Filling Slab –

- When using Mangalore tiles or coconut shells, I feel that plastering the ceiling can be a bit of a hassle. while soil pots can be uncovered for aesthetic reasons.

### 3.12.4. Filler Slab Cost –

**Table 3.13.** Cost for Filler Slab

| No | Description | Quantity | Rate | Unit | Amount (Rs) |
|---|---|---|---|---|---|
| 1 | FILLER SLAB M 20 | 24 | 5,953 | Cum | 1,42,872 |

## 3.2. Site Details:

**Table 3.14.** Construction site details

| | |
|---|---|
| Location | At Post Devgaon Rangari, Tal Kannard, Dist. Aurangabad |
| Total Build Up Area of Site | 2360 Sq ft |
| Site Supervisor | Pradeep Kadlag |

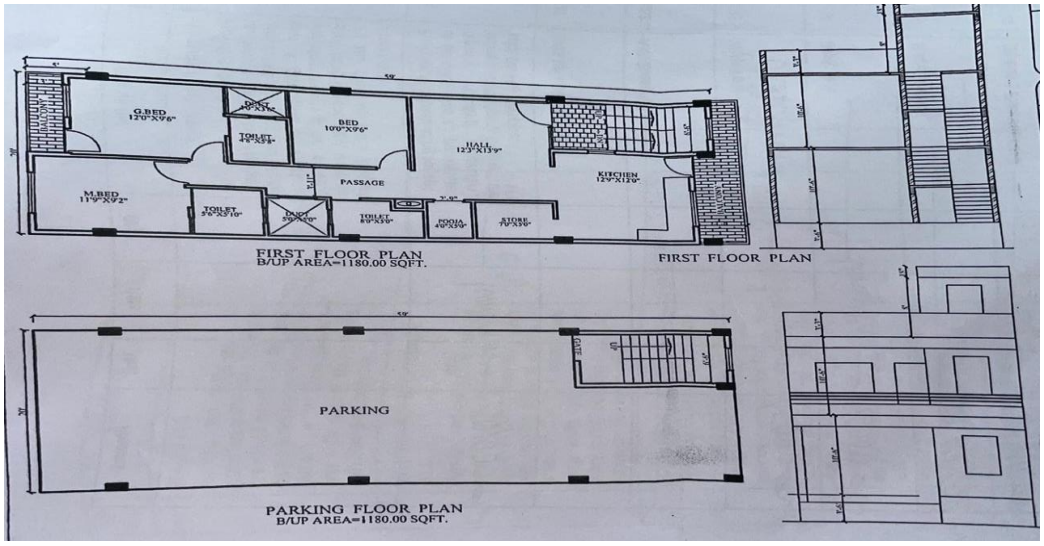


**Fig 3.13.** Site Layout Plan


**Fig 3.14.** Actual Site Photo

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Result

### 4.1.1 Filler Slab –

**Table 4.1.** Material Cost Comparison of Concrete Slab and Filler Slab

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Concrete slab | 24 | 8150 | Cum | 1400 | 2,29,200 |
| 2 | Filler slab | 24 | 5953 | Cum | 1500 | 1,78,872 |

- In a filler slab, part of concrete in the bottom of the slab (in the tension zone to be specific) is replaced by filler materials. Conventionally we have been using Mangalore tiles and clay pots as filler. Broken pieces of cement blocks, coconut shells and glass bottles are also sometimes used.
- Here we can see that cost is reduced because material cost for Filler slab is less than that concrete/ RCC slab.
- But for filler slab labour charge is more but then also we can reduce overall price if we will use filler slab instead of RCC/Concrete slab.
- Total price reduction by using filler slab can be 50,328.

### 4.1.2 Fly Ash Bricks –

**Table 4.2.** Material Cost Comparison of Clay Bricks and Fly ash Bricks

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Clay Bricks in superstructure | 30 | 6090 | Cum | 250 | 1,90,200 |
| 2 | Fly ash Bricks in superstructure | 30 | 2100 | Cum | 250 | 70,500 |
| 3 | Clay Bricks in | 10 | 6090 | Cum | 250 | 63,460 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | foundation and plinth | | | | | |
| 4 | Fly ash Bricks in foundation and plinth | 10 | 2100 | Cum | 250 | 23,500 |

- Material cost for fly ash bricks is half the price of clay bricks.
- Here we can see that cost is reduced because material cost for Fly ash bricks is less than that Clay Bricks.
- Also, labour cost is same for Clay Bricks and Fly ash Bricks so cost can be reduced in the material.
- Total price reduction by using Fly Ash Bricks can be 1,59,660.

**4.1.3 UPVC Door –**

**Table 4.3.** Material Cost Comparison of Wooden door and UPVC Door

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Wooden door | 16 | 6970 | Sq.m. | 1150 | 1,29,920 |
| 2 | uPVC Door | 16 | 3880 | Sq.m. | 970 | 77,600 |

- Wooden material is very expensive as compared to other materials.
- Here we can see that cost is reduced because material cost and the labour cost for UPVC Door is less than that Wooden Door.
- Total price reduction by using filler slab can be 52,320.

**4.1.4 UPVC Door Frame –**

**Table 4.4.** Material Cost Comparison of Wooden door frame and UPVC Door frame

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Granite door frame | 15 | 2000 | Sq.m. | 800 | 42,000 |
| 2 | uPVC Door frame | 15 | 1610 | Sq.m. | 690 | 34,500 |

- Here we can see that cost is reduced because material cost and the labour cost for UPVC Door frame is less than that Wooden Door frame.
- Total price reduction by using UPVC Door Frames can be 7,500.

**4.1.5 Precast Concrete Windows –**

**Table 4.5.** Material Cost Comparison of Aluminum window and Precast concrete window

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Aluminum window | 12 | 3600 | Sq.m. | 600 | 50,400 |
| 2 | Precast concrete window | 12 | 1070 | Sq.m. | 500 | 18,840 |

- Precast concrete windows are very cheap because they are already casted and just fitted on site so, labour cost also time is saved.
- Here we can see that too much cost is reduced because material cost and for labour cost for Precast Window Frames is less than that Aluminum window.
- Total price reduction by using Aluminum window can be 31,160.**4**

### 4.1.6 SS & Glass Railing –

**Table 4.6**. Material Cost Comparison of MS stair railing and SS & glass railing

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | MS stair railing | 20 | 2500 | Sq.m. | 700 | 64,000 |
| 2 | SS & glass railing | 20 | 1350 | Sq.m. | 800 | 43,000 |

- SS & Glass Railing are very easy to maintain, and it gives pleasant look to structure and material is also ecofriendly.
- Here we can see that cost is reduced because material cost and for labour cost for SS & Glass Railing is less than that MS railing.
- Total price reduction by using SS & Glass Railing can be 21,000.

### 4.1.7 White Gypsum Plaster –

**Table 4.7**. Material Cost Comparison of Normal Internal plaster and White gypsum plaster

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Normal Internal plaster | 550 | 257 | Sq.m. | 155 | 2,26,600 |
| 2 | White gypsum plaster | 550 | 240 | Sq.m. | 160 | 2,20,000 |
| 3 | Sand face plaster | 430 | 590 | Sq.m. | 155 | 3, 24,350 |
| 4 | White gypsum plaster | 430 | 310 | Sq.m. | 160 | 2,02,100 |

- Gypsum is very cheap and when it is finish it gives very good finish and it is ideal for painting work and wallpaper finish.
- In this material cost is reduced but labour cost is quite more but allover cost can be reduced.
- Total price reduction by using White gypsum plaster can be 1,22,250.

**4.1.8 FRP Chajja –**

**Table 4.8.** Material Cost Comparison of RCC chajja and FRP chajja

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | RCC chajja | 12 | 4900 | Sq.m. | 1100 | 72,000 |
| 2 | FRP chajja | 12 | 2500 | Sq.m. | 190 | 32,280 |

- FRP is very lightweight material, and its fitting is very easy.
- By using this material cost can be reduced in material as well as in the labour cost too.
- So, total cost reduced by using FRP Chajja is 39,720.

**4.1.9 Ceramic Flooring –**

**Table 4.9.** Material Cost Comparison of Vitrified florring and Ceramic flooring

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Vitrified florring | 180 | 1100 | Sq.m. | 250 | 2,43,000 |
| 2 | Ceramic flooring | 180 | 500 | Sq.m. | 250 | 1,35,000 |

- Ceramic tiles can be used as they are lightweight, easy to install, it also has high tensile strength.
- Its cost is reduced in the material only the labour cost is same for vitrified tiles and ceramic tiles.
- So total cost reduced by using ceramic tiles is 1,08,000**.**

**4.1.10 Precast Lintels –**

**Table 4.10**. Material Cost Comparison of RCC Lintels and Precast lintels

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | RCC Lintels | 10 | 1100 | Sq.m. | 800 | 19,000 |
| 2 | Precast lintels | 10 | 500 | Sq.m. | 180 | 6,800 |

- These precast lintels are already casted so that they can be placed and fitted don site which saves money and time on the site.
- By using these Precast lintels saves the cost in the material as well as labour cost is saved.
- So, total cost saved by using Precast lintels is 12,200.

**4.1.11 PVC Wall Panels –**

**Table 4.11.** Material Cost Comparison of Glazed Tiles and PVC wall panels

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Glazed Tiles | 20 | 900 | Sq.m. | 600 | 30,000 |
| 2 | PVC wall panels | 20 | 600 | Sq.m. | 500 | 22,000 |

- PVC wall panels can be very used as they are moisture resistant and they don't rust when used on exterior of building, they also have good temperature resisting property so using them will be more beneficial than that of glazed tiles.

- As PVC wall panels are cheap material then glazed tiles and low labour cost is required when compared with glazed tiles.
- So, cost reduction after using PVC Wall panels will be 8,000.

**4.1.12 Bamboo Reinforcement –**

**Table 4.12.** Material Cost Comparison of Steel Reinforcement and Bamboo reinforcement

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Steel Reinforcement | 4.5 | 57,000 | Sq.m. | 600 | 2,57,850 |
| 2 | Bamboo reinforcement | 4.5 | 27,000 | Sq.m. | 700 | 1,22,850 |

- As we know that Bamboo is very cheap and easily available material in India. It has good tensile property so it can be greatly used as a reinforcement instead of steel reinforcement.
- So, bamboo cuts the cost in material but its fixing as a reinforcement is not easy and special mason is required so its labour cost is high. But then also using bamboo is beneficial on site.
- Using bamboo as reinforcement saves 1,35,270.

**4.1.11 Primer Paint –**

**Table 4.13.** Material Cost Comparison of Plastic emulsion paint and Primer paint

| No | Material | Quantity | Rate | Unit | Labour rate | Amount |
|---|---|---|---|---|---|---|
| 1 | Plastic emulsion paint | 320 | 313 | Sq.m. | 250 | 1,80,160 |
| 2 | Primer paint | 320 | 210 | Sq.m. | 200 | 1,31,200 |

- Primer is the base coat used on every type of paint. But this primer has very good binding property as that of other emulsion paint on plastered wall.it is also used on porous material like concrete and wood.
- Primer has low cost as compared to very expensive emulsion paints and its labour painting cost is also low as compared with emulsion paint.
- So, total cost saved by using primer is 48,960.

**4.1.12 Original Cost Estimate of Site –**

**Table 4.14.** Original Cost Estimate of Site

| No | Description | Quantity | Rate | Unit | Labour Rates | Amount (Rs) |
|---|---|---|---|---|---|---|
| 1 | EXCAVATION | 70 | 175 | Cum | 105 | 19,600 |
| 2 | RUBBLE SOILING | 40 | 516 | Cum | 395 | 36,440 |
| 3 | P.C.C. | 18 | 3,181 | Cum | 325 | 63,108 |
| 4 | PLINTH FILLING | 60 | 446 | Cum | 116 | 23,460 |
| 5 | FOOTING M 20 | 12 | 4,907 | Cum | 1300 | 74,484 |
| 6 | COLUMN M 20 | 10 | 7,850 | Cum | 1700 | 95,500 |
| 7 | BEAMS M 20 | 32 | 7,950 | Cum | 1700 | 2,64,800 |
| 8 | SLAB M 20 | 24 | 7,880 | Cum | 1400 | 2,22,720 |
| 9 | PARDHI M 20 | 3 | 9,500 | Cum | 1300 | 32,400 |
| 10 | BRICK MASONRY IN FOUNDATION & PLINTH | 10 | 6,090 | Cum | 250 | 85,900 |
| 11 | BRICK MASONARAY THICK IN SUPERSTRUCTURE | 30 | 6,090 | Cum | 250 | 1,90,200 |
| 12 | M.S. GATE | 4 | 2,500 | Sq.m. | 500 | 12,000 |
| 13 | WOODEN DOOR | 16 | 6,970 | Sq.m. | 1150 | 1,29,520 |
| 14 | WOODEN DOOR FRAME | 15 | 2,000 | Sq.m. | 800 | 42,000 |
| 15 | RCC CHAJJA | 12 | 4,900 | Cum | 1,100 | 72,000 |
| 16 | ALUMINIUM WINDOWS | 12 | 3,600 | Sq.m. | 600 | 50,400 |
| | M.S GRILL | 12 | 2,200 | Sq.m. | 300 | 30,000 |
| 17 | MS STAIR RALING | 20 | 2,500 | Sq.m. | 700 | 64,000 |
| 18 | INTERNAL PLASTER TO WALL | 550 | 257 | Sq.m. | 155 | 2,26,600 |
| 19 | SAND FACE PLASTER | 430 | 590 | Sq.m. | 155 | 3,20,350 |
| 20 | VERTIFIED FLOORING | 180 | 1,100 | Sq.m. | 250 | 2,43,000 |
| 21 | LINTELS | 10 | 4000 | Rm | 1300 | 53,000 |
| 21 | TREADES & RISERS | 25 | 1,800 | Sq.m. | 524 | 58,100 |
| 22 | GALZED TILES | 20 | 900 | Sq.m. | 600 | 19,200 |
| 23 | MAKRANA MARBLE | 20 | 1,800 | Sq.m. | 307 | 42,140 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | WINDOWSILL | | | | | |
| 24 | STEEL REINFORCEMENT | 4.5 | 55,000 | M.T | 600 | 2,50,200 |
| 25 | PLASTIC EMULSION PAINT | 320 | 300 | Sq.m. | 250 | 1,76,000 |
| 26 | WATER TANK | LUMPSUM | | | | 45,000 |
| 27 | SEPTIC TANK | LUMPSUM | | | | 25,000 |
| 28 | SANITARY & ELECTRIFICATION | LUMPSUM | | | | 61,910 |
| 29 | TOTAL COST | | 30,28,932 Rs | | | |

### 4.1.13 Cost Estimate After Applying Low-Cost Material with Labour Rates –

**Table 4.15.** Cost Estimate After Applying Low-Cost Material with Labour Rates

| No | Description | Quantity | Rate | Unit | Labour Rates | Amount (Rs) |
|---|---|---|---|---|---|---|
| 1 | EXCAVATION | 70 | 175 | Cum | 105 | 19,600 |
| 2 | RUBBLE SOILING | 40 | 1,100 | Cum | 395 | 36,440 |
| 3 | P.C.C. | 18 | 3,181 | Cum | 325 | 63,108 |
| 4 | PLINTH FILLING | 60 | 446 | Cum | 116 | 23,460 |
| 5 | FOOTING M 20 | 12 | 4,907 | Cum | 1300 | 74,484 |
| 6 | COLUMN M 20 | 10 | 7,850 | Cum | 1700 | 95,500 |
| 7 | BEAM M 20 | 32 | 7,950 | Cum | 1700 | 2,64,800 |
| 8 | FILLER SLAB M 20 | 24 | 5,953 | Cum | 1,500 | 1,78,872 |
| 9 | PARDHI M 20 | 3 | 9,500 | Cum | 1300 | 32,400 |
| 10 | FLY ASH BRICK MASONRY IN FOUNDATION & PLINTH | 10 | 2,000 | Cum | 250 | 23,500 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11 | FLY ASH BRICK MASONARAY 150mm THICK IN SUPERSTRUCTURE | 30 | 2,000 | Cum | 250 | 70,500 |
| 12 | M.S. GATE | 4 | 2,500 | Sq.m. | 500 | 12,000 |
| 13 | uPVC DOOR | 16 | 3,880 | Sq.m. | 970 | 77,600 |
| 14 | UPVC DOOR FRAMES | 15 | 1,610 | Sq.m. | 690 | 34,500 |
| 15 | FRP CHAJJA | 12 | 2,500 | Sq.m. | 190 | 32,280 |
| 16 | ALUMINIUM WINDOWS AND M.S GRILL | 12 | 1,070 | Sq.m. | 500 | 18,840 |
| 17 | SS & GlASS RAILING | 20 | 1,350 | Sq.m. | 800 | 43,000 |
| 18 | WHITE GYPSUM INTERNAL PLATER TO WALL | 550 | 220 | Sq.m. | 160 | 2,20,000 |
| 19 | WHITE GYPSUM EXTERNAL PLATER TO WALL | 430 | 280 | Sq.m. | 160 | 2,02,100 |
| 20 | CERAMIC FLOORING | 180 | 500 | Sq.m. | 250 | 1,35,000 |
| 21 | PRECAST LINTELS | 10 | 250 | RM | 180 | 6,800 |
| 22 | TREADES & RISERS | 25 | 1,800 | Sq.m. | 524 | 58,100 |
| 23 | PVC WALL PANELS | 20 | 600 | Sq.m. | 500 | 22,000 |
| 24 | BAMBOO REINFORCEMENT | 4.5 | 27,500 | M.T | 700 | 1,22,850 |
| 25 | PRIMER PAINT | 320 | 200 | Sq.m. | 250 | 1,80,160 |
| 26 | WATER TANK | LUMPSUM | | | | 45,000 |
| 27 | SEPTIC TANK | LUMPSUM | | | | 25,000 |
| 28 | SANITARY & ELECTRIFICATION | LUMPSUM (3%) | | | | 61,910 |
| 29 | TOTAL COST | | 21,58,804 Rs | | | |

## 4.2 Discussion

- Total cost of the project = 30,28,932 Rs
- By using above-mentioned Low-cost Materials, we can complete the same project in = 21,58,804 Rs
- And Total Cost saved after applying Low-cost Material = 8,70,128 Rs
- Therefore, Total % Cost saving in project by using above-mentioned low-cost materials = 28.72 % ~ 29 %.

# CHAPTER 5

# CONCLUSION

## 5. Conclusion:

- The dream of owning house particularly for low income and middle-income families is becoming a difficult reality.
- It is necessary to adopt cost effective, innovative and environment friendly housing technologies for construction.
- This study examined the cost effectiveness of using low-cost housing technologies in comparison with traditional construction materials used.
- The materials identified as low-cost material proves to be very beneficial for the project as we can see that they save a lot of cost of project.
- Also, these materials are ecofriendly so it can also reduce today's increase problems such as pollution, excessive waste of construction material, depletion of natural resources, etc.
- From the study we can observe that totally 29 % of cost reduction can be done just by using these low-cost materials without reducing any strength of structure and without damaging environment.
- This proves the benefit and trends of implementing low-cost housing technology.

# CHAPTER 6

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