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Study of affordable building materials and building methods for India's warm and humid climate

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Abstract. People's increasing awareness of materials, architecture, and aesthetic trends is a good sign for a better future in the field of architecture and developing city conditions and living standards, but everyone wants to build their house in an affordable and innovative way, but due to a lack of awareness and a limited budget, people avoid going for better construction practices, which designers and engineers provide. As a result, many are opting for unethical practices and unauthorized contractors for their low-budget buildings. This is a serious concern currently since individuals are engaging in incorrect practices, poor working quality, and insufficient understanding, all of which are diminishing the Ifespan and quality of building forms, materials, and architectural Construction.

Keywords— Low-cost housing technology, construction materials, and cost-effectiveness, Climate: humid and warm.

INTRODUCTION

This topic aims to showcase the various materials and construction techniques used for reasonably priced buildings. The three essential necessities of a human in the modern world are food, clothes, and shelter. A home is what folks with limited resources want to create. Construction costs are high because of high personnel prices and material costs. A poor man must spend all his life's money on building a house. Building techniques and materials with a low cost are in demand. Low-cost construction doesn't have to imply sacrificing strength or utilizing useless materials; instead, it involves effectively using dependable, low-maintenance local resources and techniques. Inexpensive resources are used in alternative approaches to reduce expenses. The need for affordable housing developments is quite strong, largely as a result of urbanization. By constructing new buildings and enhancing existing ones, the choice of construction materials should take into account the requirements of the local area in order to raise the value of Be for the most wanted ones. New approaches to successfully support human settlements and take into account energy and environmental issues are being advanced by sustainability in buildings. A sustainable housing project must strike a balance between technical and concerns pertaining to the economy, society, and the environment. According to a study, engineering, and building materials for a low-income housing project might account for up to 60% of the entire cost.

LITERATURE REVIEW

The articles that are discussed here discuss different inexpensive building materials and construction methods that are both efficient and effective. Additionally, they discuss the environment, its features, and the materials that are appropriate for this sort of climate.

ALTERNATIVE LOW-COST CONSTRUCTION MATERIALS & TECHNIQUES :

The study focuses on a low-cost home that is designed and constructed using Rat Trap Bond and Filler Slab to achieve the same foundation, structure, and strength as other homes. Savings are made possible by using building techniques and materials that are readily available locally, are long-lasting, inexpensive, and need little upkeep.

a lot of research was done throughout this age to examine and classify methodical these structures, in the meantime a lot of companies or even Iranians contain cooperate in the direction of staying mainly of them as widespread seats, other than the piece of evidence is, have this creative money demonstrate the riches of dialect structural design plus wants the preceding become aware of learn of these arrangements, inspire a number of informative skill and educational principles in which the Indian exceed In this village, the vernacular architecture is mainly show their cultural values and design climatic oriented design influenced in their buildings.

INFERENCE

The lack of affordable housing for urban poor people is a key concept, and alternative building methods like Rat trap Bonds and Filler slabs are suggested. It describes the purpose, use, and benefits of the technology before outlining how cost-effective bath technologies are by providing an approximation of the proportion of material and cost savings.

AN OVERVIEW: LOW-COST HOUSE MATERIALS AND TECHNIQUES :

This research aims to highlight the various materials and construction methods used in affordable homes. In order to build a low-cost, ecologically friendly home, this research examines the use of a mixture of cow dung, straw dust, and sand, among other elements, in addition to concrete and mortar. The study examines actual housing cases and highlights the construction methodology as well as a variety of creative techniques used to make the structure affordable and environmentally friendly. To promote sustainable growth and accomplish prosperous economic construction in the future, more waste materials must be used for green building construction.

INFERENCE :

The importance and need of consuming various waste products is becoming increasingly clear. Low-cost building materials and other production methods would set an example for future construction methods. In addition to concrete and mortar, additional materials are utilized in the building, such as cow manure, straw dust, and sand. Additionally, technologies including stone blocks, filler slabs, solid

concrete, and rat trap bands are being researched.

USE OF VARIOUS CONSTRUCTION TECHNIQUES AND MATERIALS TO BUILD A COST-EFFECTIVE HOUSE SUMMARY:

The economic efficiency of low-cost housing technologies and conventional construction techniques was examined in this article. There were two case studies done in India. When compared to traditional construction techniques for walling and roofing, it was shown that applying low-cost housing technologies might reduce building expenses by around 26 11%, and 22 68%, respectively.

INFERENCE :

Knowing how implementing low-cost housing technology compares in terms of cost-effectiveness to conventional building techniques Construction methods such as Rat-trap Bond Technology, Filler Slab Technology, and Aluform Technology are described.

UTILIZATION OF RECYCLED AND WASTE MATERIALS IN VARIOUS CONSTRUCTION APPLICATIONS SUMMARY:

A review of various research concluded that the usage of recycled materials had a positive influence in a variety of ways This includes the advantages of improving the sustainability of the building sector while lowering costs, addressing environmental degradation, and minimizing the demand for natural resources. A questionnaire survey was used in this study to learn about existing practices in the building industry for utilizing waste and repurposed materials. Several firms, according to the data, were ignorant of the availability. The performance quality of the materials, cost savings, or any other benefits

INFERENCE :

This study offers an early evaluation of the practice's strengths and weaknesses in order to help the building sector develop the right regulations controlling the use of waste and recyclable materials as building materials. The use of swine manure, animal fat, silica fume, roofing shingles, empty palm fruit bunches, citrus peels, cement kiln dust, fly ash, foundry sand, slag, glass, plastic, carpet, tire scraps, asphalt paver, and concrete aggregate is growing in popularity in construction due to the lack of and rising cost of raw materials.

SUSTAINABLE BUILDING DESIGN FOR AFFORDABLE HOUSING IN WARM-HUMID CLIMATE REGION OF INDIA SUMMARY:

Long-term growth is substantially influenced by sustainable construction techniques. Evaluation of a building's environmental impact and energy efficiency is a need for sustainable design or green architecture. The cost, technology, and materials used all have an effect on a structure's sustainability. These structures are designed to increase user productivity while also making better use of energy, water, and other resources.

INFERENCE :

Utilizing passive strategies increases the utilization of renewable energy, which lowers the price of the building. Building orientation, window size and placement, shading devices, architectural form and shape, settlement pattern, and the efficient use of locally accessible materials are all examples of passive design tactics. They are also used in warm, humid areas.

CLIMATE

WARM AND HUMID CLIMATE :

A humid environment is when the heat from the sun is enough to evaporate all moisture falling as precipitation. This climate may be found in an area that reaches 15 degrees north and south of the equator. There is hardly any seasonal fluctuation during the entire year. There are six different climatic zones in India. Warm, humid places have consistently high temperatures, a lot of rain, and a lot of humidity. Winter temperatures range from 20-25 degrees (night) to 25-30 degrees (day) in the winter and 30-35 degrees (day) to 25-30 degrees (night) in the summer. Due to the close proximity to the coast, there are extremely high humidity levels between 75% and 90 %. Every year, the region gets more than 1200mm of rain.

CHARACTERISTICS :

Wintertime temperatures range from 20 to 25 degrees at night to 25 to 30 degrees during the day. Due to the area's closeness to the coast, humidity levels are quite high, ranging from 75% to 90%. Every year, the region gets more than 1200mm of rain. This area encompasses highland areas in the northeast and coastal areas in southern India.

Major cities like Goa and Mumbai get this environment on a regular basis. Visakhapatnam. Chennai and Kolkata.

DESIGN OBJECTIVES :

Reducing internal air temperature, protecting the structure from sunlight by maximizing shade, and preventing heat absorption. airflow is used to produce natural ventilation. the shrinking portion of the building's outside surface. By employing materials that take longer to heat and by creating gaps that act as a barrier between the outside and the inside. using heat-reflective materials to increase the building's overall shadow.Promoting Heat Loss Through Proper Daytime Ventilation, Proper Building Ventilation, and Minimizing Humidity Levels.

MATERIALS

PARAMETERS FOR MATERIAL SELECTION:

Pre-construction, construction, and post-construction phases make up the structure's present pattern. The structure should be constructed with energy conservation in mind at every stage. These three stages demonstrate how building materials change as a structure progresses. The majority of the pre-building process is assembly, which is broken down into preparation, pressing, and transportation. The structural stage primarily comprises development, maintenance, and elimination activities.

MATERIAL SELECTION CRITERIA :

- Recycled
- Locally accessible
- Low in embodied energy
- Recyclable
- Material selection criteria
- Biodegradable
- Prevents pollution
- Uses less energy
- Savaged
- Nontoxic

ENVIRONMENT FRIENDLY :

Building component assembly needs to take place in a comfortable setting. The methods for providing high-quality assembly, efficient structural materials, and reducing manufacturing waste should be looked into and improved.

LOCALLY AVAILABLE BUILDING MATERIALS :

Masons can utilize recyclable waste, and the construction of compressed wood or delicate sheets can use wooden waste.
Utilizing local resources lessens reliance on transportation, whose price for structural materials over long distances is significant. Utilizing readily accessible local resources for building lowers development costs while also being ecologically appropriate.

NON–TOXIC BUILDING MATERIALS :

The development of people and tenants of the building may be significantly impacted by the usage of hazardous structural materials. The use of non-toxic building materials is therefore appropriate for development. A few synthetic materials are readily available, such as ammonia, pitch resin chemicals for protection, and plyboards for decoration and construction. Before choosing them, it is important to take into account how strong they are; they should only be utilized under the most direct circumstances.
Longevity, toughness, and upkeep Strong development materials not only increase the project's lifespan but also reduce the cost of support. Lower maintenance costs often result in considerable operational cost savings for the building industry. The durability of the structure is determined by the building materials.

BIODEGRADABILITY:

The substance has to be capable of dissolving naturally when discarded. Natural or everyday materials would degrade quickly. It is also crucial to take into account if a material spontaneously degrades or releases toxic gases.

CLASSIFICATION OF ALTERNATIVE BUILDING MATERIALS :

Numerous alternative technologies and materials created by various research organizations, inventors, and manufacturers in India are useful in the construction of homes in addition to conventionally used materials. Information acquired for this study is presented in the parts that follow. There are affordable building supplies accessible. Building materials are broadly divided into natural and artificial materials, depending on the source of the resources.
Flexible connections and access to each area are made possible by the architectural form. Over time, unconventional sources provided the majority of the building supplies. All of the stone or tile pieces he collected, including fish tiles from a castle, dormers, roofing timber from a collapsed home, and wood from a jetty, go well together.

NATURAL MATERIALS :

MUD PLASTER :

By employing non-erodible mud plaster, the central building research institute in India has developed an effective low-cost way of preserving mud walls. Bitumen cutback, which is formed of bitumen and kerosene oil, is combined with a certain mud plaster to create non-erodible mud. Mud-plastered walls are not eroded by water.

STRAW :

After the grain and chaff have been removed, straw is essentially an agricultural leftover made up only of plant stalks (mostly grains). The hardest cereal straw is made of rice because it contains the most silica. Because of the pulmonary problems caused by its burning, straw is seen as an environmental problem. Straw thus offers a lot of potential as a substitute for traditional building materials. It is also non-toxic, thermally insulated, sound and moisture-insulated, and fire-resistant because it doesn't encourage combustion.

COW DUNG :

Cow excrement is used to make ash, which is then burned after being sun-dried and turning a dark color. Cow dung is utilized as an inexpensive thermal insulator to coat the walls of simple homes in many poor nations. The dried and caked excrement of cows is used as fuel. Additionally, manure may be gathered and used to create biogas, which can be used to provide electricity and heat. Depending on the available resources, cow dung may also be an optional component in the creation of adobe mud-brick structures. Cow dung that has been caked and dried is used as fuel in many developing nations. Additionally, excrement may be collected and used to create biogas.

MAN-MADE MATERIALS :

HOLLOW CONCRETE BLOCKS :

Because of their low cost, these blocks are frequently used in buildings and have high thermal insulation, fire resistance, and load-bearing capability. They are also affordable, environmentally benign, and minimal maintenance. It reduces the need for cement in masonry work, thereby lowering building costs. building walls. They are portable and have great ventilation. Electrical conduits, water pipes, and soil pipes may all be concealed by using hollow block construction.

FERROW CEMENT :

It is thinner in the section and contains less embodied energy and steel. It is constructed of cement mortar and wire mesh reinforcement, making it robust, long-lasting, and economical. utilized to build hollow columns, walls, and beams as well as to restore degraded buildings.

FLY ASH BRICKS :

In fact, it makes the concrete stronger, more segregated, and easier to pump. It is a more affordable alternative to Portland cement, which is used in concrete. Additionally, fly ash is a component of pavement, brick, block, and structural infill. 3. burned clay fly ash bricks. 1. fly ash lime bricks. 2. fly ash sand lime bricks.

AEROCON PANELS :

Materials that have been bonded to form sandwich panels. For earthquake- or cyclone-prone areas, two fiber cement sheets enclose a portland. moveable, with thin (space-saving) walls, a smooth surface, and with no foundation or ground preparation.Lightweight, thermally insulated, resistant to fire, sound, termites, and the elements, with simple workability, and a cement mixture including silica fibers and micaceous particles. It produces no VOCs or other dangerous fumes and has a smooth finish. Calcium silicate plaster is made from the calcium silicate that naturally occurs in wollastonite.Clay plaster that has been strengthened with fibers (such as polypropylene) improves its adhering properties. Brittles are less common.

COST-EFFECTIVE TECHNOLOGIES:

The foundation, or substructure, and the superstructure make up every home. Four parts make up the superstructure: walling, roofing/flooring, finishing, and doors and windows. Sections on various housing ideas are included in our collection. We are fusing conventional, common, and unconventional systems. The other approaches presented here are not only economical but also eco-friendly, energy-efficient, and in tune with nature. Additionally, they support the development of medium-sized to small firms that depend on locally accessible resources.

COST-EFFECTIVE TECHNOLOGIES FOR THE COMMON MAN

Every home consists of two components. the superstructure and the base, or substructure The four parts of the superstructure are walling, roofing/flooring finishing, doors, and windows. Sections and various housing ideas are included in our collection. We are fusing conventional, common, and unconventional systems. The alternative options shown here are not only economical but also eco-friendly, energy-efficient, and in tune with nature. They also help build small to medium-sized firms that depend on locally sourced resources.

ARCH FOUNDATION:

When the spread foundation was abandoned in favor of an inverted arch, this foundation was used. It can save construction expenses by up to 40%. This has the advantage of allowing the foundation's depth to be significantly reduced in soft soils, but it also has the drawback of requiring careful buttressing of the end piers to prevent the push-to-arch action from weakening the connection between the piers.

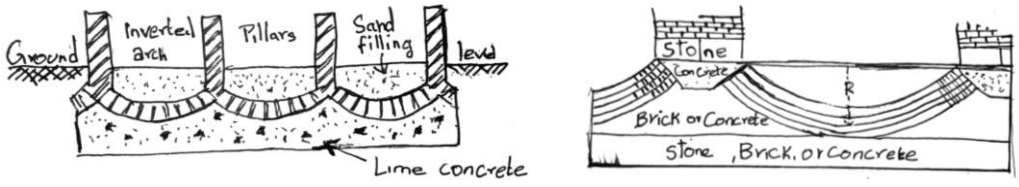

Fig.1. Arch foundation

PLINTH:

The plinth should be 1 foot above ground level and constructed using a 1:6 cement mortar, according to recommendations. To save money, the standard plinth slab of 4 to 6 inches can be removed and replaced with brick on edge. By utilizing this method, the price of the plinth foundation may be reduced by 35 to 50%.

BRICK WORK:

In a 1:6 cement mortar, bricks composed of black cotton and deficient soil stabilised with fly ash were employed. In a cement lime mortar/1:1.5:3 cement sand mortar ratio of 1:2:12, construct brickwork with rat-trap bonds. Hollow concrete blocks and cement mortar are used to create masonry. Bricks of compressed mud set in mud mortar make up brickwork. Stabilised mud bricks set in a mortar with 4% cement or lime walls made of sand-lime bricks and mortared with 1:6 cement. Sand block fusion with 1:6 cement mortar The bond refers to the way that bricks overlap when being laid. The rat-trap is built by placing bricks on their sides with a hollow of 4 (100 mm) and alternate courses of stretchers and headers. The headers and stretchers are spaced apart on successive levels to strengthen the walls.
One of man's greatest inventions is the common burned brick. • In many of the instances stated above, a "jali" is just as effective because almost all bricks, with a few exceptions, are essentially the same form and size, which is around 9 x 4.5 x 3 inches.

RAT TRAP BONDING :

This approach reduces the total expenditure of a standard 9-inch-built structure by about 25%. The construction has proven to be sturdy enough to support three stories with the aid of brick columns. Given that a typical English bond (9" thick wall) takes 350 bricks per cubic metre, the rat-trap bond only needs 280 bricks, and the fewer joints mean less mortar is used, this method lowers the cost of the wall by 25%.
Because it is a cavity wall construction, fewer bricks are needed for the masonry work.
Comparing this method of bonding brick masonry to standard English or Flemish bond masonry allows for a 25% reduction in brick material costs and a 10% to 15% reduction in overall construction costs.

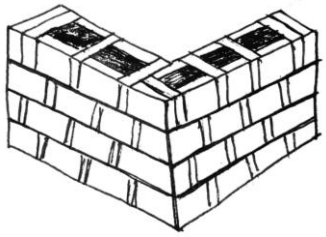

Fig.2. Rat trap bonding

CONCRETE BLOCK WALLING:

It is suggested that concrete blocks (both hollow and solid), which consume around one-third the energy of burnt brick in their manufacture, be used instead due to the excessive energy consumption of burnt brick. Concrete block masonry saves 10 to 25% overall by using less mortar, constructing walls more quickly, increasing worker productivity, and doing away with the requirement for plastering.

DOMES AND VAULTS :

Employing appropriate mortar in brick or a stabilised mud block-enhanced thatch roof on the appropriate building. Precast RCC "l" panel M15 precast concrete RC-cored units M15 precast concrete RC channel units concrete waffle units made of precast M15. Burned clay tube roofing in a vault form.
A funicular made of bricks with beams By brick jack arches, RC joists are supported. Concrete precast RCC channel units and cored units both measure 15 metres. It is feasible to reduce costs by 15% to 25%. However, a structural engineer must determine the distance between the reinforcing bars in a filler slab. Insulation from heat, the air pocket that the tile shapes generate acts as a highly effective thermal insulation layer. Careful planning that takes into account the negative zones and reinforcing areas is necessary for a filler slab's design integrity.
Systemic open prefab Housing specialists have identified this as a vital answer for slowing the rapidly increasing escalation in material and labour costs based on an acceptable output level and tiny, manageable components with rationalised manufacturing procedures. Building centres in various regions of India have been crucial to the widespread adoption of a number of these prefabricated solutions. A structure's foundation, walling systems, doors and windows, roofing systems, lintels, and staircase components can all be partially prefabricated. The prefabrication of roofing components has received attention because it is one of the major factors affecting the construction costs of any building project.

GFRG PANEL BUILDING SYSTEM :

In India, where there is a critical need for cost-effective building technologies, GFRG is particularly significant. The item is both fire-resistant and environmentally friendly. Gfrg panel systems are also known as fast wall and gypcrete. Used equally in buildings with and

without load bearings. Possessing modular chambers suitable for both interior and exterior. RCC can also be used to build floor and roof slabs. A 50% reduction in dead load, an increase in carpet area, a 15%–20% decrease in building expenses, resistance to corrosion and termites, material savings, and a decrease in CO2 emissions are a few benefits. Only 10 stories may be built in low seismic zones, which is a drawback.

SOIL CEMENT BLOCK TECHNOLOGY:

This tactic reduces building costs by about 25% compared to "the typical 9" construction method. The use of brick columns has demonstrated that the structure is strong enough to hold three floors.

CASESTUDY:1

CASESTUDY BASED ON VERNACULAR MATERIALS AND TECHNIQUES-HAMLET (BY LAURIE BAKER)TRIVANDRUM.

Through case studies of successful projects completed by well-known architects and cutting-edge construction methods in big cities, analysis is done to find solutions to the cost-effective difficulties. The materials and methods used to make the building economical and accessible to the lower-income population have been highlighted in these case studies. Both case studies were conducted in the area in accordance with the local environment (warm and humid).

The materials and methods that should satisfy the criteria for the selection of building materials for affordable construction are among the criteria used to choose the case study. Reduced energy use and pollution prevention. Locally produced, non-toxic, long-lasting, and easy-to-maintain building materials

Case study based on vernacular materials and techniques (by Laurie Baker)

Trivandrum

The Hamlet, the Baker's home in Thiruvananthapuram, perfectly captures the essence of the Baker. When development began, there was practically no vegetation on a sharply sloping, stony mountainside with limited access to water. In order to make low-cost living a habit and a way of life, Baker has adopted the goal of repurposing practically everything, from masonry to glass bottles, as building materials.

THE HISTORY OF THE HAMLET:

Baker started the building of the hamlet in a single room made of wood and thatch, similar to a log hut, which included his study and a collection of clinical or medical texts. Later, longer-lasting and more substantial constructions, like the kitchen, were constructed using standard, conventional brick and tiles. Over time, the need for separated living and working increased, necessitating an extension along the roofline; however, the inside was decided by the site's contour. The commute to Baker's house evokes everything from the freshness and shade of suburbia to the concrete jungle of Thiruvananthapuram. For more than ten years, the baker and his family resided in this home. Strangely, throughout all of those years, the family only ate in the kitchen. In fact, the villa's electrical wires were exposed. Whenever his provisions came to Trivandrum (presently Thiruvananthapuram),

On the site's lower contour, a different home known as the "niece" was built. He built a second two-room cottage for his son Tilak, who stood in front of the tree that connected the "niece." On the actual site, the impact of the construction is not felt. Baker has discovered a way to attach the building to a location that is effectively free but constrained by dense flora.

THE STORY OF THE SITE:

The location was an ungainly trapezium of plants and stone with steep gradients. The site's dry rockiness was changed throughout the years of occupancy into a contoured formation of grass, shrubs, and coconut plantations. However, Baker did not remove either one rock or even one tree, earning the hamlet the nickname "right in the rock." Baker picked a location near the apex of the half-acre plot of land he had bought from the bishop, where he could see the long line of hills with ease and wisdom.

Location: Trivandrum

Architect:LaurieBaker

Built-upArea:3972sqft

Project type:Residence

An architect's own home design is a reflection of who he is. It reflects his personality, principles, and architectural convictions. Baker's adore-mentioned term, which emphasizes the conventional and natural methods of habitation and development, is best exemplified by the construction process. The Hamlet-Bakers' Residence in Trivandrum serves as a tangible illustration of Baker's philosophy. From a multipurpose one-room hut to the initial structure on top and later additions that followed the slope downhill, the house evolved naturally through time. Flexible connections and access to each area are made possible by the architectural design. Over time, unconventional sources provided the majority of the building materials. He collected bits of stone or tile that complement each other, like fish tiles from a castle, dormers and roofing timber from a destroyed home, and wood from a jetty.

MATERIALS USED:

Materials that were primarily local and crude were used. Wood, mud bricks, repurposed wood and metal for grills, repurposed bottles inserted into walls to create the appearance of stained glass, wall decorations fashioned from trash such as used pens, broken crockery, and glass, and roofs made of Mangalore tiles are examples of recycled building materials.

CONSTRUCTION TECHNIQUES USED FOR COST-EFFECTIVENESS:

Conservation Of Energy And Resources, Respectively. Cost-Effectiveness: The Price Of An Rcc Lintel Is Decreased By Using Corbelling Above The Frame Rather Than a Lintel. Rat-Trap Binds Fewer Bricks Together To Create a Wall Of The Same Thickness While Also Providing Insulating Cavities Between The Bricks.

Utilising Jaalls For Ventilation Resulted In Adequate Lighting And Reduced Material Needs. Unlike Conventional Furniture, Built-In Furniture Produces a Permanent Structure That Is More Durable.

Depicting Materials: Filler-Slab Storeduced Reinforcement Curved walls instead of squares or rectangles, window frames, a door, and sewage materials

Strong thermal resistance, high heat storage capacity, and effective humidity control are thanks to the high moisture content in a warm, humid zone.

Usage: windows, doors, cabinets, shelves, tables, railings, etc.

Similar to steel in tensile strength, bamboo has a low risk of starting a fire, is lightweight, strong, and long-lasting. These sheets are appropriate for roofing, walling, door and window shutters, and other building components.

Similar to clay building materials, laterite stone loses compressive strength as moisture content rises. It is frequently covered in lime mortar, which gets stronger when exposed to air and sunlight.

They are used in roofs, kitchens, and bathrooms to reduce smoke through air gaps between the tiles since they are affordable, durable, and environmentally friendly. They are made of laterite clay and placed on sloping ground in locations with a lot of rain.

They are suitable for hot, humid conditions because they are environmentally friendly. are used as a vernacular building material in Tamil Nadu and Kerala because they are abundant, affordable, and used to make woven mats and patches.

CONSTRUCTION TECHNIQUES USED FOR COST-EFFECTIVENESS:

By saving resources and energy, using corbelling above the frame in place of a lintel minimizes the cost of an RCC lintel. Fewer bricks are used in rat-trap technology to produce walls of the same thickness, and gaps are left between them for insulation. The use of Jaalis for ventilation resulted in adequate lighting and reduced material needs. Built-in furniture creates a more durable, permanent structure than ordinary furniture.

To reduce reinforcement, filler slabs might be employed. Instead of square or rectangular walls, choose curved walls. Window and door frames, waste materials

Construction techniques used for cost-effectiveness: By saving resources and energy, using corbelling above the frame in place of a lintel minimizes the cost of an RCC lintel. Fewer bricks are used in rat-trap technology to produce walls of the same thickness, and gaps are left between them for insulation. The use of Jaalis for ventilation resulted in adequate lighting and reduced material needs. Built-in furniture creates a more durable, permanent structure than ordinary furniture. To reduce reinforcement, filler slabs might be employed. Instead of square or rectangular walls, choose curved walls. Window and door frames, waste materials

THE ARTISTIC ARCHITECTURE:

Baker's ideology may be seen in every aspect of Hamlet. The path leading to the hamlet's entrance was carved out of the site's rock steps. Cast iron bars with intriguing ethnic patterns were used to make the entry on the side of the road. The spiral staircase is formed of random rubble, is somewhat set back from the surrounding landscape, and resembles a ceremonial walk leading to the 'temple' built into the hillside of the stone. There is a low veranda leading to the open terrace from a water body to a living area that slopes towards the terrace on the higher contour where the house is located.

The entrance features a small stone seating area for guests, and a calling bell was also installed so that guests could announce their arrival. Broken pottery, glass, and pens were used to decorate the walls, and Baker's love of arches is evident in how the interior courtyards brought the house closer to nature.

There are numerous gardens and ponds in the courtyards. The home had a sloped roof composed of mangalo shingles. There were windows that let in natural light and allowed for optimum air movement and ventilation. He always made sure to maximise the use of natural light and reduce the need for artificial lighting.

The windows had typical, straightforward grills composed of bits and pieces that were both affordable and elegant. In the hamlet, conical construction was also used.

To accentuate the beauty of the hamlet, Baker incorporated stained-glass effects and louvered windows. Additionally, a water tank was added to collect rainwater.

Baker did a good job of utilising the interior's natural illumination. Even integrated furniture, which is typically made of bricks and stones, was used by him. Baker's bedroom has a train car-like aesthetic. The Hamlet had inventive brick jali works and wall fixtures. Baker used recycled bottles embedded into the walls in an inventive way that produced a very good lighting effect and gave the

appearance of stained glass.
The roof of the hamlet features an asymmetrical pyramidal structure with one side left open and tilting into the wind.The roof's horns and incline let hot air climb, resulting in insulation and the stack effect.

CASESTUDY:2

CASE STUDY BASED ON MODERN MATERIAL SAND TECHNIQUES- GFRG DEMONSTRATION BUILDING, IIT MADRAS, CHENNAI

INTRODUCTION:

The main issues facing the mass housing sector today are the reduction of energy-intensive construction materials and the quick delivery of housing units at reasonable prices. To meet the high demand for homes and other infrastructure, there is a substantial demand for building supplies such as cement, steel, bricks, and water. In order to address the enormous housing needs, particularly for the Economically Weaker Section (EWS) and Low Income Group (LIG) segments, alternative, inexpensive solutions are required due to the scarcity and rising costs of these materials. In order to overcome this issue, research on glass fibre reinforced gypsum (GFRG) panels was conducted for over ten years at the Indian Institute of Technology in Madras. The new method guarantees economical, quick delivery of high-quality housing to the general public while also maintaining sustainability through decreased energy use and the use of recycled waste as raw material.
Location: Chennai
Building area: 1981 sq ft construction siteThis project consists of a single ,two-story building created by the civil engineering department on the IIT Madras campus. With industry support
Researchers at IIT Madras developed a design and building approach that uses glass fibre reinforced gypsum (gfrg) panels with funding assistance from India's Department of Science and Technology (dst) and Australia's Rapid Wall Building Systems. The iit-Madras research team increased the product's use throughout the entire building system, including floors, roofs, and staircases, which greatly decreased the demand for reinforced cement concrete (rcc).The team also collaborated to create an excellent interior waterproofing solution, which is crucial for the long-term resilience of gfrgpanels, especially on toilets and roofs. The property's built-up area, which is 1981 square feet,
The huge reduction in RCC, water, cement, steel, and sand use is made possible by the GFRG panels, which also lower the building's energy and carbon impacts. Lower building expenses are the outcome of this decrease in material costs. The GFRG's lightweight design helps reduce foundation costs. Load-bearing systems can be used to construct 8–10-story structures without the use of beams and columns. The demo block is designed for families and individuals with modest incomes. For this job, only INR 1250 per square foot was spent.

ANALYSIS:

Rapid construction: GFRG finished a demo building with four units on two stories (totaling 1981 square feet) in just one month. Because wall panels are just 124 mm thick, less built-up space is needed for each carpet area. Lower embodied energy and a reduced carbon footprint are produced by significantly reducing the use of cement, sand, steel, and water.
Recycling of gypsum from industrial waste, GFRG Panel design(TERI.,2014)
Lower construction costs as a result of material savings and the absence of plastering – Reduced building weight (panels weigh just 43 kg/m2) results in less money spent on foundation costs and easier earthquake design, especially for multi-story structures. Without the need for beams and columns, structures up to 8–10 stories tall can be built with this load-bearing method. All walls,floors,and ceilings were finished with superb prefabricated GFRG panels.

MECHANICALPROPERTIES:

Based on experiments done at IIT Madras, some of the significant mechanical features of GFRG building panels (for both unfilled panels and panels filled with concrete)

CONSTRUCTION OF BUILDINGS USING GFRG:

Depending on the specific site circumstances, the foundation for GFRG structures might be built using conventional methods. Simple masonry spread footings with a network of reinforced concrete plinth beams on top, over which the GFRG wall panels can be installed (with "starter bars" inserted in the plinth beams), are sufficient for low-rise GFRG buildings. Plaster beams can be attached to reinforced concrete pedestals with small, isolated footings that are properly planned if the foundation depth is high. In the case of taller GFRG buildings, it is desirable to provide reinforced concrete walls with an appropriate spread footing or raft below, below the plinth beams. Cranes make it simple to quickly install panels. The starting bars' placement and spacing must coincide with the reinforcement in the wall panel cavities. The reinforced cavities only need to be filled with minimal-grade concrete. Quarry dust, 5% cement, and water can be used to fill the leftover cavities to provide rigidity and make it easier to nail them to the walls. Every third cavity in GFRG slabs must be strengthened by a concealed reinforced concrete beam, and the complete system must be topped with 50 mm of screed concrete, as stated. This functions as a concealed T-beam system that can be created as a one-way system to provide the necessary strength for a specific span

and live loading. The GFRG slab's usual span is 5 m, which meets the standards for residential construction.

RESULTS AND DISCUSSION:

FROM CASE STUDY 1:

Rat trap bonding is a double-wall technology that helps achieve increased thermal efficiency without sacrificing wall strength, reduces material and mortar usage, and considerably reduces construction costs. Saving about 30% of the material (brick and mortar) lowers the cost of the complete project. Additionally, the home's internal hollow provides insulation from heat and noise.Using filler slabs Instead of conventional slabs, manganese tiles, a lightweight filler material, are used. By substituting this useless concrete with a filler, filler slabs can reduce the weight of the slab and, consequently, the cost of construction.

The demand for reinforcing steel decreases as a result of the lighter slab, thus reducing construction costs. The materials used for decoration, economics, reduced sales load, nearly minimal maintenance, and a 25–30% cost savings are reduced as a result.

Arch constructions have the ability to reduce tensile strains while enclosing an open area due to its design. Braces and other arches provide tremendous structural strength and can span a large open area without the need for supporting structures.

Roofing and flooring tiles made of terracotta The bed's flooring is built of broken brickbats, which lowers the overall cost and usage of bricks. The Terracotta tiles are placed on top of the mortar layer. These falsehoods are inexpensive, low maintenance, and come in a variety of aesthetically pleasing forms and sizes.

Additionally, this type of flooring allows wire to pass through it rather than blocking the passage of electric lines. Due to their aesthetic perfection and ability to provide good natural ventilation and rainwater drainage, terracotta roofing and flooring are environmentally friendly, affordable, and long-lasting.

The lack of frames on the doors and windows is a defining characteristic. Door planks are either connected together with strap iron hinges or secured together with horizontal or diagonal battens to create cost-effective doors and straightforward photographic windows.

About half of all timber usage is used for door and window frames. The architect used an innovative way to enclose a larger volume at a lower cost by using curved walls in place of straight wall structures in the case study.

FROM CASE STUDY 2:

After the foundation was erected, the entire superstructure was finished and ready for occupation in about 28 days. Recycling industrial waste gypsum results in significantly reduced embodied energy and carbon footprints for cement, sand, steel, and water consumption.

In terms of embodied energy,GFRG construction saved morethan 50% The demonstration structure was made of gypsum panels with glass fibre reinforcement.

Which were initially planned for use swells Rapid Building Systems in Australi .The IIT-Madras research team expanded the product's use to the entire building system, including floors, roots, and Stair cases, significantly reducing the use of reinforced cement concrete (RCC). The team also collaborated on the development of an effective water-proofing material internally, which is essential for the long-term durability of GFRG panels, particularly on roofs and bathrooms. I'll now compare costs. GFRG construction currently costs between Rs. 1,600 and Rs. 1,700 per square foot.

The CFRC demo building on the IIT Madras campus has a total floor area of around 1,951 square feet and costs around Rs 23 lakh. The demo building was 25% less expensive when compared to the cost of a normal building with the same plan. Less expensive Analyzing the differences between traditional and cost-effective construction methods.

A COST COMPARISONS

TRADITIONAL CONSTRUCTION VS COST EFFECTIVE CONSTRUCTION :

The site is flat and devoid of significant natural features. Because the land was between 1.5 and 2.5 metres below road level, it needed to be filled in before the desired infrastructure and housing projects could be completed.

For the purpose of evaluating the economic foundation along with its suitability, the cost was also calculated for Type-III buildings (4 storeyed), with traditional RCC framed structure in addition to load bearing construction using alternative technologies, which were ultimately adopted for the construction of 4348 Dwelling Units.

Traditional footings were found to be unsuitable because they would require extensive earth filling and wider footing sections, which would make them impractical**.**

As a result, the underreamed piles beneath the load-bearing walls and the grade beams at a middle level of -550mm were found to be the solution. The entire land area was first filled and compacted to a level of 550 mm.

The piles received a grade beam at a level of -550mm. The grade beam was then covered with a load-bearing brick wall. vertical reinforcement (VR-1) that the grade beam provided.

The plinth band was offered at the level of the plinth. Table 2 provides a summary of the savings calculated as a result of the use of

alternative technologies.
Table 3 also provides a summary of the cost comparison for each individual head, including walling per square metre, roofing / slab per square metre, shelves and sun shades.
The cost comparison of the residential units is listed in the chapter's following pages.
The rates adopted for the estimates are from DSR - 2002. The cost comparison of such elements as foundations, superstructure, slab, etc. was also worked out and is presented for the construction of 1184 Type III houses (39.74 sqm) at Bawana.
Rates of Non-schedule items were analysed based on DSR - 2002, with the addition of a cost index of 34.34% on both estimates at the time.

COST COMPARISON CIVIL WORK

CONVENTIONAL	COST EFFECTIVE TECHNOLOGIES
Cost of construction using standard specifications Add 34.34% for a block of 16 units at 24,85,384.00. Index of Prices 8,53,481.00 Total cost per DU: 33,38,865.00 (33,38,865.00 16) 2,08,679.00 $525.11 per square metre	Cost of construction (1 block, 16 DU) Civil engineering 19,29,023.00 + 34.34% Index of Prices 6,62,427.00 Total 25,91,450.00 DU cost ($25,91,450.00 16) 1,61,966.00 P.A. 39.74 sqm $4,075.63 per square metre

Table 1. Cost comparison civil work

Savings in cost are equal to 2,08,679.00 - 1,61,966.00, or 46,713.00 (22.38%).

SUMMARY OF THE PROJECTED COST:

For the proposed building, a thorough estimate was created using both standard and affordable materials. For the estimation, rates from the Delhi Schedule of Rates (DSR) 2018 published by the Central Public Works department of the Government of India were used. The prepared estimated cost abstract .

CONCLUSION

Everyone Requires a Place To Live, And Everyone Desires a Roomy, Cosy Home. People Favour Houses That Are Larger, More Environmentally Friendly, Less Expensive, And More Aesthetically Pleasing. As a Result, There Is a Demand For Affordable And Economical Housing. The Resources And Technologies In The Area Can Benefit Low-Income People. Utilising Cost-Effective Technology Saves Money, But It Also Saves Time And Labour, Reduces Co2 Emissions, And Saves On Labour Costs. The Cost Savings Realised By Utilising The Various Technologies Discussed Above, Which Can Range From 20 To 30%, Will Allow People To Access All Primary And Basic Services At a Reasonable Cost.

There Won't Be As Much Traffic. This Study Emphasises The Importance Andfor The Purpose Of Creating Long-Lasting Green Structures That Can Serve As Models In The Future, It Is Necessary To Consume a Variety Of And Other Techniques. Low-Cost Construction Might Be Made Possible By Eschewing Traditional Methods Of Planning And Executing Building Operations That Are Categorically Based On Specific And Individual Demands And Accepting The Lowest Common Denominator, Based On Surveys, Population Needs, And Wise Use Of Materials And Resources.

a Stable Market Is Required For The Adoption Of Any Alternative Technology, And This Market Cannot Be Established Unless The Product Is Both Effective And Efficient. Right Now, Creating Affordable Housing Is a Very Challenging Task. It Takes a Lot Of Labour To Create New Technologies For The Construction Industry To Use Various Alternative Materials. Low-Cost Housing Technologies Were Used In Thislooked. It Was Highlighted That The Study's Findings And The Materials' Potential For Use As Alternate Building

Materials Could Be Used. Despite The Creation Of Numerous Low-Cost Housing Technologies, There Is Still a Housing Shortage. We Are Still Unable To Provide Housing For Those From Low-Income Families Because There Are No Established Regulations For The Structural Qualities Of These Alternative Construction Materials. In Addition, There Is a Lack Of Understanding Among Builders As To The Merits And Applicability Of Specific Materials.

The Use Of Traditional Building Techniques And Materials, Such As Laterite Blocks, Hollow Concrete Blocks, And Hollow Clay Blocks, As Well As Some Energy-Efficient Passive Design Strategies, Is Made Possible By Climate Responsive Architecture. These Tactics Offer An Effective Substitute For Artificial Cooling Techniques Andare Inexpensive. Therefore, It Should Be Mandated That All Planners Incorporate Passive Strategies And Create Energy-Efficient Buildings.

Cooperatives With a Focus On Affordable Housing Must Be Established In Order To Lower The Costs Of Transportation And Material Importation. The Budget For The Entire Building Will Be Cut By 20 To 30 Percent As a Result. This Will Make It Easier For The Typical Person In Today's Society To Fulfil His Desire To Own a Home.

In Terms Of Achievement, Contentment, Fulfilment, Self-Worth, Social Status, Cultural Identity, And Safety The Best Approaches To Take When Looking For Affordable Building Are To Use Natural Materials, Renewable Materials, Eco-Trendy Building Materials, Locally Available Materials, Minimise Resource Allocation, And Implement Innovative Methods To Reduce Costs And Achieve Sustainable And Green Building Systems. One Of Humanity's Fundamental Needs Is Housing.

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