



## A CRITICAL STUDY ON USAGE OF LOW-COST HOUSING MATERIALS ACROSS WORLD

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### Abstract

Decent housing is one of the basic needs of human beings. Presently, millions of people do not have a suitable roof over their heads. The entire ecosystem now a days needs such type of materials that will be helpful in reducing the cost of the building unit without any change in its properties than conventional building has. Low Cost-housing materials is a comparative term that has a lot to do about financing that helps to reduce construction costs by using various new techniques like effective management, appropriate use of local resources, skills, and technology, without sacrificing quality or structural life. In this review, a comparison was carried between conventional building materials and various alternative low-cost housing materials like bamboo, precast concrete, cow dung, straw dust etc. that are being used in construction industry without scarifying the integration of the structure. The objective of this research is to highlight and investigate various types of ecofriendly materials and their extraction techniques that can be used to create low-cost structures that can withstand extreme conditions. An attempt is made by me to highlight and point out various low-cost housing materials to be used in ecofriendly environment thereby enabling to maintain the cost and the structural durability.

**Keywords:** - Durability, Ecosystem, Housing, Low-cost.

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**DOI:** 10.48047/ecb/2023.12.si5a.0502

## 1 Introduction

Low-cost housing is a new concept that handles the smart budgeting and the use of approaches that helps in minimizing the construction costs by using nearby available materials, and provides better skills and technology, without compromising the structure's strength, performance, or durability. Housing units that appear to be affordable to persons earning much less than median wage are known to as low-cost housing. It will be determined by three factors: income, overall size of the living unit, and affordability (**Shankar et al., 2019**). As a result, it became essential to use cost-effective, creative, and ecologically sustainable housing approaches for the construction of structures, along with keeping them affordable. This study will investigate the use of locally grown components in different building elements in order provide low-cost options for low-income customers. The use of low-cost housing building materials in construction activities will be helpful in reducing the overall cost by 20% to 30% without compromising the structure lifespan, strength etc. (**Warrier et al., 2019**). The main objective of our review article focuses that the use of locally available materials providing an opportunity to reduce the cost of the materials and leads the society towards sustainability. In any crowded country shelter forever, one is an arising need, as we are already aware of the current situation of housing problems occurring due to rapid urbanization, there seems to be an increase in supply. The worldwide housing shortage is all-time high, including millions of people without homes, particularly in growing nations. As per the records provided by Ministry of Housing and Urban Poverty Alleviation of the Government of India, India's housing demand was predicted to be 18.78 million (**Aziz et al., 2009**). With the increase in population national resources are already being overused also the use of traditional building materials has raised the market towards sky, that leads millions of people around the world live in poverty and lack sufficient housing. So, to overrun the problem new technologies like low-cost housing materials can be used that may reduce the cost to some extent (**Jaiganesh et al., 2016**), According to the United Nations, 860 million people live in extreme poverty, representing 12% of the global population. The main Issue is because of insufficient budget. As a result, there is an evident need to provide low-cost housing accommodation for the poor which integrates sustainable materials (**Gohnert et al., 2018**). Human activities are engaged in the implementation of house modification that has grown rapidly. This same construction works or

materials to use at three low-cost housing projects in Shah Allam, Malaysia, caused issues and decided to risk affecting social environment and public health, according to an investigative report via interview sessions with citizens, residential construction companies, and neighborhood. Regardless the existence of health and safety regulations, Malaysia still has a lot of room for improvement. These challenges occur due to lack of building construction knowledge, skills, and experience. Numerous recommendations are derived from the findings to boost living conditions for a more sustainable future, also absence of proper building systems and application in housing change projects can cause difficulty in the home and its surroundings, harming the natural environment, wellness, and standard of living are all factors to consider. (**Zarina Isnin et al., 2011**). Making composite materials from easily accessible components and testing them to create low-cost, environmentally friendly materials with good thermo-physical properties. They also investigate that natural wastes are very important because it is inexpensive and environmentally friendly. Several research studies have been conducted and concluded that the construction sector is one of the largest energy consumers. It has also been noticed that researchers, governments, etc., are worried about that, so they are trying to find alternatives. It is also noted that the building sector accounts for one-third of total energy consumption and 30% of carbon dioxide emissions. **Tiskatine et. al (2018)**

## 2 Housing shortage in India

In India, it is evident that there is a big gap between the number and quality of affordable housing that people desire and what is available. In 2012, the Technical Group-12 report from the Ministry of Housing and Urban Poverty Alleviation stated that the country seemed to have an urban shortage of housing of about 18.78 million. The above amount was later changed to 102 million in 2017. Ninety-five percent of this shortage is thought to be in the affordable housing sector. Most of these migrants come from low-income families, which shows how much more affordable housing is needed in India's cities. increasing population India has major housing challenges due to urbanization, limited housing investments, and poverty. Population expansion and urbanization trends affect people's access to housing, leading to slums, increasing demand for infrastructure and services, and a decline in the poor's quality of life. In India, rural housing is built on land rights and access to resources, not the monetary economy (Government of India, 1998 Poverty is at the heart of a difficult housing issue, which is usually made

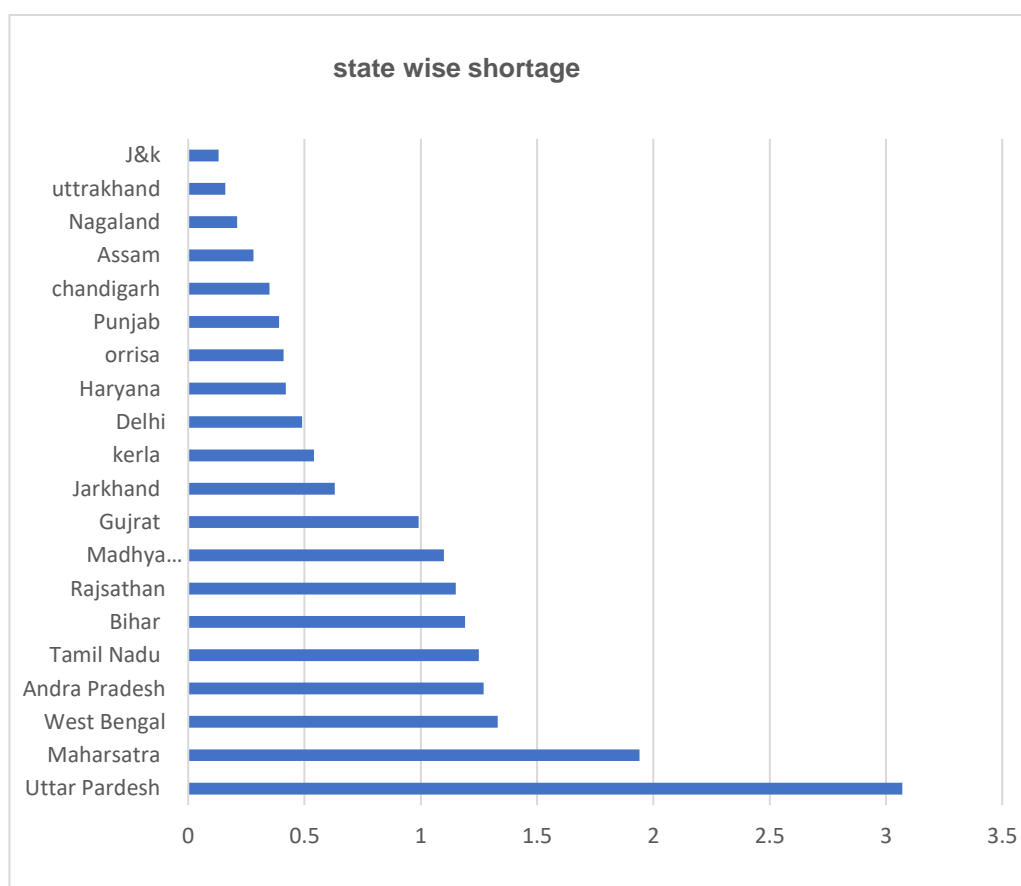
worse by a complete absence of common property resources, sluggish institutional capabilities, and insufficient legal and economic institutional arrangements.

### 3 Low-cost Housing

Low-cost housing scheme in India is to help shelter the Economically Backward sections (EWS), slums and street dwellers and the underprivileged in a way wherein a framework and access to serviced land is provided rather than a finished house. Over time, this house grows into home as per the requirements and needs of the occupants; they are allowed to design it the way they want and what suit their needs the best, from shared outdoor spaces and courtyards to an outdoor staircase

leading towards interiors reviewed Rapid urbanization is causing environmental problems in the construction industry. When people want to buy more homes, they use more energy, resources, and raw materials. This puts more carbon into the air, which is bad for the environment and for people's health. It's time to use more eco-friendly, local agricultural resources for a happier future. This also believes that use of green materials protects ecosystems, biodiversity, water quality, and natural resources. Furthermore, green buildings use less energy and materials and have better indoor air quality, which is good for the health of the people who live or work in them.

**Mokal et al. (2015)**



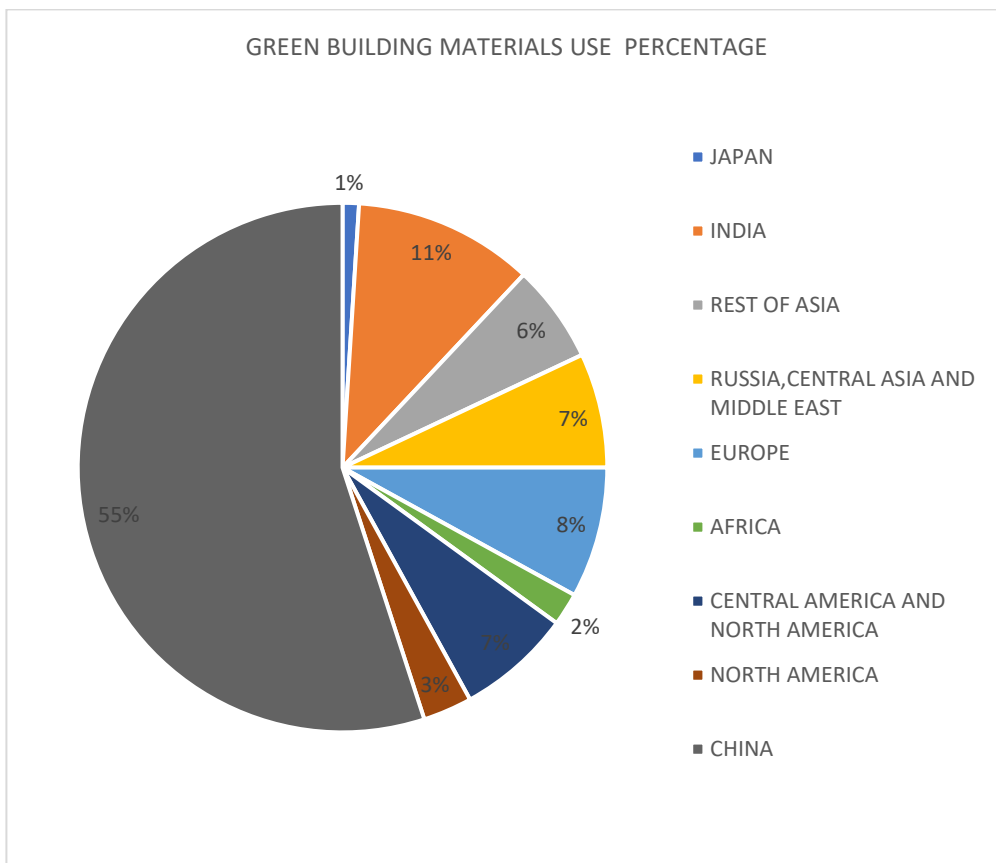
**Graph 1:** housing shortage in India state wise, Source (internet)

It depicts the housing shortage in millions; out of these states 10 states concerned 76 %

#### 3.1 Features Of Materials Used For Low-Cost Housing

- ❖ It leads approach to environmental preservation.
- ❖ It diminishes greenhouse gas (GHG) emissions to zero.

- ❖ It conserves natural resources and increases the use of renewables.
- ❖ It incorporates multiple fields of knowledge that assist in reducing the negative impact of human activities while also developing methods of environmental sustainability including economic equality, financial viability and sustainable development



**Pie chart:** use of green materials all over the world, Source (internet)

#### 4 Challenges To Green Technology Adoption

- ❖ Inadequate information regarding low-cost building materials and Government subsidies are another problem that needs to be tackled is one the major challenge.
- ❖ There are concerns regarding the ease of maintenance for eco-friendly construction materials, as well as a shortage of construction personnel who have experience in sustainable construction.
- ❖ On the accessibility of technology solutions that can be used in sustainable technology This same transition to eco-friendly alternatives and extra-creating sustainable is being slowed not only by a lack of funds, but also by the complete absence of an institutional framework that could make obtaining those investments easier.
- ❖ To enforce sustainable construction initiatives requires well-trained building inspection team members.

#### 5 Various Low-Cost Housing Materials

##### 5.1 Bamboo

Bamboo is a fast-growing plant with significant economic potential. Bamboo grows quickly and requires less energy to harvest and transport. Asia has used bamboo for thousands of years to build bridges, dwellings, and scaffolding. Due to its low weight-to-strength ratio, high tensile strength, and low cost, bamboo has drawn the attention of *Eur. Chem. Bull.* **2023**, *12(Special Issue 5)*, 5838 - 5846

scientists and engineers for use as concrete reinforcement. But also, because the quantity and quality of wood resources in the forest have gone down, it is becoming more and more important to look for ways to use wood in ways other than what has been done in the past. In terms of the environment, bamboo is like wood in that it can be regrown, biodegrades, and stores carbon. However, bamboo grows faster and has better mechanical properties than wood. Because of this property, it is seen as a promising alternative to wood as a raw material (**Sharma et al.,2005**). Bamboo has higher tensile strength than steel because its fibers run in a single direction, also due to presence silicate acid and water. Bamboo resists flames up to 4000C. Bamboo's elasticity makes it popular in earthquake-prone areas. Bamboo's less weight makes transportation and construction easier. Bamboo is safer than steel and gives 10 times greater strength than steel. They are cheap and simple. But there needs to be more cautious because it requires preservation, because insects and fungus may damage also bamboo loses water because it shrinks more than other woods that would affect the overall stability, durability, and strength of the structure.

**5.2 Fly ash (FA)** A power plant byproduct is a prevalent SCM. Utilization of fly ash for cement replacement can cut CO<sub>2</sub> emissions and improve

some composite characteristics (FAC). Fly ash can cut down hydration heat, stop thermal cracking, and increase resistance to carbonation and chloride improves workability of concrete decreases water demand up to 10%. Fly ash is a crystalline dust produced by the combustion of pulverized coal in power plants. It is a pozzolan, which makes cement with water. Fly ash mixed with lime and water resembles Portland cement. Fly ash can be used in blended cement, mosaic tiles, and hollow blocks. Fly ash in concrete enhances strength, segregation, and workability. Fly ash can save money on PCC road construction projects by replacing concrete. About 40% of the world's biggest companies get their electricity from coal-based energy sources, which also make 600 billion metric tons of fly ash (FA) and 12,000 million metric tons of CO<sub>2</sub> each year. (Montes-Hernandez *et al.*, 2009). FA is only used to make 16% of cement and concrete. The rest is dumped in basins and landfills near thermal power plants. The excess use of fly ash reduces strength. Seasonal variation can occur. It also improves salt scaling by flying ash. The use of FA rather than cement as an aid in concrete mixtures aids in reducing carbon dioxide production. (Naik *et al.*, 2000).

### 5.3 Compressed stabilized earthen bricks.

Sustainable building helps the environment. CSEB construction reduces environmental damage. Wet soil is compacted under pressure to make earth compressed blocks. Dry inorganic subsoil, non-expanding clay, aggregates, and Portland cement make up these blocks. Earth is abundant and has always been the primary building material for homes. It offers environmental benefits such as lower carbon levels, high thermal mass, and locally produced materials (walker *et.al* ;2004). No mortar needed, reducing labor and material costs. Appropriate soils are often near the construction site, which reduces transport costs. It also has various ecofriendly properties. Brick can be grouped in multiple ways. Brick is classified by ASTM as building (C 62), facing (C 216), hollow (C 652), and thin layer (C 1088) Bricks can be

load-bearing, non-load bearing, and insulating. Traditional fired bricks are different from CSEB. Static, dynamic, or vibro-static compaction and stabilizer strengthen CSEB bricks. CSEB's energy use and carbon emissions differ from traditional bricks. Compared to concrete blocks, fired clay bricks, and aerated concrete blocks, CSEB bricks produce 22 kg CO<sub>2</sub>/ton. Simple CSEB manufacturing required moderate to low skill workers. There must be preparedness of the soil, compression of the combination, as well as trying to cure. For optimal outcomes, the soil should be deliberately crafted as well as given the right amount of load optimal outcomes, the soil should be deliberately crafted as well as given the right amount of load. Attempting to cure technique in CSEB manufacturing typically takes advantage of the natural hot summers in which bricks can be bunched right within a week of compression, and yet frequency continues to grow placed above a white time frame, but it is critical to avoid rapid curing out, and thus a concrete slab is warm and moist and successfully treated under clear plastic (or moist wrapping in India) in the open air (a muggy atmosphere where air comparative humidity >70% appears to be beneficial). (H.B. Nagaraj *et.al* 2014

### 5.4 Adobe's Blocks

Adobe blocks are composed of a mixture of particulate soil, water, and sometimes even hay. When the adobe is still wet, it is shaped into bricks and then dried in the sun for several days. Adobe's sensitivity to moisture is its biggest hindrance. Adobe blocks can be used for wall construction, with wet adobe utilized for finishing touches. Adobe is sometimes considered "the material of the poor," which can limit its utilization. making up the mortar. Construction techniques are greatly affected by weather conditions. The exterior of most houses is covered in adobe to give a flat surface that can be painted. Adobe can be used in more lightly populated areas, but it is rarely seen in new markets and new.

## 6.1 Properties of low-cost housing

**Table 1:** Properties of low-cost housing ,(Source (internet)

S.NO	MATERIAL	THERMAL	STRUCTURAL
1	Bamboo	Excellent	Flexible And Steel Modulus of Elasticity Than
2	Concrete blocks	Excellent	Requires Less Mortar Due to Its Large Joint Size, It Increases Stability
3	Ferrocement	Excellent	High Strength, Low Density, High Crack Resistance of Mortar
4	Fly ash bricks	Excellent	Minimize Pollution, Energy Saving Decrease Mercury Emissions and Cost 20% Efficient Than Traditional Brick
5	Mud bricks	Excellent	Economic And Energy Efficient

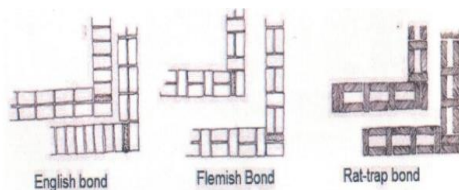
**Table 2:** Properties Of Bamboo In Comparison To Steel, Source (Internet)

PROPERTY	BAMBOO (kN/sq.cm)	STEEL(Kn/sq.cm)
Modulus of Elasticity	2000	21000
Compressive Strength	6.2-9.3	14
Tensile Strength	14.8-38.4	16
Bending Strength	7.6-27.6	14
Shear Strength	2.0	9.2

**7 Low-cost housing technologies**

**7.1 Rat trap bond**

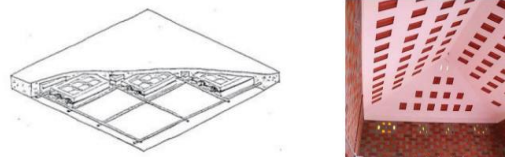
The rat trap bond is a way of building with bricks where the bricks are put together in a way that leaves a space inside the wall but keeps the same thickness as a regular wall. Bricks are laid flat in a traditional English bond or Flemish bond. In a rat trap bond, the bricks are laid on their edges, trying to make the outer and inner faces of the wall. Cross-bricks connect the inner and outer faces. The primary benefit of rat-trap bond is that, because the wall has a hole in it, fewer bricks and mortar are needed than with English or Flemish bond.



**Fig 1:** Rat trap bond Source (internet)

**7.2 FILLER SLAB TECHNOLOGY**

In this modification, a portion of the concrete is replaced with a filler material that can be a waste product. By using this technique, an anormal reinforced concrete structural slab can be transformed into a filler slab. The goal of this modification is to provide an obvious benefit over an RCC slab. The main idea behind a filler slab is that when an RCC slab of a certain width is accounted for, the cement in the bottom half of the slab is just dead weight and doesn't help to take up concentrated forces in just about any way. This is because concrete in an RCC slab is normally responsible for taking up compressive load. Therefore, this concrete can be substituted with an appropriate lightweight filler material that can be incorporated into the lower half of the slab. The procedures that are used for the design of conventional reinforced concrete slabs are the same ones that have been adopted for the design of the filler slab



**Fig 2:** Filler Slab Technology, Source (Internet)

**7.3 Aluminum/ Mivan Formwork:**

The technology is durable, low-maintenance, and portable. It saves time by casting walls, slabs, and columns simultaneously. Aluminum panels are lightweight and resilient. They are strong enough that they can be used 250 times without repetition. The various advantages of this technique are Fast construction, fewer workers, less maintenance, earthquake resistance,



**Fig 3:** Aluminum/ Mivan Formwork

**8 Research Methodology** The study technique aims to offer a structure to investigate low-cost building materials. The assessment will look at the different materials that can be utilized for affordable housing, as well as how suitable, accessible, long-lasting, and affordable they are. The methodology is listed below.

**8.1 Research Question :** The research question is identified as the first phase in this process. This review's study topic is: "What are the low-cost housing advanced materials, as well as their acceptability, supply, endurance, & economic viability?"

**8.2 Do a Literature Search:** The following procedure involves doing a literature review. Exploring relevant databases such as Google Scholar, Science Direct, ResearchGate, and others

is required. "Low-cost housing materials," "sustainable housing materials," "affordable housing materials," "durable housing materials," and "cost-effective housing materials" will be search phrases. The search will only include articles published within the last ten years.

**8.3 Following the literature review** the subsequent phase is to analyze and identify those publications that are really associated. with the research topic. The title and summary of the publications will be reviewed, as well as the selected articles will be read in full to evaluate their connection with the study issue.

**8.4 Data Extraction:** After selecting the appropriate articles, the following step is to extract the data from the articles. The documentation will reveal things on numerous low-cost housing materials, as well as their appropriateness, availability, durability, and cost efficiency.

**8.5 Reporting:** The final phase seems to be to describe the review's results. The outcomes will indeed be given the shape of a report, that will comprise an executive summary, opening, results, discussion, and conclusion

## 9 Results and discussion

- ❖ The use of low-cost materials reduces the building's effects on the environment, or more accurately, its negative effects on the environment.
- ❖ Improving and enhancing the health of the people who live or work in a building.
- ❖ Investors and the community can save money and get a return on their investments.
- ❖ Take the life span into consideration during planning and development.
- ❖ From the literature reviews we've talked about so far, we've concluded that it's important to use low-cost building materials to protect the environment people think about green technology, and the above study shows us that people do not believe in these materials, which is the reason India and other, resources, and pollution.
- ❖ The above results confirm that the use of environmentally friendly resources may reduce the overall cost of construction by 30 Both reviews give an overview of the housing shortage in emerging economies.
- ❖ Initiatives should be undertaken in a similar manner to that of many developed nations. to protect the environment.
- ❖ It has also been noted that the use of low-cost housing technologies requires a large amount of

money for installation, which might be a reason for failure. Furthermore, the use of locally assessed materials and locally sourced labor will affect construction cost

## 10 Conclusion

Humans need housing for protection, self-esteem, social position, cultural identity, fulfilment, and accomplishment. After examining several low-cost construction systems, the ideal technique is employing natural resources, reusable resources, eco-friendly building materials, locally available materials, reducing the distribution of resources, and innovative ways to lower costs to achieve green and sustainable building.

The use of low-cost building materials used in the construction of low-cost housing enhances low-income people's adequate housing. Low-cost housing can be accomplished by smart project planning and management, low-cost materials, cost-effective construction technologies, and use of alternative construction techniques. The profit earned from the implementation of these strategies can reduce construction costs to make low-cost housing more accessible to all. By use of low-cost alternative raw materials also keeps construction costs from rising due to the usage of expensive building materials that would otherwise increase the project's cost. The use of low-cost housing building materials in construction activities will be helpful in reducing the overall cost by 20% to 30% without compromising the structure lifespan, strength etc.

The construction sector has a major influence on the environment, society, and economic system; as such, sustainable construction technology is a worldwide phenomenon. Global warming and air pollution are growing worldwide, likely requiring environmentally friendly and intelligent advancement. In advanced countries like the US, Russia, Australia, and the UK, rigorous initiatives, laws, and regulations encourage global and eco-friendly development. India, China, Sri Lanka, Pakistan, and others are way behind in environmental sustainability as well as eco-friendly building. In developing countries, individuals are unaware of this global issue. These countries also lag advanced countries in terms of research and education. The paper emphasizes how low-cost materials can be used instead of traditional materials without affecting the environment, culture, resources, lifespan, and a variety of other properties that any building requires.

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