Construction Materials And Techniques For Sustainable Environment In Residential Building

Punam Pandurang Gadhave[1], Prof. K. M. Sharma[2], Prof. A. B. Shendge[3]
[1, 2, 3] Dattakala Group of Institutions Faculty of Engineering, Swami - Chincholi (Bhigwan).

Abstract- *The construction industry plays a significant role in shaping the environmental landscape, and the use of sustainable materials in residential buildings is becoming increasingly important. This paper aims to explore the latest advancements in construction materials that promote a sustainable environment within the residential sector.The study begins by identifying the key environmental challenges associated with traditional construction materials and their negative impacts on the ecosystem. It then delves into the concept of sustainability and its significance in the construction industry, emphasizing the need for eco-friendly materials that minimize resource depletion and environmental degradation.Furthermore, this research presents an extensive review of innovative construction materials specifically designed for residential buildings. These materials include recycled and bio-based products, such as reclaimed wood, recycled metal, and sustainable insulation materials. The benefits of these materials are highlighted, showcasing their ability to reduce carbon emissions, conserve natural resources, and enhance energy efficiency in residential structures.In addition, this paper explores the potential challenges and barriers faced during the adoption of sustainable construction materials in the residential sector. Factors such as cost implications, lack of awareness, and limited availability are discussed, along with possible strategies to overcome these obstacles.The findings of this study demonstrate that the integration of sustainable materials in residential construction can significantly contribute to a greener environment.*

Keywords- Construction materials, Sustainable environment, Sustainable materials: Sustainable construction products

I. INTRODUCTION

The urgent need for sustainable development has fueled a significant shift in the construction industry, with an increasing focus on environmentally friendly practices and materials. In the quest for creating residential buildings that harmoniously coexist with the natural world, the choice of construction materials plays a pivotal role. This article explores the transformative potential of construction materials in fostering sustainable environments within residential buildings.The traditional construction industry heavily relies on resource-intensive and ecologically harmful materials. However, in recent years, a wave of innovative solutions has emerged, offering a ray of hope for a greener future. These groundbreaking materials are designed to minimize the environmental impact of residential buildings, promoting energy efficiency, reducing carbon emissions, and enhancing the overall sustainability of our living spaces.

By embracing sustainable construction materials, residential buildings can become the vanguard of eco-conscious design. These materials encompass a broad spectrum, including but not limited to recycled and upcycled resources, biodegradable elements, and high-performance composites derived from renewable sources. Each material brings forth unique attributes that contribute to a sustainable environment, such as improved insulation, enhanced durability, reduced energy consumption, and lowered waste generation.The integration of sustainable construction materials offers numerous tangible benefits to homeowners, occupants, and the surrounding community. Residents can experience enhanced indoor air quality, optimized thermal comfort, and reduced utility costs, all while making a positive impact on the environment. Additionally, sustainable materials promote the health and well-being of occupants, creating healthier living spaces and minimizing the ecological footprint of residential buildings.

As the world strives to mitigate the effects of climate change and resource depletion, the adoption of sustainable construction materials has gained significant momentum. Governments, regulatory bodies, and industry professionals are increasingly recognizing the imperative to transition to eco-friendly building practices. The demand for sustainable materials continues to soar, fostering innovation and opening doors to new possibilities in the construction sector.

1.2 Simple ways to increase the green rating of your building

The design and construction industries are growing exponentially, and their impact on our environment is staggering. To mitigate these effects, the practices of sustainable design and Sustainable Building techniques have steadily emerged. These practices are incentivized through the process of 'green rating'. A 'Sustainable Building rating system' is a tool that evaluates the performance of your building and its impact on the environment. These rating systems encourage designers and construction industry professionals to use green strategies and reduce their impact on the environment. LEED, Passivhaus, Living Building Challenge are few of the international rating systems. The predominant rating systems in India are GRIHA, LEED, and IGBC.

1.2.1 Here are simple ways to increase the green rating of your building:

1. Energy use optimization

A building perpetually consumes energy from the time of its inception to the end of its life cycle. This is a major contributor to the emission of greenhouse gases, which consequently contributes to climate change. We can significantly improve the green rating of our building by optimizing its energy consumption through pre-construction analysis and providing proportional solutions.

Strategies such as the use of energy-efficient equipment and the integration of renewable energy technologies (solar, wind, thermal energy systems) can achieve the same.

2. Water management

Water is a life-giving resource. While water covers seventy percent of our planet's surface, only a small percentage of it is potable. While these statistics seem bleak, rains are an important contributor of freshwater. Water management is thus a vital aspect of sustainable design.

Conventionally buildings depend on local government bodies for their water supply. Through the means of rainwater harvesting, buildings can achieve self-sufficiency. Another strategy to reduce dependency on government water supply is through wastewater or greywater management. Greywater is the water that is discharged into the drainage system after its cycle of use. Through proper treatment, greywater can be re-utilized for non-potable purposes. We can thus improve the green rating of our building through the proper management of water.

3. Waste management

The waste generated by buildings is proportional to the enormous quantities of energy they consume. On-site waste management is an effective technique to improve the green rating of your building. Providing infrastructure to manage waste on-site must be incorporated within the design process. Segregation of waste at source, composting of organic waste, and recycling of non-biodegradable waste are methods that can be enforced to effectively manage waste.

4. Optimized site planning

Incorporation of site topography/ contours and other natural features of the site into the design process can help improve the green rating of your building. Site contours, when incorporated in the design, can reduce the need for cutting and filling, subsequently preserving the topsoil. Using the natural contours also helps preserve the natural drainage of the site and helps recharge the groundwater reserves.

5. Preserve on-site trees and vegetation

Preserving the vegetation existing on-site is a simple way of improving the green rating of your building. Incorporating existing vegetation into the design is an effective and sustainable solution. We must take care to avoid the cutting of mature trees to accommodate the design. If we cannot alter the design, the conflicting tree must be safely transplanted within the site. If transplantation of the tree is not possible, we must take care to plant multiple trees of the same native species for every tree that is cut.

6. Placement of fenestrations

Placement of fenestrations or openings by studying the climatic conditions can help control the heat gained annually by a building. This can further help optimize the need for active cooling or heating, making the building energy efficient. The windows/ openings can be planned in a way to facilitate cross ventilation and optimum daylight to reduce dependency on artificial light and ventilation.

7. Alternative materials

Material choice is an important aspect of sustainable design. Choosing recyclable or biodegradable materials can improve your green rating score. Recyclable materials help reduce the ever-increasing dumping of waste in landfills and the carbon footprint of your building. Locally-sourced materials reduce the need for transportation.

Fly ash bricks, rammed earth/Compressed Stabilized Earth Blocks, local stones, bamboo or wood are a few alternative materials that can be incorporated into your design if they are locally available.

8. Occupant comfort

Occupant comfort implies the interaction of the building and the people using it. The four major aspects to 'occupant comfort' are natural light, thermal comfort, and air quality. The quality of indoor air is a direct result of the chemicals emitted by the materials used. Using non-VOC (Volatile Organic Compounds) materials can help improve indoor air quality. Achieving optimum comfort conditions inside the built environment increases the Sustainable Building rating.

9. Accessibility for all

Incorporating barrier-free design, as per the recognized standards, in the design of your building can help improve your Sustainable Building rating. Universal design goes hand-in-hand with sustainability. Ensuring access to everyone fosters a safe environment. Provision of ramps, disabled-friendly spaces, tactile hazard surfaces is a few examples of barrier-free design.

10. Metering and maintenance

Post-occupancy monitoring goes a long way in ensuring the proper functioning of the building. This helps in reducing the breakdown of accessory mechanical services. Metering of energy and water consumption can help designers analyze the building performance. Using these methods of post-construction monitoring can improve the green rating score.

1.3 Sustainable Building Materials

Most parts of the world are now heading towards a sustainable future and a quest to reduce carbon emissions and global warming. So we must find a way to maximise our natural resources and help our Mother Earth. The scarcity of non-renewable natural resources has lead to the use of Sustainable Building materials in the construction industry which enhances building performance while reducing operating costs.Sustainable Building (also known as green construction or sustainable building) relates to alternative energy in terms of being friendly to the environment. It basically consists of constructing buildings that are environmentally sound and more energy efficient.But Sustainable Building design is not just about using energy, water and other resources more efficiently, its more about reducing carbon consumption, construction waste, and less use of toxic materials.

Sustainable Building designs have the potential to enhance a buildings life-cycle by careful selection of its site, design, construction, and operation. Architects and builders have found new renewable energy technologies and construction materials both limiting and reducing the ecological impact of a building on the environment. Good passive solar design lets the sun's energy flow into a building, heating and lighting it in an energy efficient way.

1. Structural Insulated Panels -

While structural insulated panels are not a new type of technology, but they are popular as an alternative to conventional wood frame construction. These panels can be custom fabricated individually for each project, making for an easier building design and construction. They also provide insulating values as high as R-45, depending on the thickness of the panel, by using polyurethane foam or compressed straw between the panels. Structural insulated panels are airtight, and make a building more comfortable and energy efficient.

2. Straw Bales -

Bales of straw staked together are another common Sustainable Building material used in home construction. The building is constructed using traditional framing methods and the space is filled with bales of straw rather than conventional nonrenewable fiberglass insulation.

Straw bale construction provides good insulation and thick walls resulting in deep windowsills. As well as warmth, straw bales also act as a good sound insulator from external road noise. The main disadvantage is water penetration of the straw bales which can cause a buildup of condensation, rot and deterioration.

3. Bamboo

Bamboo is relatively new to green construction. The sustainable plant grows fast and has little of no negative impact on the environment. Bamboo is stronger than steel and concrete, with bamboo poles fixed together in a similar way to wooden structures creating a stable structure. As well as walls, bamboo can be used to create beams, trusses and coverings. Buildings constructed from bamboo are not only beautiful but are also cost effective and beneficial to climate change reduction.

4. Recycled Cork-

Recycled cork waste is an energy-efficient thermal insulation material which can also be used for the sound proofing of rooms. Recycled cork and cork waste is a natural, renewable and relatively cheap construction material. No toxic gases are produced when made into floor tiles or wall panels which themselves can be stained, painted or dyed into any colour of choice. Cork is naturally waterproof but can be flammable at high temperature.

5. Non-VOC Products-

Paints, varnishes, wood preservatives, waxes contain volatile organic compounds (VOCs) which emit harmful indoor fumes and gases. Household products containing VOC may have short or long term adverse health effects in indoors once applied. VOC emissions also contribute to atmospheric degradation and climate change. Non-VOC products reduce the environmental impact of buildings by eliminating toxic ingredients increasing environmental and human health protection.

6. Reclaimed Wood-

Instead of exploiting depleted natural resources like trees and forests, wood reclamation yards are now becoming more common. Green and eco-friendy designers, builders and architects are starting to use more reclaimed materials in their constructions, increasing the buildings sustainability.

Recycled wood and lumber can not only be used for timber frame construction, as salvaged wood tends to be harder than new wood because it derives from older trees, but can be used in flooring and carpentry. The recycling of wood, lumber and wood waste reduces the cost of new materials, construction, and the consumption of natural resources. Recycled wood also decreases deforestation and the demand for more exotic timber.

1.4 AIM

"Promoting the Use of Environmentally-Friendly Construction Materials in Residential Buildings for Sustainable Development"

1.5 OBJECTIVES

2. Develop and implement sustainable construction materials to promote eco-friendly practices in residential building construction.
3. Enhance the availability and affordability of environmentally friendly construction materials for residential buildings, ensuring long-term sustainability.
4. Foster the use of sustainable construction materials in residential building projects to minimize environmental impact and promote resource efficiency.
5. Encourage the adoption of construction materials with a low carbon footprint in residential building construction, contributing to a more sustainable built environment.
6. Facilitate research and innovation in construction materials for residential buildings, focusing on sustainable options that support a greener and healthier living environment.

II. LITERATURE REVIEW

Johnny Kwok Wai Wong.et.al,2015

This paper aims to provide thought-provoking insights into the shortcomings in the scope of the existing green BIM literature, and outlines the most important directions for future research. A total of 84 green-BIM-related papers have been reviewed and compared. Most green BIM research. centres on environmental performance at the design (44 papers) and construction stages (25 papers) of building lifecycles. Few studies concentrated on the development of BIM-based tools for managing environmental performance during the building maintenance, retrofitting (8 papers), and demolition (12 papers) stages. It is suggested that a 'one-stop-shop' BIM for environmental sustainability monitoring and management over a building's full life cycle should be considered in future research. Future green BIM tools should also include the three R's concept (reduce, reuse and recycle) in their sustainability analysis for both new development and retrofitting projects.

F. Asdrubali.et.al,2015

The paper presents a comparison between two different rating systems to evaluate buildings sustainability: LEED (USA) and ITACA (Italy), thanks to the application of both methods to two residential buildings located in Italy.

The LEED Sustainable Building rating system encourages an integrated design approach, with a points scheme that allots credits for building design features deemed to improve sustainability, which includes reductions in energy use, improvements in indoor environment quality, protection of the construction site, reduction in water consumption and use of sustainable materials.

ITACA procedure, the environmental quality rating system adopted in Italy, consists of the compilation of a group of worksheets, one for each different performance indicator, at the aim of describing the building environmental quality, including the maintenance of indoor comfort during the entire life cycle.

The chosen buildings are located in central Italy; they are both energy efficient and designed according to the principles of bioclimatic architecture, even if they are characterized by different features. Five common areas (site, water, energy, materials, indoor environmental quality) were identified in order to compare the two methods and to normalize their score; this original approach can be transferred also to the comparison of other building environmental assessment tools.

Abraham Mwasha.et.al,2011

The focus of this paper is to investigate the principal sustainable energy performance indicators for modeling the sustainable performance of the residential building envelope and develop an approach for determining the most appropriate sustainable energy performance indicators. In doing that, this paper provides an overview of previous research on sustainable energy performance indicators and discusses conceptual framework for developing sustainable energy performance indicators. In order to identify these indicators that influence the capability of building performance assessment models, a comprehensive survey of construction industry professionals was conducted using questionnaire survey technique while the data was analyzed

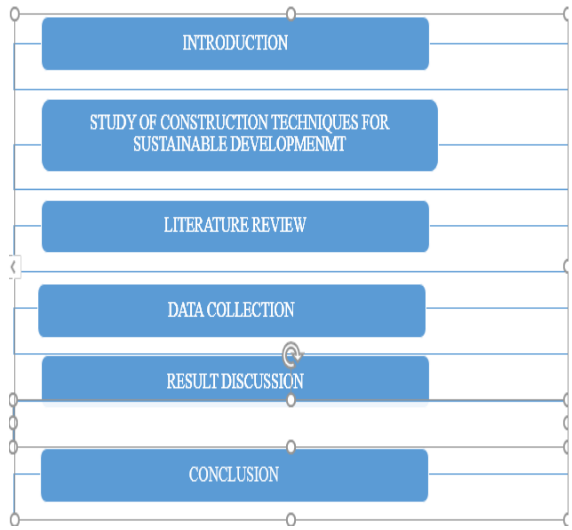
The success of modeling the sustainable performance of the residential building envelope will be to a great extent associated to the sustainable energy performance indicators used. The sustainable energy performance indicators that these building assessment models are developed around should be chosen by taking into account the targeted objectives. However, it is very common to find building performance assessment models that do not take into account these considerations and therefore have a limited capability and scope. This leads to inadequate aggregate indicators for the actual assessment of the sustainable performance of the building envelope for a sustainable energy efficient building.

Milad Samari1.et.al, 2012

In this research, the respondents were randomly selected from the professionals of Malaysian construction industry across the country and the method applied for collecting data is questionnaire survey. All the questionnaires were sent out to the respondents manually or through e-mail. A total of 673 sets of questionnaire were sent out and 167 (24.81%) questionnaires were received. The quantitative method was used for analysing data through SPSS version 19. Based on the results, the level of developing Sustainable Building in Malaysia is not satisfied and government has a key role in the development of Sustainable Buildings in Malaysia. The main barriers can be listed as: lack of credit resources to cover up front cost, risk of investment, lack of demand as well as higher final price.

Sustainable Building is the foundation of the sustainable construction development. Construction industry with the high contributes with gross domestic product, has undeniable impacts on the economy. Although Sustainable Buildings provide a wide range of benefits for the society, Sustainable Building development suffers from different kinds of market barriers in developing countries including Malaysia.

III. METHODOLOGY



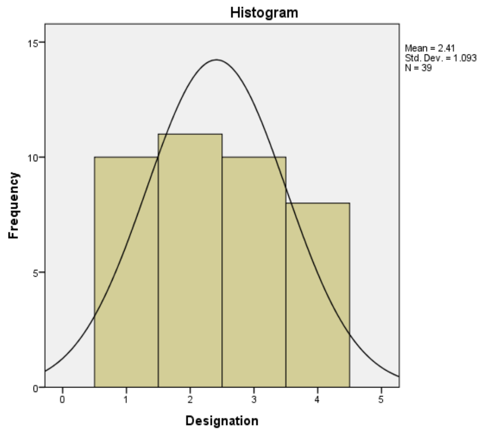
IV. DATA ANALYSIS & INTERPRETATION

SPSS is short for Statistical Package for the Social Sciences, and it’s used by various kinds of researchers for complex statistical data analysis. The SPSS software package was created for the management and statistical analysis of social science data. SPSS’s Visualization Designer program allows researchers to use their data to create a wide variety of visuals like density charts and radial boxplots from their survey data with ease. In addition to the four programs mentioned above, SPSS also provides solutions for data management, which allow researchers to perform case selection, create derived data, and perform file reshaping.

1. Designation

		Frequency	Percent
Valid	Project Manager	10	25.6
	Contractor	11	28.2
	Owner	10	25.6

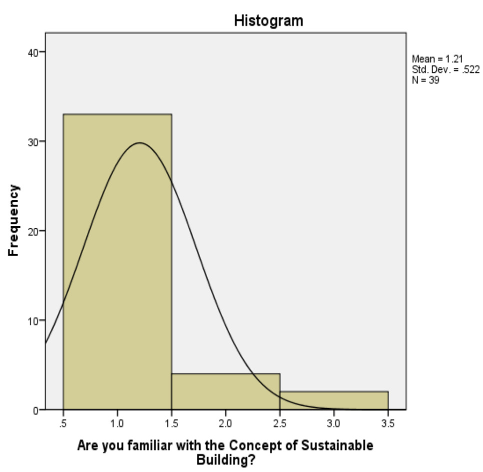
	Any other	8	20.5
	Total	39	100.0



Interpretation

We have taken the survey of designation. In The total responses is 39.it has minimum designation is any other (8cases, 20.5%), as well as maximum is contractor (11cases,28.2%)

		Frequency	Percent
Valid	yes	33	84.6
	No	4	10.3
	May be	2	5.1
	Total	39	100.0

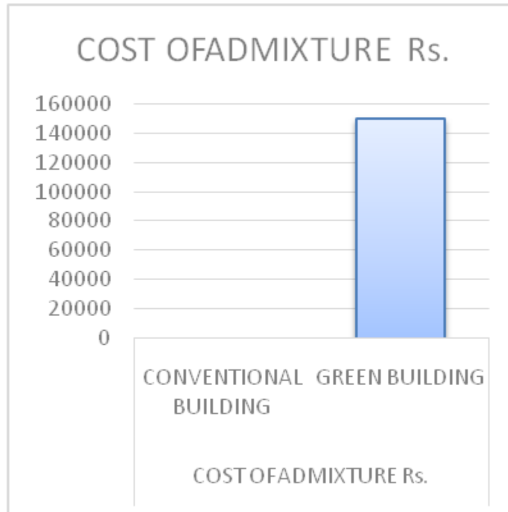


Interpretation

We have taken the survey of Are you familiar with the Concept of Sustainable Building. In The total respondents is 39.it has minimum respondents is May be (2,5.1) as well as maximum respondents is Yes (33,84.6)

V. RESULT

COST OFADMIXTURE Rs.	
CONVENTIONAL BUILDING	**GREEN BUILDING**
1559950	1114151

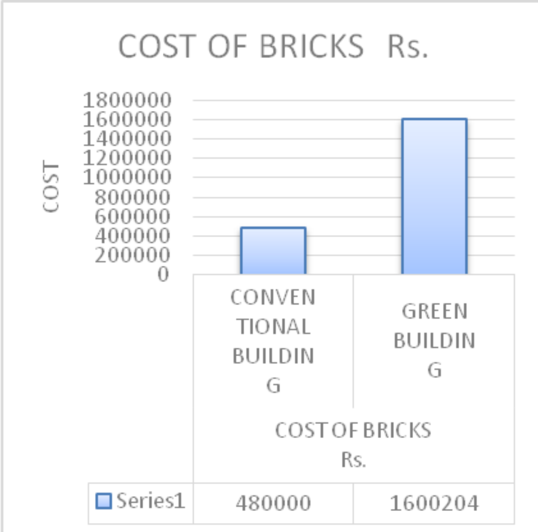


Conventional Building: The cost of admixture is Rs. 1,559,950.

Green Building: The cost of admixture is Rs. 1,114,151.

The table indicates that the cost of admixture in a green building is significantly lower compared to a conventional building.

COST OF BRICKS Rs.	
CONVENTIONAL BUILDING	**GREEN BUILDING**
480000	1600204

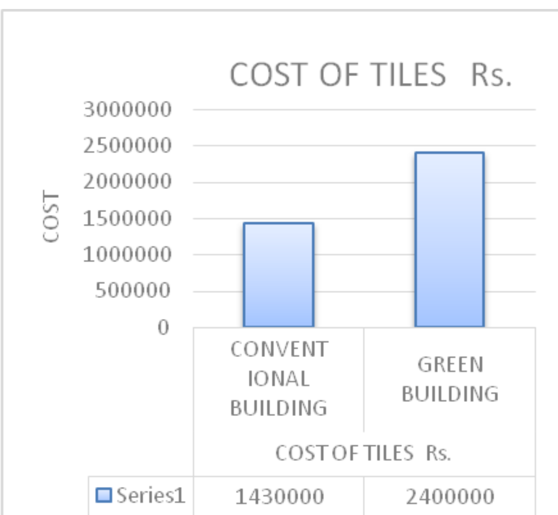


The table illustrates the cost of bricks in two different types of buildings: a conventional building and a green building. The cost is measured in Indian Rupees (Rs).

For the conventional building, the cost of bricks is Rs. 480,000.

In contrast, the cost of bricks for the green building is significantly higher, totaling Rs. 1,600,204.

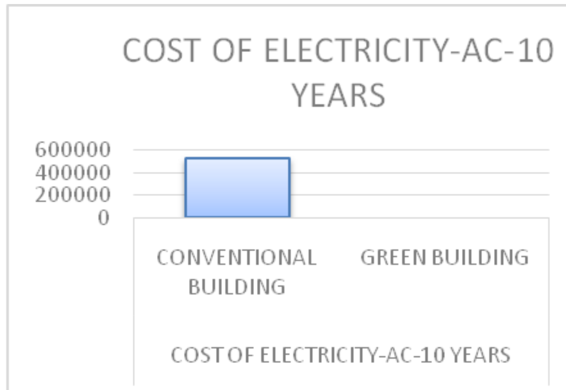
COST OF TILES Rs.	
CONVENTIONAL BUILDING	**GREEN BUILDING**
1430000	2400000



In the case of conventional buildings, the cost of tiles is Rs. 1,430,000. This represents the amount of money required to purchase and install tiles in a typical conventional building.

On the other hand, green buildings, which are designed with sustainable and environmentally friendly features, have a higher cost of tiles. In this scenario, the cost of tiles for a green building is Rs. 2,400,000. The increased cost reflects the use of eco-friendly and energy-efficient tiles, which may be more expensive compared to traditional options. The higher investment in green building materials aligns with the goal of reducing environmental impact and promoting sustainability.

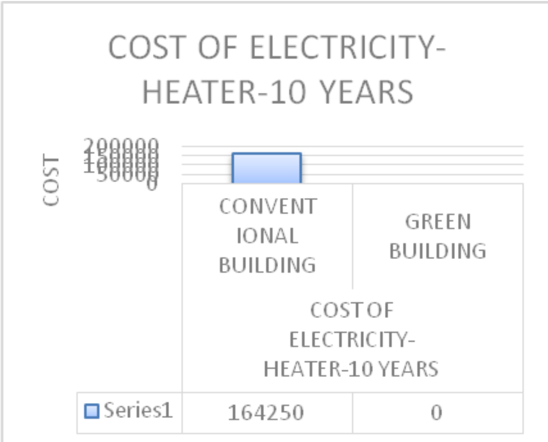
COST OF ELECTRICITY-AC-10 YEARS	
CONVENTIONAL BUILDING	**GREEN BUILDING**
529250	0



In the case of the conventional building, the cost of electricity for AC usage amounts to $529,250 over the 10-year period.

On the other hand, the green building is designed to be energy-efficient and employs sustainable practices. As a result, it incurs zero costs for electricity in relation to AC usage during the same 10-year timeframe

COST OF ELECTRICITY-HEATER-10 YEARS	
CONVENTIONAL BUILDING	**GREEN BUILDING**
164250	0



In the conventional building, the cost of electricity for the heater over the 10-year period amounts to $164,250. This indicates the total expenses associated with operating the heater using conventional energy sources in the conventional building.

On the other hand, the green building demonstrates a significant contrast, as the cost of electricity for the heater over the same 10-year duration is $0. This implies that the green building utilizes alternative energy sources or energy-efficient technologies that effectively eliminate the need for electricity expenses associated with the heater.

VI. CONCLUSION

the selection of construction materials plays a vital role in promoting a sustainable environment within residential buildings. By embracing sustainable materials, we can significantly reduce the negative environmental impacts associated with traditional construction practices.

The use of sustainable construction materials, such as recycled steel, reclaimed wood, and energy-efficient insulation, allows us to minimize the depletion of natural resources. These materials also contribute to lower greenhouse gas emissions and help combat climate change. Additionally, incorporating renewable energy systems, like solar panels or geothermal heating, further enhances the sustainability of residential buildings.

Furthermore, sustainable materials offer numerous benefits beyond environmental considerations. They often exhibit superior durability, reducing the need for frequent repairs and replacements. This not only lowers maintenance costs but also ensures long-term structural integrity. Moreover, sustainable materials can enhance indoor air quality by minimizing the release of harmful chemicals, thus promoting healthier living environments for residents.

The adoption of sustainable construction materials in residential buildings represents a shift towards a more responsible and eco-friendly approach to development. While initial costs may be slightly higher, the long-term savings, both in terms of energy efficiency and maintenance, make them a wise investment. It is essential for architects, builders, and homeowners to recognize the importance of sustainable materials and embrace their use to create a harmonious balance between human needs and environmental preservation.

Ultimately, by prioritizing sustainable materials, we can construct residential buildings that not only provide comfortable and healthy spaces for occupants but also contribute positively to the overall well-being of our planet.

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