COMPARISON OF DIFFERENT BUILDING MATERIALS FOR ENHANCEMENT OF BUILDING COMFORT

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Abstract

As people spend more time indoors, the need for buildings that are not only energy-efficient but also comfortable and healthy has become more critical. The objective of this project is to compare the performance of different building materials in enhancing the building comfort by monitoring the temperature levels of three different rooms on an hourly basis. In order to achieve this objective, a sensor was designed and installed in each room to record the temperature readings. The data collected by the sensors was then analyzed and compared to determine the effect of different building materials on the indoor environment. The experiment was conducted over a period of 21 days and the data was collected for each hour of the day. The results of the study indicated that the choice of building material has a significant impact on the indoor environment, with some materials performing better than others in terms of maintaining comfortable temperature levels do. The data collected was then presented in graphical form to facilitate easy comparison of the performance of different building materials. Overall, the findings of this study can be used to inform decisions about the choice of building materials for different construction projects in order to optimize the building comfort and ensure a healthy indoor environment.

Keyword- Temperature measurement device, Enhancement of building comfort, Three Different Building Materials clay burnt Brick masonry, Stone Masonry and AAC Block

I. INTRODUCTION:

Buildings are fundamental to our daily lives, providing us with shelter, security, and comfort. With an increasing number of people spending most of their time indoors, it has become more important than ever to create buildings that are not only energy-efficient but also comfortable and healthy. Building materials play a crucial role in achieving these goals, as they can affect the indoor environment's thermal, acoustic, and visual properties. By using appropriate materials, buildings can provide a comfortable indoor environment, reduce energy consumption, and improve occupants' health and well-being.

This project fills that research gap by conducting a detailed evaluation of various building materials. By installing sensors in three distinct rooms and collecting data over a 21-day period, we will capture the fluctuations in temperature throughout the day and night. The data collected will provide valuable insights into the performance of different materials and their influence on indoor comfort.

In summary, this project aims to contribute to the understanding of the impact of building materials on indoor comfort. By comparing the performance of different materials through continuous monitoring of temperature levels, we seek to provide valuable insights for enhancing building design and material selection, ultimately creating comfortable and healthy indoor environments.

1 Definition of Building Comfort:

Building Comfort, in terms of thermal insulation, involves creating a well-insulated and thermally efficient building envelope that effectively regulates indoor temperature, reduces energy consumption, and provides a comfortable and pleasant living or working environment for occupants.

Thermal insulation plays a crucial role in achieving building comfort by reducing heat gain or loss through the building envelope, which includes walls, roofs, floors, and windows. It involves the use of materials and construction techniques that limit the transfer of heat, helping to maintain a stable and comfortable indoor temperature.

2 Background

The background of the project lies in the importance of creating comfortable living and working environments. Buildings play a crucial role in providing shelter, and the comfort of occupants is essential for their well-being, productivity, and overall quality of life. The selection of suitable building materials can significantly affect indoor temperature levels, thereby influencing the comfort and satisfaction of occupants.

The project aims to assess and compare the performance of different building materials in terms of their impact on indoor temperature and humidity. This assessment is conducted by deploying sensors in three

different rooms constructed with different materials. The sensors measure temperature levels on an hourly basis, providing valuable data for analysis.
By studying and comparing the data collected from the three rooms, the project seeks to identify
Patterns, trends, and variations in temperature and humidity. This information can help determine which building materials contribute to improved indoor comfort. The project also aims to create graphical representations of the data, enabling visual interpretation and facilitating easy comparison between the rooms.

3. Need of study

As people spend more time indoors, there is a greater need for buildings that are not only energy-efficient but also comfortable and healthy.
The need for this project stems from the growing awareness of the impact of the built environment on human health and well-being.
Building materials play a critical role in achieving these goals, and there is a need to understand their advantages and limitations in different contexts.
This project will contribute to the development of sustainable and healthy building design by providing a comprehensive review of building materials for enhancing building comfort.

4. Scoop of Study

- The study specifically focuses on evaluating the performance of different building materials in enhancing building comfort, with a particular emphasis on temperature levels. The selection of materials plays a critical role in determining the indoor environment's quality, and your study aims to compare their effects.
- The scope of this project is to explore the different types of building materials that can be used to enhance building comfort and to evaluate their effectiveness and practicality.
- The project will focus on materials such as insulation, concrete, wood, green roofs, and rammed earth, among others.
- The project will involve a literature review of existing research and case studies of buildings that have successfully incorporated these materials.
- The project will also evaluate the challenges and limitations associated with using these materials in building design and construction and provide recommendations for their use in different contexts.
- The project will not cover the technical details of the installation or maintenance of these materials but will focus on their potential benefits and drawbacks in creating a comfortable indoor environment.

II OBJECTIVES

- To Review the literature on building materials for enhancing building comfort..
- To assess the effect of different building materials on maintaining comfortable temperature level..
- To monitor and analyze the temperature levels in three different rooms using sensors installed in each room.
- To compare the performance of different building materials in terms of enhancing indoor building comfort.
- To Evaluate the challenges and limitations associated with using these materials in building design and construction.
- To provide insights and recommendations for the selection of building materials that optimize building comfort and ensure a healthy indoor environment.

By achieving these objectives, this project aims to enhance our understanding of the importance of building materials in creating comfortable indoor environments and to provide practical guidance for architects, designers, and builders seeking to incorporate these materials in their projects.

III LITRATURE REVIEW

[1] Iftikhar A Raja, J. Fergus Nicol, Kathryn J McCartney, and Michael A Humphreys (2001), "Thermal comfort: use of controls in naturally ventilated buildings"

This review paper examines both logical and adaptive approaches to provide an overview of thermal comfort. The authors present a thorough examination of the thermoregulatory system of the human body as well as mathematical simulations of heat transfer between the human body and its surroundings. The review includes both awake and sleeping people in a variety of scenarios. This paper clarifies the idea of thermal comfort and its implications in various contexts by reviewing pertinent literature. The results also provide insights into predicting the impact of temperature on the ventilation rate in naturally ventilated buildings.

[2] Aydin Gezer, Nevin. (2003) the effects of construction materials on thermal comfort in residential buildings.

The paper examines the impact of different construction materials on thermal comfort in residential buildings through the use of Ecotect 5.0, a computer program that simulates the indoor thermal environment of a building.
The authors conducted a case study to analyze the thermal performance of three different building models with different construction materials: a concrete building, a brick building, and a building with a combination of concrete and brick. The study showed that the choice of construction material has a significant impact on the thermal comfort of a building. The concrete building had the highest thermal inertia, which led to a slower response time to changes in outdoor temperature and higher indoor temperatures in the summer. The brick building had a lower thermal inertia and therefore had a more rapid response to changes in outdoor temperature, resulting in more stable indoor temperatures.
Overall, the paper provides useful insights into the importance of Construction materials in achieving thermal comfort in residential buildings.

[3] Noël Djongyang, René Tchinda, and Donatien Njomo (2010), "Thermal comfort: A review paper"
This review paper examines both logical and adaptive approaches to provide an overview of thermal comfort. The authors present a thorough examination of the thermoregulatory system of the human body as well as mathematical simulations of heat transfer

between the human body and its surroundings. The review includes both awake and sleeping people in a variety of scenarios. This paper clarifies the idea of thermal comfort and its implications in various contexts by reviewing pertinent literature.

[4] Spiru Paraschiv (2021), "Increasing the energy efficiency of a building by thermal insulation to reduce the thermal load of the micro-combined cooling, heating and power system."

The paper discusses the potential benefits of improving the energy efficiency of buildings through thermal insulation in order to reduce the thermal load of micro-combined cooling, heating, and power systems. The authors conducted a case study to analyze the thermal performance of building

and the effectiveness of thermal insulation in reducing energy consumption. The results indicated that thermal insulation can significantly reduce consumption of energy and improve the performance of micro-combined cooling, heating, and power systems. The authors also discussed the importance of considering various factors, such as climate conditions and building materials, when implementing thermal insulation measures in buildings. Overall, the paper provides valuable insights into the potential benefits of thermal insulation in improving the energy efficiency of buildings and reducing the thermal load of micro-combined cooling, heating, and power systems

IV.METHODOLOGY

The experimental aspect of the study is focused on comparing the performance of different building materials in enhancing building comfort. This involves selecting and installing specific materials in the three different rooms to create controlled conditions for data collection. By
Manipulating the independent variable (building materials), we can observe and measure the effects on the dependent variables (temperature levels).
The observational aspect of the study involves continuously monitoring the temperature levels in each room using installed sensors. This allows for the collection of real-time data over a 21-day period, providing insights into the variations and trends in indoor environmental conditions.
This combination of experimental and observational design was chosen to achieve the research objectives effectively. By conducting controlled experiments, we can directly compare the performance of different building materials under consistent conditions. This enables us to identify and measure the specific impact of each material on indoor comfort.
The observational aspect complements the experimental design by capturing the natural fluctuations and dynamics of temperature levels in real-world settings. It allows us to analyze the long- term trends, diurnal patterns, and interactions between various factors that may influence indoor comfort.
By using a combination of experimental and observational approaches, we can obtain comprehensive and reliable data on the performance of different building materials in enhancing building comfort. This design aligns with the research objectives of comparing materials, analyzing their effects on temperature levels, and providing insights for informed decision-making in building material selection.

Avg. Temperature Data During Day from 06:00 AM to 06:00 PM					
Date	**Day**	**Avg. Temperature**			**Outdoor Temperature**
		Room 1	**Room 2**	**Room 3**	
05-03-2024	1	32	31	30	34
06-03-2024	2	32	31	30	34
07-03-2024	3	31	30	29.5	33
08-03-2024	4	33	32.5	32	34
09-03-2024	5	32.5	32	31.8	33
10-03-2024	6	32	31.7	31	33
11-03-2024	7	32.6	32.1	29.8	33
12-03-2024	8	32.8	32.3	29.9	33
13-03-2024	9	32.9	32.6	31.5	33
14-03-2024	10	33	32.8	31.7	34
15-03-2024	11	32.4	32	31.5	33
16-03-2024	12	32.5	32.1	31.6	33
17-03-2024	13	33	32.5	32.1	34
18-03-2024	14	32.7	32.3	31	33
19-03-2024	15	33.4	33	32.5	34
20-03-2024	16	33.2	32.8	32	34
21-03-2024	17	33.5	32.9	32.1	34
22-03-2024	18	33.6	32.9	32.1	34
23-03-2024	19	32.6	31.8	30.9	33
24-03-2024	20	32.1	31.5	31	33
25-03-2024	21	33.5	33	32.5	34

Data Analysis

Table of Temperature Data During Day Period

Avg. Temperature Data During Night from 06:00 PM to 06:00 AM					
Date	Day	Avg. Temperature			Outdoor Temperatre
		Room 1	Room 2	Room 3	
05-03-2024	1	24.6	23.5	22.4	26
06-03-2024	2	23.9	22.7	21.5	25
07-03-2024	3	24.9	23.6	22.6	26
08-03-2024	4	22.7	21.7	20.6	24
09-03-2024	5	21.8	20.4	20	23
10-03-2024	6	22.8	21.7	20.4	24
11-03-2024	7	24	22.7	21.4	25
12-03-2024	8	22.8	21.5	20.4	24
13-03-2024	9	22.8	21.7	20.4	24
14-03-2024	10	22.5	21.4	20	24
15-03-2024	11	23.6	22.3	21.2	25
16-03-2024	12	22.5	21.2	19.9	24
17-03-2024	13	22.7	21.7	20	24
18-03-2024	14	23.7	22.4	21.3	25
19-03-2024	15	22.6	21.4	20.1	24
20-03-2024	16	23.5	22.2	21.2	25
21-03-2024	17	23.7	22.5	21.5	25
22-03-2024	18	23.6	22.5	21.2	25
23-03-2024	19	23.7	22.3	21.2	25
24-03-2024	20	23.6	22.6	21.3	25
25-03-2024	21	26.7	25.2	23.9	28

Table of Temperature Data During Night Period

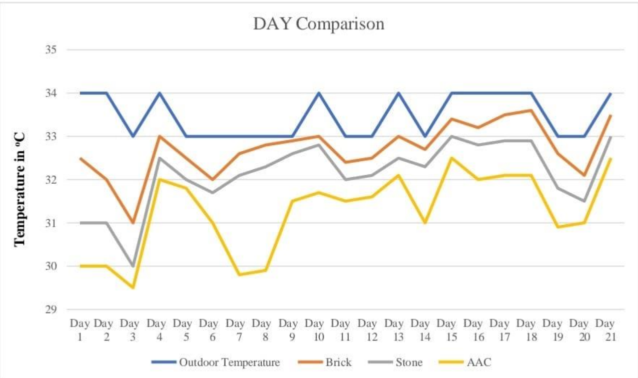
Temperature Data at 12:00 PM					
Date	Day	Avg. Temperature			Outdoor Temperaure
		Room 1	Room 2	Room 3	
05-03-2024	1	31.8	30.8	29.7	33
06-03-2024	2	30	28.8	27.6	31
07-03-2024	3	30.9	29.5	28.5	32
08-03-2024	4	30.8	29.6	28.2	32
09-03-2024	5	29.7	28.3	27	31
10-03-2024	6	31	29.8	28.7	32
11-03-2024	7	30.6	29.6	28.1	32
12-03-2024	8	30.5	29.2	27.8	32
13-03-2024	9	30.9	29.9	28.6	32
14-03-2024	10	30.8	29.6	28.2	32
15-03-2024	11	30.6	29.5	28.2	32
16-03-2024	12	29.7	28.7	27.4	31
17-03-2024	13	31.7	30.4	29.4	33
18-03-2024	14	31.7	30.4	29	33
19-03-2024	15	32	30.9	29.9	33
20-03-2024	16	30.7	29.5	28.1	32
21-03-2024	17	30.6	29.3	28.3	32
22-03-2024	18	31	29.5	28.5	32
23-03-2024	19	29.6	28.6	27.1	31
24-03-2024	20	31	29.6	28.2	32
25-03-2024	21	31.6	30.6	29.2	33

Table 3.4 Table of Temperature Data at 12:00 PM

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

RESULT & ANALYSIS

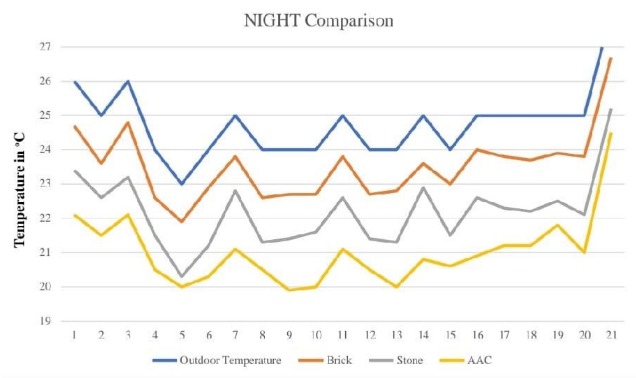
Comparison of average day-time temperature between outdoor and all rooms



Graph Temperature Variation Comparison (Outdoor vs All Rooms) Day

- The average temperature inside the room with a brick wall is consistently lower than the outdoor temperature, with an average difference of approximately 1.3 to 2.3 °C.
- The room with a stone wall also maintains a lower average temperature compared to the outdoor temperature, with an average difference of approximately 2.4 to 3.6 °C.
- The AAC block room shows the lowest average temperature among the three rooms, with an average difference of approximately 3 to 4.1 degrees Celsius compared to the outdoor temperature.
- The brick wall provides moderate insulation, as it demonstrates a relatively smaller temperature difference between the indoor and outdoor environments compared to the stone and AAC block walls.
- The stone wall exhibits slightly lower insulation performance, allowing more heat transfer from the outside to the inside, resulting in a higher indoor temperature.
- The AAC block wall, with its superior insulation properties, shows the highest level of thermal resistance, resulting in the lowest indoor temperature.

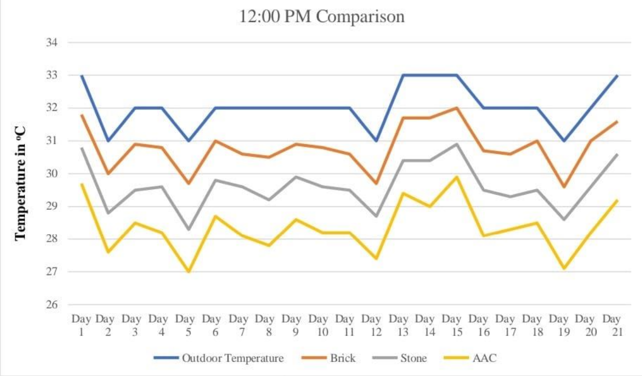
Comparison of average night-time temperature between outdoor and all rooms



Graph 4.8 Temperature Variation Comparison (Outdoor vs All Rooms) Night

- The brick room consistently maintains a lower average temperature compared to the outdoor temperature during the night, with an average difference of approximately 1.2 to 2.2 °C.
- The stone room also exhibits a lower average temperature compared to the outdoor temperature, with an average difference of approximately 1.8 to 2.9 °C.
- The AAC block room shows the lowest average temperature among the three rooms, with an average difference of approximately 2.6 to 3.5 degrees Celsius compared to the outdoor temperature.
- The temperature trends observed during the night follow a similar pattern for all three rooms, reflecting the impact of outdoor temperature variations on the indoor environment.
- The rooms with all three wall types show lower indoor temperatures compared to the outdoor temperature during the night, indicating improved thermal comfort.
- The brick and stone rooms provide better thermal comfort compared to the AAC block room due to their relatively lower temperature differences between indoor and outdoor environments.
- The AAC block room may require additional heating during colder periods to maintain optimal comfort levels

Comparison of temperature at 12:00 PM between outdoor and all the three rooms.



Graph 4.12 Temperature Variation Comparison (Outdoor vs All Rooms) at 12:00 PM

- Brick: The room temperature for the Brick material generally remains slightly lower than the outdoor temperature. This trend is consistent across most of the data points provided for Brick.
- Stone: Similar to Brick, the room temperature for the Stone material is slightly lower than the outdoor temperature in most cases. However, there may be a slightly larger temperature difference between the outdoor and room temperature compared to Brick.
- AAC (Autoclaved Aerated Concrete): The room temperature for the AAC material tends to be lower than the outdoor temperature, similar to Brick and Stone. However, there may be a slightly higher temperature difference between the outdoor and room temperature for AAC.
- All materials: Regardless of the material, there is a general trend of the room temperature being slightly lower than the outdoor temperature. This indicates that the materials used in the construction have a cooling effect on the indoor environment.
- There are differences in the room temperature among the materials for the same outdoor temperature.

V. CONCLUTION

Bricks are known for their high thermal mass, which means they can absorb and store heat effectively. However, in terms of thermal resistance, bricks alone are not very efficient. They have moderate insulation properties and tend to conduct heat relatively easily. To enhance the thermal resistance of brick walls, additional insulation materials such as polystyrene or mineral wool can be added.

Natural stone, like brick, also possesses high thermal mass. It can store and release heat slowly, which can help regulate temperature fluctuations. However, similar to bricks, stone itself is not an excellent insulator. Its thermal conductivity is relatively high, which means it can transfer heat readily. Stone walls may require additional insulation layers to improve their thermal resistance.

AAC blocks are lightweight, precast concrete blocks that have been infused with air bubbles during the manufacturing process. These air bubbles contribute to their excellent insulation properties. AAC blocks offer higher thermal resistance compared to traditional brick or stone. They have lower thermal conductivity, which means they are less prone to heat transfer. Consequently, AAC blocks provide better insulation against heat and cold.

In summary, between brick, stone, and AAC blocks, the latter, Autoclaved Aerated Concrete (AAC) blocks, generally provide better thermal resistance due to their lower thermal conductivity and superior insulation properties

VI. RECOMMENDATIONS

1. Polystyrene
2. Glass Wool Insulation
3. Polyurethane (PU) FoamInsulation
4. Cellulose
5. Reflective Insulation

VII REFERENCES

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