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Green Built Environment with Eco-Friendly Insulation Materials in Concrete Cavity Wall

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Abstract—*The construction sector is continuously making efforts to enhance sustainability by adopting environmentally-friendly and economically viable materials and technologies. This endeavour arises from the necessity to minimize the negative effects of construction on non-renewable resources and energy usage. To accomplish this objective, scientists and experts are investigating various possibilities, such as utilizing recycled materials, responsibly sourcing wood, incorporating waste materials, implementing green roofs, utilizing by-products, installing solar panels, and employing water-saving technologies.*

Present study observes environment friendly insulation material such as Coconut coir, in Concrete cavity wall with Temperature and Moisture sensors and determine thermal conductivity using the R-Value in HVAC systems. The cavity wall's concrete composition was formulated using industrial by-products and waste materials. The construction techniques employed in the research project offer favourable acoustic properties, lower embodied energy, and improved thermal and noise insulation. Study concludes by checking the feasibility of the HVAC system with different biodegradable insulation materials in the cavity between the walls, as it is eco-friendly and economical in applications such as theatres, malls and conventional halls etc.

Keywords: *Waste materials, Cavity wall, Thermal insulation, HVAC system.*

INTRODUCTION

The construction industry plays a vital role in addressing global sustainability challenges and promoting a green built environment. With the increasing focus on energy efficiency and environmental conservation, there is a growing interest in exploring eco- friendly insulation materials for enhancing the performance of buildings. This research paper aims to investigate the feasibility and effectiveness of incorporating eco-friendly coconut coir insulation material in concrete cavity walls to create a sustainable and energy-efficient built environment. The idea of a green constructed environment centres on the creation, building, and management of structures that limit their ecological footprint while prioritizing the health and welfare of occupants. Sustainable construction methods aim to diminish energy usage, preserve resources, and decrease emissions of greenhouse gases. One crucial aspect of achieving energy efficiency in buildings is the effective insulation of the building envelope, particularly the walls.

Concrete cavity walls are a commonly used construction technique that offers structural stability, durability, and thermal performance. Nonetheless, conventional insulation materials employed in cavity walls, like mineral wool or expanded polystyrene, frequently raise environmental issues related to their manufacturing, application, and disposal. Consequently, there is a burgeoning curiosity in investigating alternative insulation materials that are eco-friendly, provide similar or enhanced performance, and minimize their impact on the environment. Coconut coir, derived from the husk of the coconut, has gained attention as a potential eco-friendly insulation material. Coconut coir is a natural, renewable, and biodegradable material abundant in tropical regions. It offers several desirable properties, including excellent thermal insulation, moisture regulation, sound absorption, and fire resistance. Moreover, utilizing coconut coir insulation material provides an opportunity to repurpose a by-product that would otherwise be discarded or underutilized.

This research paper aims to assess the thermal performance, moisture resistance, and environmental impact of coconut coir insulation material in comparison to traditional insulation materials. By evaluating its suitability for concrete cavity walls, the paper seeks to provide insights into the feasibility of incorporating coconut coir insulation material in green built environments. The findings of this study will contribute to the knowledge base and promote sustainable practices within the construction industry.

LITERATURE SURVEY

Thermal Insulation

The thermal insulation performance of cavity walls is typically measured by the thermal conductivity or thermal resistance of the insulation material used. Thermal conductivity, often denoted as λ (lambda), represents the material's ability to conduct heat. As the thermal conductivity value decreases, the insulation performance improves, resulting in reduced heat transfer through the material.

Characteristics and Effectiveness of Insulation Materials

Insulation materials serve the purpose of reducing heat transfer and improving energy efficiency in buildings. Each insulation material has its unique characteristics and benefits in terms of performance. When selecting the most appropriate insulation material for a specific application, it is essential to consider factors such as thermal resistance, fire resistance, moisture resistance, sound absorption, environmental impact, and installation requirements.

Thermal Conductivity (K-Value)

Thermal conductivity is the metric used to evaluate the heat transfer per unit area over time through a plate of a particular material with a standardized thickness. It quantifies the material's capacity to transmit heat when there is a one-unit temperature difference between the opposing surfaces of the plate. It occurs when heat moves along a temperature gradient from a high temperature which has a high-molecular- energy region to a lower temperature which has a low-molecular-energy region.

Thermal Resistance (R-Value)

Thermal resistance is characterized as the relationship between the temperature disparity across a material's two sides and the rate at which heat is transferred per unit area. It is measured in units of m2 · K/W (square meter kelvin per watt). The insulation effectiveness of a building material increases with a higher R-value. The R-value is measured according to the ASTM C168 standard. It can be calculated based on the temperature differential and heat flux.

Thermal Transmittance (U-Value)

The U-value for coconut coir insulation material can vary depending on factors such as its thickness, density, and the specific manufacturing process used. Since coconut coir is a relatively niche and less commonly used insulation material, there may not be readily available standardized U-value data specifically for coconut coir insulation.

MATERIALS AND METHODOLOGY

The Whole Process of development of Concrete Cavity Wall is explained below

Fig. 3.1: Reinforcement for Foundation and for double wall

Fig. 3.2: Construction materials like Stone Dust, Fine Aggregates, Cement, and Bauxite are commonly utilized

Proportioning of Ingredients: Based on the mix design, the proportions of cement, fine aggregate (including stone dust as a partial replacement), coarse aggregate, Bauxite and water are determined. The formwork should be designed and laid out to match the desired dimensions, shape, and alignment of the cavity wall. This includes determining the thickness of the wall, the position of openings (such as windows and doors), and any architectural details of features.

Fig. 3.3: Form Work and Mixing of Concrete

Casting and Curing: The freshly mixed concrete is then cast into the cavity wall formwork. The formwork should be properly prepared and positioned to shape the desired cavity wall. After casting, the concrete is cured to ensure proper hydration and strength development. Curing was done for up to 14 Days.

Fig. 3.4: Curing

Fig. 3.5: Plastering

Coconut Coir Insulation and sensors – After incorporating coconut coir in the insulation, frequent watering to the coir should be done by using the Moisture Temperature sensors.

Fig. 3.6: Concrete Cavity Wall Prototype with Insulation

Data Collection using the arduino software, the data from Temperature and Moisture sensors is noted for every 15s (Real time data for every 15s is generated)

Fig. 3.7: Frequent generation of data from the sensors and the software

RESULTS AND CONCLUSION

By utilizing sensors and the Arduino software, data analysis has revealed a temperature disparity ranging from 6°C to 8°C between the exterior and interior walls.

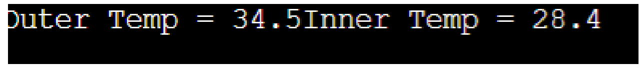

Fig. 4.1: Results from the Arduino Dashboard (Output)

In conclusion, the incorporation of eco-friendly coconut coir insulation material in concrete cavity walls offers significant benefits in creating a green built environment. The thermal insulation properties of coconut coir insulation contribute to reduced energy consumption and enhanced thermal comfort. Its moisture regulating capabilities help to maintain optimal humidity levels and prevent moisture related issues. Furthermore, the sustainability aspect of coconut coir insulation aligns with eco-conscious building practices and promotes the efficient use of resources. This Concrete Cavity Wall can be used in application of Theatres, Convention Centres and Malls.

REFERENCES

[1] P. Lertwattanaruk and A. Suntijitto, "Properties of natural fibre cement materials containing coconut coir and oil palm fibres for residential building applications," Constr. Build. Mater., vol. 94, pp. 664–669, 2015.

[2] J. Salas, M. Alvarez, and J. Veras, "Lightweight insulating concretes with rice husk," Int. J. Cem. Compos. Light. Concr., vol. 8, no. 3, pp. 171–180, 1986.

[3] Chacko, R., S. Hema, and M. Vadivel. 2016. "Experimental studies on co-conut fibre and banana fibre reinforced concrete." Int. J. Earth Sci. Eng.9(3):529–533.

[4] American Society of Heating, Refrigerating, and Air-Conditioning Engineers (2017). Pocket Guide for Air-Conditioning, Heating, Ventilation, and Refrigeration, 9th edn—SI (Atlanta).

[5] Wang, L., Chen, S. S., Tsang, D. C.W., Poon, C. S., and Shih, K. Value-added recycling of construction waste wood into noise and thermal insulating cement-bonded particleboards. Constr. Build. Mater. 125, 316–325. doi: 10.1016/j.conbuildmat.2016.08.053.

[6] Manu, S., Shukla, Y., Rawal, R., Thomas, L. E., and de Dear, R. (2016). Field studies of thermal comfort across multiple climate zones for the subcontinent: India Model for Adaptive Comfort (IMAC). Build. Environ. 98, 55–70. doi: 10.1016/j.buildenv.2015.12.019.

[7] How to use sensors using Arduino and Raspberry Pi, National Institute of Technology (2017), Department of Environmental Civil Engineering and Architecture web cite, http://www.kochict.ac.jp/~kimura/lecture.html.

[8] Oushabi, A., S. Sair, Y. Abboud, O. Tanane, and A. El-Bouari. 2015."Natural thermal-insulation materials composed of renewable resour-ces: Characterization of local date palm fibers (LDPF)." J. Mater.Environ. Sci. 6 (12): 3395–3402.

[9] Shu, L. S., A. E. Fiorato, and J. W. Howanski. 1979. "Heat transmission coefficients of concrete block walls with core insulation. "In Proc., ASHRAE/DOE-ORNL Conf. Thermal Performance of the Exterior Envelopes of Buildings,421–435. Atlanta: American Society of Heating Refrigerating and Air-Conditioning Engineers.

[10] Ali, M. 2010. "Coconut fibre: A versatile material and its applications in engineering." In Proc., 2nd Int. Conf. on Sustainable Construction Materials and Technologies, edited by J. Zachar, P. Claisse, T. R. Naik, E. Ganjian. Coventry, UK: International Committee of the SCMT Conferences.

[11] Dimdina, I., A. Jakovicˇs, S. Gendelis, and J. Klavin. 2013. "A testing ground for measuring influence of building envelope materials on energy efficiency and indoor environment."In Proc., CLIMA,editedby K. Kabele, M. Urban, K. Suchý, and M. Lain, 1–10. Prague, Czech Republic: Society of Environmental Engineering.

[12] L. Aditya et al., "A review on insulation materials for energy conservation in buildings," Renew. Sustain. Energy Rev., vol. 73, no. February, pp. 1352–1365, 2017.

[13] F. Asdrubali, F. D'Alessandro, and S. Schiavoni, "A review of unconventional sustainable building insulation materials," Sustain. Mater. Technol., vol. 4, no. 2015, pp. 1–17, 2015.

[14] Yuhazri, Y. M., H. Sihombing, A. R. Jeefferie, A. Z. A. Mujahid, A. G. Balamurugan, M. N. Norazman, and A. Shohaimi. 2011. "Optimization of coconut fibers toward heat insulator applications."Global Eng. Technol. Rev. 1 (1): 35–40.

[15] Dimdin□a, I., A. Jakovicˇs, S. Gendelis, and J. Klavin. 2013. "A testing ground for measuring influence of building envelope materials on energy efficiency and indoor environment."In Proc., CLIMA,editedby K. Kabele, M. Urban, K. Suchý, and M. Lain, 1–10. Prague, Czech Republic: Society of Environmental Engineering.