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A Review Article on "Sustainable Construction Material"

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ABSTRACT: Sustainable construction materials have gained immense significance in the contemporary era due to environmental concerns, resource depletion, and the need for more eco-friendly building practices. This review article aims to comprehensively analyze and summarize the various sustainable construction materials, their characteristics, advantages, limitations, and applications in the construction industry. The article begins by defining the concept of sustainable construction materials, emphasizing the importance of environmental, social, and economic sustainability. It explores a wide array of materials such as Human Hair fiber, bamboo, fly ash, coconut fiber, and more. Each material's sustainable attributes, including recyclability, durability, energy efficiency, and reduced environmental impact, are thoroughly examined. Furthermore, the review investigates the manufacturing processes, life cycle assessment, and environmental performance of these materials. It discusses the challenges and barriers to the widespread adoption of sustainable construction materials, including cost considerations, regulatory hurdles, and technological limitations. Finally, the review outlines future research directions and potential advancements in sustainable construction materials, emphasizing the need for continued innovation, education, and collaboration among stakeholders to promote their integration into mainstream construction practices.

KEYWORDS: Sustainable construction, Construction materials, Eco-friendly materials, green building, Environmental sustainability, Recycled materials

I. INTRODUCTION

The global construction industry is undergoing a transformative shift towards sustainability, prompted by the pressing need to mitigate environmental impacts, conserve resources, and foster a more resilient built environment. Within this paradigm shift, the quest for sustainable construction materials has emerged as a pivotal area of focus, offering innovative solutions to address the challenges of climate change, resource scarcity, and environmental degradation. This review article aims to provide a comprehensive examination and analysis of sustainable construction materials, exploring their diverse range, inherent properties, applications, and their potential to revolutionize the construction landscape. In an era marked by heightened environmental consciousness and the pursuit of more responsible building practices, understanding and integrating these materials into construction processes hold immense promise for achieving a greener, more sustainable future.

The discourse begins by elucidating the concept of sustainability in construction, emphasizing the multifaceted dimensions encompassing environmental, social, and economic considerations. It navigates through the evolution of construction materials, highlighting the imperative for a paradigmatic shift towards eco-friendly, resource-efficient alternatives that minimize environmental impact and enhance resilience. Through a systematic exploration of various sustainable construction materials, this review will delve into their distinct properties, production processes, and performance characteristics. Materials such as recycled aggregates, bamboo, engineered wood, rammed earth, hempcrete, and others will be examined in-depth, shedding light on their sustainability attributes, structural viability, thermal properties, and overall environmental footprint. Moreover, the review will critically evaluate the challenges and barriers hindering the widespread adoption of sustainable construction materials. Factors encompassing technological limitations, cost implications, regulatory frameworks, and market acceptance will be scrutinized, offering insights into the complexities associated with their integration into mainstream construction practices.

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II. LITERATURE REVIEW

[1] Sustainable Construction Materials for Buildings (2017)- Ritu and Sitender Chhillar

Sustainable construction is the way of adopting materials and products in building and construction that requires less use of natural resources and increases the usability of such materials and products for the same or similar purpose, thereby making reduction in waste generation as well. Moreover, sustainable construction technique enhances the resilience of the industry as such materials are readily available in the market. Steel and other metals, glass and prefabricated parts using combination of these, as well as recyclable alternatives for concrete are few examples of sustainable materials and products. Sustainable construction is to be started right with planning and design. So, the roles of developers, builders and designers are pivotal. Nevertheless, as sustainable construction involves prefabricated products also, it would be helpful to assign relevant specialists and suppliers early in the design stage. Again, implementation down the entire construction value chain is also necessary. There is a need for sharing and exchanging of knowledge and expertise in the design and the use of such materials. The capacity building and skill development in construction and installation are equally critical. From safety and quality point of view, the performance of such buildings and structures should remain high.

[2] Sustainable Building Replacing Normal Construction Materials with Sustainable Materials (2022)- Suhana Navas, Ruksana S, Riya Junaid, Aleeaha M Ali, Anees Beegom

The construction industry of the world is rapidly developing with the abrupt increase of the urban population. To meet the needs of the evolving industry and the surging population, the need of raw materials for the construction industry is rising day by day. Energy consumption in the building sector is very high. Carbondioxide emission are connected with offsite manufacturing of building materials and components (cradle to site). the materials such as cement, hollow concrete block, bricks, reinforcement bars etc. emit unconsiderable amount of carbondioxide during the manufacturing process. Embodied energy can be consumed directly in construction of building and other relative processes or indirectly for extracting raw materials manufacturing the building materials and relative products and transporting. In the present study we are entirely replacing the traditional material with sustainable material. Construction industry consumes more than fifty percentage of the raw materials obtained from the earth's crust. In the nearby future these resources will get emptied. So it's time to find the suitable sustainable alternative for the building components.

[3] Review of Sustainable Building Materials for Construction Industry (2020)-
Satyam Kumar, Vishal Puri, M. L. Aggarwal

In any construction activity, the material is an essential component. But in construction, there is a large dependency on man-made materials as compared with materials from natural resources. Manufacturing of manmade building materials emits a large amount of CO2, CO, NO2, and other environmentally unfriendly gasses and by-products which may be poisonous and harmful for human health as well as for the environment. Because of this infrastructure sector is one of the leading causes of environmental degradation. With drastic exposure in population in recent times, the demand for these man-made materials has been increased a lot. To meet this need of the current situation, we have to look for sustainable, eco-friendly materials that have characteristics like energy efficiency, easy availability, and not disturbing towards environment ecology system. The main aim of these green building materials is to reduce the impact of construction activities on human health and the natural environment.

[4] Advances in Sustainable Building Materials and Construction (2018)-
Prof. Dr. Moncef L. Nehdi

The built environment is the most energy-intensive sector of the economy. Moreover, the construction industry is the most responsible one worldwide for depleting natural resources. Portland cement production alone is currently the third largest source of global CO_2 anthropogenic emissions. With the advent of climate change threats to ecosystems, biodiversity, and human life, research on energy-efficient buildings as well as sustainable and eco-efficient construction materials has become of paramount importance. This Topical Collection seeks robust research studies on eco-efficient and carbon-neutral construction materials, building materials with high amounts of recycled content, the beneficiation of by-products and waste materials in construction, green construction practices, sustainable construction materials with enhanced mechanical, durability, and thermal performance, and related innovative research centered on the sustainability of building construction. Both experimental and modeling studies will be considered.

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[5] Naraindas Bheel, Paul Awoyera, Santosh mehro, Amelec Viloria, Carlos Alberto, Serverich sierra(GITEC) July 2020

Concrete is one of the most consumed human-made material in the world, annually 10 million tones of concrete are manufactured. It is molarability, strength& durability made it usable in building. A human hair used as fiber in concrete by the volume of cement sustainable development goals meet current needs & requirement without risk to figure generation.

[6] T. Naveen Kumar, Kamershetiy Gaoutami, Jinna Aditya, Kuppala Kavya, V-Raja Mahendar, R c Reddy And Shweta Kaushik (2015)

From this experiment study it is found that the optimum content of human hair fibre to be added to M40 grade of concrete is 1.5%, 2% is observed that there has been improvement in the properties of M40 grade of concrete in terms of its compressive strength, flexural strength and split tensile strength corresponding to the percentage of hair by weight of cement in concrete.

[7] Bamboo: A Sustainable and Low-Cost Housing Material for India (2016)-
Naman P. Parikh, Akshay Modi, Dr. Mayank K. Desai

Bamboo has very convincing structural properties. It has a high strength to weight ratio which shall facilitate lighter constructions. It has a tensile strength comparable to steel. Also bamboo composites can be produced to enhance the required properties. Bamboo has very good earthquake resistant properties. Using bamboo as a structural material may reduce the cost of construction to about 40%.

[8] Feasibility of using Coconut Fibre to Improve Concrete Strength (2022)-
Aliu Adekunle O , Fakuyi Funmi , Olabisi Williams

The use of coconut fibre to increase concrete's bearing capacity was looked into. A concrete beam measuring 50mm x 50mm x 1000mm, coconut fibre was added in varying amounts of 1%, 2%, 3%, 4% and 5% by weight in partial replacement of cement. Load Testing was done on the produced samples on days 7, 14, 21, and 28. It was found that concrete made with coconut fibres tends to be more load-resistant, and able to prevent the concrete from breaking apart after failure than conventional concrete.

GAP FINDINGS: -

Evaluate the cost implications of using sustainable materials compared to traditional materials. Identify any cost gaps and explore ways to make sustainable materials more economically viable. Investigate the potential for recycling and reusing construction materials, as this can significantly reduce waste and environmental impact. Identify gaps in infrastructure or technology for these practices. Assess the level of awareness and knowledge about sustainable construction materials among professionals in the industry. Identify gaps in education and training that hinder the adoption of sustainable practices. Assess the performance and durability of sustainable materials compared to conventional ones. Identify areas where sustainable materials may need improvement to gain wider acceptance. In this project, it is attempted to highlight the benefits and advantages of such materials and products for construction of buildings and structures.

III. PROPOSED METHODOLOGY

1. **Data Collection:**

- Collect relevant literature, academic papers, reports, case studies, and authoritative sources focusing on sustainable construction materials.
- Categorize collected data based on the type of materials and their sustainability attributes.

2. **Critical Analysis and Synthesis:**

- Review and analyze each selected article or source critically, extracting key information related to the properties, manufacturing processes, environmental impact, and applications of various sustainable construction materials.
- Organize and synthesize the gathered information into thematic sections, highlighting the characteristics, advantages, limitations, and applications of each material.

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3. **Comparison and Evaluation:**
- Compare and contrast different sustainable construction materials based on their sustainability attributes, structural performance, environmental impact, cost-effectiveness, and feasibility for widespread adoption.
- Evaluate the strengths and weaknesses of each material, considering their suitability for various construction applications and their impact on the overall sustainability of the built environment.

4. **Identification of Challenges and Future Directions:**
- Identify and discuss the challenges, barriers, and limitations hindering the widespread adoption of sustainable construction materials in the industry.
- Propose potential avenues for research, technological advancements, policy interventions, and industry initiatives to overcome these challenges and promote the integration of sustainable materials in construction practices.

IV. CONCLUSION

The exploration of sustainable construction materials presented in this review underscores their pivotal role in shaping a more environmentally conscious, resilient, and resource-efficient built environment. The diverse range of materials—from recycled aggregates to innovative composites—offers promising alternatives that align with the ethos of sustainability, addressing the multifaceted challenges faced by the construction industry.

In conclusion, sustainable construction materials stand as catalysts for steering the construction industry toward a more sustainable paradigm. Embracing these materials represents a conscientious stride towards building structures that harmonize with the environment, enhance resilience, and leave a lasting legacy of sustainability for future generations.

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