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Review of Gypsum-Enhanced Fly Ash-Sand-Lime Bricks for Sustainable Construction

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ABSTRACT

Gypsum-enhanced fly ash-sand-lime bricks have emerged as a promising sustainable alternative to traditional construction materials. This review explores the properties, production process, and potential applications of these bricks in sustainable construction practices. The incorporation of fly ash, a byproduct of coal-fired power plants, along with sand, lime, and gypsum, offers environmental benefits by reducing the reliance on natural resources and diverting waste materials from landfills. The addition of gypsum further enhances the properties of the bricks, including improved strength, reduced water absorption, and enhanced fire resistance. The review evaluates the mechanical, thermal, and durability characteristics of gypsum-enhanced fly ash-sand-lime bricks through a comprehensive analysis of existing research studies. Additionally, the potential applications of these bricks in various construction projects, such as residential, commercial, and industrial buildings, are discussed. The sustainable aspects, economic feasibility, and challenges associated with the production and use of these bricks are also examined. Overall, this review highlights the significant potential of gypsum-enhanced fly ash-sand-lime bricks as an eco-friendly and durable construction material, contributing to sustainable development and a greener built environment.

INTRODUCTION

In recent years, the construction industry has witnessed a growing demand for sustainable building materials that minimize environmental impact without compromising structural performance. Traditional materials, such as clay bricks and concrete blocks, often involve the extraction of non-renewable resources and contribute to carbon emissions during manufacturing. As a result, researchers and industry professionals are exploring alternative materials that utilize industrial byproducts and waste materials to create environmentally friendly construction solutions.

One such material that has gained attention is gypsum-enhanced fly ash-sand-lime bricks. These bricks combine fly ash, a residue obtained from coal-fired power plants, with sand, lime, and gypsum to produce a sustainable construction material. Fly ash, which is abundantly available and typically considered a waste product, can be effectively utilized in these bricks, reducing its environmental impact and promoting waste diversion from landfills.

The addition of gypsum in the manufacturing process further enhances the properties of the bricks. Gypsum is a naturally occurring mineral that possesses excellent binding and fire-resistant properties. Its incorporation improves the strength and durability of the bricks, reduces water absorption, and enhances their fire resistance. These characteristics make gypsum-enhanced fly ash-sand-lime bricks suitable for various construction applications.

This review aims to provide an in-depth analysis of gypsum-enhanced fly ash-sand-lime bricks, focusing on their properties, production process, and potential applications in sustainable construction. The mechanical, thermal, and durability characteristics of these bricks will be evaluated through a comprehensive examination of existing research studies. Furthermore, the economic feasibility and challenges associated with their production and use will be discussed.

The utilization of gypsum-enhanced fly ash-sand-lime bricks can contribute significantly to sustainable construction practices. By reducing the reliance on traditional building materials, such as clay and concrete, the environmental impact of construction can be minimized. Additionally, the incorporation of fly ash and gypsum offers the potential for waste reduction, resource conservation, and improved energy efficiency.

NEED OF THE STUDY

The growing concern for sustainability in the construction industry has led to an increased demand for eco-friendly building materials. Traditional construction materials, such as clay bricks and concrete blocks, have significant environmental drawbacks due to the extraction of non-renewable resources and the generation of greenhouse gas emissions during production. Therefore, there is a critical need to explore alternative materials that minimize environmental impact while maintaining structural integrity.

Gypsum-enhanced fly ash-sand-lime bricks offer a potential solution to address this need. By incorporating fly ash, a byproduct of coal combustion in power plants, these bricks provide a means of utilizing an abundant industrial waste material that would otherwise be disposed of in landfills. Furthermore, the addition of gypsum enhances the properties of the bricks, contributing to improved strength, reduced water absorption, and enhanced fire resistance.

However, despite the potential benefits of gypsum-enhanced fly ash-sand-lime bricks, there is a need for a comprehensive study to evaluate their properties, production process, and potential applications. Existing research studies have provided valuable insights, but a consolidated analysis is necessary to fully understand the capabilities and limitations of these bricks in sustainable construction.

This study aims to address this need by conducting a thorough review of gypsum-enhanced fly ash-sand-lime bricks. By evaluating their mechanical, thermal, and durability characteristics, the study will provide a comprehensive understanding of the performance and suitability of these bricks in various construction applications. Additionally, analyzing the economic feasibility and challenges associated with their production and use will help identify potential barriers and opportunities for their wider adoption.

LITERATURE REVIEW

T. U. Ahmed et al (2018) This abstract presents an experimental study on the mechanical properties of fly ash-gypsum bricks. The use of fly ash, a byproduct of coal combustion in power plants, as a partial replacement for traditional clay bricks offers significant environmental benefits. Gypsum, a natural mineral with excellent binding properties, is incorporated into the mix to enhance the mechanical characteristics of the bricks. The objective of this study is to investigate the impact of different proportions of fly ash and gypsum on the mechanical properties of the bricks, including compressive strength, flexural strength, and water absorption. In this experimental study, fly ash-gypsum brick specimens are prepared by varying the proportions of fly ash and gypsum while keeping other mix parameters constant. The specimens are then subjected to compressive strength and flexural strength tests following standard testing procedures. Water absorption tests are conducted to evaluate the bricks' resistance to moisture penetration. The experimental results are analyzed to determine the optimal proportion of fly ash and gypsum for achieving the desired mechanical properties.

Md. Ashikuzzaman (2018) The experimental results revealed that the forming load significantly influenced the mechanical properties of the fly-ash bricks. It was observed that increasing the forming load led to a substantial increase in compressive strength. This can be attributed to the densification and compaction of the brick particles during the forming process. The bricks formed under higher loads exhibited improved load-bearing capacity, indicating their suitability for structural applications.Flexural strength results also showed a positive correlation with the forming load. Higher forming loads resulted in bricks with greater flexural strength, indicating enhanced resistance to bending forces. This is attributed to the improved interlocking and particle bonding within the brick matrix, leading to increased structural integrity. Water absorption tests demonstrated that the forming load had a notable effect on the bricks' resistance to moisture penetration. Bricks formed under higher loads exhibited lower water absorption, indicating improved durability and reduced susceptibility to moisture-related damage. Based on the findings, it can be concluded that the forming load plays a crucial role in determining the mechanical properties of fly-ash bricks. Higher forming loads result in bricks with superior compressive strength, flexural strength, and water absorption characteristics. Therefore, optimizing the forming load is essential for producing high-quality fly-ash bricks with enhanced mechanical performance.

This abstract presents a critical review of fly ash bricks, focusing on their properties, production process, and potential advantages and limitations. Fly ash, a byproduct of coal combustion in power plants, is commonly used as a partial replacement for traditional clay bricks to mitigate environmental impact and promote sustainable construction practices. The review analyzes the mechanical, thermal, and environmental properties of fly ash bricks based on existing literature. The mechanical properties, including compressive strength, flexural strength, and water absorption, are examined to assess the structural integrity and durability of the bricks. Thermal properties, such as thermal conductivity and heat resistance, are evaluated to determine their suitability for energy-efficient constructions. Additionally, the environmental impact of fly ash bricks, including their potential for carbon dioxide emission reduction and waste diversion from landfills, is discussed.the review explores the production process of fly ash bricks, including the preparation of raw materials, mixing procedures, and curing techniques. The influence of various factors, such as fly ash composition, binder types, and curing conditions, on the quality and performance of the bricks is examined.

S.P. Salma Begum (2017) This study presents a performance analysis of fly ash bricks and compares them with common red burnt clay bricks. Fly ash, a byproduct of coal combustion in power plants, is utilized as a partial replacement for clay in brick manufacturing to reduce environmental impact and promote sustainable construction practices. The objective of this study is to assess and compare the mechanical, thermal, and environmental performance of fly ash bricks in relation to traditional clay bricks.The mechanical properties examined include compressive strength, flexural strength, and water absorption. These properties are crucial for evaluating the structural integrity, load-bearing capacity, and durability of the bricks. Additionally, the thermal properties, such as thermal conductivity and heat resistance, are analyzed to assess the energy efficiency and thermal insulation capabilities of the bricks. The environmental performance of both types of bricks is evaluated based on carbon emissions, energy consumption, and waste generation throughout their life cycle.Experimental tests are conducted on samples of fly ash bricks and clay bricks following standard procedures. The results are analyzed, and a comparative analysis is performed to identify the differences and similarities between the two types of bricks.

ShivasheeshKaushik, NimishaRaj(2017) Through the Taguchi experimental design, various factors including fly ash content, cement-to-fly ash ratio, water-to-binder ratio, and curing time were considered as key parameters influencing the compressive strength. The L9 orthogonal array was used to conduct a series of experiments, and the signal-to-noise (S/N) ratio was employed to evaluate the performance of each combination.The analysis of variance (ANOVA) was performed to identify the significant factors affecting the compressive strength of the fly ash bricks. The results indicated that the fly ash content and the cement-to-fly ash ratio were the most influential factors. Additionally, the interaction effect between these two factors was found to be significant.The optimal combination of parameters was determined using the Taguchi method's desirability function approach, which maximized the compressive strength. The results demonstrated that the desired compressive strength could be achieved by selecting appropriate levels of the influential factors.

CONCLUSION

In conclusion, the review of gypsum-enhanced fly ash-sand-lime bricks highlights their potential as a sustainable construction material. These bricks offer several advantages, including the utilization of fly ash, a byproduct of coal combustion, and the incorporation of gypsum to enhance their mechanical properties.

The review findings indicate that gypsum-enhanced fly ash-sand-lime bricks exhibit favorable mechanical characteristics, including improved compressive strength, flexural strength, and reduced water absorption. The addition of gypsum enhances the binding properties of the bricks, leading to improved strength and durability. This makes them suitable for various construction applications, including load-bearing structures. Furthermore, the environmental benefits of gypsum-enhanced fly ash-sand-lime bricks are noteworthy. By utilizing fly ash, a waste material, these bricks contribute to waste reduction and minimize the consumption of natural resources. The reduction in carbon emissions associated with their production and the potential for recycling and reuse further enhance their sustainability profile.

However, it is important to acknowledge the limitations and challenges associated with gypsum-enhanced fly ash-sand-lime bricks. These include variations in material properties due to inconsistent fly ash composition, the potential for efflorescence and dimensional stability issues, and the need for careful control of the manufacturing process to ensure consistent quality. To fully realize the potential of gypsum-enhanced fly ash-sand-lime bricks, further research and development are needed. Areas of focus may include optimizing the mix proportions, improving the manufacturing process, addressing the challenges of efflorescence and dimensional stability, and conducting long-term durability studies. gypsum-enhanced fly ash-sand-lime bricks have shown promise as a sustainable construction material. Their utilization can contribute to waste reduction, energy conservation, and reduced environmental impact. Further research and technological advancements will help overcome the challenges and enhance the performance of these bricks, facilitating their wider adoption in sustainable construction practices.

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