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Selection of Either (Fly Ash, Rubber And Rice Husk) Material for Rigid Pavement: Review

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Abstract: Road transportation plays a crucial role in India's economic development, providing cost-effective, accessible, and adaptable means of transportation for both passengers and freight. Pavement, as a key component of highway design, must withstand vehicular loads and foot traffic while ensuring safe and efficient movement. This paper reviews existing literature on pavement materials, focusing on sustainable alternatives such as fly ash-based geopolymers, basalt fiber-reinforced concrete, and asphalt mixtures incorporating recycled aggregates and rubber. Additionally, it proposes the combination of rice husk and crumb rubber in concrete as a sustainable approach for pavement construction. The study aims to evaluate the mechanical properties of concrete with partial material replacements through experimental investigation. By addressing gaps in durability studies, comparative analysis, and non-destructive testing, this research seeks to provide valuable insights into the feasibility and sustainability of utilizing waste materials in concrete production. Ultimately, it aims to contribute to advancing sustainable practices in the construction industry and addressing the challenge of waste accumulation.
Keywords: Pavement, Rigid Pavement, Fly Ash, Rice Husk, Cumber Rubber.

I. INTRODUCTION

The importance of road outlined the significance and advantages of road transportation in India, as well as its critical role in the country's economic development. It emphasizes how road transport is cost-effective, easily accessible, and adaptable to individual needs, making it a preferred mode of transportation for both passengers and freight. It elucidates the importance of roads in providing connectivity to remote areas, facilitating the transportation of goods and passengers, and ensuring national security and defence. The multifaceted role of road transportation in India's socio-economic landscape and underscores its indispensable contribution to the nation's growth and development. Pavement, in the realm of highway design, encompasses the entire layered structure of a road, including the surfacing layer as well as the base and sub-base layers, if present, all resting atop the subgrade soil. It serves as the durable surface material tasked with withstanding vehicular loads and foot traffic, ensuring the safe and efficient movement of vehicles and pedestrians. An ideal pavement is characterized by its ability to distribute loads effectively, withstand stresses, provide safety and comfort to road users, maintain visibility, and ensure durability with minimal maintenance needs. These attributes collectively contribute to the functionality, safety, and longevity of the road infrastructure.

II. LITERATURE REVIEW

1) Tahir, M.F.M., Abdullah, M.M.A.B., Rahim, S.Z.A., Mohd Hasan, M.R., Sandu, A.V., Vizureanu, P., Ghazali, C.M.R. and Kadir, A.A., 2022 et al aimed to address the issue of acid susceptibility in ordinary Portland cement (OPC) used for rigid pavement construction, which can lead to increased maintenance costs. To mitigate this issue, the study proposed the use of fly ash-based geopolymer as a more sustainable alternative, given its lower CO_2 emissions during synthesis and higher acid resistance compared to OPC. The research optimized the formulation of fly ash-based geopolymer to achieve the highest compressive strength, with specific considerations given to sodium hydroxide concentration, the ratio of sodium silicate to sodium hydroxide, and the ratio of solid-to-liquid. The results indicated that the optimal parameters for fly ash-based geopolymer yielded a maximum compressive strength of 47 MPa. Furthermore, the study compared the durability of fly ash-based geopolymer concrete and OPC concrete in acidic environments. It was found that fly ash-based geopolymer exhibited higher durability compared to OPC concrete, with a percentage of compressive strength loss ranging from 7.38% to 21.94% for OPC concrete. Overall, the study concludes that fly ash-based geopolymer is a superior material for rigid pavement applications due to its higher compressive strength and durability in acidic environments. The findings contribute to the advancement of knowledge in the field and provide a basis for future developments and applications of fly ash-based geopolymers in pavement construction.

2) Abbass, M. and Singh, G., 2022 et al focused on the reinforcement of rigid pavements using basalt fibers (B.F's) in combination with rice husk ash (RHA) as a sustainable alternative to conventional Portland cement concrete. Basalt fibers, rich in alumina, were chosen in conjunction with RHA, which is abundant in silica, to enhance the durability of the pavement. In the experimental setup, various combinations of basalt fibers were incorporated into the mixtures, ranging from 1% to 25% in the RHA mix. The sodium silicate to sodium hydroxide ratio and the alkaline activator to binder content ratio were kept constant at 0.4 and 2.0, respectively, with a sodium hydroxide concentration of 14 M. Superplasticizer (SZ) was utilized to improve the fluidity of the geopolymer concrete, and the source material was standardized at 500 kg/m3. The results indicated that mix RHB10, comprising 10% basalt fibers, exhibited favorable properties including low water absorption (1.54%), minimal weight loss during acid attack testing (27.43%), shallow chloride ion penetration depth (2 mm), and limited expansion after 28 weeks of sulfate attack (12 mm). Additionally, the rice husk ash mix (RHAM) outperformed the control mix OPCM in terms of durability. Conclusions drawn from the experimental study highlighted the enhanced performance of rice husk ash and basalt fiber-based geopolymer concrete compared to standard conventional concrete. Specifically, the geopolymer concrete with basalt fibers up to 10% demonstrated reduced water absorption and weight loss, as well as improved resistance to acid attack. Beyond this threshold, however, water-absorbing capacity increased with higher fiber content. Overall, the findings suggest that incorporating basalt fibers into rice husk ash-based geopolymer concrete can enhance the durability and performance of rigid pavements, offering a sustainable alternative to conventional Portland cement concrete.
3) Awad and Alsaleh (2021) et al. propose a practical solution for producing cost-effective pavement suitable for rural streets with light traffic loads. Their approach involves utilizing asphalt mixtures composed of recycled aggregates (RA), fine used rubber (FR), and waste plastic (WP). The mechanical properties of these asphalt mixtures incorporating RA were investigated, along with the effects of adding WP to hot RA before mixing with asphalt at 180°C using the dry method. The study also compared the performance of asphalt mixtures using FR as an alternative to fine aggregate. Various ratios of WP (ranging from 0% to 8%) and FR (ranging from 0% to 6% of the percentage of fine RA) were evaluated. The outcomes of the tests conducted on modified asphalt mixtures incorporating both FR and WP revealed a significant increase in Marshall's stability. Based on the results, it was determined that adding FR up to 3% and WP up to 4% of the total weight of fine aggregates led to optimal performance. This suggests that asphalt mixtures incorporating RA, FR, and WP can meet the necessary conditions for use in rural areas while maintaining cost-effectiveness compared to other options. In summary, the study presents a feasible approach for producing low-cost pavement suitable for rural streets by leveraging recycled aggregates, fine used rubber, and waste plastic in asphalt mixtures. By optimizing the composition of these mixtures, the researchers have demonstrated the potential to create durable and cost-effective pavement solutions for areas with light traffic loads.
4) Abdurrahman et al. (2019) et al. conducted research to design and assess various concrete mixes aimed at improving the mechanical properties of rigid pavement materials. In their study, eight different mixtures were formulated with varying water/cement ratios (ranging from 0.30 to 0.40), crumb rubber content (ranging from 2.5% to 7.5%), and rice husk ash content (ranging from 7.5% to 10%). The control mix consisted of plain cement concrete (PCC). The incorporation of crumb rubber in the mixtures replaced a portion of the fine aggregate content, while rice husk ash substituted the cement content. Specimens were cast and cured in water ponds for a duration of 28 days, after which the mechanical properties, specifically compressive strength and flexural strength, were determined for all variations. The results revealed that Mix 1, with a water/cement ratio of 0.30, 5% crumb rubber, and 10% rice husk ash, exhibited the highest compressive strength and flexural strength values of 36.38 MPa and 4.53 MPa, respectively, after 28 days. These values met the requirements specified in the Indonesian Standard Bina Marga 2018 for rigid pavement materials. The study concluded that the appropriate combination of crumb rubber and rice husk ash contributed to the enhancement of concrete's mechanical properties. Specifically, the optimized Mix 1 demonstrated promising potential as a rigid pavement material, offering improved compressive and flexural strength compared to conventional PCC concrete formulations.
5) Pacheco-Torres et al. (2018) et al. conducted a comprehensive test program to investigate the impact of rubber size and content on the mechanical properties of concrete pavements. Various mixtures were prepared with rubber particles of different sizes (ranging from 1 to 4 mm, 10 mm, and 16 mm) added in different proportions (10%, 20%, and 30%). The study also introduced a novel testing method to evaluate deformation, specifically transversal micro-cracks, experienced by the material under cyclic loading conditions simulating traffic loads. The results revealed that there exists an optimal combination of rubber particle size and content that enhances the performance of the material under cyclic load stresses. This finding suggests that the material is suitable for use in constructing rigid concrete pavements. The researchers concluded that effectively managing hard-to-eliminate waste, such as rubber from end-of-life tires, presents scientific, technical, and regulatory challenges. However,

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incorporating this waste material into concrete road surfaces offers a viable solution to reduce waste volume and minimize environmental impact. In addition to proposing a novel experimental procedure for measuring deformation under cyclic loading, the study provides valuable insights into the potential of using rubberized concrete in pavement construction as a sustainable and environmentally friendly alternative.

III. MATERIAL

A. Combination of Rice Husk And Crumb Rubber In Concrete

The combination of rice husk and crumb rubber in concrete offers a promising approach to enhance the sustainability and performance of concrete pavements. Rice husk, a by-product of rice milling, is rich in silica and can be used as a partial replacement for cement in concrete mixtures. On the other hand, crumb rubber, derived from recycled tires, can replace a portion of the fine aggregate content in concrete. By incorporating these materials into concrete, several benefits can be realized:

Sustainability: Both rice husk and crumb rubber are waste materials that can be diverted from landfills and utilized in concrete production, thereby reducing environmental impact and promoting sustainable practices.

Improved Mechanical Properties: The combination of rice husk and crumb rubber can enhance the mechanical properties of concrete, including compressive strength, flexural strength, and durability. Rice husk ash acts as a pozzolanic material, contributing to the strength and durability of concrete, while crumb rubber improves impact resistance and reduces brittleness.

Reduced Environmental Footprint: Utilizing waste materials like rice husk and crumb rubber in concrete reduces the consumption of natural resources and energy associated with traditional concrete production methods. This contributes to a lower carbon footprint and helps mitigate the environmental impact of construction activities.

Cost-effectiveness: Incorporating waste materials into concrete can lead to cost savings, as these materials are often available at lower or even no cost. Additionally, the improved properties of rice husk and crumb rubber concrete may result in reduced maintenance and repair costs over the lifespan of the pavement.

Overall, the combination of rice husk and crumb rubber in concrete presents a sustainable and environmentally friendly solution for pavement construction. Through careful mix design and optimization, concrete mixtures can be tailored to meet specific performance requirements while minimizing environmental impact and promoting resource efficiency. Continued research and development in this area are essential for unlocking the full potential of waste materials in concrete construction and advancing sustainable practices in the built environment.

IV. OBJECTIVE OF STUDY

The main objective of the study is to evaluate the properties of concrete:

1) Find the best material based on locally availability and their properties on basis of which the experimental study will be carried out either partially or wholly replacement as required.
2) To prepare standard concrete mix of M40 grade in the laboratory for rigid pavement.
3) Partial replacement of the material with the cement and sand in defined proportion and prepare the mix of M40 grade.
4) Perform various test to justify.

V. SCOPE AND IDENTIFYING GAP OF RESEARCH

The proposed research aims to experimentally investigate the partial replacement of materials such as fly ash, rice husk, and rubber, depending on their availability. The mechanical performance of these materials will be evaluated through a comprehensive literature review and other sources to determine the most suitable material. Once the optimal material is identified, it will be experimentally tested for compressive strength in concrete mixtures utilizing the chosen material. The overarching goal of the research is to address the issue of waste accumulation in society by repurposing these materials for concrete production. However, there are several **gaps identified** in the existing literature and research methodologies:

Limited Durability Studies: Existing studies have typically focused on the mechanical properties of concrete with partial material replacements, but comprehensive durability studies beyond 90 days have not been conducted. Investigating the long-term durability of concrete structures incorporating these alternative materials is essential for assessing their practical feasibility and sustainability.

Lack of Comparative Analysis: There is a lack of comparison between the laboratory experiments conducted in the research and conventional concrete. Understanding the relationship and differences between the properties of concrete with partial material replacements and conventional concrete is crucial for assessing their performance in real-world applications.

Absence of Non-Destructive Testing (NDT) Studies: Durability studies conducted using non-destructive testing techniques are missing from the existing research. NDT methods such as ultrasonic testing, radar, or electrical resistivity can provide valuable insights into the internal condition and durability of concrete structures over time.

Limited Exploration of Additional Factors: Aspects such as water-cement ratio, creep, and other relevant parameters have not been thoroughly studied in existing research. Investigating these factors is essential for understanding the overall performance and behavior of concrete with partial material replacements in different environmental conditions.

Addressing these gaps in the proposed research will contribute to a more comprehensive understanding of the feasibility, performance, and sustainability of concrete with partial material replacements. It will also provide valuable insights for future research and practical applications in the construction industry.

VI. CONCLUSION

1) Over the period of time, after doing the survey of the consumer market as well as industrial visit including dumping site we selected the material rice husk and crumb rubber out of fly ash, rice husk and crumb rubber as waste rubber tire is available and having plenty of paddy field in the areas forced to utilize them in my research work.
2) The combination of fly ash and rubber in concrete presents a promising avenue for enhancing the sustainability and performance of rigid pavements. Fly ash and rubber, both waste materials, offer environmental benefits when diverted from landfills and incorporated into concrete. By carefully controlling the proportions and mix design parameters, concrete with fly ash and rubber can exhibit improved mechanical properties, such as compressive strength, flexural strength, and impact resistance. However, thorough testing and quality control measures are essential to ensure optimal performance in real-world applications. The proposed research aims to further explore the potential of these materials by experimentally evaluating their properties and performance in concrete mixtures. Addressing existing gaps in durability studies, comparative analysis with conventional concrete, and the exploration of additional factors like water-cement ratio and creep will contribute to a comprehensive understanding of the feasibility and sustainability of concrete with partial material replacements. Ultimately, this research endeavors to provide valuable insights for advancing sustainable practices in the construction industry and addressing the challenge of waste accumulation in society.

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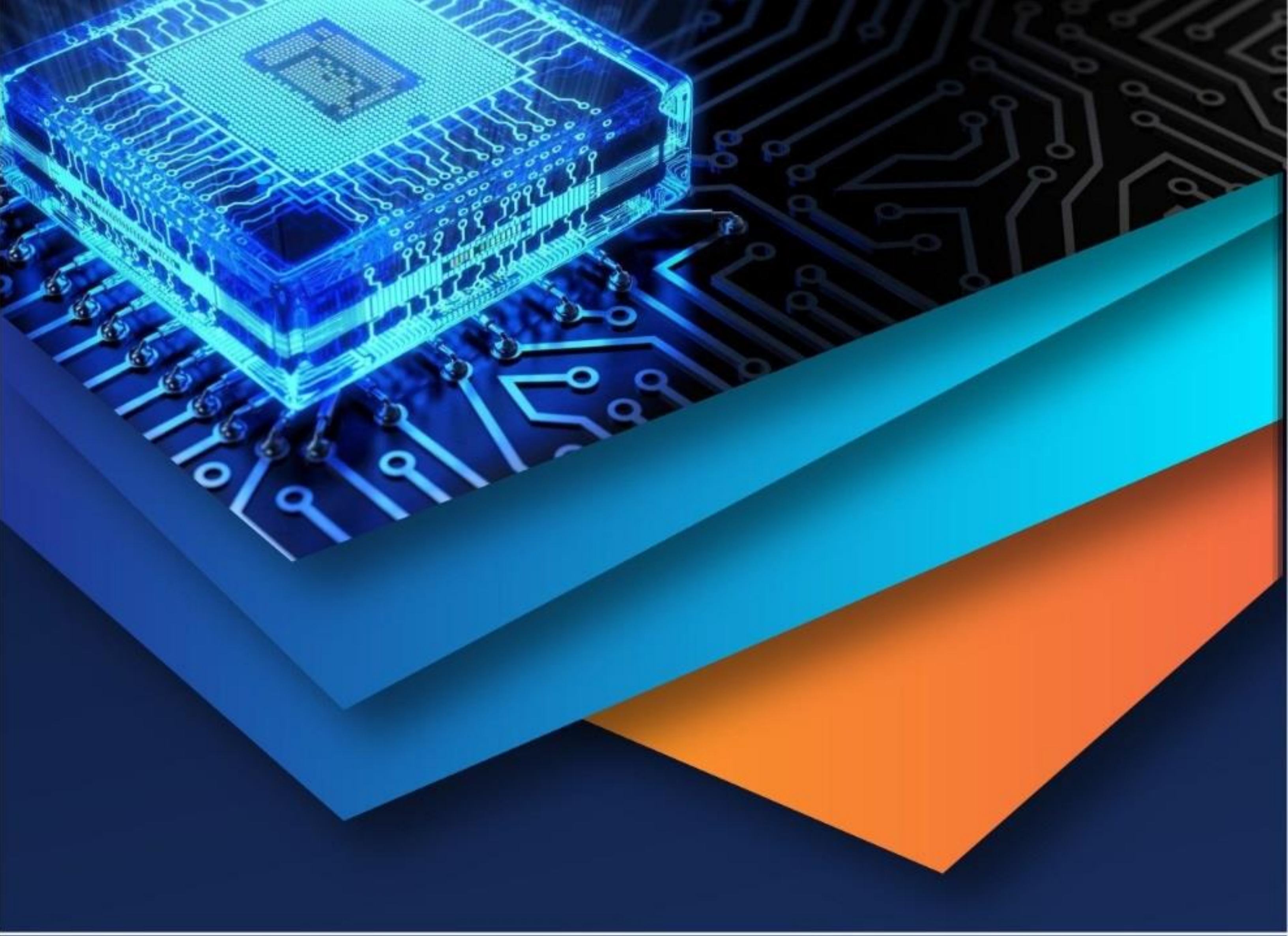

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