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# "TO REDUCE IMPACT OF CEMENT MANUFACTURING BY INCORPORATING INDUSTRIAL WASTE AND ALTERNATIVE BINDERS"

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## ABSTRACT

The environmental impact of Ordinary Portland Cement (OPC) manufacturing has raised significant concerns because of the significant amount of energy used and carbon emissions produced in its production. In response, this research investigates the possibilities of partially replacing cement with red mud, an industrial waste byproduct of the aluminum industry, and hydrated lime, a more sustainable and eco-friendly binder. The experimental investigation involved incorporating varying percentages of red mud (0%, 4%, 8%, 12%, 16%, and 20% by weight of cement) along with a constant dose of hydrated lime, and evaluating the concrete's mechanical properties and workability. Tests of compressive strength were performed on days 7, 14, as well as 28. The findings showed that the ideal level of replacement for red mud was 16%, which achieved the maximum compressive strength after 28 days of 38.11 N/mm2, compared to 31.8 N/mm2 for the control mix.

**KEYWORDS: -** Environmental impact, Enhancing strength characteristics, Workability, Red-mud, industrial waste, opc cement

## INTRODUCTION

Although numerous attempts have been made to reuse red mud in various applications, most have not proven to be economically viable. This paper investigates the potential of using Red Using mud in concrete to partially replace Portland cement. The combination of red filth and

hydrated lime in concrete offers several advantages, especially in the context of sustainable construction practices. Here are some of the key benefits

**Sustainability and Waste Utilization**

**Use of Red Mud**: A byproduct of the Bayer process, which separates bauxite and alumina, is red mud. Generally speaking, it is regarded as a waste material with disposal issues for the environment. Red mud is an eco-friendly substitute for concrete since it lessens the environmental effect of disposal.

**Reduction of Waste**: The incorporation of red mud in concrete helps in falling the expanse of industrial waste being liable of, contributing to environmental conservation and sustainability.

**Improved Durability**

**Enhanced Resistance to Chemicals**: Concrete made with red mud can have improved resistance to chemical attacks, including sulfates, chlorides, and acidic environments, due to the alkaline nature of red mud.

**Reduced Water Absorption**: Red mud can reduce the water absorption properties of concrete, which leads to lower permeability, enhancing durability

**Literature Review**

Monu Gaur (2018) : Red mud is a strong waste buildup of the assimilation of bauxite metals with scathing soft drink for alumina generation. Its transfer remains an overall issue as far as ecological concerns. Amid the previous decades, broad work has been finished by a ton of scientists to create different financial routes for the usage of red mud. This paper gives a survey on the far reaching usage of red mud internationally. The exploration advancement of safe amassing of red mud is condensed. Gigantic amount of red mud is produced worldwide consistently representing an intense and disturbing ecological issue. This paper depicts the creation and portrayal of bauxite and red mud in perspective of World and Indian setting. It audits thoroughly the transfer and balance techniques for red mud and gives the nitty gritty evaluation of the work conveyed up to this point for the use of red mud in various fields. The concoction and mineralogical qualities of red mud are abridged with their natural concerns Project identifies with the supplanting of bond with red mud at certain rate i.e. 10%, 20%, 30% and with a steady level of hydrated lime (5%) the throwing work has been done of the

block mould (150mm*150mm*150mm) and cylindrical shaped mould (150mm*300mm) and the consequence of 7 days and 28 days compressive quality has been discovered and which is been fruitful as of not long ago. What's more, to locate a proficient method to do it viably and discover the regions in which enhancement should be possible is the sole reason for our venture And by incompletely supplanting the red mud as solid constituents which results in a legitimate discard squander and an expansion in quality of cement and the effectiveness of the red mud as per cost and condition point of view too. Also, by supplanting the red mud and utilizing it as a basic material it gives expanded quality and less transfer of red mud in the earth which results in lesser contamination and diminished natural risks.

Ramaboyana Gangulalah(2021): The examination was directed to study about the properties of cement by utilizing red mud as substitution of bond in cement. The Bayer Process for the generation of alumina from Bauxite metal is described by low vitality effectiveness and it results in the creation of huge measures of residue like, high alkalinity bauxite deposits known as red mud. Presently red mud is created nearly at equivalent mass proportion to metallurgical alumina and is arranged into fixed or unlocked counterfeit impoundments (landfills), prompting significant natural issues. It involves oxides of iron, titanium, aluminum and silica alongside some other minor constituents. presence of Alumina and Iron oxide in red mud repays the inadequacy of similar parts in limestone which is the essential crude material for concrete generation.

Kubilay Kaptan (2024): There is an increasing global recognition of the need for environmental sustainability in mitigating the adverse impacts of cement production. Despite the implementation of various carbon dioxide (CO2) mitigation strategies in the cement industry, such as waste heat recovery, the use of alternative raw materials and alternative fuels, energy efficiency improvements, and carbon capture and storage, overall emissions have s till increased due to the higher production levels. The resolution of this matter can be efficiently achieved by the substitution of traditional materials with an alternative material, such as calcined clay (CC), construction and demolition waste (CDW), which have a significant impact on various areas of sustainable development, including environmental, economic, and social considerations. The primary objectives of employing CDW in the Portland cement production are twofold: firstly, to mitigate the release of CO2 into the atmosphere, as it is a significant contributor to environmental pollution and climate change; and secondly, to optimize the utilization of waste materials, thereby addressing the challenges

associated with their disposal. The purpose of th is work is to present a thorough examination of the existing body of literature pertaining to the partial replacement of traditional raw materials by CDW and the partial replacement of Portland cement by CDW and to analyze

## METHODOLOGY

OPC, or ordinary Portland cement After 28 days of curing, cement of the 33 Grade variety reaches a minimum compressive strength of 33 N/mm². It is one of the older and more commonly used grades of cement, primarily suited for general construction work. OPC 33 is especially recommended for non-structural uses where a high level of strength is not essential. Due to its smooth finish and workability, it is ideal for masonry work, plastering, and rendering. Its relatively lower heat of hydration also helps reduce the risk of cracking in such applications.

OPC, or ordinary Portland cement A cement that achieves a is referred to as 43 Grade, as per IS 8112:2013 standards. It is widely used in general construction work, including residential buildings, pavements, and precast structures. Due to its moderate strength development and heat of hydration, it's well-suited for applications where strength gain is not required at a rapid rate.OPC 43 Grade is also used in high-strength concrete work, especially when durability and long-term strength are important. For specialized applications such as railway sleepers, a designated type of 43 Grade known as 43-S Grade is used. The “S” stands for “Sleeper,” and this variant undergoes additional testing for parameters such as setting time, drying shrinkage, and early-age strength to ensure performance in demanding structural environments.

After 28 days of curing, , reaches a compressive strength of 53 N/mm². This cement grade is primarily used in applications that demand high early strength and durability. Its rapid strength gain makes it ideal for use in precast concrete components, prestressed concrete works, and when building long-span structures like high-rise buildings and bridges, where quick demanding and load-bearing capacity are crucial. A specialized variant of OPC 53, known as 53-S grade, is specifically manufactured for the production of railway sleepers, which require consistent strength and durability to withstand dynamic loads and vibrations. Overall, OPC 53 Grade plays a vital role in modern construction due to its superior performance in structural and high-load applications.

The process of choosing the right ingredients and their ratios to make concrete is known as "mix design mix that meets specific performance requirements, such as strength, durability, workability, and cost-efficiency. The design process takes into account the intended application, environmental conditions, and desired properties of the concrete. In this study we take M25 grade of concrete. The experimental setup to reduce the environmental impact of cement manufacturing by incorporating industrial waste and alternative binders involves a systematic approach aimed at evaluating the performance, sustainability, and feasibility of eco-friendly cementations materials. Durability assessments, including water absorption, acid resistance, and thermal stability, are also conducted. Throughout the experiment, environmental parameters such as embodied carbon and energy consumption are monitored using life cycle assessment (LCA) tools. The results are compared to conventional cement concrete to determine the effectiveness. of the alternative binders and waste materials in reducing the environmental footprint without compromising performance.

## CONCLUSION

- Higher density (lower weight reduction) can imply better compaction**,** lower porosity**,** and improved durability**.**
- The use of red mud up to 16% appears to positively influence the compactness and likely the durability of concrete.
- Beyond 16%, durability start to decline due to less effective matrix formation or poor dispersion.
- Overall, red mud acts as a promising supplementary material, but there is an optimal 16% for balancing strength, density, and durability.

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