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Importance of RE Utilization of Aggregate in Developing Concrete from Demolition Concrete Waste: Review

Mohd. Irfan[1], Er. Rohit Kumar[2], Dr. Gurvinder Singh[3]
[1]*Mtech Scholar, Department of Civil Engineering, Arni University, Kangra*
[2]*Assistant Professor, Department of Civil Engineering, Arni University, Kangra*
[3]*Associate Professor, Department of Computer Science and Application, Arni University, Kangra*

Abstract: The utilization of demolition concrete waste for developing new concrete offers promising avenues for sustainable construction practices. This review explores the importance of reusing aggregates derived from demolition concrete waste in concrete production. Through an extensive analysis of existing literature, this review evaluates the environmental benefits, technical feasibility, and challenges associated with incorporating recycled aggregates into concrete mixes. Key considerations such as aggregate quality, performance characteristics, and the impact on structural integrity are examined. Additionally, the review identifies gaps in current research and suggests future directions for advancing the utilization of demolition concrete waste in concrete production. Overall, this review highlights the significance of reutilizing aggregates from demolition concrete waste as a means to mitigate environmental impact, conserve natural resources, and promote sustainable development in the construction industry.
Keywords: demolition concrete, M60 grade, demolition concrete aggregate, recycle aggregate.

I. INTRODUCTION

The essence of sustainable development emphasizes the preservation of the environment and conservation of rapidly diminishing natural resources. While concrete remains a widely used building material due to its versatility and strength, conventional concrete is criticized for its environmental impact, including depletion of natural resources, high energy consumption, and disposal issues. Natural aggregates, a key component of concrete, are being increasingly consumed, raising concerns about their availability.

Construction waste is another environmental concern, often managed through landfill disposal, which creates large waste deposits. Recycling construction waste into recycled aggregates (RA) for concrete production has gained attention as a solution to reduce landfill waste and preserve natural resources. However, the quality of recycled aggregates is generally lower than that of natural aggregates, mainly due to attached mortar from demolished concrete.

Efforts to improve recycled aggregate quality include increasing crushing processes, which enhances coarse aggregate quality but also raises production costs. The performance of concrete using recycled aggregates needs to be thoroughly investigated, particularly focusing on time-dependent features that have received limited attention.

Utilizing waste from demolished concrete is crucial amid increasing stress on natural resources. However, challenges arise in segregating coarse aggregates from mortar and fine aggregates. While segregation of coarse aggregates is feasible, finer materials pose a greater challenge due to their intimate mixing with cement. Overcoming these challenges is essential for effective recycling of demolished concrete and reducing the strain on natural resources.

II. LITERATURE REVIEW

1) De Andrade Salgado, F. and de Andrade Silva, F., along with other researchers, have emphasized the environmental advantages of using recycled aggregate from construction and demolition waste over conventional aggregates. This practice not only reduces the consumption of natural resources but also decreases the land required for waste disposal. Over the past few decades, numerous studies have investigated the feasibility of recycled aggregate in various civil engineering applications, offering significant potential for enhancing economic and environmental sustainability on a national scale. This article provides a literature review on the production and utilization of recycled aggregate in concrete. Despite its advantages, recycled aggregate can exhibit higher water absorption and lower density, which may lead to a slight reduction in workability and compressive strength of concrete. To address these challenges, researchers have explored methods to remove adhered mortar or seal pores in recycled aggregates, thereby improving material quality. Some studies have also demonstrated the feasibility of using recycled aggregate concrete in structural elements, both in laboratory-scale and real-world projects. In summary, this review aims to address consumer concerns and promote the widespread adoption of recycled aggregate in civil engineering projects. The literature survey covered an extensive database, with a particular focus on articles published after the year 2000, providing valuable insights into the potential applications and benefits of recycled aggregate in sustainable construction practices.

2) **Sobotka, A. and Sagan, J.**, along with their collaborators in 2021, highlighted the diverse technological and organizational systems available for managing concrete waste in construction projects. These systems must align with project-specific constraints and vary in terms of costs, environmental impact, and community disturbance. To select the most favorable solution, considering factors like sustainable development, a multi-criteria analysis of available options is essential. Their work introduces a decision support system designed to aid in selecting the optimal technological and organizational solution for concrete waste management. This system relies on a mathematical simulation model to generate rating indicators for different waste management systems. These indicators allow decision-makers to compare and rank the available variants effectively. Additionally, the system evaluates qualitative parameters such as required building site area and waste management time, providing a comprehensive assessment of each option. Overall, this approach offers a systematic and analytical framework for decision-making in concrete waste management, facilitating the consideration of various factors to promote sustainability and efficiency in construction projects.
3) Dadsetan, S., Siad, H., Lachemi, M., and Sahmaran, M., along with their collaborators in 2019, focused on Geopolymers, a new generation of construction materials made from industrial by-products and supplementary cementitious materials (SCMs) rich in silica and alumina. With the increasing demand for SCMs due to global climate change action plans, there's a growing interest in using construction and demolition wastes (CDWs) in the geopolymerization process. Their paper provides a summary of literature regarding the utilization of CDWs such as concrete, brick, and ceramic as source materials in geopolymer technology, either independently or in conjunction with SCMs. The literature suggests that CDW materials can effectively serve as primary source materials in geopolymer technology. However, due to the complex parameters involved in geopolymerization, the research should shift towards defining threshold levels and acceptable criteria rather than solely focusing on identifying the best composition outcomes. In essence, their work underscores the potential of CDWs in advancing geopolymer technology and highlights the need for further research to establish standardized guidelines for optimizing geopolymer compositions using CDWs.
4) Akhtar, A. and Sarmah, A.K., along with their collaborators in 2018, conducted a review aimed at presenting the global status of construction and demolition (C&D) waste generation and critically reviewing recent studies on improving recycled aggregate concrete properties using supplementary materials. They compiled and analyzed information from 40 countries across six continents, focusing on C&D waste generation rates and government policies. The review highlights that worldwide C&D waste generation exceeded 3.0 billion tonnes annually until 2012, with a continuous upward trend. Developing countries like India and China face significant challenges in managing their substantial C&D waste streams and require comprehensive monitoring systems and government initiatives to promote mass awareness and utilization. Recycled aggregates derived from C&D waste typically exhibit inferior quality, prompting researchers to explore the use of various pozzolanic materials to enhance their properties. Several studies recommend the incorporation of supplementary materials to improve the performance of recycled aggregate concrete. Overall, this review underscores the pressing need for effective C&D waste management strategies globally, particularly in rapidly developing economies, and emphasizes the importance of research efforts aimed at enhancing the quality of recycled aggregate concrete through the use of supplementary materials.

III. METHODS OF CONCRETE DEMOLITION

The methods of concrete demolition encompass a variety of techniques tailored to break down and remove concrete structures efficiently. The selection of a method depends on several factors such as the size and type of structure, location, precision required, and environmental considerations.

Here's a detailed overview of some common concrete demolition methods:

1) *Manual Demolition:* Hand Tools: Workers use manual tools like jackhammers, chisels, and sledgehammers for breaking and removing concrete, suitable for smaller projects or precise tasks.
2) *Mechanical Demolition:* Excavators and Backhoes: Hydraulic excavators with attachments like hydraulic breakers or hammers are commonly used, along with backhoes equipped with breakers for smaller projects.

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3) *Concrete Crushers:* Machines with powerful jaws or crushers effectively break concrete into manageable pieces, suitable for larger structures.
4) *Controlled Explosives:* Strategically placed explosive charges bring down large structures, requiring careful planning, engineering, and coordination for safety and environmental impact.
5) *Hydraulic Bursting:* Expansive Force: Hydraulic power generates expansive forces to crack concrete, often used for removing reinforced concrete, especially in confined spaces.
6) *Diamond Wire Saw:* Utilizes diamond beads embedded wire for precise cutting of large structures, effective for complex shapes or confined spaces.
7) *Expansive Grouts:* Injected into drilled holes, expansive grouts create internal pressure to crack and break concrete, suitable for controlled demolition.
8) *High-Pressure Water Jetting:* High-pressure water jets, sometimes at elevated temperatures, selectively break down concrete without causing micro-fractures.
9) *Thermal Methods:* Hydro Demolition: High-pressure water jets, sometimes at high temperatures, selectively remove concrete without damaging surrounding areas, often used for bridge and road repair.
10) *Robotic Demolition:* Remote-Controlled Robots: Equipped with tools like breakers or crushers, robotic demolition ensures precision in tasks where human access is limited or safety concerns are high.
11) *Pneumatic Breakers:* Jackhammers powered by compressed air are effective for smaller demolition tasks or where other power sources are impractical, allowing controlled concrete breaking.

Each method offers its advantages and considerations, with the choice dependent on project-specific requirements. Professional demolition contractors evaluate the situation carefully to determine the most suitable method, prioritizing safety, efficiency, and environmental impact while adhering to local regulations and safety standards.

IV. OBJECTIVE OF STUDY

The main objective of the study is to evaluate the properties of concrete:
1) To prepare concrete of M60 grade in the lab
2) To prepare concrete mix of M60 grade in the laboratory with the partial replacement of the demolition concrete aggregate in different %age upto 50%
3) To check the workability of the mix prepared with both conventional and with partial replacement.

V. SCOPE AND IDENTIFYING GAP OF RESEARCH

Research will be carried out as utilization of the demolition concrete in such a way that the separation of the aggregate from the collected demolition concrete is re utilization in the mix of the concrete for the grade of M60.

The partial replacement of the natural aggregate up to 50% with that of the aggregate obtained from the demolition concrete will be done.

In identifying gaps in the study, several key areas emerge where further research could enhance the understanding and applicability of the findings:
1) *Partial Replacement of Aggregate Beyond 30%:* The study has focused on partial replacement of aggregate up to 30%, leaving a gap in knowledge regarding the feasibility and performance of higher replacement percentages. Investigating the effects of using higher replacement percentages could provide valuable insights into the limits and potential benefits of such practices.
2) *Relationship between Laboratory Experiment and Conventional Concrete:* The study lacks an analysis of the relationship between laboratory experiments and conventional concrete. Understanding how findings from experimental studies translate to real-world concrete applications is essential for validating the effectiveness and practicality of proposed methods.
3) *Durability Study Using Non-Destructive Testing (NDT):* The absence of a durability study utilizing non-destructive testing (NDT) methods represents a gap in the research. Incorporating NDT techniques such as ultrasonic testing or radar imaging could offer valuable data on the long-term performance and integrity of concrete structures made with recycled aggregates.
4) *Exploration of Additional Factors (e.g., Water Cement Ratio, Creep):* The study overlooks important factors such as water-cement ratio and creep, which play significant roles in determining concrete performance and longevity. Investigating these aspects in the context of recycled aggregate concrete could provide comprehensive insights into its behaviour under various conditions.

5) *Combination Study of Demolition Concrete Aggregate and NDT Testing*: The study does not explore the combination of using demolition concrete aggregate and conducting NDT testing. Examining how the properties of recycled aggregate concrete derived from demolition waste correlate with NDT results could inform the development of more accurate assessment techniques for recycled concrete structures.

Addressing these gaps through further research endeavors would contribute to a more comprehensive understanding of the potential and limitations of using recycled aggregates in concrete construction, ultimately enhancing sustainability and performance in the built environment.

VI. CONCLUSION

The review of studies on recycled aggregate concrete properties underlines the potential for innovative approaches to address environmental concerns and enhance the performance of construction materials. It underscores the importance of continued research to optimize geopolymer compositions and improve the quality of recycled aggregate concrete.

The methods of concrete demolition section provide a detailed overview of various techniques used to break down and remove concrete structures, highlighting the factors influencing method selection and the importance of adhering to safety and environmental standards.

Finally, the objective and scope of the research are outlined, focusing on evaluating the properties of concrete with partial replacement of aggregate from demolition waste. Identified gaps in the study point towards the need for further research to explore higher replacement percentages, investigate the relationship between laboratory experiments and real-world applications, conduct durability studies using non-destructive testing methods, explore additional factors such as water-cement ratio and creep, and examine the combination of demolition concrete aggregate with NDT testing.

Addressing these gaps through further research endeavours would contribute to a more comprehensive understanding of the potential and limitations of using recycled aggregates in concrete construction, ultimately enhancing sustainability and performance in the built environment.

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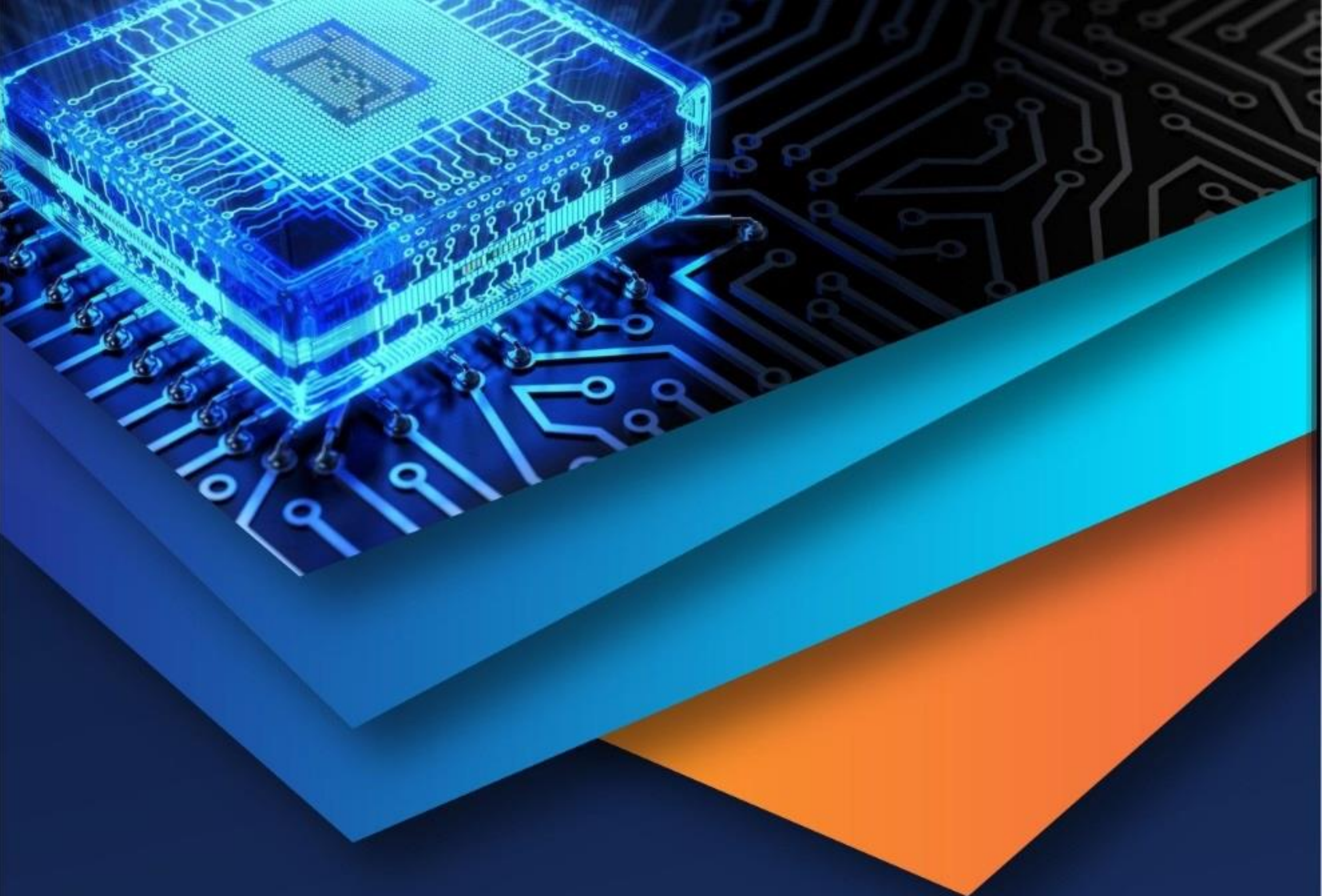

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