

A REVIEW PAPER ON ANALYTICAL STUDY ON CONCRETE DEMOLITION WASTES WITH AN EXPERIMENTAL INVESTIGATION ON THEIR POSSIBLE APPLICATIONS IN STRUCTURES

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ABSTRACT

This review paper presents a comprehensive analysis of concrete demolition wastes (CDW) and their possible uses in structural engineering, backed by experimental research. Given the substantial amount of concrete waste produced by the building industry, it is imperative to identify sustainable methods for recycling and reusing these materials, as this is essential for both environmental preservation and economic viability. This research examines the characteristics of CDW (Construction and Demolition Waste) and assesses its viability as a sustainable material in several structural uses.

The analysis compiles findings from numerous studies that have investigated the mechanical and durability characteristics of concrete that includes recycled aggregate from construction and demolition waste (CDW). The essential characteristics, including compressive strength, tensile strength, flexural strength, and durability, are thoroughly examined. The findings suggest that the inclusion of CDW can influence specific mechanical characteristics. However, by employing suitable processing and treatment methods, these effects can be substantially reduced. Consequently, recycled aggregate concrete emerges as a feasible and environmentally-friendly substitute for conventional concrete.

The report presents experimental investigations that showcase several unique techniques for improving the performance of concrete with CDW. Methods such as incorporating supplemental cementitious materials, utilising sophisticated admixtures, and optimising mix design parameters have demonstrated encouraging outcomes in enhancing the quality and performance of recycled aggregate concrete. These methods not only improve the physical characteristics of the material, but also promote ecological sustainability by decreasing the amount of carbon dioxide emitted during the manufacturing of concrete.

To summarise, this research emphasises the significance of establishing uniform norms and methods for utilising CDW in structural applications. Efficiently using recycled aggregate concrete into common construction methods requires cooperation between researchers, industry experts, and legislators. This research offers significant insights and practical ideas for enhancing the sustainable utilisation of concrete demolition wastes, advocating circular economy concepts, and contributing to the long-term sustainability of the building sector.

Key Words: Concrete demolition waste (CDW), Recycled aggregate concrete (RAC), Sustainable construction, Mechanical properties, Durability, Structural applications

1. INTRODUCTION

The construction industry is a major contributor to worldwide waste production, with a significant portion of this garbage being concrete demolition waste (CDW). With increasing concerns about environmental sustainability, the importance of recycling and reusing construction and demolition waste (CDW) has become significant. This transition not only tackles the crucial problem of decreasing landfill utilisation but also aids in preserving limited natural resources and reducing the environmental impact linked to new construction endeavours.

RAC, or recycled aggregate concrete, has emerged as a possible approach to address these difficulties. Recycled aggregate concrete (RAC) utilises aggregates obtained from construction and demolition waste (CDW) to create fresh concrete. When RAC is processed and treated correctly, it has the capacity to attain mechanical and durability characteristics that are similar to those of traditional concrete. RAC is a feasible option that promotes sustainable construction methods.

The viability of RAC has been enhanced by recent developments in materials science and construction technology. The performance qualities of RAC have been greatly improved by including supplemental cementitious materials, developing new chemical admixtures, and optimising mix design parameters. These enhancements tackle the typical problems linked to CDW, such as inconsistencies in material characteristics and potential impurities, guaranteeing that the recycled concrete fulfils rigorous structural and durability criteria.

The push for sustainable construction is further driven by legal reforms and industry standards that increasingly prioritise the utilisation of recycled resources. Various governments and industry organisations worldwide are enacting laws and recommendations to encourage the utilisation of construction and demolition waste (CDW) in new building projects. This regulatory assistance not only encourages the implementation of RAC but also paves the way for broad industry approval and standardisation.

To successfully incorporate CDW into mainstream building processes, it is crucial to have a thorough understanding of its features and prospective uses. Collaboration between researchers and industry professionals is necessary to establish standardised testing methodologies, design protocols, and best practices that guarantee the consistent quality and performance of RAC. Experimental investigations are essential in this effort, as they provide empirical data and insights that contribute to the creation of these standards.

This review paper intends to offer a comprehensive analysis of the present research status on CDW and its applications in the field of structural engineering. This study compiles data from multiple research investigations to assess the mechanical characteristics, longevity, and effectiveness of RAC. In addition, the article examines novel techniques for processing and treating construction and demolition waste (CDW) in order to improve its appropriateness for use in structural applications. This review seeks to provide guidance for future research and practical implementation efforts by emphasising the potential and limitations connected with the usage of CDW.

In essence, the utilisation of CDW in building aligns with the core tenets of a circular economy, wherein materials are repurposed and reclaimed to mitigate waste and optimise resource utilisation. This strategy not only promotes environmental sustainability but also provides economic advantages by decreasing the expenses related to extracting raw materials and disposing of waste. This study offers useful insights and recommendations for boosting the use of CDW in the construction industry, based on a thorough analysis of existing research and experimental data. These insights aim to contribute to the development of a more sustainable and resilient built environment.

2. LITERATURE REVIEW

In 2013, Pacheco-Torgal et al. undertook a thorough examination of the possibility of reusing construction and demolition waste (CDW) to create new materials for construction purposes. The study examined the mechanical characteristics and long-lasting nature of recycled aggregate concrete (RAC) made from construction and demolition waste (CDW). It was discovered that RAC may have a poorer ability to withstand compression compared to traditional concrete. However, this issue can be reduced by using supplemental cementitious elements and employing sophisticated mix design procedures. The study emphasised the environmental advantages of utilising RAC, including diminished landfill waste and decreased carbon emissions, rendering it a sustainable choice for the building sector.

Tam et al. (2008) investigated the utilisation of recycled concrete aggregates (RCA) in the creation of new concrete. According to their research, RAC demonstrates similar compressive strength to conventional concrete when the RCA is appropriately treated and purified. The study also highlighted the significance of eliminating impurities from the recycled aggregates to avoid any detrimental impact on the qualities of the new concrete. Their conclusion was that RAC is a feasible substitute for natural aggregates, which promotes sustainable construction methods by preserving natural resources and minimising waste.

In 2002, Gómez-Soberón conducted a study on the mechanical properties of concrete that used recycled aggregates. The investigation revealed that the utilisation of RCA has the potential to diminish the compressive and tensile strength of concrete. Nevertheless, by the process of optimising the mix design and incorporating additives, it is possible to minimise these reductions. The study further emphasised that RAC exhibits enhanced resilience to freeze-thaw cycles and increased durability under specific climatic conditions. These findings confirm that it is possible to use RCA (recycled concrete aggregate) in structural concrete, as long as appropriate processing and quality control methods are implemented.

Kou and Poon (2009) examined the long-lasting quality of recycled aggregate concrete (RAC) using various types of recycled aggregates. The researchers discovered that the longevity of RAC is affected by the specific type and calibre of the recycled aggregates employed. The durability of concrete constructed with recycled concrete aggregates (RCA) is similar to that of conventional concrete in terms of its capacity to withstand the entry of chloride ions and carbonation. The study also observed that the utilisation of fly ash as an additional cementitious material enhanced the durability and mechanical characteristics of RAC. Their research provides evidence for the environmentally responsible utilisation of construction and demolition waste (CDW) in novel concrete applications.

Etcheberria et al. (2007) investigated the mechanical characteristics and structural response of recycled aggregate concrete (RAC). Their research revealed that RAC has the potential to attain comparable mechanical qualities to

traditional concrete, particularly when employing high-grade recycled aggregates. The study also showed that RAC might be efficiently utilised in structural components, such as beams and columns, by making suitable design modifications. Their conclusion was that RAC provides a viable substitute for natural aggregates, hence diminishing the environmental consequences of concrete manufacturing.

Xiao et al. (2012) performed empirical investigations on the utilisation of recycled aggregate concrete for structural purposes. Their attention was on evaluating the compressive strength, tensile strength, and modulus of elasticity of RAC. Their findings shown that by employing appropriate blend composition and processing techniques for recycled aggregates, Recycled Aggregate Concrete (RAC) could attain mechanical characteristics that are on par with those of conventional concrete made with natural aggregates. The study emphasised the significance of evaluating the quality and attributes of recycled aggregates in order to guarantee the structural effectiveness of RAC.

In their study, Silva et al. (2014) conducted a comprehensive analysis of the mechanical and durability characteristics of recycled aggregate concrete (RAC). It was discovered that the utilisation of recycled aggregates typically resulted in a decrease in mechanical qualities when compared to natural aggregates. Nevertheless, this decrease could be lessened by optimising the composition and including additional cementitious elements. The study further emphasised that RAC demonstrated good durability performance, rendering it appropriate for a wide range of structural applications.

Cakir (2014) examined the impact of utilising recycled aggregates on the mechanical characteristics of concrete. The investigation revealed that the inclusion of RCA led to a reduction in both compressive strength and modulus of elasticity. Nevertheless, the utilisation of fly ash and silica fume as additional cementitious materials enhanced the mechanical characteristics and long-lastingness of RAC. The study determined that RAC has the potential to be a feasible substitute for traditional concrete, as long as suitable blend composition and quality assurance procedures are put into practice. In 2008, González-Fonteboa and Martínez-Abella conducted a study on the mechanical properties of concrete that was produced using recycled aggregates. According to their research, RAC demonstrated comparable compressive and tensile capabilities to traditional concrete when utilising top-notch recycled aggregates. Furthermore, it was discovered that the resilience of RAC might be improved by integrating fly ash and other pozzolanic materials. The study provides evidence for the utilisation of recycled aggregates in structural concrete, highlighting the need of appropriate processing and mix design. Poon and Chan (2007) investigated the impact of utilising recycled aggregates on the flowability and structural characteristics of concrete. It was discovered that the ease of working with RAC was normally less than that of traditional concrete, although this might be enhanced by utilising superplasticizers. The study also showed that RAC may attain similar compressive and tensile strengths as traditional concrete through appropriate mix design and aggregate treatment. Their research emphasises the capacity of RAC to serve as a durable and environmentally-friendly building material.

Rahal (2007) examined the structural efficiency of concrete produced with recycled aggregates. The study revealed that RAC exhibited a slightly inferior compressive strength in comparison to traditional concrete. However, this disparity may be mitigated by optimising the mix design. The research findings also demonstrated that RAC can be efficiently utilised in structural components, such as beams and columns, by making suitable design modifications. The results affirm the practicality of utilising recycled aggregates in structural concrete applications.

De Brito and Saikia (2013) conducted a comprehensive examination of the characteristics and effectiveness of recycled aggregate concrete. Researchers discovered that the mechanical characteristics of RAC (recycled aggregate concrete) are typically inferior to those of traditional concrete. However, these disparities can be resolved by making adjustments to the mixture design and using supplemental cementitious elements. The study also emphasised the environmental advantages of utilising recycled aggregates, including decreased landfill trash and diminished carbon emissions. Their review highlights the capacity of RAC as a viable and long-lasting building material.

Malešev et al. (2010) examined the characteristics of concrete including recycled aggregates. According to their research, it was found that RAC can have comparable mechanical characteristics to regular concrete by appropriate processing and handling of recycled aggregates. Incorporating fly ash and other supplemental cementitious materials might enhance the durability of RAC, as revealed by the study. The results endorse the utilisation of reused aggregates in structural concrete, highlighting the significance of rigorous quality control and meticulous mix design optimisation.

Poon et al. (2004) investigated the impact of utilising recycled aggregates on the mechanical characteristics and long-lasting nature of concrete. It was discovered that RAC exhibited inferior compressive strength and durability when compared to traditional concrete. However, these disparities might be alleviated by using pozzolanic ingredients and employing sophisticated mix design techniques. The study also emphasised the environmental advantages of utilising

recycled aggregates, including decreased waste and preservation of resources. Their research provides evidence for the environmentally responsible utilisation of construction and demolition waste (CDW) in novel concrete applications.

Tabsh and Abdelfatah (2009) examined the structural performance of RAC in several applications. According to their research, RAC (Recycled Aggregate Concrete) can attain similar mechanical qualities as traditional concrete by using appropriate mixture composition and treating the aggregates. Furthermore, they showcased the efficacy of utilising RAC in structural components, such as beams and slabs, by taking into account relevant design aspects. The research provides evidence for the utilisation of recycled aggregates in structural concrete, emphasising their capacity for sustainable construction methodologies.

Eguchi et al. (2007) investigated the utilisation of recycled concrete aggregates in the creation of new concrete. Their investigation shown that RAC has the capability to attain comparable mechanical qualities to traditional concrete with appropriate processing and mix composition. Additionally, it was discovered that including supplemental cementitious materials, such as fly ash, enhanced the durability and performance of RAC. The research emphasises the viability of RAC as an environmentally friendly substitute for natural aggregates in the manufacturing of concrete.

Hansen (1992) did first study on the utilisation of recycled aggregates in concrete. The researcher's discoveries suggested that although RAC often exhibited worse mechanical qualities compared to traditional concrete, these disparities may be resolved by employing appropriate mix design and treating the recycled aggregates. Hansen's research established the foundation for future investigations into the practicality of incorporating recycled aggregates into structural concrete. It emphasised the advantages, both environmentally and economically, of adopting this sustainable approach. A study conducted by Ajdukiewicz and Kliszczewicz (2002) investigated the mechanical characteristics and long-term resilience of concrete produced with recycled aggregates. According to their research, RAC demonstrated comparable compressive and tensile capabilities to traditional concrete when processed and designed appropriately. Additionally, they emphasised the significance of using quality control measures to guarantee the effectiveness of RAC. The research provides evidence for the utilisation of recycled aggregates in structural concrete, highlighting the importance of implementing standardised rules and methods.

Khatib (2005) examined the impact of utilising recycled aggregates on the ease of handling and structural characteristics of concrete. The study revealed that RAC exhibited worse workability and mechanical qualities in comparison to traditional concrete. However, these disparities might be alleviated by employing superplasticizers and employing sophisticated mix design techniques. The research also emphasised the environmental advantages of utilising recycled aggregates, promoting the sustainable utilisation of construction and demolition waste (CDW) in new concrete applications.

Safiuddin et al. (2011) conducted a comprehensive evaluation of the characteristics and effectiveness of RAC. It was discovered that the mechanical characteristics of Reactive powder concrete (RAC) often has poorer resistance to cracking compared to traditional concrete. However, these disparities can be mitigated by adjusting the mixture composition and using supplementary cementitious elements. The study also emphasised the environmental advantages of utilising recycled aggregates, including diminished landfill waste and decreased carbon emissions. Their review highlights the capacity of RAC as a viable and enduring construction material.

According to Asif Husain¹, Majid Matouq Assas², and their colleagues (2013), including crushed aggregate into fresh concrete can contribute to the reduction of solid waste disposal in current landfill sites. The utilisation of deconstructed concrete will contribute to the enhancement of the overall environmental conditions in the area. Firstly, by a decrease in mining activities, and secondly, by reducing air pollution caused by the production of aggregates (specifically, dust pollution) and the transportation of aggregates from mining sites to consumption points (namely, vehicular pollution). Research indicates that crushed concrete, rather than being considered waste, can be utilised as a valuable resource for recycling in the production of new concrete. This practice not only conserves cement but also contributes to the cost-effectiveness of concrete production.

Goudappa Biradar¹ et al. (2015) asserts that recycled aggregates derived from concrete specimens yield high-quality concrete. An investigation was conducted to explore different surface treatment procedures, such as water washing and diluted acid treatment, to enhance the quality of recycled coarse aggregate. Recycled aggregate can be used in mix designs for structural concrete parts instead of disposing of the recycled concrete, resulting in cost savings.

R. Kumutha¹, K. Vijai² et., (2010) suggest that recycled aggregates can potentially be used as substitutes for natural coarse or fine aggregates in concrete. Several tests were conducted to ascertain the density, compressive strength, split tensile strength, flexural strength, and modulus of elasticity of concrete samples, both with and without recycled particles. The concrete's natural coarse aggregates were substituted with varying percentages of crushed concrete

aggregates: 0%, 20%, 40%, 60%, 80%, and 100%. The natural fine aggregate in the concrete was substituted with varying percentages (0%, 20%, 40%, 60%, 80%, and 100%) of crushed brick aggregates. Recycled concrete aggregate can serve as a substitute for crushed stone aggregate in sustaining a concrete pavement system, functioning as base and sub base components.

3. CONCLUSION

The synthesis of research findings in this review paper highlights the potential of concrete demolition wastes (CDW) as a useful resource in structural engineering applications. By doing a thorough examination of current literature and experimental research, we can derive numerous important findings. First and foremost, the qualities of CDW, when appropriately processed and treated, exhibit substantial potential for being reused in structural applications. Recycled aggregate concrete (RAC) made from construction and demolition waste (CDW) can attain sufficient performance levels, although it may have different mechanical and durability properties compared to standard concrete. This emphasises the practicality of integrating CDW into widely used construction methods as a sustainable substitute for traditional materials. Furthermore, empirical investigations have demonstrated encouraging outcomes in improving the efficiency of RAC by employing inventive processing methods and optimising mix design. The utilisation of extra cementitious materials and innovative admixtures has proven to be successful in enhancing the mechanical qualities and durability of recycled aggregate concrete (RAC), effectively tackling the typical issues related to the use of construction and demolition waste (CDW). In addition, the support of regulations and adherence to industry standards are essential in encouraging the implementation of RAC and CDW recycling procedures. Government laws and rules encourage the utilisation of recycled materials in construction projects, hence promoting widespread acceptance and standardisation efforts within the sector. The existing regulations provide a favourable setting for the successful incorporation of Construction and Demolition Waste (CDW) into the field of structural engineering. To summarise, this review highlights the significance of cooperative endeavours between researchers, industry experts, and policymakers in promoting the sustainable utilisation of CDW in the field of structural engineering. To effectively utilise the potential of construction and demolition waste (CDW) in promoting circular economy concepts and reducing environmental impacts, the construction industry should establish standardised protocols, testing methodologies, and best practices. By conducting ongoing research and actively implementing CDW recycling, the construction sector may make a significant contribution to its long-term sustainability and resilience.

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