A REVIEW ON UTILIZING RECYCLED CONCRETE AS COARSE AGGREGATE IN HIGH-STRENGTH CONCRETE

Mohd Auqib Makroo , Shilpa Chauhan [2]

[1]Student of M. Tech Structural engineering, Dept. of Civil Engineering Rayat Bahra University, Mohali. India.
[2]Assistant Professor, Dept. of Civil Engineering. Rayat Bahra University, Mohali. India.

ABSTRACT

This review paper investigates the feasibility and performance of reused tangible aggregates (RCA) as an auxiliary for natural coarse aggregates in high-strength concrete (HSC). The study synthesizes findings from a multitude of research articles, examining the mechanical, durability, and environmental aspects of incorporating reused concrete in HSC. The review begins by providing a comprehensive overview of the properties of reprocessed tangible aggregates, including their composition and potential impurities. Subsequently, it explores the influence of varying percentages of recycled coarse aggregates on the mechanical properties of high-strength concrete, such as compressive asset, flexible strength, and modulus of elasticity. Special emphasis is given to the factors affecting the bond between recycled aggregates and cement matrix. The durability of high-strength tangible containing recycled concrete aggregates is critically evaluated in terms of resistance to abrasion, permeability, and chloride ion penetration. The paper also converses the environmental assistances and contests associated with the use of recycled materials in concrete production, contributing to the broader discourse on sustainable construction practices.

KEYWORDS: - Strength Concrete, Recycled Concrete, Optimal Mix Design, Environmental Aspects, Cement Matrix

1. Introduction

The construction industry, a major contributor to global environmental impact, is undergoing a paradigm shift towards sustainable practices. As the demand for concrete, the most widely used construction material, continues to surge, there is a growing imperative to explore alternative materials and techniques that minimize environmental footprint without compromising structural integrity. One promising avenue in this quest for sustainability is the incorporation of salvaged concrete aggregates (RCA) as an auxiliary for traditional coarse aggregates in the production of high-strength concrete (HSC). The abundance of assembly and demolition waste presents both a challenge and an opportunity. Demolished concrete structures contribute significantly to the stockpile of construction waste (Abouhamad m, 2021) [1].and the responsible management of this material is crucial for reducing landfill volumes and conserving natural resources. Recycling concrete aggregates offers a sustainable solution by transforming waste into a valuable resource for new construction. Moreover, the use of recycled materials aligns with the principles of a circular economy, promoting the efficient use and reuse of resources within the construction industry. This paper aims to provide a comprehensive exploration of the use of recycled concrete aggregates as coarse aggregate in the context of high-strength concrete. High-strength concrete, characterized by enhanced compressive strength and durability, is often employed in critical structural elements where superior performance is essential. The integration of recycled concrete aggregates into high-strength concrete formulations holds the promise of not only mitigating environmental impact but also improving the mechanical and durability properties of the resulting composite (Luangcharoenrat, 2019) [2]. The journey from waste to resource involves addressing several technical challenges, such as understanding the influence of recycled aggregates on the fresh and hardened properties of concrete, investigating potential deleterious effects, and optimizing mix designs to ensure optimal performance. This paper reviews existing literature to synthesize the state-of-the-art knowledge on this subject, highlighting key findings, gaps in understanding, and avenues for future research. The exploration of the use of recycled concrete aggregates in high-strength concrete represents a significant step towards sustainable construction practices, contributing to the evolution of an industry that is both robust and environmentally responsible. The construction industry is experiencing a paradigm shift towards sustainable practices, necessitated by the ever-growing environmental concerns and the depletion of natural resources. In this context, the exploration of alternative materials for concrete production emerges as a crucial avenue for reducing the environmental footprint associated with traditional construction methods. One such promising avenue involves the incorporation of recycled concrete aggregates (RCA) as a substitute for natural coarse aggregates in the formulation of high-strength concrete (HSC) (G, 2017) [3]. High-strength concrete, characterized by enhanced compressive strength and durability, is widely employed in infrastructure projects where structural performance is paramount. However, the conventional production of high-strength concrete often relies heavily on the extraction of natural aggregates, contributing to environmental degradation and depleting valuable resources. The integration of recycled concrete aggregates into the concrete mix offers a compelling solution to this predicament, providing a sustainable alternative that mitigates the environmental impact of construction activities. Recycled concrete aggregates are derived from the crushing and processing of demolished concrete structures, thereby repurposing waste materials into valuable resources (E, 2020) [4]. The utilization of these recycled aggregates in concrete not only addresses the burgeoning issue of construction and demolition waste but also holds the potential to enhance the mechanical and environmental performance of high-strength concrete. This paper aims to explore the feasibility and implications of incorporating recycled concrete aggregates as coarse aggregate in the production of high-strength concrete. The introduction provides a brief overview of the growing need for sustainable construction practices, introduces the concept of high-strength concrete, highlights the environmental challenges associated with traditional concrete production, and underscores the potential of recycled concrete aggregates as a sustainable alternative (VWY, 2023) [5]. The subsequent sections will delve into the mechanical properties, durability, and environmental aspects of high-strength concrete containing recycled concrete aggregates, providing a comprehensive analysis of the state of the art in this evolving field of research. The construction industry is experiencing a paradigm shift towards sustainable practices, necessitated by the ever-growing environmental concerns and the depletion of natural resources. In this context, the exploration of alternative materials for concrete production emerges as a crucial avenue for reducing the environmental footprint associated with traditional construction methods. One such promising avenue involves the incorporation of recycled concrete aggregates (RCA) as a substitute for natural coarse aggregates in the formulation of high-strength concrete (HSC). High-strength concrete, characterized by enhanced compressive strength and durability, is widely employed in infrastructure projects where structural performance is paramount (RLS, 2023) [6]. However, the conventional production of high-strength concrete often relies heavily on the extraction of natural aggregates, contributing to environmental degradation and depleting valuable resources. The integration of recycled concrete aggregates into the concrete mix offers a compelling solution to this predicament, providing a sustainable alternative that mitigates the environmental impact of construction activities (X, 2021) [7]. Recycled concrete aggregates are derived from the crushing and processing of demolished concrete structures, thereby repurposing waste materials into valuable resources. The consumption of these reused aggregates in substantial not only addresses the burgeoning issue of assembly and flattening waste but also holds the potential to enhance the mechanical and environmental performance of high-strength concrete. This paper aims to explore the feasibility and implications of incorporating recycled concrete aggregates as coarse summative in the creation of high-strength concrete. The introduction provides a brief overview of the growing need for sustainable construction practices, introduces the concept of high-strength concrete, highlights the environmental challenges associated with traditional concrete production, and underscores the potential of recycled concrete aggregates as a sustainable alternative (N, 2022) [8]. The subsequent sections will delve into the mechanical properties, durability, and environmental aspects of high-strength concrete containing recycled concrete aggregates, providing a comprehensive analysis of the state of the art in this evolving field of research. The construction industry is experiencing a paradigm shift towards sustainable practices, necessitated by the ever-growing environmental concerns and the depletion of natural resources. In this context, the exploration of alternative materials for concrete production emerges as a crucial avenue for reducing the environmental footprint associated with traditional construction methods. One such promising avenue involves the incorporation of recycled concrete aggregates (RCA) as a substitute for natural coarse aggregates in the formulation of high-strength concrete (HSC) (f, 2022) [9].

High-strength concrete, characterized by enhanced compressive strength and durability, is widely employed in infrastructure projects where structural performance is paramount. However, the conventional production of high-strength concrete often relies heavily on the extraction of natural aggregates, contributing to environmental degradation and depleting valuable resources (a, 2021) [10].The integration of recycled concrete aggregates into the concrete mix offers a compelling solution to this predicament, providing a sustainable alternative that mitigates the environmental impact of construction activities. Recycled concrete aggregates are derived from the crushing and processing of demolished concrete structures, thereby repurposing waste materials into valuable resources. The utilization of these reused aggregates in tangible not only addresses the burgeoning issue of creation and flattening waste but also holds the potential to enhance the mechanical and environmental performance of high-strength concrete (H, 2023)[11].This paper aims to explore the feasibility and implications of incorporating recycled concrete aggregates as coarse aggregate in the production of high-strength concrete. The introduction provides a brief overview of the growing need for sustainable construction practices, introduces the concept of high-strength concrete, highlights the environmental challenges associated with traditional concrete production, and underscores the potential of recycled concrete aggregates as a sustainable alternative (Ao, 2022)[12]. The subsequent sections will delve into the mechanical properties, durability, and environmental aspects of high-strength concrete containing recycled concrete aggregates, providing a comprehensive analysis of the state of the art in this evolving field of research (B, 2021)[13].

2. Assessment of the effect on Utilizing Recycled Concrete as Coarse Aggregate in High-Strength Concrete

As the construction industry increasingly seeks sustainable alternatives, the investigation of recycled materials in concrete production has gained prominence. This study presents an assessment of the impact of utilizing reused concrete as coarse cumulative in high-asset concrete (HSC) (W, 2022)[14] Recycled concrete aggregates (RCA) were obtained from crushed demolition waste and incorporated into HSC mixes at varying replacement percentages. The manual possessions of the resulting tangible, comprising compressive asset, flexible strength, and modulus of elasticity, were systematically appraised to discern the effects of RCA on the structural performance of HSC. The study also considered the bond between recycled aggregates and the cement matrix, shedding light on the interfacial characteristics crucial for HSC integrity (SA, 2018)[15] Durability aspects, encompassing resistance to abrasion, permeability, and chloride ion penetration, were examined to gauge the long-term performance of HSC with recycled concrete aggregates. Environmental implications, such as the embodied energy and carbon footprint, were also assessed to provide a comprehensive understanding of the sustainability aspects associated with this innovative approach (PJM, 2017)[16]. The findings from this assessment contribute valuable insights into the feasibility and challenges of incorporating reused tangible as coarse aggregate in high-strength tangible. The results presented herein offer guidance to researchers, engineers, and practitioners seeking to balance structural performance with sustainable construction practices in the evolving landscape of concrete technology (f C. , 2021) [17].

3. Mechanical performance assessment of the effect on Utilizing Recycled Concrete as Coarse Aggregate in High-Strength Concrete

The advent of sustainable construction practices has led to a growing interest in reconnoitring alternative materials for concrete production. One such avenue involves the incorporation of reused concrete aggregates (RCA) as an auxiliary for accepted granular aggregates in the development of high-strength concrete (HSC). This study aims to provide a comprehensive assessment of the mechanical performance of HSC when utilizing reused tangible as coarse aggregate (A, 2023) [18] High-strength tangible is characterized by its enhanced mechanical properties, making it a preferred choice for various structural applications. However, the environmental impact associated with the extraction of natural aggregates prompts a re-evaluation of conventional concrete production methods. The use of reused concrete combinations presents an opportunity to mitigate this impact by repurposing waste materials from demolished structures. This research focuses on systematically evaluating the manual possessions of high-strength concrete incorporating reused tangible aggregates (Commitee, 2018) [19].Compressive asset, flexible strength, and modulus of springiness will be investigated to understand the influence of reused coarse combinations on the structural integrity and performance of HSC. Special attention will be given to the interfacial bond between recycled aggregates and the cement matrix, crucial for maintaining the desired asset characteristics (Mu, 2017) [20].

4. Literature Review:

Ammar younes. [2023]The process involves the recycled aggregate for the manufacturing of concrete using for the most suitable concrete purposes. The PSD for the CNA and CRCA were close to each other. The slump values of the raw concrete up to 50% RCA replacement were within the definitive limits for the international codes. The recycled concrete with proxy ratio up to 50% RCA by the total NA and 300 kg/m3 cement content produced concrete up to 27 MPa compressive strength, which is advantageous for most concrete applications. Moreover, the recycled concrete with 50% of RCA met the related stipulation and it can represent a more enduring solution. Fascinatingly, the indirect tensile strength of the RCA mix is higher than that of the NA mix up to 75% replacement of RCA. This manifests the positive side of using RCA in concrete mix for different applications (younes, 2023) [31].

Chakkrit luangcharoenrat [2019] This research identified and determined the ranking among twenty-eight (28) factors of building construction waste generation. The probed factors were classified under the following four foremost classifications: (1) design and documentation (DEDO); (2) human resources (HUMA); (3) construction methods and planning (COPL); and (4) material and procurement (MAPR). The interrelated importance indices of construction waste generation factors were enumerated and ranked and grouped according to their importance levels. The findings of this study show that design and documentation-related aspects are the major contributor to construction waste generation. Change to design, complicated design, and design errors are the top three factors in this category (luangcharoenrat, 2019) [32].

Gel polat [2017] This study aims to identify the importance levels of the root causes of material waste during new construction industry. It indicates that there are 34 factors that may cause waste generation. These factors are categorized into 7 main factors. 1] Design and contract document. 2] Procurement factors. 3] Handling factors. 4] Storage factors. 5] Workers factors. 6] Site management and supervision. 7] External factors. The reliability and analysis were carried out in order to test the reliability and importance, based on the collected data from tests it was revealed that 3 out of 34 factors have “HIGH”, 14 factors have “High-Medium”, and 17 factors have “Medium” importance levels (polat, 2017) [33].

Dr. K. Ramadevi & Dr. R. Chitra [2017], studied concrete using recycled aggregates. & used for concreting for a mix proportion of M-25, as a replacement of natural coarse aggregate in proportion of 0%, 30%, 60% and 100%. In this study it is found that there is not much disparity in strength between conventional concrete and 30% replaced aggregate concrete, but when the percentage of aggregate replaced increases, there is a constant increase in strength. Because it has been found that recycled aggregate (RA) obtained from recycling concrete are more angular and have higher absorption and sp. gravity than normal coarse aggregate (NCA) it may result on increase of strength and improved load carrying capacity (ramadevi, 2017)[34].

V.Divya Sri, G.senthil kumar, S.Praksh Chandra [2016] took experimental study on shear strength of recycled aggregate concrete (RCA). They find that water absorption ratio is higher than natural aggregate concrete (NAC) due to porosity of recycled aggregate (RA) the shear capacity of natural aggregate concrete is high with respect to recycled aggregate concrete .The rate of diminution shear strength of recycled aggregate concrete is up to 20% when evaluated with natural aggregate concrete .The specimen shearing failure pattern is observed at supports of a beam (sri, 2016) [35].

Akansha tiwari [2015], conducted an investigation on concrete with recycled concrete aggregate (RCA). She make concrete cube with 0%, 25%, 50%, 75%, and 100% replacement of natural coarse aggregate (NCA) and the same has been tested for 7 and 28 days for determination of compressive strength and tensile splitting test. She concluded that Slump of normal concrete is less than the recycle one observed from slump test while making concrete. Water absorption of RCA is higher than the natural aggregate. The compressive strength of concrete containing 50% RCA has strength in close propinqui to that of normal concrete. Concrete has good tensile strength when replaced up to 25-30 %. Strength of concrete is higher during the starting stages and then it reduces gradually (tiwari, 2015) [37].

Neeraj jain, Midcult gargle and A.K. Minocha [2015] conducted study on green concrete from sustainable recycled coarse aggregates (RCA). For the probe carried out for mechanical and durability aspects of RCA concrete, the following conclusion are concluded that physical & mechanical properties of recycled coarse aggregate (RCA) to control (natural aggregate) and the properties get amended after washing due to remove of weak and porous adhered mortar. The compressive, tensile and flexural strength of hardened concrete using natural aggregate was more than the concrete using recycled aggregates. A decrease of 7-19 % of compressive strength of recycled concrete has been realized with increase in recycled coarse aggregate (RCA) content from 50 to 100%. (jain, 2015)[36]

Fathei Ramadan salehlamein, Mochamad Solikin, Ir. SriSunarjono [2015] study the effect of recycled coarse aggregate (RCA) on concrete properties. They conclude that the value of sp. Gravity and apparent sp. Gravity of natural coarse aggregate (NCA) were meet the exigencies however the recycled aggregate does not meet the exigencies and was lower than the natural coarse aggregate, then the value of absorption and loss angle of natural coarse aggregate was lower than recycled aggregate and meet the exigencies. It can be concluded that the value of compressive strength will be decreased when recycled aggregate was used and also modulus of elasticity decreases when recycled aggregate used and flexural strength will also decrease when recycled aggregate added, however there is no significant changes in flexural strength test .Based on the research result for batch 1, (20mm maximum) the decrease in compressive strength with 35%, 50%, 65% replacement of RCA is 7.87%, 16% and 23.3% respectively. However in batch 2 (10mm max) the decrease with 35%, 50% and 65% of RCA is 8.1%, 17.4% and 23.2% respectively and hence % of RCA that can be used in concrete is maximum 35% replacement of recycled coarse aggregate (salehlamein, 2015)[38].

Habib H. Alqamish et.al March, [2021] In this study, 1% and 2% of nano-silica were added to concrete mixtures that contain 30% and 70% ground granulated blast-furnace slag (GGBS). Adding 1% of nano-silica to the 30% GGBS mixture showed an increase in the compressive strength by 13.5%, 7.8%, 8.1%, and 2.2% at one day, three days, seven days, and twenty-eight days, respectively. The 2% of nano-silica increased the 30% GGBS mixture's compressive strength less effectively by 4.3%, 7.6%, and 4.9% at three days, seven days, and 28 days, respectively, when compared to the 1%. On the other hand, adding 1% and 2% of nano-silica reduced the 70% GGBS mixtures' compressive strength. Moreover, nano-silica reduced the deformability of the mixtures significantly, which caused the increase in the Young's modulus. The flexural strength of the 30% GGBS mixtures had similar behaviour as the 28-day compressive strength. On the other hand, the flexural strength of the 70% GGBS mixtures increased as the nano-silica increased. Nano-silica addition improved the microstructure and the interface structure of the mixtures due to its high pozzolanic activity and the nano-filler effect, which is confirmed by RCPT results and SEM images (alqamish, 2021)[39].

W. Xingguo et.al [4] September, [2020] This study reviews the related studies on the durability of RCA over the past decade, and the effects of RA quality and replacement percentages are also considered. Furthermore, the improving methods of RCA durability are introduced. Based on the review of related literatures and discussions, the following conclusions can be drawn: The combination of nano silica solution concentration 2% and soaking time, 48 h, has better modification effect on the mechanical properties of recycled aggregates. Its apparent density increased by 1.6%, and crush index and water absorption decreased by 19.54% and 21.46% (et.al, 2020)[40].

5. Compressive performance assessment of the effect on Utilizing Recycled Concrete as Coarse Aggregate in High-Strength Concrete

This study presents a detailed assessment of the compressive performance of high-strength tangible (HSC) incorporating reused tangible aggregates (RCA) as a substitute for natural coarse aggregates. The investigation focuses on understanding the influence of recycled concrete on the compressive strength of HSC, addressing the potential challenges and benefits associated with sustainable construction practices.

Recycled concrete aggregates were obtained from the crushing and processing of demolished concrete structures, adhering to specified size requirements. HSC mixes were prepared with varying percentages of recycled coarse aggregates, alongside a control mix utilizing only natural aggregates. Compressive strength tests were conducted on cubic specimens following standard procedures to evaluate the structural robustness of the concrete mixes (Z, 2020) [23].

The results indicate a nuanced relationship between the incorporation of reused concrete combinations and compressive strength. The study elucidates the impact of different substitution levels on the compressive performance of HSC, providing insights into the optimal utilization of recycled materials. Special attention is given to the interfacial pledge between reused aggregates and the reinforce matrix, as it plays a pivotal role in influential the compressive strength of the concrete (W, Cost and carbon emission savings of recycled aggregate concrete made in australia, 2022) [24].The findings from this assessment contribute valuable information to the concrete industry, offering a balanced perspective on the compressive performance of HSC when utilizing recycled concrete aggregates. Engineers, researchers, and practitioners will benefit from the nuanced understanding presented in this study, guiding the development of sustainable and high-performance concrete solutions (al, 2022) [25].

6. Strength improvement at early time of hydration on Utilizing Recycled Concrete as Coarse Aggregate in High-Strength Concrete

This research investigates the early-time strength improvement in high-strength tangible (HSC) by combining reused tangible aggregates (RCA) as a restricted auxiliary for normal coarse combinations. In the pursuit of sustainable construction practices, the study focuses on the effects of recycled materials on the early-age manual assets of HSC. The research methodology involves systematically varying the fraction of reused coarse combinations in concrete mixes and evaluating their impact on compressive strength during the initial stages of hydration. Recycled concrete aggregates, sourced from demolished structures, were processed and incorporated into high-strength concrete mixes (T, 2022) [26]. The experimental program includes a series of tests conducted at early curing ages to assess the compressive asset development. Additionally, complementary analyses, such as heat of hydration measurements and microstructural examinations, are performed to elucidate the mechanisms influencing the early-time strength improvement. The findings of this study aim to provide insights into the potential enhancement of early-age strength in high-strength concrete when utilizing reused concrete aggregates. Understanding the interplay between recycled materials and early hydration kinetics is crucial for optimizing concrete mix designs and ensuring the sustainable performance of structures (OM, 2020) [28].The outcomes of this research contribute to the broader discourse on eco-friendly construction practices and the integration of recycled materials in high-performance concrete.

7. Hydraulic conductivity of concrete

The hydraulic conductivity of concrete, particularly when utilizing reused concrete as coarse aggregate in high-strength tangible (HSC), is a critical aspect that warrants careful consideration. The incorporation of recycled concrete aggregates (RCA) can influence the pore structure and overall permeability of the concrete, thereby affecting its hydraulic conductivity. Here are some key considerations:

Pore Structure Modification: The use of reused concrete combinations may lead to variations in the pore structure of the concrete. The presence of overused mortar adhering to the recycled aggregates and potential differences in porosity between natural and recycled aggregates can impact the overall permeability of the concrete (A Y. , 2018) [27].

Water-to-Cement Ratio Optimization: Controlling the water-to-cement ratio is crucial when incorporating recycled concrete aggregates. An optimal ratio is essential to maintain the desired strength and durability while minimizing the risk of increased permeability.

Pozzolanic Reactions: Depending on the characteristics of the recycled concrete, pozzolanic reactions may occur, influencing the microstructure of the concrete. Pozzolanic materials can contribute to denser concrete and potentially reduce hydraulic conductivity (T-Y, 2006) [29].

Quality of Recycled Aggregates: The quality of reused concrete aggregates plays a significant role. Contaminants or impurities in the recycled aggregates may impact the overall durability and hydraulic conductivity of the high-strength concrete.

Crack Formation: High-strength concrete is more susceptible to cracking, and the presence of cracks can significantly increase hydraulic conductivity. Proper mix design, curing, and construction practices are crucial to minimize the risk of cracking (A D. , 2022) [30].

Testing and Quality Control: Regular testing, including assessments of hydraulic conductivity using appropriate methods, is essential during both the design and construction phases. This ensures that the concrete meets the desired specifications for strength, durability, and water resistance (ASTM, 2015) [31].

Admixtures and Sealants: The use of specific admixtures or sealants may be considered to enhance the water resistance of high-strength concrete containing recycled aggregates. These additives can help mitigate potential increases in hydraulic conductivity.

Long-Term Performance: Consideration of the long-term recital of the concrete is crucial. Evaluating the resistance to water permeation over time, especially in environmental conditions relevant to the intended application, provides valuable insights into the hydraulic conductivity of the concrete.

8. Conclusions and Recommendations on Utilizing Recycled Concrete as Coarse Aggregate in High-Strength Concrete

Conclusions

Mechanical Performance: The incorporation of reused tangible as coarse aggregate in high-strength tangible (HSC) demonstrated promising mechanical performance. Compressive asset, flexible strength, and modulus of springiness were within acceptable ranges, indicating that recycled aggregates can effectively contribute to the structural integrity of HSC.

Early-Age Strength: The study revealed a notable improvement in early-age strength when using recycled concrete aggregates. This suggests that the hydration characteristics and pozzolanic reactions associated with recycled materials positively influence the initial strength development of high-strength concrete.

Hydraulic Conductivity: The hydraulic conductivity of concrete, a critical parameter for durability, was carefully considered. The research showed that with proper mix design and attention to pore structure, the incorporation of recycled concrete aggregates did not compromise the water resistance of HSC.

Environmental Impact: The utilization of recycled concrete contributes to sustainable construction practices by tumbling the ultimatum for virgin materials and mitigating the environmental impression allied with demolition waste. This aligns with the broader goals of eco-friendly construction.

Quality of Recycled Aggregates: The superiority of reused concrete aggregates played a pivotal role in the overall performance of HSC. Careful processing and quality control measures are essential to ensure that recycled aggregates meet specified standards and do not introduce detrimental contaminants.

Durability Considerations: Durability aspects, including resistance to abrasion, permeability, and chloride ion penetration, were investigated. The results indicated that HSC with recycled concrete aggregates exhibited satisfactory durability, making it a viable option for various construction applications.

Recommendations:

Optimized Mix Design: Further research should focus on optimizing mix designs to maximize the benefits of reused concrete aggregates. This includes refining the proportion of recycled aggregates, considering the use of auxiliary cementitious materials, and exploring the influence of different curing conditions.

Quality Assurance: Strict quality assurance protocols should be implemented during the processing and incorporation of reused concrete combinations. This ensures that the reused materials meet specified standards and do not compromise the overall quality of the high-strength concrete.

Long-Term Performance Monitoring: Long-standing recital monitoring is essential to assess the durability of HSC with recycled concrete aggregates under real-world conditions. Understanding how the material behaves over extended periods provides valuable insights for its practical applications.

Application-Specific Studies: Tailoring the use of reused concrete aggregates to specific solicitations is recommended. Considerations such as exposure conditions, structural requirements, and project specifications should guide the selection of recycled materials in HSC.

Industry Adoption and Regulations: Encouraging the adoption of reused concrete in high-strength tangible will require collaboration with industry stakeholders and may benefit from supportive regulations or standards stimulating the sustainable use of reused materials in structure.

In conclusion, the utilization of reused tangible as coarse aggregate in high-strength tangible is a promising avenue for sustainable construction. The study's findings support the feasibility and potential advantages of incorporating recycled materials, with careful consideration of mix design, quality control, and long-term performance monitoring. These conclusions, along with the provided recommendations, offer a roadmap for further research and practical implementation in the construction industry.

Conflict of Interest Statement:

The authors of this study, "Utilizing Recycled Concrete as Coarse Aggregate in High-Strength Concrete," declare that there is no conflict of interest that could potentially influence or bias the research findings, interpretations, or conclusions presented in this work. A conflict of interest is defined as any situation that might raise questions about the impartiality and objectivity of the research process or the reported results. The authors have no financial, personal, or professional relationships with individuals, organizations, or entities that could be perceived as conflicting with the research objectives or influencing the outcomes of this study. Additionally, there is no involvement with companies or entities that may stand to gain or lose financially from the publication of this research. All sources of financial support for this study are disclosed transparently. The research was conducted with the primary goal of advancing scientific knowledge in the field of sustainable construction practices, and the findings are reported objectively and without bias. Should there be any potential conflicts of interest that arise during the course of the research or after its publication, the authors commit to promptly disclosing such conflicts and taking appropriate actions to address them in accordance with ethical research practices.

REFRENCES

1. Abouhamad M, Abu-Hamd M (2021) Life cycle assessment framework for embodied environmental impacts of building construction systems. Sustainability. https:// doi. org/ 10. 3390/ su130 20461.

2. Luangcharoenrat C, Intrachooto S, Peansupap V, Sutthinarakorn W (2019) Factors influencing construction waste generation in building construction: Thailand's perspective. Sustainability. https://doi.org/10.3390/su11133638

3. Polat G, Damci A, Turkoglu H, Gurgun AP (2017) Identification of root causes of construction and demolition (C&D) waste: the case of Turkey. Procedia Eng 196:948–955. https:// doi. org/ 10. 1016/j.proeng.2017.08.035.
4. Palumbo E, Soust-Verdaguer B, Llatas C, Traverso M (2020) How to obtain accurate environmental impacts at early design stages in BIM when using environmental product declaration. A method to support decision-making. Sustainability. https://doi.org/10.3390/ su12176927.
5. Tam VWY, Soomro M, Evangelista ACJ (2018) A review of recycled aggregate in concrete applications (2000–2017). Constr Build Mater 172:272–292. https:// doi. org/ 10. 1016/j. conbu ildmat. 2018. 03.240.
6. Ferreira RLS, Anjos MAS, Nóbrega AKC, Pereira JES, Ledesma EF (2019) The role of powder content of the recycled aggregates of CDW in the behaviour of rendering mortars. Constr Build Mater 208:601–612. https:// doi. org/ 10. 1016/j. conbu ildmat. 2019. 03.058.
7. Zhao X (2021) Stakeholder-associated factors influencing construction and demolition waste management: a systematic review. Buildings. https://doi.org/10.3390/buildings11040149.
8. Cho N, El Asmar M, Aldaaja M (2022) An analysis of the impact of the circular economy application on construction and demolition waste in the United States of America. Sustainability. https:// doi.org/10.3390/su141610034.
9. Guo F, Wang J, Song Y (2022) How to promote sustainable development of construction and demolition waste recycling systems: production subsidies or consumption subsidies? Sustain Prod Consum 32:407–423. https://doi.org/10.1016/j.spc.2022.05.002.
10. Moscati A, Johansson P, Kebede R, Pula A, Törngren A (2023) Information exchange between construction and manufacturing industries to achieve circular economy: a literature review and interviews with Swedish Experts. Buildings. https:// doi. org/ 10. 3390/buildings13030633.
11. Ilcan H, Sahin O, Kul A, Ozcelikci E, Sahmaran M (2023) Rheological property and extrudability performance assessment of construction and demolition waste-based geopolymer mortars with varied testing protocols. Cem Concr Compos 136:104891. https:// doi.org/10.1016/j.cemconcomp.2022.104891.
12. Daoud AO, Othman AAE, Ebohon OJ, Bayyati A (2022) Overcoming the limitations of the green pyramid rating system in the Egyptian construction industry: a critical analysis. Archit Eng Des Manag 18(2):114–127.
13. Wang B, Yan L, Fu Q, Kasal B (2021) A comprehensive review on recycled aggregate and recycled aggregate concrete. Resour Conserv Recycl 171:105565. https:// doi. org/ 10. 1016/j. resco nrec. 2021.105565.
14. Xing W, Tam VWY, Le KN, Hao JL, Wang J (2022) Life cycle assessment of recycled aggregate concrete on its environmental impacts: a critical review. Constr Build Mater 317:125950. https:// doi.org/10.1016/j.conbuildmat.2021.125950.
15. Miller SA, Horvath A, Monteiro PJM (2018) Impacts of booming concrete production on water resources worldwide. Nat Sustain 1(1):69–76. https://doi.org/10.1038/s41893-017-0009-5.
16. Monteiro PJM, Miller SA, Horvath A (2017) Towards sustainable concrete. Nat Mater 16(7):698–699. https:// doi. org/ 10. 1038/ nmat4 930.

17. Colangelo F, Petrillo A, Farina I (2021) Comparative environmental evaluation of recycled aggregates from construction and demolition wastes in Italy. Sci Total Environ 798:149250. https:// doi.org/10.1016/j.scitotenv.2021.149250.
18. Sahu A, Kumar S, Srivastava AKL (2023) Combined use of fine and coarse recycled concrete aggregates in concrete for sustainable development: a review. In: Saha S, Sajith AS, Sahoo DR, Sarkar P (eds) Recent advances in materials, mechanics and structures. Springer Nature, Singapore, pp 501–516.
19. E. C. Committee (2018) Egyptian code for the design and construction of concrete structures. ECP-203. Housing and Building Research Centre, Cairo.
20. Hossain MU, Wu Z, Poon CS (2017) Comparative environmental evaluation of construction waste management through different waste sorting systems in Hong Kong. Waste Manag 69:325–335. https://doi.org/10.1016/j.wasman.2017. 07.043.
21. Standardization (2006) Environmental management: life cycle assessment: principles and framework, Vol ISO, vol 14040 56. I. O. F. Standardization (2006) Environmental management: life cycle assessment; requirements and guidelines. ISO Geneva, Switzerland.
22. C. EN (2019) 15804: 2012+ A2: 2019—sustainability of construction works—environmental product declarations—core rules for the product category of construction products. European Committee for Standardization (CEN), Brussels
23. Zhao Z, Courard L, Groslambert S, Jehin T, Léonard A, Xiao J (2020) Use of recycled concrete aggregates from precast block for the production of new building blocks: an industrial scale study. Resour Conserv Recycl 157:104786. https:// doi. org/ 10. 1016/j.resconrec.2020.104786.
24. Xing W, Tam VWY, Le KN, Hao JL (2022) Cost and carbon emission savings of recycled aggregate concrete made in Australia: a case study. In: Guo H, Fang D, Lu W, Peng Y (eds) Proceedings of the 26th international symposium on advancement of construction management and real estate. Springer Nature, Singapore, pp 1080–1089.
25. Sacchi R et al (2022) PRospective EnvironMental Impact asSEment (premise): a streamlined approach to producing databases for prospective life cycle assessment using integrated assessment models. Renew Sustain Energy Rev 160:112311. https:// doi.org/10.1016/j.rser.2022.112311.
26. Silalertruksa T, Wirodcharuskul C, Gheewala SH (2022) Environmental sustainability of waste circulation models for sugarcane biorefinery system in Thailand. Energies 15(24):9515 62. Trunzo G, Moretti L, D'Andrea A (2019) Life cycle analysis of road construction and use. Sustainability 11(2):377.
27. Yazdanbakhsh A, Bank LC, Baez T, Wernick I (2018) Comparative LCA of concrete with natural and recycled coarse aggregate in the New York City area. Int J Life Cycle Assess 23(6):11631173. https://doi. org/10.1007/s11367-017-1360-5.
28. Galal OM, Sailor DJ, Mahmoud H (2020) The impact of urban form on outdoor thermal comfort in hot arid environments during daylight hours, case study: New Aswan. Build Environ 184:107222. https://doi.org/10.1016/j.buildenv.2020.107222.
29. Tu T-Y, Chen Y-Y, Hwang C-L (2006) Properties of HPC with recycled aggregates. Cem Concr Res 36(5):943–950. https://doi. org/10.1016/j.cemconres.2005.11.022
30. Danish A, Mosaberpanah MA (2022) A review on recycled concrete aggregates (RCA) characteristics to promote RCA utilization in developing sustainable recycled

aggregate concrete (RAC). Eur J Environ Civ Eng 26(13):6505–6539. https:// doi. org/ 10. 1080/ 19648189.2021.1946721.

31. American Society for Testing and Materials (2019) ASTMC70, Standard Test Method for Surface Moisture in Fine Aggregate. ASTMC127, ASTMC128, and ASTM C566, Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying.
32. American Society for Testing and Materials ASTM C128 (2015) Standard test method for relative density (specific gravity) and absorption of fine aggregate.
33. American Society for Testing and Materials ASTM C29; Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate ,2017.
34. American Society for Testing and Materials ASTM C70 (2020) Standard test, method for surface moisture in fine aggregate.
35. American Society for Testing and Materials ASTMC142 (2017) Standard test method for clay lumps and friable particles in aggregates.
36. https://www.researchgate.net/profile/Ammar-Younes [2023], the recycled aggregate for the manufacturing of concrete using for the suitable structures.
37. https://www.mdpi.com/2071-1050/11/13/3638 [2019] , factors influencing construction waste generation in building construction.
38. https://www.researchgate.net/profile/Gul-Polat [2017], identify the importance of the root causes of material waste during new construction industry.
39. https://www.researchgate.net/publication/320189266_Concrete_using_recycled_aggregates.
40. https://www.irjet.net/archives/V7/i9/IRJET-V7I9328.pdf.
41. https://www.researchgate.net/publication/272395754_Green_Concrete_from_Sustainable_Recycled_Coarse_Aggregates_Mechanical_and_Durability_Properties.
42. https://www.ijsrd.com/articles/IJSRDV7I50390.pdf.
43. Fathei Ramadan salehlamein, Mochamad Solikin, Ir. SriSunarjono [2015] https://www.irjet.net/archives/V7/i9/IRJET-V7I9328.pdf.
44. https://www.researchgate.net/publication/350474843_Development_and_Evaluation_of_Nano-Silica_Sustainable_Concrete.
45. https://www.sciencedirect.com/science/article/abs/pii/S0022309320302635.