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The Integration of Material Recycling & Green Building Principles for Advance Sustainable Materials Management

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Abstract

This paper conducts a comprehensive review of integrating material recycling and green building principles within the land of civil engineering, emphasizing the urgency of sustainable practices in the construction sector. We systematically examine the challenges, benefits, and methodologies employed in sustainable construction, with a particular focus on the pivotal roles of recycling materials and the adoption of green building techniques. Key areas of discussion include strategies for effective construction waste management, particularly through the implementation of the "3R" approach. We also delve into the comparative analysis of various green building rating systems and their impact on construction waste management. Furthermore, the paper discusses innovative materials like geopolymer concrete that incorporate recycled aggregates, which play a significant role in sustainable development. An essential aspect of this study is highlighting the efficient management of construction and demolition waste, underscoring the need for legislative and institutional reforms. We also explore the influential role of consumer behavior in adopting green practices. The research acknowledges the geographical limitations of current studies in this field and advocates for a more inclusive, interdisciplinary approach. This approach should integrate technical, economic, and social perspectives to further advance sustainable practices in construction. Our paper aims to provide a vital resource for understanding the current status and future potential of sustainable construction methods. It advocates for an integrated approach that focuses on reducing the environmental impact and promoting long-term sustainability in civil engineering.

Keywords
Sustainable, Recycling, Demolition, Geopolymer and 3R.

1. Introduction
At the core of contemporary civil engineering lies a pressing and transformative challenge: the integration of material recycling and green building principles. This challenge, driven by the imperative for sustainable development, positions civil engineering not just as a contributor to infrastructure but as a pivotal force in ecological stewardship. Our research ventures into this transformative domain, seeking to redefine the traditional paradigms of construction with an emphasis on environmental harmony and resource efficiency.

This paper ventures beyond conventional approaches, scrutinizing the innovative amalgamation of material recycling and green construction techniques within civil engineering. The construction sector, historically a significant contributor to environmental degradation and resource depletion, now stands at the forefront of an ecological revolution. By dissecting the dynamics of recycling and sustainable building practices, this study aims to unfold new methodologies and perspectives that align construction practices with the principles of sustainability.

We embark on a journey that navigates through the multifaceted aspects of sustainable construction — from the granular details of waste reduction techniques to the broader vistas of policy and societal impacts. Our exploration is not just an academic exercise; it is a quest to unearth practical, scalable solutions that can effectively turn the tides toward a more sustainable and environmentally conscious construction paradigm. Through this study, we aim to offer a beacon for the construction industry, illuminating paths toward a future where civil engineering and ecological balance coexist in synergistic harmony.

Objectives
The paper focuses on conducting comprehensive lifecycle assessments of construction materials. This approach is pivotal for minimizing waste generation, enhancing energy efficiency, and conserving natural resources, thereby contributing to a more sustainable construction process.

By emphasizing the reduction of raw material extraction, processing, and transportation, the research seeks to lessen the adverse environmental impacts associated with these stages of construction.

A key goal is to advocate for and implement strategies that reduce landfill dependency by promoting recycling and reuse. This approach supports the development of a circular economy in the construction industry, where waste materials are repurposed for new uses.

The research aims to align with existing regulations and best practices for responsible environmental management in civil engineering. This compliance ensures that the construction processes meet or exceed the sustainability benchmarks set by regulatory authorities.

The study aims to demonstrate that the incorporation of green building and recycling practices can lead to substantial long-term cost savings. This is achieved through reduced expenses in energy consumption, waste management, and material procurement.

2. Literature Review
Waste management strategy for the construction industry-“3R”- Strategy

Solid waste generation is mostly a result of the building sector, which creates serious environmental and financial problems. The "3R" strategy of Reduction, Recycling, and Reuse has become an essential waste management method as an alternative to this problem.

The main objective is reduction, with a focus on the early avoidance of waste creation. As per the research conducted by Cai and Waldmann (2019), this strategy is essential, particularly in light of the significant quantity of garbage produced per person worldwide. The construction industry may limit waste creation and lessen its ecological impact by using high-performance materials and boosting building longevity.

In the opinion of Kabirifar *et al.,* (2020), the 3R strategy's reuse and recycling strategies are equally important. Recycling components from existing buildings is known as recycling, and it may help save energy and raw resources. Even while it could result in some additional pollutants, it is still more ecologically friendly than mining and processing fresh resources. However, as it avoids waste and decreases the demand for new resources, direct reuse of building materials and components is even more energy and environmentally beneficial.

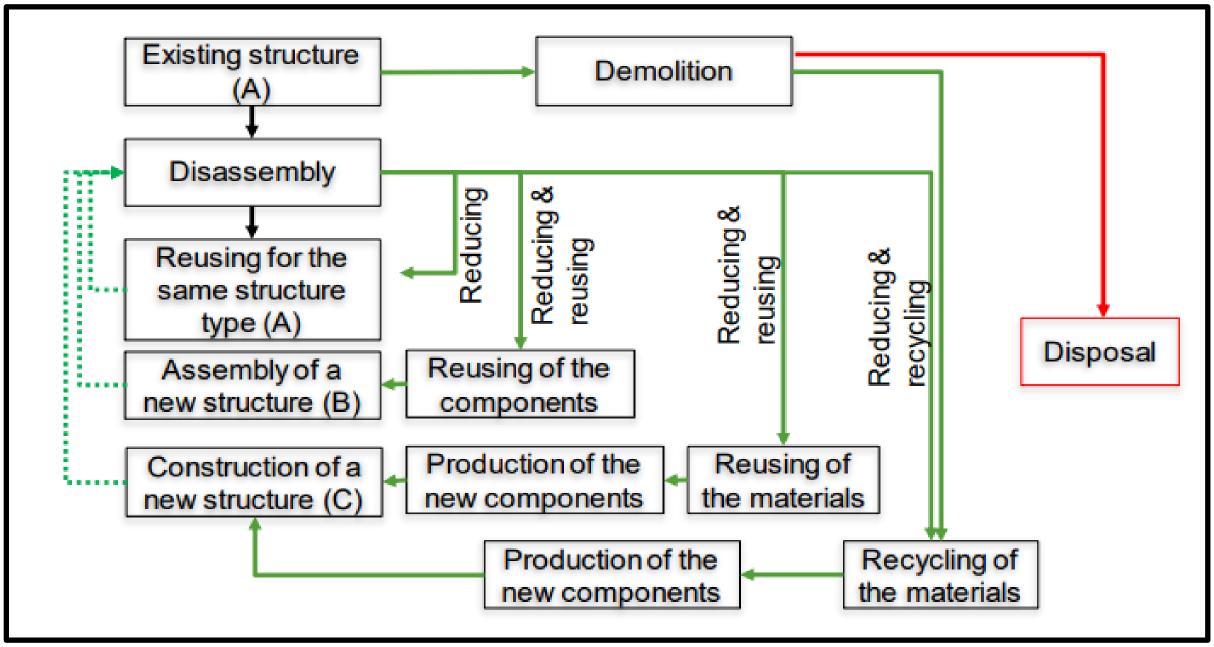

Figure 1. Management Strategy of Demounted Structures (Source: Cai and Waldmann, 2019)

Current deconstruction and demolition technologies

A key component of sustainable building methods is the management of construction and demolition waste (C&DW). A key factor in accomplishing environmental and financial goals is choosing between deconstruction and demolition methods. In the aspect of Bertino *et al.* (2021), deconstruction is the process of selectively removing parts or materials from a building in order to preserve and recycle them. This strategy supports sustainability objectives and may increase the useful life of raw materials while lowering pollution and disposal expenses. However, as criticized by Campbell and Morris (2017), deconstruction, confronts difficulties, such as a lack of guidelines and design techniques, longer processing times, and possible cost inflation.

In comparison, the process of demolition is less complicated and more frequent, particularly for minor buildings. For bigger operations, it generally employs heavy equipment or even wrecking balls. Although demolition is quicker and takes less time, it produces more noise and mixed garbage, which makes recycling and reuse challenging. As mentioned by Akinade *et al.* (2020), the appropriateness of current deconstruction and demolition methods for various building kinds varies. Masonry and wood constructions can be removed using hand tools, but it takes a long time and is messy. For newer buildings, high-reach removal, which utilizes towering excavators to crush structures, is effective. While ideal for brick buildings, wrecking ball destruction generates noise, dust, and material waste. Controlled explosives produce implosions but have disadvantages including noise and material degradation. Cutting and takedown techniques have a significant potential for recycling, but they need more meticulous labor and are more expensive. Disassembly, particularly in buildings designed for disassembly (DfD), enables systematic component reuse, offers significant recycling potential, and reduces noise and dust.

Main barriers and lack of current reuse/recycling in the construction industry

Reuse and recycling in the construction sector currently deal with a number of significant challenges and shortcomings that impede its development towards sustainability. In the view of Ratnasabapathy *et al.* (2021), a major obstacle to the industry's capacity to manage construction and demolition waste (C&DW) efficiently is the lack of adequate regulatory frameworks and political initiatives. Furthermore, the certification of recycled materials and recovered parts is hindered by the absence of comprehensive information and norms. DfD techniques need to be improved, especially in terms of guaranteeing the structural safety of junctions between pieces. In order to encourage recycling, rules for C&DW disposal and landfill management need to be improved, maybe via higher disposal prices. Improved material separation techniques as well as more appropriate deconstruction and smart demolition technologies must also be developed. For the quality of recycled materials and components to be ensured, effective quantitative evaluation procedures are crucial. It is critical to reduce the design and construction expenses related to DfD buildings and to comprehend the remaining service life of reused components.

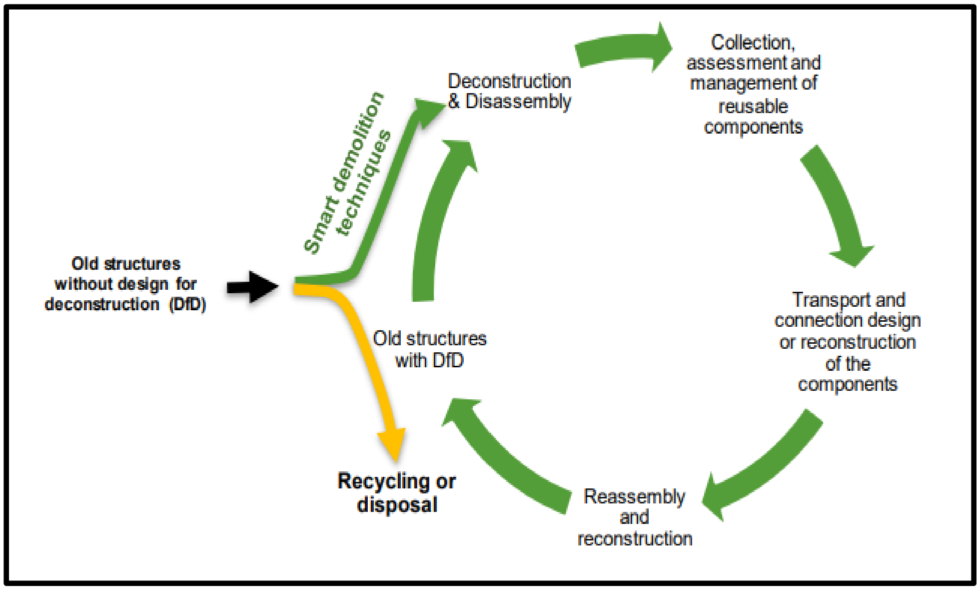

Figure 2. Ideal reuse of value components in eco-construction industry (Source: Cai and Waldmann, 2019)

Evaluating the effects of green building on construction waste management: A comparative study of three green building rating systems

This article examines the connection between green building methods and construction waste management (CWM), which is a crucial aspect of sustainable construction. According to the research by Lu *et al.,* (2019), the Leadership in Energy and Environmental Design (LEED) program from the United States, the GB Evaluation Label (GBEL) program from mainland China, and the Building Environmental Evaluation and Management Method (BEAM Plus) program from Hong Kong are the three major Green Building Rating Systems (GBRSs) that are the subject of this research. It tries to assess the impacts these GBRSs have on CWM and pinpoints possible causes for any effects that may have been seen. A mixed-method strategy combining data analysis and semi-structured interviews makes up the study technique. Due to the integration of quantitative data and expert qualitative analysis, this technique enables a thorough evaluation of the impacts of GBRSs on CWM. Surprisingly, the research shows that, although having particular credits aimed towards CWM, the three chosen GBRSs do not substantially encourage higher CWM performance. This shows that the anticipated beneficial impact of GBRSs on CWM is not really being experienced. The study uses empirical project data from genuine GB initiatives in various locations to provide verifiable proof of the phenomena. As per the views of Illankoon and Lu (2020), the discrepancy between GBRSs' goals and their actual impacts on CWM is highlighted by the persistently low ratings in the material elements, where CWM-related credits are situated. Industry experts' interviews have provided insight into a number of elements that affect the discrepancy between GBRSs and CWM performance. Among them are the dearth of incentives provided by scoring procedures, the high expenses connected with getting CWM-related credits, worries over the reuse and recycling of construction materials, and the difficulty of the documentation procedures. Two main recommendations are given in the article for enhancing CWM with GBRSs. As demonstrated by BANDA (2019), in order to guarantee project stakeholders' adherence to CWM methods, it is first suggested that progressive legal and economic mechanisms be adopted and included in contract wording. In addition, it suggests enhancing the application of CWM-related credits and encouraging the use of recyclable and reusable construction materials to fine-tune GBRSs.

Therefore, it is clear that in relation to CWM, this paper identifies a substantial gap in GBRS efficacy and offers insightful explanations for why it exists. It emphasizes the necessity for legislative and institutional reforms to incentivize responsible CWM practices within the framework of GBRSs, underlining the need to coordinate green building practices with CWM aims to achieve complete sustainability in the construction sector.

Determining the Impact of Construction and Demolition Waste Reduction Practices on Green Building Projects in Gauteng Province, South Africa

This article emphasizes the crucial role that sustainable waste management techniques play in the building sector and how they directly affect green building initiatives. As cited by Aboginije *et al.,* (2020), the Gauteng Province, a significant producer of building and demolition debris in South Africa, is the subject of the study's primary attention. In order to evaluate the viewpoints of construction industry experts with varied degrees of experience and skill, the study uses a thorough approach that includes questionnaires.The initial stage of the article successfully sets the scene by highlighting the importance of the building sector in contributing to economic development while admitting its detrimental environmental implications, specifically in terms of waste creation. It draws attention to how conventional, labor-intensive construction has given way to a more complex, resource-intensive industry that depends on highly trained personnel and cutting-edge gear. It also highlights how construction and demolition (C&D) debris is increasingly being seen as a useful resource as opposed to only being a waste product for landfills (Aboginije *et al.,* 2020). The article's outline of C&D trash, which includes numerous materials produced during building, renovation, repair, demolition, and even emergencies, is one of the most important things to remember from it. This description emphasizes the waste's potential for recycling and reuse while defining the breadth of the topic.

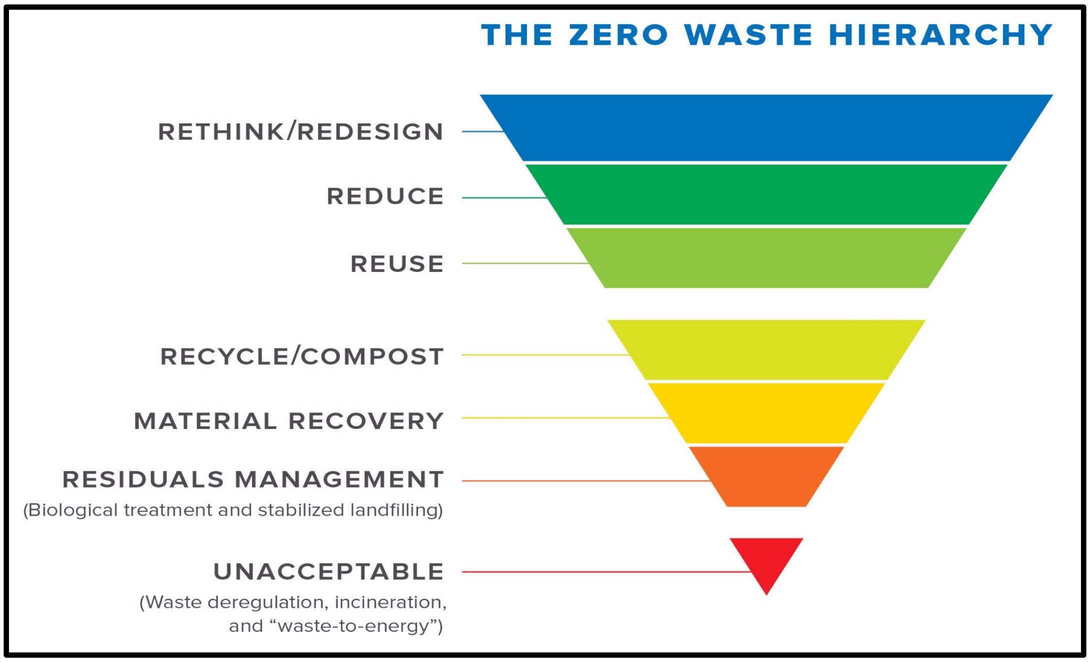

Figure 3. Zero Waste Hierarchy [Source: Aboginije *et al.,* 2020]

The article discusses the urgent need for ethical waste management procedures, especially in places like Gauteng where there is significant trash creation. According to the report by Aboginije *et al.,* (2020), C&D debris makes up up to 15–30% of the garbage dumped in landfills, underscoring the pressing need to address this problem. Also appropriately underlined are the environmental and health risks connected to improper waste management, such as air and water pollution, the spread of illness, and habitat damage. An in-depth analysis of the waste management hierarchy is provided, highlighting the value of reducing, reusing, recycling, and recovering materials before turning to landfill disposal. This hierarchy complements the Zero Waste Hierarchy, which places a strong emphasis on resource preservation and ethical waste management (Aboginije *et al.,* 2020). The methodology of the article offers insightful information about the study's respondents' ages, occupations, levels of education, and years of experience. By presenting a broad and competent sample of Gauteng's construction industry experts, this information provides support to the study's conclusions (Aboginije *et al.,* 2020). The research's findings, provided as impact indicators, offer a precise and organized evaluation of the effects of different waste reduction techniques on green construction projects. The most significant influence on green construction projects, according to the report, comes from avoiding intricate design and details, choosing materials with a longer lifetime, and creating robust secondary materials markets (Aboginije *et al.,* 2020). The article also emphasizes the significance of on-site waste management planning and policy implementation, both of which are essential for incorporating sustainable waste practices into building projects.

Sustainable Development of Innovative Green Construction Materials: A Study for Economical Eco-Friendly Recycled Aggregate Based Geopolymer Concrete.

In order to mitigate the construction industry's negative environmental effects, this article examines the creation of environmentally friendly building materials that make use of recycled aggregates and other sorts of effluents. This research is important in light of the increasing need for environmentally friendly and sustainable building techniques brought on by urbanization, rising world population, and worries about carbon footprints.

As articulated by Alhazmi *et al.* (2020), the use of recycled aggregate geopolymer concrete (RAGC) as an ecologically conscious substitute for conventional concrete is the primary focus of the study. By employing geopolymers as binders and recycled coarse aggregates in place of natural coarse aggregates, RAGC is produced. Because it has a reduced carbon footprint than Portland cement-based concrete, geopolymer concrete is a viable choice for environmentally friendly buildings. One of the study's main results is that the effluent type utilized in the manufacture of RAGC has a big influence on its compressive strength (CS). The outstanding performance of textile mill effluent (TE) resulted in a 25% increase in CS as compared to the freshwater-based control mix. This implies that effluents may improve the mechanical qualities of RAGC when applied appropriately. In addition, the research looks at three other essential durability characteristics for building materials: split tensile strength (STS), chloride ion migration (CIM), and resistance to sulfuric acid assault. As demonstrated by Alhazmi *et al.,* (2020), although the effluent type had a substantial impact on CS, STS, CIM, and acid attack resistance were only little impacted. This suggests that RAGC may still withstand effluent usage. The study emphasizes that not all effluents are equally appropriate for RAGC production and that effluent selection matters. For instance, a considerable drop in CS was seen in sugar mill effluent (SF), which was probably caused by the organic contaminants in SF. However, as criticized by Alhazmi *et al.,* (2020), the chemical composition of the textile mill effluent (TE) and fertilizer mill effluent (FE), which interacted positively with the RAGC components, had favorable impacts on CS.

This paper places a strong emphasis on the necessity to address the rising demand for freshwater in building and the effects of wastewater discharge on the environment. Water consumption in construction may be decreased by integrating effluents into the manufacturing of concrete, helping to create a more sustainable equilibrium between water supply and demand.

Research on high quality development strategy of green building: A full life cycle perspective on recycled building materials

The purpose of this research study is to discuss the potential and problems related to recycled building materials (RBM) from the perspective of China's green building (GB) assessment standard. As per the research by Guo *et al.,* (2022), to examine the dynamics and decision-making procedures around RBM in construction, the authors utilize a four-way evolutionary game model including Local Government (LG), RBM providers, developers, and homebuyers. In order to analyze how important aspects, affect the adoption of RBM, they also use actual market data from Sanya and Wuhan cities.

As per the views of Zheng *et al.* (2017), although a significant contributor to economic development in China, the building sector has also been linked to excessive resource consumption, pollution, and the production of construction and demolition waste (C&DW). There are serious environmental problems caused by the insufficient recycling of C&DW. China's GB assessment standard places a strong emphasis on using RBM to address these problems. The broad adoption of RBM has been hampered by how well-liked it is, however. The authors contend that RBM's usage has been constrained due to worries about its durability, which has resulted in low sales and minimal recycling of C&DW.

The research creates an evolutionary game model that takes into account the tactics used by LG, RBM suppliers, developers, and homebuyers over the whole life cycle of RBM, from manufacture to building and house sales, in order to solve this issue. In the critical sight of Zuo *et al.* (2017), the model identifies four evolutionary stable options, with LG forgoing planning, manufacturers emphasizing upcycling, and developers and homebuyers opting for RBM as the best course of action. This implies that market-driven initiatives may be successful and that LG's involvement may not always be required.

By creating a system of incentives and punishments, the authors highlight the role that LG plays in encouraging the adoption of RBM. On the other hand, as criticized by Mattoni *et al.* (2018), high penalties might encourage vendors to upcycle, and builders often construct homes with RBM and other features that consumers like. The research emphasizes how crucial it is to take LG's budgetary limitations into account while pushing RBM and suggests that early subsidies be tapered out in favor of greater supplier oversight.

The incorporation of consumers in the analysis is one important feature of this study. Developers and suppliers' decisions are heavily influenced by the preferences of homebuyers. The RBM industry may grow greatly if consumers prefer RBM-built houses and have a satisfying living experience.
This report offers insightful information on the dynamics of RBM adoption in the Chinese construction sector. It includes guidelines for LG, suppliers, developers, and homebuyers to enhance sustainable development.

3. Methods

Design for Deconstruction: Build structures and infrastructure with the goal of simple disassembly and material recovery at the end of their useful lives. This is known as "design for demolition." This entails the use of standardized parts, the reduction of adhesives and coatings, and material separation simplicity of design.

Green building certifications: Aim for certifications that highlight environmentally friendly practices, waste minimization, and sustainable material choices, such as BREEAM (Building Research Establishment Environmental Assessment Method) or LEED (Leadership in Energy and Environmental Design).

Prefabrication and Modular Construction: To reduce waste production, maximize material utilization, and enhance construction efficiency, apply prefabricated and modular construction techniques. Better control over material utilization and waste minimization are made possible by off-site fabrication.

4. Data Collection, Graphical Results and Discussion

The generation estimate represents C&D debris amounts from construction, renovation and demolition activities for buildings, roads and bridges, and other structures. C&D debris end-of-life (EOL) management includes quantities of materials going to next use or directed to landfills. “Next use” designates an intended next-use market which, depending on the material, may include fuel, manufactured products, aggregate, compost and mulch or soil amendment. The manufactured products next use encompasses estimates of C&D debris processed (e.g., ground, crushed or extracted and melted) for incorporation in the manufacture of new materials and products. For example, C&D asphalt is processed for use in the production of asphalt mixtures.

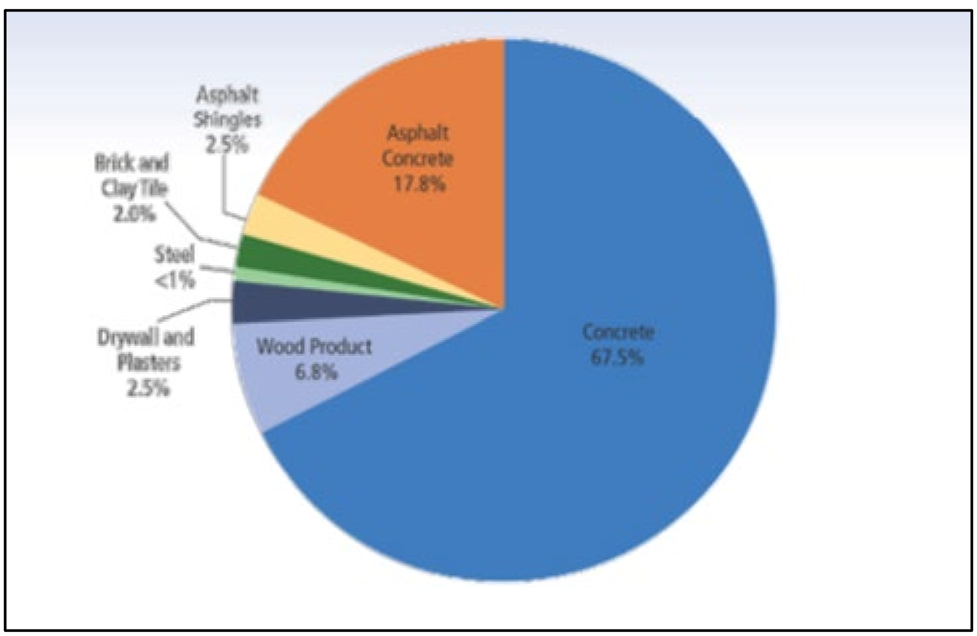

Figure 4. C&D Debris Generation Composition by Material (before processing), 2018 600 Million Tons [Assessing Trends in Materials Generation and Management in the United States,2020]

In 2018, 600 million tons of C&D debris were generated. Figure 4 shows the 2018 generation composition for C&D debris. C&D concrete was the largest portion at 67.5 percent, followed by asphalt concrete at 17.8 percent. C&D wood products made up 6.8 percent, and the other products accounted for 7.9 percent combined.

The 2018 generation estimates are presented in more detail in Table 1. As shown in Table 1. demolition represented over 90 percent of total C&D debris generation. Construction, on the other hand, represented under 10 percent [Assessing Trends in Materials Generation and Management in the United States,2020].

Table 1. C&D Debris Generation by Material and Activity, 2018 (in millions of tons)

Description	Waste During Construction	Demolition Debris	Total C&D Debris
Concrete	24.2	381	405.2
Wood Products	3.4	37.4	40.8
Drywall and Plasters	3.9	11.3	15.2
Steel	0	4.7	4.7
Brick and Clay Tile	0.3	12	12.3
Asphalt Shingles	1.2	13.9	15.1
Asphalt Concrete	0	107	107
Total	33.0	567.3	600.3

To implement a recycling program for C&D materials, we should typically start by setting up separate waste streams on the construction or demolition site to ensure that materials are sorted correctly. This is critical because contamination can significantly reduce the recyclability of certain materials.

Additionally, it would involve partnering with local recycling facilities that can process the materials, understanding the market demand for recycled materials, and possibly investing in on-site recycling equipment for larger projects. Recycling the materials listed in the C&D debris generation table we have provided can be approached through various methods, specific to each material type. Here's a brief overview:

Concrete: It can be crushed and reused as aggregate for new concrete or as a base material for roads.
Wood Products: Clean wood can be repurposed into new wood products, used for biomass fuel, or made into mulch or wood chips.
Drywall and Plasters: Gypsum from drywall can be recycled back into new drywall manufacturing or used as a soil amendment in agriculture.
Steel: It is one of the most recycled materials in the world and can be melted down and reformed into new steel products.
Brick and Clay Tile: Bricks can be cleaned and reused, or crushed and used as aggregate, fill material, or incorporated into new bricks or tiles.
Asphalt Shingles: Recycled asphalt shingles can be used in pavement applications, road construction, and as a raw material in new shingles.
Asphalt Concrete: Like concrete, it can be recycled and used in new asphalt pavement mixes or as a base material for roads.

For each material, specific processes and local recycling facilities will vary, and it's essential to consult with local environmental authorities and recycling experts to ensure compliance with regulations and to find the most sustainable and cost-effective recycling options.

5.3 Proposed Improvements & Validation

Here are a few additional suggestions to enhance the proposed improvements:

Tailor recycling strategies to the specifics of each project, accounting for the scale of operations, local recycling facility capabilities, and the particular mix of materials generated.
Invest in advanced sorting technology, such as near-infrared (NIR) separators, to improve the efficiency and purity of material streams.

Encourage research into innovative uses for recycled materials, expanding their applications beyond traditional uses.
Advocate for the development of local, state, or national policies that incentivize the recycling of C&D materials, potentially through tax credits, rebates, or grant programs.
Provide regular education and training for workers on best practices in recycling and waste management to ensure high rates of compliance and efficiency.

Partner with universities and research institutions to study the lifecycle of recycled materials and to improve the recycling process, increasing the value and demand for recycled materials.
Implement comprehensive lifecycle analyses for materials to identify the most environmentally and economically beneficial recycling pathways.Establish a long-term goal of zero-waste projects, where nearly all materials are reused or recycled, significantly reducing the need for landfill space.

Although technology is continually advancing, the articles describe current technologies and methods. Future studies should examine cutting-edge recycling methods, environmentally friendly construction materials, and innovative demolition procedures, among other cutting-edge waste management advances. It's essential to assess their viability and efficacy if we want to continue to be at the forefront of sustainable building methods.
The social and behavioral elements that affect sustainable building are often ignored in favor of the technical and financial considerations. A comprehensive knowledge of this sector requires research on customer preferences, human behavior, and the role of education and awareness campaigns in promoting green building methods.
Environmental, economic, and social concerns interact in complicated ways in sustainable building and waste management. To address the many problems and potential in this area, future research should take a more multidisciplinary approach that combines ideas from multiple disciplines, such as engineering, economics, sociology, and psychology.

6. Conclusion

This investigation into material recycling and the embodiment of green construction principles has illuminated a path for civil engineering—a path that wends toward an eco-conscious horizon. It has laid bare the necessity for our built environments to not only coexist with the natural world but to enhance it, nurturing the landscapes from which they rise. The confluence of research presented herein does not simply recommend a shift towards sustainable practices; it delineates the imperative of such a transformation as a moral and existential necessity for the industry.

In the microcosm of our efforts, like those witnessed in the bustling construction sites of South Africa's Gauteng Province, lies a microcosm of the global challenge. It is here, in the dust and debris, where the potential for regeneration is most potent. By championing innovative practices such as the crafting of geopolymer concrete or the astute repurposing of resources, we stand on the cusp of an era where the term 'waste' becomes an antiquated lexicon, replaced by 'resource' in the civil engineering vernacular.

Ultimately, the synthesis of this research is a beacon, guiding the construction industry not only towards minimizing its environmental impact but towards forging a legacy of stewardship and sustainability. It is a call to engineers, architects, policymakers, and all custodians of the built environment to embrace the responsibility of this era: to construct not just with concrete and steel, but with foresight and care for the Earth that yields these materials. For in the conscientious layering of bricks and mortar lies the blueprint for a world where human ingenuity and ecological balance are interwoven—sustaining and sustained by the evergreen spirit of innovation.

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Biography

Abul Kashem Mohammad Yahia is currently doing Master of Civil Engineering at Lamar University, Beaumont, Texas, USA. He has been completed Civil Engineering BSc at Dhaka University of Engineering & Technology (DUET), Gazipur, Bangladesh. He has over twenty-five years of experience in multistoried building specially apartment, commercial and industrial building designing, construction as well as construction management of the mega project. He worked international multinational company in Japan cooperation agency (JICA) and Bureau Veritas (BD) Pvt.Ltd. He has enormous knowledge of Structural Safety Inspection, Auditing and Detailed Engineering assessment of the existing structures for industrial building as well as check for conformity or non-conformity with code compliances. With a keen focus on these emerging fields, he aims to contribute to the advancement and implementation of these technical knowledge in various Civil Engineering sector. As a high motivated individual. Abul Kashem Mohammad Yahia is committed to conducting research that addresses real world challenges and enhances productivity and efficiency in engineering process. He has research interests in Civil Engineering construction materials, structural design and construction and effect of materials in using different construction project.

Fakir Sheik Zihad is currently doing MEng in Industrial Engineering at Lamar University, Beaumont, Texas. He completed his Electrical and Electronics Engineering BSc at American International University - Bangladesh (AIUB). He has over nine years of experience in the LED and electronics industries. His prowess in operations management, amplified by his academic background, Lean Six Sigma & CSPO certifications, and project management training, has been instrumental in sourcing, R&D, and quality control projects. His international experience spans supplier sourcing, PSI, and mold inspection. Zihad's specialties include Lab Management Standards (ISO17025:2017) and Quality Standards (ISO9001:2015), demonstrated in ISO audits, machine installation, maintenance, calibration, and the implementation of TQM, Kaizen, and 5S strategies. His knowledge of PLC, LED lighting technology, and product training aids retail sales market growth.

Md. Enamul Kabir is currently pursuing a Master’s of Civil Engineering from Lamar University, Beaumont, Texas. He has been completed his bachelor’s degree in Civil Engineering from Stamford University, Bangladesh. A highly skilled civil engineer with over 8+ years of experience in building construction, Roads & Highway Department, Bangladesh Government Railway Project (Construction of Single Line Dual Gauge Railway Track from Dohazari to Cox’s Bazar via Ramu & Ramu to Gundum near Myanmar), which is a part of Trans-Asian Railway. This Project is funded by Asian Development Bank (ADB) and he also worked in Bangladesh Local Government Engineering Department (LGED) and also enough experience in different Infrastructure section. He has proficiency in software applications such as AutoCAD 2D & 3D, STAAD Pro, Revit, Etabs, QGIS, ArcGIS and P6. Besides these, he has enough experience in reviewing, Planning section, QA and QC testing Materials section and also supervising various construction projects. He also completed his Masters of Business Administration (MBA) from Jagannath University, Bangladesh and he also earned a Post Graduate Diploma course on Project Management (PGD) from ABP Academy, UK.

Mohammad Shahjalal is currently pursuing a master’s degree in Industrial Engineering from Lamar University, Beaumont, Texas. He holds a bachelor’s degree in Civil Engineering from Dhaka University of Engineering and Technology (DUET). A highly skilled civil engineer with over 25 years of experience in high-rise building construction, Infrastructure, supervision, and design in Bangladesh and Qatar. Shahjalal's proficiency in software applications such as AutoCAD, STAAD Pro, Sap 2000, SAFE, CIM, and P6 Professional has contributed significantly to his success in the industry. Additionally, he has vast experience in reviewing, pre-qualifying, Materials, and supervising various construction projects. His passion for his work, combined with his attention to detail and strong work ethic, has earned him a reputation as one of the most reliable and efficient civil engineers in the region.

Md Al-Arafat is currently doing a master's in engineering management at Lamar University. He completed his Bachelor of Engineering (Civil) from University of Technology Malaysia (UTM) in 2022. After completed his bachelor’s degree from a renowned university in Malaysia, he worked as a Asst. Project Manager in a Singaporean Pre-cast company, Greyform. He also completed his Bachelor Business Administration (BBA) in 2014. He is a founder member of Green Builders Consultancy, Dhaka Bangladesh. As a Civil Engineering ha has a solid knowledge in construction sector. He has a research interest in Civil, Environmental and Sustainable construction Engineering.