ISSN 1533-9211

DOI: 10.5281/zenodo.22127064

STATUTORY REQUIREMENTS AND INDUSTRY READINESS FOR RECYCLED CONCRETE AGGREGATE UTILISATION IN KWAZULU-NATAL, SOUTH AFRICA

T.L NKOSI[1] and S.H.P. CHIKAFALIMANI[2]

[1,2]Construction Management & Quantity Surveying, Durban University of Technology, Durban, RSA.
Email: [1]thalenten@dut.ac.za, [2]SamuelC@dut.ac.za

Abstract

Construction and demolition waste (CDW) presents a significant environmental and resource-management challenge for South Africa, where concrete rubble is commonly disposed of despite its potential recovery as recycled concrete aggregate (RCA). The utilisation of RCA can support circular construction by diverting waste from landfill, reducing demand for virgin aggregate and creating secondary-material markets; however, its adoption depends on material quality, technical specifications, institutional capability and market confidence. Recent literature identifies fragmented standards, limited policy support, weak market mechanisms and slow professional acceptance as persistent barriers to the implementation of recycled aggregate concrete. This review examines statutory requirements and industry readiness for RCA utilisation in KwaZulu-Natal, South Africa. It synthesises peer-reviewed literature published primarily between 2016 and 2026, together with national legislation, policy instruments, technical guidance and relevant industry documentation. The review evaluates four dimensions of readiness: regulatory and policy alignment; technical feasibility and quality assurance; supply-chain and market capability; and procurement and institutional support. The findings indicate that South Africa's waste-management framework promotes waste minimisation, reuse, recycling and recovery, and recognises construction and demolition waste as a priority stream for resource recovery. Nevertheless, the practical uptake of RCA remains constrained by inconsistent source separation, variable feedstock quality, insufficient certification and testing arrangements, limited specifications for higher-value applications, uncertain supply, low client demand and procurement practices focused on lowest initial cost. Technical evidence indicates that RCA can be effectively used in selected applications when processing, grading, replacement ratios and quality assurance are aligned with the performance requirements of the intended use. The review proposes an implementation pathway for KwaZulu-Natal centred on clear application-specific specifications, material certification, demonstration projects, green public procurement, targeted professional training and coordinated relationships among municipalities, waste generators, recyclers, consultants and contractors. The article contributes to the literature on circular construction and provides a policy-to-practice framework for strengthening the productive reuse of concrete waste in South Africa.

Keywords: Circular Economy; Construction And Demolition Waste; Green Procurement; Industry Readiness; Recycled Concrete Aggregate; South Africa; Statutory Requirements; Sustainable Construction; Waste Management.

1. INTRODUCTION

The construction industry is a major consumer of virgin materials and a substantial generator of construction and demolition waste (CDW), creating environmental, logistical and economic pressures across the built environment lifecycle (Amadi, 2025). In South Africa, CDW management remains a critical concern because landfilling is still the dominant disposal route, while available landfill airspace in major urban centres is increasingly constrained (Amadi, 2025). Concrete rubble forms a significant recoverable component of CDW because concrete is extensively used in buildings, roads, bridges, housing, municipal services and other infrastructure assets (Berge and von Blottnitz, 2022). When concrete waste is disposed of rather than recovered, the construction sector loses a potentially valuable material resource and reinforces a linear production model based on extraction, consumption and disposal (Ginga, Ongpeng and Daly, 2020). KwaZulu-Natal is a

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.22127064

relevant context for examining this issue because it contains major urban centres, active construction markets, extensive public infrastructure and a continuing need for infrastructure repair, rehabilitation and development. Construction, demolition and infrastructure-maintenance activities in eThekwini and other KwaZulu-Natal municipalities produce concrete rubble and mixed CDW that could be diverted from landfill through source separation, processing and material recovery (Amadi, 2025). However, the availability of recoverable concrete waste does not automatically produce a functional recycled-material market, as waste must be separated at source, transported, processed, tested, certified and matched to viable construction applications before it can replace conventional aggregate (Ghaffar, Burman and Nussbaum, 2020). The extent to which these activities occur consistently within KwaZulu-Natal's construction supply chain remains unclear, creating a need to assess industry readiness for recycled concrete aggregate utilisation.

Recycled concrete aggregate (RCA) is produced by crushing and grading recovered concrete from demolition, renovation and construction activities for reuse as a secondary aggregate material (Ohemeng and Ekolu, 2020). RCA can be applied in a range of construction uses, including road base and subbase layers, pavement works, drainage layers, masonry products, non-structural concrete and, subject to appropriate technical controls, selected concrete applications (De Brito and Kurda, 2021). The performance of RCA is influenced by the quality of the parent concrete, source segregation, contamination, particle grading, residual mortar content, water absorption, density and processing procedures (Hafez *et al*., 2020). These factors require rigorous quality assurance and application-specific specifications, particularly where RCA is proposed for higher-value or structural applications. The environmental value of RCA lies in its potential to divert concrete waste from landfill, reduce the extraction of virgin aggregates and advance circular-economy principles in construction (Ginga, Ongpeng and Daly, 2020). RCA can also reduce the environmental burden associated with quarrying, aggregate transport and disposal of concrete rubble, although these benefits depend on processing energy, transport distances, recovery rates and the proportion of natural aggregate displaced in the final application (Linares and López-Uceda, 2024). Recent lifecycle research indicates that recycled aggregate production can produce substantially lower environmental impacts than virgin aggregate extraction, but local supply-chain conditions remain decisive in determining whether these advantages are realised in practice (Linares and López-Uceda, 2024).

The economic rationale for RCA is similarly dependent on local conditions. A South African cost-benefit study found that producing recycled concrete aggregates may be economically and environmentally advantageous when landfill charges, processing costs, transport distances and the avoided extraction of natural aggregate are considered together (Ohemeng and Ekolu, 2020). RCA can create economic opportunities through waste collection, material sorting, crushing, laboratory testing, transport and supply, while also potentially reducing disposal costs for contractors and extending municipal landfill life (Ghaffar, Burman and Nussbaum, 2020). However, low prices and ready availability of virgin aggregate can weaken the market competitiveness of RCA, particularly where the recycled product lacks recognised certification, guaranteed supply volumes or established technical specifications (Knoeri *et al*., 2020). Despite its environmental and economic potential, RCA use remains limited in mainstream South African construction. Recent reviews identify several interrelated barriers, including weak separation of CDW at source, inconsistent waste data, inadequate recycling infrastructure, limited monitoring systems, illegal dumping, insufficient

ISSN 1533-9211
DOI: 10.5281/zenodo.22127064

financial incentives and low confidence in recycled construction products (Amadi, 2025). Material variability and potential contamination can further discourage engineers, contractors and clients from specifying RCA unless reliable processing, testing and certification mechanisms demonstrate conformance with specified performance requirements (De Brito and Kurda, 2021). The slow transition from laboratory evidence to regular construction-site use therefore reflects institutional and market limitations as much as it reflects concerns about technical feasibility (Akinade and Oyedele, 2019).

South Africa's policy direction supports a transition from landfill disposal towards waste prevention, reuse, recovery and recycling. The National Waste Management Strategy promotes the recycling of CDW and calls for support for enterprises that produce building aggregates and other construction inputs from recovered waste streams (Department of Forestry, Fisheries and the Environment, 2020). Nonetheless, policy support at national level is not always translated into enforceable recycled-content targets, harmonised RCA specifications, municipal waste-separation requirements or public-procurement criteria that create dependable demand for recycled aggregate in construction projects (Ogunmakinde, 2019). This gap between statutory aspiration and construction-site practice is central to the present study.

The study is premised on the argument that successful RCA adoption depends on industry readiness rather than material availability alone. Industry readiness includes the existence of reliable CDW feedstock, recycling and processing facilities, testing laboratories, technical specifications, professional knowledge, procurement incentives, client acceptance, logistics networks and institutional coordination between public authorities and private-sector actors (Ginga, Ongpeng and Daly, 2020). The adoption of RCA consequently requires alignment between regulators, municipalities, infrastructure clients, consultants, contractors, demolition firms, recyclers, aggregate suppliers and professional bodies (Adams *et al*., 2017). Without this alignment, the recovery of concrete waste may remain an isolated recycling activity rather than becoming a routine component of KwaZulu-Natal's construction-materials supply chain. This paper investigates statutory requirements and industry readiness for recycled concrete aggregate utilisation in KwaZulu-Natal, South Africa. It examines whether current policy, waste-management provisions, technical requirements and procurement practices enable or constrain the use of RCA in construction projects. The study further assesses stakeholder awareness, technical perceptions, supply-chain capacity, institutional barriers and possible interventions for improving RCA adoption. By providing context-specific evidence, the article contributes to scholarship on circular construction, CDW governance and sustainable procurement while offering practical direction for municipalities, clients, consultants, contractors and recycling enterprises.

2. LITERATURE REVIEW

2.1 Construction and Demolition Waste and Circular Construction

Construction and demolition waste (CDW) is generated during the construction, renovation, repair, refurbishment and demolition of buildings and infrastructure, and it comprises materials such as concrete, masonry, metals, timber, glass, plastics, soils and packaging waste (Berge and von Blottnitz, 2022). South African CDW quantities are substantially underreported in official waste statistics, which weakens planning for collection, recovery, recycling infrastructure and secondary-

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.22127064

material markets (Berge and von Blottnitz, 2022). Estimates using a material-lifetime method indicated that South Africa potentially generated approximately 20.2 million tonnes of CDW in 2017, while a per-capita approach estimated that approximately 10.8 million tonnes reached disposal sites, both figures exceeding the 4.48 million tonnes recorded in official statistics for the same year (Berge and von Blottnitz, 2022). This data gap is significant because accurate information on waste generation, composition and movement are required to establish viable recycling systems and to assess the availability of feedstock for recycled aggregate production. Circular construction applies circular-economy principles to the built environment by seeking to reduce material extraction, retain product and material value, extend asset life, recover materials after demolition and minimise waste disposal (Adams *et al*., 2017). Rather than treating demolished concrete as a residual waste stream, circular construction regards it as a secondary material resource that may be reused, recycled or processed into new construction inputs (Ginga, Ongpeng and Daly, 2020). The hierarchy of preferred CDW interventions generally prioritises waste prevention, reuse and high-value recovery above disposal or low-value downcycling because these approaches preserve more material value and reduce resource consumption (Galvez-Martos *et al*., 2018).

The South African transition to circular construction is constrained by institutional fragmentation, limited waste separation at source, inadequate waste data, inconsistent enforcement, landfill dependence and weak markets for recycled materials (Amadi, 2025). A recent South African review argues that circular-economy methods developed in industrialised countries cannot simply be transferred to South Africa without adapting them to local technical capacity, informal-sector activity, economic conditions and waste-management systems (Amadi, 2025). Consequently, RCA utilisation in KwaZulu-Natal should be assessed within the practical context of local demolition practices, transport distances, material-processing capacity, client requirements and municipal procurement systems.

2.2 Recycled Concrete Aggregate: Production and Properties

Recycled concrete aggregate is produced by recovering, crushing, screening and grading waste concrete derived from construction, demolition and rehabilitation works (Ohemeng and Ekolu, 2020). RCA normally comprises natural aggregate particles covered partly by adhered cement mortar, which distinguishes it from virgin aggregate and affects its physical, mechanical and durability-related properties (Zhang *et al*., 2024). The properties of RCA depend on the parent concrete quality, crushing and processing method, degree of source separation, particle-size distribution, contamination level, residual mortar content and storage conditions (De Brito and Kurda, 2021). Compared with natural aggregate, RCA commonly has lower density, higher porosity, greater water absorption and more variable quality because the attached mortar is generally more porous than natural stone aggregate (Al-Humaidawi *et al*., 2025)

These characteristics can reduce the workability of fresh concrete, increase water demand and affect strength, shrinkage, modulus of elasticity, permeability and long-term durability if mix design and moisture management are not adjusted appropriately (Liu *et al*., 2025). Nevertheless, material limitations do not render RCA unsuitable for construction; they indicate the need for application-specific material characterisation, mix design, replacement limits and quality-control procedures.

ISSN 1533-9211
DOI: 10.5281/zenodo.22127064

RCA processing quality is particularly important because mixed CDW may include masonry, timber, glass, plastics, gypsum, asphalt, soil and other contaminants that compromise consistency and performance (Huang *et al*., 2023). Contamination can be reduced through selective demolition, source separation, controlled stockpiling, mechanical sorting, removal of deleterious material, crushing and screening procedures, and laboratory testing before the material enters the construction supply chain (Ghaffar, Burman and Nussbaum, 2020). Recent reviews further identify treatment approaches such as mechanical abrasion, carbonation, polymer impregnation and nano-silica treatments as methods that can reduce the adverse effects of adhered mortar and improve the density, strength and durability performance of RCA and recycled aggregate concrete (Al-Humaidawi *et al*., 2025)

2.3 Technical Feasibility and Applications

RCA can be used across a hierarchy of applications with different performance requirements. Lower-risk applications include road subbase, pavement layers, drainage layers, backfill, landscaping products, blocks and non-structural concrete, while higher-value applications include structural concrete, precast products and high-performance concrete (Ohemeng and Ekolu, 2020). The suitability of RCA should be determined by the performance requirements of the intended application rather than a universal assumption that all recycled aggregate is suitable, or unsuitable, for all purposes (Zhang *et al*., 2024). In road construction, RCA can provide a practical entry point for expanded uptake because unbound pavement applications generally tolerate greater material variability than structural concrete, provided that grading, strength, durability and contamination requirements are met (Bian *et al*., 2024). This opportunity is particularly relevant to KwaZulu-Natal, where municipal road rehabilitation, pavement maintenance and infrastructure upgrades may create stable demand for recycled aggregate if procurement specifications permit its use. The use of RCA in road layers can also minimise the need for virgin crushed stone where locally processed recycled material meets the required engineering performance criteria (Bian *et al*., 2024).

The application of RCA in concrete requires more stringent control because RCA may influence fresh and hardened concrete behaviour. Recent evidence suggests that RCA can reduce concrete workability because rough particle surfaces and high-water absorption increase internal friction and water demand within the mix (Abdalla *et al*., 2025).

Higher replacement ratios may reduce compressive strength, tensile strength, elastic modulus and durability where the aggregate quality is poor or the mixture is not redesigned to account for RCA properties (Liu *et al*., 2025). However, recycled aggregate concrete can meet specified performance requirements where RCA is derived from controlled concrete sources, appropriately graded, pre-treated or moisture conditioned, and incorporated through performance-based mix design and quality assurance (Zhang *et al*., 2024).

The technical feasibility of RCA is therefore closely connected to traceability and certification. A reliable RCA market requires consistent classification of aggregate quality, defined contaminant limits, standardised testing procedures, clear performance specifications and certification mechanisms that allow designers and contractors to verify fitness for purpose (De Brito and Kurda, 2021). Where these arrangements are absent, RCA may be perceived as a high-risk or inferior material even when it is technically suitable for a specific application. This perception can constrain adoption more strongly than actual material performance.

ISSN 1533-9211

DOI: 10.5281/zenodo.22127064

2.4 Regulatory and Statutory Context

South Africa's waste-management regime provides a broad statutory basis for waste prevention, reuse, recycling and recovery. The National Environmental Management: Waste Act 59 of 2008 defines building and demolition waste as waste generated during construction and demolition activities, excluding hazardous waste, thereby placing CDW within the national waste-governance framework (Republic of South Africa, 2008). The National Waste Management Strategy 2020 further promotes diversion of waste from landfill and identifies the recycling of CDW into building aggregates and other construction inputs as an intervention to support resource recovery and enterprise development (Department of Forestry, Fisheries and the Environment, 2020). Although the statutory framework establishes a policy basis for CDW recovery, it does not automatically ensure that recovered materials are specified in construction projects. Waste law generally regulates waste generation, storage, transport, treatment and disposal, whereas construction uptake is shaped by engineering standards, procurement rules, professional liability, product certification and client confidence (Amadi, 2025). This separation between waste governance and construction-materials governance contributes to a policy-practice gap, in which waste recycling is encouraged but recycled products do not necessarily obtain predictable demand in public or private construction markets.

RCA used to become routine, statutory goals must be translated into practical instruments, including municipal CDW-management requirements, demolition waste-management plans, source-separation obligations, recycler licensing conditions, material-quality standards, approved-product registers and green-procurement criteria. Public procurement can play a critical role because government infrastructure and housing programmes can create demand certainty for recycled materials through performance-based specifications, pilot-project requirements and evaluation criteria that reward lifecycle value rather than lowest upfront cost alone (Akinade and Oyedele, 2019). However, such instruments must be designed carefully to avoid mandating RCA in applications for which locally available material has not been adequately tested or certified.

2.5 Industry Readiness and Adoption Barriers

Industry readiness refers to the extent to which technical, organisational, market and institutional conditions enable the consistent production, procurement and use of RCA. This includes reliable CDW feedstock, selective demolition practices, recycling plants, equipment, quality-control systems, testing facilities, logistics, technical knowledge, demand certainty and procurement support (Ghaffar, Burman and Nussbaum, 2020). If any of these elements is weak, RCA adoption may remain limited to isolated pilot projects or low-value informal uses.

Technical barriers include variable source materials, residual mortar, high water absorption, contamination, uncertain durability performance and the absence of consistent local specifications for different applications (Al-Humaidawi *et al*., 2025). These issues are amplified where waste concrete is mixed with other CDW materials before collection, because the recycler must undertake additional sorting and processing to achieve reliable aggregate quality. Selective demolition and on-site waste segregation are consequently important upstream requirements for producing material that can meet engineering specifications (Ginga, Ongpeng and Daly, 2020). Economic and supply-chain barriers include capital costs for crushing and screening equipment, uncertain volumes of suitable concrete feedstock, volatile transport costs, limited storage space, inconsistent demand and

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.22127064

competition from cheap or readily available virgin aggregate (Ohemeng and Ekolu, 2020). A South African cost-benefit analysis found that the economic competitiveness of recycled aggregate is influenced by processing, transport and landfill costs, indicating that local logistics and market conditions are decisive rather than uniform across the country (Ohemeng and Ekolu, 2020). KwaZulu-Natal's industry readiness must therefore be assessed through a location-sensitive lens that considers the spatial relationship between demolition sites, recycling facilities, quarries, landfills and receiving construction projects.

Institutional barriers involve limited regulatory coordination, insufficient technical guidance, fragmented responsibilities among waste and construction stakeholders, weak enforcement of waste separation and a lack of procurement mechanisms that reward circular-material use (Amadi, 2025). Professional resistance can also emerge where engineers, contractors and clients associate recycled materials with inconsistent quality, project delays, uncertain liability or reputational risk. These concerns can be addressed through credible testing, transparent certification, demonstration projects and performance-based specifications rather than through policy exhortation alone (Zhang *et al*., 2024).

2.6 Synthesis and Research Gap

The reviewed literature indicates that RCA has measurable potential to support CDW diversion, reduce dependence on virgin aggregate and advance circular construction. It also indicates that technical feasibility is application dependent: lower-risk uses such as road base, subbase and non-structural products may offer feasible early markets, while structural and high-performance applications require stronger source control, material processing, and testing and mix-design management. The South African regulatory environment supports recycling in principle, but the connection between waste-management objectives and construction procurement remains weak. A key gap is the absence of an integrated KwaZulu-Natal-focused synthesis that links statutory requirements, technical feasibility, industry-readiness conditions and procurement mechanisms for RCA utilisation. Existing scholarship frequently examines material performance, general CDW management or broad circular-economy policy separately, rather than examining the institutional conditions needed to translate recovered concrete into consistently specified construction material. This review addresses that gap by analysing how regulatory alignment, material quality assurance, supply-chain capacity, market confidence and procurement practice collectively shape the prospects for RCA utilisation in KwaZulu-Natal. Table 1 synthesises the principal themes emerging from the reviewed literature and identifies their implications for recycled concrete aggregate utilisation in KwaZulu-Natal

Table 1: Literature Synthesis on Statutory Requirements and Industry Readiness for Recycled Concrete Aggregate Utilisation in Kwazulu-Natal, South Africa

Theme	Core issue	Key evidence from literature	Implication for KwaZulu-Natal
CDW generation	Underreporting and landfill dependence	South African CDW generation exceeds official estimates	Improve waste data, tracking and source separation
RCA properties	High porosity and water absorption	Quality depends on parent concrete and processing	Require application-specific testing and certification
Technical	Suitability varies by	Road layers and non-structural	Prioritise pilot projects in roads

ISSN 1533-9211
DOI: 10.5281/zenodo.22127064

application	end use	uses offer lower-risk opportunities	and municipal works
Regulation	Policy encourages recycling but does not assure market uptake	Waste policy and material-specification systems are disconnected	Link waste plans, standards and procurement conditions
Industry readiness	Weak supply chains and low confidence	Adoption depends on technical, market and institutional alignment	Develop recycler–contractor–municipality partnerships
Procurement	Lowest-cost evaluation discourages circular materials	Demand certainty is necessary for recycling markets	Introduce lifecycle and recycled-content criteria

Source: Authors' own compilation based on Berge and von Blottnitz (2022), Ohemeng and Ekolu (2020), Ginga, Ongpeng and Daly (2020), Akinade and Oyedele (2019), De Brito and Kurda (2021), and Amadi (2025).

Overall, the reviewed literature shows that RCA utilisation in KwaZulu-Natal depends on more than material availability; it requires aligned statutory provisions, reliable quality assurance, viable supply chains and procurement systems that create market demand. The following section outlines the review methodology used to identify, select and synthesise the relevant literature and policy evidence. Drawing on the reviewed literature, Figure 1 presents the proposed Statutory Requirements and Industry Readiness Framework for recycled concrete aggregate utilisation in KwaZulu-Natal. The framework illustrates that effective RCA uptake depends on the alignment of regulatory support, source separation, processing and certification capacity, procurement acceptance and construction-site application.

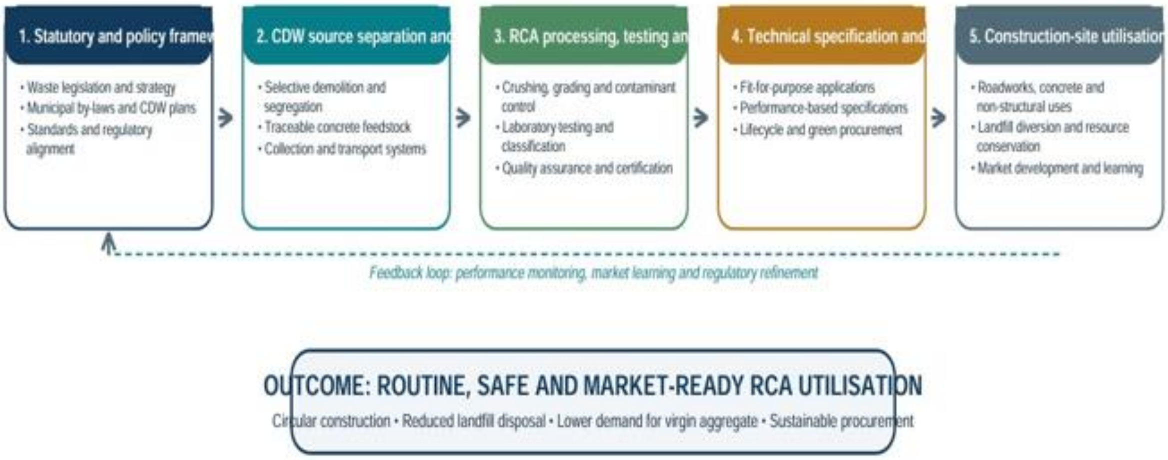

Figure 1: Statutory Requirements and Industry Readiness Framework for RCA Utilisation in Kwazulu-Natal

Source: Authors' own conceptualisation based on the reviewed literature

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.22127064

3. METHODOLOGY

This article adopted a narrative literature-review design to critically examine statutory requirements and industry readiness for recycled concrete aggregate (RCA) utilisation in KwaZulu-Natal, South Africa. A narrative review was appropriate because the subject extends across material engineering, construction and demolition waste management, circular construction, waste legislation, public procurement and institutional capacity. The review drew on peer-reviewed journal articles, academic books, technical reports, legislation, national policy documents and relevant industry guidance to develop an integrated understanding of the technical feasibility, regulatory environment and implementation barriers affecting RCA utilisation. The literature search focused primarily on studies published between 2016 and 2026 in databases and repositories including Scopus, Web of Science, Google Scholar, ScienceDirect, SpringerLink, Taylor & Francis Online, Sabinet and South African government websites. Search terms included “recycled concrete aggregate”, “recycled aggregate concrete”, “construction and demolition waste”, “circular economy”, “sustainable construction”, “green procurement”, “waste legislation”, “South Africa” and “KwaZulu-Natal”.

Relevant sources were selected based on their contribution to understanding RCA production and performance, CDW recovery, statutory and policy requirements, recycling supply chains, technical standards, procurement mechanisms and construction-industry adoption barriers. Priority was given to recent peer-reviewed studies and South African evidence, while international studies were included where they provided applicable technical insights or implementation lessons not sufficiently available in local literature. The reviewed evidence was analysed thematically and organised into four interconnected areas: statutory and policy alignment; technical feasibility and material quality; supply-chain and market readiness; and procurement and institutional barriers. This thematic approach enabled the review to identify relationships between regulatory objectives and practical construction-site conditions, while also highlighting the gaps that restrict the routine utilisation of RCA in KwaZulu-Natal.

4. FINDINGS

The literature indicates that recycled concrete aggregate (RCA) has substantial potential to support circular construction in KwaZulu-Natal by diverting concrete waste from landfill and reducing demand for virgin aggregate; however, its uptake depends on the alignment of waste-management systems, material-quality control, construction specifications and market demand (Berge and von Blottnitz, 2022). Technical evidence shows that RCA can be used effectively in lower-risk applications, particularly road base, subbase, backfill, drainage layers and selected non-structural concrete products, provided that it is adequately processed, graded and tested against the performance requirements of the intended application (Kumar *et al.*, 2024). Higher-value applications, including structural concrete, require stricter control because RCA often has greater porosity, water absorption and variability than virgin aggregate, which can influence workability, strength and durability unless mix designs and moisture conditions are properly managed (Akbulut *et al.*, 2025).

The review further finds that South Africa’s waste-policy framework encourages waste minimisation, diversion from landfill, recycling and recovery of construction and demolition waste, but this strategic direction has not consistently translated into application-specific RCA standards,

The Seybold REPORT
ISSN 1533-9211
DOI: 10.5281/zenodo.22127064

material-certification systems or procurement requirements that create predictable construction-sector demand (Department of Forestry, Fisheries and the Environment, 2020). Consequently, statutory support for recycling remains insufficient when it is not accompanied by municipal source-separation requirements, quality-assurance protocols, approved-material registers and green procurement criteria. International policy evidence similarly indicates that recognised standards, independent certification and clear recycled-content requirements can increase confidence in secondary construction materials and reduce perceived technical and contractual risk among clients, engineers and contractors (Foster *et al*., 2025).

Industry readiness is constrained by inconsistent CDW feedstock, limited separation at demolition sites, variable RCA quality, inadequate testing and certification facilities, uncertain supply volumes, transport costs, limited professional familiarity and competition from affordable virgin aggregate. Recent South African evidence further identifies knowledge and skills deficits, regulatory and operational constraints, weak government support and limited collaboration across industry stakeholders as major barriers to broader use of recycled materials in the built environment (Akinshipe *et al*., 2025). The findings suggest that KwaZulu-Natal should initially prioritise technically manageable and high-volume RCA applications, particularly municipal roadworks and non-structural products, while developing material classification, testing, certification and demonstration-project systems that can build confidence for more demanding applications. A coordinated implementation approach involving municipalities, waste generators, recyclers, consultants, contractors, testing laboratories and public clients is therefore necessary to convert national circular-economy policy ambitions into routine construction-site utilisation of RCA.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

This review finds that recycled concrete aggregate (RCA) offers a credible pathway for improving construction and demolition waste management and advancing circular construction in KwaZulu-Natal. RCA can divert recoverable concrete waste from landfill, reduce dependence on virgin aggregate and create opportunities for local recycling, processing and material-supply enterprises. However, technical feasibility alone is insufficient to ensure market uptake. The successful utilisation of RCA depends on the alignment of material quality, source separation, testing and certification, technical specifications, supply-chain reliability, client confidence and public procurement support. Recent evidence confirms that RCA can be used effectively in selected applications when the material is processed and controlled according to the performance requirements of its intended use, while higher-value structural applications require more rigorous quality assurance and mix-design control (Akbulut et al., 2025).

South Africa's National Waste Management Strategy provides a policy basis for waste minimisation, recycling and the development of secondary-material markets, including construction inputs derived from construction and demolition waste (Department of Forestry, Fisheries and the Environment, 2020). Nevertheless, the review identifies a persistent gap between national policy objectives and construction-site implementation. The limited uptake of RCA is associated with inconsistent waste separation, variable material quality, insufficient local standards and certification procedures, weak procurement incentives, limited industry knowledge, uncertain supply volumes

ISSN 1533-9211
DOI: 10.5281/zenodo.22127064

and continued reliance on affordable virgin aggregate. The principal challenge is therefore institutional and market based, rather than solely a lack of technical capability. Effective RCA adoption in KwaZulu-Natal requires an integrated system that links demolition waste generation, material recovery, processing, and quality control, specification, procurement and end-use applications.

5.2 Recommendations

- **Develop application-specific RCA standards**

National standards bodies, professional institutions and material-testing organisations should develop or adapt clear performance-based specifications for RCA in road base, subbase, drainage layers, concrete blocks, paving and non-structural concrete. Local codes and standards are necessary to reduce uncertainty and improve confidence among designers, contractors and clients (Gebremariam et al., 2025).

- **Strengthen source separation and selective demolition**

KwaZulu-Natal municipalities should require construction and demolition waste-management plans for major projects, including provisions for concrete separation, traceable stockpiling and diversion from landfill. Improved source separation would reduce contamination and enable recyclers to produce more consistent RCA.

- **Establish quality assurance and certification systems**

RCA suppliers should implement routine testing for grading, particle density, water absorption, crushing strength, contaminants and other application-specific performance indicators. A recognised certification or approved-supplier system would enable engineers and contractors to select RCA with greater confidence.

- **Prioritise low-risk, high-volume applications**

Municipalities and public infrastructure clients should begin with pilot projects using RCA in road subbase, pavement layers, drainage works, backfill, non-structural concrete products and landscaping applications. These uses can create early and reliable demand while generating local performance data.

- **Use green public procurement**

Public clients should include recycled-material criteria, lifecycle-cost assessment and waste-diversion targets in tender documents. Procurement should reward technically compliant RCA use rather than evaluating bids solely on lowest initial cost. Green procurement can create the predictable demand necessary for recycling markets to develop.

- **Develop recycling capacity and logistics networks**

Government and industry should support fixed and mobile crushing facilities, collection systems, stockpiling areas and transport arrangements that connect demolition sites with processing facilities and receiving projects. Mobile recycling units may be particularly valuable for large demolition and infrastructure projects where moving rubble over long distances would undermine the economic and environmental case for recycling (Akinshipe et al., 2025).

ISSN 1533-9211

DOI: 10.5281/zenodo.22127064

- **Build professional and institutional capacity**

Training should be provided to municipal officials, engineers, architects, quantity surveyors, contractors, procurement practitioners and waste-management personnel on RCA characteristics, standards, applications, quality controls and procurement requirements. Capacity development is necessary to address risk perceptions and improve informed material selection.

- **Create a provincial RCA implementation platform**

KwaZulu-Natal should establish a collaborative platform involving municipalities, provincial government, contractors, consultants, recyclers, quarry operators, universities, testing laboratories and professional bodies. The platform could coordinate pilot projects, monitor performance, share technical information, identify supply-chain constraints and recommend updates to specifications and procurement procedures.

- **Monitor implementation and publish performance evidence**

Demonstration projects should be monitored for technical performance, cost, transport impacts, waste-diversion rates, procurement outcomes and user acceptance. Publishing results will strengthen the evidence base for future RCA specifications and support gradual expansion into higher-value applications.

References

1) Adams, K.T., Osmani, M., Thorpe, T. and Thornback, J. (2017) 'Circular economy in construction: Current awareness, challenges and enablers', Proceedings of the Institution of Civil Engineers – Waste and Resource Management, 170(1), pp. 15–24.

2) Akinade, O.O. and Oyedele, L.O. (2019) 'Integrating construction supply chains within a circular economy: An ANFIS-based waste analytics system', Journal of Cleaner Production, 229, pp. 863–873.

3) Akinshipe, O., Aigbavboa, C. and Thwala, W. (2025) 'Sustainable measures to improve construction and demolition waste management in South Africa', Journal of Construction in Developing Countries, 29(2), pp. 120.

4) Akbulut, Z.F., Alibeigibeni, A., Albidah, A. and Alrshoudi, F. (2025) 'Enhancing concrete sustainability: A critical review of the performance of recycled concrete aggregates in structural concrete', Buildings, 15(8), 1361. doi: 10.3390/buildings15081361.

5) Al-Humaidawi, B.H., Al-Khalaf, M.N., Al-Sulttani, A.O. and Al-Dujaili, A.H. (2025) 'Impact of treatment methods on recycled concrete aggregate performance: A comprehensive review', Environmental Science and Pollution Research, 32(24), pp. 14405–14438. doi: 10.1007/s11356-025-36497-y.

6) Amadi, I.G. (2025) 'State-of-the-art review on construction and demolition waste: The South African context', Cleaner Waste Systems, 10, 100189.sciencedirect+1

7) Berge, S. and von Blottnitz, H. (2022) 'An estimate of construction and demolition waste quantities and composition expected in South Africa', South African Journal of Science, 118(special issue), pp. 1–5. doi: 10.17159/sajs.2022/12485.

8) Bian, Y., Xie, Y., Li, X. and Zhang, H. (2024) 'Incorporation of recycled concrete aggregates as road construction materials: A review of engineering performance and sustainability', Discover Civil Engineering, 1, Article 58.1

9) De Brito, J. and Kurda, R. (2021) The past and future of sustainable concrete: A critical review and new strategies on cement-based materials. Oxford: Woodhead Publishing.

10) Department of Forestry, Fisheries and the Environment (DFFE) (2020) National Waste Management Strategy 2020. Pretoria: Government of South Africa.gov+1

ISSN 1533-9211

DOI: 10.5281/zenodo.22127064

11) Ghaffar, S.H., Burman, M. and Braimah, N. (2020) ‘Pathways to circular construction: An integrated management of construction and demolition waste for resource recovery’, Journal of Cleaner Production, 244, 118710. doi: 10.1016/j.jclepro.2019.118710.bura.brunel.ac+1

12) Ginga, C.P., Ongpeng, J.M.C. and Daly, M.K.M. (2020) ‘Circular economy on construction and demolition waste: A literature review on material recovery and production’, Materials, 13(13), 2970. doi: 10.3390/ma13132970.pmc.ncbi.nlm.nih+1

13) Linares, J. and López-Uceda, A. (2024) ‘Life-cycle assessment applied to the comparative environmental evaluation of natural and recycled aggregates’, Sustainability, 16(13), 5401.

14) Martínez-Lage, I., Vázquez-Herrero, C., Varela, M.E. and Sainz-González, J. (2020) ‘Sustainability evaluation of concretes with mixed recycled aggregate based on a holistic approach: Technical, economic and environmental analysis’, Journal of Cleaner Production, 273, 123018.

15) Ohemeng, E.A. and Ekolu, S.O. (2020) ‘Comparative analysis on costs and benefits of producing natural and recycled concrete aggregates: A South African case study’, Case Studies in Construction Materials, 13, e00450. doi: 10.1016/j.cscm.2020.e00450.mdpi+1

16) Republic of South Africa (2008) National Environmental Management: Waste Act 59 of 2008. Pretoria: Government Printer.

17) Zhang, Y., Wang, X., Li, J. and Chen, H. (2024) ‘A comprehensive review on recycled aggregate and recycled aggregate concrete’, Construction and Building Materials, 448, 137912.