



E-ISSN: 2707-8272
P-ISSN: 2707-8264
Impact Factor (RJIF): 5.44
IJRCET 2025; 6(2): 86-91
Journal's Website
Received: 05-08-2025
Accepted: 08-09-2025

Kowshika VR
Research Scholar,
International School of
Management Excellence
(ISME), University of Mysuru,
Karnataka, India

Dr. Vijaya Bhaskaran
Research Supervisor,
International School of
Management Excellence
(ISME), University of Mysuru,
Karnataka, India

Darshan G
P.G Scholar, RASTA Centre
for Road Technology, VTU-
Extension Centre, Bengaluru,
Karnataka, India

Corresponding Author:
Darshan G
P.G Scholar, RASTA Centre
for Road Technology, VTU-
Extension Centre, Bengaluru,
Karnataka, India

Sustainable strategies for managing and utilizing processing wastes from ready-mixed concrete Plants: A review

Kowshika VR, Vijaya Bhaskaran and Darshan G

DOI: <https://www.doi.org/10.22271/27078264.2025.v6.i2b.101>

Abstract

The returned fresh concrete, hardened leftovers, slurry trash, recovered aggregates, and high-alkaline wash-out water are among the substantial amounts of waste produced by the ready-mixed concrete (RMC) business. Because of their hazardous qualities and growing disposal costs, these wastes provide both economic and environmental difficulties. Reusing under-designed concrete, adding partially hydrated cementitious materials, recycling hardened concrete into recycled concrete aggregates (RCA), and reclaiming aggregates and water through wash-out systems are some of the sustainable methods for managing and using RMC processing wastes that are examined in this review. Reduced mechanical performance, decreased workability, high variability, extra admixture requirements, and strict quality-control requirements restrict the practical adoption of these technologies, despite the fact that they promote resource conservation and lessen environmental responsibilities. The study emphasizes the need for comprehensive, plant-specific waste management frameworks that are backed by cooperation between precast manufacturers and RMC producers. To move the RMC industry toward a more sustainable and circular future, it is imperative to develop recycling technology and set clear norms.

Keywords: Waste Management; Ready-Mix Concrete; Recycled Aggregate; Slurry Waste; Sustainability; Concrete Industry

Introduction

Concrete, the second most consumed material on Earth after water, forms the backbone of global infrastructure development. Cement-based materials alone account for nearly one-fourth of global material consumption ^[1], and over their service life cycles, they are responsible for a comparable share of waste generation. Considering that concrete represents approximately up to 45% of total cement consumption, and that aggregates and water together constitute about seven to eight times the cement quantity ^[2], the global concrete production was estimated at nearly 109 billion tonnes per year (Mineral Commodity Summaries, 2017). With such immense scale and ubiquity, even a marginal improvement in the efficiency of resource use or waste reduction practices can have a substantial impact on environmental sustainability.

Emissions and energy consumption are inherent in the cement and concrete industries. About 5% of the world's anthropogenic CO₂ emissions come from the manufacturing of cement alone (IEA/WBCSD, 2009). The calcination of limestone and the high-temperature kiln activities necessary for cement production are the main causes of this substantial carbon footprint. As a result, sustainability evaluations throughout the world now place a strong emphasis on the concrete industry's environmental performance. For the construction sector to further sustainable growth, it is imperative to manage and mitigate the environmental consequences related to the manufacture, transportation, and use of concrete materials. Because of the significant amount of waste and leftover materials produced during manufacturing, distribution, and plant operations, the ready-mixed concrete (RMC) industry in particular is receiving more attention. Returned concrete, wash water, slurry, and leftover aggregate materials are some of these wastes that, if improperly handled, result in serious environmental problems and resource inefficiencies. There is little primary data on waste creation and management during the earlier stages of production, despite the fact that a lot of study has concentrated on the end-of-life phase of concrete buildings. The total resource efficiency of the concrete supply chain may be significantly increased by addressing this

issue with efficient waste minimization and recycling techniques.

Since the late 1980s, global research and practice have increasingly focused on the recycling and reuse of hardened concrete derived from construction and demolition (C&D) waste streams [3]. While these efforts have led to the development of effective recycling principles and treatment technologies for end-of-life concrete, such approaches are not directly applicable to the wastes generated during the ready-mixed concrete (RMC) production and supply stages. The key difference lies in the state and timing of waste generation. RMC wastes typically occur in fresh, unhardened, or early-hardened conditions within the first few hours after batching.

Returned concrete, which frequently maintains enough workability upon returning to the batching facility, makes up a sizable component of these wastes. This material is sometimes recycled to create low-grade or non-structural concrete products like standard-sized blocks, backfill materials, or blinding layers, either with or without the inclusion of set-retarding admixtures. However, the returning concrete is frequently just thrown away, either in makeshift mounds on the plant's property or, once it has solidified, moved to public landfills. Both resource management and environmental sustainability face several difficulties as a result of such activities. In addition to taking up precious factory space and interfering with traffic and logistics, temporary on-site dumping raises operating expenses since it requires double handling, such as crushing

hardened concrete to make transportation simpler. Additionally, the buildup of these wastes presents possible environmental hazards, such as dust emissions, pollution of adjacent land and water sources, and a rise in the carbon intensity of manufacturing as a whole.

About 70% of recovered aggregates and up to 30% of unrecoverable paste, which includes cementitious materials, water, partly hydrated cement, pozzolanic products, small fine aggregates, and traces of unreacted admixtures, are frequently found in returned concrete debris. Many ready-mixed concrete (RMC) facilities use aggregate reclaimers to recover useable materials. These machines use enormous amounts of fresh or recycled grey water produced during cleaning operations to wash off cement paste. Large volumes of grey water, frequently rich in fine cementitious particles, are produced during the aggregate washing process. In order to deal with this, a number of factories use slurry dewatering or water reclamation systems, which separate slurry solids from grey water and produce recovered water that may be used again. A crucial environmental management tactic that improves resource efficiency and lowers wastewater discharge is the use of aggregate and water reclamation systems. By using these technologies, plants can reduce the amount of freshwater they need and the environmental impact of producing RMC. Batching plants create and handle a variety of processing wastes, such as solid residues, slurry, and grey water, depending on the size and design of the reclamation system.

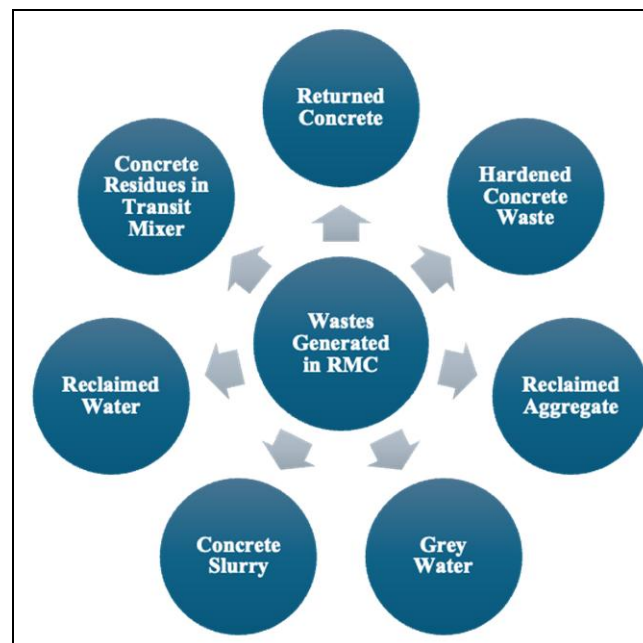


Fig 1: Wastes Generated from RMC Plant

Over 200 million tons of new concrete are returned to RMC plants and garbage each year from a worldwide viewpoint; this is mostly dependent on the degree of QA and QC in both concrete manufacturing and building activities. The expense of disposing of leftover trash has become a significant issue due to the increased focus on sustainable development and environmental preservation. Due to their high alkalinity and heavy metal content, fresh wastes from concrete batching plants, such as waste returned concrete, concrete slurry waste, grey water, and recovered water, are categorized as hazardous materials in many nations [4]. For

example, according to Technical Guideline WM2, wastes in the UK with a pH more than 11.5 are classified as hazard class H8. According to studies, slurry waste usually has a pH between 11.5 and 13.0 [5]. Because such highly alkaline wastes must be pre-treated to make them non-hazardous and are susceptible to rising landfill charges, disposing of them presents both environmental and financial issues. For instance, the projected cost of treating CSW in Japan before it is disposed of in a landfill is \$60 per tonne [6].

As sustainable practice in construction has gained priority in most part of world, sustainable management of waste

generated during from RMC production has become a major concern.

Waste Management Approaches in RMC Plant

In most of the condition, the RMC produce concrete by centralized batching system. It is found that more than 75% of the concrete work is done with concrete produced by RMC in construction activity. The concrete produced is customizable and as per requirement of the client. The raw materials are blended and mixed with batching and mixing control system. The concrete produced from RMC is suitable for all kind of infrastructure development work. Once the concrete is produced, it is supplied to the required site with transit mixer. In the entire process the waste from RMC is generated from there different source like returned fresh concrete, residues inside the truck mixer and waste from washing truck mixer and batching plant.

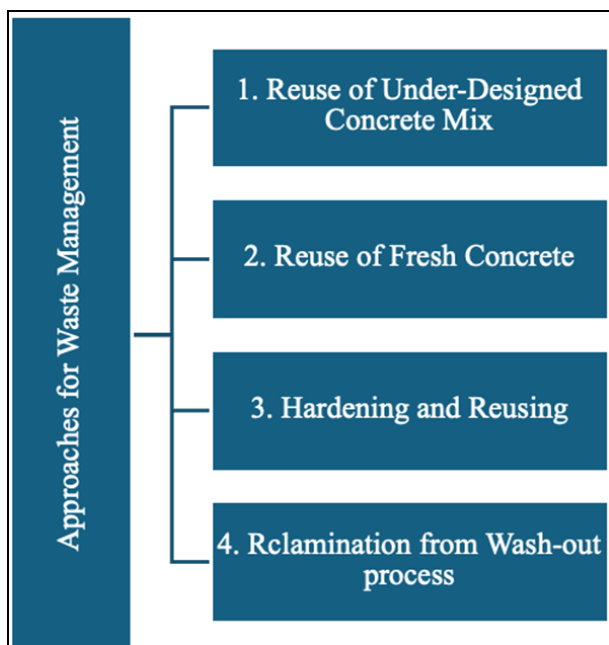


Fig 2: Approaches for Waste Management

Reuse of Under-Designed Concrete Mix

One major source of fresh concrete waste is returned or under-designed concrete from ready-mixed concrete (RMC) manufacturers, which is mostly caused by overordering or residual residues in truck mixers. While leftover concrete is the consequence of washout and cleaning procedures, overordering frequently happens as a result of inaccurate site estimation and scheduling. A medium-sized batching plant that produces around 1000 m³ of concrete a day may produce 8-10 tons of fresh waste, or 0.4-0.5% of the overall production, which presents problems for the environment and the economy [7].

Reusing fresh returned concrete in low-grade or non-structural applications including blinding layers, backfilling, pavement blocks, partition wall blocks, and weight blocks is one of the simplest ways to handle this waste. By taking use of fresh waste concrete's natural workability, this method drastically lowers processing and material requirements. However, cost-efficiency may be impacted by the short working time, transit distances, and accessibility to local precast facilities [8].

Depending on the state of the concrete and the plant's capability, a number of processing techniques are used in

addition to direct reuse. These consist of: partly reusing partly hydrated cementitious materials as accelerators in fresh batches. Manufacturing of precast blocks or retaining wall modules utilizing overordered concrete.

All things considered, reusing under-designed or returned concrete is a workable circular strategy that lowers waste production, preserves raw materials, and decreases disposal expenses, all of which are in line with the RMC industry's sustainable management objectives [7, 8].

Reuse of Fresh Concrete

This waste management approach is a techno-managerial methodology of reuse of fresh concrete waste such as returned concrete waste and residues inside the truck mixer is utilised as a raw material for production of fresh concrete. To meet the criteria like workability, quality and durability, additives like retarders and stabilizer to slow hydration process and activation agent to accelerate the hydration process [9]. Factors like amount of retarder, age, dosage and holding period of retarder greatly influence on properties of concrete blended with returned fresh concrete. Though we have many approaches to reuse the returned fresh concrete, but there is no proper guidelines and specification. This might bring up high risk and challenge for QA and QC.

Usage of Hardened Concrete

Recycled concrete aggregate (RCA) refers to aggregate material obtained by crushing and processing clean concrete waste with minimal contamination by other building-waste materials RCA has distinct physical and chemical properties from natural aggregates since it usually keeps adhering mortar and leftover cement paste. These differences include increased water absorption, lower density, and more quality fluctuation. If the proper mix design modifications or treatments are not used, these variations may negatively impact the mechanical performance and longevity of concrete manufactured using RCA. Positively, RCA contributes to material circularity, lessens the demand for virgin aggregate extraction, and reduces construction-waste quantities. In order to safely and successfully utilize the benefits of RCA in structural and non-structural concrete applications, ongoing research focuses on enhancing RCA quality (via treatments or preprocessing), defining ideal replacement amounts, and creating uniform protocols.

When compared to mixes including natural aggregates, concrete manufactured using recycled concrete aggregate (RCA) often exhibits worse mechanical performance; the degree of this loss varies depending on the replacement amount. Compressive strength usually drops by 5-20% with up to 30% RCA replacement, which is generally regarded as acceptable for many structural and non-structural applications. Studies show that even with full replacement, there is a 15-20% decline in strength at higher replacement levels, such as 60-100% RCA. Due in large part to the increased porosity and weaker adhering mortar found in RCA, other mechanical parameters are also impacted: splitting tensile strength reduces by around 33-39%, while flexural strength declines by about 28-41%. These numerical trends highlight that although RCA can be effectively used in concrete production, especially at lower replacement rates, careful mix design adjustments and quality control are needed to maintain performance [10-15].

2.4 Reclaiming from Wash-Out Process

In RMC plants, during the operation process a substantial volume of wash-out water (Waste Wash Water) is generated from the cleaning the truck mixer, pump lines and batching equipment. The reclaimed water is collected from the sedimentation process and coarse aggregate along with fine solid particles are reclaimed with the help of reclaimer. Cleaning-up and removal of residual of concrete is very essential for maintaining working efficiency of the transit mixer and other batching equipment. In mechanical reclamation systems, useful aggregates are separated from fresh returned concrete waste by washing. The wash water, contains aggregate and fine cementitious particles, undergoes series of sedimentation process and settles in the pits. Reclaimed aggregates (coarse and fine) and grey water with suspended particulates are the two primary byproducts of the process. The last settling pit that the grey water passes through yields comparatively cleaner recovered water, which is frequently utilized for non-critical tasks like dust suppression, road washing, first truck drum cleaning, or cleaning out new RCW. The heavier slurry solids are accumulated in the earlier pits and are regularly removed, these collected materials may be landfilled or assessed for possible usage. As a result, the system typically generates two additional outputs: recovered water, and waste concrete slurry. Further, the grey water can be treated by using filter press to extract suspended solids mechanically. The reclaimed water further can be used for washing the truck mixer again. Other source of fresh concrete waste includes trails performed for production and remains from batching plant [16]. The application of above reclaimed materials are discussed in detail in further section the article.

Functional Properties and Engineering Deployment of Reclaimed Materials

Materials reclaimed through methods such as downgraded concrete production, recovered residues from batch mixers, and hardened fresh concrete generally exhibit inferior characteristics, including poor workability, reduced durability, lower strength, and higher recycling costs, when compared to natural raw materials. The downgraded and under designed fresh concrete can be used in the manufacturing of products like cement blocks, paver blocks and non-structural element in the building. However, this is not practically implemented due to issue in workability, strength and poor management of setting time. The residues from the batch plant and transit mixer can be reused by blending with the fresh production process. Studies have shown that incorporating 25–50% partially hydrated cementitious materials in ultra-high-performance concrete can significantly enhance 24-hour early strength, noticeably accelerate setting, and help reduce shrinkage [17]. It is found that batching up to 5% of reuse of fresh concrete had no effect of setting time, strength, and dry shrinkage. The problem found mainly due to time gap until next batching process. However, this can be solved with proper dosing of retarder and additives, may also cause high cost of production. The reclaimed material from second approach should have characteristic properties similar to the demolition waste. The RCA can be used up-to 10% of total mass of natural aggregate for most of the concrete application. The mechanical properties like compressive strength, tensile strength and flexural strength is reduced with increase in the recycled concrete aggregate. The approach three, processing the waste from wash-out process

is most common process to treat waste in the RMC plant. The method adopted depend on site condition, facility and production capacity. With different reclaiming system different wastes.

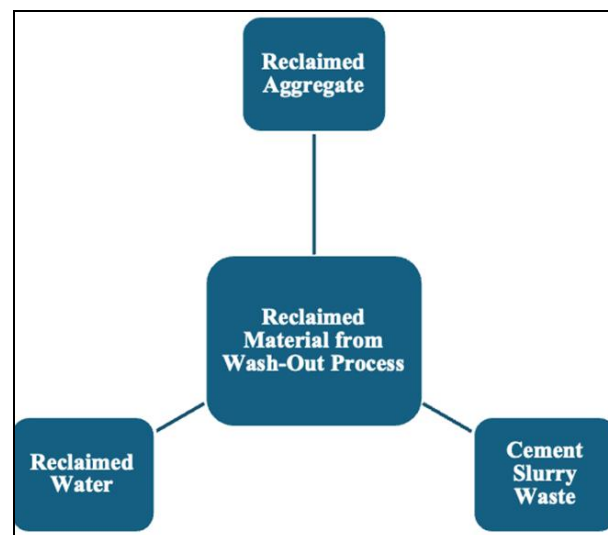


Fig 3 Reclaimed Materials (Wash-Out Process)

The reclaimed aggregate from RMC plant during reclaiming process is considered as an alternative source of natural aggregate. It is found to be advantageous for conserving natural resource and low cost production. Studies have found that reclaimed aggregate can be fully replaced with natural aggregate. However, the cement content has to be increased to meet the mechanical properties of concrete with natural aggregate. The maximum permissible limit of replacement of natural aggregate with RCA is allowed up to 15 % has no change in mechanical properties [18], but the workability gets reduced. On such a case the workability can be adjusted with suitable dosage of superplasticizer. The reclaimed waste cement slurry waste from wash-out process is a mixture of fine aggregate, cement hydration product and cement particles collected from sedimentation pit. The slurry waste has more water content, hence it fails to develop high strength after dry-out process. Hence, this residual can be used as replacement of sand and filler material but not for cement replacement. This type of slurry waste is allowed up to 30% of sand and will be able to achieve the similar strength. But decreases the workability of fresh concrete [19]. Also, up to 2% of cement replacement is allowed with dry cement slurry waste [20]. The disposal of reclaimed water from wash-out process is very challenging due to high pH value, and requires careful consideration to make the disposal environmentally friendly. Hence, this waste is used for cleaning equipment and machinery. The reuse of such water is done by utilizing it in washing purposes and mixing new concrete by meeting the requirements. This could be the simple and sustainable method of saving water. The incorporation of waste water in new concrete production lowers the setting time and workability with decreased mechanical properties.

Discussion

Reusing and recycling RMC byproducts effectively may significantly reduce the financial and environmental costs of treating hazardous trash. These methods also aid in the prevention of pollution and the preservation of energy and

natural resources. Cost analysis and environmental evaluations must be included in order for each facility to choose the best recycling route given its unique circumstances. Enhancing cooperation between local precast concrete manufacturers and RMC companies makes recycling possibilities even more feasible. An integrated and well-coordinated waste-management system is necessary since each RMC facility produces a variety of trash and operates under particular local restrictions. However, there are many restrictions on the use of recycled materials, including limited allowable replacement levels, the necessity for extra admixtures, the need for additional storage or recycling space, strict quality-control procedures, and even the demand for regulatory clearance prior to use. These practical issues currently limit the widespread use of RMC derived wastes, despite the fact that many of them have potential uses in building materials. Because of this, it is becoming more and more crucial to create recycling procedures that are both economical and technically sound in order to minimize the need for disposal. Increasing landfill fees and the need for pre-treatment because these wastes are dangerous in many areas. Significant amounts of trash are being produced in the RMC sector despite improvements in recycling returned new concrete, underscoring the continuous need for better waste-management techniques.

Conclusions

Although the ready-mixed concrete (RMC) business is essential to the development of contemporary infrastructure, it produces large amounts of trash throughout the manufacture, distribution, and equipment cleaning phases. This research shows that a significant amount of returned concrete, slurry waste, recovered aggregates, and high-alkaline wash-out water are either misused or disposed of despite continuous improvements in recycling technology and a revived worldwide focus on sustainability. The need for more effective and comprehensive waste-management techniques is further highlighted by the hazardous character of these wastes, especially their high pH levels and heavy-metal concentration, which raise disposal costs and environmental concerns. Numerous strategies for handling RMC processing waste have demonstrated encouraging possibilities. Utilizing recycled concrete aggregates (RCA), reclaiming aggregates and water from wash-out processes, using partially hydrated cementitious materials as accelerators, and reusing under-designed or returned fresh concrete in low-grade applications are all ways to conserve resources and lessen environmental impact. Each approach, however, has practical drawbacks, including decreased mechanical performance at greater replacement levels, loss of workability, increased need for admixtures, higher operating costs, and the need for stringent regulatory approval and quality control. A single solution is insufficient since each RMC plant produces several waste streams with different properties. Rather, a thorough, plant-specific waste-management strategy that integrates economic viability, environmental sustainability, and technological feasibility is crucial. The use of recycling paths may be further improved by increased cooperation between manufacturers of precast concrete, RMC producers, and regulatory bodies. Decision-makers will be able to determine the best waste-utilization methods based on production sizes and local conditions by including life-cycle

cost analysis and environmental impact assessments.

Overall, sustainable management of RMC wastes is not only feasible but also essential for minimizing environmental contamination, cutting down on the social and financial expenses related to treating hazardous waste, and encouraging the effective use of natural resources. In order to move the sector toward a more circular and ecologically conscious future, it will be essential to set clear standards and guidelines, improve quality-control processes, and advance reclamation technology.

References

1. VR K, Bhaskaran V, Natarajan R, Faridmehr I. Enhancing strength and corrosion resistance of steel-reinforced concrete: performance evaluation of ICRETE mineral additive in sustainable concrete mixes with PFA and GGBS. *Infrastructures*. 2024;9(12):228.
2. Kowshika V, Bhaskaran V, AB K, Faridmehr I, Narayana B. Utilising ready-mix concrete waste for production of sustainable concrete and creating circular economy. *International Journal of Management*. 2025;16(3):398–416.
3. Wiedmann TO, Schandl H, Lenzen M, Moran D, Suh S, West J, Kanemoto K. The material footprint of nations. *Proceedings of the National Academy of Sciences*. 2015;112(20):6271–6276.
4. Scrivener K, Snellings R, Lothenbach B, editors. A practical guide to microstructural analysis of cementitious materials. Boca Raton: CRC Press; 2016. 540 p.
5. Paranhos RS, Cazacliu BG, Sampaio CH, Petter CO, Neto RO, Huchet F. A sorting method to value recycled concrete. *Journal of Cleaner Production*. 2016;112:2249–2258.
6. Borger J, Carrasquillo RL, Fowler DW. Use of recycled wash water and returned plastic concrete in the production of fresh concrete. *Advanced Cement Based Materials*. 1994;1(6):267–274.
7. Arunvivek GK, Maheswaran G, Kumar SS. Eco-friendly solution to mitigate toxic effects of hazardous construction industry waste by reusing in concrete for pollution control. *Nature Environment and Pollution Technology*. 2015;14(4):963.
8. Iizuka A, Sakai Y, Yamasaki A, Honma M, Hayakawa Y, Yanagisawa Y. Bench-scale operation of a concrete sludge recycling plant. *Industrial & Engineering Chemistry Research*. 2012;51(17):6099–6104.
9. Kazaz A, Ulubeyli S. Current methods for the utilization of fresh concrete waste returned to batching plants. *Procedia Engineering*. 2016;161:42–46.
10. Cosgun N, Esin T. A study regarding the environmental management system of ready mixed concrete production in Turkey. *Building and Environment*. 2006;41(8):1099–1105.
11. Borger J, Carrasquillo RL, Fowler DW. Use of recycled wash water and returned plastic concrete in the production of fresh concrete. *Advanced Cement Based Materials*. 1994;1(6):267–274. (*Duplicate of #6*)
12. Marinković S, Carević V. Comparative studies of life cycle analysis between conventional and recycled aggregate concrete. In: *New trends in eco-efficient and recycled concrete*. Cambridge: Woodhead Publishing; 2019. p. 257–291.
13. Chindaprasirt P, Cao T. Reuse of recycled aggregate in

- alkali-activated concrete production. In: Handbook of alkali-activated cements, mortars and concretes. Cambridge: Woodhead Publishing; 2015. p. 519–538.
14. Kisku N, Joshi H, Ansari M, Panda SK, Nayak S, Dutta SC. A critical review and assessment of recycled aggregate as a sustainable construction material. *Construction and Building Materials*. 2017;131:721–740.
 15. Shi C, Li Y, Zhang J, Li W, Chong L, Xie Z. Performance enhancement of recycled concrete aggregate – a review. *Journal of Cleaner Production*. 2016;112:466–472.
 16. Marinković SB, Malešev M, Ignjatović I. Life cycle assessment of concrete made using recycled concrete or natural aggregates. In: *Eco-efficient construction and building materials*. Cambridge: Woodhead Publishing; 2014. p. 239–266.
 17. Tam VW, Wattage H, Le KN, Butera A, Soomro M. Methods to improve microstructural properties of recycled concrete aggregate: a critical review. *Construction and Building Materials*. 2021;270:121490.
 18. Vieira LDBP, de Figueiredo AD. Evaluation of concrete recycling system efficiency for ready-mix concrete plants. *Waste Management*. 2016;56:337–351.
 19. Soliman AM, Nehdi ML. Effect of partially hydrated cementitious materials and superabsorbent polymer on early-age shrinkage of UHPC. *Construction and Building Materials*. 2013;41:270–275.
 20. Arunvivek GK, Maheswaran G, Kumar SS. Eco-friendly solution to mitigate toxic effects of hazardous construction industry waste by reusing in concrete. *Nature Environment and Pollution Technology*. 2015;14(4):963. (*Duplicate of #7*)
 21. Correia SL, Souza FL, Dienstmann G, Segadaes AM. Assessment of the recycling potential of fresh concrete waste using factorial design of experiments. *Waste Management*. 2009;29(11):2886–2891.
 22. Zervaki M, Leptokaridis C, Tsimas S. Reuse of by-products from ready-mixed concrete plants for cement mortar production. *Journal of Sustainable Development of Energy, Water and Environment Systems*. 2013;1(2):152–162.
 23. Manjunatha LR, Anvekar SR, Sagari SS, Kumarswamy A. A study on customer preferences and perceptions on quality and services of ready mixed concrete as a sustainable building material in Bangalore City, Karnataka. *International Journal of Research in Engineering and Technology*. 2014;3:2319–1163.
 24. Kumar R, Tegar JP. Critical analysis of properties of ready-mix concrete with site-mix concrete in smart road projects. *International Research Journal of Engineering and Technology*. 2018;5(6):1734–1739.
 25. Manu Mohan DEJ. Study on slump retention of ready-mix concrete: a review. 2020.
 26. Kabus O, Butska L, Makarenko O, Pershina L, Tymoshchenko A. Evaluating efficiency of fluidity retention of ready-mix concrete during transport to construction sites. *MATEC Web of Conferences*. 2018;230:03005.
 27. Mahajan R, Buthello R. Quality control of ready mixed concrete. *IOSR Journal of Mechanical and Civil Engineering*. 2015;12(5):1–7.
 28. Keshore D, Joshi N, Dwivedi HK. Implementation of Six Sigma for quality evaluation of RMC plants using DMAIC methodology. *International Journal of Engineering Research and Technology*. 2017;6(11):153–157.
 29. Park SH, Ryu HS, Park WJ. Influence of unit water content control on concrete performance in ready-mixed concrete production. *Materials*. 2024;17(4):834.
 30. Gokulanathan V, Arun K, Priyadharshini P. Fresh and hardened properties of non-potable-water-mixed concrete: a comprehensive review. *Construction and Building Materials*. 2021;309:125089.
 31. Melesse K. Assessment of quality management practices in ready-mix concrete suppliers: the case of Dugda Construction Plc. Doctoral dissertation. St. Mary's University; 2021.
 32. Chandwani V, Agrawal V, Nagar R, Singh S. Modelling slump of ready-mix concrete using artificial neural networks. *International Journal of Technology*. 2015;6(2):207–216.
 33. Kazaz A, Ulubeyli S, Turker F. Quality perspective of the ready-mixed concrete industry in Turkey. *Building and Environment*. 2004;39(11):1349–1357.
 34. Sinha A, Singh N, Kumar G, Pal S. Quality factors prioritisation of ready-mix and site-mix concrete: a case study in Indian context. In: *Proceedings of the International Conference on Scientific and Natural Computing (SNC 2021)*. Singapore: Springer; 2021. p. 179–187.
 35. Ghazi S, Al-Zwainy FMS, Manogaran GM. Critical review to evaluate performance of ready-mix concrete production plants. *Al-Nahrain Journal for Engineering Sciences*. 2023;26(3):205–215.
 36. Arularasi V, Pachiappan T, Avudaiappan S, Raman SN, Guindos P, Amran M, *et al.* Effects of admixtures on energy consumption during ready-mix concrete mixing. *Materials*. 2022;15(12):4143.
 37. Kate GK, Thakare SB. Experimental study on high-strength, high-volume fly ash concrete for sustainable construction. *IOP Conference Series: Materials Science and Engineering*. 2017;225:012247.
 38. Raghavendra YB, Reddy R. Optimum usage of GGBS in the ready-mix concrete industry. *International Journal of Engineering Advanced Technology*. 2019;8:4542–4553.
 39. Raghavendra YB, Hossiney N, HT D. Properties of high-strength concrete with reduced Portland cement: a case study. *Cogent Engineering*. 2021;8(1):1938369.
 40. Matarul J, Mannan MA, Yussop N, Endut MZ, Ibrahim A. Optimising concrete enhancement of ready-mix concrete with partial fly ash replacement. *Journal of Physics: Conference Series*. 2019;1349:012029.