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Use of Recycled Ceramic Tiles as A Coarse Aggregate in Concrete

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ABSTRACT: The rapid growth of construction activities and the parallel generation of construction and demolition waste have raised significant environmental concerns. One such waste material is ceramic tile waste, which, if not properly managed, contributes to landfill issues. This study explores the feasibility of using recycled ceramic tiles as a partial or complete replacement for natural coarse aggregates in concrete production. The physical and mechanical properties of recycled ceramic aggregate are examined and compared with conventional aggregates. Concrete mixes incorporating various percentages of ceramic tile aggregate were tested for workability, compressive strength, tensile strength, and durability. The results indicate that recycled ceramic tiles can be effectively used as a coarse aggregate replacement without compromising concrete performance up to certain replacement levels. The use of ceramic waste not only reduces the consumption of natural aggregates but also promotes sustainable construction practices by minimizing environmental impact and supporting waste management.

I. INTRODUCTION

Concrete is one of the most globally used construction material, this is so because of its durability, resistance to fire, simple to use etc, and all these under very economical price value due to which its use is increasing day by day. Due to this high demand of natural aggregates for concrete production, a drastic reduction in natural aggregates have been seen which is harming the environment. To decrease the environmental impact of concrete production many substitute materials have been used as a replacement of natural aggregate for concrete production. The alternative materials that can be used in place of aggregate in concrete can be found out from construction and metallurgical industries. Ceramic have been very popular as a furnishing material. But, when ceramic reaches the end of its lifetime, it loses its value and becomes mere wastes.

On the other hand, bagasse ash, a byproduct of the sugar industry, is rich in silica and exhibits pozzolanic properties. When used as a partial replacement for cement, bagasse ash enhances concrete durability, reduces carbon emissions, and contributes to cost-effective construction solutions.

This report explores the feasibility of using waste ceramic as aggregate and bagasse ash as a cementitious material in concrete. It examines their physical and chemical properties, their effects on concrete performance, and the environmental benefits of their utilization in sustainable construction practices.

II. LITERATURE REVIEW

1. K. McNeil and T. H.-K. Kang, "Recycled Concrete Aggregates: A Review," Int. J. Concrete Struct Mater. vol. 7, no. 1, Art. no. 1, Mar. 2013.

In this paper we have studied that, after demolition of old roads and buildings, the removed concrete is often considered worthless and disposed of as demolition waste. By collecting the used concrete and breaking it up, recycled concrete aggregate (RCA) is created. This paper focuses on coarse RCA which is the coarse aggregate from the original concrete that is created after the mortar is separated from the rock which is reused. The use of RCA in new construction applications is still a relatively new technique. After the immediate need to recycle concrete, the use of RCA tapered off. In the 1970s, the United States began to reintroduce the use of RCA in non-structural uses, such as fill material, foundations, and base

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course material (Buck 1977). [1]

2. M. T. R. Sonawane and D. S. S. Pimplikar, "Use of Recycled Aggregate in Concrete," Int. J. Eng. Res. Technol., vol. 2, Art. no. 1, Jan. 2013.

This paper reports the basic properties of recycled fine aggregate and recycled coarse aggregate & also compares these properties with natural aggregates. Basic changes in all aggregate properties are determined and their effects on concreting work are discussed at length. Similarly, the properties of recycled aggregate concrete are also determined. Basic concrete properties like compressive strength, flexural strength, workability etc. are explained here for different combinations of recycled aggregate with natural aggregate. Codal guidelines of recycled aggregates concrete in various countries are stated here with their effects, on concreting work. In general, present status of recycled aggregate in India along with its future need and its successful utilization are discussed here.[2]

3. H. Qasrawi, I. Marie, and H. Tantawi, "Use of Recycled Concrete Rubbles as Coarse Aggregate in Concrete," Jan. 2012.

The effect of using recycled aggregates concrete (RCA) on the basic properties of normal concrete is studied. First, recycled aggregate properties have been determined and compared to those of normal aggregates. Except for absorption, there was not a significant difference between the two. Later, recycled aggregates were introduced in concrete mixes. In these mixes, natural coarse aggregate was partly or totally replaced by recycled aggregates. Results showed that the use of recycled aggregates has an adverse effect on the workability of concrete. Such an effect can be easily retained by using plasticizers. Also, concrete strength has been reduced by 5% to 25% depending on the percent of the normal aggregate replaced by recycled aggregate and the water-cement ratio. With respect to thetensile strength, recycled aggregate concrete was slightly lower.[3]

4. G. Andreu and E. Miren, "Experimental analysis of properties of high performance recycled aggregate concrete," Constr. Build. Mater., vol. 52, Feb. 2014.

The increasing demand for sustainable construction materials has led to a growing interest in the use of Recycled Aggregate Concrete (RAC). However, the properties of RAC can vary significantly depending on the quality of the recycled aggregates and the mix design. High Performance Recycled Aggregate Concrete (HPRAC) has the potential to overcome some of the limitations associated with traditional RAC, but its properties need to be thoroughly investigated**.[4]**

5. Anusuri Uma Maheswari, B. Naidu Babu, K. Jagan, Use of recycled concrete rubbles as coarse aggregate in concrete, **Volume 9, Issue 7 July 2021.**

In India, Construction and Demolition (C&D) waste is increasing, while natural resource preservation is crucial. This study explores using demolished concrete debris as recycled concrete aggregate to conserve resources and reduce landfill impact. The research investigates the effect of recycled aggregates on concrete strength, replacing natural aggregates at 0%, 10%, 20%, 30%, and 40% levels. Results show that up to 30% replacement, there's a slight strength decrease compared to conventional concrete. The goal is to develop economical and sustainable concrete using site-available concrete waste.[5]

6. N. Sivakumar, V. Sivakumar, Study on recycled concrete aggregate. International Journal of Engineering and Science Vol.4, Issue 01 (January 2014).

Any construction activity requires several materials such as concrete, steel, brick, stone, glass, clay, mud, wood, and so on. However, the cement concrete remains the main construction material used in construction industries. For its suitability and adaptability with respect to the changing environment, the concrete must be such that it can conserve resources, protect the environment, economize and lead to proper utilization of energy. To achieve this, major emphasis must be laid on the use of wastes and byproducts in cement and concrete used for new constructions. The utilization of recycled aggregate is particularly very promising as 75 per cent of concrete is made of aggregates. The use of recycled aggregates from construction and demolition wastes is showing prospective application in construction as alternative to primary (natural) aggregates.[6]

7. Z. Ahmed and S. K. Y. Ali, "Experimental Study on Recycled Concrete Aggregates," vol. 08, no. 04, 2021.

The construction industry faces pressure to address the unsustainable disposal of Construction and Demolition (C&D) waste, which is a significant environmental and economic concern in India and other developing countries. This study investigates the recycling of demolished concrete waste as a sustainable alternative to natural aggregates in concrete production. The research involves collecting and processing demolished concrete, replacing natural aggregates with

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recycled aggregates at varying percentages, and testing the performance of the resulting concrete. The goal is to reduce environmental pollution, conserve natural resources, and promote sustainable construction practices [7].

8. O. A. Qasim, N. Hilal, M. I. Al Biajawi, N. H. Sor, and T. A. Tawfik, "Studying the usability of recycled aggregate to produce new concrete," *J.* Eng. Appl. Sci., vol. 71, no. 1, p. 129, Jun. 2024

As time has progressed, the production, methods, and processes for manufacturing concrete have developed considerably. The most important construction material used in the realization of many large projects is concrete, as it is considered one of the most important materials that is most readily available and easy to work with. Conservation of the environment and natural resources is found to be one of the most important features of any country's development and is considered the main pillar of construction projects, but some problems arise because of industrial and technological development. There is a method that is currently being followed internationally, which is the recycling of waste, especially construction waste, as it is considered a fundamental plan to reduce construction waste. To most important environmental problems arising from the development of construction around the world are the demolition or reconstruction of old buildings.[8]

9. Available: A Review Of Recycled Concrete Aggregates As A Sustainable Construction Material. Accessed: Aug.10,2024.

With a significant volume of literature published on the properties and microstructure of RCAs, research has shown that RCAs can be a suitable replacement for natural aggregates in concrete mixtures. The use of RCAs can help reduce waste disposal, conserve energy, and decrease the environmental impact of construction activities. This paper provides an overview of the history, properties, and applications of RCAs, including their mechanical and durability parameters, and pre-treatment methods, highlighting the benefits and gaps in current research.[9]

10. K. P. Verian, W. Ashraf, and Y. Cao, "Properties of recycled concrete aggregate and their influence in new concrete production," Resour. Conserv. Recycl., vol. 133, pp. 30–49, Jun. 2018.

This review examines the potential and challenges of using recycled concrete aggregate (RCA) as a substitute for natural aggregate (NA) in concrete mixtures. While RCA conserves the environment by reducing the need for new quarries and landfill waste, its properties can impact concrete strength and durability. Research has yielded mixed results, with some studies showing degraded concrete properties and others achieving comparable performance to normal concrete. The manuscript evaluates techniques to improve RCA concrete performance, reports cost savings, and provides recommendations for its application.[10]

III. METHODOLOGY

1. **Material Collection and Preparation: Waste** ceramic tiles were collected, cleaned, and crushed into coarse aggregate sizes (10-20 mm). Bagasse ash was obtained from sugar mills and sieved to achieve uniform fineness.
2. **Concrete Mix Design:**

Different concrete mix designs were prepared by replacing natural coarse aggregates with ceramic tile aggregates at 0%, 5%, 10% replacement levels. Cement was partially replaced with bagasse ash at 0%, 5% levels. Use IS 10262:2019 for mix proportioning.

3. **Design Stipulations**:
   - Grade of Concrete: M50
   - Type of Cement: OPC 53 Grade
   - Maximum Nominal Aggregate Size: 12-20mm
   - Exposure Condition: Moderate (Assumed; adjust as per project requirement)
   - Workability: 100 mm slump (Assumed; adjust as per requirement)
   - Water-Cement Ratio (W/C): 0.33
   - Degree of Supervision: Good

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- Type of Admixture (if any): Superplasticizer.

4. **Mix Proportions by Weight:**

- Cement: 407 kg
- Water: 148.5 kg
- Fine Aggregate: 760 kg
- Coarse Aggregate: 1128kg
- Superplasticizer: 4.5 kg (1% of cement weight)

5. **Final Mix Ratio (By Weight):**

- Cement: FA: CA: Water
  1: 1.86: 2.77: 0.33

IV: RESULT

TEST ON HARDENED CONCRETE

(a) Slump Cone Test: Workability of concrete refers to the ease with which the concrete can be mixed, transported, placed and compacted fully. This test method is used to determine the slump of freshly mixed concrete. Slump is the relative measurement of workability of concrete. The test may be done in the laboratory and in field.


Fig. No.: 1


Fig. No. :2


Fig. No.: 3

(b) Compressive Strength Test: Compressive strength is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. To evaluate the compressive strength cubes of size 150 mm x 150 mm x 150 mm were casted using C.I. mould.

(c) Conventional Concrete test:

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Table no.2: Compressive strength Result at 7Days and 14 Days

	Cube 1	Cube 2	Cube 3
Normal 7 days	55.55	42.66	44.44
Normal 14 days	22.22	26.66	20

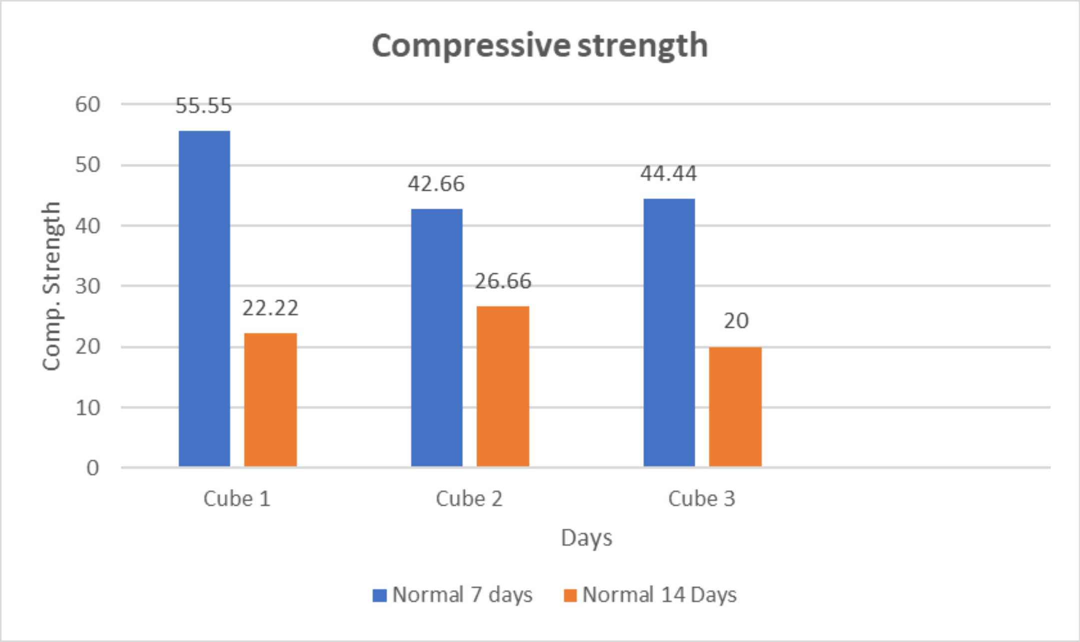

Fig. No. 4: 7 Days and 14 Days Compressive strength for Conventional Concrete

- **5% REPLACEMENT OF TILES IN CONCRETE:**

  - **Table no.2: Compressive strength Result at 7Days and 14 Days**

	Cube 1	Cube 2	Cube 3
Normal 7 days	28.88	14.22	36.44
Normal 14 days	28.28	26.66	24.44

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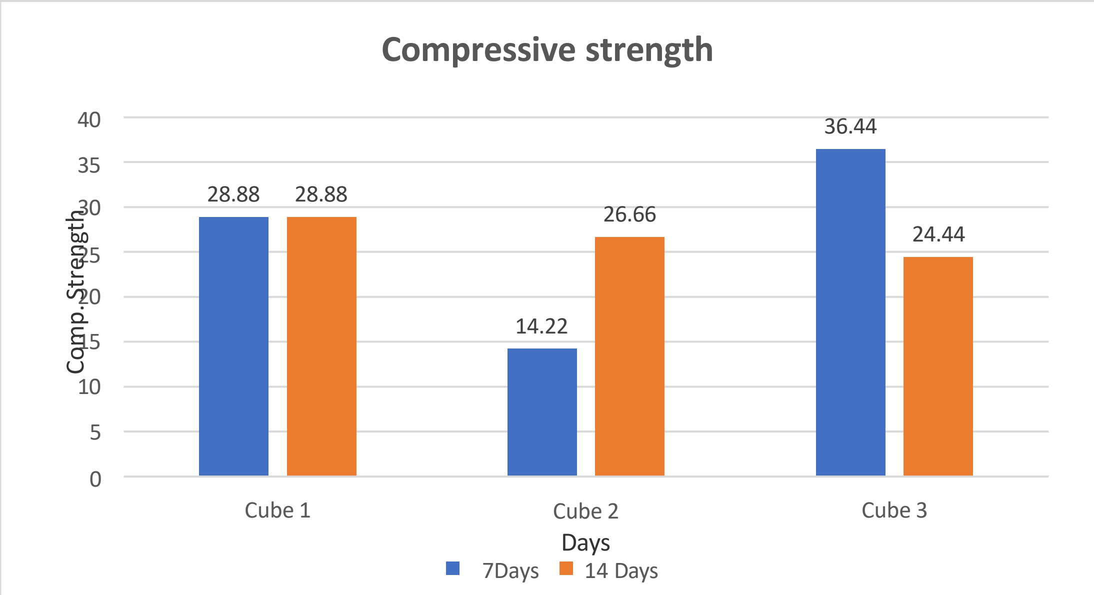

Fig. No.5: 7 Days and 14 Days Compressive strength for 5% replacement.

10% REPLACEMENT OF TILES IN CONCRETE: -

Table no.4: Compressive strength Result at 7Days and 14 Days

Particulars	Cube 1	Cube 2	Cube 3
Normal 7 days	17.77	11.11	11.11
Normal 14 days	20	13.33	11.11

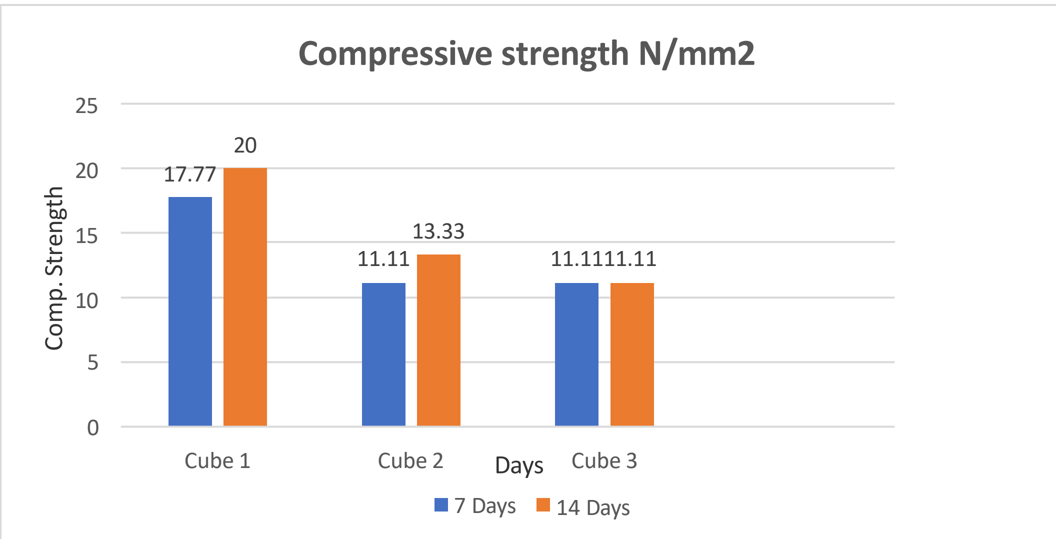

Fig. No.6: 7 Days and 14 Days Compressive strength for 10% replacement.

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- **SPLIT TENSILE STRENGTH:**

	Cube 1	Cube 2	Cube 3
Normal 7 days	6.5	2.5	3.5
Normal 14 days	3	2.82	3.5

Table no.5: Tensile strength Result at 7 Days and 14 Days

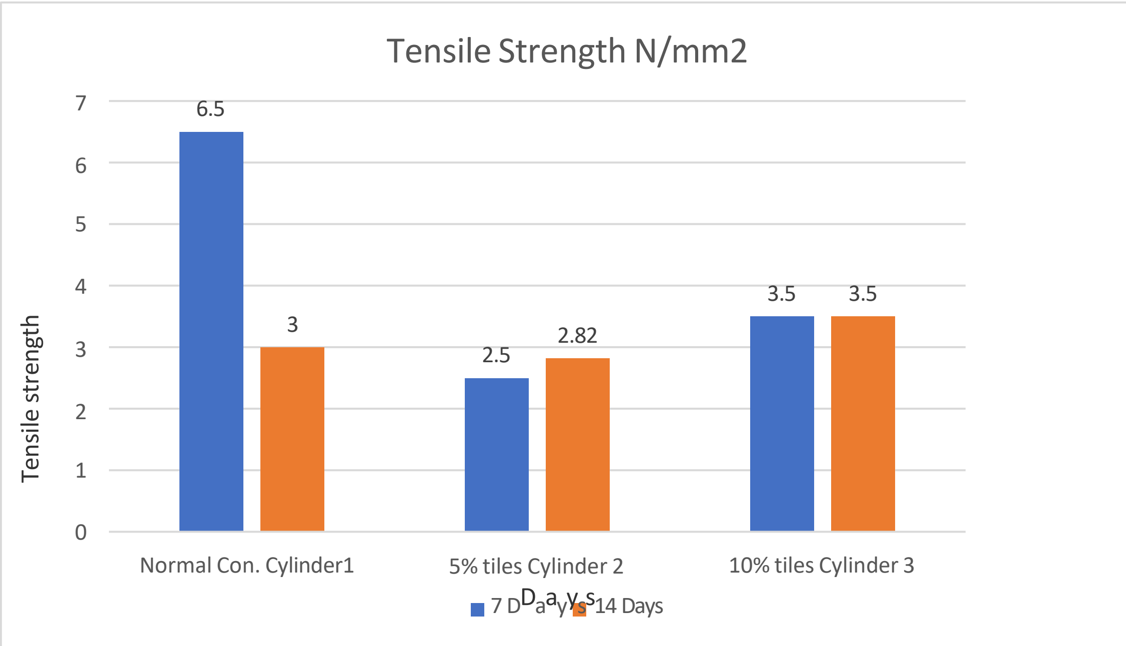

Fig. No.7: 7 Days and 14 Days Spilt Tensile Strength

- **Flexural Strength:**

Table no.6: Flexural strength Result at 14 Days

	Cube 1	Cube 2	Cube 3
Normal 14 days	316.36	600	320

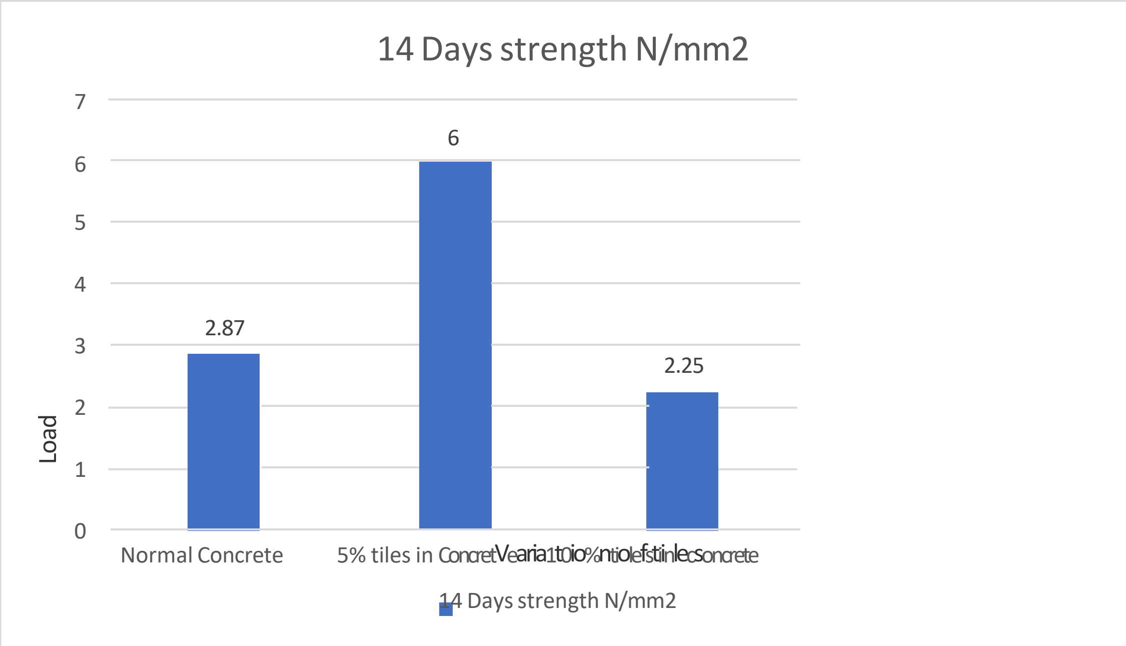

Fig. No.8: 14 Days Flexural Strength of Beam

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IV. CONCLUSION AND FUTURE WORK

A. The concrete mix with 5% ceramic tile and 5% bagasse ash replacement offers an optimal balance between mechanical performance, durability, and sustainability, making it a viable alternative to conventional concrete.

B. While the 10% tile replacement mix enhances environmental benefits, its mechanical properties may limit its use to non-structural applications.

C. The study suggests that incorporating recycled ceramic tiles and bagasse ash in concrete can contribute to the construction industry's sustainability goals, promoting a circular economy and green building practices.

REFERENCES

[1] K. McNeil and T. H.-K. Kang, "Recycled Concrete Aggregates: A Review," *Int. J. Concr. Struct. Mater.*, vol. 7, no. 1, Art. no. 1, Mar. 2013, doi: 10.1007/s40069-013-0032-5.

[2] H. Qasrawi, I. Marie, and H. Tantawi, "Use of recycled concrete rubbles as coarse aggregate in concrete".

[3] N. Sivakumar, S. Muthukumar, V. Sivakumar, D. Gowtham, and V. Muthuraj, "Experimental Studies on High Strength Concrete by using Recycled Coarse Aggregate".

[4] M. T. R. Sonawane and D. S. S. Pimplikar, "Use Of Recycled Aggregate In Concrete," *Int. J. Eng. Res.*, vol. 2, no. 1, 2013.

[5] G. Andreu and E. Miren, "Experimental analysis of properties of high performance recycled aggregate concrete," *Constr. Build. Mater.*, vol. 52, pp. 227–235, Feb. 2014, doi: 10.1016/j.conbuildmat.2013.11.054.

[6] A. U. Maheswari, B. N. Babu, and K. Jagan, "STUDY OF PARTIAL REPLACEMNT OF NATURAL AGGREGATE BY RECYCLED AGGREGATE ON CONCRETE," vol. 9, no. 7, 2021.

[7] Z. Ahmed and S. K. Y. Ali, "Experimental Study on Recycled Concrete Aggregates," vol. 08, no. 04, 2021.

[8] O. A. Qasim, N. Hilal, M. I. Al Biajawi, N. H. Sor, and T. A. Tawfik, "Studying the usability of recycled aggregate to produce new concrete," *J. Eng. Appl. Sci.*, vol. 71, no. 1, p. 129, Dec. 2024, doi: 10.1186/s44147-024-00463-1.

[9] R. Rampit, J. Smith, and I. Ray, "A REVIEW OF RECYCLED CONCRETE AGGREGATES AS A SUSTAINABLE CONSTRUCTION MATERIAL," in *Proceedings of the International Conference on Emerging Trends in Engineering & Technology (IConETech-2020)*, Faculty of Engineering, The University of the West Indies, St. Augustine, 2020, pp. 190–200. doi: 10.47412/DNIZ7049.

[10] K. P. Verian, W. Ashraf, and Y. Cao, "Properties of recycled concrete aggregate and their influence in new concrete production," *Resour. Conserv. Recycl.*, vol. 133, pp. 30–49, Jun. 2018, doi: 10.1016/j.resconrec.2018.02.005.