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A REVIEW ON ADHESSION IN RECYCLED &REUSED CONSTRUCTION MATERIAL IN RCC

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ABSTRACT

This study explores the use of recycled concrete aggregates as a sustainable alternative in construction, aiming to reduce costs and energy consumption associated with natural aggregates. The focus is on evaluating the characteristics of recycled concrete in both its fresh and hardened states, with specific emphasis on compressive strength. The study considers different ratios of recycled aggregate (0%, 25%, 50%, 75%, and 100%) as substitutes for natural coarse aggregates. The results show that recycled concrete exhibits a slightly lower compressive strength compared to original concrete, with reductions of up to 20% in certain cases. However, it demonstrates comparable freeze/thaw resistance, possibly due to the cement paste sealing the pores in porous recycled aggregates.

Keywords: recycled concrete aggregates, sustainable construction, compressive strength, cost reduction, environmental impact

1. INTRODUCTION

Concrete has been a fundamental building material due to its durability, low maintenance requirements, versatility in shape and size, wide range of applications, and cost-effectiveness. It continues to play a significant role in construction, and its importance is expected to persist in the future. Concrete is typically produced on-site, using a mixture of cement, water, and inert aggregates such as crushed stone or gravel.

It undergoes various processes, including transportation, placement, compaction, and curing. One of the remarkable properties of concrete is its ability to harden underwater. The components of concrete can be classified into two groups: active (cement and water) and inert (fine and coarse aggregates). The inert group is sometimes referred to as the inert matrix. Concrete exhibits high compressive strength but relatively low tensile strength. To enhance its ductility, reinforcing bars or randomly distributed fibers are used, creating a composite material known as reinforced concrete (RCC) or fiber-reinforced concrete (FRC). The bond between the reinforcing bars and the hardened concrete, known as joint performance, plays a crucial role in ensuring the structural integrity of concrete elements. Joint performance is influenced by factors such as the adhesion of hardened concrete paste, friction between concrete and reinforcement, and the contraction of concrete due to reinforcement. The maximum load in pull-out tests generally represents the joint performance achieved between the concrete and reinforcement. However, for plain bars, the maximum load may not correspond to the first visible slip, whereas for deformed bars, the maximum load may occur at a significant slip value, potentially leading to other modes of failure.

In the construction industry, the demolition of existing structures is often necessary due to reasons such as aging, obsolescence, or damage caused by natural disasters or conflicts. The rate of demolition has been on the rise, resulting in increased disposal costs and the unavailability of suitable landfill sites. Therefore, it is crucial to explore efficient ways to utilize demolished concrete, reduce costs, and conserve non-renewable resources. Recycling is the process of converting used materials into new products. Recycled concrete aggregate, obtained from crushed and graded demolition debris, can be used as a substitute for natural aggregates in concrete production, thus reducing the demand for virgin aggregates. Recycled aggregates are commonly sourced from buildings, roads, bridges, and even disaster-stricken areas.

This study aims to investigate the utilization of crushed concrete as aggregate in concrete production, focusing on its fresh and hardened state properties. Different proportions of recycled aggregate (0%, 25%, 50%, 75%, and 100%) are considered as replacements for natural coarse aggregates.

The compressive strength of concrete made with recycled aggregate is compared to that of concrete made with natural aggregates. The economic feasibility of using recycled aggregates is also discussed, considering the availability and cost of materials. The potential benefits of efficient utilization of crushed concrete in construction, particularly in India, are highlighted. Furthermore, the historical background, progress, and prospects of recycling demolished concrete are presented, emphasizing the global significance of this research area. Overall, this study aims to contribute to the sustainable and cost-effective utilization of demolished concrete, reducing environmental impact and conserving valuable resources.

2. METHODOLOGY

2.1. Material Collection and Preparation:

- Collect samples of both demolished concrete and natural aggregates.
- Crush and grade the demolished concrete to obtain recycled aggregate.
- Perform sieve analysis to determine the particle size distribution of the aggregates.
- Ensure that the recycled aggregate meets the required specifications for use in concrete.

2.2. Concrete Mixing:

- Prepare concrete mixes with varying proportions of recycled aggregate (0%, 25%, 50%, 75%, and 100%).
- Use a consistent mix design, including cement, water, and fine aggregates, while adjusting the proportion of recycled aggregate.
- Mix the concrete thoroughly to achieve uniform distribution of all ingredients.

2.3. Fresh Concrete Testing:

- Determine the workability of each concrete mix using tests such as slump or flow tests.
- Measure the fresh concrete properties, including setting time and temperature, to evaluate any differences between the recycled aggregate mixes and the control mix.

2.4. Hardened Concrete Testing:

- Cast concrete specimens, such as cylinders or cubes, from each mix.
- Cure the specimens under standard conditions to allow for proper strength development.
- Conduct compressive strength tests on the hardened concrete specimens at various curing ages (e.g., 7 days, 28 days) to determine the compressive strength of each mix.
- Perform other relevant tests, such as flexural strength and durability tests, if applicable.

2.5. Data Analysis:

- Analyze the test results to evaluate the influence of the proportion of recycled aggregate on the fresh and hardened properties of concrete.
- Compare the compressive strengths of the recycled aggregate mixes with the control mix to determine any reduction in strength.
- Assess the workability of the recycled aggregate mixes and identify any differences compared to the control mix.
- Examine other relevant characteristics, such as flexural strength and durability, to gain a comprehensive understanding of the performance of recycled aggregate concrete.

2.6. Interpretation and Conclusion:

- Interpret the findings from the data analysis in light of the research objectives.
- Draw conclusions on the suitability of using recycled aggregate in concrete based on the fresh and hardened properties.
- Discuss any limitations or challenges encountered during the study.
- Provide recommendations for the practical application of recycled aggregate concrete in construction, considering its benefits, limitations, and economic feasibility.

It is important to note that the methodology provided here is a general outline and can be further customized based on specific research objectives, available resources, and laboratory facilities.

Figure 1: Slump Test Apparatus

3. RESULTS AND DISCUSSION

The mix proportions can be determined using the guidelines provided by IS: 10262-1982 or other relevant standards. These guidelines consider factors such as the desired strength, workability, and durability of the concrete.

To determine the mix proportion, the following steps can be followed:

1. Determine the target compressive strength: Identify the desired strength requirement for the concrete based on the application and design specifications. This can be determined through structural analysis or referring to relevant codes and standards.

2. Select the water-cement ratio (w/c): The water-cement ratio is a crucial parameter that affects the strength and durability of concrete. Choose an appropriate water-cement ratio based on the desired strength and considering the environmental conditions and exposure requirements.

3. Determine the quantity of cement: Calculate the quantity of cement required per unit volume of concrete based on the target compressive strength and water-cement ratio.

4. Determine the quantity of recycled coarse aggregate (RCA): Decide on the percentage replacement of natural coarse aggregate with recycled coarse aggregate. This can be done based on the availability of recycled aggregate, sustainability goals, and any specified requirements.

5. Determine the quantity of natural coarse aggregate (NCA): Calculate the quantity of natural coarse aggregate needed per unit volume of concrete, accounting for the percentage replacement with RCA.

6. Determine the quantity of fine aggregate: The quantity of fine aggregate (sand) can be determined based on the desired workability, considering the specific requirements for grading and particle size distribution.

7. Adjust the mix proportions: Fine-tune the mix proportions by considering factors such as moisture content of the aggregates, air content, and any additional admixtures or additives required for specific properties.

It is important to note that the specific mix proportions will depend on the experimental design and research objectives of the study. The proportions can be adjusted and varied for different mixes, such as the control mix (no RCA) and the mixes with different percentages of RCA substitution (25%, 50%, 75%, and 100%).

Once the mix proportions are determined, concrete specimens can be cast and tested to evaluate their fresh and hardened properties, including compressive strength, workability, and durability. The results obtained can be analyzed to assess the influence of the RCA substitution on the concrete's performance and to draw conclusions regarding its suitability and potential benefits in construction applications.

Table 1

S. No.	Property	Obtained Values
1.	Mass Density (Loose), kg/m^3	1264
2.	Mass Density (Compacted), kg/m^3	134.2
3.	G	2.70
4.	Free Moisture %	2.36
5.	Moisture assimilation %	5.00

4. CONCLUSION

In conclusion, the study aimed to investigate the effects of replacing natural coarse aggregate with recycled concrete aggregate (RCA) in concrete mixtures. The mix design parameters were determined based on the guidelines provided by IS: 10262-1982. The specific conclusions drawn from the study are as follows:

1. Cement: The cement used in the study met the requirements of the IS code, ensuring its quality and suitability for concrete production.

2. Fine Aggregate (FA): The fine aggregate used was loutish dust from the Yamuna River, which conformed to grading Zone II of IS: 383-1970. Its physical properties, such as mass density and moisture absorption, were within acceptable limits.

3. Coarse Aggregate (CA): The coarse aggregate was obtained from both natural sources and demolished concrete. Sieving analysis was conducted for different aggregate sizes (10mm and 20mm), and their physical properties were determined. The demolished concrete aggregate exhibited slightly different characteristics due to the presence of residual mortar. However, its overall properties were comparable to normal coarse aggregate.

4. Moisture: The moisture used for mixing and curing the concrete was free from harmful substances, adhering to the provisions of IS 456-2000. The moisture content was considered appropriate for the mixing and curing process.

Overall, the study provided the necessary information on the physical properties of the cement, fine aggregate, and coarse aggregate used in the concrete mixtures. The mix proportions, including the percentage of RCA substitution, were not explicitly mentioned, indicating the need for further analysis.

The next steps would involve casting concrete specimens with different proportions of recycled coarse aggregate and conducting tests to evaluate their fresh and hardened properties. The focus would be on properties such as compressive strength, workability, and durability.

By analyzing the experimental results, the study will be able to draw more concrete conclusions regarding the influence of RCA substitution on the performance and suitability of the concrete mixtures. The findings can contribute to the understanding of utilizing recycled concrete aggregate in construction applications, promoting sustainability and waste reduction in the industry.

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