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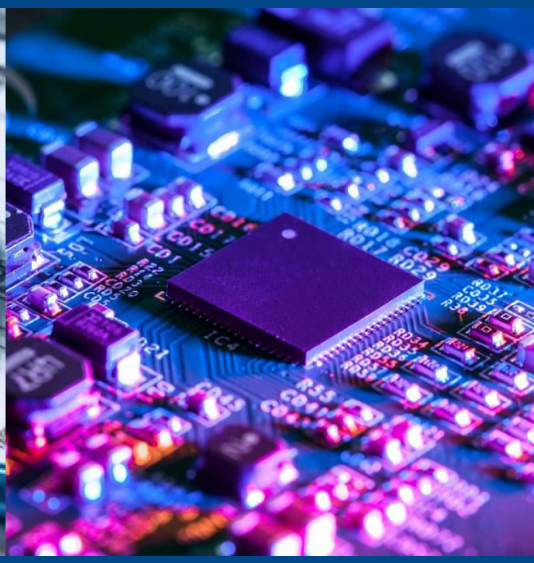

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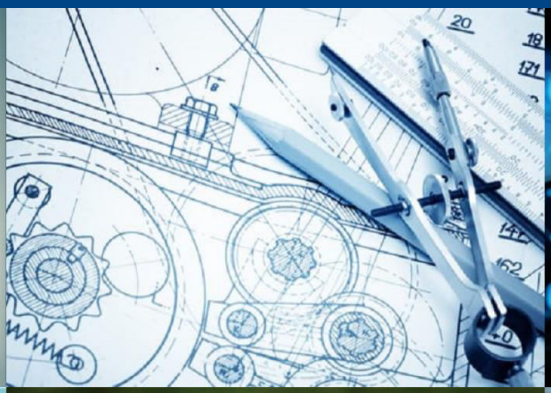

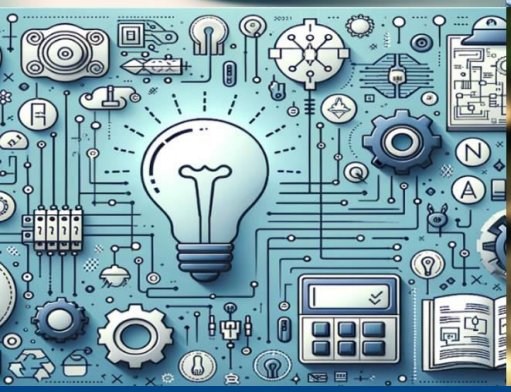

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Experimental Investigation on the Properties of Polymer-Impregnated Recycled Concrete Aggregate

Kiruthiga S[1], Dr. Sathees Kumar P[2], Abbas Ibrahim S[3], Mohamed Suhail S[4], Mohamed Ibrahim A[5], Mohamed Farid M[6]

Assistant Professor, Department of Civil Engineering, Mohamed Sathak Engineering College, Kilakarai, Ramanathapuram, Tamil Nadu, India[1]

Professor& Head of The Department, Department of Civil Engineering, Mohamed Sathak Engineering College, Kilakarai, Ramanathapuram, Tamil Nadu, India[2]

UG Scholar, Department of Civil Engineering, Mohamed Sathak Engineering College, Kilakarai, Ramanathapuram, Tamil Nadu, India[3-6]

ABSTRACT: This study investigates the mechanical and durability properties of conventional coarse aggregate (CCA), recycled concrete aggregate (RCA), and polymer impregnated RCA (PIRCA). Styrene-acrylate polymer was used to treat RCA at 10% and 20% concentrations. Concrete was prepared with 25% replacement of natural aggregate using RCA and PIRCA. Test results show that RCA has higher water absorption and lower strength compared to conventional aggregate. However, polymer treatment improves the properties of RCA. The 25% PIRCA concrete shows better workability, increased compressive strength, and reduced chloride permeability compared to normal RCA concrete. Overall, polymer impregnation enhances the performance of recycled aggregate and makes it suitable for concrete applications

KEYWORDS: Recycled Concrete Aggregate (RCA),Sustainable Construction, Compressive Strength, Durability

I. INTRODUCTION

The rapid growth of construction activities has led to excessive consumption of natural resources and generation of large quantities of construction and demolition waste. Recycled Concrete Aggregate (RCA) has emerged as a sustainable alternative to natural aggregates, helping to reduce environmental impact and conserve resources. However, the use of RCA often results in reduced strength and durability due to the presence of adhered mortar and higher porosity. To overcome these limitations, polymer modification techniques have been introduced. Polymer impregnation, particularly using materials such as styrene acrylate polymer, improves the bonding characteristics and reduces water absorption in recycled aggregates. This leads to enhanced mechanical properties and durability of concrete.

II. SCOPE OF THE STUDY

- This study is limited to the preparation and testing of concrete using polymer-impregnated recycled concrete aggregates.
- The work includes material collection, mix preparation, and testing of basic properties such as compressive strength.
- The study mainly focuses on strength and durability aspects under controlled laboratory conditions.
- Advanced testing and large-scale field applications are not considered within the scope of this project.

III. AUTHOR

Safiuddin et. al: Have studied the utilization of recycled concrete aggregate (RCA) in concrete production has emerged as a promising avenue for sustainable construction practices. They have provided a comprehensive overview of the current state-of-the-art research on the use of RCA in concrete mixtures. Various aspects of incorporating RCA into

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concrete, including its influence on fresh and hardened properties, environmental impacts, economic considerations, and durability performance, are critically examined.

Mehran Shirani et. al :Have investigated the optimum mix design of recycled concrete based on the fresh and hardened properties of concrete. Various proportions of RCA replacement are examined to evaluate their impact on properties such as workability, compressive strength, durability, and shrinkage. Experimental results are analyzed to determine the optimal combination of ingredients that achieve desired performance while maximizing the utilization of recycled materials.

Katrina McNeil et. al:Have presented a comprehensive review of recycled concrete aggregates (RCAs), focusing on their production, properties, and applications. Recycled concrete aggregates are increasingly being utilized as a sustainable alternative to natural aggregates in various construction projects. The review covers the processes involved in producing RCAs, including collection, sorting, crushing, and quality control measures. It examines the physical, mechanical, and durability properties of RCAs and compares them with those of conventional aggregates.

Jingwei Ying et. al:Have investigated the influence of parent concrete properties on the compressive strength and chloride diffusion coefficient of concrete incorporating strengthened recycled aggregates (SRA). The use of recycled aggregates in concrete production presents opportunities for sustainable construction practices, but variations in parent concrete properties can impact the performance of recycled materials. Strengthening techniques, such as mechanical processing or chemical treatments, are employed to improve the quality of recycled aggregates and enhance their suitability for structural applications. This study systematically examines the relationship between the properties of parent concrete and the performance of concrete containing SRA.

Valerie Spaeth et. al:Have investigated the enhancement of recycled concrete aggregate (RCA) properties through polymer treatments. With the growing demand for sustainable construction materials, the utilization of RCA has gained attention for reducing environmental impact and conserving natural resources. However, RCA often exhibits inferior properties compared to natural aggregates, including higher porosity, lower strength, and increased water absorption. Polymer treatments offer a potential solution to mitigate these deficiencies by modifying the surface properties and enhancing the mechanical and durability characteristics of RCA. This study systematically examines various polymer types, application methods, and dosage levels to optimize the effectiveness of treatments in improving RCA properties.

IV. OBJECTIVES

- To study the properties of recycled concrete aggregates (RCA).
- To investigate the effect of polymer impregnation on RCA.
- To evaluate the mechanical properties of concrete made with polymer-modified RCA.
- To compare the performance with conventional concrete.

V. MATERIALS AND METHODLOGY 5.1MATERIAL

5.1.1Cement

Cement is the critical binder that helps hold everything together. It is a powder made from calcined limestone and clay. Cement has two setting stages: initial setting (30-45 minutes) and final setting (6-10 hours). These times ensure sufficient working time and proper hardening for construction.

5.1.2Water

Water reacts with cement to initiate a chemical reaction called hydration. The hydration reaction leads to the hardening and setting of the concrete. The appropriate water-to-cement ratio is crucial for achieving the desired strength and durability of the final product.

5.1.3Fine aggregate

Fine aggregate is the filler for the voids in the coarse aggregate one of the main Ingredient in concrete. Fine aggregate can hold moisture in three forms: surface, absorbed, or free water. This property impacts the water-cement ratio and

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workability. Fine aggregates should have a rounded or angular shape and smooth texture for better workability and bonding in concrete.

5.1.4 Coarse aggregate

Coarse aggregates are typically used in coarser concrete mixes, while fine aggregates are used in finer mixes. Coarse aggregate is less expensive than cement. By forming a large part of the concrete volume, it reduces the overall cost of the mix. In pavements and other high-wear applications, coarse aggregate provides resistance to abrasion and impact, extending the service life of the structure.

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5.1.5 Recycled Concrete Aggregate

Obtained from demolished concrete, cleaned and sieved to required size.

5.1.6 Polymer

Styrene acrylate polymer used for impregnation of RCA to improve its properties.

5.2 METHODOLOGY

In the present study, M30 grade with nominal mix as per IS10262:2019 was used. Concrete mix proportion by weight for 1m3 and water cement ratio of 0.5. Table 1.Gives the mix used for study

Table 1: Mix proportion

S.NO	Cement	Water	Fine aggregate	Coarse aggregate
Normal concrete	1	0.5	0.75	1.5
Recycled concrete	1	0.5	1.9	3

5.2.2 CASTING AND TESTING

RCA was added in concrete in step of (25%) The percentage of partially replacement are arrived with trial study using RCA. For each percent of RCA partially replacement as coarse aggregate, cubes, were casted. Final strength of cubes, are tested for 7days and 28 days curing. The average compressive strength, are then determined for each mix proportion and discussed in the result and discussion.

VI. RESULT AND DISCUSSION

The cube specimens are tested for compressive strength at the end of 7days and 28days.

fc = P / A N / mm2

The results of the compressive strength tests on concrete cubes are shown in Table 2

S.No	Types of specimen	Compressive strength (Mpa)				Types of failure
		T1	T2	T3	Average	
1	CCA	26.81	29.43	30.10	28.78	Crushing failure
2	RCA	28.48	29.53	27.47	28.51	
3	25%PI10RCA	29.31	30.55	29.15	29.67	
4	25%PI20RCA	30.14	31.51	30.83	30.83	

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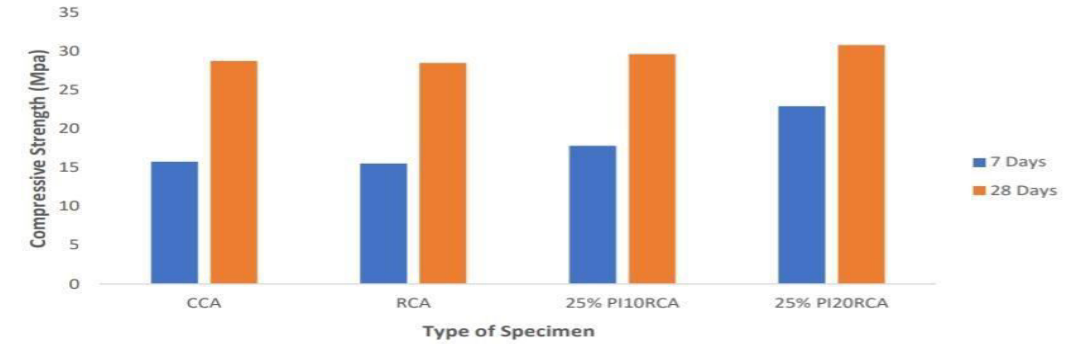

VII. CONCLUSION

- The mechanical properties of CCA, RCA and PIRCA were conducted as per IS 2386
- The RCA offered significant increase in impact value (54%), crushing value (25%); and appreciable increase in water absorption (7-fold), abrasion value (11%) as compared to CCA. The RCA as such did not comply with all mandatory provisions of IS 2386.
- The polymer impregnation of RCA exhibits marginally improved mechanical properties, and improvement is more with increase in dosage of polymer.
- The usage 25% RCA in CCA increased the water absorption, crushing value, impact strength and abrasion value marginally (up to 10%) as compared to CCA.
- The usage of 25% PIRCA (20% w/w styrene acrylate co-polymer) in CCA offered improved water absorption and mechanical properties and satisfy the provisions of IS 2386.
- The flow test results revealed optimum flow (60%) at minimum water cement ratio for PI20RCA aggregate incorporated concrete (25%) as compared to conventional RCA.
- The compressive strength test results exhibit significantly improved 7-day strength for 25% PI20RCA concrete (up to 45%) as compared to control concrete (CCA). The 28-day strength reveal marginal improvement in compressive strength of the order of 7% as compared to control concrete.

REFERENCES

1. ASTM C1202-19: Standard test method for electrical indication of concrete's ability to resist chloride ion penetration. American Society for Testing and Materials. ASTM International.
2. ASTM C1585-20: Standard test method for measurement of rate of absorption of water by hydraulic-cement concretes. American Society for Testing and Materials. ASTM International.
3. Choong, Wee Kang & Lau, Teck & Sin, Choon & Ali Mohamed, Abdullahi. (2013). Effects of Recycled Aggregates on Water-Cement Ratio for Concrete. Applied Mechanics and Materials. vol. 423-426. pg. 1010-1013.
4. Ding, Yangfei & She, Anming & Yao, Wu. (2023). Investigation of Water Absorption Behavior of Recycled Aggregates and its Effect on Concrete Strength. Materials, vol. 16, pg 4505.
5. IS 1199 - (1959): Methods of sampling and analysis of concrete, Bureau of Indian Standards, New Delhi

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