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Study on Properties of Recycled Aggregate Concrete by New Combination Method

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Abstract - *This paper present a new methodology of combination between Recycled Aggregate (RA) and Natural Aggregate (NA) in concrete for the purposes of improving the quality of Recycled Aggregate Concrete (RAC). Aggregate occupies 70–80% of the volume of concrete, and plays an important role in deciding properties of concrete. Coarse aggregate forms the matrix of particles as a main frame bearing the load in concrete structure. The volume of void among coarse aggregate particles is filled up by fine aggregates and cement paste, which affects the density, the amount of cement mortar and performance of concrete. The current aggregate combination method in RAC based on the replacement percentage of the entire of coarse aggregate mixture including all particle sizes in coarse aggregate particles or fine aggregate combined with all particle sizes of NA. Nonetheless, in this new method, replace only large size of RA particle by NA in coarse aggregates. This study investigated mechanical properties of RAC by using new methodology at different sieves such as 5.6mm, 6.7mm and 7.78mm sieves and comparing with conventional mix contain 100% RCA. New methodology enhanced significantly mechanical properties of RAC comparing to conventional mix.*

Key Words: **Recycled aggregate concrete, recycled coarse aggregate, new combination method, conventional mix, mechanical properties**

1. INTRODUCTION

With the high speed of economic growth, nowadays, most countries have been investing a huge amount of budget into constructing infrastructures, which leads to the fact that the demands of construction materials such as concrete have been increasing significantly. Concrete is the major construction material and plays a crucial role in the improvement of infrastructures such as highways, bridges, buildings etc. It is estimated that the total annual consumption concrete production on over the world is more than 10 billion tons. Besides, natural material for concrete is dwindling sharply due to the exploitation activities of human. Furthermore, the amount of Construction and Demolition Waste (CDW) has been raising considerably in the past decades, because a huge number of building and infrastructures has reached the end of service life, destroyed by natural disasters and wars. The recycled aggregate are composed of natural aggregate and mortar adhered (generally referred to as Attached Mortar, (AM)) to the grains. Thus, the recycled aggregate differ from natural aggregates mainly due to the presence of the AM: this results in higher porosity and hence higher water absorption for recycled aggregate.

2. MATERIALS USED

2.1 Cement

Ordinary Portland Cement (53 grade) confirming to IS: 12269-1987 was used for all the concrete mixtures. The tests were conducted according to IS 4031-1988.The physical properties are given in Table 1.

Table -1: Physical Properties of Cement

Sl. No.	Properties	Recommended Value	Value
1	Specific gravity	3.10 to 3.16 [15]	3.122
2	Standard consistency	26-33 [16]	33 %
3	Initial setting time (in minutes)	Not less than 30 [17]	88
4	Final setting time (in minutes)	Not greater than 600 minutes [17]	289

2.2 Fine Aggregate

Natural fine aggregate used is Manufactured sand. Fine aggregate under saturated surface dry condition was used for casting. It was graded as per the codal provisions. The properties are given in Table 2.

Table -2: Physical Properties of Fine Aggregate

SI No	Properties	Recommended Value	Test Results
1	Water absorption	0.1 to 2 [18]	1.3%
2	Specific gravity	2.6 to 2.8 [19]	2.68

2.3 Natural Coarse Aggregate

The maximum size of coarse aggregate used in the concrete mixture is 20mm.Tests were conducted according to IS 2386 – 1963. Physical properties are given in Table 3.

Table -3: Physical Properties of Natural Coarse Aggregate

Sl No	Properties	Recommended Value	Test Results
1	Water absorption	0.1 to 2 [18]	0.59%
2	Specific gravity	2.6 to 2.8 [19]	2.694

2.4 Recycled Coarse Aggregate

Recycled coarse aggregate of 20 mm size is used for the study. Recycled aggregate was obtained from the crushed remain of old building. Physical properties are given in Table 4.

Table -4: Physical Properties of Recycled Coarse Aggregate

SI No	Properties	Test Results
1	Water absorption	0.73%
2	Specific gravity	2.64

2.5 Water

Portable water which is available at the laboratory premises was used for mixing of concrete ingredients. Water from sources like industrial plants, sewage and other contaminated should not used for concrete making.

3. PREPARATION OF TESTED SPECIMEN

The mixtures were cast in 150×150×150mm steel cube moulds, 150×300mm cylinder moulds and 100×100×500mm beam moulds. For each mix 3 cubes, 6 cylinders and 3 beams were cast. The aggregates were used in surface dry condition and the specimens were subjected to water curing for a period of 7, 28 and 56 days. Table 5 shows the mix designation.

Table -5: Mix Designation

Mix Designation	Description
S0	Mix with 100% RA as coarse aggregate
S1	73% of NCA retained over 7.78mm sieve and 27% of RCA passed 7.78mm sieve
S2	77% of NCA retained over 6.7mm sieve and 23% of RCA passed 6.7mm sieve
S3	83% of NCA retained over 5.6mm sieve and 17% of RCA passed 5.6mm sieve

4. TEST RESULTS

4.1 Compressive Cube Strength

Compressive strength of concrete cubes for each mix was determined. Compressive cube strength of sample are shown in Fig. 1.

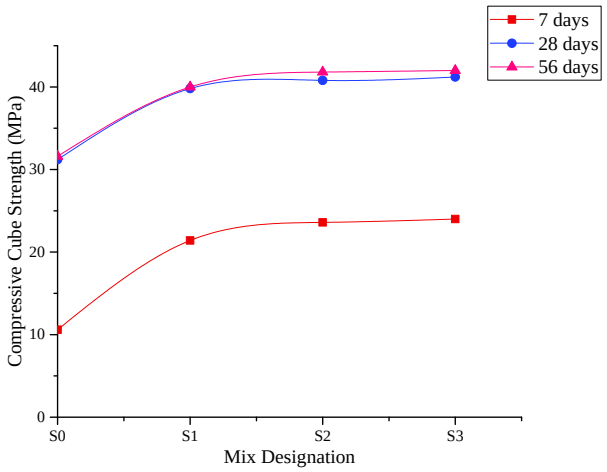

Fig -1: Compressive Cube Strength Vs Mix Designation

4.2 Flexural Strength

The aim of flexural strength is used to estimate the load at which the concrete members may crack as it is difficult to determine the tensile strength of concrete by conducting a direct tension test. Flexural strength result of sample are shown in Fig. 2

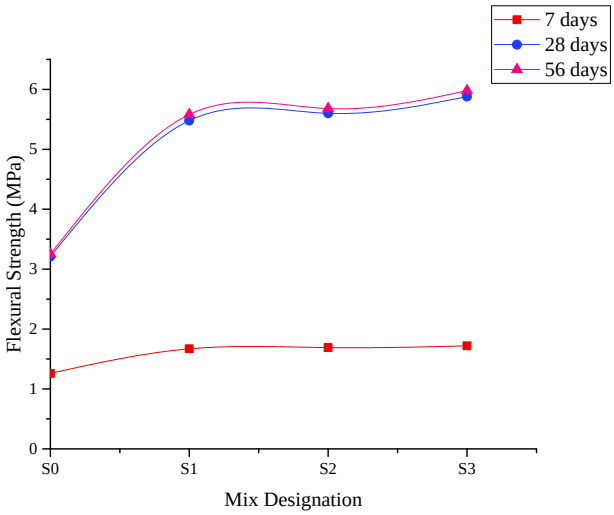

Fig -2: Flexural Strength Vs Mix Designation

4.3 Split Tensile Strength

Splitting test is an indirect test used for determining the tensile strength of concrete. Split tensile strength result of sample are shown in Fig. 3.

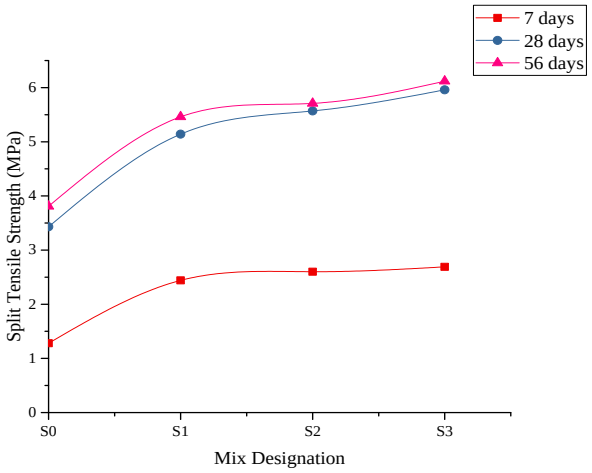

Fig -3: Split Tensile Strength Vs Mix Designation

4.4 Shear Strength

Shear strength result of sample are shown in Fig. 4

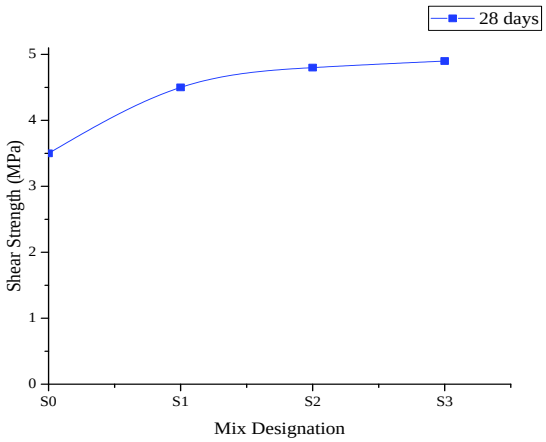

Fig -4: Shear Strength Vs Mix Designation

4.5 Modulus of Elasticity

Modulus of elasticity result of sample are shown in Fig. 5.

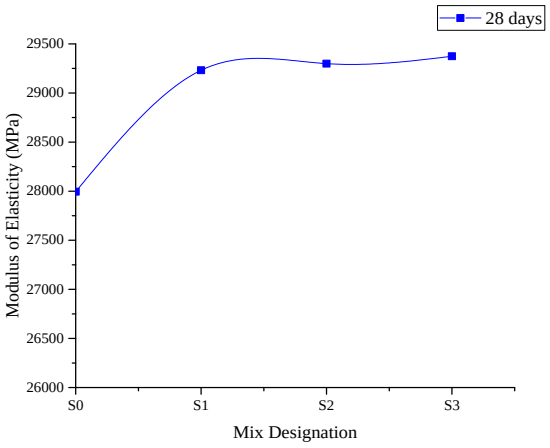

Fig -5: Modulus of Elasticity Vs Mix Designation

5. CONCLUSION

The improvement of quality of RAC by using the new combination method proposed in this study was investigated. In order to evaluate the effectiveness of the new method, this paper investigated the mechanical properties of recycled aggregate concrete according to new combination methods. From the experimental results, the important conclusions are summarized as follows:

- New combination method improves significantly the mechanical properties of RAC.
- The RA contents affected the compressive strength of RAC. The compressive strength of RAC decreased with increasing the RA content.
- The compressive strength of different mixes in new combination method significantly varied with conventional mix. It might be due to only large size of RA replaced by NA in coarse aggregate.
- RA filled up the voids between strong frames of natural aggregate and the rough surface texture and absorption capacity of the old mortar, which gives a favourable condition for improve bonding and interlocking between cement paste and RA.
- The compressive strength of RAC using the new method is relatively equal to that of NA concrete This should be explained that the use of large aggregate size in coarse aggregate blend are natural aggregates which created a stronger form for concrete structure.
- This reduction in split compressive strength, flexural strength, tensile strength, and shear strength in conventional mix is due to the decrease in adhesive strength between the RA and the cement binder.

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