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Study on Mechanical Properties of Binary Blended Recycled Aggregate Concrete Using Rice Husk Ash

Shaista Begum[1], D. Rupesh Kumar[2], Sidra Khan[3]

[1]AsscociateProfessor, [3]M.E Scholar, Civil Engineering, Deccan College of Engineering and Technology, Darussalam, Hyderabad, 500001, TS, India.

[2]AsscociateProfessor, Civil Engineering, College of Engineering, Osmania University, Hyderabad, TS, India.

[1]ershaistaw@gmail.com, [2]rkdhondy@gmail.com, [3]sidrah9225@gmail.com

***Abstract*—The present experimental investigation is conducted to study the mechanical properties of binary blended recycled aggregate concrete using rice husk ash having a particle size of about 45µ replaced with ordinary Portland cement. The experiment was conducted in three stages. In the first stage the properties such as compressive strength, split tensile strength and workability of the natural coarse aggregate were found. In the second stage properties of partially (5%,10%,15%,20%,25%,30%) and 100% replaced NCA with RCA were determined and found to be 30% less than conventional concrete at 100% replacement. This reduction was due to excess water absorption by RCA and weak interfacial Transition zone which results in lower workability. In the last stage with the aim to overcome above deficiencies of RAC with 100% RCA, Rice Husk Ash was used as the partial replacement of OPC (5%, 10%, 15%, 20%, and 25%) along with super plasticizer of about 0.8% of weight of binding material. The fresh and harden concrete properties were analyzed after 28 days of curing and found that at 10% replacement of OPC with RHA along with super plasticizer was optimum and gave compressive strength of 40.0 N/mm2 which is very near to the strength of conventional concrete i.e., 39N/mm2 .Similarly the split tensile strength of BBRAC mixes was found to be nearly equal to NAC.The workability of BBRAC mix with 100% RCA was found to be 53% more compare to NAC mix after addition of super plasticizer**.

***Keywords*—Recycled aggregate, Ricehuskash, Binary blended, Natural aggregate, Super Plasticizer.**

I. Introduction

One of the feasible alternative is to reuse construction and demolition waste as aggregates called recycled aggregate to make new concrete called recycled aggregate concrete (RAC). The main problem preventing a broader application of RAC is the poorquality of RAC comparing to the conventional concrete. This inferiority is due to the

coating of old cement mortar to the recycled aggregate. Approximately 20% of cement mortar is attached to 20mm to 30mm size aggregate particles as per the investigations made by Building Contractors Society of Japan [1].

Specific gravity of recycled aggregate was found to be 4.5% to 7.6% less when compared with specific gravity of natural aggregateas per the investigations carried by Hansen and Narud [2] and Fathei Ramdan [3]in their investigation. As per the studies of Bhikshma, V. Kishore, R.[4] and Sherif Yehia, Kareem Helal and Anaam Abusharkh[5], the rough and porous surface texture leads to excess water absorption by recycled aggregate thus leading to higher water cement ratio. Less W/C ratio and addition of super plasticizer can improve the ITZ of recycled aggregate concrete. Treatment of the recycled aggregate concrete by impregnation of silica fume solution and by ultrasonic cleaning results in the good bonding between the new cement matrix and the recycled aggregate [6].Recycled Aggregate concrete can be an economic and useful in construction. In this present study the attempts have been made to regain the strength of Recycled Aggregate Concrete by using mineral and chemical admixtures. The rice husk ash formed under the controlled burning temperature of about 500°C to 700°C having a particle size of about 45µ is replaced with ordinary Portland cement to enhance the packing/density of the mix because of its extreme fineness. Chemical admixture i.e., super plasticizer of about 0.8% of weight of binding material is used you improve its workability. Grading, Specific gravity test and water absorption tests are conducted on fine aggregate and recycled

Aggregates.LosAngeles test is also performed to find recycled aggregate's resistance to abrasion. Compression tests, Split tensile strength tests and workability tests are conducted [7, 8].

II. Experimental Investigations

The following materials are used for the casting of specimens.

Cement: Ordinary Portland cement of 53 Grade from Ultra Tech conforming to I.S: 12269([9] is used.

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Fine Aggregate: River sand locally available is used conforming to I.S: 383[10].

Recycled coarse aggregate: The RCA of 20mm maximum size of angular shape obtained from local demolished structure in Hyderabad is used.

Water: Locally available portable water was used for mixing and curing which is portable and free from injurious substances that may be deleterious to concrete or steel.

Rice husk ash: Rice husk ash used in the present investigation is collected from the brick kiln located at the outskirts of Hyderabad which was under controlled burning of around 600-700°C and the particle of RHA is below 45 micron and specific gravity is 2.3.

Super plasticizer: A high range water reducing Polycarboxylate based super plasticizer (sodium naphthalene formaldehyde) supplied by BASF with relative density 1.10 was used.

III. METHODOLOGY

The properties of cement such as normal consistency, specific gravity, fineness etc., and the properties of fine aggregates, natural coarse and recycled coarse aggregates like specific gravity, grain size, and water absorption are determined using the suitable test procedures. The details of the M30 grade Concrete mix used are tabulated in Table I is arrived at as per IS: 10262[11]. Workability test on concrete with different water-cement ratio is carried out. Concrete cubes of size 150 x 150 x 150 mm are casted in standard as per obtained mix proportions for determining the compressive strength and cylinders of diameter 150mm and height 300mm for cylindrical specimen casted for determining the split tensile strength, cured and tested following standard procedures.

IV. DISCUSSION OF RESULTS

The tabulated results of compressive strength, split tensile strength and workability of binary blended recycled aggregate concrete specimens with5%,10%,15%,20%,25%,30% and 100% RCA replaced with natural aggregate and specimens with 5%, 10%, 15%, 20%, 25% RHA replaced with OPC are shown in figures 1 to 7.

In the first stage it can be clearly noticed (Figure1& Figure 2) that as the percentage replacement of natural coarse aggregate with RCA in the concrete increase, the compressive strength is decreasing.

Compressive strength of concrete with 100% recycled aggregate is found as 28 N/mm^2 and split tensile strength is found to be 3.68 N/mm^2. This is because the residual cement paste on surface of recycled coarse aggregate absorbs the water and make the concrete less workable and the another reason of this is weak interfacial transition zone between the surface of coarse aggregate and new cement paste which eventually decreases the compressive strength and split tensile strength of concrete.

In the second stage in the same 100%recycled aggregate concrete, OPC is replaced with RHA in different percentages. From figure3 it is seen that there is an increase in the compressive strength up to 10% replacement of OPC with RHA after that the replacement didn't show any positive results. This might be because rice husk ash particles will have greater surface area, the surface of Rice husk ash particle absorbs the available free water and make the concrete less workable and hence the reduction in compressive strength was noticed beyond 10% replacement of OPC with RHA.

The split tensile strength decreased from3.85 N/mm^2 to 2.88 N/mm^2 on replacing the natural aggregate with 100% recycled aggregate (Figure2). This is because the residual cement paste on surface of recycled coarse aggregate absorbs the water and make the concrete less workable and the another reason of this is weak interfacial transition zone between the surface of coarse aggregate and new cement paste which eventually decreases the split tensile strength of concrete.

When OPC was replaced with RHA in different percentages, it is observed in figure 4 that there is an increase in the split tensile strength up to 10% replacement of OPC with RHA after that the replacement didn't show any positive results because of greater surface area of rice husk ash particles. Rice husk ash particle absorbs the

available free water and make the concrete less workable and hence the reduction in split tensile strength was noticed beyond 10% replacement of OPC with RHA.

The workability which was the major concern of recycled aggregate concrete for a fixed water cement ratio is found to be maximum (Figure 5) for binary blended recycled aggregate concrete with 10% rice husk ash and 0.8% by weight of cement.

The details of the M30 Concrete mix used are given in TABLE I is arrived at as per I.S: 10262[11].

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TABLE I
QUANTITY OF MATERIALS FOR GRADE M30

S.No.	Material (kg/m^3)	Quality of material in (kg)
1.	Cement	350
2.	Rice Husk Ash	0
3.	Water	158
4.	Fine Aggregate	850
5.	Coarse Aggregate	1130
6.	Super Plasticizer	0.8% by weight of cement
7.	Water Cement Ratio (W/C)	0.45
9.	Workability	75-100 mm

Cement: Fine aggregate: Coarse aggregate is 1:2.42:3.21 with water-cement ratio 0.42.

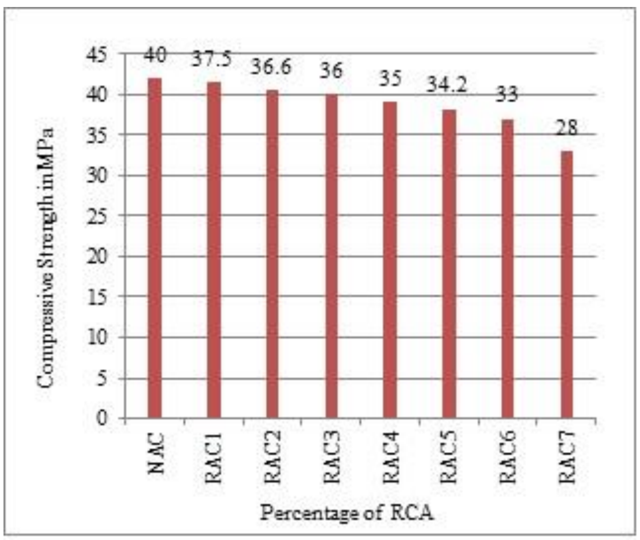

Figure 1 Variation of Compressive Strength With Respect To Percentage Replacement of NCA with RCA

Figure 1 shows that the compressive strength of M30 grade recycled aggregate concrete is reduced with the increase in the percentage of replacement of recycled aggregate. On 100% replacementof natural aggregate, the compressive strength is reduced by 30.0%.

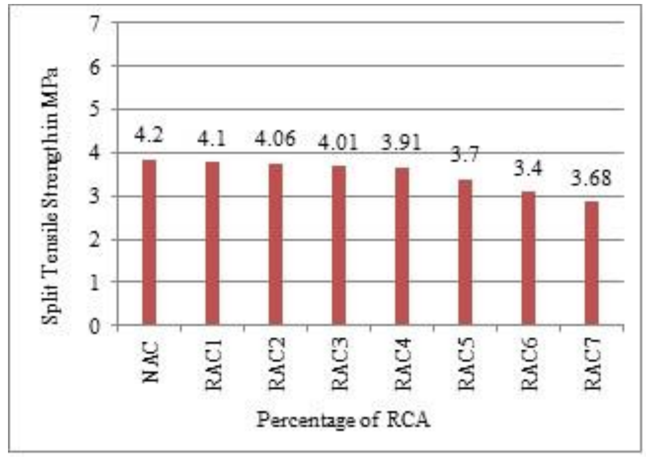

Figure 2: Variation of Split Tensile Strength with Respect to Percentage Replacement of NCA with RCA

Figure 2 shows that the split tensile strength of M30grade recycled aggregate concrete is decreased with the increase in the percentage of replacement of recycled aggregate. On 100% replacement of natural aggregate, split tensile strength is reduced by 12.38%.

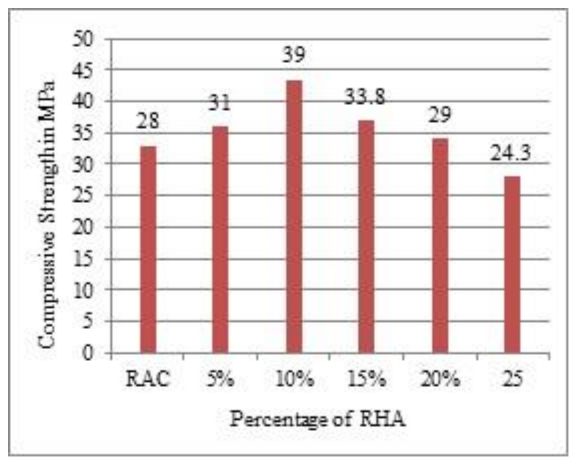

Figure 3 Variation of Compressive Strength with Respect to Percentage Replacement to OPC with RHA

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Figure 3 shows the increase in the compressive strength of 100% recycled aggregate concrete. The increase is 39.28% on replacement of 10% OPC with rice husk ash.

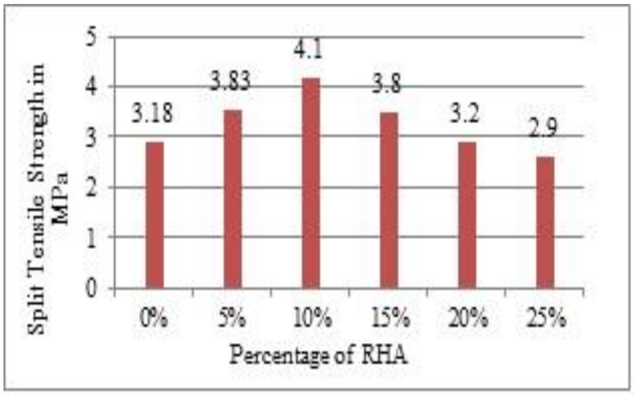

Figure 4 Variation of Split Tensile Strength With Respect To Percentage Replacement of OPC with RHA.

Figure 4 shows that the split tensile strength of 100% recycled aggregate concrete is increased by 38.36% on replacement of 10%OPC with rice husk ash.

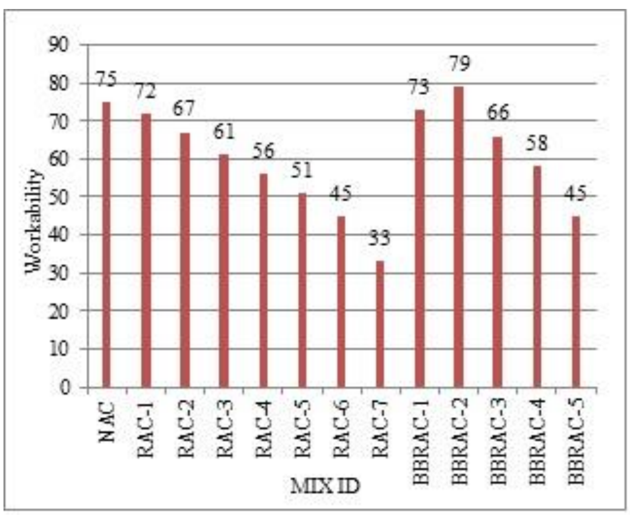

Figure 5 Variation of Workability in OPCC, RAC, BBRAC in terms Of Slump

In Figure 5 it can be observed that by adding super plasticizer equal to 0.8% of weight of cement, the workability of recycled aggregate concrete of M30 grade is increased by139.0%.

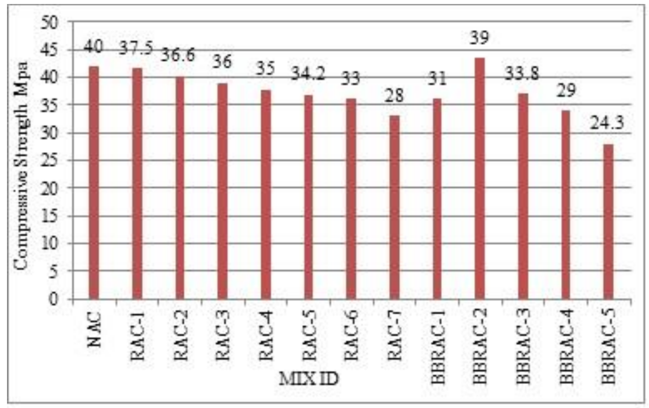

Figure 6 Variation of Compressive Strength in OPCC, RAC and BBRAC

Figure 6 shows that BBRAC-2 concrete with 100%recycled aggregate, 10% rice husk ash replaced with OPC and a suitable amount of super plasticizer has increased the compressive strength of RAC. Only a small difference of 2.50% is found between RAC and NAC.

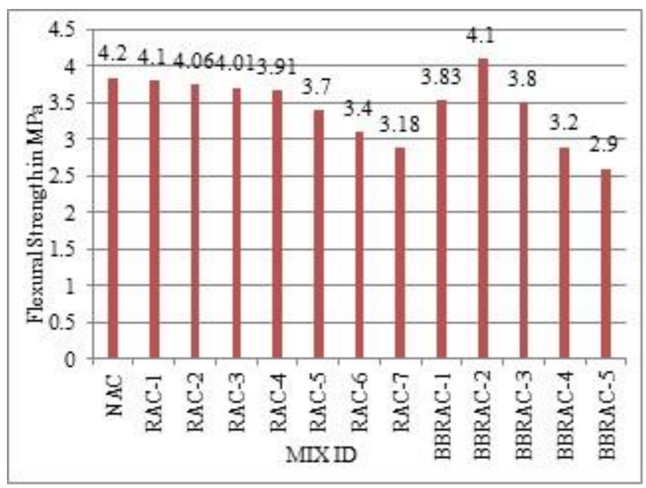

Figure 7 Variation of Split Tensile Strength in OPCC, RAC, and BBRAC

Figure 7 shows that BBRAC-2 concrete with 100%recycled aggregate, 10% rice husk ash replaced with OPC and a suitable amount of super plasticizer has increased the split tensile strength and it is only 2.38%less compared to NAC.

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V. CONCLUSIONS

1. The compressive strength and split tensile strength of 100% replaced M30 grade RAC is found to be 30% and 12.38% less when compared to M30 grade conventional mix.
2. The compressive strength and split tensile strength of binary blended recycled aggregate concrete(BBRAC) mix was found to be 39.28% and 38.36% more when compared to RAC with 100% recycled aggregate.
3. The workability of BBRAC was found to increase by 139% after addition of super plasticizer when compare to RAC with 100% recycled aggregate.

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