An Experimental Study Of The Utilization Of Recycled Aggregate Towards Enhancing Construction And Demolition Waste Management In Construction Projects

R. Rema[a], R.Remya[b]

[a]Corresponding author,Research scholar, Department of Civil Engineering, Noorul Islam University, TN, India.

[b]Assiatant professor, Dr.NGP institute of Technology, TN, India

Abstract:

Construction and Demolition Waste were normally disposed into landfills and in low lying areas and seems to be gradually engaged in construction. According to various researchers, it has been suggested that 90% of the C&DW composition can be recycled and reused as secondary materials. The purpose of this paper is to highlights the performance of C&D based recycled aggregate in SCC to enhance waste management on construction sites. The experimental study conducted with recycled coarse aggregate from C&D concrete waste as an effective replacement for regular coarse aggregate in SCC and the results compared to mix controls. Initially determine the physical properties of materials used in concrete mixture. Later Investigate the appropriate workability and resistance to segregation, passing capacity and filling capacity have been demonstrated by slump flow test, L box test and sieve segregation test. Finally, determine the mechanical properties are such as compressive, split tensile and flexural strength. The result shows that through incorporating the use of recycled aggregate fresh properties with or without recycled, aggregate is nearly identical, but the mechanical properties were minimized due to poor adhesion between the old mortar and the aggregate. So, it was concluded that the 50% of RCA replacement would be better strength of SCC mix and was used for different constructive elements. These findings open-up the possibility of using RCA in SCC preparation in an area where the natural aggregate is rare and expensive. The use of recycled aggregate will achieve cost reductions and environment friendly.

Keywords: *Re-use of recycled aggregate, Construction and Demolition Waste, Concretes, Construction Project, Strength, Durability, Workability & Management*

1. Introduction

According to the "Ministry of Environment Forest & Climate Change 2016", the building materials, residue & rubble are considered the construction and demolition waste system. C&DW is created by reconstruction or redesign of the structure during new construction. C&DW will raise the rapid growth from time to time in the Republic of India. Therefore, the C&DWM will also be examined to determine the solution for C&DW. Inert and non-inert materials listed in C&DW. Such kinds of C&DW are not appropriate for land recovery and are disposed of at landfills or fly-tips. Landfilling and fly-tipping are India's traditional practices. Because of this pattern recycling is now called a "C&DWM technique". Private agencies have established C&D recycling plants at various locations to distinguish C&D waste for recycling or other reuse initiatives. Based on the recycling concepts, various research works was carried out. From that it is clearly identified the recycled aggregates from waste concrete is more angular and have higher absorption & specific gravity than natural rough aggregates, resulting in increased strength and improved load-bearing capacity. Admixtures are required in the preparation of concrete because recycled aggregates adsorb needs more water as compared to normal aggregates. We found that due to the mortar binding to its surface, the density of the recycled aggregate is less than the normal aggregate. Thus, the density of concrete gradually decreases as compared to the normal aggregate. Experimentally it was indicated that RCA usage rates from 25 to 50% have positive effect on strength, workability and fracture properties but have a slight decrease in Young's modulus. As a result, the compressive and the tensile strength are decrease steadily with the rising degree of aggregate substitution.SCC has appropriate workability and resistance to segregation, passing and filling ability capacity. But the replacement of RAC along with steel fiber in the proportion (0%, 0.5%, 1%, 1.5%, and 2%) has improved shear strength performance by 135 percent and shear toughness by four times compared to that of RCA concrete.

In this work, we mainly focused on an important problem on the rarity of aggregate by the construction sector. To triumph over this trouble, the use of RA is preferred. The utilization of recycled aggregate might also lower the amount of traditional aggregate and helps to reduce waste. While using recycled materials as aggregates gives numerous benefits which includes Landfill vicinity used for disposal is reduced, and existing conventional aggregate sources aren't as quickly depleted. Thus, it meets all satisfactory necessities for its utility in the construction industry. Analyses carried out in SCC using recycled coarse aggregate were limited. Therefore, these papers mainly determine the physical properties of materials, workability and the strength in SCC mix. Andit highlights the performance of C&D based recycled aggregate in SCC to enhance waste management on construction sites.

The content of the paper is arranged as follows: Section 2: Background of the research. Section 3: Discussion on the practical performance of recycled coarse aggregate. Section 4: Shows a research methodology adopted. Section 5: focuses on the materials used. Section 6: Evaluate the physical properties of materials. Section 7 deals with Specimen casting and test methods. Results and discussion in Section 8: finally draws the conclusions.

2. Background

Construction & demolition waste generation and the production of recycled aggregate get increased all year around. Recycling of C&DW is one of the ways to create a solution to environmental and shortage of resources. Normally, the recycled coarse aggregate is poor quality then it is used in road construction and nonstructural application and not in concrete structures. Therefore, the Indian government has enhanced the quality standards for recycled concrete aggregates then it can be used in structural application.The performancesof RCA have been reviewed and it was discussed below:

Tang et.al., (2016) carried out an experimental study in replacing recycled coarse aggregates (RCA) 0 percent, 50 percent and 100 percent in SCC. The RCA usage rates from 25 to 50% have a positive effect on strength, workability and fracture properties, but have a slight decrease in Young's modulus. In addition, that with a higher degree of substitution the strength decreases decline gradually. In the mix proportion, Sherif et.al (2015) outlined some of the approaches to design mixtures that could be followed with RA are the direct volume replacement, weight replacement, and equivalent mortar replacement. The blending process also has the potential to affect overall concrete properties. Only material replacements and pre-soaking approaches indicated improved concrete properties developed with Fernando et.al (2016) pointed out that, some admixtures were required in the preparation of SCC because to the mortar binding to its surface of RC.Since recycled aggregates adsorb more water than normal aggregates.

In the physical properties, Sherif et.al (2015) suggest that vital properties affecting the application of RA in concrete processing are absorption, aggregate texture, size and gradation, basic specific gravity, density, and abrasion resistance. In addition to the crushing process, contamination and impurities, variation in the RA properties due to loading effect concrete properties produced using RA. The adherence of mortar to RA leads to lower density, high absorption and high Loss of Abrasion. Additionally, sulfate and alkaline content cause extensive reactions. According to Kwan et. al.,(2012), the effect of SF with RCA of hardened concrete shows a reverse relationship between density and water absorption ratio. In the fresh state properties Ryou & Lee (2014); Xu et.al (2018) described that the recycled aggregate consumes more water compared to natural aggregates due to the high porosity and water absorption of the recycled aggregate, resulting in disadvantages on traditional RAC properties. Thus enhancing, its properties the surface was coated with dispersant water-soluble polycarboxylate (PC). Slump loss can be managed based on the time elapsed by calculating its workability.In the hardened state properties, Cakir (2014) reported concrete strength is well known depending on the strength of the aggregates, the cement matrix, and the interfacial transition zone (ITZ) between the matrix and the aggregate Rahal, (2007) revealed that the strength and elasticity modulus decreased as an increased in the replacement ratio. Kwan et.al. (2012) reported that the effect of SF/PPC with RCA of hardened concrete increases by 5 percent and 10 percent of compressive strength. Abdel-Hay, (2017) Curing with Paint content was suggested to be advantageous in all cases and ages than water or air healing except for full replacement. By this maximum strength was obtained.

In the durability of RA, Fabiana et. al., (2011) Xu et.al., (2018) Kwan et.al (2012) proposed that the recycled aggregate could be used as a coarse base and sub-base layer for road construction.Since recycled coarse aggregate greatly improves resistance and penetration of the elastic modulus. Ryou & Lee (2014) found that RCA coated with PC dispersant the durable properties is better than the coarse aggregate. It has a good impact on mechanical tests results.

Hence, all of the concrete test results with RCA were satisfactory compared with the control except full replacement. However, it showed minor bleeding with more than 75 percent of RCA replacement. The targets of this research were to test the fresh and hardened properties of concrete specimens to be produced with or without reused aggregates to replace conventional coarse aggregate in different percentages (0 percent, 25 percent, 50 percent, 75 percent, and 100 percent) with the Reused aggregate in SCC. It is also more cost-effective, environmentally friendly compared to traditional concretes.

3. Performance of Recycled Coarse Aggregate(Present trends in use of RCA)

According to MoHUA (2016) and NITI Aayog (2019) the recycled aggregates have different properties and cannot be adapted to all kinds of applications. Usually, RCA is used in concrete for bulk fills, bank protection drainage bases, pavements, sidewalks, kerbs and so on. In earlier, 30% of the replacement of RCA is acceptable for pavements work.Currently, however, the replacement ratio has risen to 50%.The Indian Roads Congress (IRC) IRC-121:2017, BIS 383(2016) standard and the India National Building Code (NBC-CED46) 2005 tabulate the maximum usage of recycled aggregates to build roads in table:1 (Source: MoHUA (2016) and NITI Aayog(2019). Some practical applications of recycled materials in the Indian construction sectorwere listed as follows. Initially, the PWD of Delhi (2015) recommended that, up to 2-10% of recycled products used to construct a building and for road construction. In addition that recycled concrete block (18 lakhs) was used in the construction of additional office complexes of the supreme court of India by the central public work department (CPWD). Next, according to NITI Aayog (2019) and the ministry of housing and urban affairs (2016) CPWD combined with Goa Municipal Corporation for enhancing recycling products from C&D waste. Furthermore, LEED and GRIHA are the building rating schemes to enhance the usage of products obtained from C&D waste.Finally, come to international practices in ERC-Tech, a Czech firm, they used highly controlled nano-additives technology to strengthen the structural properties.From the above it was concluded that recycled materials were encouraged to be used with appropriate standards by government and private sector.In practically also proven that C&D waste aggregates may be used effectively in structural applications with additives.

Table1: Recommended use of recycled aggregates in BIS 383:2016

Sl.No.	Types of aggregate	Maximum utilization%		
		Plain cement concrete	Reinforced cement concrete	Lean concrete(less than M15 grade)
1.	Coarse aggregate			
	Recycled coarse aggregate(RCA)	25	20(only up to M25 grade)	100
	Recycled aggregate(RA)	Nil	Nil	100
2.	Fine aggregate			
	Recycled coarse aggregate (RCA)	25	20(only up to M25 grade)	100

4. Research Methodology

The flowchart for this research was shown as Figure 1 below:
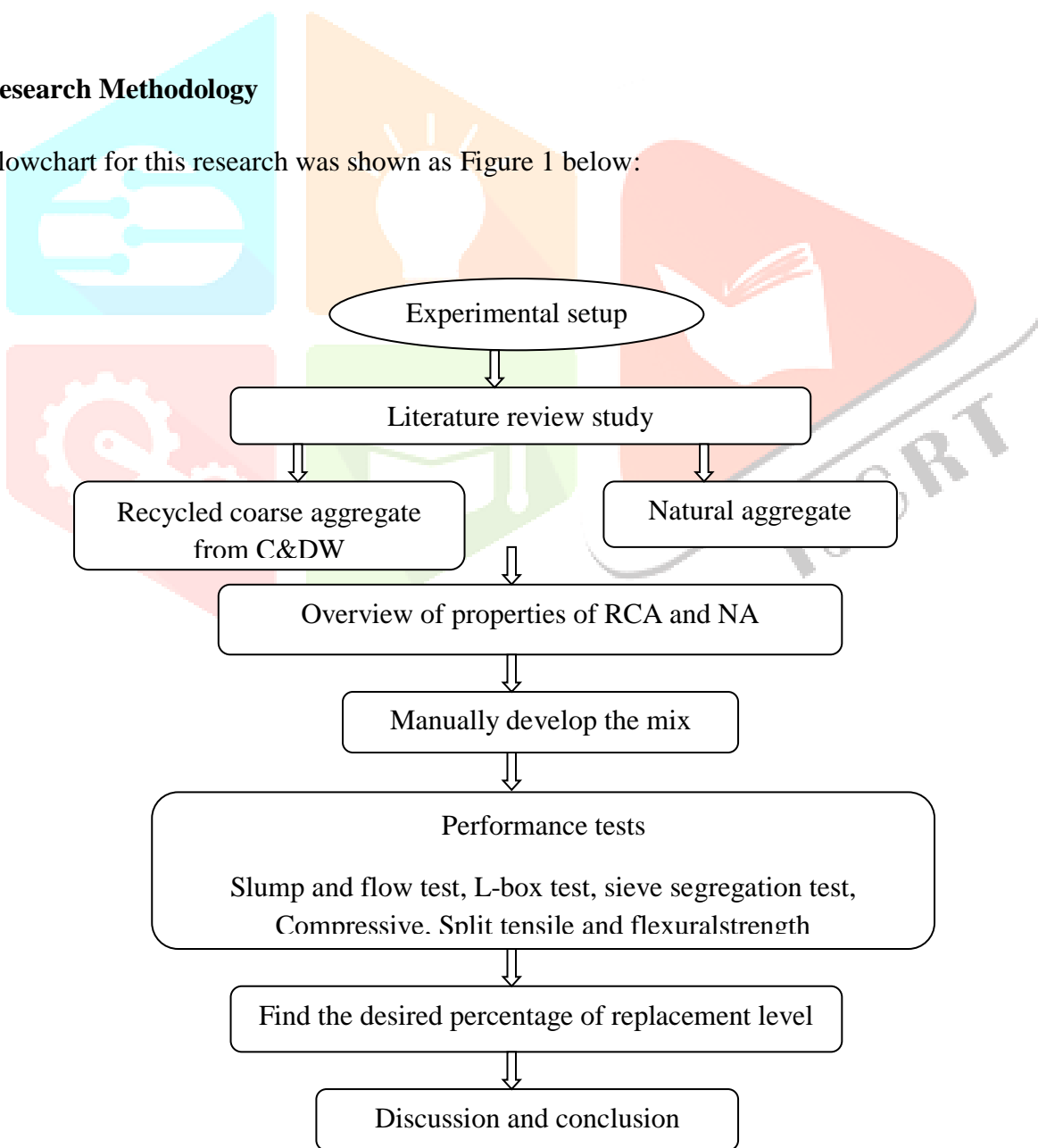

Figure 1: Flow chart for this research

In this paper, by reviewing other similar studies, the data collection can be done. Massive quantities of crushed concrete obtained in India and around the world. CD waste management should reflect the hierarchy of waste management, with reuse and recycling being the first priority for waste prevention and minimization. There are numerous opportunities for the beneficial reuse and recycling of demolition materials during site removal and restoration work. The resulting use of recycled materials in works of restoration often decreases the quantity of waste that must eventually be consigned to landfill sites. Therefore, the use of recycled aggregate to partially replace the virgin aggregate has become most prominent because of rising landfill prices, lack of natural resources combined with the rise in aggregate requirements for construction. The key objectives of the experimental setup were to determine the physical properties of RCA. Investigate appropriate workability and resistance to segregation, passing capacity and filling capacity have been demonstrated by slump flow test, L box test and sieve segregation test. Also, we need to determine the mechanical properties such as compressive, tensile splitting strength and flexural strength.

The studies have been conducted by replacing RCA in SCC and the replacement is done as per volume because of high porosity in RCA. The recycled coarse aggregates (RCAs) as a supplement (0 percent, 25 percent, 50 percent, 75 percent & 100 percent) for conventional coarse aggregate in self-compacting concrete (SCC). That means, in the first mix, we have taken 100 percent conventional coarse aggregate as control mix. In the second mix, we have taken 75 percent conventional coarse aggregate + 25 percent recycled coarse aggregates as RCA 1. In the third mix, we have taken 50 percent conventional coarse aggregates + 50% recycled coarse aggregates as RCA 2. In the fourth mix, we have taken 25 percent conventional coarse aggregate + 75 percent recycled aggregates as RCA 3. In the fifth mix, we have taken 100% recycled coarse aggregate as RCA 4.

The design of the mix is done under IS 10262-2009. The components such as cement, water, fine aggregates and coarse aggregate / RCA are in the concrete mix. RCA derived from the demolition concrete on the site, broken by manual means. Conventional coarse aggregate is taken from the nearby quarry. Cement used in this work is ordinary Portland.For the above replacement mixes; the water/binder ratio and the superplasticizer dosage were similar. Concrete cubes (150 x 150 x 150 mm), prisms ($100 \times 100 \times 500$) mm and cylinders (150dia x 300ht mm) were casted for all concrete mixes. After 24 hours, the specimens were remolded and allowed for healing for 7, 14, 28 days respectively. While the specimens were healed, they were removed and dried at the prescribed time. The specimens can be examined. The following tests were performed: compression strength, tensile resistance and flexural strength. The test results were then analyzed and evaluated.

From the above literature study, all the concrete test results with RCA in SCC were satisfactory compared with the control except full replacement. However, it showed the minor bleeding with increasing percent of RCA replacement. This study focuses on the workability of recycled aggregates in SCC andlimitable research on the properties of recycled aggregates is under way.

5. Materials used

The components used in the experimental setup includes cement, water, fine and coarse aggregate and recycled coarse aggregate. Which are explained as follows: Ordinary Portland cement (grade 53) was used and satisfied Indian Standard Specification IS: 12269:1987. Water is another component of concrete because it actively participates in the chemical reaction with cement. Another component is fine aggregates, it is nothing, but normal river sand and it's confirmed the specification Zone II as per IS: 383-1970. Conventional coarse aggregate is taken from a nearby quarry. Furthermore, components are the recycled coarse aggregate, obtained from the demolition site. Additional components used are Superplastizers and Silica Fume. Ploycarboxylic based Superplastizers is used to improve the workability of the mixes and its density varies from 1.082 to 1.142 Kg/l. The silica fume also used in mixtures from Elkem Company (specification: ASTMC 1240-12) and its specific gravity is 2.3.

6. Evaluation of Physical Properties of Materials

This section primarily focuses on the physical properties according to Indian standards, because these are linked directly to the evaluation of concrete properties. Usually, the following test specific gravity, soundness, standard consistency, Initial and final setting time has been carried out for the cement material. Let's discuss the test results one by one, to check standard consistency and Initial and final setting time the vicat apparatus was used. Through the test, we can quantify the water required to create cement paste can be measured. Next, come to soundness test the le-chatelier apparatus was used. By the way, we found how cement can maintain its volume after it gets hardened as per IS: 4031 requirements. In the specific gravity test, pycnometer apparatus was used. This test was used to measure the quality of cement.

Table: 2 Cement properties

Cement properties	Values
Specific gravity	3.13
Standard consistency	30%
Initial setting time	30 min
Final setting time	600min
Soundness	1.1mm

Commonly specific gravity, fineness modulus and water absorption test has been carried out for testing of aggregates. The test method for fine/coarse/recycled coarse aggregates was similar in determining the properties of the aggregates. It is calculated according to the requirements of IS 383-1970(10 mm size). Normally, for the testing of the fineness modulus of aggregate, a sieve sets can be required mechanically or manually. If the aggregate passes through 4.75 mm sieve was considered as FA. If the aggregate retained on 4.75 mm sieve was considered as CA. This was applicable to RCA. The specific gravity test was used to measure the quality of cement and the water adsorption test used to assess the water capacity of aggregates. The tested values of the above-mentioned experiments and then is computed as shown in Tables 2-4.

Table 3: Properties of Fine and conventional coarse aggregate

Type	Specific gravity	Water absorption	Fineness modulus
Fine aggregate	2.60	0.32%	2.73
Crushed granite	2.65	1.10%	7.38

Table 4: Properties of reused aggregates.

Type	Size	Specific gravity	Water absorption	Fineness modulus
Crushed granite	10	2.65	1.10%	7.38
Recycled Aggregate	10	2.45	7.80%	5.70

From the tabulated values, it clearly shows that for both conventional and recycled coarse aggregates has slight difference in values of the fineness modulus and specific gravity. But water adsorption of RCA is more than the conventional coarse aggregate due to the binding of mortar on the aggregate surface. Many researchers also pointed that recycled coarse aggregates adsorb more water as compared to normal aggregates. It enhances the ability of RCA particles to absorb or provide water to the SCC mortar by increasing the possibility for water exchange with the surrounding paste in the RCA concrete.

7. Specimens Casting and Test Methods

7.1 Specimens Casting

The mix proportion of self-compacting concrete was determined based on Indian standard (IS 10262:2009). Four different SCC mixes were designed with different percentages of RCA as substitution (25, 50, 75 and 100%) of conventional coarse aggregate by volume. For all the mixes the W/C ratio, superplastizers and silica fume dosage were similar as used in the control mix. The mix designs are given in the table. 5. Before

preparation of the SCC, recycled coarse aggregates were immersed in water for 24 hours to compensate the water absorption level. Also, it should be left out for one hour, till experimental set-up is processed to achieve dry surface. For the Preparation of SCC, the concrete was mixed by manual means. Immediately, after the completion of mixing, the slump flow, L-box and sieve segregation test were conducted. In addition to that, the test specimens of concrete cubes (150 x 150 x 150 mm), prisms ($100 \times 100 \times 500$) mm and cylinders (150dia x 300ht mm) were casted for all concrete mixes. After 24 hours, the specimens were remolded and allowed for curing for 7, 14 and 28 days respectively. The samples are then taken out at the specified time and allow air dried. Then the various strength (compressive, flexural and splitting tensile strengths) tests have been tested.

Table 5: Mix Design

Mix ID	Cement (kg/m^3)	FA (kg/m^3)	SF (kg/m^3)	Water (kg/m^3)	NCA (kg/m^3)	RCA	Fine Aggregate	SP
Control	440	160	30	220	655	0	810	4.5
RA1	440	160	30	220	490	157	810	4.5
RA2	440	160	30	220	328	307	810	4.5
RA3	440	160	30	220	163	460	810	4.5
RA4	440	160	30	220	0	615	810	4.5

7.2 Test methods

7.2.1 Fresh properties

In test process, the fresh properties of SCC were carried out by slump flow, L-box and sieve segregation. Firstly, the slump test was carried out in accordance with IS 1199-1959; it is used to decide how fresh concrete mix works. Through the slump flow test, flow rate and the viscosity of SCC were calculated using time T500. During the slump flow test, the fresh concrete was poured into the slump cone apparatus. Then the cone was pushed upward and noted the time taken to measure the flow from upward to concrete flow to a diameter of 500mm, this time considered as T 500. The flowability of concrete was seen from the above test. Secondly, the L-box test was carried out. Initially theapparatus in vertical position follows that concrete is poured into box. Then doors of the box are open, the time needed for concrete flow is noted and measure the height of positions. Thus, it shows the concrete filling and passing ability. Furthermore, the Sieve segregation test was used to access the resistance to sieve segregation and conforming to ISO 3310-2 standard. In this, the concrete is poured out from a certain height through the sieve 5 mm and stand for a few sec, and the segregated portion passed through the sieve is weighed and noted.

For each blend, two inspections were conducted at two different times. The first set of tests were carried out immediately after mixing, and the second set was carried out one hour later to assess any changes in the SCC's workability over time. Concrete was not stirred throughout the 1-hour rest period; however the mixture was agitated for roughly 1 minute prior to the second measurement using the initial mixing speed. The effects of fresh state properties are listed in Table 6.

Table 6: Fresh state properties

Mix ID	Wet Density	Slump flow		t_{500} (s)		L-Box		Sieve Segregation
		Initial mm	Final mm	Initial (sec)	Final (sec)	Initial mm	Final mm	
Control	2365	720	645	2.9	3.9	0.96	0.89	9.88
RA1	2355	710	620	3.8	5.9	0.97	0.88	7.76
RA2	2345	725	650	3.9	6.4	0.98	0.89	6.36
RA3	2335	710	615	4.3	6.9	0.94	0.82	6.05
RA4	2330	705	595	4.4	7.8	0.95	0.83	5.32

7.2.2 Hardened state properties

Here, we have discussed the hardened properties of SCC, in that the following tests such as compressive, split tensile and flexural strengthwere performed. To determine the above test, specimens of concrete cubes, prisms and cylinders were cast for all concrete mixes. After 24 hours, the specimens were remolded and allowed for curing for 7, 14 and 28 days respectively.When the specimens were healed, they were removed from the water at the indicated time and allowed to air dry. The specimens can be examined.Let's discuss the test firstly, Compressive strength was conducted in a compression testing machine on a concrete cube as per IS 516-1959. From the compression test, we were able to determine the capacity of a material to carry loads on its surfaces without any crack. It relies mainly on several factors including W/C ratio, cement resistance, and materials used. The compressive strength (f ck) was determined using the equation below.

$$f_{ck} = \frac{Load\ at\ failure\ in\ N}{Area\ of\ cube\ in\ mm^2}$$

The Second was Split tensile strength test, this test was conducted in the compression testing machine on a cylindrical concrete specimen as per IS 5816-1999. From the test, we can identify the tensile strength of concrete. The split tensile strength (f ck) was determined using the equation below.

$$f_s = \frac{2P}{\pi LD}$$

Where,

P=compressive load on cylinder in N

L = length of the cylinder in mm

D = diameter of the cylinder in mm

In addition, the flexural test (two points load method) was conducted in the flexural testing machine of 1000KN capacity on a concrete prism as per IS 516-1959. The bending test implicitly assesses the tensile of the concrete.

From the flexural test, it clearly shows to resist the failure of unreinforced concrete beams or slabs. The flexural strength (f ck) was determined using the equation below.

If a > 13.3 cm $$f_b = \frac{Pl}{b\,d^2}$$

If a < 13.3 cm $$f_b = \frac{3Pa}{b\,d^2}$$

Where

b = breadth in mm

d = depth

a = distance of crack from shorter length of beam in mm

l = length of the prism

The specimens were placed in the testing machine, and the load was applied slowly over the specimens. Thenmaximum load applied to the specimen is noted. And the strength values are determined by dividing the overall load used for the specimen by the cross-sectional area during the study, and the calculated values were then tabled in the table7. The results of strength are shown in Figures: 5-7 respectively.

Table 7: Hardened State properties

Mix ID	Compressive strength N/mm^2			Split Tensile strength N/mm^2			Flexural strength N/mm^2		
	7 days	14 days	28 days	7 days	14 days	28 days	7 days	14 days	28 days
Control	18.00	24.64	37.00	1.89	2.58	2.88	2.51	3.30	3.53
RA1	17.12	21.07	37.34	1.85	2.35	2.74	2.28	2.65	3.25
RA2	17.15	21.78	37.42	1.85	2.38	2.77	2.29	2.72	3.28
RA3	11.81	17.65	28.05	1.63	2.27	2.51	2.15	2.50	2.78
RA4	11.08	17.40	27.11	1.45	2.13	2.53	2.03	2.32	2.55

8. Result and Discussion

8.1 Fresh Concrete Test Results.

From figure 2 and 3, we conclude that the actual flow measures upto 100% replacement of RCA did not affect the slump flow diameter. Sherif et.al, (2015) also indicated that for all the mixes had reached the desired flow diameter. However, the t500 times increased with increased RCA content. From the above result comparable flow capabilities for all SCC, the viscosity gets increased with higher RCA material.

The same process was observed in the slump flow tests performed after one-hour mixing; however, with increased RCA content, the t500 times experienced a higher percentage from control to 100% RCA. The t500 increases by 47% at initial measurement and 93% after 1 hour. The time-dependent shift in slump flow effects may have been caused by the continued water absorption of recycled coarse aggregate. This show clearly in the table: 4 the absorb ability of RCA was approximately seven times more than that of conventional coarse aggregates. That means although both aggregates were soaked for 24 hours and then dried for 1 hour before mixing of concrete. Fernando et.al (2016); Yehia et.al (2015) states that recycled coarse aggregates adsorb more water as compared to normal aggregates. It enhances the ability of RCA particles to absorb or provide water to the SCC mortar by increasing the possibility for water exchange with the surrounding paste in the RCA concrete.
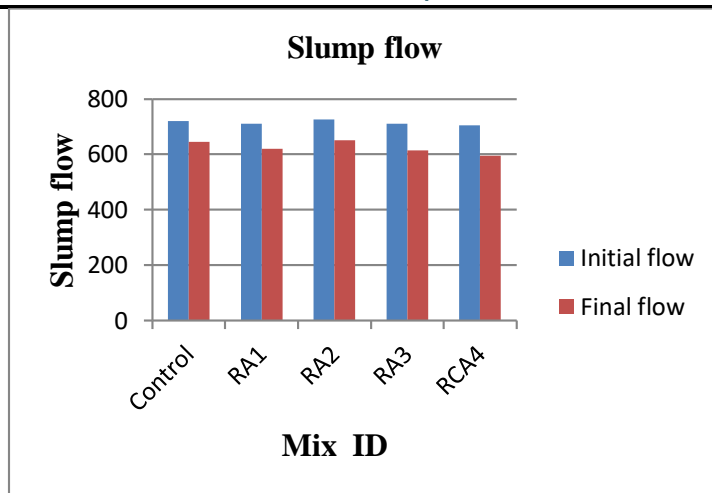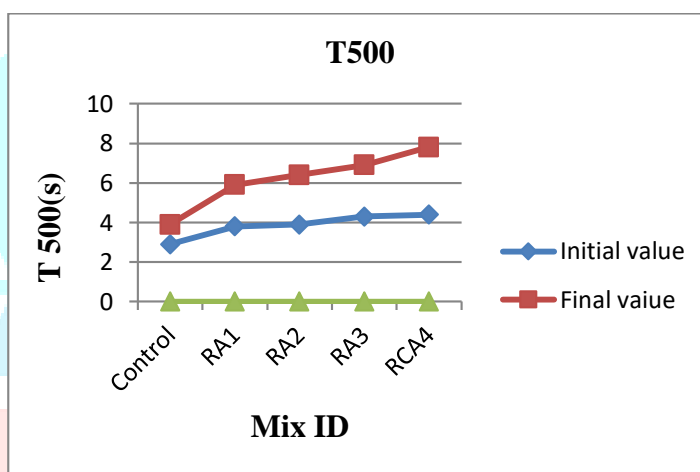
Figure 2: Slump flow results

Figure 3: t_{500} Test Results

8.1.1 L-box Test

Figure.4 shows an L-box test. This test measures the SCC's ability to pass, which quantifies the SCC's suitability for usage in a member with crowded reinforcement as described in the preceding section. The figure illustrates that substituting RCA for natural coarse aggregates has only a little impact on the initial blocking ratios, with only a small reduction in the blocking ratio for both the 75 percent and 100 percent RCA use rates. L-box tests conducted after one hour of mixing show a small rise in the blocking ratio for the 75% and 100% RCA. This is because regenerated coarse aggregates absorb water at a faster rate.
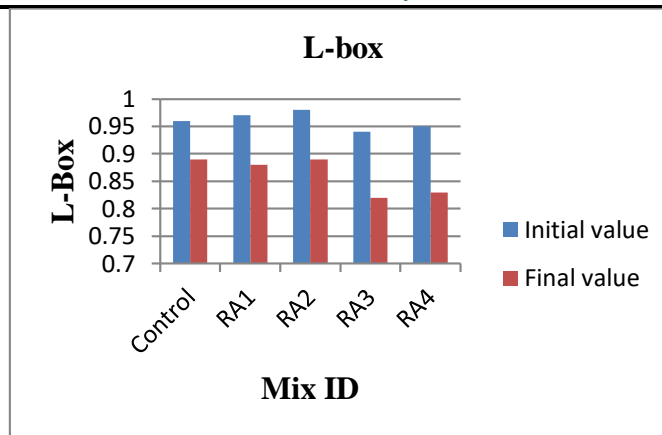
Figure 4: L-Box Test Results

8.1.2 Sieve Segregation Test

As can be shown in Figure 5, the SCC segregation resistance increased as the RCA material increased. Because recycled coarse aggregates absorb water at a higher rate, it's possible.
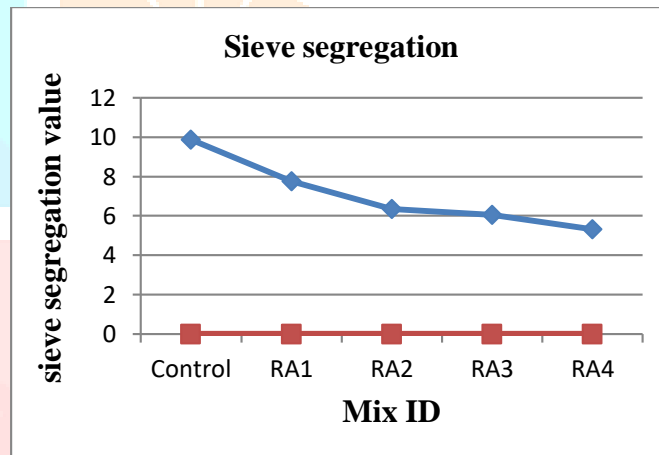

Figure 5: Sieve Segregation Results

8.2 Strength Properties Results

8.2.1 Compressive Strength Test

The strength of concrete cubes was assessed at ages 7, 14 and 28 days. From the fig 6, it can assess that, there is a certain increase in the strength is noted by increasing amount of recycled coarse aggregate. The compressive strength at the replacement rate of 25 and 50 percent was found to be almost exactly the same as the control concrete, while 75 and 100 percent replacement with recycled coarse aggregate results in slight decrease in compressive strength, because of improper particle distribution and contains numerous impurities.
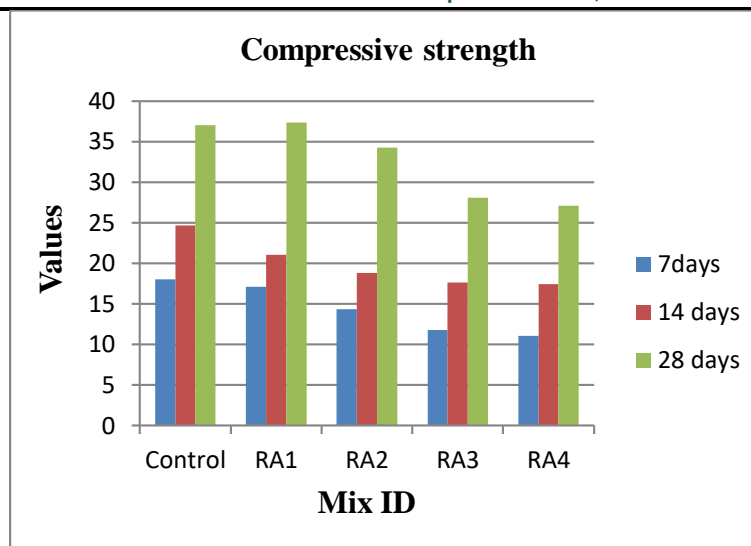
Figure 6: Compressive strength test Results

8.2.2 Split tensile Strength Test

The tensile strength of concrete cylinders was calculated at ages 7, 14and 28 days. It may be noted from the fig 7, the strength was somewhat increased by increasing amount of recycled coarse aggregate. The tensile strength at the replacement rate of 25 and 50 percent was found to be almost exactly the same as the control concrete, while 75 and 100 percent replacement with recycled coarse aggregate results in slight decrease in tensile strength, due to excessive distribution of particle.
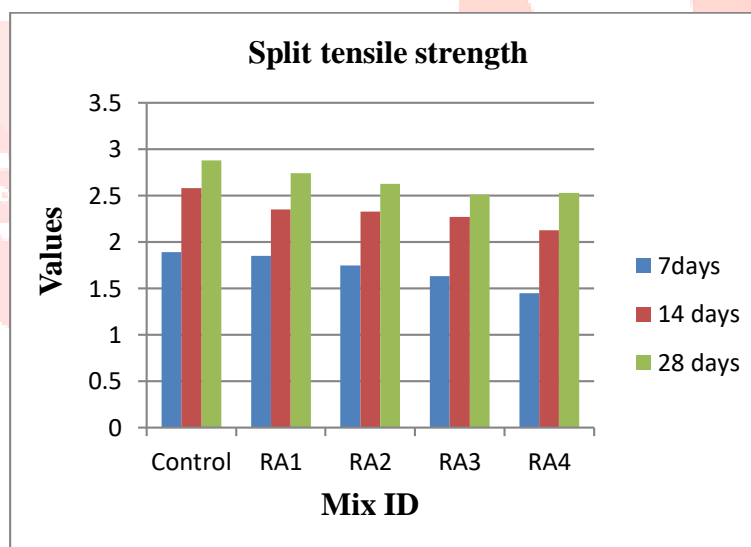

Figure 7: Split tensile strength test Results

8.2.3 Flexural Strength Test

The flexural strength of concrete prisms was determined at ages 7, 14and 28 days. It can be expected from fig 8 that there is a certain increase in strength by increasing quantities of recycled coarse aggregate. At a replacement rate of 25 and 50%, the flexural strength was approximately identical to the control concrete, While 75 and 100 percent replacement with recycled coarse aggregate results in slight decrease in flexural

strength, Fernando et.al. (2016) noted that the quality and surface characteristics of recycled aggregates are negatively affected, interdependently of their level of replacement.
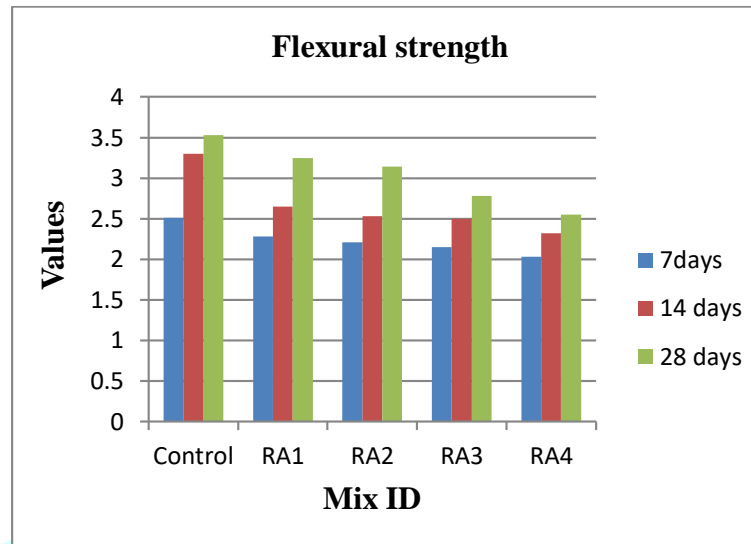

Figure 8: Flexural strength test Results

9. CONCLUSION:

Environmental protection was the primary concern throughout the construction sector. The use of recycled coarse aggregate from demolition waste as a substitute for conventional coarse aggregate is regarded as sustainable process. It was notedthat through incorporating the use of recycled aggregate the fresh properties with or without recycled aggregate are nearly identical but the mechanical properties were minimized due to poor adhesion between the old mortar and the aggregate. The SCC's passing ability was found to be significantly reduced by over 50 percent for RCA use; however, SCCs remained within acceptable passing capacity limits at the 75% and 100% reuse of recycled aggregate. Overall from research on Concrete workability were acceptable with or without recycled aggregates. The mechanical properties such as compressive strength, splitting tensile strength and flexural strength slowly decrease with increased level of aggregate replacement. These findings open up the possibility of using RCA in SCC preparation, where natural aggregates are rare and expensive; but where overuse of raw materials has an adverse environmental impact that restricts their potential sustainable use or where there is lack of disposal areas. The use of coarsely recycled aggregates will lead to cost savings and environmental friendliness.

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