Study the Effect on Strength Properties of Cement slurry Mixed Recycled Aggregate Concrete

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Abstract- *In India, many talks are being heard about sustainable construction and researchers are taking up studies here and there on use of unconventional construction materials that are aimed in using waste materials. However, focused attention on sustainability of materials for construction is needed. Though the time is not yet ripe for forming such an association in India, it is time for everyone concerned in the topic to start thinking about such a move.*

So here in this research main concern on the reuse of construction and demolition waste in conventional concrete. In this research we use recycled coarse aggregate as well as recycled fine aggregate with replacement of natural aggregates. As per previous records there is considerably decrement in the strength property by using these kinds of recycled materials. This happen due to lower quality of recycled aggregates to improve the quality of R.A. here we apply cement slurry treatment on the R.A. and use this Processed Recycled Aggregates (PRA) with fine recycled aggregates (FRA). In this research we replaced 10, 20, 30% RA with natural aggregates. Then we replaced PRA 10, 20 and 30% with N.A. Also we combine proportion of PRA and FRA and measure compressive, tensile and flexural strength of concrete. Also we measure workability and compaction factor for all the mix. In the mix design we used 0.57 W/C because there is higher water absorption of R.A.

At the end we also compare the cost of RAC and NAC as well as PRAC, RAC and NAC. R.F.A.combined it with processed R.C.A. to reduce the overall cost of concrete.

Keywords- Natural Coarse Aggregates (NCA), Recycled Coarse Aggregates (RCA), Recycled Fine Aggregates (R.F.A), Calcium Metasilicte (CM), Recycled Aggregates Concrete (RAC), Processed Recycled aggregates (PRA).

I. INTRODUCTION

Concrete has been proved to be a leading construction material for more than a century. It is estimated that the global production of concrete is at an annual rate of 1 m3 per capita (Neville 2003). The global consumption of natural aggregate will be in the range of 8–12 billion tonnes after 2010 (Tsung et al. 2006) Over 1 billion tonnes of construction and demolition waste (C&DW) is generated every year worldwide (Amnon 2004).

The large-scale depletion of natural aggregate and the increased amounts of C&DW going to landfill sites are causing significant damage to the environment and developing serious problems, denting the public and the environmentalist's aspirations for a waste-free society. The use of the recycled aggregates created from processing construction and demolition waste in new construction has become more important over the last two decades.

There are many factors contributing to this, from the availability of new material and the damage caused by the quarrying of natural aggregate to the increased disposal costs of waste materials. Recently, these aggregates started to be used for intermediate utility applications, such as foundations for building sand roads. The advantages of recycling construction and demolition waste are (1) it reduces the amount of construction and demolition waste entering landfill sites; and (2) it reduces the use of natural resources in construction, contributes to the environment, provides a renewable source of construction material, and, if used in situ, reduces haulage costs. For economical and environmental reasons and because of the increased amount of recycled

aggregates, there has been a growing global interest in maximizing the use of recycled aggregates in construction. In view of the increased volumes of construction, demolition waste, and industrial by-products such as fly ash (FA) and the advantages offered by the use of admixtures in modern concrete, it is considered very beneficial from different prospects with similar performance characteristics to natural aggregate concrete. When proved successful, recycled aggregate concrete (RAC) can be substituted for natural aggregate concrete in many concrete applications.

In the last 15 years, it has become clear that the availability of good quality natural aggregates is decreasing. The shortage of the resources of natural aggregates has opened the possibility for the use of recycled materials to replace part of the natural aggregates.

As per record of news paper (23rd August2015) in India there is amount of construction waste generated.

City	Construction waste (MT)
Delhi	4600
Mumbai	2500
Chennai	2500
Calcutta	1600
Bangalore	875
Ahmadabad	700

As per Technology informational forecasting and assessment council estimated waste generation during construction 40 to 60 kg. Per sq. m. Similarly waste generation during renovation/ repair work is estimated to be 40 to 50 kg/Esq. of waste respectively.

Though it is now necessary to use of these recycled aggregates in place of natural ones. Properties of recycled aggregates have to be compared to those of natural aggregate to evaluate its suitability for applications in construction industry.

II. LITERATURE REVIEW

In the literature review there Is many papers studied and as per their view here following comparison carried out. Here studied natural and recycled aggregate properties and also parent concrete and RCA fresh and hardened properties. For the determining the various properties of aggregates the methods are in IS 2385 P-5.

Recycled Aggregates: Aggregates can come from either natural or manufactured source. Natural aggregates are come from rock, of which there are three broad geological classifications. In our project work we collect R.A. from porbandar based C & D waste and used in the work.

Abrasion Value: Codal provision for abrasion value as per IS 2386 PART 5 is 30%. P.Saravana kumar et al (ASCE-0899-1561/2012) reported that the abrasion value of natural aggregate is 12% for fine aggregate. Also Bhibhuti Bhusan et al (ASCE-0950-0618/2014) reported that abrasion value of natural aggregate is 19.72%.

A.Akbarnerhad et al (ASCE-8099-1561/2013) reported on the crushing procedure of recycled aggregate and determine the abrasion value of R.A (recycled aggregate) varies from 31 to 39%. P.Saravana kumar et al. (ASCE -0899-1561/2012) reported on fine recycled aggregate abrasion value and observed that 7 to 10 % as per age of aggregates. Alla M. Rashall et al (ASCE -2013) reported on use of metakaoline in place of fine aggregate and observed that abrasion value 23.12% in MK content. Bhibhuti bhusan et al (ASCE-0950-0618/2014) reported that abrasion value of RCA is 36.56%. Poblo pere et al (ASCE-2012) reported on cement treated recycled material and determine the abrasion value of RCA 38.00%.

Impact value: Codal provision for impact value as per IS-2386 PART 5 is 30% for wearing surfaces and 45% for non wearing surface. P.Sarvana kumar et al. (ASCE-0899-1561/2012) reported that impact value of N.A is 5.85% for F.A. And bhibhuti bhusan et al (ASCE-0950-0618/2014) reported that impact value 0f N.A. is 15.35%.

P.Saravana kumar et al (ASCE-0899-1561/2012) reported that impact value of R.F.A is 9.66%, 12.79%, 18.45% after 5, 10, 15 years. Bhibhuti bhusan Mukharjee et al (ASCE-0950-0618/2014) reported that impact value of R.C.A. 34.85%. Sallehan ismail et al (ASCE-0950-0618/2014) reported that impact value of R.C.A is higher than N.A by 13%.These results shows us that recycled fine and coarse aggregates are weaker than natural aggregates.

Crushing value: Codal provision for crushing value of aggregate as per IS-2386 part 5 is 30% for wearing surface and 45% for non wearing surface. P.Saravana kumar et al.(ASCE-0899-1561/2012) reported that crushing value of

N.A is 17.75 for F.A. and Bhibhuti bhusan et al (ASCE-0950-0618/2014) reported that crushing value of N,A is 15.1%.
Sallehan ismail et al. (ASCE-0950-0618/2014) reported on the use of treated coarse recycled concrete aggregate and observed that crushing value higher than the N.A. Bhibhuti bhusan mukharjee et al (ASCE-0950-0618/2014) reported that crushing value of R.C.A is 31.52%.

Specific Gravity: Kunal rafat siddique et al (ASCE 2013) reported that specific gravity of natural coarse aggregate 2.59 and fine aggregate 2.62. Bhibhuti bhusan et al (ASCE-0950-0618/2014) also reported that specific gravity of NA P.Sarvana kumar (ASCE-0899-1561/2012) also reported same specific gravity of N.A 2.72.

P.Saravana kumar et al. reported that specific gravity of recycled aggregate decrease with increase of the age of sourse of recycled aggregate specific gravity of R.A. varies from 2.63 to 2.68. S.K.singh et al (use of recycled aggregate-NBMCM-2011) reported that specific gravity of RA 2.35 to 2.58 which is lower than N.A. Bhibhuti bhusan Mukharjee et al (ASCE-0950-0618/2014) determined the values of specific gravity of RCA is 2.46.

Water absorption: Leonardo F.R. Miranda et al. (ASCE-899-1561/2013) reported that water absorption value of fine aggregate is varies from 4.5% to 7.6%. While Kunal rafat Siddque et al (ASCE 2013) reported that water absorption of C.A 0.80 % and fine aggregate has 1.02 % of water absorption. Bhibhuti bhusan et al (ASCE-0950-0618/2014) reported that water absorption value for N.A is 0.5%. Valeria corinaldesiet et al. (ASCE 2010) reported on the behavior of beam-column joints made of recycled aggregate concrete under cyclic loading than water absorption value is 3.4% for N.A. Water absorption value of R.A is higher than 4% to 4.8%. Leonardo F.R. Miranda et al (ASCE-0899-1561/2013) reported that water absorption value of R.A is varies from 4.5 to 7.5%. A.Akbarnerhad et al (ASCE-8099-1561/2013) reported values vary from 2.7 to 5.1%. Sidnel H.C. et al (ASCE-0899-1561/2014) reported the value of water absorption varies from 1.65 to 6.2 % for recycled sand. Bhibhuti bhusan mukharjee et al (ASCCE-0950-0618/2014) determined the values of RCA are 4.6%. Valeria corinaldesi et al (ASSCE-2010) reported that water absorption value of RCA 7.0%. Poblo perez et al (ASCE-2012) reported that the value of water absorption is 4.72%.

Treatment of Recycled Aggregates:

Amnon Katz et al (ASCE 0899-1561/2008) studied on the treatments of recycled aggregates they applied two different treatment silica fume treatment and ultrasonic cleaning treatment. By used silica fume treatment compressive strength improve by 30 % and 15% after 7 & 28 days. And by using ultrasonic treatment compressive strength improved by 7% after 28 days.

Kunal Rafat siddique et al (ASCE/2013) studied on the use of cement kiln dust replaced with fine aggregate and applied Bacterial treatment on CKD and then it replaced with F.A. CKD waste produced during cement production and it harmful for the nature and humans too so by applied bacterial treatment and then replaced with F.A. and compressive strength increased by 7.15% to 26.6% with 10% replacement. Erhan guneyisi et al (ASCE/2014) applied four different surface treatments on the properties of self compacting concrete with recycled aggregates. Treatments are I) Two stage mixing approaches ii) Pre- soaking in HCl solution. iii) Water glass dispersion IV) Cement silica fumes slurry. And they conclude that water glass dispersion treatment gives best result among all. Sallehan Ismail et al (ASCE-0950-0618/2014) Studied on mechanical and drying shrinkage properties of concrete containing treated Recycled aggregates they firstly C.A. soaking in HCl 0.5 Molar solution then impregnated in calcium metasilicate (CM) to coat surface. 60% replaced with N.A. and conclude that there is increase in mechanical properties of aggregates and strength property by using treated aggregates.

Properties of Concrete: For concrete there are two main type of properties 1) Fresh concrete properties and 2) Hardened concrete properties.

In this paper here compressive strength, split tensile strength, Flexural strength, Elastic modulus, workability, durability etc are analyzed for the parent concrete and Recycled aggregate concrete(RCA).

Compressive strength: Amnon katz (ASCE-0899-1561/2008) studied on treatment of recycled aggregate and determine the compressive strength of RAC(Recycled aggregate concrete) reported that by applying silica fume treatment it increase 30 to 15% and by applying ultrasonic treatment it increase 7% after 28 days. P.Saravana kumar et al (ASCE/2012) reported that there is decrease in comp. strength about 5.5% in same mix proportion. Alla M. Rashall (ASCE/2013) studied on fine aggregate replacement with metakaoline and reported that there is increase in compressive strength up to 40% and then decrement start in compressive strength. Jared R. wright et al (ASCE-1561/04014073/2013) studied on use of glasscrete and suggested that while use glass in concrete there is must be less W/C ratio. Sallehan Ismail et al (ASCE-0950-0618/2014) studied on mechanical strength

properties of treated and untreated RAC and reported that there is increase in all properties of concrete compare to the untreated R.A. Bhibhuti bhusan mukharjee et al (ASCE-0950-0618/2014) reported that there is decrease in compressive strength by using R.A. up to 8.9% but with using of nano silica as SP there is increase in compressive strength up to 12%. Macro pepe et al (ASCE/2014) reported that compressive strength of RA is 27.50 n/mm^2.made of recycled aggregate concrete under cyclic loading (valeria corinaldesi et al. 2010)

Split tensile strength: P.Saravana kumar et al (ASCE/2012) reported that there is decrease in split tensile strength of 9%, 105, and 13.4% after 5,10,15 years aged R.A. Leonardo F.R. Miranda et al (ASCE-089901561/2013) studied on the use of recycled sand and determined the split tensile strength and it gives best results by using 50% replacement of recycled sand. Alla M.Raashall (ASCE/2013) studied on using of metakaoline(MK) reported that there is increase in split tensile strength up to use of MK 40% than there decrease in it by 15% of nominal split tensile strength. P.Pereira et al (ASCE/2013) studied on effect of super plasticizer on the mechanical performance of concrete made with recycled sand and suggested that there is decrease in split tensile strength by 15.6 to 24.5% without use of SP and with SP using there is increase in strength by 26.6% to 52.8%. Marco pepe et al (ASCE/2014) reported that split tensile strength of parent concrete 3.85 MPA and RAC is 3.36MPa.

Flexural strength: Valeria corinaldesi et al (ASCE 2010) studied on the behavior of the beam and column joints made with recycled aggregate concrete and reported that there is decreased in the flexural strength by 10%.

Workability: As in above water absorption properties we discussed and results added by them we can say that as water absorption increased by using R.A. there is create problem in the workability of RAC.(P.Saravana kumar et al ASCE/2012). Amnon katz (ASCE-0899-1561/2010) also reported that water absorption of R.A. increased due to old mortar on it because of high water absorption in R.A. There decreased in workability.

III. EXPERIMENTAL PROGRAMME

Firstly we collect recycled aggregates from C&D waste site and from it we separate R.C.A. with help of crusher and labour. After the separation we find out Natural aggregates and Recycled aggregates physical properties.

Then we used these aggregates by two ways directly uses of it and giving them process and uses of it. R.C.A. replacement of N.A. up to 10 to 30%.

Treatments to the R.A:

We applied cement slurry treatment to the R.A. to improve the properties of R.A. On the surface of R.A. there is old mortar adhere on it and due to this there is higher abrasion, impact and crushing value of aggregates. Also we observe in past research there is higher water absorption this happen due to on the surface of R.A. there is minute voids are available. By applied cement slurry treatment to the R.A. there is voids are poured and also old mortars are removed from the surface. In this treatment we used 1:10 ration of cement to water.

Make cement slurry as stated above proportion and put R.A. in to it for 24 hours. After 24 hours R.A. get out from the slurry and make them totally dry and then used in the concrete.

Physical properties of N.A., R.A. and P.R.A. are finding out and compare each.

(Properties of coarse aggregates)

Properties	N.C.A.	R.C.A.	P.R.A.
Impact value	17.18	26.58	24.5
Crushing Value	22.56	26.14	26.0
Abrasion value	23.54	33.35	29.51
Specific Gravity	2.61	2.56	2.60
Water Absorption	0.48	4.02	1.09
Fineness Modulus	7.42	7.02	7.12

(Properties of Fine aggregates)

Properties	Sand	`R.F.A.
Fineness Modulus	3.23	4.48
Water Absorption	0.38	5.1
Specific Gravity	2.64	2.12
Silt Content	1.07	5.56

IV. RESULTS AND DISCUSSION

(Compressive Strength After 7 and 28 days)

Sr. No.	Designation	Mix	Casting Date	Compressive Strength After 7 days (N/mm²)	Compressive Strength After 28 Days (N/mm²)
1	NAC	A	14/1/2016	15.88	22.69
2	10%RA	B	21/1/2016	15.53	20.32
3	20%RA	C	21/1/2016	14.76	20.21
4	30%RA	D	21/1/2016	14.44	19.878
5	10%PRA	E	11/2/2016	17.27	26.01
6	20%PRA	F	11/2/2016	16.68	26.293
7	30%PRA	G	11/2/2016	16.35	26.78

(Tensile strength After 7 and 28 days)

Sr. No.	Designation	Mix	Casting Date	Tensile Strength After 7 days (N/mm²)	Tensile Strength After 28 Days (N/mm²)
1	NAC	A	14/1/2016	1.95	2.299
2	10%RA	B	21/1/2016	1.45	1.957
3	20%RA	C	21/1/2016	1.386	1.834
4	30%RA	D	21/1/2016	1.33	1.712
5	10%PRA	E	11/2/2016	1.723	1.979
6	20%PRA	F	11/2/2016	1.62	2.045
7	30%PRA	G	11/2/2016	1.41	2.144

(Flexural strength results after 7 and 28 days)

Sr. No.	Designation	Mix	Casting Date	Flexural Strength After 7 days (N/mm²)	Flexural Strength After 28 Days (N/mm²)
1	NAC	A	14/1/2016	3.94	5.73
2	10%RA	B	21/1/2016	3.58	5.31
3	20%RA	C	21/1/2016	3.21	4.76
4	30%RA	D	21/1/2016	2.68	4.06
5	10%PRA	E	11/2/2016	3.56	6.06
6	20%PRA	F	11/2/2016	3.72	6.9
7	30%PRA	G	11/2/2016	3.92	7.53

(Workability and Compaction factor test)

Sr. No.	Designation	Mix	Slump Value (mm)	Compaction Factor
1	NAC	A	85	0.920
2	10%RA	B	70	0.890
3	20%RA	C	68	0.886
4	30%RA	D	63	0.876
5	10%PRA	E	89	0.928
6	20%PRA	F	91	0.932
7	30%PRA	G	96	0.942

V. CONCLUSION

- As discussed earlier we used normal R.A. and P.R.A. By using R.A. all the strength criteria are decreased. Compressive strength decreased up to 12 to 15% by using R.A. Same decreased in tensile strength and flexural strength.
- After then we applied Cement slurry treatment to the R.A. then we observe there is improve all the strength parameter.
- Also we measure workability and compaction factor of fresh concrete and there is lower workability of P.R.A.
- At the end we conclude that there is lower workability by using P.R.A. but there we get higher strength of concrete. Here we used W/C ratio 0.57 so if we modify mix design criteria or change in W/C ratio.

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