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An Experimental Study on the Effects of Recycled Concrete Consisting of Recycled Aggregates in Place of Natural Aggregates

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Abstract: ***In recycled aggregate concrete the cement mortar attached to the aggregates produce poor quality of concrete, thus rendering it useless. So a treatment process is used which separates the mortar from the aggregates, thus making it usable and also addressing the issue of sustainability. A study on the mechanical properties was done which was compared with conventional concrete and concrete with recycled aggregates. Cubes and cylinders were cast with replacement of 25%, 50%, 75% and 100% where the replacement percentage giving the highest strength was observed.***

Keywords: recycled coarse aggregates, treatment process, compression strength, split tensile strength

I. INTRODUCTION

Recycled concrete which is obtained from construction and demolition waste, isn't used on a large scale and rather ends up being dumped. Research is still being done to incorporate the use of recycled aggregates in concrete. Due to a large demand of natural aggregates, a decrease in the amount of aggregates is observed, bringing about the need to reuse the aggregates obtained from demolition of buildings. This paper brings out the use of recycled aggregates in place of coarse aggregate in concrete. Treatment of the recycled aggregates was done to improve the properties of the aggregates, thus making it useful once again. In this study, acid treatment process was used where the aggregates were pre-soaked prior to its use in concrete. Compressive strength and split tensile strength tests were done on the concrete specimens and were used as an indication of the load carrying capacity of the specimens.

II. MATERIALS AND METHODS

A. Cement

Ordinary Portland cement of grade 53 was used in the current study and the basic tests on cement are conducted as per IS 8112-1989.

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B. Fine Aggregate

River sand was used as fine aggregates. The determination of properties of sand were conducted by carrying out the tests as per IS 2386 (Part –I). The sand conforms to zone II and the specific gravity for sand is 2.5.

C. Coarse Aggregate

The maximum size of 20mm coarse aggregates were used for study of properties. The basic tests were conducted and experimented as per IS: 2386 (Part III) for natural coarse aggregate, recycled coarse aggregates and treated recycled coarse aggregates.

D. Recycled Coarse Aggregates (RCA)

The recycled coarse aggregates were collected from a site in Chennai which are from a demolished building. The aggregates were attached with mortar paste in forms of concrete blocks and are crushed. Laborers have used hammers to chipped the concrete blocks and sieved to get 20mm size of aggregates. Preliminary tests are conducted on natural coarse aggregates (NCA), recycled coarse aggregate (URCA) and Treated coarse aggregate (TRCA) are penned down in table 1.

Type of Aggregate	Tests conducted			
	Specific gravity	Impact strength (%)	Crushing value (%)	Water absorption (%)
NCA	2.680	18.43	16.9	1.2
RCA	2.40	34.15	58.76	5.9
TRCA	2.53	28.35	32.2	2.3

Table 1 Properties of coarse aggregate

E. Acid

Sulphuric acid (H_2SO_4) was used for the treatment process. The molar mass is 98.08 g/mole and density is 1.84 g/cm^3.

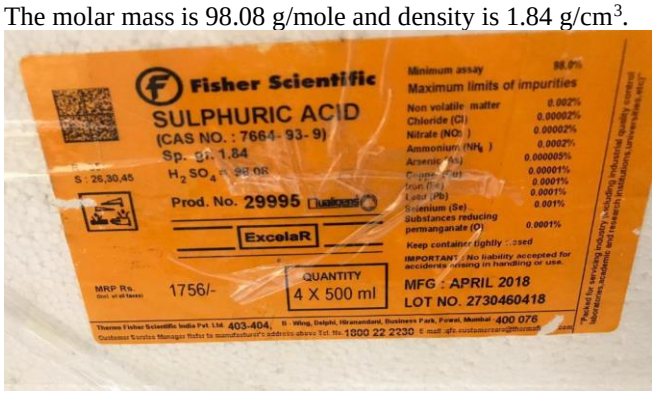

Figure 1 Shows the specification of the acid.

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F. Mix design and Determination of Proportions

A concrete mix for M30 grade was prepared as per IS 10262 -2009 achieving a ratio of 1:1.2:2.3 with water cement ratio of 0.45. The mix design was adapted for casting of specimens for various mix proportions with replacement of 25%, 50%, 75% and 100% of NCA with RCA (untreated and treated). The concrete specimens cast are conventional concrete (CC) with NCA, Untreated Recycled Aggregate concrete (UTRA) with recycled coarse aggregates and Treated Recycled Aggregate concrete (TRA) with treated coarse aggregates.

G. Improvement in properties of RCA

Treatment process is used for improving the properties of RCA. The RCA consists of cement mortar attached to it. Removal of loosely cement mortar was done by immersion of RCA in acid having concentration of 0.1 mole. The solution was prepared with addition of H_2SO_4 and distilled water. It consists of 1000ml of H_2SO_4 with 180 litres of distilled water and 205 kg RCA of maximum size 20mm was used. The aggregates were pro-soaked for 18 hours in the solution which were then washed with water for 3-4 times. At 110º C the aggregates were dried for 2 hours in the oven. Figure 2 shows the treatment process of RCA with H_2SO_4 mixed with distilled water.

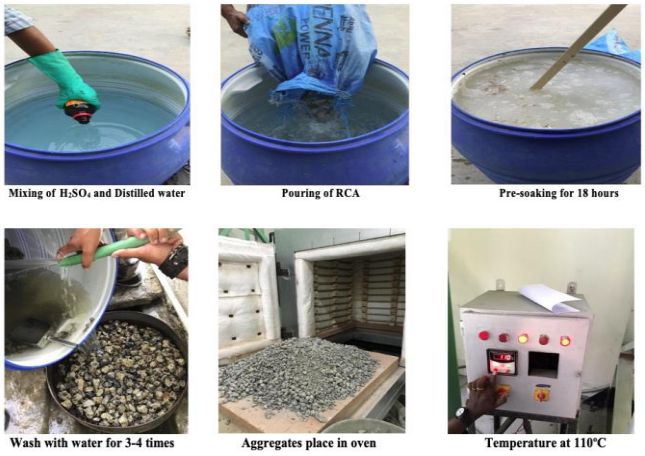

Fig. 2 Treatment process of RCA

H Casting and curing of specimens

Specimens of concrete cubes with mould dimensions of 150mmx150mmx150 mm and concrete cylinders with mould dimensions of 300mm long and 150mm diameter were cast for conducting tests such as compressive strength and split tensile strength. The specimens are demoulded after 24 hours and kept for curing. The specimens were cured by ponding technique for maximum of 28 days to achieve the characteristics strength. Figure 3 shows the casting and curing of the concrete specimens.

Fig 3 Casting and Curing of Specimens

III. RESULTS AND DISCUSSION

A. Compressive Strength

Compressive strength tests are conducted on cubes as per IS 516 1959 for conventional concrete (CC) and replacements of 25%, 50%, 75% and 100% for Untreated Recycled Aggregate concrete (UTRA) and Treated Recycled Aggregate concrete (TRA). The results are noted at 7^{th}, 14^{th} and 28^{th} day. The values obtained for compressive strength after testing is penned down in the table 2. It clearly shows that at 25% replacement of TRA after 28^{th} days of curing the compressive strength increases more than conventional concrete and UTRA.

Table 2 Compressive tests of CC, UTRA and TRA at different ages

Mix type	Replacement of RCA	Compressive strength N/mm^2		
		7^{th} day	14^{th} day	28^{th} day
CC	0%	26.08	29.8	36.35
UTRA	25%	32.13	34.88	38.17
	50%	27.2	33.7	37.06
	75%	25.7	28.9	31.06
	100%	20.84	25.9	29.9
TRA	25%	36.57	41.15	45.3
	50%	31.8	37.28	40.4
	75%	29.8	34.22	40.6
	100%	28.8	33.46	40.3

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From the table, it is noted that the concrete mix consisting of treated recycled aggregates (≥ 40 N/mm^2) displayed better compressive strength values than that of conventional aggregates (36.35 N/mm^2). Figure 4 shows the graphical representation of comparison of compressive strength between the conventional concrete, untreated recycled coarse aggregate concrete and treated recycled coarse aggregate concrete.

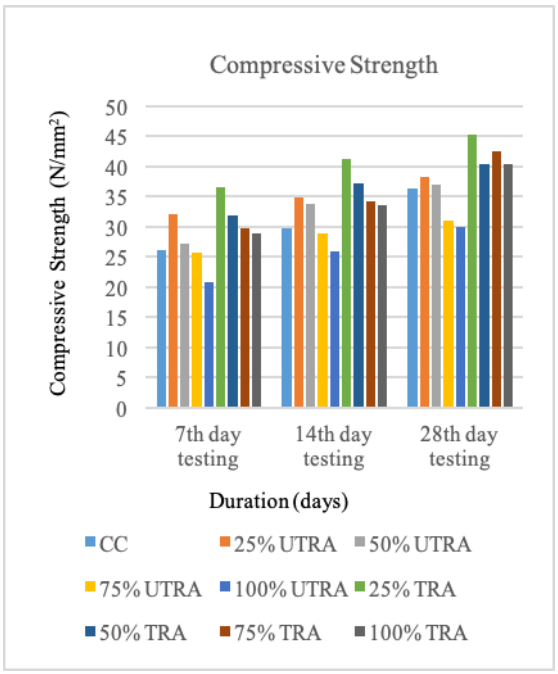

Fig 4 Compressive Strength

Figure 5 shows the compressive strength tests conducted on cubes.

Fig 5 Compressive Strength Tests on cubes

B. Split Tensile Strength

The cylindrical specimens for CC, UTRA and TRA were tested as per IS 5816 1970 and the values for split tensile strength of specimens at different ages are tabulated at table 3.

Table 3 Split Tensile Strength of CC, UTRA and TRA

Mix type	Replacement of RCA	Split Tensile Strength N/mm^2		
		7th day	14th day	28th day
CC	0%	2.59	3.15	3.83
UTRA	25%	2.17	2.39	3.02
	50%	2.32	2.87	2.91
	75%	1.85	2.39	3.15
	100%	1.4	2.16	2.7
TRA	25%	2.5	3.2	3.9
	50%	2.4	2.7	3.23
	75%	2.16	2.5	3.12
	100%	1.68	2.2	2.9

From the table, it is observed that the concrete mix consisting of treated recycled aggregates having a replacement percentage of 25 (3.9 N/mm^2) displayed enhanced split tensile strength values in comparison with that of conventional aggregates (3.83 N/mm^2)

The graph in figure 6 shows the comparison between CC, UTRA and TRA.

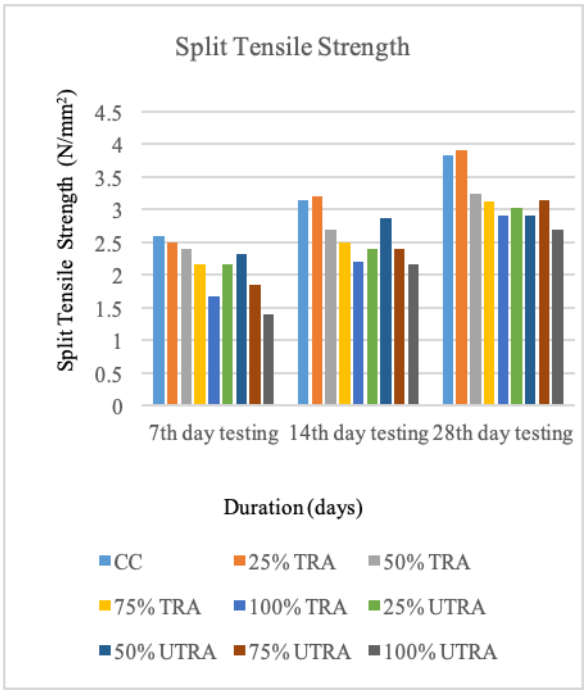

Fig 6 Comparison of CC, UTRA and TRA

Figure 7 shows the Split Tensile Tests conducted on cylinder specimens.

Fig 7 Split Tensile Strength Tests on cylinders

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C. Flexural Strength

The mould size of 100mm x 100mm x 500mm are used. In order to carry out the flexural strength test, specimens consisting of CC without RCA, UTRA and TRA with 25% replacement of RCA (untreated and treated) are casted. The tests are carried out as per IS specifications and the values obtained for flexural strength after testing is penned down in the table 4.

Table 4. Flexural strength of CC, UTRA and TRA at Different Ages

Mix type	Replacement of RCA	Flexural Strength (N/mm^2)		
		7th day	14th day	28th day
CC	0%	2.5	5	6.5
UTRA	25%	5	6	6.5
TRA	25%	6.5	7	7.5

The Table 4 above shows the result of flexural strength test on CC without RCA, UTRA and TRA with 25% replacement of RCA (untreated and treated). It can be seen that the concrete mix consisting of treated coarse aggregates (TRA) having a replacement percentage of 25 achieves higher strength than CC and TRA after 28 days of curing.
The graph in figure 8 shows the comparison flexural strength of different proportions at different ages.

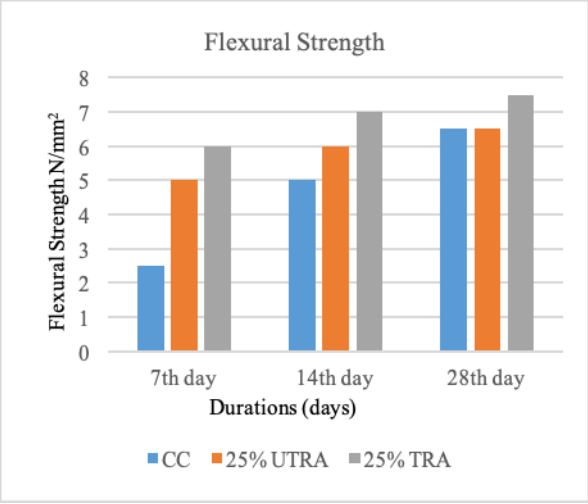

Fig 8 Flexural Strength

Figure 8 shows Flexural Strength Tests conducted on cylinder specimens.

Fig One Point Load Testing on Beams

IV CONCLUSION

- The basic tests on the properties of the Treated Recycled Coarse Aggregates showed similar values to that of Natural Coarse Aggregates.
- From the experimental investigation it is concluded that in the case of Treated Recycled Aggregate Concrete (TRA) partial replacement of aggregates at 25% yielded superior values in compressive, split tensile, and flexural strength tests.
- It is also noted that the remaining replacement percentages (50,75 and 100) in the case of treated coarse aggregates produce comparable values to that of conventional concrete in both compressive and split tensile strength tests.

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REFERENCES

1. Monalisa, Behera, S.K. Bhattacharyya, A.K. Minocha, R. Deoliya, S. Maiti, (2014). Recycled aggregate from C&D waste & its use in concrete. Elsevier, 68 501-516.
2. George Dimitriou, Pericles Savva, Michael F.Petrou, 2017. Enhancing mechanical and durability properties of recycled aggregate concrete. Elsevier, 158 (2018) 228-235).
3. Iva Despotovic, 2016. The improvement of recycled concrete aggregate. Contemporary achievements in construction 22 April 2016 Subotica, SERBIA.
4. Caijun Shi, Yaku Li, Jiaki Zhang, Wengui Li, Linlin Chong, Zhaobin Xie, 2016. Performance enhancement of recycled concrete. Elsevier, 112 466-472.
5. Anmnon Katz, 2004. Treatments for improvement of recycled aggregate. Journal of materials in civil engineering, ASCE, NOV/DEC 2004/597.
6. Shrinath.H, Bharat Kumar, Avinash Sumit, Vinodkumar L, 2016. Influence of treatment methods on recycled aggregate concrete made with recycled coarse aggregate. International journal of scientific development and research, volume 1, Issue 5, may.
7. V.P. kukadia, Dr. D.N.Parekh, Dr. R.K. Gajjar, 2017. Influence of aggregates treatment on properties of recycled aggregate concrete. International journal of civil engineering and technology, volume 8, Issue 3, march, pp 351-361.
8. MD safiuddin, M.A. salam, M.Z. Jumaat, 2011. Effects of recycled aggregate on the fresh properties of self-consolidating concrete. Archives of civil and mechanical engineering, volume XI, No.4.
9. Duan, Z.H., and Poon, C.S. (2014), Properties of recycled aggregate concrete made with recycled aggregates with different amounts of old adhered mortars. Materials and Design, Vol. 58, pp.19-29.
10. Sami W. Tabsh, Akmal S. Abdelfatah, 2009. Influence of recycled concrete aggregates on strength properties of concrete. Construction and Building Materials, Elsevier, 1163-1167.
11. Mirjana Malesev, Vlastimir Radonjanin, Snezana Marinkovic, 2010. Recycled Concrete as Aggregate for Structural Concrete Production. Sustainability 2, 1204-1225, MDPI.

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