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PROPERTY OF CONCRETE USING RECYCLED AGGREGATE

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ABSTRACT: The use of recycled concrete in load bearing structures has not gained wide acceptance probably because of reduction in mechanical and physical properties, such as expected fresh and hardened material properties. Concrete is not the only recycled material that has been used in previous construction applications. Construction and demolition (C and D) waste is defined as the solid waste generated by the construction, remodeling, renovation, repair, alteration or demolition of residential, commercial, government or institutional buildings, industrial, commercial facilities and infrastructures etc. Construction and demolition waste is considered as high volume, low risk. It is commonly understood that this waste can be considered a resource, either for reuse in its original form or for recycling or energy recovery. If suitably selected, ground, cleaned and sieved in appropriate industrial crushing plants, these materials can be profitably used in concrete. Despite this, most Construction and Demolition waste ends up in landfills. This Paper highlights the composition of Construction and Demolition waste, the need for its recycling and examines experimentally the properties of recycled aggregate concrete options that can be implemented for its efficient use in the field of concrete technology by addition of cement composition of 10%, 20%, 30%, 40%, 50%, and 60% in natural aggregate concrete and recycled aggregate concrete having w/c ratio of 0.42. And check out all the strength properties of hardened concrete and properties of green concrete. Recycling concrete is a viable option to decrease the demand on high quality natural resources and to limit the amount of waste that is disposed in landfills.

Keywords: Recycled aggregate concrete, Construction and Demolition waste, Workability, Water-Cement ratio, Natural aggregate concrete.

I. INTRODUCTION

The term construction and demolition stands for building disposing and make the aggregate in useful form. In presently one more serious problem is disposing the raw concrete aggregate at comfortable cost. As the solid waste produced by the construction, remodeling, renovation, repair, alteration or demolition of residential, commercial, government or institutional buildings, industrial, commercial facilities and infrastructures such as roads, bridges, dams, tunnels, railways and airports. Construction and demolition waste is considered as high volume, low risk. It is commonly understood that this waste can be considered a resource, either for reuse in its original form or for recycling or energy recovery. Because of increasing waste production and public concerns about the environment, it is desirable to recycle materials from building demolition. If suitably selected, ground, cleaned and sieved in appropriate industrial crushing plants, these materials can be profitably used in concrete. If recycled aggregates were practically useful in construction area, two aspects would be expected. One is illustrated at the beginning of introductions; the other one is that we could reduce consumption of natural aggregate resources. Engineers have also used recycled concrete As an aggregate in the construction of new structures such as concrete pavements but with limited frequency. The use of recycled concrete in load bearing structures has not gained wide acceptance. Despite this, most Construction and Demolition waste ends up in landfills To achieve sustainable issue in construction area, researchers and companies focus on using waste concrete as a new construction material. It is called recycled aggregate which can be produced by concrete crusher. The aggregates are categorized by size as coarse and fine aggregate. The use of recycled aggregate generally increases the drying shrinkage and creep and decreases the compressive strength and modulus of elasticity of concrete compared to those of natural aggregate concrete (G. Murali, C.M. Vivek Vardhan 2012)[1].

Sometimes, good sized precast element are also obtained during the demolition, which

Figure 1Texture comparison between Natural aggregate & Recycle aggregate

have a potential of being reused or otherwise, these are also crushed and converted into the recycled aggregates (Shishir Bansal, S K Singh 2014)[2].

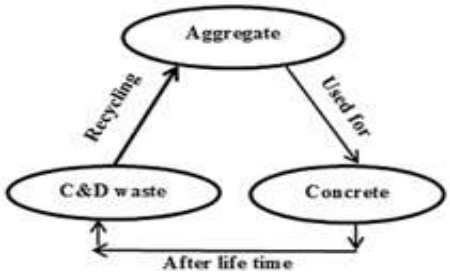


Figure 2 Schematic representation of recycling technique

Recycled aggregate concrete passing 4.76 mm sieve is not recommended for general use in concrete because it usually has an adverse effect on water demand and may contain increased levels of contamination. In specific circumstances where there is a high degree of control (e.g. fines from reclaimed product at a precast concrete works), 10% replacement of natural sand can be made without adverse effect on the product(CSE 2013)[3]. Adding water may increase workability, but will have adverse influence on the strength and the durability of the resulting concrete. Generally, the addition of some more super plasticizer will be sufficient; a common alternative is to increase both water and cement, thereby keeping the water/cement ratio constant [Akash Rao 2006] (4).

II. LITERATURE REVIEW

As we know the properties of natural aggregate concrete gets changes due to the replacement of natural aggregate by recycled aggregate. Many papers have being published which tells about the compressive strength, flexural strength, split tensile strength, water absorption, and Workability of concrete according to their opinion. Construction and Demolition (C&D) debris is defined as that part of the solid waste stream that results from land clearing and excavation, and the construction, demolition, remodeling and repair of structures, roads and utilities(Building Research Establishment Watford UK, 2013)[5] (Shivakumar, M. N, Nithin K.S, B.M Gangadharappa, IJRET) Porous concrete may be an alternative to the conventional concrete because of low density and high porosity. He also conclude that Aggregate ratio of 1:8 with 50 % of CA and 50% of BDW is recommended for low traffic volume. Similarly mix design with w/c ratio of 0.40 and 0.45 with 50% of CA and 50% of BDW is suitable for intended use. [G. Murali, C.M. Vivek Vardhan, Gabriela Rajan, G.J. Janani, N. Shifu Jajan and R. Ramya sri 2012] (1) The test results showed that the flexural, compressive and split tensile strength of the recycled aggregate concrete is found to be lower than the natural aggregate. However the strength of recycled aggregate concrete can be improved by the water and acid treatments. Furthermore Recycled aggregate treated with nitric acid displayed the decent result compared to the hydrochloric and sulphuric acid and from economical point of view; water and acid treated recycled aggregates can be used in place of natural aggregates for temporary structures. (Mr. Tushar R Sonawane, Prof. Dr. Sunil S. Pimplikar)[7] Due to use of recycled aggregate in construction, energy & cost of transportation of natural resources & excavation is significantly saved. This in turn directly reduces the impact of waste material on environment and he also conclude that various tests conducted on recycled aggregates and results compared with natural aggregates are satisfactory as per IS 2386. Asif Husain and Majid Matouq Assas 2013](8) concluded that the Impact value tests on aggregates allow only 20% of dismantled aggregate, the higher percentage of recycled aggregate increases the crushing value of the aggregates, Water absorption increases from 1.5% (for 100% fresh new aggregate) to 4.6% (for 100% dismantled aggregate) and With different w/c ratio as recommended in IS456-2000 compressive strength of mix increases by 26.75% when fresh aggregate is replaced by 75% dismantled aggregate, however slump decreases to 2/3rd value. Increasing w/c ratio from 0.60 to 0.625 i.e. by 4.16%, slump increases from 21mm to 60mm when fresh aggregate is replaced by 75% dismantled with 12.68% increase of compressive strength of the mix.

III. MATERIAL USED

3.1 Cement: OPC (Ordinary Portland cement) of (43-grade) has been used in this experimental work. OPC 43-grade cement has been investigate the strength of cement at 28 days as per IS 4031-1988.The various properties of the cement are described in Table 1.

TABLE 1: Property of Cement

Sr. No.	Characteristics	Experimental value	Specified value as per IS:8112-1989
1	Consistency of cement (%)	31%	---
2	Specific gravity	2.98	3.15
3	Initial setting time (minutes)	35	>30 As Per IS 4031-1968
4	Final setting time (minutes)	270	<600 As per IS4031-1968
5	Compressive strength (N/mm^2) (i) 3 days (ii) 7 days (iii)28days	 25.30 38.26 47.28	 >23 >33 >43
6	Soundness (mm)	1.00	10
7	Fineness of Cement	5%	10% As Per IS 269-1976

3.2 Fine Aggregate: The physical Properties of sand like Fineness Modulus, Specific Gravity and water absorption are 3.49, 2.67 and 2.31%and comes under Zone II

3.3 Natural coarse aggregate: The Coarse aggregate are obtained from a local quarry has been used. Coarse aggregates with a maximum size of 20mm and having specific gravity of 2.89. In this experimental work coarse gravel of 20mm and crushed aggregate of 10mm are mixed in 60:40. The physical Properties of coarse aggregates like Fineness Modulus, Specific Gravity are 2.31, 2.89 respectively.

3.4 Recycled Coarse Aggregate: Crushed concrete aggregate waste passing through 20mm and retained on 4.75mm I.S sieve were used as recycled coarse aggregate and they met the grading requirement.

3.5 Water: Portable water available in laboratory was used for mixing and curing the concrete specimens, Which should be free from injurious amounts of oils, acids, alkalis, salts and sugar, organic substances that may be deleterious to concrete. Pre Soaking Treatments: The recycled aggregates were crushed and soaked in water for 24 hours for water treatment then kept for drying.

3.6 MIX PROPORTION

we mixed cement composition in Recycled and natural aggregate with 20%, 30%, 40%, 50%, and 60% of aggregate and prepare sample, denoted by MX20(20% cement and 80% RA), MX30%, MX40%, MX50%, MX60% Respectively and having w/c ratio of 0.42. We used two stage mixing approach (TSMA) Firstly we have added RCA+RFA for 60 Seconds then addition of Cementations Materials for 60 Seconds, then ¾ of Water For 120 seconds and at last we added rest of ¼ of water + Sand for 60 seconds. Now fill these pastes in cube having standard size of 150 mm3 in three layers and each layer is compacted by 25 blows with tamping road. After 24 hours they are put in a water tank for cuing then in another mould we mixing cement composition with NA, and same composition and rest process is same as in RCA. And 30 to 40 samples has been prepared and used in UTM.

IV. EXPERIMENTAL PROGRAMME

4.1 COMPRESSIVE STRENGTH TEST: To examine the compressive strength of Recycled aggregate concrete, cube of 150mmX150mmX150mm has been used, in this experimental work 30-40 cube has been casted to determine the compressive strength. Now with this prepared green concrete we make mould of cube size 150 mm and after 24 hours curing them in tank containing potable water. After that the specimen are tested at 7 days and 28 days at compression testing machine (CTM) the test is shown in figure 3.

4.2 SPLIT TENSILE STRENGTH TEST:

To examine the tensile strength of recycled aggregate concrete Split-tensile strength test is most accurate, in this process; cylinder of size 150mm x 300mm has been used in experimental work 30-40 cylinders has been casted to determine the tensile strength.

Figure 3 cube under compression testing machine (CTM)

After 24 hours and placed in the curing tank. After that, cylinders were tested horizontally under compression testing machine (CTM).

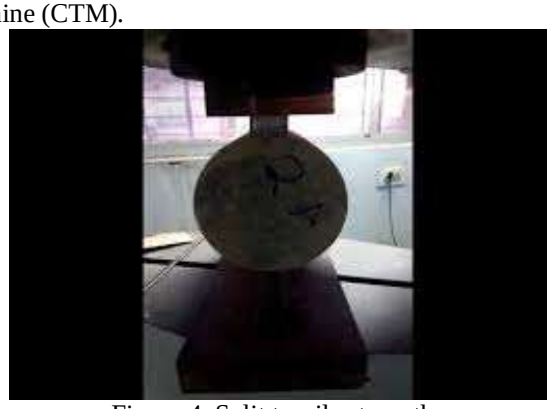


Figure 4 Split tensile strength

4.3 WORKABILITY: Workability is one of the physical parameters of concrete which means how ease to work; it affects the strength and durability of concrete. Concrete is said to be workable when it is easily placed and compacted homogeneously without honeycombs, bleeding or Segregation etc. its mainly depends upon the w/c ratio. We will find out workability of recycled aggregate concrete by slump test.

4.4 WATER ABSORPTION

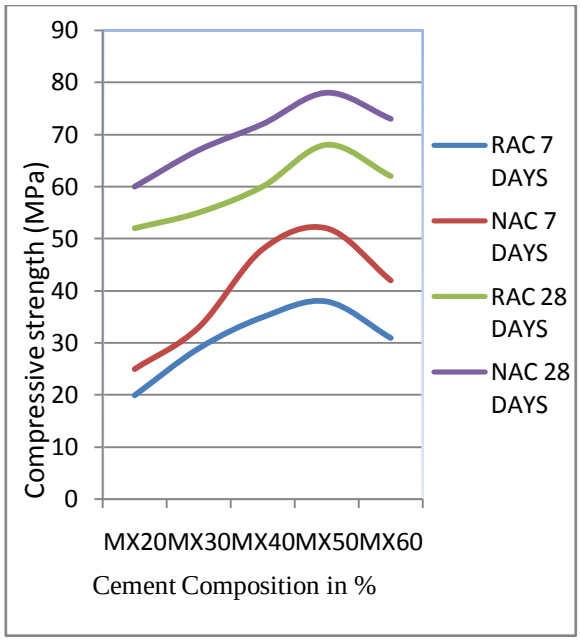
Water absorption test is conducted to find out the amount of water absorbed by the recycled aggregates. Water absorption of RCA is higher than NA due to attachment of mortar with aggregates. Porosity rather than content of mortar had a significant effect on water. As size of aggregate decreases then water absorption capacity increases.

V. TEST RESULTS

5.1 Compressive Strength: All specimens prepared for RAC & NAC before in the experimental program were prepared, cured, and tested for compressive strength at 7 and 28 day. Observations which had been taking from experimental program had been shown below in table I Variation of compressive strength with different age is shown below in graph which shows that compressive strength of both RAC & NAC get decrease with more than 50 % addition of cement composition.

Table no.1 for Compressive strength

Cement Composition in %	Weight (Kg)	Compressive Strength (MPa) (For 7 days)		Compressive Strength (MPa) (For 28days)	
		RAC	NAC	RAC	NAC
MX20	5	20	25	52	60
MX30	5	29	33	55	67
MX40	5	35	48	60	72
MX50	5	38	52	68	78
MX60	5	31	42	62	73



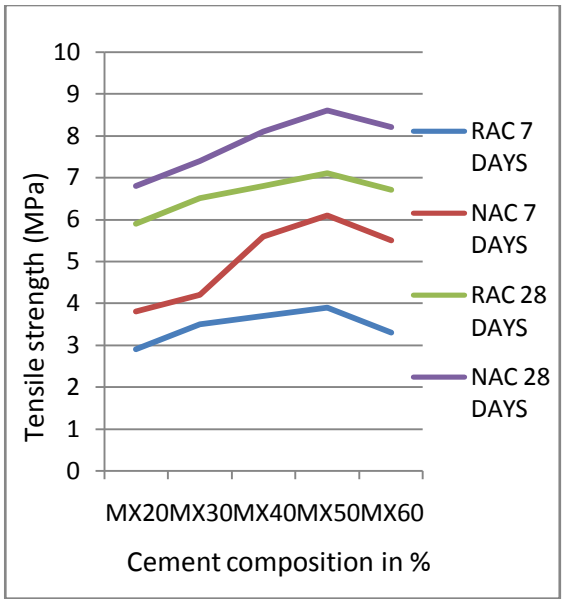
Graph no. 1 for Compressive strength

5.2 Tensile strength: For calculating tensile strength using Split tensile strength test, as cylinder having size of 150mm x 300mm is testing in same universal testing machine. First three cube samples are tested after 7 Days of curing and remaining are after 28 days of curing results of Split Tensile strength are shown in table II.

Table no.2 for Tensile strength (RAC & NAC)

Cement Composition in %	Weight (Kg)	Tensile Strength (MPa) (For 7 days)		Tensile Strength (MPa) (For 28 days)	
		NAC	RAC	NAC	RAC
MX20	5	3.8	2.9	6.8	5.9
MX30	5	4.2	3.5	7.4	6.5
MX40	5	5.6	3.7	8.1	6.8
MX50	5	6.1	3.9	8.6	7.1
MX60	5	5.5	3.3	8.2	6.7

Graphically representation of tensile strength for RAC & NAC



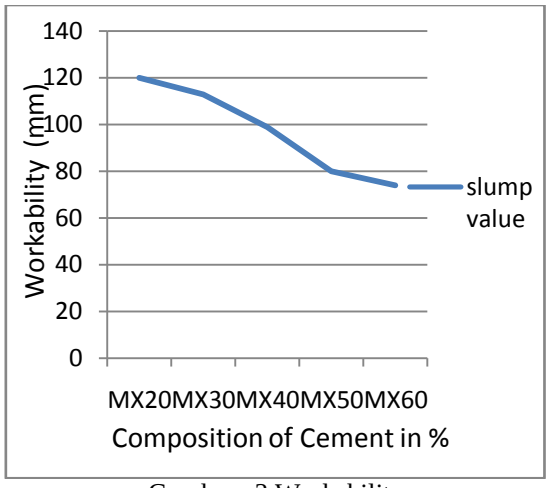
Graph no.2 Tensile strength for RAC & NAC

From the fig. no.2 it is observed we can use cement content up to 50 % in Split tensile strength test of recycled aggregate concrete. After that there is decreasing in tensile strength. Primary reason of strength reduction may be the adhered mortar to the RCA and other non-aggregate material. This can be corrected by using proper cleaning techniques and casting methods under highly skilled supervision.

5.3 Workability: Slump flow test of concrete is performed to testing the size maintaining ability of concrete that is very important for any construction project. The slump is taken for each mixing of RCA and NCA having 20%, 40%, 60%, 80% and 100% replacement with cement composition. The changes in values with parameter are shown below in table III. This result of workability of RCA & NCA is also shown below graphically in fig. no.3. These results show that slump of concrete made with natural aggregates is higher while the concrete with 100% replacement of RCA has fewer Slumps. The low slump in RCA is caused by the high absorption of RCA which absorbs water during the mixing process.

Table III for Slump test.

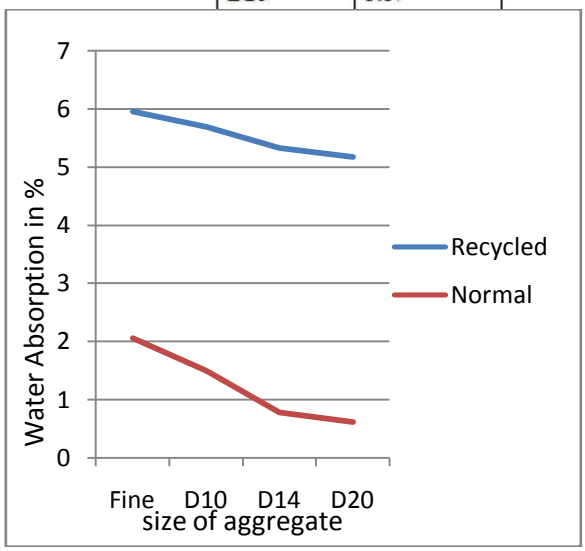
Sample	Mould height (mm)	Cement Ratio	Test (mm)
MX20	300	1:08	120
MX30	300	1:08	113
MX40	300	1:08	99
MX50	300	1:08	80
MX60	300	1:08	74



Graph no.3 Workability

5.4 Water Absorption test: Water absorption was conducted on Recycled aggregates and natural aggregates, in which different size of sample of NA and RA (Fine, D10, D14, and D20) after addition of water for 24 hour. Results are shown in table IV & Graph no.4.From this table we concluded that water absorption test for RA get increase by 2 to 5 % as compare to NA and water absorption value get increases becouse aggregate having of small size absorb more water due to high voids and porosity of smaller particals and also due to already deposition of cement with crushed recycled aggregate. Test results of water absorption test are shown below in Table IV

Types of	Aggregate	Water Absorption %
Normal	Fine	2.05
	D10	1.49
	D14	0.78
	D20	0.61
Recycled	Fine	5.95
	D10	5.69
	D14	5.32
	D20	5.17



Graph no.4 Water Absorption

VI. CONCLUSIONS

Experimental works on the use of recycled aggregates have proven that very good quality concrete could not be produced with recycled aggregates. The use of aggregates produced from recycled construction and demolition waste should be further promoted. Based on the experimental investigation the following conclusions are drawn:

- The recycled aggregate concrete has a convenient compressive strength, flexural strength, and bond strength, which means a convenient concrete for structural elements in concrete structures.
- The workability of recycled aggregate concrete mix is lower than natural aggregate, concrete mix with 30.0% recycled aggregate concrete has satisfied workable concrete.
- The maximum compressive strength of 89 MPa for NAC and 68MPa for RAC which is at 50% replacement of used recycled aggregate concrete.
- The maximum tensile strength for NAC is 8.6 MPa and 7.1Mpa for RAC which is at 50% replacement of used recycled aggregate concrete
- We conclude that as we increases the cement Composition then as w/c ratio is decreases and paste become stiff so workability decreased.
- Water absorption capacity of recycled aggregate concrete is get increases 5 to 7 %, due to rough surface and porosity of recycled coarse aggregate. Thus the water absorption results are satisfactory.

After making this experimental study on recycled aggregate concrete we conclude that it should b used at a place where the importance of their properties should not b very high. We can use the recycled aggregate concrete in construction of roads, land filling pavement blocks and kerbs. Presently maximum part of recycled aggregate concrete is used in floor and transportation road construction process. We have to conserve natural resources if we required a sustainable environment for our future generation.

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