STRENGTH PROPERTIES OF RECYCLED AGGREGATE CONCRETE - CONVENTIONAL CONCRETE AND SELF – COMPACTING CONCRETE

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ABSTRACT:- *The objective of the present investigation is M30,M40 grades concrete has been considered. Compressive strength and Flexural strength of conventional as well as self-compacting concrete were investigated. The Development of these strength with different age of curing is investigated.*

The properties of recycled aggregate differed from those natural aggregate. For the production of concrete for both conventional and self-compacting concrete, these recycled aggregates are replaced by normal concrete, always in ascending order of 10%, 20%, 30%. However, these changes did not affect the properties of the recycled aggregate, both in the normal case and in the self-compaction of the concrete. However, in the case of self-compacting concrete, it has been observed that the quality of the concrete deteriorates after a certain percentage of recycled aggregate with natural aggregate. The high water absorption of the recycled aggregate is ensured by the process before wetting, whereby the recycled aggregate becomes functional as a natural inert substance.

Keywords: *Compressive strength, Tensile Strength, Flexural Strength.*

I INTRODUCTION

The world is making rapid development in the field of science and technology where this system depletes natural resources due to its high use. A lot of environmental pollution is caused by excessive use of resources.

In recent years, mitigation of this pollution has increased with the use of sustainable materials. Strong support helps the environment by reducing the consumption of unchanging natural resources. Water is the primary material used in the process where matter is the second most commonly used material in the world, which uses the ecological properties of the environment for its production. Thus, to reduce the use of resources, many researchers have designed to use recycled materials in the manufacturing such as fly ash and recycled aggregated materials. Over the past few decades, a number of research projects have been carried out to assess the material and durability of aggregates. As a result, there has been significant progress in the incorporation of mixed materials as building blocks with RAC members. Compared to natural mixtures, mixtures generally have water extraction and porosity, low strength and low density. For this reason , the RAC operating system achieves grater physical and material efficiency compared to the conventional aggregate(NAC), which includes low performance and poor performance. For 100% composite materials, the compressive strength of the RAC was reduced by 9-40% according to the experimental design.

According to the report, from this world it is estimated that 10 billion tons are produced annually and 1 billion tons are produced annually by a single construction company due to structural damage. As the composition of 70% of the aggregates, the aggregation of the elements from the aggregate aggregation will work effectively in reducing the said deviation.

Scope of this Investigation:

- **Production of recycled concrete aggregate:** Jaw crushers are basically used to process the

aggregates from the old concrete. This applies to bulk needs. But in this case the aggregates were prepared by hand pressure.

- **Concrete mixes:** OPC grade 53 was used to prepare the M30,M40 mixtures for conventional and self – compacting concrete and RCA replacement up to 10%, 20%, 30% natural aggregates
- **Specimens for casting:** 78 cubes of size 150mm*150mm*150mm.
- **Test period:** The cubes were tested for 3,7,28 days strength for compressive strength and 28 days strength for split tensile strength and flexural strength.

II LITERATURE REVIEW:

Vinod M Mohitkar and Prashant O Modani (1), Recycled aggregate self-compacted concrete (2015) In construction industry the use of recycled aggregates has been increasing sustainably as a green solution.The fresh concrete properties according to EFNARC guidelines are satisified by S.C.C. made of R.C.A. Concrete made of RCA gain early strength due to the presence of previously hydrated old concrete adhered to RCA.Good resistance for chloride and acid attack upto 40%.

Prashant O Modani and Vinod M Mohitkar(6),Self-compacting concrete with recycled aggregate-a solution for sustainable development(2014),The value of the mechanical properties of the recycle aggregate self-compacting concrete increase initially nd reduce from 40% replacement of R.C.A.The acid attack and the alkanity values also effect the concrete from 40%replacement by R.C.A.

Narud (8), Recycled concrete in low-strength concrete in fly ash technical report (1981) found that the S.S.D density for recycled fine aggregates produced For a specific concrete which was made with a water-cement ratio of 0.7, from it was 2276 kg/m3 .Generally, the S.S. D for hardened concrete range between 2080-2401kg/m3.But for aggregates recycled from such concrete the densities will be around 2000kg/m3 which is much lower than the prior mentioned case.

The **Nixon(9), Recycled aggregate as an aggregate for concrete-a review (1978)** report explains that that the strength values for the concrete produced by using the recycled aggregates showed lower strength values.

The **Geradu and Hendriks(10), recycling and reuse as a basis of sustainable development in construction industry (1996)** report explains that the compressive strength of recycled aggregate concrete made with recycled coarse aggregate and natural sand isalmost 95% or more than the strength of that of the conventional concrete.

Vyncke (11), Recycling and construction and demolition waste in Belgium: sActual situation and future evaluation (1994) report he confirmed that compressive strength of the concrete made with the recycled coarse aggregates had an increase of 8.5% than that of the conventional concrete

The **Kasai (12), Physical properties of recycled concrete using recycled coarse aggregates made of construction with finishing materials (1994)** report explains that also proved that the strength of the concrete made of recycled aggregates can also be higher than the concrete made of identical aggregates.

The **S.K.SHARMA, P.C.Nagaraj and others(13), State-of-art report on recycled aggregate concrete (1997)** report explains that in the case of SCC also the values of the compressive strength do not change majorly rather a increase in the figures is observed.

The **Ramamurthy, K &Gumatse (14), Properties of recyced aggregate concrete (1998)** explains that due to the use of recycled aggregates the rebound value and the ultra-sonic pulse velocity value of concrete are reduce. It was also found that the though there was a decrease

in the above mentioned characteristics the relation between the compressive strength and ultrasonic pulse velocity and that of compressive strength value and rebound value did not change notably.

The **CD Pauw (15), Reuse of of building materials and disposal of structure waste materials (1994)** report explains that the range ofthermal expansion coefficient for recycled aggregate concrete and that of natural aggregate concrete is almost similar.

The **Rasheeduzzafar and Khan(17), Recycled concrete the source of new concrete (1984)** report explains that the low strength values and higher water absorption of the recycled aggregate self-compacted concrete can be compensated by using the lowered water-cement ratio of 0.05-0.1 than the normal concrete.

III EXPERIMENTAL INVESTIGATIONS

To carry out our desired investigation, the experiment is planned to be carried out in the following 3 steps:

1. **Procurement of the materials and their testing:** The major constituents of the concrete viz., cement, natural coarse aggregate, fine aggregate, fly ash which are available in the market are procures. The recycled coarse aggregates which are not openly available in the market are processed individually. The concrete cubes, cylinders etc., which have been casted previously and which are not of any more structural usage are gathered and are broken down to the desired sizes manually. Later they are stacked separately other constituents of concrete.

2. **Testing the concrete for molding and curing:** Moulding of the specimen basically is done after all the workability test are carried out both in the case of conventional concrete and self-compacted concrete. Basically the specimens are initially layered with the grease or any oil to prevent the problem of surface friction.
The concrete mixe, is placed into the specimens each in one by three level and is tempered in each case for about 25 to 35 times and the upper layer of the mould after filling it completely is smoothened and placed on the table vibrator so that the upper portion of the cube or specimen is finish smoothly.

Figure 1 Casting of Moulds

3. **Testing the casted specimen:** Concrete is strong in compression when compared to that in tension so , to overcome this reinforcement is provided t the concrete members but in some cases due to the properties of concrete such as shrinkage, rusting of steel reinforcement etc., concrete is also subjected to certain tension forces. To calculate the strength Flexural strength test and Split tensile strength test are performed.

IV RESULTS AND CONCLUSIONS

PROPORTIONING OF CONCRETE MIX DESIGN
STIPULATIONS FOR PROPORTIONING

1. Grade Designations M 30
2. Type of cement grade OPC m53
3. Maximum nominal

size of aggregate 12mm
4. Minimum cement content 320kg/m3
5. Maximum water-cement ratio 0.40
6. Workability 100mm
7. Exposure condition Severe
8. Method of concrete placing pumping
9. Degree of Supervision Good
10. Type of aggregate crushed angular aggregate
11. Maximum cement content 400kg/m3
12. Chemical admixture type Super plasticizer

TEST DATA OF MATERIALS

TEST DATA OF MATERIALS

1. Cement used OPC 53 grade
2. Specific gravity of cement 3.14
3. Chemical admixture Superplasticizer
4. Specific gravity of
   a. Coarse aggregate (12mm) 2.6
   b. Fine aggregate 2.55

WATER ABSORPTION

1. Coarse aggregate (12mm) 0.7
2. Fine aggregate 1.6
3. Recycled aggregates 5.6

TARGET STRENGTH

1. fck 38.25

WATER CEMENT RATIO

1. Water cement ratio 0.40
2. Selection of water content 148 kg
3. Volume of coarse aggregate 0.640
4. Volume of fine aggregate 0.366
5. Cement content 370kg/m3

MIX CALCULATIONS

1. volume of concrete 1m3
2. volume of cement 0.140m3
3. volume of chemical admixture (superplasticizer) Percent by mass of cementitious materia 0.006
4. volume of all in aggregate 0.743m3
5. mass of coarse aggregate (12mm) 1192kg
6. mass of fine aggregate 680kg
7.

MIX PROPORTIONS FOR FINAL TRIAL -Conventional Concrete

Material	M30 Grade Concrete	M40 Grade Concrete
Cement	11.1kg	12kg
Coarse aggregate(12mm)	28.56kg	35.04 kg
Fine aggregate	26.83kg	19.8 kg
Water	6.56lt	4.8lt
Admixture	0.066kg	0.072 kg

MIX PROPORTIONS FOR FINAL TRIAL-Self-Compacting Concrete

Material	M30 Grade Concrete	M40 Grade Concrete
Cement	11.1kg	12kg
Coarse aggregate(12mm)	22.05 kg	19.8 kg
Fly ash	4.14 kg	5.01 kg
Fine aggregate	28.44kg	29.28 kg
Water	5.97lt	5.91lt
Admixture	0.066kg	0.072 kg

Mix proportions M30 (CONVENTIONAL CONCRETE)

Cement (Kg)	COARSE AGGRGATE (Kg)	FINE AGGREGATE (Kg)	WATER (Kg)	SP DOSAGE (Kg)	
	NATURAL	RECYCLED			
370	1192	0	680	148	2.22
370	1072. 8	119.2	680	148	2.22
370	953.6	238.4	680	148	2.22
370	834.4	357.6	680	148	2.22

Mix proportions
M40(CONVENTIONAL CONCRETE)

Cement (Kg)	COARSE AGGRGATE (Kg)		FINE AGGREGATE (Kg)	WATER (Kg)	SP DOSAGE (Kg)
	NATURAL	RECYCLED			
400	1168	0	660	160	2.4
400	1051.2	116. 8	660	160	2.4
400	934.4	233.6	660	160	2.4
400	817.6	350.4	660	160	2.4

Mix Proportions M30(S.C.C)

Cement (Kg)	FLY ASH (KG)	COARSE AGGRGATE (Kg)		FINE AGGREGATE (Kg)	WATER (Kg)	SP DOSAGE (Kg)
		NATURAL	RECYCLED			
370	138	723	0	948	199	2.22
370	138	650	72.3	948	199	2.22
370	138	588	144	948	199	2.22
370	138	514.5	216	948	199	2.22

Mix Proportions M40(S.C.C)

Cement (Kg)	FLY ASH (KG)	COARSE AGGRGATE (Kg)		FINE AGGREGATE (Kg)	WATER (Kg)	SP DOSAGE (Kg)
		NATURAL	RECYCLED			
400	167	660	0	976	197	2.4
400	167	594	66	976	197	2.4
400	167	528	132	976	197	2.4
400	167	462	198	976	197	2.4

Cement and Aggregate results
Workability of the concrete
Physical properties-Cement

S.No	Property	Value
1	Fineness of cement	5.9%
2	Specific Gravity	3.14
3	Normal consistency	32%
4	Setting time • initial setting time • Final setting time	32min 562min
5	Lechateliers test	2.1mm
6	Compressive strength@ 3days	32.5 Mpa
7	Compressive strength@7days	44.5 Mpa
8	Compressive strength@28days	59.0 Mpa

Workability of conventional concrete

% REPLACEMENT OF AGGREGATES M 30:	0	10	20	30
SLUMP CONE	65	66	67	67
COMPACTION FACTOR	0.98	0.972	0.968	0.950
M40:				
SLUMP CONE	65	66	66	67
COMPACTION FACTOR	0.98	0.972	0.968	0.950

Workability of SCC - M30

% REPLACEMENT OF AGGREGATES M 30:	0	10	20	30
SLUMP CONE	665	665	660	655
V-FUNNEL	9.8	9.72	9.68	9.50
L-BOX	0.94	0.92	0.90	0.89

Workability of SCC - M40

% REPLACEMENT OF AGGREGATES M30:	0	10	20	30
SLUMP CONE	670	665	665	660
V-FUNNEL	9.6	9.5	9.3	9.1
L-BOX	0.91	0.89	0.883	0.880

Strength properties of concrete:

Compressive strength of M 30 concrete:

% REPLACEMENT OF RECYCLED AGGREGTAES	CONVENTIONAL CONCRETE			SELF-COMPACTING CONCRETE (M 30)		
	3 DAYS	7 DAYS	28 DAYS	3 DAYS	7 DAYS	28 DAYS
0	12.72	23.54	34.82	13.85	25.68	36.57
10	13.01	25.12	35.21	13.63	28.53	37
20	13.89	28.09	36.34	13.23	30.28	38.42
30	13.24	27.24	35.51	13.91	28.83	37.02

Compressive strength of M 40 concrete:

%REPLACEMENT OF RECYCLED AGGREGTAES	CONVENTIONAL CONCRETE			SELF-COMPACTING CONCRETE (M 30)		
	3 DAYS	7 DAYS	28 DAYS	3 DAYS	7 DAYS	28 DAYS
0	23.98	34.23	44.53	24.85	36.68	45.63
10	24.46	35.34	45.25	24.03	38.53	46
20	25.72	36.89	46.81	24.67	39.28	48
30	24.81	35.92	45.81	23.93	38.23	47.03

Flexural Strength of M30 Concrete:

% REPLACEMENT OF RECYCLED AGGREGTAES	CONVENTIONAL CONCRETE			SELF-COMPACTING CONCRETE (M 30)		
	3 DAYS	7 DAYS	28 DAYS	3 DAYS	7 DAYS	28 DAYS
0	1.94	2.4	3.43	2.23	2.76	3.62
10	2.06	2.64	3.57	2.36	2.89	3.88
20	2.22	2.95	3.84	2.68	3.18	4.04
30	2.1	2.74	3.66	2.48	2.91	3.90

Flexural strength of M 40 concrete:

% REPLACEMENT OF RECYCLED AGGREGTAES	CONVENTIONAL CONCRETE			SELF-COMPACTING CONCRETE (M 30)		
	3 DAYS	7 DAYS	28 DAYS	3 DAYS	7 DAYS	28 DAYS
0	1.9	3.2	3.9	2.1	3.8	4.5
10	2.1	3.4	4.12	2.19	3.92	4.62
20	2.21	3.58	4.34	2.26	4.08	4.79
30	2.27	3.43	4.22	2.20	4.26	4.64

Tensile strength of M 30 concrete:

% REPLACEMENT OF RECYCLED AGGREGTAES	CONVENTIONAL CONCRETE			SELF-COMPACTING CONCRETE (M 30)		
	3 DAYS	7 DAYS	28 DAYS	3 DAYS	7 DAYS	28 DAYS
0	1.41	2.34	3.41	1.67	2.41	3.68
10	1.53	2.51	3.64	1.72	2.65	3.9
20	1.68	2.94	3.94	1.97	3.05	4.1
30	1.57	2.71	3.82	1.82	2.91	3.83

Tensile strength of M 40 concrete:

% REPLACEMENT OF RECYCLED AGGREGTAES	CONVENTIONAL CONCRETE			SELF-COMPACTING CONCRETE (M 30)		
	3 DAYS	7 DAYS	28 DAYS	3 DAYS	7 DAYS	28 DAYS
0	1.34	2.9	3.76	1.7	3.12	4.05
10	1.58	2.98	3.84	1.9	3.19	4.19
20	1.82	3.18	4.03	2.19	3.26	4.27
30	1.62	3.01	3.91	1.92	3.2	4.2

V CONCLUSIONS

1) As per the results obtained in the present investigation we have observed that the value of the strength parameters of the concrete prepared by using the recycled aggregates has been gradually increasing.

2) As the grade of concrete is increasing the percentage of strength of concrete in every parameter is also increasing according to the obtained results.

3) But this increase in the strength has decreased as the percentage of replacement of concrete is more than 20%.

4) The cube compressive strength of recycled aggregate concrete with partial replacement of 10%, 20%,30% natural aggregate is increased by 4.25%more than conventional concrete compared to self-compacting concrete cube strength. Similar values are also obtained in the case of split-tensile strength and flexural strength.

5) The compressive strength, flexural strength and split-tensile strength of recycled aggregate concrete with partial replacement of 30% natural aggregate decreases by 8% less than that for 20% replacement in case of both conventional and recycled aggregates.

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