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Mechanical Properties of Recycled Aggregate Based Self Compacting Concrete

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ABSTRACT:- Self Compacting Concrete has an excellent flowing properties and has the ability to amalgamate under its own weight. The Demolition waste generated after collapsing of structure can be used as a partial replacement of coarse aggregate in self compacting concrete. The present study involves in the comparison of fresh and hardened properties of self compacting concrete with M35 grade of concrete with 0%, 25%, 50%,75%,100% replacement ofrecycled coarse aggregate..Hardened properties are evaluated by destructive and non destructive method The optimum percentage of replacement of recycled coarse aggregate is proposed by comparing compressive strength of different percentages of replacement of coarse aggregate.

Keywords:- Self compacting concrete , Demolition waste , Fresh and Hardened Properties.

I. INTRODUCTION:-

Self-hardening concrete is a highly fluid concrete that spreads in the foam without the need for mechanical vibration.Self Compacting concrete was the brainchild of Professor Okamura. . In recent years, due to the large increase in population and urbanization, a large amount of waste has been generated due to construction and demolition. Recycled concrete can be used as a coarse aggregate to produce a new concrete mix of moderate strength. The desired aggregate size can be obtained during this crushing process.

Recycled raw aggregate content up to 20%was within the allowed values defined by this standard and was considerably scc. The compressive strength of scc prepared with recycled raw aggregate increases with the increase of the recycled aggregate content.(D.Nieto et.al**).** . A coarse aggregate size increasing from 7 to 12 mm leads to an increase in tensile strength in flexion of 28 days and divided up to 9 and 11%. RAC with recycled aggregate content up to 25% has close but slightly lower mechanical properties up to 5% lower elastic modulus, 8% lower tensile strength**.(** Togay Ozbakkalogu Aliakbar Gholampour) . For M25 grade of concrete The test result indicates that in 28 days the SCC test marginally reaches the required compressive strength up to a replacement ratio of 0.30 (kc pant et.al).

Three concrete grades M20, M40 and M60 are prepared with recycled aggregate substitutions of 0%, 25%, 50% and 100% to verify the compressive strength, resistance to acids and water absorption.The results suggest that up to 25% of the aggregates can be replaced without significant consequences on the concrete produced(C Sumanth Reddy et.**al).** It is observed that up to 40% of recycled aggregate can be effectively used inthe production of SCC without any significant reduction in strength and durability. The compressive and tensile strength has an inverse relationship with the percentage of recycled raw aggregate.(Prashant O.et al**)**

II. OBJECTIVES

1. To determine the fresh properties (slump, V-funnel, L-box) of recycled aggregate based self-compacting concrete. To determine the Hardened Properties , Compressive strength and split tensile strength are performed.
2. To determine the maximum percentage replacement and of recycled coarse aggregate 0%, 25%, 50%, 75%, 100% by natural coarse aggregate.
3. To compare the destructive (compressive strength, split tensile strength) and non destructive tests on recycled aggregate based self-compacting concrete

III. MATERIAL PROPERTIES

- **cement**

The quality OPC 53 gives the structures high strength and durability because of its optimum particle size distribution and superior crystalline structure. As a high-strength cement, it offers many

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benefits wherever concrete is required for a particular high-strength application, such as in the construction of skyscrapers, bridges, overhead bridges, chimneys, runways, concrete tracks and other supporting structures.

Table 1: Properties of cement

Test	Experimental value
Specific gravity	3.15
Fineness	5%
Initial setting time	75 min
Final setting time	242 min

- **fine Aggregates**

The most important function of fine aggregates is to help the process of workability and homogeneity of the mixture. Fine aggregate also helps cement paste keep coarse aggregate particles suspended

Table 2 Physical properties of fine aggregate

Property	**Value**
Fineness Modulus	2.71
Specific gravity	2.65
Gradation	Zone II

- **Coarse Aggregate:-**

The coarse aggregate is used primarily for the purpose of providing volume to the concrete. To increase the density of the resulting mixture, coarse aggregate is often used in two or more sizes.

Table 3: Physical properties of coarse aggregate

Properties	**Natural Coarse Aggregate**	
	10mm	**20mm**
Specific Gravity	2.6	2.7
Bulk Density (g/cc)	1.3	1.72
Fineness Modulus	7.21	7.11
Impact Value	20	19

- **Recycled Coarse Aggregate**

Crushed concrete is available today in large quantities, resulting from the demolition of old structures and the waste of concrete from new structures. When dilapidated structures are demolished and rebuilt, construction waste is produced, and some of which is used illegally as landfill materials causing serious environmental pollution, thus becoming a social problem.

Table 4: Physical properties of recycled coarse aggregate

Properties	**Recycled Coarse Aggregate**
	10mm
Specific Gravity	2.5

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Bulk Density (g/cc)	1.2
Fineness Modulus	7.25
Impact Value	13.3

- **Super plasticizer**

Super plasticizers, also known as high-range water reducers, are additives used in the manufacture of high-strength concrete. Super plasticizers reduce water content by30% or more

Table 5:- Properties of SP

Description	**Property**
Colour	Brown
Density	1.8 g/Cm^3
Specific Gravity	1.20-1.21 At 30^{o}c
Chloride Content	No

IV. MIX PROPORTIONS

The present experimental investigation M35 and grade of self compacting concrete with partial replacement of recycled coarse aggregate has been designed. The following are the mix proportions.

Table 6:- Quantity of material for 1m^3 concrete

Sl. No	**Material**	**Quantity per m^3**
1	Cement	523.61
2	Fine Aggregate	924
3	Coarse Aggregate	680
4	Water	195.20
5	Water to cement ratio	0.38
6	Super plasticizer	6.28

V. EXPERIMENTAL INVESTIGATION

The test performed on the fresh self compacting concrete are not standardized. Based on the above mix proportions SCC is prepared. The following tsts are performed on the SCC i.e , Slump Test, L- Box test, and V Funnel Test on Fresh concrete by varying the percentage of recycled aggregate as 0%,25%,50% and 100%. The tests performed on the hardened concrete are Compressive strength test and Split Tensile Strength. Rebound hammer test and ultrasonic pulse velocity results are also discussd in this paper.

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VI. RESULTS

a) Fresh Properties

i) **Slump flow test**

The following table 7 shows the diameter spread of the concrete

Table 7: slump flow test results

Slump flow	**Replacement of NCA with RCA**					**Suggested Value by EFNARC**
	0 (%)	**25 (%)**	**50 (%)**	**75 (%)**	**100(%)**	
Time (sec)	3	5	2	4	2	2-5 sec
Diameter spread (mm)	570	585	605	575	560	550-800 mm

ii) **L box Test**

The following table 8 shows the passing ability of the concrete

Table 8:- L-box test results

% replacement of RCA	**H2/H1**	**Suggested by EFNARC specifications**
0	0.82	0.8-1.0
25	0.88	
50	0.90	
75	0.86	
100	0.83	

iii) V Funnel

The following table 9 shows the segregation resistance of the concrete

Table9: V-funnel test results

% replacement of RCA	**T5 min (sec)**	**Suggested by EFNARC**
0	19	8-20 sec
25	20	
50	18	
75	16	

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100	12	

b) Hardened properties of concrete

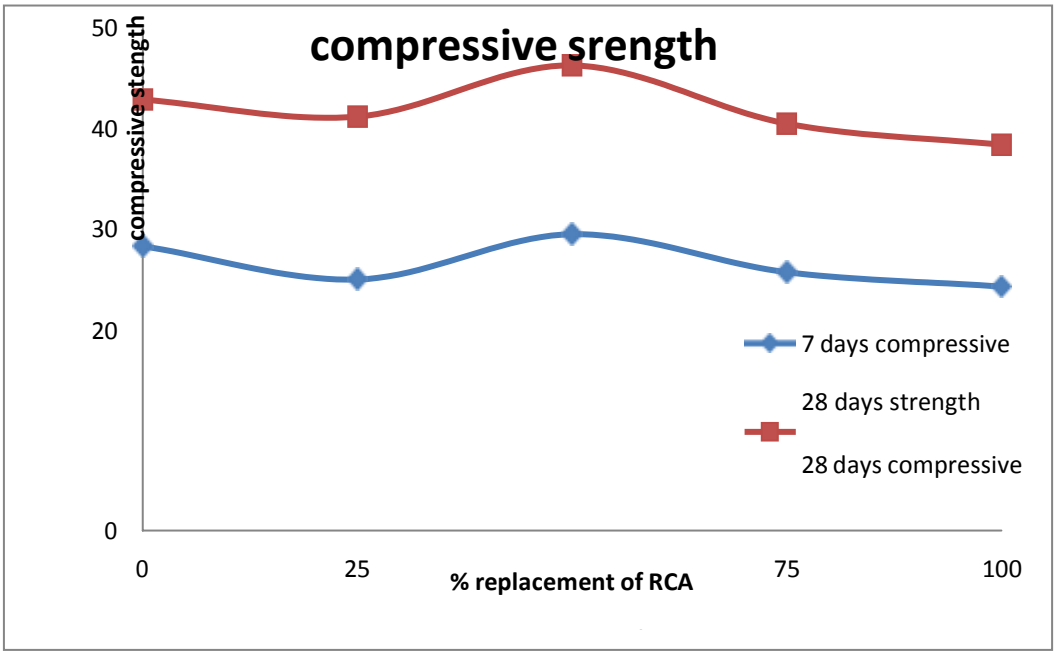
i) Compressive strength

The following table 13 shows the results obtained in the compressive strength test conducted on cube that are cured for 7, 28 days

Table 10 Compressive strength

% replacement of RCA	Compressive strength for 7 days curing (MPa)	Compressive strength for 28 days (MPa)
0	28.31	42.91
25	27.19	42.23
50	29.42	44.35
75	26.73	40.50
100	25.30	38.41

Figure 1:-Compressive strength of SCC using RCA



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ii) Split tensile test
The following table 14 shows the results obtained in the split tensile test conducted on cylinder that are cured for 7, 28 days

Table 11 Split tensile test

% replacement of RCA	Split tensile strength for 7 days curing (MPa)	Split tensile strength For 28 days (MPa)
0	2.28	4.25
25	2.42	4.28
50	2.51	4.30
75	2.19	4.21
100	2.13	4.16

iii) Rebound Hammer Test
The following table 12 shows the results obtained in the compressive strength test conducted on cube that are cured for 7, 28 days using rebound hammer.

Table 12 Rebound hammer test

% replacement of RCA	Compressive strength for 7 days curing(MPa)	Compressive strength for 28 days curing(MPa)
0	27.31	41.72
25	27.90	42.10
50	29.10	43.32
75	26.22	41.75
100	24.70	39.33

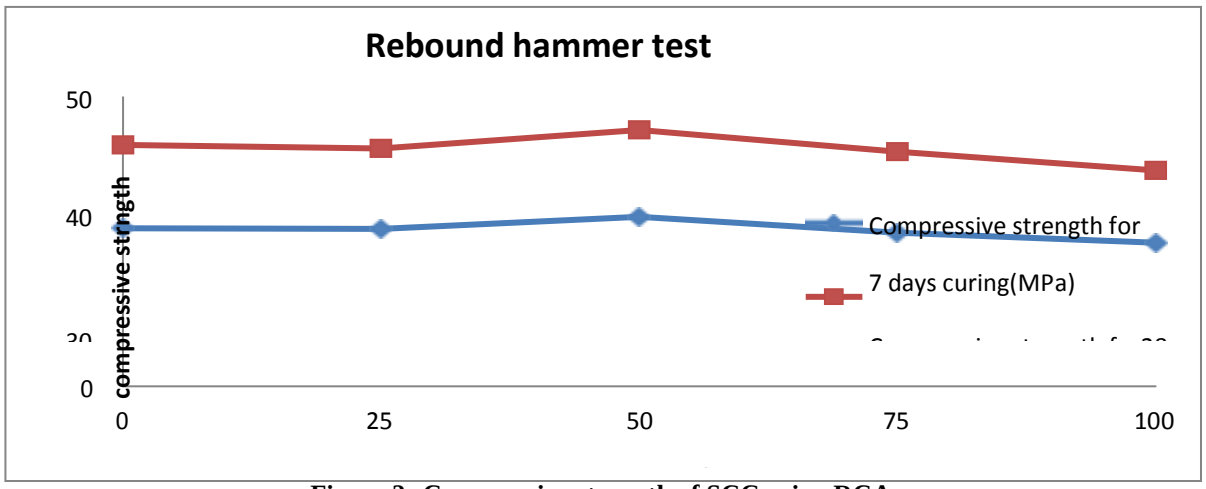

Figure 2:-Compressive strength of SCC using RCA

iv) Ultrasonic Pulse Velocity
The following table 13 shows the results obtained for the quality of concrete using ultra sonicpulse velocity

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Table 13:- Ultra sonic pulse velocity

% replacement of RCA	Time (μ Sec)	Velocity Km/sec
0	34	4.298
25	34.7	4.323
50	34.9	4.298
75	36.9	4.065
100	38.4	3.906

VII. CONCLUSIONS

- Self-compacting concrete made with recycled coarse aggregates have satisfied the fresh properties required for SCC as per EFNARC specification.
- Result of L Box satisfying EFNARC guidelines can be achieved by proper gradation of coarse aggregate, which increases the passing ability.
- It has been observed that that the optimum compressive strength of self compacting concrete is obtained at 50% replacement of RCA. Further the strength has decreased with increase in replacement percentage RCA.
- It has been observed that that the optimum split tensile strength of self compacting concrete is obtained at 50% replacement of RCA. Further the strength has decreased with increase in replacement percentage RCA. It has been observed that that the optimum compressive strength of self compacting concrete using rebound hammer test is obtained at 50% replacement of RCA.
- It is also observed that the compressive strength results obtained from both destructive and non destructive tests (i.e. from rebound hammer test and compressive strength test respectively) were nearly equal.
- The quality of all test specimens was resulted GOOD from UPV test for all % replacement of RCA. Such that they can be adopted for construction purpose.

scope of the project

Further studies should be carried out on Durability properties of recycled based aggregates SCC.

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