INFLUENCE OF SILICA FUME ON RECYCLED AGGREGATE CONCRETE

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Abstract— In this study, the properties of concrete with Recycled Aggregate and with addition Silica Fume is investigated. Coarse Aggregate in concrete is partially replaced with Recycled Aggregate in 25,50 percentages. 2.5,5,7.5 percentage of Silica Fume is added is added to the concrete . Properties such as workability, compressive strength,Tensilet strength, density of concrete were evaluated and the results were analyzed and compared with the conventional concrete. The results showed that the compressive strength of Recycled Aggregate concrete with addition of Silica Fume observed to be more or less equivalent to the conventional concrete. The aim behind the use of Recycled Aggregate concrete is is to make eco-friendly concrete .Silica Fume is added for strengthening of concrete. The fineness and binding strength of SilicaFume increased the strength of Recycled Aggregate Concrete.

Index Terms— Recycled Aggregate, Silica Fume, Compressive strength, Tensile Strength.

I. INTRODUCTION

Concrete is the world's most widely used construction material. The growth of Infrastructure is increasing the utilization of concrete exponentially. Due to this there is continuous extraction of Aggregate from natural Resources which will lead to the imbalance of Eco system. To full fill the increasing needs by balancing the Eco system the concrete should be such that it should be Eco friendly, economical and materials are locally available. The utilization of reusable materials such as coal slag, oil palm shells, Recycled Aggregate etc., in aggregates is particularly very promising as nearly 70-80% of concrete is made of aggregates. Use of Recycled Aggregate also avoids the problem of land fills. In the present study Coarse Aggregate(CA) is partially replaced with Recycled Aggregate (RA) and silica fume is added in different percentages.

II. MATERIALS, SPECIFICATION AND PROPERTIES

In this work Portland 53 grade ordinary Portland cement whose specific gravity is 3.1 is used as binder. Robo sand is used as fine aggregate having specific gravity of 2.5 with maximum grain size of 4.75 mm. As per IS 383:1970 sieve analysis is done and .Fine aggregate with Zone II is used. coarse aggregate with size of 20mm with Sub rounded shape and specific gravity of 2.78 is used .Impact value of coarse Aggregate used is 28.77. Recycled Aggregate of size between 8mm to 16mm is used as partial replacement for the coarse aggregate. Specific gravity of Recycled Aggregate is 2.6. Water absorption of Recycled Aggregate is 7.5%.

.TABLE I: SPECIFICATIONS OF MATERIALS

Materials	Specification	Property	Results
Cement	OPC-53 grade	Specific Gravity	3.1
Fine Aggregate	Robo Sand, Zone II	Specific Gravity	2.54
Coarse Aggregate	Nominal size 20mm, Sub rounded	Specific Gravity	2.78
		Impact Value	28.77
Recycled Aggregate	8 to 16mm	Specific Gravity	2.6

TABLE II: PROPERTIES OF SILICA FUME

Property	Unit	Value
SiO_2	%	Minimum 85.0
H_2O	%	Maximum 3.0
Retained on 45µm	%	Maximum 10.0
Loss on ignition	%	Maximum 6.0
Specific surface area	m^2/g	Minimum 15.0
Pozzolanic activity index	%	Minimum 105

FIG1:SILICA FUME

III. MIX DESIGN

Mix design for M40 grade of the concrete is carried out as per IS 10262 -2019.Water cement ratio of 0.4 is adopted .Coarse Aggregate is replaced with Recycled Aggregates in terms of 25%, 50% and Silica Fume of 2.5,5,and 7.5 percentage is added. Mix No is assigned for each percentage replacements.

TABLE III:MIX PROPORTIONS

Mix No	Silica Fume percentage	Replacement of coarse aggregate with Recycled Aggregate	Cement Kg)	FA(Kg)	CA(Kg)	RA(Kg)
CC	0	0%	375	642	1152	0
RAC1	2.5	0%	375	642	1152	0
RAC2		25%	375	642	864	288
RAC3		50%	375	642	576	576
RAC4	5	0%	375	642	1152	0
RAC5		25%	375	642	864	288
RAC6		50%	375	642	576	576
RAC7	7.5	0%	375	642	1152	0
RAC8		25%	375	642	864	288
RAC9		50%	375	642	576	576

IV. EXPERIMENTAL METHOD

Properties of materials used in the mix are tested by different procedures for preparing the mix. Using these properties and IS 10262:2019 mix design for M40 grade is done. Water cement ratio of 0.4 is selected to prepare M40 grade of Normal concrete .For mixes with Recycled Aggregate and Silica fume superplasticizer is added to get the required slump.Concrete cubes and Cylinders are casted for Normal concrete with and without Silica Fume . Concrete cubes and cylinders are also casted for both control mix and 25,50 percentage partially replaced Recycled aggregate concrete with addition of Silica Fume. 150x150x150 mm cubes are casted to test the compressive strength .Cubes are water cured and tested for compressive strength. Cylinders of standard size 150 x 300 mm are casted to determine the tensile strength..Concrete is Batched as per the achieved the mix design and mixing of concrete is done for 1-2 min after addition of water in the tilting mixture. The concrete is casted in 3 layers by tamping each layer with 25 blows in pre-oiled cast iron moulds . The casted concrete is compacted and surface finished using vibrator and they are left for 24 hours for setting. These specimen are water cured for 7,14 and 28days and strength tests are conducted.

The preparation of silica fume-based concrete is different from that of Normal Concrete .To prepare Silica fume based concrete cubes and cylinders initially 75% of the water content is place in the mixer then coarse aggregate are added to the mixer. Silica fume is added slowly into the revolving mixer and allowed to mix for 90 Seconds. Add the cementitious materials into the revolving mixer and mixed for90 Seconds .Finally fine aggregates added to the mixer and Super plasticizer is mixed with remaining 25% of water content and poured into the mixer. The materials are mixed for 5 minutes. Stop the rotatory mixer and allow it to rest for 3 minutes. Finally once again the mix is rotated for 5 more minutes. The silica fume concrete will be ready to be filled in the moulds for casting of specimens.

V. RESULTS AND DISCUSSION

A. TEST RESULTS ON FRESH CONCRETE

Slump cone is used to test the workability of various mixes of fresh concrete. Slump decreased with percentage increase in RA content and with addition of Silica Fume.

TABLE 5: SLUMP VALUES OF CONCRETE MIXES FOR VARIOUS PERCENTAGES OF RA REPLACEMENT AND ADDITION OF SILICA FUME

Mix No	Slump(mm)
CC	60
RAC1	57
RAC2	54
RAC3	50
RAC4	55
RAC5	52
RAC6	50
RAC7	53
RAC8	51
RAC9	50

B. TEST RESULTS ON HARDENED CONCRETE

The cubes after curing for required no of days are tested using Compression Testing Machine.The cubes are placed in the CTM and the platen is lowered till it touches the top surface of the specimen. Compressive strength is conducted as per IS 516-1959. To obtain the required workability for concrete with RA Conplast SP430 sulphonated Napthalene based super plasticizer with specific Gravity 1.18 is used

TABLE IV:COMPRESSIVE STRENGTH OF DIFFERENT MIXES

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Mix No	Silica Fume percent	Replacementof CA with RA	**7 days (Mpa)**	**14 days (Mpa)**	**28 days (Mpa)** 0.5%
CC	0	0%	36.67	40.4	48.5
RAC 1	2.5	0%	38.25	42.34	49.99
RAC 2		25%	31.17	36.54	44.56
RAC 3		50%	26.23	29.15	40.46
RAC 4	5	0%	41.74	49	52.66
RAC 5		25%	35.31	36.17	47.26
RAC 6		50%	31.53	33.34	42.23
RAC 7	7.5	0%	45.86	49.78	54.24
RAC 8		25%	31.24	39.27	48.12
RAC 9		50%	28.5	32.12	44.23

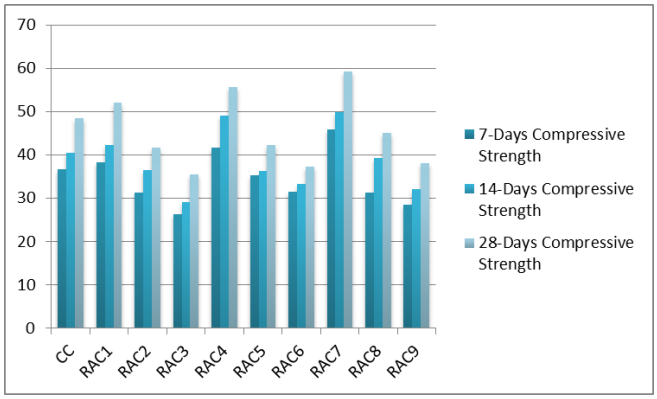

FIG 2: COMPRESSIVE STRENGTH OF VARIOUS MIXES

The variations in the FIG 2 shows that the Compressive Strength for all the replacements with RA decreased compared to Control concrete. Compressive strength of the mixes increased from 3 to 8% with increase of Silica Fume from 2.5 to 7.5 % respectively. The compressive strength for mix with 25% RA and

7.5% Silica fume is found to be almost equal to the Control mix. The compressive strength of the concrete replaced by RA 25 and 50 % decreased by about 15% and 20% respectively.

Split Tensile Strength test is conducted on Cylindrical Specimen as per IS 5816:1999. The trend in FIG 3 shows Maximum tensile strength with RA is 4MPa ,obtained for concrete with 25% RA and 7.5% Silica Fume. With increase in addition of Silica Fume content Tensile Strength increased from 4.22MPa to 4.37Mpa.With 25% RA and 7.5% Silica Fume tensile strength is almost near to the CC.

TABLE V:SPLIT TENSILE STRENGTH FOR DIFFERENT MIXES

Mix No	Tensile Strength (MPa)
CC	4.12
RAC1	4.22
RAC2	3.42
RAC3	2.9
RAC4	4.36
RAC5	3.6
RAC6	3.2
RAC7	4.37
RAC8	4
RAC9	3.8

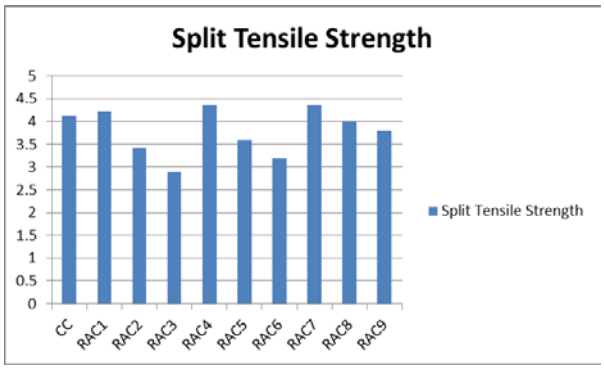

FIG 3:TENSILE STRENGTH OF VARIOS MIXES

VII.CONCLUSIONS

The Compressive strength of all the mixes with RA decreased with increase in percentage replacements.

The compressive strength attained at 25% replacement with 7.5 % addition of Silica Fume is almost equal to that of M40 grade concrete.

Sustainable concrete of M40 grade can be prepared by partially replacing CA with RA and at low percentages of Silica Fume

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