Experimental Investigation On Recycled Aggregate Concrete With Replacement Of Normal Sand To Silica Sand

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Abstract- *In real developing countries there are a surge in development and huge amount of activity in construction causing an unfavorable impact on the earth. The utilization such a waste as reused in a concrete can be helpful for both ecological and sparing perspectives in the development in construction industry.In this research discuss comparatively study on NAC (Normal aggregate concrete) to RAC (Recycled aggregate concrete) with using silica sand. And also comparing effect on physical properties of concrete using silica sand and normal sand by compression strength test, flexural strength test and split tensile strength test.*

Keywords- Normal aggregate concrete, Recycle aggregate concrete, Silica sand

I. INTRODUCTION

Using concrete demolition and waste products to produce recycled concrete aggregate (RCA) for new concrete production was identified by researchers as this will have a positive impact on the environment, resource preservation, and the economy by reducing the use of non-renewable materials, such as natural aggregate (NA), with also reducing the areas of landfills [1].Industry is always trying to find better and economical material to manufacture new product. However, most of the RCA studies in the literature concluded that the mechanical strengths decreased as the percentage of RCA increased [2-4]. The quality of NA is usually higher than that of RCA because RCA contains mortar particles and surface cracks within it that introduce higher, porosity, and weak portions, water absorption which reduce mechanical strength and introduce workability and durability concerns [5, 6]. The use of alternative aggregate like silica sand is a natural step in solving part of above problems.

Silica sand is obtained from the raw material (locally available in mamuara village in Kutch district). After washing the raw material the silica sand is separated by sieve size 1.18 of raw material. Raw material is washed for taking out the clay material which is useful in making the tiles. In the raw material about 10% is clay which is supplied to the ceramic factories.

From the raw material different size of silica sand are separated by different size of sieve. Sand size of 30 meshes to 80 meshes (500 micron) is used in the glass industries. Sand size 1.18mm to 600 micron can be used in making concrete mix as the partial replacement of fine aggregate. Nearly about 200 tons of silica sand is obtained daily after washing the raw material. Sometimes it is used in the glass factories otherwise they dump them back into the mines.

II. MATERIAL

An extensive experimental Program involving the various processes of material testing, mix proportioning, mixing, casting and curing of test specimens were done. The forthcoming sections elaborate the various physical and chemical properties of each material separately.

1. Cement: Ordinary Portland cement of 53 grade were used, conforming to recommendations stated in IS 4031(1999). OPC manufactured from ultratech cement plant was used throughout the experimental work. The physical properties of OPC are tabulated in Table1.
2. Water: As per recommendation ofIS: 456 (2000), the water to be used for mixing and curing of concrete should be free from deleterious materials. Therefore potable water was used in the present study in all operations demanding control over water quality.
3. Coarse Aggregate: The NA used in this study was crushed granite, and the coarse RCA was obtained by crushing old specimens of concrete beams, slabs, and cubes with a steel hammer and impact machine. Then, the concrete chunks were placed in a jaw crusher that brokethem into the required sizes.The size of aggregate is more than 4.75 mm it terms as coarse aggregate. The Course Aggregates from crushed igneous rock, conforming to IS 383-1970 is being use. The flakiness and elongation index

were maintained well below 15%. The result obtained are tabulated for NA and RCA in Table 2 and Table 3 respectively

4. Fine Aggregate: The sizes between 4.75 mm to 150 micron are termed as fine aggregate. The river sand is being used as fine aggregate conforming to the requirements of IS 383-1970. The river sand is wash and screen, to eliminate deleterious materials and over size particles.
    - Natural Sand: The fine aggregate - sand shall be hard, strong, dense, and durable clean with uncoated grains. The maximum size of the particles shall be 4.75 mm. The sand shall not contain any harmful materials such as iron, coal, silt, clay, alkali, sea shells organic impurities, loam etc. Aggregate, which are chemically reactive with the alkalis of the cement, shall not be used. The result obtained for normal sand are in Table 4.
    - Silica Sand: Silica Sand is quartz that over time, through the work of water and wind, has been broken down intotiny granules. Silica (SiO2) is the name given to a group of minerals composed solely of silicon and oxygen. Theresult obtained for normal sand are in Table 5.

Table 1 Properties of Cement

Physical properties	Results
Specific gravity	3.12
Soundness	1.05 mm
Standard Consistency	33%
Initial setting time	35 min
Final setting time	255 min
Compressive strength	54.54 N/mm²

Table 2 Physical Properties of Natural Aggregate

Properties	Coarse aggregate
Fineness modulus	3.25
Specific gravity	2.65
Absorption (%)	0.68
Bulk Density (Kg/m³)	1741
Free Surface Moisture (%)	0.5

Table 3 Physical Properties of Recycled Aggregate

Properties	Coarse aggregate
Fineness modulus	3.11
Specific gravity	2.35
Absorption (%)	0.97
Bulk Density (Kg/m³)	1320
Free Surface Moisture (%)	0.5

Table 4 Physical Properties of Natural Sand (FA)

Properties	Fine Aggregate
Zone	Zone- II
Fineness modulus	2.82
Specific gravity	2.55
Absorption (%)	1.50
Bulk Density (Kg/m³)	1753
Silt Content (%)	1.20
Free Surface Moisture (%)	1

Table 5 Physical Properties of Silica Sand (FA)

Properties	Fine Aggregate
Zone	Zone- II
Fineness modulus	2.56
Specific gravity	2.60
Absorption (%)	1.50
Bulk Density (Kg/m³)	1568
Silt Content (%)	1.20
Free Surface Moisture (%)	1.4

III. EXPERIMENTAL PROGRAMME

1. Mix proportions:

Four concrete mixes were designed for this study.Table 6 shows the mix proportions of M25. The mixes were divided by aggregate into three groups: (1) NC (Normal Concrete); (2) RAC (Recycled Aggregate Concrete). For creating this mix proportion, there should be obtaining a trail mix design of various percentage ratios.

2. Trial mix design:

Trial mix test is for NC by adopting 10% 20% 30% 40% 50% 60% 70% replacement of silica sand to ordinary sand. For this trail mix compression strength test is adopted and by that test we can state which replacement gives the best result among these and that replacement will further will be used in entire study. And from the fig 1 we can see that 50% replacement of silica sand to normal or ordinary sand is giving the best results among all which is 18.82% greater than the NC.

Table 5 Mix Proportion

Mix type	Cement	Water	Normal Sand	Silica Sand	NA	RA
NC	337	142	834	0	1114	0
RC	337	148	0	898	0	1064
NCS	337	142	417	417	1114	0
RCS	337	148	449	449	0	1064

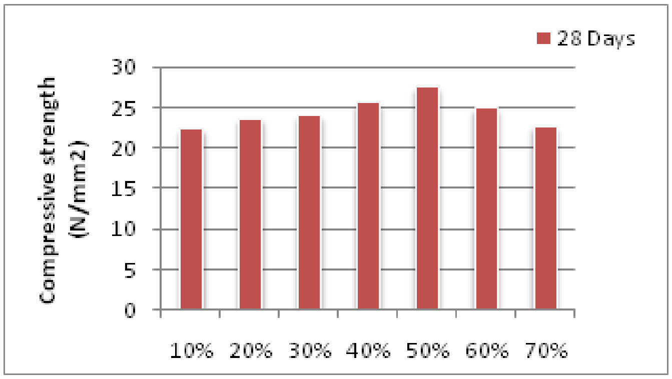

Fig 1 Trial mix design test

3. Test to be perform on these concrete mix :
   A. Workability test (Slump cone test)
   B. Compressive strength test
   C. Flexural strength test
   D. Split tensile test

IV. TESTS & DISCUSSION

A. Workability Test (Slump cone test):

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as anindicator of an improperly mixed batch. For this test the dimensions of cone is; bottom diameter 200mm, top diameter 100mm and height 300mm.

From fig 2 that is clear that by adding silica sand to the normal or recycled aggregate concrete the workability increases. Recycled concrete's workability is little lower than normal concrete but when the silica sand is added it's workability increases by 10.8%. And by replacing silica sand in place of normal sand in normal concrete mix, its workability increase 20%.

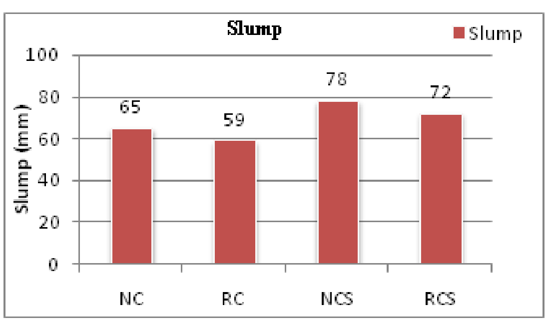

Fig 2 Slump test

B. Compressive Strength Test:

150 mm × 150 mm × 150 mm concrete cubes should were first casted by using M25 grade concrete. During casting, mould shall be filled in four layers, each approximately one quarter of the height of the mould. Each layer shall be tamped with twenty-five strokes of the rounded end of the tamping rod. The strokes shall be distributed in a uniform manner over the cross-section of the mould and for the second and subsequent layers shall penetrate into the underlying layer. The bottom layer shall be tamped throughout its depth. After the top layer has been rodded, the concrete shall be struck off level with a trowel or the tamping rod, so that the mould is exactly filled. After 24 h the specimens were remove from the mould and subjected to water curing for 7,14 and 28 days. After curing, the specimens were tested for compressive strength using a calibrated Compression Testing Machine of 3,000 KN capacity.

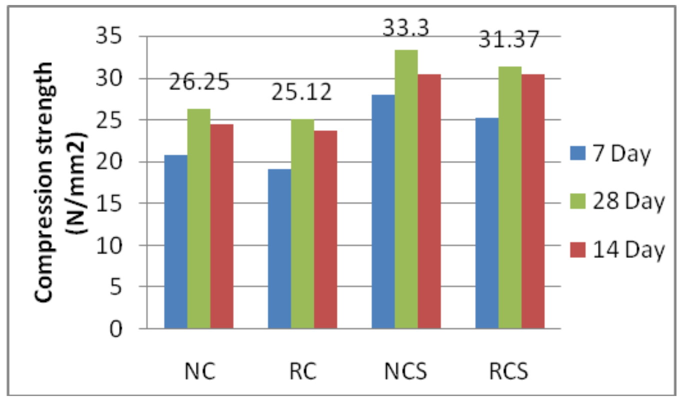

Fig 3 Compression Strength Test

From Fig 3, as silica sand is added to various mix the compression strength increases linearly. Here as compare to normal concrete when silica sand is added to normal concrete it gain early strength in 7 Days it already increases 33.81% and after 28 Days 23.88% increases in strength. If we compare concrete to recycled concrete with silica same it gain early strength gain so in 7 days the strength gain by 20.96%. AS well as After 28 days the compressive strength will increase almost 25%

C. Flexural strength test:

Flexural strength is usually found by testing beam samples under either central point loading or third point loading. To evaluate flexural strength it is decided to prepare 150 mm thick specimens. For this purpose Iron moulds are prepared having width and length as 150 mm and 700 mm respectively. All the samples are cured for the 28 days before testing, and then coated with white wash of lime in order to see crack formation during the test easily. Specimens are prepared with 700 mm length. And thus, during the flexural test all the details such as first crack load and displacement, crack patterns, crack locations, number of cracks, ultimate load and displacement etc. are noted clearly.

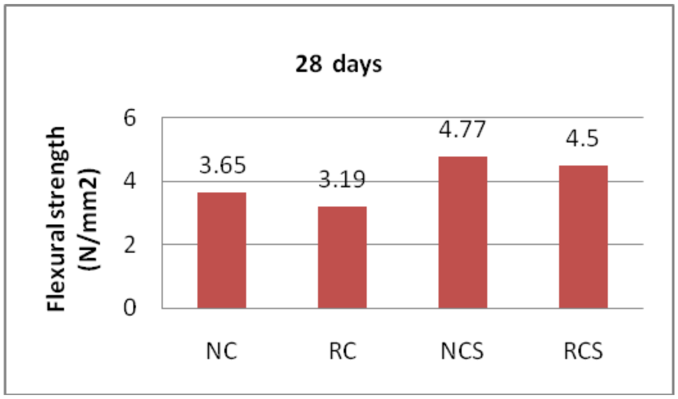

Fig 4 Flexural Strength Test

As per Fig 4, it clearly shows that flexural strength increases in after 50% replacing of silica sand in place of normal sand. Flexural strength of recycled concrete is less than normal concrete but by replacing silica sand to that mix its strength increases 23.28% which will be economically beneficial as recycled aggregate are added in it. Also the normal concrete with silica sand's flexural strength is 30.68% greater than normal concrete.

D. Split tensile strength:

The tensile strength of concrete is approximately 10% of its compressive strength. The tensile strength of concrete can be measured by the direct tensile loading test or indirect tensile load test. However the application of direct tensile load to the test specimens is rather difficult. For this reason tensile strength of concrete is usually measured by the flexural (bending) strength of concrete or by the indirect tension test like splitting test. Tensile splitting strength tests of concrete block specimens determined at 7& 28 days of age. For every age three specimens should be tested.

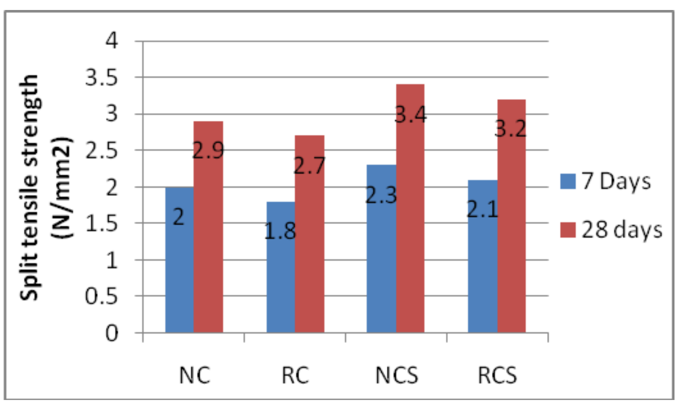

Fig 5 Split tensile strength test

From fig 5 here the tensile strength of recycle concrete is slight less than normal concrete so as we added silica in place of ordinary sand to that mix initially there is no such strength gain it became 2 N/mm2 to 2.1 KN/mm2 in 7 days and after 28 days the strength gain approx. 11%. For normal concrete when the silica sand is replacing its strength gain 15% and 19.25% after 7 days and 28 days respectively.

V. CONCLUSION

1) By the replacement of silica sand in to normal sand, the compressive strength gradually increases up to replacement of 50% .Then by replacing further compressive strength decreases , The best result conduct for compressive strength is at 50% replacement compares to normal concrete
2) RCA caused lower the workability but by replacing the silica sand in RCA, higher the workability 10.8%.
3) For NC with 50% silica sand replacement (NCS) increases the workability 20%
4) RCA has lower compressive strength and flexural strength than NC.
5) Replacing silica sand in RCA mix (RCS) increase the compressive and flexural strength 25% and 23.28%respectively.
6) For NC mix, while replacing silica sand to ordinary sand compressive strength and flexural strength gains 23.88% and 30.68% respectively.
7) For tensile strength, only 11% strength gain in RCS mix and 19.25% strength gain in NCS mixes.
8) Among All mixes RCS gives the better and economically beneficial results.

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