EXPERIMENTAL INVESTIGATION ON CONCRETE BY REPLACEMENT OF SAND BY SILICA SAND AND ARTIFICIAL SAND

[1]Vishal B. Swami
Student ,
M.S.Bidwe Engineering College, Latur,India

[2]Gundappa N. Shete
Professor
M.S.Bidwe Engineering College, Latur,India

Abstract—The use of alternative sand like silica sand , artificial sand is a natural step in solving part of depletion of natural aggregates. The experimental investigation on replacement of different material for concrete making started before half a . Concrete made from silica sand and artificial sand as fine aggregate was studied for compressive strength, Split tensile strength and Flexural strength. So in this project, Silica sand and artificial sand had been used as replacement of fine aggregate by different percentage for making concrete of M-30 grade, with w/c ratio 0.42. The percentage replacement will be 0%, 10%, 20%, 30% with natural fine aggregates. For making concrete OPC cement is used. Cubes, beams and cylinders will be casted and tested compressive strength, Split tensile strength, and flexural strength. Optimum replacement of silica sand and artificial sand can be used in concrete for high compressive strength, Split tensile strength, and flexural strength

Index Terms — Silica sand, Artificial Sand, Compressive strength, Split Tensile strength & Flexural strength

I. INTRODUCTION

In the world of construction, concrete like other materials is playing an important role in development. concrete is a composite material which is a mixture of cement, fine aggregate , coarse aggregate and water .The major constituents of which is natural aggregate such as gravel, sand, Alternatively, artificial aggregates , silica sand , fly ash may be used where appropriate. It possesses many advantages including low cost, general availability of raw material, adaptability, low energy requirement and utilization under different environmental conditions. The goal of sustainable construction is to reduce the environmental impact of a constructed facility over its lifetime. Concrete is the main material used in construction in the world. Industry is always trying to find new, better and economical material to manufacture new product, which is very beneficial to the industry. In the recent days, the various concrete develop and used in the construction, industrial and highway engineering. In this project we have used silica sand and artificial sand

II. MATERIALS

A. Fine Aggregate (IS 2386 (Part- 1), (Part-3))

1)Sieve analysis of Fine aggregate

The sieve analysis is conducted to determine the particle size distribution of fine aggregate. The different sieves sizes used for sieve analysis of fine aggregate was 4.75 mm, 2.36 mm, 1.18 mm, 600 µm, 300 µm, 150 µm and 75µm. And test result is shown in the following table. Sand which is used for the construction purpose must be clean, free from waste stones and impurities

Table - 2.1
Sieve analysis of fine aggregate

Sieve size (mm)	*Weight retain (gms)*	*Cumulative weight retain (gms)*	*Cumulative percentage weight retain (%)*	*Cumulative percentage weight passing*
4.75	*0*	*0*	*0*	*100*
2.36	*125*	*125*	*2.55*	*97.45*
1.18	*375*	*500*	*10.20*	*89.80*
600 micron	*1910*	*2410*	*49.14*	*50.86*
300 micron	*2294*	*4704*	*95.92*	*4.08*
150 micron	*200*	*4904*	*100.0*	*0.0*

2) Physical properties of fine aggregate

Specific gravity of fine aggregate can be find out by Pycnometer and test result is tabulated in table and other physical properties also tabulated in following table

Table - 2.2
Physical properties of fine aggregate

Gradation	*Fall in Zone III*
Specific Gravity	*2.63*
Fineness Modulus	*2.58*
Water absorption	*Nil*

Table - 2.3
Specific Gravity of fine aggregate

Sr no	Description	Value
1	Weight of pycnometer (W1) gms	643.83
2	Weight of pycnometer + soil (W2) gms	875
3	Weight of water + pycnometer + soil (W3) gms	1572
4	Weight of pycnometer + water (W4) gms	1450
5	Specific Gravity = $\frac{-}{\quad}$	2.63

B. Silica sand (IS 2386 (Part-1), (Part-3))

1) Sieve analysis of Silica sand

Silica sand are separated by different size of sieve. Sand size of 30 mesh to 80 mesh (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

Table - 2.4
Sieve analysis of silica sand

Sieve size (mm)	Weight retain (gms)	Cumulative weight retain (gms)	Cumulative percentage weight retain (%)	Cumulative percentage weight passing
4.75	0	0	0	100
2.36	35	3	0.7	99.3
1.18	365	400	8.1	91.9
600 micron	2115	2515	50.8	49.2
300 micron	2370	4885	98.6	1.4
150 micron	70	4955	100.0	0.0

2) Physical properties of silica sand

Specific gravity of Silica sand can be find out by Pycnometer and test result is tabulated in table and other physical properties also tabulated in following table.

Table - 2.5
Physical properties of silica sand

Specific Gravity	2.63
Fineness Modulus	2.58

Table - 2.6
Specific Gravity of silica sand

Sr no	Description	Value
1	Weight of pcynometer (W1) gms	680
2	Weight of Water + soil (W2) gms	890
3	Weight of water + pcynometer + soil (W3) gms	1568
4	Weight of pcynometer + water (W4) gms	1445
5	Specific Gravity = $\frac{-}{\quad}$	2.63

C. Artificial Sand

Artificial sand is a process controlled crushed fine aggregate produced from quarried stone by crushing or grinding and classification to obtain a controlled gradation product that completely passes the 4.75mm sieve. Artificial sand generally contain more angular particles with rough surface textures and flatter face than natural sand that are more rounded as a result of weathering. Over the time some investigations have shown that angular particles, rough surface of artificial sand influences the workability and finish ability in fresh concrete. The artificial sand have to satisfy the technical requisites such as workability, strength and durability of concrete and hence it has become necessary to study these properties in order tocheck the suitability and appropriate replacement level of artificial sand in comparison with the natural sand for producing concretes in an economical way

Table - 2.7
Physical properties of Artificial sand

Specific Gravity	2.87
Fineness Modulus	2.58

III MIX DESIGN

Design stipulations	
Characteristics compressive strength required in the field at 28 days	30Mpa
Maximum size of aggregate	10mm
Test data for materials	
Cement	OPC 53 Grade
Specific gravity of cement	3.15
Compressive strength of cement at 7 days	satisfies the requirement of IS269-1989
Specific gravity of coarse aggregate	2.68
Specific gravity of Fine aggregate	2.63
Type of exposure (assumed)	Mild
Specific gravity of silica sand	2.63
Specific gravity of artificial sand	*2.87*

Design procedure

Step 1: Target mean strength of concrete

fck*=fck+tS

where fck-Characteristic compressive strength at 28 days=30 Mpa

S-Standard deviation=4 (As per IS 456:2000)

t-a statistical value depending on the risk factor=1.65

fck*=fck+tS

=30+1.65x4

fck =36.6 Mpa

Step 2: Selection of water cement ratio

As per IS 456:2000

w/c=0.42 (By strength)

w/c=0.60 (By durability)

adopt lower w/c ratio

Step 3: Selection of water content

For 20mm size aggregate-water content including surface water per cubic meter of concrete=186 kg or 186 litres

Step 4: Determination of cement content

w/c=0.42

186/cement=0.42

Cement=443kg/m³

Step 5:Determination of fine aggregate

Given 2% air content by volume of concrete

Applying equation,

V=[W+(C/Sc)+(1/p)(fa/Sfa)](1/1000)

Where V-Absolute volume of fresh concrete which is equal to the gross volume(m³)minus the volume of entrapped air

W-Water content(kg/m³) of concrete

C-Mass of cement kg/m³ of concrete

p-Ratio of fine aggregate (FA) to total aggregate by absolute volume

fa-total mass of fine aggregate

Sfa-Specific gravity of fine aggregate

V=Gross volume – Volume of entrapped air

=1-(2/100)

V =0.98 m³

W=186kg/m³, C=405 kg/m³, Sc=3.15,p=35%, Sfa=2.63

V=[W+(C/Sc)+(1/p)(fa/Sfa)](1/1000)

0.98=[186+(405/3.15)+(1/0.35)(fa/2.63)](1/1000)

Fa= 559 kg/m³

Step 6: Determination of coarse aggregate content

Ca=(1-p/p)fa(Sca/Sfa)

Ca=(1-0.35/0.35)x613.053x(2.68/2.63)

Ca=1154 kg/m³

Step7: Mix proportion becomes

Table 3.12: Mix proportion

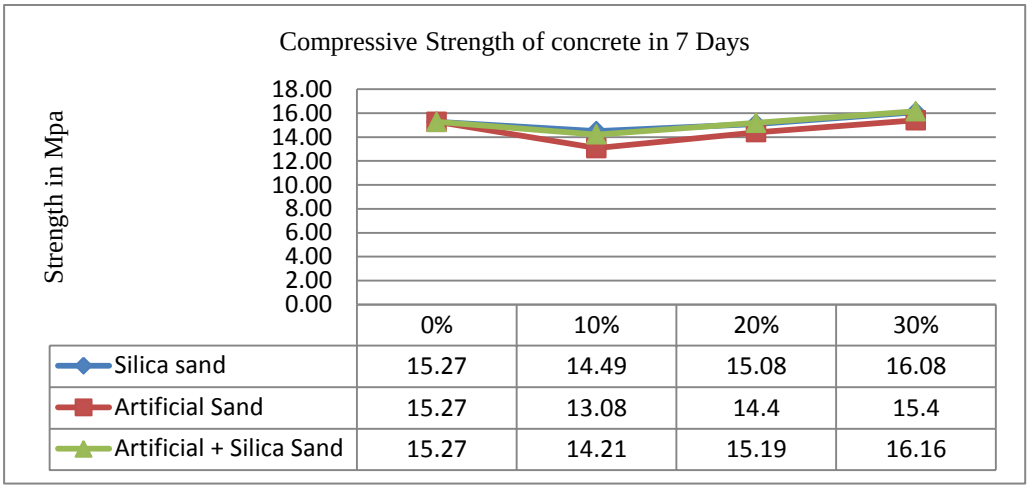
Water(Litres)	Cement(kg)	Fine aggregate(kg)	Coarse aggregate(kg)
186	443	559	1154
0.42	1	1.26	2.61

IV RESULTS

For M 30 grade of concrete with W/C ratio of 0.42 mix was casted.. The cubes, beams were tested for compressive strength ,split tensile strength and flexural strength. These tested were carried out at age of 7 days and 28 days.

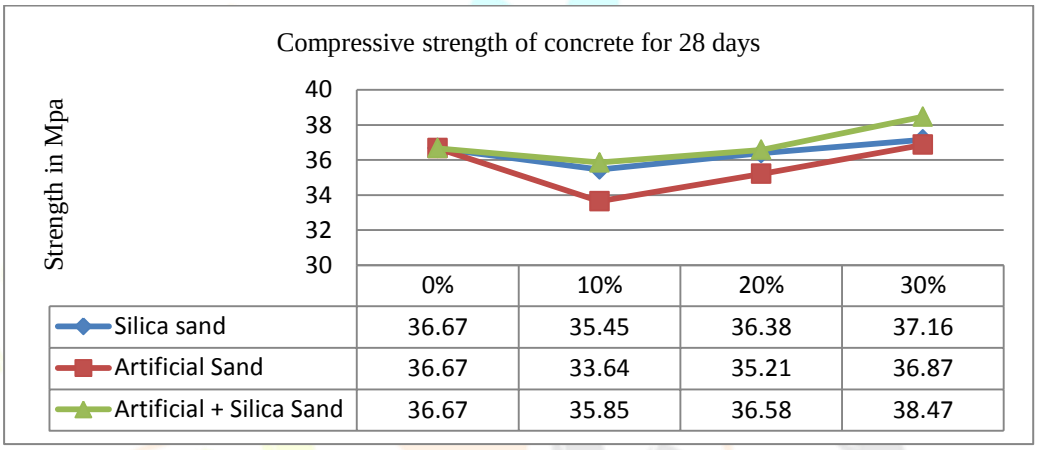
A. Hardened Properties of Concrete

1) Compressive strength test results



	0%	10%	20%	30%
Silica sand	15.27	14.49	15.08	16.08
Artificial Sand	15.27	13.08	14.4	15.4
Artificial + Silica Sand	15.27	14.21	15.19	16.16

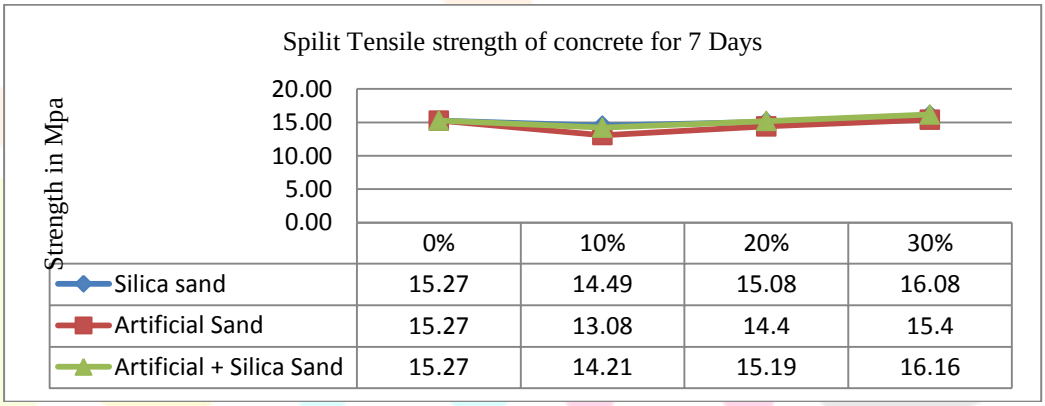
Graph No 1 – Compressive Strength of concrete for 7 Days



	0%	10%	20%	30%
Silica sand	36.67	35.45	36.38	37.16
Artificial Sand	36.67	33.64	35.21	36.87
Artificial + Silica Sand	36.67	35.85	36.58	38.47

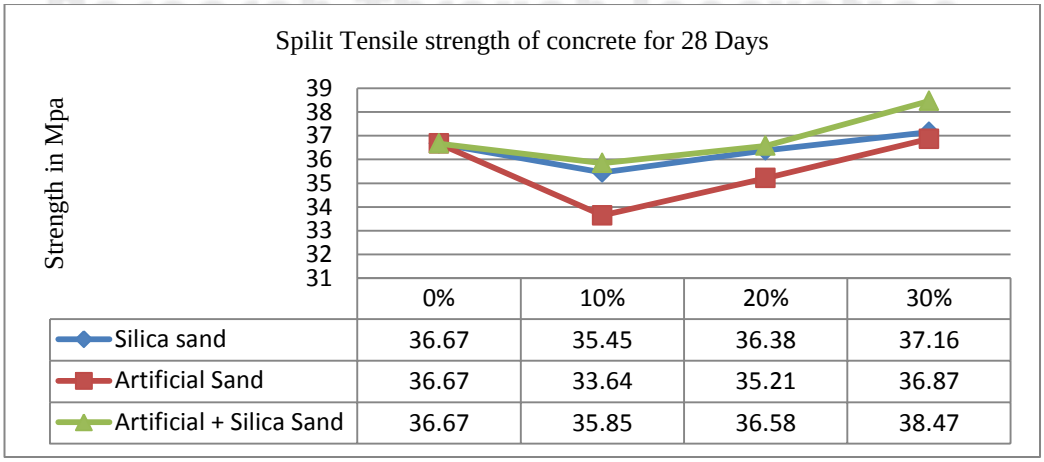
Graph No 2 – Compressive Strength of concrete for 28 Days

2) Split - Tensile Strength test results



	0%	10%	20%	30%
Silica sand	15.27	14.49	15.08	16.08
Artificial Sand	15.27	13.08	14.4	15.4
Artificial + Silica Sand	15.27	14.21	15.19	16.16

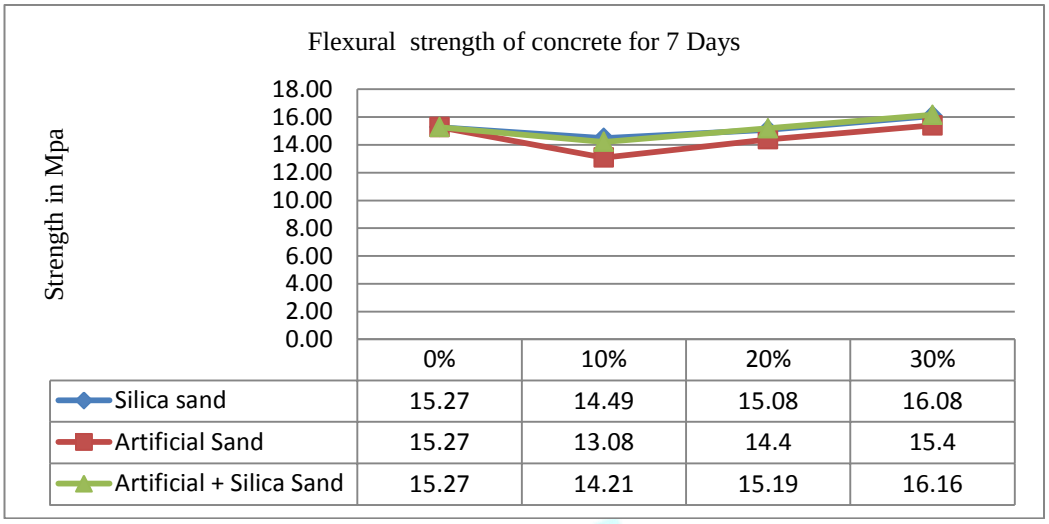
Graph No 3 – Split - Tensile Strength of concrete for 7 Days



	0%	10%	20%	30%
Silica sand	36.67	35.45	36.38	37.16
Artificial Sand	36.67	33.64	35.21	36.87
Artificial + Silica Sand	36.67	35.85	36.58	38.47

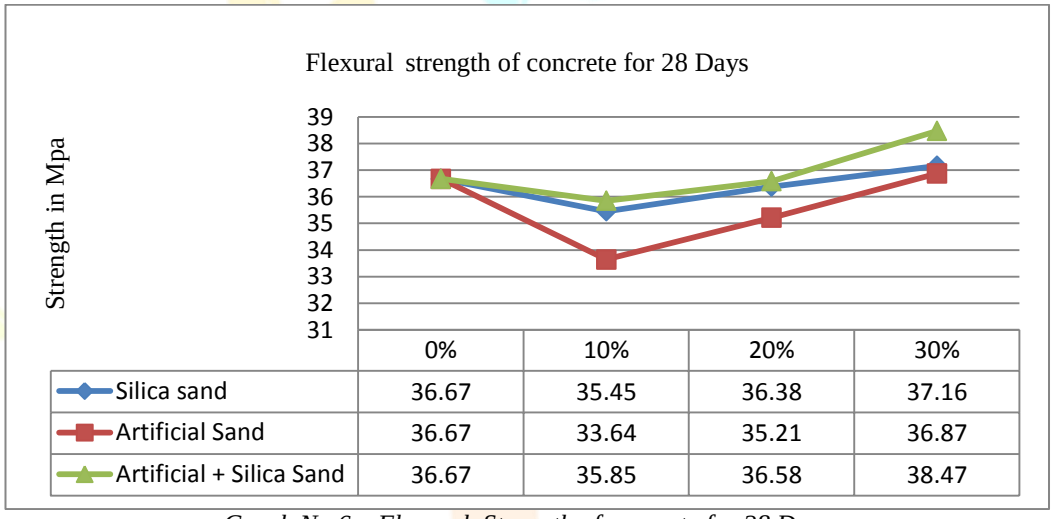
Graph No 4 – Split - Tensile Strength of concrete for 28 Days

3) Flexural Strength test results



	0%	10%	20%	30%
Silica sand	15.27	14.49	15.08	16.08
Artificial Sand	15.27	13.08	14.4	15.4
Artificial + Silica Sand	15.27	14.21	15.19	16.16

Graph No 5 – Flexural Strength of concrete for 7 Days



	0%	10%	20%	30%
Silica sand	36.67	35.45	36.38	37.16
Artificial Sand	36.67	33.64	35.21	36.87
Artificial + Silica Sand	36.67	35.85	36.58	38.47

Graph No 6 – Flexural Strength of concrete for 28 Days

V. CONCLUSION

1. The compression test result indicates an increasing trend of compressive strength in the early age of the concrete specimens with 30 % silica sand. However, it shows that the strength of specimens was gradually increased up to 30% replacement of silica sand and artificial sand after 28 days. The target strength for M30 grade is 36.6 MPa that are achieved for all the specimens tested in the study
2. The results also show that the concrete specimens with 30% replacement of Silica sand and artificial sand get the highest strength as compared to conventional concrete specimens with different percentage of silica sand, artificial sand. From the obtained result, it is possible to use 30% Silica sand and artificial sand for higher strength of concretese
3. The Compressive Strength is increased by 1.05% for replacement of 30% Silica sand and 1.02% for replacement of 30% artificial sand and 1.09% for 30 % of Silica sand and artificial sand at 7 day
4. The Compressive Strength is increased by 1.09% for replacement of 30% Silica sand and 1.05% for replacement of 30% artificial sand and 1.13% for 30 % of Silica sand and artificial sand at 28 day.
5. The Split tensile Strength is increased by 1.04% for replacement of 30% Silica sand and 1.01 % for replacement of 30% artificial sand and 1.09 % for 30 % of Silica sand and artificial sand at 7 days
6. The Split tensile Strength is increased by 1.07% for replacement of 30% Silica sand and 1.05% for replacement of 30% artificial sand and 1.1% for 30 % of Silica sand and artificial sand at 28 days
7. The flexural strength of beam is increased by 1.22% for 30% of Silica sand and 1.14% for 30% of and 1.45% for 30% Silica sand and artificial sand at 7 days
8. The flexural strength of beam is increased by 1.35% for 30% of Silica sand and 1.20% for 30% of and 1.58% for 30% Silica sand and artificial sand at 28 days
9. The Physical and Chemical properties of Silica sand and artificial sand are satisfied the requirement of code provisions. The other strength and durability test conducted shows that the Silica sand and artificial sand is fit to be used in concrete mix

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