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EXPERIMENTAL INVESTIGATION'S ON RICH MINERAL SILICA (ECOSAND) IN CONCRETE (RMSC)

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ABSTRACT

Rich mineral silica (Ecosand) being waste material generated from manufacture of cement from industry. It can be used to increases efficiency in concrete. An experimental study has been done to achieve high strength concrete using Rich mineral silica (Ecosand) from manufacture of cement as the partial replacement of natural sand (upto 50%) in concrete and then to studied its mechanical properties .Experimental are also shows that the compressive strength, flexural strength, splitting tensile strength and structural behaviour of beam of rich mineral silica(Ecosand) and natural sand such that the combination of two aggregate can be increased efficiency in concrete. The grading of aggregate of tested results shows closest to zone II or zone III.

KEYWORDS: Ecosand, natural sand, design mix, compressive strength, splitting tensile strength, flexural strength, beam.

INTRODUCTION

In its simplest form, concrete is a mixture of paste and aggregates. The paste, composed of Portland cement and water, coats the surface of the fine and coarse aggregates. Through a chemical reaction called hydration, the paste hardens and gains strength to form the rock- like mass known as concrete. Cement manufacturing consists of raw meal grinding, blending, pre-calcining, and clinker burning and cement grinding. In short, limestone and other materials containing calcium, silicon, aluminium and iron oxides are crushed and milled into a raw meal. The process of manufacture consists of grinding of raw materials into fine powder, mixing them intimately and burning them in kiln at 1400 oC: so-called clinker burning. Clinker is cooled; ground to fine powder with some gypsum.the end product is called clinker. Figure 1 shows a simplified flow sheet presenting the cement manufacturing process.

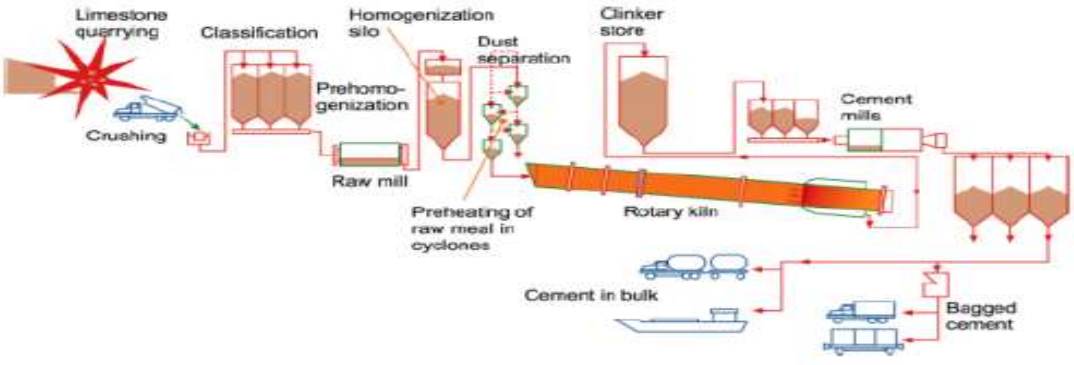

Figure 1. Cement manufacturing from the quarrying of limestone to the bagging of cement.

Limestone is calcareous sedimentary rocks formed at the bottom of lakes and seas with the accumulation of shells, bones and other calcium rich goods. It is composed of calcite (CaCO3). The organic matter upon which it settles in lakes or seas are preserved as fossils. Over thousands and millions of years, layer after layer is built up adding weight. The heat and pressure causes chemical reaction at the bottom and the sediments turn into solid stone, the

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limestone. The rock which contains more than 95% of calcium carbonate is known as high-calcium limestone. Recrystallised limestone takes good polish and is usually used as decorative and building stone. A part of calcium molecules if being replaced by magnesium, it is known as magnesium lime stone or dolomite limestone. Limestone that will take a polish are considered marbles by most people, but technically, if there are still shells visible or the structure is not crystalline, it is still a limestone.

RICH MINERAL SILICA (ECOSAND)

Limestone, Bauxite ore and iron ore some of the ingredients in manufacture of cement. All these compounds contain silica and hence the composition of silica in cement may go higher. Hence the excess silica is removed using some techniques like "Froth Floatation" which is dumped out as Ecosand. Ecosand are very fine particles. So it can be mixed with sand at an optimum level to get a better grading of aggregates. Ecosand being waste material generated from manufacture of cement from industry. It can be used to increases efficiency in concrete. The partial replacement of natural sand in conventional mix designs used in laboratory has given better results. It has been used replacement percentage of **10% to 50% by weight of fine aggregate** and has got improved compressive strength, flexural strength, splitting tensile strength in concrete.

Figure2: Ecosand material

Experimental study shows that the compressive strength, flexural strength, splitting tensile strength, of Eco sand and natural sands such that the combination of two aggregate can be increased efficiency in concrete. The grading of aggregate is closest to zone ii or zone iii of Eco sand and natural sand for adaptation of that combination in concrete mixes. Chemical properties of Ecosand is SiO_2- 46.10%, CaO- 28.30%, Al_2O_3 – 3.10%, Fe_2O_3 – 1.10%, MgO – 0.4%, LOI -15.20%, moisture – 5.80%

Table 2.1 Physical properties of aggregate used

Type of aggregate	**Bulk specific gravity (SSD*)**	**Absorption capacity (%)**	**Fineness modulus**
Coarse aggregate	2.7	0.5 to 1%	2.70
Fine aggregate	2.60	2 %	2.53
Ecosand	2.62	2 %	0.92

*Saturated surface dry

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Table 2.2 Workability of concrete

Material	**% of fine aggregate**						
Eco sand	100	0.00	10	20	30	40	50
Natural sand	0.00	100	90	80	70	60	50
Fineness Modulus(FM)	0.92	2.53	2.32	2.15	1.81	1.64	1.56
Zone	Out of zone	iii	Iii	iv	iv	iv	iv

Table 2.2 Test result of fineness modulus of fine aggregate (Ecosand + natural sand)

Table 2.3 concrete mix details

Mix M20	**Target cube compressive strength (MPa)**	**Mix ratio by weight (cement: sand: Eco sand: coarse agg.)**	**w/c ratio by weight**
A	26.60	1 : 1.465 : 0.000 : 3.247	0.50
B	26.60	1 : 1.318 : 0.146 : 3.247	0.50
C	26.60	1 : 1.172 : 0.293 : 3.247	0.50
D	26.60	1 : 0.969 : 0.415 : 3.355	0.50
E	26.60	1 : 0.830 : 0.554 : 3.355	0.50
F	26.60	1 : 0.692 : 0.692 : 3.355	0.50

Table 2.4 Mix ratio of aggregate

FA = fine aggregate, TA = total aggregate, ES = Ecosand, CA = coarse aggregate

Percentage of Ecosand	**Slump (mm)**	**Compaction factor**
0 to 20%	40	0.85
30% to 50%	50	0.86

FA/TA	*ES/TA*	*20/CA*	*12.5/CA*
1.0	***0.0***	***0.6***	***0.4***
0.9	***0.1***	***0.6***	***0.4***
0.8	***0.2***	***0.6***	***0.4***
0.7	***0.3***	***0.6***	***0.4***
0.6	***0.4***	***0.6***	***0.4***
0.5	***0.5***	***0.6***	***0.4***

Grading of aggregate = (20 mm and 12.5 mm)

TEST RESULTS ON HARDENED CONCRETE

Test on Hardened concrete

The hardened properties of concrete like compressive strength test, split tensile strength test, flexural strength test , structural behaviour of beam and the micro structural properties like saturated water absorption for the concrete mixes were conducted as per IS:516-1959,5816-1999.

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Impact Factor: 4.116
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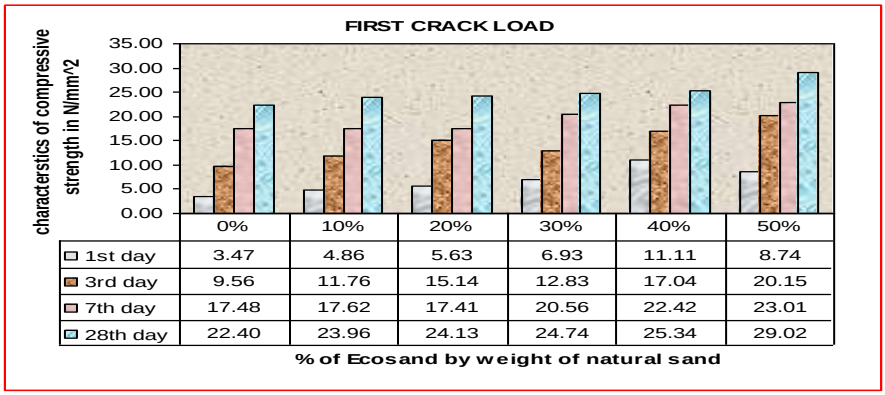
Compressive strength

The compressive strength is a measure of the concrete's ability to resist loads which tend to crush it. The compressive strength was conducted on the cubes of size 150mm³ were tested as per IS: 516-1959 specifications. The density of the specimens was also determined at the same time. The cubes were tested for compressive strength at 1st day of after 24 hours demoulded and 3rd day, 7th day, 28th day of different curing time and the value of the test result are shown in the below charts.

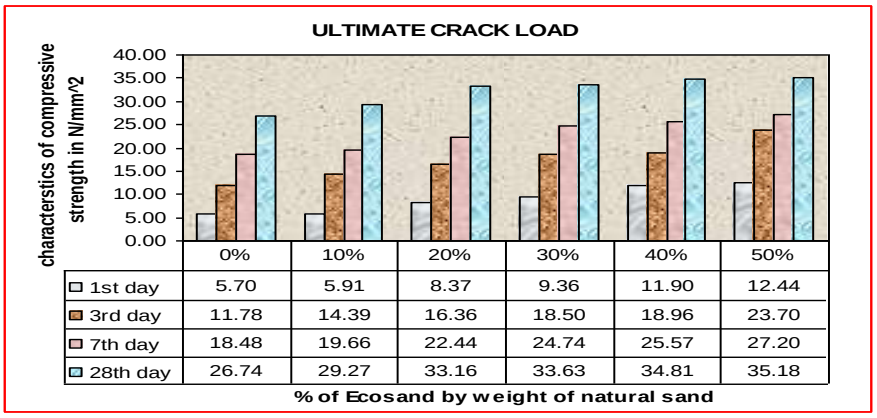
RESULTS AND DISCUSSION

Chart 3.1.1 cube compressive strength of concrete



	0%	10%	20%	30%	40%	50%
1st day	3.47	4.86	5.63	6.93	11.11	8.74
3rd day	9.56	11.76	15.14	12.83	17.04	20.15
7th day	17.48	17.62	17.41	20.56	22.42	23.01
28th day	22.40	23.96	24.13	24.74	25.34	29.02

Chart: 3.1.2 cube compressive strength of concrete



	0%	10%	20%	30%	40%	50%
1st day	5.70	5.91	8.37	9.36	11.90	12.44
3rd day	11.78	14.39	16.36	18.50	18.96	23.70
7th day	18.48	19.66	22.44	24.74	25.57	27.20
28th day	26.74	29.27	33.16	33.63	34.81	35.18

Tensile strength of concrete

The flexural and splitting tensile strength shall be obtained as describes in IS 516 and IS 5816 respectively. When the designer wishes to use an estimate of tensile strength from the compressive strength. Flexural strength, fcr = 0.7√fck N/mm², fck = characteristics cube compressive strength of concrete in N/mm².

Flexural strength of concrete

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100mm x 100 mm concrete beam with a span length of 500mm. the flexural strength is expressed as modulus of rupture (MR) in MPa. Flexural modulus of rupture is about 10 to 20 percent of compressive strength depending on the type, size and volume of coarse aggregate used. However the bests correlation for specific materials is obtained by laboratory test for given materials and mix design. The MR determined by third point loading is lower than MR determined center point loading, sometimes as much as 15%. The test for flexural strength haven been carried out using third point loading.

Chart: 3.1.3 Flexural strength

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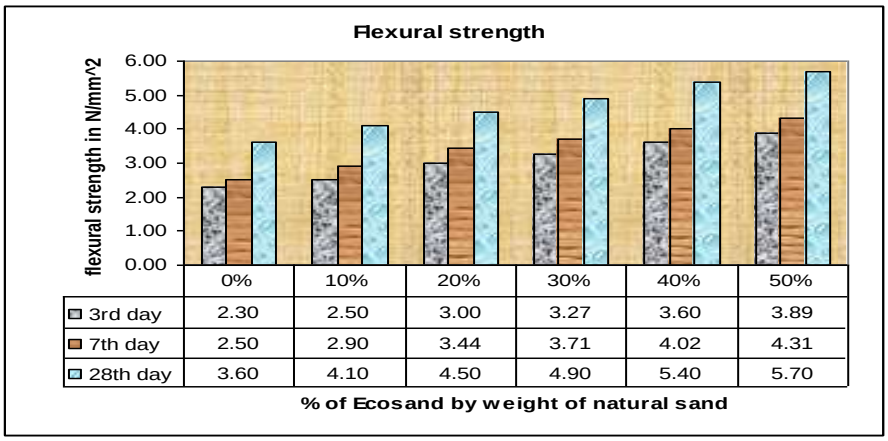
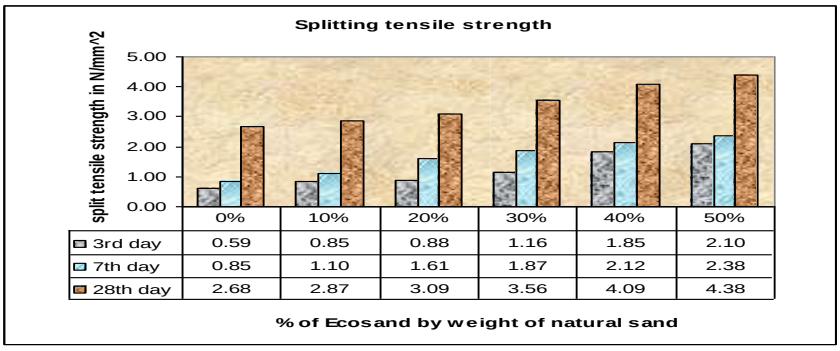


	0%	10%	20%	30%	40%	50%
3rd day	2.30	2.50	3.00	3.27	3.60	3.89
7th day	2.50	2.90	3.44	3.71	4.02	4.31
28th day	3.60	4.10	4.50	4.90	5.40	5.70

Splitting tensile strength

To find out the tensile strength, 150mm diameter and 300 mm length cylinder were casted. Indirect tensile test or Brazilian test or Split cylinder test method of finding the tensile strength of concrete. It is easy to perform and gives more uniform strength than direct tension test. The specimen is loaded horizontally between the loading surfaces of the compression testing machine and is loaded until the failure of the cylinder.

Chart: 3.1.4 Splitting tensile strength



	0%	10%	20%	30%	40%	50%
3rd day	0.59	0.85	0.88	1.16	1.85	2.10
7th day	0.85	1.10	1.61	1.87	2.12	2.38
28th day	2.68	2.87	3.09	3.56	4.09	4.38

SCOPE FOR FUTURE WORK:

The future scope of work is as followed

1. find the flexural behaviour of beam for 0% and 30% of Ecosand by weight of natural sand
2. find the load-deflection of beam
3. compare the load-deflection results of 0% and 30% of Ecosand by weight of natural sand

BEAM DETAILS

- Size of beam = .15*.25*2.1 m
- Dia of main bar =12 mm, Fe=415 N/mm²
- Stirrups = 8mm dia @ 100 mm spacing
- Clear cover = 25 mm
- Area of steel = 226.19 mm²
- Moment of resistance = 15.41 KN-m
- Applied Load (l/3 distance) = 22.015 KN

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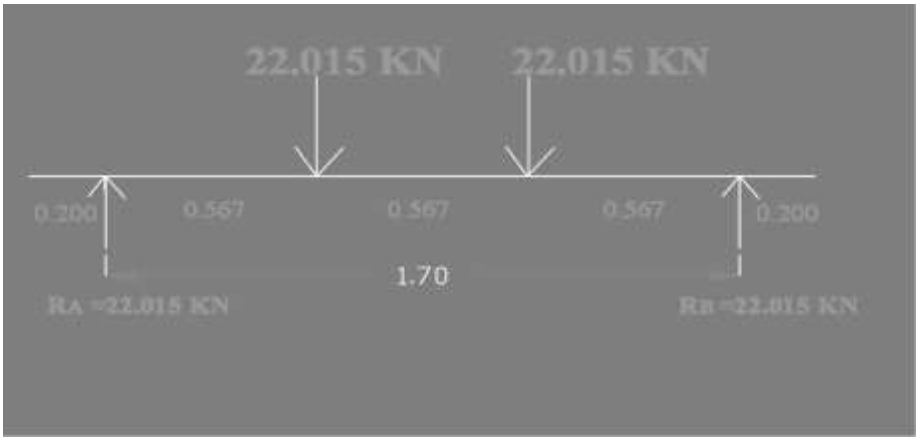

CONCLUSION

- The cube compressive strength obtained by using the combination of fine aggregate and Eco sand gives a higher value.
- The cylinder split tensile strength obtained by using the combination of fine aggregate and Eco sand gives a higher value.
- The prism flexural strength obtained by using the combination of fine aggregate and Eco sand gives a higher value.
- Eco sand being waste material can be used in concrete.
- Low frictional resistance of Eco sand will increase the workability of concrete.
- The low rates of these waste material and also increase in rate of sand day by day shows that usage of these material will prove cheaper.
- The low rates of these waste material and also increase in rate of cement day by day shows that usage of these materials the cement content it may be reduced.

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