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An Experimental study of concrete on Effect of Eco sand as a partial replacement of Fine Aggregates

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Abstract : One of the constituent of concrete is natural sand or river sand. The issues of environmental degradation and expensive nature of the river sand are increasing day by day. The Global consumption of natural sand or river sand has become more due to excessive use of concrete so that the demand of river sand is very high and there is shortage of good quality of river sand. These reasons make us to switch on the alternative sources. Many researches has been done yet to replace the river sand. The objective of this research is to an experimental study of concrete using eco sand as a replacement of fine aggregates. So Eco Sand is replaced with 5%, 10%, 15% and 20% by weight of fine aggregates and mechanical properties such as Compressive strength, Spilt Tensile strength and Flexural strength are investigated. Eco sand acts like filler minerals which helps to reduce pores, reduce moisture resistivity. M40 grade of concrete is taken for study. The rheology studies are also made in detail as the fine content of concrete increases, the water demand increases to make it workable. Hence to overcome this problem, 1% of chemical admixture (water reducer) i.e., super plasticizer is used. The compressive strength, flexural strength and split tensile strength increase when fine aggregate was replaced by eco sand at 5, 10, 15, and 20%. The Optimum percentage of replacement is 15%.

Keyword: Eco sand, Replacement of fine aggregates, River sand, Strength comparison, Super plasticizer

I. INTRODUCTION

A. General

Concrete is a complex material which is composed primarily of cement, fine aggregates and coarse aggregates mixed with portable water that hardens with time. The aggregates are mostly crushed rocks or coarse gravels like lime stones, together with fine aggregates i.e., sand. Portland cement is usually used for production of concrete and other materials which have cementious properties such as fly ash and slag cement all are function as a binder for the aggregates. The cement in concrete reacts with water and forms a hardened mass. In addition the additive which are mineral admixture such as fly ash, slag, are added to cement manufacturing process to improve the properties. During the increased demand for river sand causes a dramatic issues in producing a conventional concrete. This made many researches to be developed and focus on the alternate for fine aggregates. On based on this research, a trail mix was prepared by replacing fine aggregates with an industrial by-product called Eco Sand. The foremost conspicuous of those are Eco-sand (that is a by-product of cement), fly ash, a by-product of coal fired power plants, granulated blast furnace slag, a by-product ofsteelmaking, and a by-product of industrial electric arc furnaces. The utilization of these by-products reduces the problem faced for demand of material aggregates required for concrete.

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B. Eco sand

Eco sand is a by-product of cement manufacturing process and it poses a serious land fill problem. Hence, as a solution to the above mentioned issue, it can be used as an aggregate in concrete depending on its property. The Eco sand does not absorb moisture and it can be made as a fine aggregates replacement in concrete. It acts as an inert materials and being very small particle 530 nm range, it can fill pores and add physical durability to concrete.

II. METHODOLOGY

M40 grade of concrete is taken for study. The fine aggregate is replaced by eco sand at 5%, 10%, 15% and 20% by weight of fine aggregate. The specimens are casted to test the compressive, split tensile and flexural strength of concrete. The cement, fine aggregate, coarse aggregate are tested for properties testing and are tabulated.

III. MATERIAL AND ITS PROPERTIES

A. *Cement*

The Ordinary Portland Cement 53 (OPC53) which is confirming by IS: 8112-1989 used for this study. Cement is a substance which is binder property that used for construction for set, get hardens and adheres with other alternatives materials by binding them together. The materials which are used for manufacture of cement consists of lime, silica, alumina oxide. When these materials subjected to high clinkering temperature combines with each other to form a complex compounds are called Bogue's compounds (C_3A, C_3S and C_2S). The cement plays the important role in the selection of water quantity and workability of concrete.

Table A. Physical Properties of Cement

Properties	Result
Specific gravity	3.09
Fineness test	4%

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Consistency test	31%
Initial setting time test	33 min
Final setting time test	300 min

B. *Eco Sand*

For this experimental study, eco sand obtained from ACC cement factory, Madukkarai, Coimbatore.

Table B. Physical properties of Eco Sand

Properties	Result
Specific Gravity	2.51
Water absorption Capacity	2%
Fineness Modulus	0.93

C.*Aggregates*

Grain size of sand is from zone II and size of aggregates is 20mm. Some tests for fine aggregates and coarse aggregates has been done such as specific gravity test, water absorption test, sieve analysis test, aggregates crushing value and aggregates impact value.

i. Fine aggregates

The naturally occurring sand (river sand) is used as fine aggregates. River sand is generally preferred over crushed sand. Fine aggregate with a rounded particle shape and smooth texture is largely used. Sand which is river sand is passing through 4.75mm sieve is utilized in this project. Tests on fine aggregate were conducted under the guidelines given in IS 2720:1991.

Table a. Physical Properties of F.A

Properties	Result
Size	Passing through 4.75mm sieve
Specific Gravity	2.60
Fineness Modulus	7.12
Water Absorption	1.62%

ii. *Coarse aggregates*

Coarse aggregate confirming a size of 20mm with granulated angular in size and have dry surface is used in this study. The Coarse combination is that the strongest and least porous part of concrete. The coarse aggregates used for this experimental study is obtained from the local supplier. The tests for coarse combination are carried out as per is IS 2386 (Part 4 & 5): 1936.

Table b. Physical properties of C.A

Properties	Result
Size	20mm
Specific Gravity	2.78
Fineness Modulus	7.218
Water absorption	0.55%
Crushing value	8.2%
Impact value	14.2%

D.*Admixture*

Super plasticizer i.e., Adhere mix-700 High Grade is used to increase workability and to reduce water consumption by adding 1% super plasticizers that is known as high range water reducers. When super plasticizer is added in concrete, it allows the reduction of water to the cement ratio and increase the strength but not affect the workability of the concrete.

E. *Details of concrete mix*

In this experimental study, design for M40 is based on IS 10262:2009. Water cement ratio adopted is 0.4 and the mix ratio which is adopted is 1: 2.26: 3.39.

IV. RESULTS AND DISCUSSION

The Compression test, split tensile test, and flexural test of concrete were found. From the results it is evident that, the replacement of fine aggregate by eco sand gives appreciable strength enhancement. As a future study, the fine aggregate can be completely replaced by eco sand and tested for strength parameter.

A.*Compressive Strength*

The concrete cubes of size 150mm × 150mm were cast and cured for 28 days and the results are tabulated. The compressive strength was computed on 7, 14, & 28 days. The specimens is placed in compressive testing machine (CTM) machine. Then the load which is applied on specimen is gradually increased and the point where the cube fails is noted and it is the load at which failure occurs. The test specimen is conducted tests on 7^{th} day, 14^{th} day and 28^{th} day resp. and the compressive strength of eco sand concrete results are shown in Table A.1and the graph of compressive strength of eco sand concreteshown in Figure A.1.

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Table A.1. Compressive Strength of cement concrete specimens with different percentage replacement of F.A with eco sand.

Replacement percentage	7th Day (N/mm2)	14thDay (N/mm2)	`28thDay (N/mm2)
0%	27.84	37.63	44.92
5%	28.85	39.27	48.13
10%	35.51	45.87	54.42
15%	44.23	53.52	60.39
20%	41.74	49.61	56.65

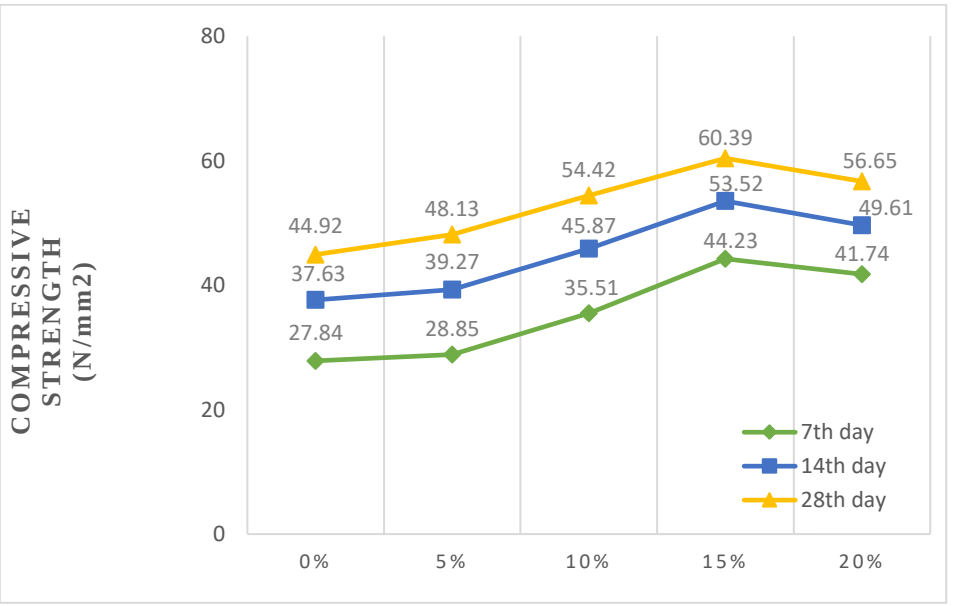

Fig. A.1. Graph of compressive strength test

B.*Split Tensile Strength*

The concrete cylinder of size 150mm × 300mm were cast and tested. The Tensile Strength of concrete is very important properties because concrete has brittle nature so concrete is very weak in tension and also it is not expected to resist the direct tension. When concrete subjected to tensile force, it develop cracks. So it is necessary to determine the tensile strength of concrete.The test specimen is taken and conducted test on 7th day, 14th day and 28th day and result observation. The specimen is placed in CTM machine. Then the applied load increased gradually and the point where the specimen fails is noted and consider as the load at which failure occur.

Table B.1. Split Tensile strength of cement concrete specimens with different percentage replacement of F.A with eco sand.

Replacement percentage	7th Day (N/mm2)	14th Day (N/mm2)	`28th Day (N/mm2)
0%	2.96	3.61	4.73
5%	3.29	4.84	5.68
10%	3.81	5.07	6.51
15%	4.62	5.98	7.36
20%	4.10	5.13	6.84

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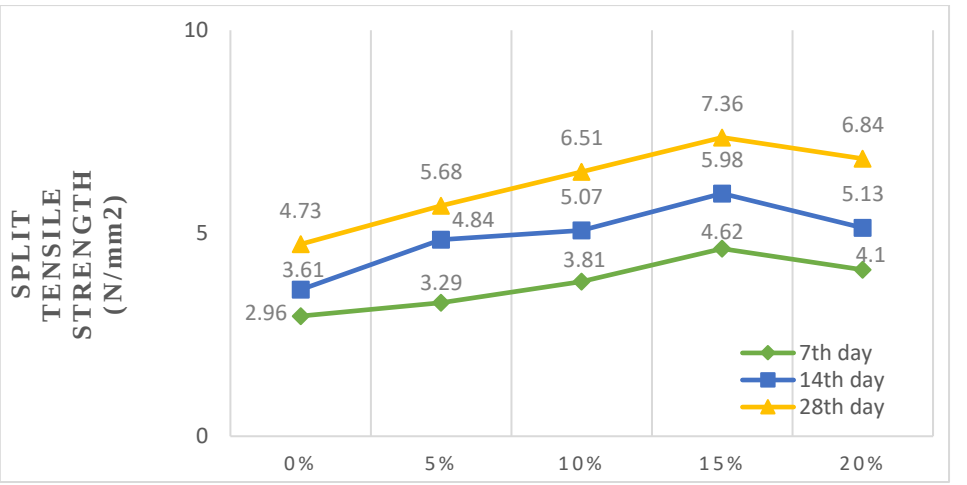

Fig. B.1. Graph of split tensile strength test

C.*Flexural Strength*

Flexural test is done for the tensile strength of concrete indirectly. This test is done for check the unreinforced concrete slab or beam to withstand failure in bending. The results of flexural strength test on concrete expressed as a modulus of rapture in Megapascal (MPa). The Flexural strength test on concrete slab or beam was tested by two point load. The test specimen is taken and conducted test on 7th day, 14th day and 28th day and result observation. The table C.1 shows the split tensile strength tests results and Figures C.1 shows graph of split tensile strength test results.

Table C.1. Flexural Strength of cement concrete specimens with different percentage replacement of F.A with eco sand.

Replacement percentage	7thDay (N/mm2)	14th Day (N/mm2)	`28th Day (N/mm2)
0%	2.40	4.16	4.89
5%	4.10	4.93	5.76
10%	5.32	5.76	6.47
15%	5.78	6.70	8.15
20%	5.39	5.91	7.30

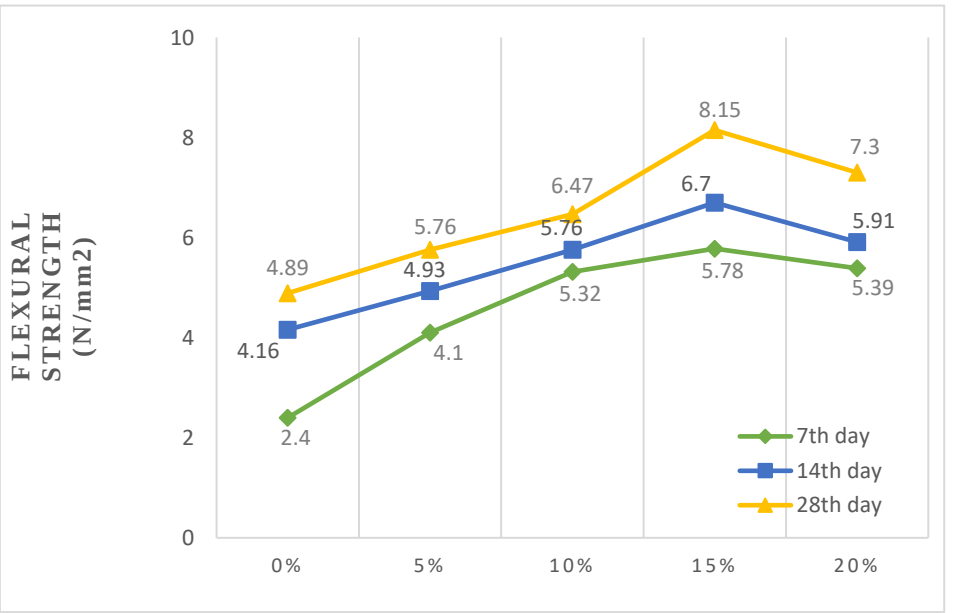

Fig. C.1. Graph of Flexural strength test

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V. CONCLUSION

- The construction work with Eco sand cement concrete becomes environmentally economical and safe.
- Eco sand can be substitute for fine aggregates which helps to reduce the cost of concrete and also reduce the consumption of sand. So that replacement of fine aggregates with Eco sand in concrete can be replaced up to 15% for M40 grade concrete.
- When fine aggregates is replaced with Eco sand, at 15% eco sand cement concrete, compressivestrength is increased 25.61%, split tensile is increased 35.73% and flexural strength is increased 40.14% achieved at 28th day as compared to conventional concrete.
- At 20% replacement of fine aggregates by eco sand produces strength enhancement than conventional but the strength is lower than 15% replacement.
- Hence it is concluded that Eco sand cement concrete can be used for all types of normal construction activities.
- After 15% replacement, strength was decreasing because of extra water demand which could be balanced with addition of chemical admixture at a greater percentage. For future study, super plasticizer can be used by more percentage to get high strength at higher percentage replacement of Eco sand as a fine aggregate.

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