

Assessment of Characteristic Strength of M30 Grade Concrete Using Soil as a Partial Replacement of Sand

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ABSTRACT: Concrete is a composite material with a mixture of Cement, Fine aggregate, coarse aggregate. Sand is a natural prime material used for preparation of mortar and concrete and which plays a major role in mix. With natural sand deposits the world over drying up, there is an acute need for a product that matches the properties of natural sand in concrete. Existing natural sand deposits are being emptied at the same rate as urbanization and new deposits are located either underground. The arguments are mostly in regards to protecting riverbeds against erosion and the importance of having natural sand as a filter for ground water. The above concerns, combined with issues of preserving areas of beauty, recreational value and biodiversity, are an integral part of the process of most local government agencies granting permission to aggregate producers across the world. Many researchers are finding different materials to replace sand and one of the major materials is local available soil. Using different proportion of this available soil along with sand the required concrete mix can be obtained. This paper presents a review on the study of Strength of concrete cubes with replacement of fine aggregate with local available soil with different percentages (10%, 20%, 30%, 40%, 50% & 60%) by using Compression testing and Split tensile test.

KEYWORDS: urbanization, Biodiversity, characteristic strength.

I. INTRODUCTION

Concrete is the most popular building material in the world. Cement, sand and aggregates are essential needs for any construction industry. Sand is a major material used for preparation of mortar and concrete and plays a most important role in mix design. In general consumption of natural sand is high; sand has been used as a unique raw material. River sand has been one of the most popular options for the fine aggregate of concrete in the past, but over use of the material has led to environmental concerns due to the large use of concrete and mortar. Hence the demand of natural sand is very high in developing countries to satisfy the rapid infrastructure growth. The developing country like India facing shortage of good quality natural sand and particularly in India, natural sand deposits are being used up and causing serious threat to environment as well as the society. The properties have to be established by extensive testing and it is to be shown that it conform to the requirement of relevant Indian standards related to concrete making. In the selection of soil for the manufacture of concrete it has become mandatory to check that it satisfies the properties of fine aggregate as prescribed by the relevant codes. The main properties of soil are that it should conform to the grading curve, similar to that of sand, since this curve indicates the particle size distribution of the sample. It is very important, since all sizes of particles will fill the gaps and avoid porosity in concrete and increases its density and gives good strength

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NEED FOR THE REPLACEMENT OF SAND

Due to continue use of the aggregate, river sand is becomes scare and the production of concrete is degrading the environment. It affects the living organism of river severely because the surface of river sand goes downwards in the river bed. This will affect the storage capacity of river and leads to severe water scarcity during lean season. So there is an imperative need to develop alternative materials for replacing natural river sand in concrete. For reducing the usage of the raw material large replacement is done using the various by-product materials that are available in the present day. Study on local available soils to meet the sand specification and also possesses other advantages which makes it potentially a very good and appropriate material for construction. Many studies are made with several other materials which gave the concrete to be a material made of recycled materials. The properties of concrete in fresh and hardened state are studied in the various papers that are used as a reference for this. Some of the tests are compressive strength and Split Tensile test is the major one that are considered.

II. OBJECTIVES AND SCOPE

- To establish the suitability or otherwise of soil as replacement of sand in concrete making through preliminary tests.
- If found suitable, study the behaviour of cubes cast out of such concrete, by carrying out laboratory controlled tests.
- To study physical properties of Cement, Fine aggregate and Coarse aggregate.
- The experimental investigation involves establishment of suitability or otherwise of soil as replacement of sand in concrete making through preliminary tests like sieve analysis, compressive strength of cubes, after classifying the soil proposed to be used as replacement; soil collected from Anantapur are used as replacement.
- The samples were tested at the age of 1, 3, 7 and 28 days after casting which is during the curing works. No admixture was used in this experiment.
- To make construction effective

III. LITERATURE REVIEW

- **Dr. T.S.Thandavamoorthy** has worked out and investigated the feasibility of use of locally available soil as replacement for sand as fine aggregate. He concluded that the local available soils has the same properties that of river sand which is a prime source use as fine aggregate, his investigations has proved that soil can be used as fine aggregate in concrete.
- **Aggarwal et al.** have carried out experimental investigations to study the effect of use of bottom ash (the coarser material, which falls into furnace bottom in modern large thermal power plants and constitute about 20 per cent of total ash content of the coal fed in the boilers) as a replacement of fine aggregates. Different strength properties studied consisted of compressive strength, flexural strength and splitting tensile strength. The strength development for various percentages of 0 - 50 replacement of fine aggregates with bottom ash was easily equated to the strength development of normal concrete at various ages.
- **Nagabhushana and Sharada Bai** studied the properties of mortar and concrete in which Crushed rock powder was used as a partial and full replacement to natural sand. For mortar CRP is replaced at percentages of 20, 40, 60, 80 and 100. The strength properties of concrete were investigated with replacement levels of 20, 30, 40%. The natural aggregates are becoming scare and continued use of these aggregates in the production of concrete is degrading the environment. Thus, it is becoming inevitable to use alternative materials for aggregates in concrete which include recycled aggregates, fly ash, manufactured sand, crushed rock powder, etc. the use of such materials not only results in conservation of natural resources but also helps in maintaining good environmental conditions.
- **Siddique** presented the results of an experimental investigation carried out to evaluate the mechanical properties of concrete mixtures in which fine aggregate i.e., sand was partially replaced with Class F fly ash. Sand was replaced in five percentages. i.e., 10, 20, 30, 40 and 50 of Class F fly ash by weight. Tests were performed for properties of fresh concrete. Compressive strength, splitting tensile strength, flexural strength, and modulus of

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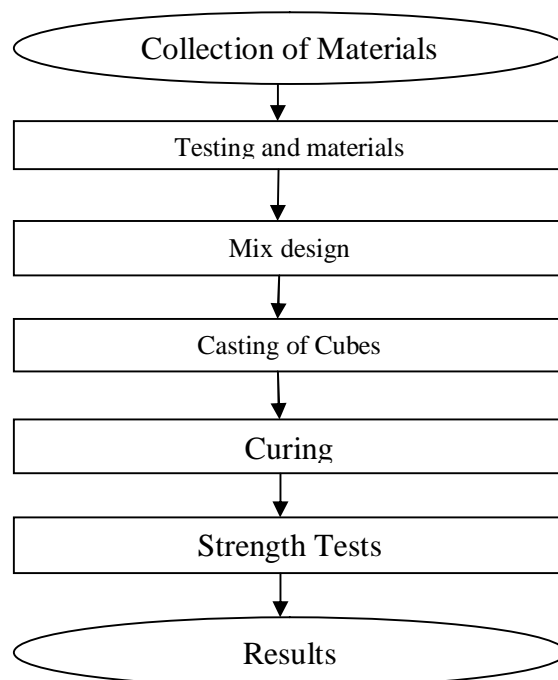
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elasticity were determined at 7, 14, 28, 56, 91 and 365 days. Test results indicated significant improvement in the strength properties of plain concrete by the inclusion of fly ash as partial replacement of fine aggregate (sand), and could be effectively used in structural concrete.

- **Seif** reported that the fine aggregates of Egyptian dunes were considered as an important natural source of fine aggregate making them a major component in concrete and mortar mixes. The dune sands in Kharga Oasis were composed mainly of quartz, feldspars and trace amounts of other minerals. The silt and clay contents were negligible. Using the USCS-classification, the studied dune sands were poorly graded sand. Texturally, these dune sands were consisting of rounded spherical grains with less abundant angular components. Based on the grain-size, textural, mineralogical and chemical results obtained in this study, it was recommended that dune sands in Kharga Oasis could be used as fine aggregates in cement mortar.
- **Hamza** et al. was to utilize marble and granite waste of different sizes in the manufacturing of concrete bricks, with full replacement of conventional coarse and fine aggregates with marble waste scrapes and slurry powder of content up to 40 per cent. The bricks produced were tested for physical and mechanical properties according to the requirements of the American Standards for Testing Materials (ASTM) and the Egyptian Code. The test results revealed that the recycled products had physical and mechanical properties that qualified them for use in the building sector, where all cement brick samples tested in this study complied with the Egyptian code requirement for structural bricks, with granite slurry having a positive effect on cement brick samples that reached its optimum at 10 per cent slurry incorporation.

IV. METHODOLOGY

The methodology involves in collection of materials required for the concrete cubes and tested to know the properties of the materials. Mix design is done to know the requirement of quantities by knowing w/c ratio. Strength parameters of the cubes are to be measured to know the percentage of replacement of soil to sand



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V. MATERIALS

Properties of Cement:

Ordinary Portland cement of 53 grade cement is used in this investigation. Various Properties of the cement has been tested according to IS 12269-1987 and IS 4031-1988 is given below:

S.NO	PROPERTIES	VALUE
1	Specific gravity	3.15
2	Fineness	97.80
3	Initial Setting	65min
4	Final Setting	9hrs 15min
5	Standard Consistency	29.54%
6	Compressive Strength N/mm ²	55.26%

Properties of Fine Aggregate:

The Fine aggregate help in filling the voids present between Coarse aggregate and they mix with cementaneous materials and form paste to coat aggregate particles affect the compactability of the mix.

S.NO	PROPERTIES	VALUES
1	Type	River Sand
2	Specific gravity	2.605
3	Water Absorption	1.23%
4	Grading	Zone-II
5	Fineness Modulus	3.04
6	Density	1.57

Properties of Coarse Aggregate:

Selection of size of Coarse Aggregate mainly depends on the project Application, Workability, Segregation, Strength and availability. The maximum size of Aggregate was 20mm.

S.NO	PROPERTIES	VALUES
1	Type	Crushed Stone
2	Specific gravity	2.884
3	Water Absorption	0.97%
4	Size	20mm
5	Density	1.48
6	Fineness Modulus	7.48

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Properties of Local Available Soil:

The soil has been taken locally available for the test and the properties have been tested to know the type of soil we are going to use as a replacement to fine aggregate are listed below:

S.NO	PROPERTIES	VALUES
1	Specific Gravity	2.48
2	Fineness Modulus	3.37
3	Liquid limit	36.80
4	Plastic Limit	23.02
5	Plasticity Index	13.78
6	Type	Medium Plastic Soils

VI. MIX DESIGN

Requirements of concrete mix design The requirements which form the basis of selection and proportioning of mix ingredients are: a) The minimum compressive strength required from structural consideration b) The adequate workability necessary for full compaction with the compacting equipment available. c) Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular site conditions d) Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

Grade designation: M30

1 Mass of Cement in kg/m ³	: 380
2 Mass of Water in kg/m ³	: 160
3 Mass of Fine Aggregate in kg/m ³	: 711
4 Mass of Coarse Aggregate in kg/m ³	: 1283
6 Water Cement Ratio	: 0.42

VII. RESULT

- **Compressive strength of concrete:** Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used.

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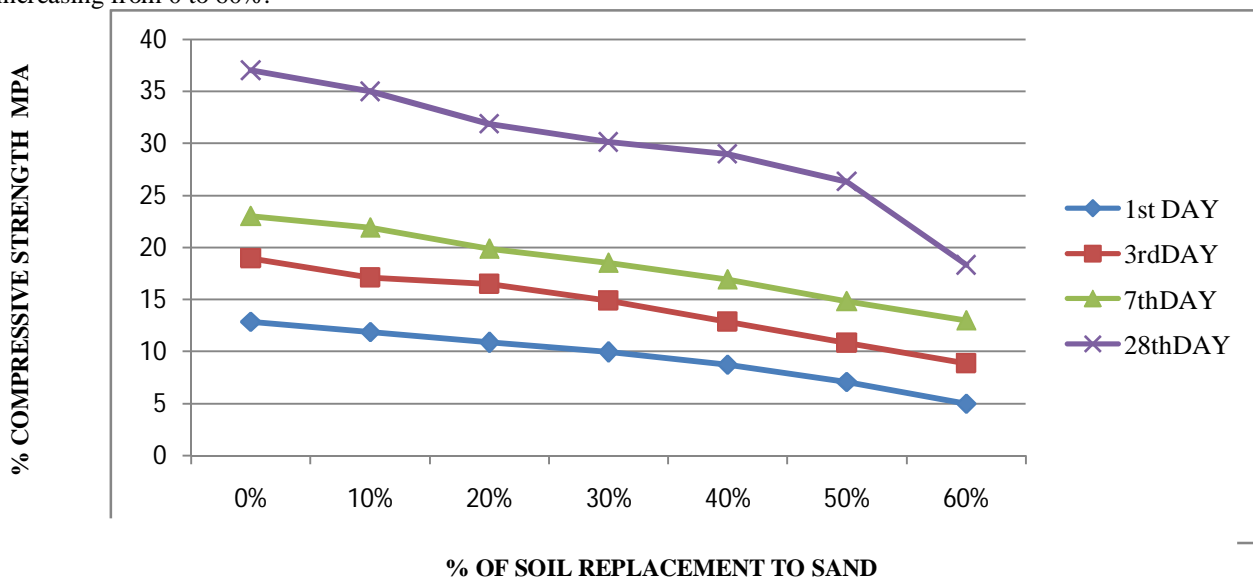
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The following data is tabulated below:

S.NO	% OF SOIL REPLACEMENT TO SAND	1 st DAY MPA	3 rd DAY MPA	7 th DAY MPA	28 th DAY MPA
1	0%	12.89	18.98	23.01	37.01
2	10%	11.88	17.14	21.89	34.98
3	20%	10.88	16.48	19.86	31.88
4	30%	9.96	14.90	18.54	30.12
5	40%	8.74	12.88	16.94	29.01
6	50%	7.12	10.86	14.86	26.32
7	60%	5.00	8.89	13.01	18.32

The following data of variation of compressive strength is represented in Line Diagram as follows.

These graph shows variation of Characteristic compressive strength of concrete cubes tested showing depreciation (i.e., sloping downwards) in the strength while percentage of soil as a replacement for fine aggregate is increasing from 0 to 60%.



- Split Tensile strength of concrete:** Tensile strength of concrete is one of the basic and important properties. Split tensile test is done as per I.S.5816-1959[6]. The test is conducted on compression testing machine of capacity 3000kN. During the test the platens of the compression machine should not be allowed to rotate in a plane perpendicular to the axis of the cylinder. The cylinder is placed horizontally between the loadings surfaces of the

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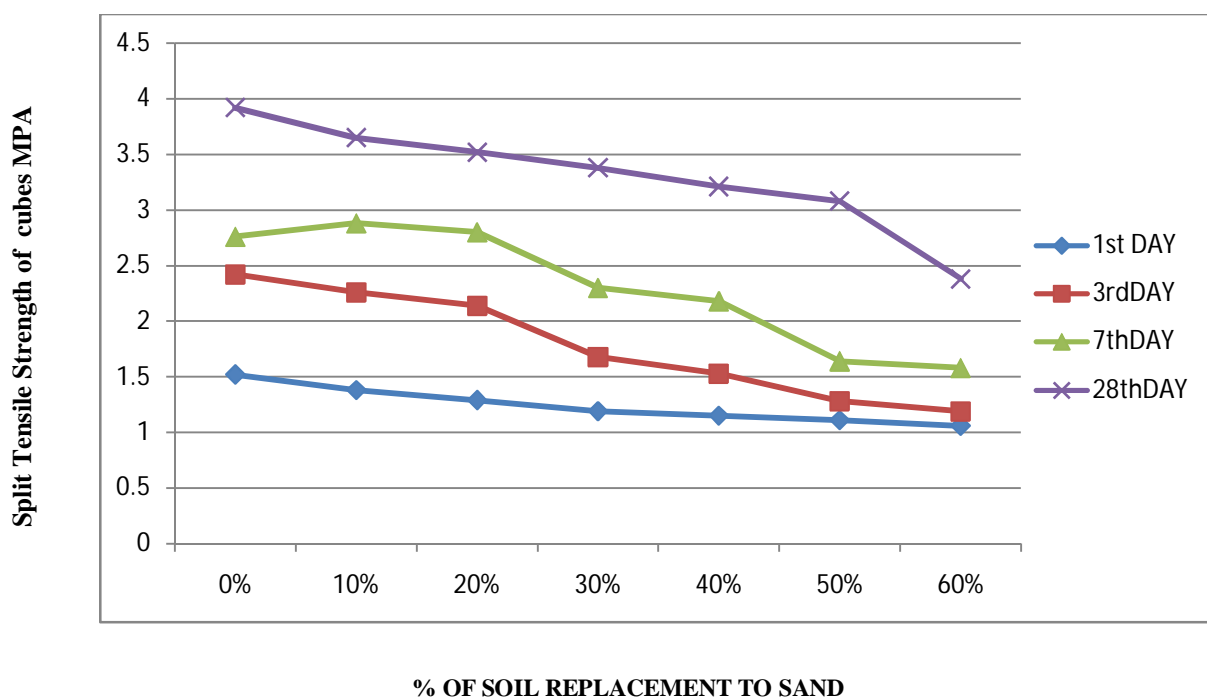
testing machine and the load is applied till the failure of cylinder. Packing material like plywood used to avoid sudden loading.

The following data is tabulated below:

S.NO	% OF SOIL REPLACEMENT TO SAND	1 st DAY MPA	3 rd DAY MPA	7 th DAY MPA	28 th DAY MPA
1	0%	1.52	2.42	2.76	3.92
2	10%	1.38	2.26	2.88	3.65
3	20%	1.29	2.14	2.80	3.52
4	30%	1.19	1.68	2.30	3.38
5	40%	1.15	1.53	2.18	3.21
6	50%	1.11	1.28	1.64	3.08
7	60%	1.06	1.19	1.58	2.38

The following data of variation of Split Tensile strength is represented in Line Diagram form as follows.

These graph shows variation of tensile strength of concrete cubes tested showing depreciation (i.e., sloping downwards) in the strength while percentage of soil as a replacement for fine aggregate is increasing from 0 to 60%.



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VIII. CONCLUSION

1. The specific gravity for river sand was 2.707 whereas for local soil it was 2.48
2. The fineness modulus for river sand was 3.09 whereas for local soil it was 3.37, percentage of fines for local available soil will be less than as compared to River sand.
3. As per the Atterberg limits the soils we consider are the medium plastic soils (silt).
4. From the compressive strength test and Split Tensile test values, for the cubes replaced with 10%, 20%, and 30% of soil are having value above mean target strength. Thus sand can be replaced with local available soil up to 30%..
5. From various tests conducted, it can be concluded that the properties of local soil is as good as the regular river sand and the investigation has proved that it can as well be used as fine aggregate in the production of concrete in place of river sand because its availability now a days has become scarce and also expensive.

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