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ENHANCEMENT OF STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE WITH RED SOIL

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Abstract— Concrete is the major construction material in the construction industry. Concrete uses fine aggregate to fill the voids between the coarse aggregates. The most commonly used fine aggregate is natural river sand. Due to the growth of population and urbanization, there is a rapid growth in construction activity thereby consuming a lot of sand for concrete. At the present situation, there is a huge demand for sand and natural resources which are running low. Hence there is a need for some substitute material which must satisfy their requirement of fine aggregate. Red soil is one such material which is available is greater quantities. Studies have been conducted on red soil which was collected from Dhammanapet in Warangal District. This study has been performed on M25 grade concrete using OPC 53-grade cement. Tests have been performed by replacing the fine aggregate with red soil by an equal increment of 10%. This experimental study concluded that there is a decrease in compressive strength and a slight increase in the tensile strength of concrete with a decrease in workability by the replacement of Red soil in fine aggregates. Also beyond 40% replacement of sand with red soil, there is difficulty in the casting of concrete cubes and cylinders and the surfaces smoothness is reduced. However, at the 20% replacement, the required strength for the mix has been obtained. Admixtures which increase the workability of concrete are suggested to be used with the red soil for the future study.

Keywords — Concrete, River sand, Urbanization, Red soil, Workability.

I. INTRODUCTION

Most commonly man made construction material in the world is Concrete. Cement, sand and aggregate are essential materials in making concrete. In general, consumption of natural sand is high, due to larger usage in making cement mortar and concrete in construction industry. Hence the demand of natural sand is very high in developing countries like India to satisfy the rapid infrastructure growth. Now a day there is a scarcity of sand and it has become very difficult to get easily in economical way. In India due to large usage of natural sand deposits a serious threat is occurring to environment as well as the society. Many problems are occurring due to rapid extraction of sand from river beds like losing water retaining soil strata, deepening the river beds and causing bank slides, loss of vegetation on the bank of rivers, disturbs the aquatic life as well as disturbs agriculture due to lowering the water table in the well are some of the examples. In order to overcome it and fulfil the requirement of the fine aggregates, some alternative material must be found. Hence, in this project it is planned to carry an experimental work by preparing concrete blocks with partial replacement of sand by available natural red soil.

II. OBJECTIVES OF THE STUDY

Basically this paper is based on the dissertation work carried out to find a material which is suitable as a fine aggregate and also available in large quantities and also minimize the use of river sand and thereby preventing it from exhaustion.

Some of the objectives are:

- To study the properties of cement and red soil.
- To study the mix proportioning of materials for concreting.
- To study different properties of concrete.
- To observe the variation of Tensile and compressive strength of concrete at various percentage of sand replacement.
- To judge the suitability of red soil as a fine aggregate.

By keeping the above objectives in mind the aims of present work is to check the suitability and utilization of red soil as a partial replacement of fine aggregate in concrete.

III. MATERIALS USED

Cement

OPC (53 Grade) confirming to IS: 269-1976 was used throughout the investigation. Different tests were performed on the cement to ensure that it confirms to the requirements of the IS specifications. Cement physical properties were determined as per IS:4031-1968 and are tabulated in Table:1

Table -1: Physical Properties of 53 Grade Cement

Properties	**Values**
1. Specific gravity of cement	3.12
2. Fineness of cement	5%
3. Consistency of cement	33%
4. Initial setting time of cement	105 min
5. Final setting time of cement	10 hours

Aggregates:

The maximum size of coarse aggregate from stone crusher used for this investigation is 20 mm and specific gravity is 2.7. The nominal size of the fine aggregate used is 4.75mm and its specific gravity is 2.42.

Water:

Fresh and clean water is used for casting and curing of specimen and it should be free from organic materials.

Red Soil:

Red soil is formed due to the weathering of Igneous and a metamorphic rock. Red soil is one of the problematic soils which were collected from Dhammanapet Warangal. Red colour of the soil is due to the presence of iron oxide and it is deficient in Nitrogen and Lime and the properties of red soil vary from place to place significantly in smaller ratio. The availability of red soil is high in Indian, depending on their properties some soils may give good strength and some may not. Hence it may be replaced as fine aggregates in making concrete.

The physical properties of Red soil which are collected from Dhammanapet Warangal are tabulated below

Table- II: Properties of Red soil.

Properties	**Values**
1. Liquid – limit (%)	26.50
2. Plastic-limit (%)	19.31
3. Shrinkage limit (%)	7.65
4. Plasticity – index(%)	7.19
5. Specific gravity	2.34
6. Grain size distribution a. Coefficient of uniformity (Cu) b. Coefficient of curvature (Cc)	 3.57 0.98

From the above table it is observed that Cu < 4 and Cc <1. Therefore it is a poorly graded soil. Using plasticity chart it is found that the soil is Cl – Ml. As the plasticity is less than 35% it has low plasticity. The specific gravity of red soil is in the range of specific gravity of sand. Hence it can be used as fine aggregate.

IV. CONCRETE MIX

Based on the physical properties of cement and aggregates, design mix is prepared for M25 Grade concrete with water cement ratio 0.45 as per the IS: 10262-2009.

Mix Proportion are tabulated below in Table -3

Table -III**:** Concrete Design Mix Proportion

Cement	**Fine Aggregate**	**Coarse Aggregate**	**Water Content**
1	1.47	2.88	0.45

V**. RESULTS AND DISCUSSION**

Test results for workability concrete mixes for M25 Grade by replacement of fine aggregates with red soil in various percentages.

Slump Cone Test

A slump test is a method used to determine the Workability and Consistency of concrete.

Below table shows the slump test results for replacement of fine aggregates with red soil in various percentages.

Table-IV**:** Slump test

Replacement in FA With Red Soil in Various Percentages	**Slump in cm**
0	16
10	0
20	0
30	0
40	0

From the above values it is observed that with the replacement of fine aggregates with red soil in various percentages in concrete the workability will be reduced.

Compressive Strength Test:

In the present experimental work the size of specimen is 15cm x 15cm x 15cm which are commonly used. Concrete cubes are casted as per above dimensions and are cured for 28 days

The following table shows the value of compressive strength of concrete for a curing period of 28days with the replacement of fine aggregates with red soil in various percentages in concrete.

Table- V**:** Compressive Strength Test

Replacement in FA With Red Soil in Various Percentages	**Compressive Strength in MPa**
0	33.96
10	29.14
20	24.36
30	21.21
40	19.62

Split Tensile Strength:

The split tensile strength of concrete is performed on cylinders with dimension 150mmX300mm. The cylinders are casted as per the dimensions and cured for 28 days.

The following table shows the value of Split tensile strength of concrete for a curing period of 28days with the replacement of fine aggregates with red soil in various percentages in concrete.

Table- VI**:** Split Tensile Strength Test

Replacement in FA With Red Soil in Various Percentages	**Split tensile Strength in MPa**
0	2.16
10	2.31
20	2.45
30	2.49
40	2.07

VI.CONCLUSIONS

From the Experimentation it is concluded that:

- From the above graph of compressive strength it is clear that red soil does not increase the compressive strength of concrete. But at the 20% of replacement it gives the required strength for M25 grade of concrete.
- There is an increase in split tensile strength of concrete with the increase in percentage of red soil as fine aggregate. However at the 40% replacement of fine aggregate it was drastically dropped beyond the conventional concrete.
- Also beyond 40% replacement of sand with red soil, there is difficulty in casting of concrete cubes and cylinders and the surface smoothness is reduced.
- From the above values it is indicated that, with the addition of red soil to the concrete the workability will be reduced. Hence the conventional concrete has good slump value where as the red soil added concrete has true slump.

The above results show that the optimum utilization of Red soil in concrete is 20% as a partial replacement of sand. This study concludes that Red soil can be innovative supplementary fine aggregate material but judicious decision must be taken by expert engineers.

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