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# Optimizing Concrete Mixtures with Red Soil As A Partial Fine Aggregate Replacement: An In-Depth Investigation

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**Abstract:**
An experimental investigation is carried out to study the behavior of concrete by replacing the fine aggregate with locally available red soil. It involves a certain test to find the quality improvement of concrete when red soil is added to it. The partial replacement of sand with red soil has been done according to the specific mix proportion to gain good strength in concrete. In past studies of the journal main problem arising that increase of red soil is to reduce the strength of concrete and it absorb more amount of water. In this project, it is preferred to analysis the strength of M20 Concrete and the amount of red soil is to be added in following percentage such as 15%, 30% & 45%. Mechanical properties such as compressive strength, split tensile strength, flexural strength tests have been carried out for red soil mixed concrete and plain concrete to differentiate the strength and imperviousness in it. The tests are done during $7^{th}$, $14^{th}$ & $28^{th}$ days after curing.

**Keywords:** Red Soil, Porosity, Water Absorption, Imperviousness

## INTRODUCTION

Now a day there is a scarcity of sand and it has become very difficult to get sand easily in economical way. Overcoming of this problem is very essential to research the alternative materials. In order to 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 fine aggregate by available natural red soil. 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, 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. So, we used red soil in this project. Red soil availability is in all kind of areas and it has unlimited resources in all areas which can be effectively used for admixture of concrete in constructing buildings. Red soil is formed due to weathering of igneous and metamorphic rocks. It is highly impervious after it is mixed with concrete because of its size and its color is in red due to the presence of iron in it.

In India regions, the availability of red soil is in Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, Jharkhand and it is also available throughout the world. In this study, red soil is taken from Tiruttani, Tiruvallur(dt), Tamil Nadu.

### Material

### Cement

Ordinary Portland cement grade 43 has been used in this concrete.

### Fine aggregate

Locally available nature river sand to be used.

### Coarse aggregate

A well graded natural aggregate to be used in the concrete.

### Red soil

A normal local available red soil is to be taken in this project is shown in figure 1

**Figure 1. Red soil from Tiruttani, Tiruvallur (dt)**

### Objectives

- To increase the strength of the red soil mixed concrete compare to conventional concrete
- To reduce the usage of fine aggregate in concrete
- To reduce the porosity and water absorption of red soil mixed concrete
- To achieve high strength with more economical

## PROPERTIES OF MATERIALS

### Cement

The cement is a binding material. It is conforming to IS 456-2000-53 grade. It consists of grinding the raw materials, mixing them intimately in certain proportion depending upon their purity and composition and burning them in a kiln at a temperature of about 1300 – 1500 degree centigrade at which temperature, the material partially fuses to form modular chapped clinker. The clinker is cooled and ground to a fine powder with addition of 2 to 3% of gypsum the product formed by using this procedure Portland cement. Of all the materials that influence the behavior of concrete, cement is the most important constituent, because it is used to bind sand and aggregate and it resists atmospheric action.

### Fine Aggregate

The materials smaller than 4.75 mm size is called fine aggregates. Natural sand is generally used as fine aggregate. In this experimental work replacement of river sand (fineness modulus of crushed sand equal to 3.2) conforming to grading Zone III of IS – 383 – 1970 was usedas fine aggregates.

### Coarse Aggregate

Locally available well graded granite aggregates of normal size greater than 4.75 mm and less than 16mm having fineness modulus of 2.72 was used as coarse aggregates. The size of aggregate should be 20mm size.

### Red Soil

Red soil is rich in iron oxide, but deficient in nitrogen and lime. Its color is mainly due to ferric oxides occurring as thin coatings on the soil particles while the iron oxide occurs as hematite or as hydrous ferric oxide, the color is red and when it occurs in the hydrate form as limonite the soil gets a yellow color. Ordinarily the surface soils are red while the horizon below gets yellowish color.

### Sieve Analysis

The sieve analysis is used determine the fineness modulus and zone grading of aggregate as 2.69 and zone IIIrespectively.

### Water Absorption Test

Basically, the aggregate doesn't absorb more amountof water. It absorbs only small amount that 0.96%

### Impact Test

The test can be done in toughness test machine to determine the impact strength. The value is 16.30%

### Shape Test

The shape test is two such as flakiness and elongation test. It's mainly to determine the shape, thickness and length of the aggregate.

**Red soil**

**Specific Gravity**

This test is done by le Pycnometer apparatus. And thevalue of specific gravity of cement is 2.7

**Cement**

**TESTING OF MATERIALS**

**Void Ratio & Porosity**

The void is also done by le pycnometer apparatus and use the relation to determine the porosity value as 1.34% & 63.45%.

**Specific Gravity**

This test is done by le chartelier's apparatus. And thevalue of specific gravity of cement is 3.14.

**Fineness Test**

The fineness value of the cement is 3.63% from 1 kgof the cement sample.

**Initial & Final Setting Time**

The initial and final setting time of the cent is done in vicat apparatus. The determined value of initial and finalsetting time of cement is 30min & 600min respectively.

**Fine Aggregate**

**Specific Gravity**

This test is done by le Pycnometer apparatus and thevalue of specific gravity of cement is 3.14.

**Void Ratio & Porosity**

The void is also done by le Pycnometer apparatus and use the relation to determine the porosity value as 0.409& 29.02%

**Sieve Analysis**

The sieve analysis is used determine the fineness modulus and zone grading of aggregate as 3.11 and zone IIIrespectively.

**Coarse Aggregate**

**Specific Gravity**

This test is done by le Pycnometer apparatus. Andthe value of specific gravity of cement is 3.54.

**Miscellaneous Test**

The liquid limit and plastic limit of the red soil is 75%and 40% respectively. Then, the plasticity index of the red soil is 31.43.

**MIX DESIGN**

Mix design can be defined as the process of selecting suitable ingredient of concrete and determining their relative proportion with the object of producing concrete of certain maximum strength and durability as economically as possible.

**Manufacture of concrete**

Production of quality concrete requires meticulous care exercised at every stage of manufacture of concrete. If meticulous care is not exercised, and good rules are not observed, the resultant concrete is going to be of bad concrete. Therefore, it is necessary for us to know what are the good rules to be followed in each stage of manufacture of concrete for producing good quality concrete.

1. Batching
2. Mixing
3. Placing
4. Compacting
5. Curing

**Batching**

Batching is the correct method of measuring the materials. For important concrete, invariably, weigh

batching system should be adopted. Use of weight system in batching, facilitates accuracy, flexibility and simplicity. Different types of weigh batchers are available, the Particular type to be used depends upon the nature of job. When weigh batching is adopted, the measurement of water must be done accurately using measuring jars.

**Mixing**

Hand mixing is practiced for small scale concrete works. Hand mixing should be done over an impervious concrete or brick floor of sufficiently large size to take one bag of cement. Spread out the measured quantity of coarse aggregate and fine aggregate in alternate layers. Pour the cement on the top of it, and mix them dry by shovel, turning the mixture over and over again until uniformity of color is achieved. This uniform mixture is spread out in a thickness of about 20 cm. This operation is continued till such a good time a good uniform, homogenous concrete is obtained. It is a particular importance to see that the water is not poured but it is only sprinkled. Water in a small quantity should be added towards the end of the mixing to get the just required consistency. At that stage, even a small quantity of water makes difference. After that the red soil is placed in concrete at the different percentage of concrete is added to the quantity of red soil.

**Placing**

It is not enough that a concrete mix correctly designed, batched, mixed, it is of utmost importance that the concrete must be placed in systematic manner to yield optimum results. The precautions to be taken and methods adopted while placing concrete in the moulds.

**Compaction**

Hand compaction of concrete is adopted in case of small concrete works. Sometimes, this method is also applied in such situation, where a large quantity of reinforcement is used, which cannot be normally compacted by mechanical means. Hand compaction consists of rodding, ramming or tamping. When hand compaction is adopted, the consistency of concrete is maintained at a high level. Tamping is one of the usual methods adopted in compacting roof or floor slab or road pavements where the thickness of concrete is comparatively less and the surface to be finished smooth and level.

**Curing**

Concrete derives its strength by the hydration of Cement particles. The hydration of cement is not a momentary action but a process continuing for long time. Curing can also be described as keeping the concrete moist and warm enough so that the hydration of cement can continue. More elaborately, it can be described as the process of maintaining satisfactory moisture content and a favorable temperature in concrete during the period immediately following placement, so that the hydration of cement may continue until the desired properties are developed to a sufficient degree to meet the requirement of service. The casted cubes and cylinders are immersed in water tanks for 7days, 14 days and 28 days.

**Testing of specimen**

The cubes were tested for compressive strength in compression testing machine and the cylinders were tested for split tensile strength same as compression testing machine, but the position of cylinder in horizontal position and take the accurate result and flexural test was tested in Flexural testing machine

then noted the result with respective ages of curing as 7, 14 and 28 days.

**Figure 2. Testing on concrete samples**

## RESULT AND DISCUSSION

Results of the test on concrete samples are given below: For 15% red soil, both the compressive strength, split tensile strength and flexural strength were increased compared to plain concrete in all days.

For 30% red soil, both the compressive strength and split tensile strength were increased in 7 days respectively; result in 14 and 28 days compared to plain concrete specimen

For 45% red soil, both the compressive strength and split tensile strength were decreased compared to plain concrete in all days.

For both 15% and 30% replacement of sand by red soil, both the compressive, split tensile strength and flexural strength were increased from plain concrete specimen with 0% red soil while loading in all curing periods. Overall, the most improved compressive strength, split tensile strength and flexural strength were found for 45% replacement of sand by red soil as it showed almost similar compressive and split tensile strength in 28 days of curing period, but both the strength was decreased in 7 days of curing because concrete absorbed more water with increase of soil.

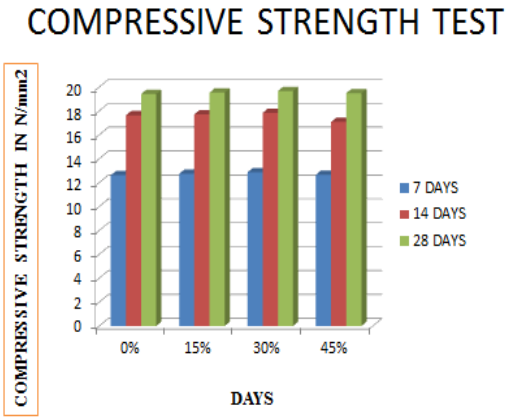


**Table 1. Compression strength test result @ 7, 14 & 28 days**

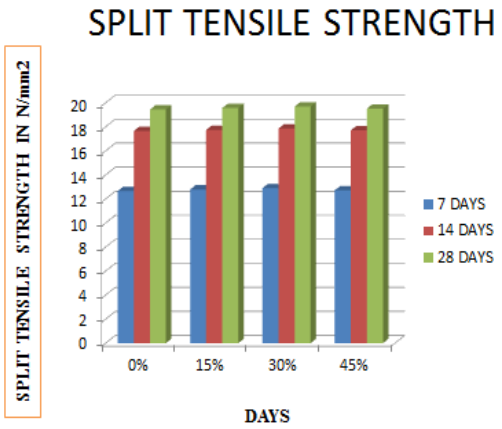


**Table 2. Split tensile strength test result @ 7, 14 & 28 days**

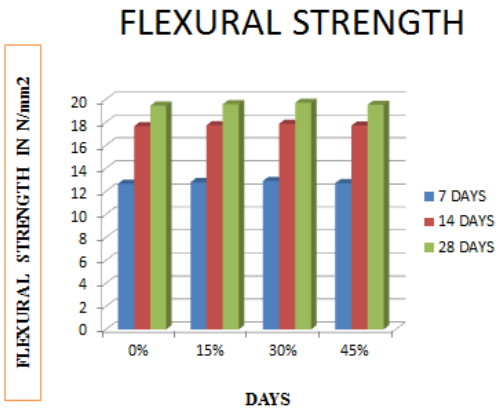


**Table 3. Flexural strength test result @ 7, 14 & 28 days**

## CONCLUSION

The test results were that the red soil mixed concrete is comparatively higher than plain concrete in strength and imperviousness. In compressive strength for 28 days, for plain concrete the values are 19.6N/mm2 and in red soil mixed concrete it has higher the values 22.3N/mm2. Experimental observations also reveals that the strength of the concrete is also well improved when the red soil get mixed with lime powder. The red soil mixed concrete of compressive strength, split tensile strength and flexural test are more strength compared to the conventional concrete.

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