Experimental Investigation on Concrete by Replacement of Fine Aggregates with Stabilised Soil

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Abstract

River sand in the construction field, especially in the production of concrete is of high demand. Even M-sand and other material are used as its replacement; there is always a need for better alternatives. An experimental Investigation has been carried out to study the behaviour of concrete by replacing the fine aggregates with stabilised red soil. Here in this study M-Sand and lime is used to stabilise the red soil as to improve the engineering properties of the soil. The plain cement concrete of M15 grade has been casted and its Mechanical properties such as Compressive strength, Split tensile strength are tested and the durability properties like porosity, thermal resistance and soundness are also tested in this study. It is observed that a good progress in both mechanical and durability properties of this special concrete when compared to the conventional concrete.

Keywords - *soil concrete, red soil, stabilised soil.*

I. INTRODUCTION

The developing countries like India are 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. Rapid extraction of sand from river bed causing so many problems like losing water retaining soil strata, deepening of 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 etc. are some of the examples. Thus this paper showcases the ideology of using stabilised red soil as replacement of natural fine aggregates in the concrete production.

Red soil is the third largest soil group in India. Red soil is the best part of the Indian earth's land on which we can see by the physically in our surround of the state like in the Tamil Nadu, southern Karnataka, north-eastern Andhra Pradesh and some parts of Madhya Pradesh, Chhattisgarh, and Odisha. It is the combination of the rock material and the ignitions part of the rocks and the mountain. They are sandier and less clayey soils**.**

II. STABILISATION OF SOIL

The term stabilisation is defined as the method of changing the natural soil to meet engineering properties. It may be done to improve the grain size, strength, shrinking ability etc., Soil can be stabilized by material like lime, cement, gypsum, etc. Recent trend are practising the stabilisation of soil by M-Sand. In this study, we have used M-Sand and lime as a stabilizer to stabilize the red soil. In this study, mixture of 10% of lime; 30% of M-Sand and 60% of Red soil comprises the fine aggregate portion of the concrete mix.

A. Need of Lime stabilisation

Red soil have some clay particle in it, when it is used with concrete, it will leads to shrinkage of soil while drying that induce the damages in the concrete structures. When lime stabilisation is done, the chemical reaction between the lime, water and red soil breaks down the clay particles by increasing the pH of the soil. From this reaction, Silica and alumina are released and react with calcium from to form cementitious product namely Calcium Silicate Hydrates (CSH) and Calcium Aluminates Hydrates (CAH).

B. Need of M-Sand stabilisation

Since red soil is highly permeable in nature, it will reduce the durability of the concrete. Thus stabilising the soil by m-sand reduced the permeability with increase in proportion of M-Sand and also reduce the voids between the soil particles. It also result in the increase of soil strength.

III. OBJECTIVES

- To study the strength of the concrete by replacing the natural fines aggregates with stabilized red soil.
- To investigate the durability of this special concrete.
- To produce better and low cost replacement product without compromising the strength of the concrete.

To minimize or to avoid the usage of river sand in the concrete and there by safeguarding the environment.

IV. ADVANTAGES AND DISAVANTAGES

A. *Advantages*

- Increase the mechanical properties as well as durable properties of the concrete.
- Minimize the usage and limits the over extraction of the conventional fine aggregates.
- Cost effective when compared to conventional fine aggregates

B. *Dis-Advantages*

- Porosity is higher than that of conventional concrete but on the other hand permeability is lower so it will not damage the structure any more.

V. LITERATURE REVIEW

James Alexander, Karunya University, The ratio 1.5 (fine aggregate) is divided as 1 & 0.5 where 1 refers to sand and 0.5 refers to red soil. In this paper, only 1\3rd of sand is get replaced by the red soil. It is observed that compressed strength, split tensile strength and flexural strength had a good improvement in red soil mixed concrete compared to conventional concrete.

Dhanalakshmi, V.R.S College of engineering, It is observed that, there is a increase in compressive strength, split tensile strength and flexural strength as increase in percentage of quarry dust and red soil increases. The slump value is decrease about 53.19% compared to conventional concrete while adding red soil of 30 % and 20% quarry dust.

Dr. N. Mahendran, PSNA college of Engineering, investigate the use of clay soil as partial replacement for fine aggregate in the concrete production in various percentage like 0%,5%,10% and 15% with concrete of grade M20. It is concluded that increase in clay particle decrease the compressive strength. But using of admixture along with clay increase strength.

Ankit Singh Negi, University of Energy studies, Dehradun. The main objective of the paper is to increase the bearing capacity of the soil, its resistance to weathering process and soil permeability. This paper deals with the complete analysis of the improvement of properties and its stabilisation using lime.

T.S.Thandavamoorthy, Adhiparasakthi Engineering college, investigate the durability property of concrete with soil as fine aggregate to conduct test like acid test, alkaline test, porosity, water absorption, thermal test, etc., Soil concrete has high water absorption and porosity due to coarse particles between 40 to 90% in it. The porosity of soil was 2.7 times greater than 179.

Mr.Hemanth kumar, Malnad College of Engineering, For replacement combination 55% natural soil + 45% M-sand unsoaked CBR value has increased from 3.12% to14.63% but as increase in M-sand percentage decrease the CBR value.

Suraj.M.C, Jayachamendraja college of Engineering, It can be observed that the compressive strength of mortar with 0% sand and 15% cement has the highest strength. The water need of the mortar to attain 110% flow increase as the clay content increase. The compressive strength increases with the increase in clay content.

VI. MATERIAL TESTING REULTS

TABLE I
Test result of cement

S.No.	Properties	Value
1.	Finess	2.41%
2.	Specific Gravity	3.15
3.	Initial Setting time	20 minutes
4.	Final Setting time	600 minutes

TABLE II
Test result of Coarse Aggregate

S.No.	Properties	Value
1.	Impact value	7.45%
2.	Crushing value	13.90%
3.	Water absorption	1.80%
4.	Specific gravity	2.66

TABLE III
Test result of Stabilised soil

S.No.	Properties	Value
1.	Finess Modulus	2.89
2.	Zone	II
3.	Plasticity Index	6.23
4.	Specific gravity	2.67

TABLE IV
Test of Fresh Concrete

S.No.	Properties	Value
1.	Slump Value	50
2.	Flow percent	80%
3.	Compaction factor	83%

VII. EXPERIMENTAL INVESITIGATION

A. *Preparation and Casting of Specimen*

This study included a preparation cube samples (150 × 150 × 150 mm) for compressive strength test and samples of cylinder (150 mm diameter × 300 mm height) for split tensile strength test. For each mix, 3 cubes were tested for compressive strength at 7 days 14 days and 28 days of

curing, 3 samples of cylinder were tested for split tensile strength for 7 days, 14 days and 28 days of curing.

TABLE IIV
Designation of concrete and proportion of lime, m-sand and red soil.

MIX	Permeability		
	Trial 1	Trial 2	Trial 3
Conventional	2.82	2.98	2.87
M1	2.98	3.25	3.66
M2	4.24	4.98	4.89
M3	4.90	5.32	5.21

These proportions of stabilised soil are mixed in concrete instead of natural fine aggregates. M15 Concrete of mix ratio 1:2:4 is prepared and casted with proper compaction. The cube specimens were test for 7^{th}, 14^{th} and 28^{th} for investigate its compressive strength and split tensile strength.

B. Compression test Results

TABLE V
Compressive strength (N/mm^2) of concrete

MIX	Proportion of Ingredients for stabilisation (%)		
	RED SOIL	LIME	MSAND
M 1	40	10	50
M 2	50	10	40
M 3	60	10	30

B. Tensile test Results

TABLE VI
Tensile strength (N/mm^2) of concrete

MIX	Compressive strength (N/mm^2)		
	7^{th} day	14^{th} day	28^{th} day
Conventional	10.22	13.60	14.98
M1	10.14	13.49	14.97
M2	10.35	13.60	15.09
M3	11.12	14.28	16.20

C. Water Permeability Test

TABLE VII
Water permeability of concrete

MIX	Tensile strength (N/mm^2)		
	7^{th} day	14^{th} day	28^{th} day
Conventional	2.18	2.92	3.55
M1	2.16	2.74	3.41
M2	2.35	3.10	3.64
M3	2.82	3.22	3.88

D. *Porosity Test on Concrete*

TABLE VIII
Water permeability of concrete

MIX	Permeability		
	Trial 1	Trial 2	Trial 3
Conventional	6.2	6.4	7.1
M1	3.6	4.2	4.8
M2	1.5	1.9	2.3
M3	0.7	0.9	0.7

VIII. RESULT

- The compressive strength of M3 Mix concrete is much higher than that that of other mixes samples.
- The compressive strength of conventional concrete is 14.98 N/mm^2 while in case of stabilized red soil concrete it give up to 16.20 N/mm^2
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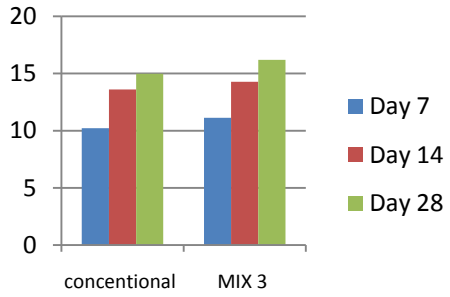
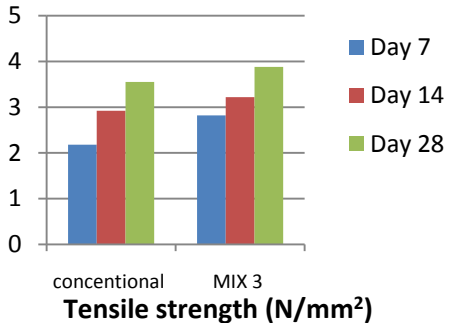


Compressive strength (N/mm^2)

- Similarly, the M3 Mix is observed to be have higher compressive strength that other mixes.
- Normal concrete have 3.55 N/mm^2 of tensile strength but the stabilized red soil concrete show higher tensile strength of 3.88 N/mm^2



- It is witnessed that the stabilized red soil concrete is less permeable in nature when compared to the normal concrete.

- While the conventional concrete exhibits 7.1 of permeability, the stabilized red soil concrete shows just 0.7 of water permeability.

IX. CONCLUSION

- ✓ Higher compressive and tensile strength are found in the concrete mix with stabilised soil consisting of 60% of red soil, 10% of lime and 30% of M-Sand.

- ✓ The compressive and tensile strength has increased above 100% of nominal strength by the usage of stabilised soil.

- ✓ The porosity of red soil concrete is high but on the other hand it have very low permeability.

- ✓ Red soil is cheaper than that of river sand and m-sand and also available in large area.

- ✓ The process of stabilisation through lime and m-sand gives out two cementious product like Calcium Silicate Hydrates (CSH) and Calcium Aluminates Hydrates (CAH). Hence it will reduce the demand of cement content in concrete.

- ✓ Its is suggested to use this stabilised red soil concrete in PCC Work.

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