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Strength Properties of Laterised Concrete

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Abstract:- A study was conducted to determine the suitability of laterite soil as fine aggregate in M25 concrete. Firstly water absorption of laterite soil is conducted. For concrete mix, the replacement of the fine aggregate by laterite soil is in the range of 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%and 40% respectively. The test was conducted as per Indian standards specification.

Addition of laterite to any particular concrete mix is found to reduce its strength characteristics. This is due to fineness of laterite which ultimately increase the air voids as fine particle is at the bottom side and air voids at the top level do not fill properly. But the addition of super plasticizer helps to increase the strength values up to 15% laterite content and further mixing reduce the same. Laterite content of 15% by weight of sand content has shown the best results. Thus it is indicating the possibility of using laterite as a partial replacement for sand up to this level.

I. INTRODUCTION

The huge quantity of concrete is consumed by construction industry all over the world. In India, the conventional concrete is produced using natural sand from river beds as fine aggregate. Decreasing natural resources poses the environmental problem and hence government restriction on sand quarrying resulted in scarcity and significant increase in its cost. Normally particles are not present in river sand up to required quantity. Digging sand, from river bed in excess quantity is hazardous to environment. The deep pits dug in the river bed, affects the ground water level. Persons making concrete in such localities usually import sand from relatively distant places at high costs, and this increases the overall cost of making concrete and of providing housing for the people. Thus, there is an increasing need to source alternative locally-available materials that could serve as suitable replacement to sand as fine aggregate in concrete.

In Malabar region of Kerala, the laterite stone is commonly used for the construction purpose. There are several laterite stone quarries in Kannur region. During excavation of laterite stone, around 25 – 30 per cent laterite stone scrap is generated. It is estimated that about 2.83 cum (100 ft3) of the laterite stone scrap is generated during excavation of about 11.33 cum (400 ft3) of the laterite stone. This laterite stone scrap creates problem in quarries and needs removal for further excavation. In order to add value to this waste material, it is felt necessary to manufacture the blocks or utilize other structural purpose using different constituents that are suitable for the construction.

Aggregate which occupy 70-75% of the total volume of concrete has been one material which if alternatives are provided will bring down the overall cost of construction provided a reliable design data based on concrete produced with such materials. It is mainly found in the tropics. The objective of this project is to examine the Physical properties of M25 concrete made with laterite available in Ulikkal Kannur as replacement of natural fine aggregate in concrete.

II. EXPERIMENTAL INVESTIGATION

The aim of the present investigation was to experimentally study the suitability of using laterite soil as fine aggregate in concrete (M25) and laterite block as a load bearing structure. The scope of this study is more about the determination of the mechanical properties i.e. compressive strength, split tensile strength and flexural strength of aggregate for laterite concrete. The investigation will be done by replacing 0% to 40% (interval of replacement 5%) replacement of sand with laterite soil available in Ulikkal Kannur .

Based on the properties of aggregate, the mix proportion for M25 concrete designed as per provisions in IS Code 10262-1982 for 0% to 40% (interval of replacement 5%) replacement of natural sand with laterite soil. Laterite soil of eight different proportions viz.5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%and 50% of weight of sand were used to make corresponding laterality concrete. Based on the prepared mix design, cubes, cylinders and beams were casted. The super plasticizer Rheobuild 924KL is added to increase the workability of the mix. Based on this mix design required cubes, beams and cylinders were casted, cured and then subjected for testing.

A. Water Absorption Test on Laterite Soil

The water content is determined by oven dry method. The water absorption is determined in surface dry condition.

Water content = 11%
Water absorption = 5%

To account the water absorption by the laterite soil 5% extra water should be added to the mix.

B. Super Plasticizer

It has seen that the workability is getting low with the addition of laterite soil. To solve this problem and to increase the strength we have added some amounts of super plasticizer Rheo build 924KL. For 50 kg cement 160 ml is added.

Rheobuild 924 is a water-reducing super plasticizer and is formulated to produce plastic workable concrete. This concrete flows easily, maintaining high plasticity for time periods longer than conventional concrete. It has the low water-cementations materials ratio of no-slump concrete, providing excellent engineering (hardened) properties. Its major benefits are,

- Job time and cost reduced through higher productivity rates and/or reduced labor
- Early strength allows for accelerated construction methods, resulting in completion dates ahead of schedule
- Engineering specification changes can allow for greater limits on the free-fall of concrete, lift heights, concrete temperatures and potential economic mixture adjustments.
- Less dependence on consolidation energy.

C. Slump test

The concrete slump test is an empirical test that measures the workability of fresh concrete. This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability. It is a term which describes the state of fresh concrete. The results obtained from slump test is given below in the table 1.

Fig 1:- Slump test

Replacement of natural sand (%)	Slump value(cm)
0	12
5	12
10	11
15	10
20	9
25	8
30	8
35	6
40	4

Table 1. Slump value for different % replacement of sand

Slump Value(cm)	Workability of Mix
0-2.5	Very Low
2.5-5	Low
5-10	Medium
10-18	High

Table 2. Standard values of slump

D. 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. The super plasticizer is added to the concrete. This concrete is poured in the mould and tampered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 28 days curing. Load should be applied gradually at the rate of 140 kg/cm^2 per minute till the specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete. Generally the cube compressive strength is more than the cylinder compressive strength.

III. CUBE COMPRESSIVE STRENGTH

Here we use cubical moulds of size 15 cm x 15cm x 15 cm which is commonly used.

Fig 2:- Compressive strength testing machine

The failure load and strength obtained for different % replacement of sand with laterite soil on 28 days test is given in table 3.

Replacement of sand (%)	Load (KN)	Compressive strength (N/mm^2)
0	680	30.22
10	650	28.88
20	470	20.88
30	460	20.44
40	300	13.33
50	210	9.33

Table 3. Failure load and strength obtained for % replacement of sand with laterite soil on 28days test (without using super plasticizer)

Replacement of sand (%)	Load (KN)	Compressive strength (N/mm^2)
0	890	39.55
5	815	36.22
10	805	35.77
15	925	41.11
20	700	31.11
25	680	30.22
30	650	28.88
35	640	28.44
40	610	27.11

Table 4. Failure load and strength obtained for % replacement of sand with laterite soil on 28 days test (with the use of super plasticizer)

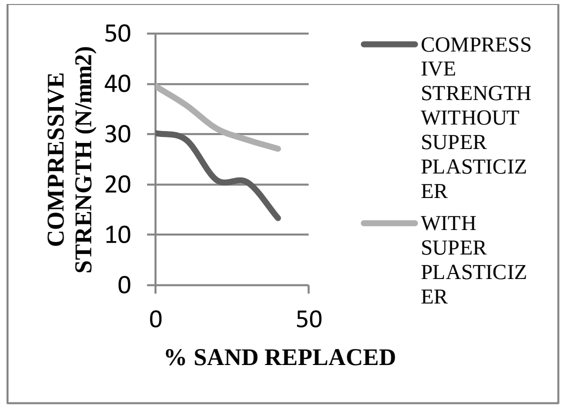

Fig 3:- Showing % replaced Vs compressive strength obtained for replacement of sand with laterite soil for 28 day test.

A. Cylinder compressive strength

Here we use cylindrical moulds of 15 cm diameter and 30 cm height.

Replacement of sand (%)	Load (KN)	Compressive strength (N/mm^2)
0	510	7.21
5	520	7.35
10	530	7.49
15	520	7.35
20	425	6.01
25	415	5.87
30	415	5.87
35	400	5.65
40	390	5.51

Table 5. Failure load and strength obtained for % replacement of sand with laterite soil on 28 days test.

B. Split Tensile Test

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure.

The splitting tests are well known indirect tests used for determining the tensile strength of concrete sometimes referred to as split tensile strength of concrete. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens. Due to the compression loading a fairly uniform tensile stress is developed over nearly 2/3 of the loaded diameter as obtained from an elastic analysis. The magnitude of this tensile stress (acting in a direction perpendicular to the line of action of applied loading) is given by the formula (IS: 5816 1970):

Tensile stress= $2P/\pi dl$

Where, P= failure load

d= diameter of cylinder

l= height of cylinder

Fig 4:- Split tensile testing machine

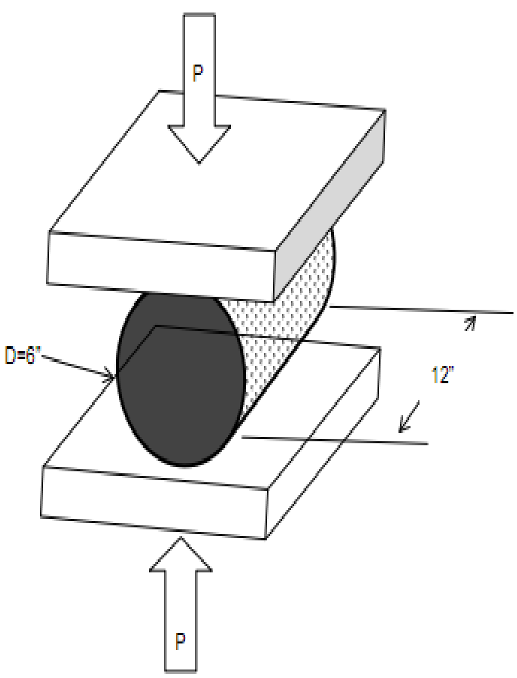

Fig 5:- Split tensile test

The split tensile strength obtained for different % replacement of sand with laterite soil on 28 days test is given in table 6.

Replacement of natural sand (%)	Load(KN)	Split tensile strength(N/mm²)
0	340	4.81
10	350	4.95
20	315	4.45
30	250	3.53
40	210	2.97
50	Specimen failed	No result

Table 6. Split tensile strength obtained for different % replacement of sand with laterite soil on 28 days test (without using super plasticizer)

Replacement of natural sand (%)	Load(KN)	Split tensile strength(N/mm²)
0	450	6.36
5	460	6.50
10	465	6.57
15	470	6.64
20	430	6.08
25	380	5.37
30	320	4.52
35	315	4.45
40	300	4.24

Table 7. Split tensile strength obtained for different % replacement of sand with laterite soil on 28 days test (with the use of super plasticizer)

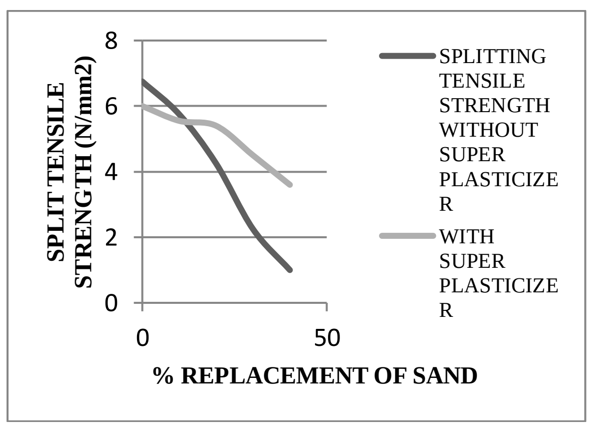

Fig 6:- Split Tensile strength Vs % Replaced obtained for replacement of sand with laterite soil for 28 day test.

C. Flexural Strength Test

Flexural strength is one measure of the tensile strength of concrete. It is a measure of unreinforced concrete beam or slab to resist failure in bending. It is measured by loading concrete beams with a span length at least three times the depth. The flexural strength is expressed as Modulus of Rupture and is determined by standard test methods.

Fig 7:- Flexural strength testing machine

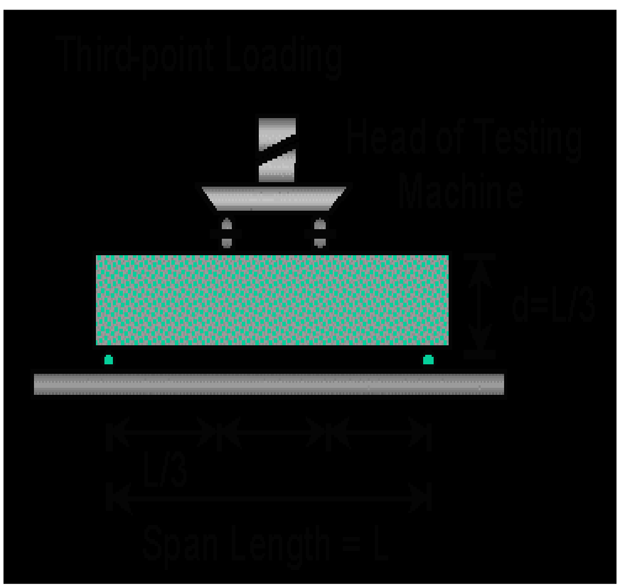

Fig 8:- Flexural strength test

The flexural strength obtained for different % replacement of sand with laterite soil on 28 day test is given in table 8.

Replacement of natural sand (%)	Load(KN)	Flexural strength(N/mm²)
0	13.5	6.75
10	11.5	5.75
20	8.5	4.25
30	4.5	2.25
40	3.0	1.00
50	Specimen failed	No result

Table 8. Flexural strength obtained for different % replacement of sand with laterite soil on 28 days test

replacement of natural sand (%)	Load(KN)	Flexural strength(N/mm²)
0	20	6.00
5	18	5.40
10	18.5	5.55
15	23.5	7.05
20	18	5.4
25	16	4.80
30	15	4.50
35	13	3.90
40	12	3.60

Table 9. Flexural strength obtained for different % replacement of sand with laterite soil on 28 days test

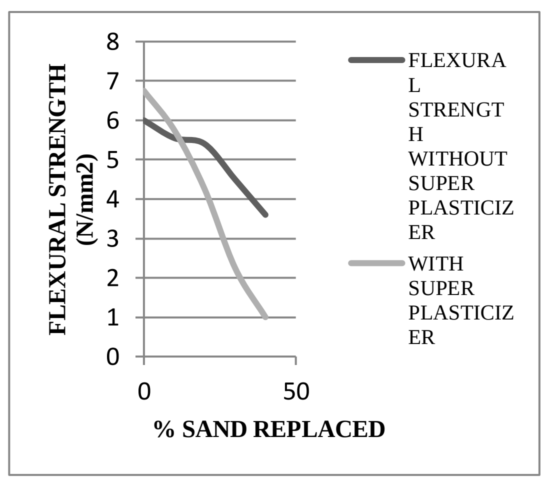

Fig 9:- Showing flexural strength Vs % Replaced obtained for replacement of sand with laterite soil for 28 day test.

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IV. CONCLUSION

The slump decreases as the percentage of laterite content replaced becomes higher. This result indicates that concrete become less workable as the amount of laterite aggregate added increases, thus implying the need for larger amount of water required to make the mixes more workable. Reduction in the laterite, concrete mix workability is probably due to the higher rate of water absorption of this aggregate which possess higher porosity as compared to river sand aggregate. The addition of super plasticizer increases the workability and enhances the concrete strength performance. Integrating 15% laterite aggregate in concrete mix results in concrete exhibiting compressive strength comparable with plain concrete. Replacement of laterite aggregate up to 30% produces laterite concrete with the targeted strength of 30 MPa at 28 days. However, replacement beyond 30% causes significant strength reduction.

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