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Investigation On The Utilization Of Laterite As Replacement Of Fine Aggregate To Develop Ecofriendly Concrete

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Abstract - *Availability of river sand is becoming scarce, due to rapid increase in infrastructure projects in India. Acute shortage of river sand, has led to indiscriminate sand mining. Adverse effect of sand mining includes river bank erosion, river bed degradation, loss of biodiversity and deterioration of river water quality and ground water availability. To address the above issues, research efforts are on, to find substitutes for river sand to be used as fine aggregate in mortars and concretes. One among the locally available resources is laterite. Laterite is a product of tropical or sub-tropical weathering, which is an abundant soil material in many parts of India. An attempt has been made to characterize the processing technique to obtain good quality lateritic fine aggregates (lateritic FA). Experiments were designed and conducted to study the performance of lateritic FA as replacement to river sand, in cement mortars and concretes.*

The river deposits are the most common source of fine aggregate. So there are great demands within the construction industries for river sand as fine aggregate used in the production of concrete. This has created a very difficult situation, also there is great fear from environmentalist and the ecology will be distorted. Hence, the need to find the materials which are affordable and available partially or totally replaced river sand in the production of concrete. Hence we are forced to think the alternative materials.

This report aims to present the study done to establish scientific data regarding the compressive strength, tensile strength and flexural strength of concrete on partial replacement of fine aggregate with laterite soil in concrete mix of M-30 grade. The sand shall be replaced gradually in the mentioned grade of concrete by 0%, 10%, 20% and 30% with laterite soil and the specimen shall be tested at curing intervals of 3days, 7days, and 28days. For compressive strength and at curing interval of 3 days, 7 days, and 28 days for tensile strength as well as for flexural strength.

Key Words: Laterite soil, steel fibers, super plasticizer (conplast Sp-430)

1. INTRODUCTION

Visual observation of the laterite material shows that the variation of sand is much sharper than those considered in previous works. This is confirmed by the preliminary assessment of its particle size distributions. There is, therefore, every reason to believe that this lateritic sand can be used in structural concrete production. The particle sizes of aggregates are known to affect the strength properties of concrete greatly. In related developments, substantial quantities of lateritic soil are found in heaps around the low as a replacement material in concreting operations. The focus of a good national development is to look inward with the intent to mobilize all-natural resources for economics purposes. One of the policy thrusts of the present government is to provide affordable housing for the people.

Compressive strength is arguably the most widely used strength parameter for concrete. This may be due to the nature of concrete, being strong in compression and weak in tension. The use of lateritic as a partial sand replacer can help achieve this purpose and impact positively in reducing the cost of building materials. This study aims to proper documentation of the material to support their specification in design and construction.

2. OBJECTIVES

- The objective of this study is to determine the strength of concrete by partially replacing river sand with laterite sand at 0%, 10%, 20%, and 30% and curing they concrete for 3days, 7days, and 28 days for compressive strength, tensile strength as well as for flexural strength.
- Preparing the normal concrete by utilizing normal quality river bedded sand of Krishan river and ascertaining its strength via methods prescribed by applicable IS Codes of testing
- Comparing the strength development of concrete and ascertaining the feasibility of using laterite soil concerning practically and economy of the study.
- To conclude the effect of lateralized concrete concerning its adaption to normal mixes for equivalent gain of strength and economy of the mix so created.

3. LITERATURE REVIEW

J. Santhiyaa Jenifer & S. Ramasundarm (2015) Studied the physical properties of laterite namely specific gravity, particle size distribution and density. An attempt was made to use of laterite as a fine aggregate in concrete. The quantity of laterite varies from 0% to 100% at interval of 25% in this study. The 1:1.5:3 mix of concrete is used for determining the mechanical strength and durability characteristics. The density of laterite mixed concrete increases when percentage of laterite increases. The results of laterite sand mixed concrete are compared with conventional concrete. At 50 percentage replacement of sand by laterite sand produces high compressive strength. The tensile and flexural strength increases when the percentage of laterite sand increases.

Biju Mathew, Benny Joseph & C Freeda Christy The natural M- Sand was replaced with laterite at the rate of 10%, 20% and 30 % by weight for design mix of M25 controlled concrete. A total of 36 specimens prepared to determine the cube compressive strength, and flexural strength. From the studies, addition of laterite reduces workability in concrete. Compressive strength decrees with increases in % of laterite replacement with sand. The flexural strength has only slight variation with controlled concrete. Laterite of 20 % by weight of sand content has shown the best results, thus indicating possibility of using laterite as a partial replacement.

Prof. Vishal S. & Pranita S.Bhandari (2013) Here an attempt is made to partially replace Portland cement by silica fume. The main objective of this research work was to determine the optimum replacement percentages of silica fume. To fulfill the objective various properties of concrete using silica fume have been evaluated. Further to determine the optimum replacement percentage comparison between the regular concrete and concrete containing silica fume is done .It has been seen that when cement is replaced by silica fume compressive strength increases up to certain percentage (10% replacement of cement by silica fume).But higher replacement of cement by silica fume gives lower strength Debabrata Pradhan & D. Dutta (2013) The main objective of this paper has been made to investigate the different mechanical properties like compressive strength, compacting factor, slump of concrete incorporating silica fume. The experiments were carried out by replacing cement with different percentages of silica fume at a single constant water-cementitious materials ratio keeping other mix design variables constant. The silica fume was replaced by 0%, 5%, 10%, 15% and 20% for watercementitious materials (w/cm) ratio for 0.40. For all mixes compressive strengths were determined at 24 hours, 7 and 28 days for 100 mm and 150 mm cubes. Other properties like compacting factor and slump were also determined for five mixes of concrete. The optimum percentage of replacement of silica fume is obtained was 10%.

Concrete is so closely related with every construction activity that it touches every human being in his day to day living. It is an artificial compound generally made by mixing of binding material (cement), fine aggregates, coarse aggregates, water and admixtures in suitable proportions. Concrete does not solidify from drying after mixing and placement; the water reacts with the cement in a chemical process known as hydration. In India the annual consumption of cement is in the order of approximately 22 million tons. Concrete is a site-made material unlike other materials of construction and as such can vary to a very great extent in is quality, properties and performance due to the use of natural materials except cement. From materials of varying properties, to make concrete of stipulated qualities, an intimate knowledge of the interaction of various ingredients that go into the making of concrete is required to be known, both in the fresh and hardened conditions. This knowledge is necessary for concrete technologists as well as for site engineers. The increased demand for the usage of the huge quantity of concrete leads to increase in cost of binding material (cement) and depletion of natural sources of fine aggregate which in turn increase s cost of concrete. Due to above cause alternative materials are required to partially or fully replacements for Portland cement or fine aggregate or coarse aggregate in the concrete mixture to continue the construction work, without changing the previous properties of the concrete like strength, workability and durability. It has been observed that based on the availability of laterite, a fine aggregate, and laterite could either partially or fully replace sand as fine aggregate. The criterion for concrete strength requirement is always based on the characteristics compressive strength obtained after 28- day curing.

There are large number of investigation was carried out throughout the world for replacing natural sand with alternative material such as manufactured sand. The study on replacement of natural sand with laterite is negligibly small. Olubisi A. Ige(2013) describes the compressive strength of laterized mortar with laterite-fine aggregate ratio variation decreases when subjected to alternate wetting and drying and increases when subjected to magnesium sulphate (Mg2SO4). It was also discovered that a laterized cement motar with a laterite-fine aggregate ratio of 20% conditioned to a temperature range of 1000C attained optimum compressive strength

4. MATERIALS AND MIX PROPORTION

4.1 MATERIALS

Cement: In this research work, 53 grades Ordinary Portland Cement is used for all concreting purposes. Free from lumps. That was good in color. The tests on cement were done as per standard codal provisions. The physical properties are shown below.

Table -1: Physical properties of cement

Properties	Results of Conducted Tests
Fineness	8%
Specific Gravity	3.03
Normal consistency	33%
Initial setting time	46min
Final setting time	400min

Fine aggregates (FA): For this investigation, fine aggregates are locally available good quality Shahpur sand. Passing through 4.75mm sieve, it is found under zone II. The physical properties are as shown below.

Table -2: Physical property of fine aggregate

Properties	Results of test conducted
Sp. Gravity	2.65
Fineness Modulus	3.27
Water absorption	0.9

Coarse aggregates (CA): The aggregate size more than 4.75mm they are called as coarse aggregates. In this exploration work, 20mm down size aggregates are utilized.

Table -3: Physical properties of Coarse aggregate

Properties	Results of test conducted
Specific Gravity	2.68
B.density(kg/m^3)	2086
Water absorption	0.5

Water: The water is used in concrete plays an important part in the mixing, laying compaction setting and hardening of concrete. The strength of concrete directly depends on the quality and quantity of water is used in the mix.

Laterite soil: Chemical composition of laterite soil/gravel varies widely based on genesis, climate conditions, and age of laterization. Lateritic soil contains more than 60% Fe_2O_3 and little of Al_2O_3. The chemical analysis of Indian soils shows that soils rich in iron and aluminum but poor in nitrogen, potassium, lime and organic matter. The specific gravity of laterite soil is done according to Is codes. Is found to be 2.44

Fig -1: Laterite soil

Fibers: Double-end hooked steel fibers with an aspect ratio of 50, length 5cm and diameter 1mm were used in this research work Methodology

Fig -2: Steel fibers used in the project

Super plasticizer: In this research work conplastSP-430 is used as a super plasticizer. 1% of cementitious material will be the dosage of super plasticizer.

Fig -3: Super Plasticizer used in the project

4.2 MIX DESIGN

According to IS: 10262-2009 mix design was done for the purpose of concrete casting of various mixes with the help of all the above preliminary investigation test outcomes. The mix design was done for M30 grade. From the mix design, the conventional trial mix was prepared and it having mix ratio is 1:1.92:2.76 and the w/c of 0.40.

Table -4: Mix Proportion of concrete

Material	Quantity(kg/m³)	Proportion
Cement	425.5	1
F.A	664.92	1.56
C.A	1130.6	2.66
Water	191.5	0.45
Chemical admixture	4.5	1%

5. EXPERIMENTAL PROGRAM

5.1 GENERAL

In this research work total 84 cubes, 63 cylinders, 63 prisms are cast and tested at 3, 7 & 28 days respectively. For finding out the mechanical properties as well as permanence properties of the concrete.

Cement kg/m³	% Laterite	Fine Aggregate		Coarse Aggregate
		sand	Laterite	
425.5	0%	664.92	0	1130.6
425.5	10%	597.6	66.4	1130.6
425.5	20%	532.12	132.8	1130.6
425.5	30%	464.8	199.2	1130.6

Table -5: Mix Proportion were involved in this project

5.2 MIXING AND CASTING

The mixture of all materials was hand-made by mixing on a steel plate. Cement, Laterite soil, F.A, C.A, and fibers are thoroughly mixed before adding water. After dry mixing then the water, curing agent and super plasticizer are added and then mixed until a treatable concrete mixture is obtained. Then oil the internal surface of molds, they are filled by concrete and compaction is done by stuffing rod.

Fig -4: Mixing and casting

6. RESULTS AND DISCUSSIONS

6.1 COMPACTION FACTOR TESt

Workability gives an idea of the capability of being workability. That workability of concrete can be found out by the compaction factor test.

6.2 SLUMP CONE TEST

Slump test was conducted to determine the workability

Table -6: Results of compaction factor and slump cone test

MIX	Compaction factor	Slump (mm)
M0	0.85	75
M10	0.90	60
M20	0.92	55
M30	0.95	52

6.3 COMPRESSIVE STRENGTH

This is one of the essential properties of the concrete. Alternate properties of concrete have an unmistakable association with compressive strength. On the off chance that the compressive strength of concrete is enhanced at that point there is change in different properties of concrete, in this manner compressive strength of the concrete is basic test. Cube of size 150X150X150mm is cast according to different mix proportions of this research work. after curing for the number of days these cubes are tested in a compressive machine, to get a desired compressive strength for different days of curing.

Table -7: Results of Compressive strength test

Mix	Compressive Strength in N/mm2	
	7days	28 days
CC	21.96	34.50
Mix1	22.37	34.73
Mix2	24.51	36.81
Mix3	22.33	35.70

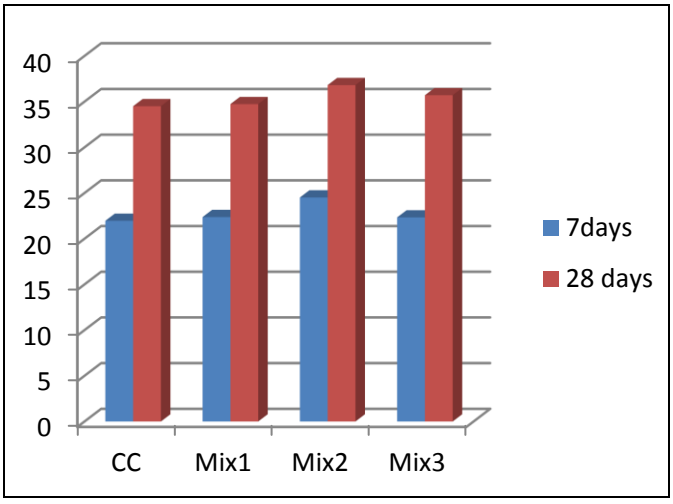

Chart-1 Compressive strength graph

6.4 SPLIT TENSILE STRENGTH

It is the standard test to determine the tensile strength of concrete indirectly. stand. Size of cylinder of concrete specimen of dia 150mm and length 300mm is placed horizontally between the loading surfaces of compression testing machine.

Table -8: Results of Split tensile strength test

Mix	Split tensile Strength in N/mm2	
	7days	28 days
CC	2.06	3.08
Mix1	2.03	2.96
Mix2	2.28	3.34
Mix3	2.09	3.17

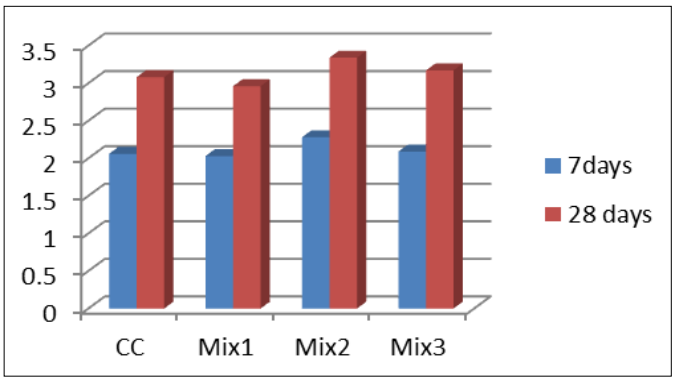

Chart 2 - Split tensile strength graph

6.5 FLEXURAL STRENGTH TEST

This test is performed by the center point loading method to determine the flexural strength of concrete. The size of the specimen is 100x100x500 mm was utilized.

Table -9: Results of Flexural strength test

Mix	Flexural Strength in N/mm^2	
	7 days	28 days
CC	3.08	4.06
Mix1	3.14	4.13
Mix2	3.45	4.27
Mix3	3.32	4.17

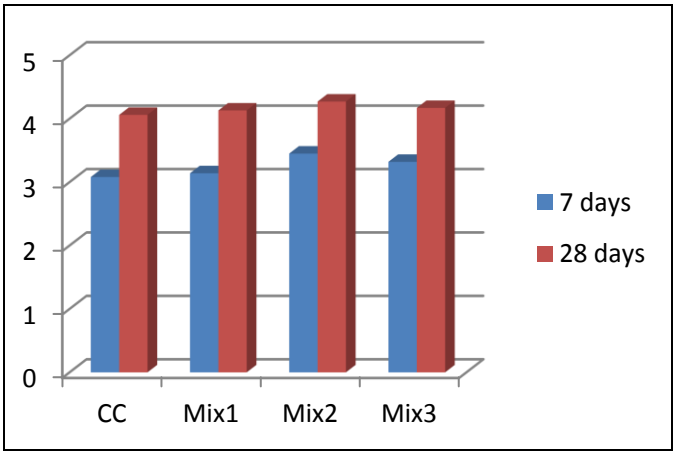

Chart 3- Flexural strength graph

7. CONCLUSIONS

- In this research, the fresh property of M30 Grade concrete that is workability is gone on increasing by increase in the curing period.
- From the results, it can be seen that the maximum compressive strength is obtained at 20% replacement of laterite soil.
- Addition to laterite to any particular concrete mix is found to reduce its compressive strength. This is due to fineness of laterite which ultimately increase the air voids as fine particle at bottom, side and air voids at the top level do not fill properly.
- In porosity, in red soil mixed concrete, porosity is higher than plain concrete but the permeability is low in red soil compared to the plain concrete. Due to tiny pores in fine soil, it can hold water tighter in small pores so that it is low in permeability, It resists the fluid passage. Hence it is impervious.
- Red soil can be used in RCC as well as prestressed concrete.
- Compressive strength decreases with an increase in the replacement level of sand.
- Specific gravity of laterite soil and sand is nearly equal. Hence density remains the same.
- From the results, it can be seen that the maximum tensile strength is obtained at 20% replacement of laterite soil.

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