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Partial Replacement of Fine Aggregate by Laterite Soil

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Abstract

Cement, sand and coarse aggregate are the basic ingredients for any construction. Sand is a prime material used for preparation of mortar and concrete and which plays a major role in mix design. Now a day's erosion of rivers and considering environmental issues there is a scarcity of river sand. The less availability or shortage of river sand will affect the construction industry. Hence there is a need to find the new alternatives to river sand. There is a need of different materials to replace fine aggregate and one of the major materials is locally available soil. Laterite soil is one of the easily available local soils and using different proportion of available soil along with river sand the required concrete mix can be obtained. The investigation presents, the result of an experimental program to study the strength performance of lateric concrete.

Keywords: Laterite Soil, Laterite Concrete, Partial Replacement, M30 Grade Concrete

I. INTRODUCTION

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.

II. OBJECTIVES & SCOPE OF STUDY

A. Objectives

1) To study the influence of laterite soil on the compressive strength of concrete and compare the result with that of concrete produced using selected river sand.
2) To replace the fine aggregate by laterite soil.
3) To achieve the required compressive strength by the replaced laterite soil.
4) To check the percentage of replacement and respective compressive strength.
5) To compare the feasibility of material, casting, curing and testing of replaced laterite soil.
6) To compare the cost effectiveness achieved by these replaced laterite soil.

B. Scope

1) To get the economical and ecofriendly lateraled concrete by satisfying all the durability conditions.

2) Concrete with laterite soil gained better flexural strength and split tensile strength compared to conventional concrete.
3) To compare the properties of replacement concrete with laterite soil and ordinary Portland cement.
4) To improve the compressive, flexural and split tensile strength of concrete by adding laterite soil with concrete.
5) As there is scarcity of sand, it can be replaced by laterite soil, so that sand is conserve.

III. MATERIALS & METHODOLOGY

A. Cement

Ordinary Portland cement of 43 grade confirming to IS 8122-1989 was used throughout the project work. The cement was stored in airtight drums to minimize the effect of moisture content in the atmosphere.

Table – 1
Physical Characteristics of Cement (OPC, 43 Grade)

SI NO	*TESTS*	*RESULTS*	*REQUIREMENTS AS PER IS :8112-2013*
1	*Normal Consistency*	*36%*	*…….*
2	*Initial setting time*	*30*	*Min 30 minutes*
3	*Final setting time*	*360*	*Max 600 Minutes*
4	*Specific gravity*	*3.12*	*2.99-3.15*
5	*Fineness*	*6%*	*Should be less than10%*
6	*Compressive strength (N/mm^2)*		
	3days strength	*26.05N/mm^2*	*Min 23N/mm^2*
	7days strength	*41.14N/mm^2*	*Min 37.5N/mm^2*
	28 days strength	*53.680N/mm^2*	*Min 43N/mm^2& Max 58N/mm^2*

B. Fine Aggregate

Sand consists small angular or rounded grains of silica. Sand is commonly used as the fine aggregate in cement concrete. Both natural and artificial sands are used for this purpose

C. Coarse Aggregate

It is an excellent coarse aggregate provide. It is obtained by crushing granite, sandstone, crushed granite chips are commonly and advantageously used in reinforced cement concrete. Broken bricks well burnt and over burnt bricks are broken into suitable size and used aggregate for concrete in foundations and under floors. But generally crushed stones are only used as coarse aggregate.

D. Water

The water is used in concrete plays on 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.

E. Laterite Soil

Fig. 1: Laterite Soil

Laterite soil was first studied by F. Buchanan in 1905. The name was derived from the Latin word ‘Later’ meaning brick. Laterite is a soil and rock type rich in iron and aluminium and is commonly considered to have formed in hot and wet tropical areas. This soil is rusty red color because of high iron oxide content. These are formed from the weathering of parent rock. Chemical composition of laterite soil/gravel varies widely based on genesis, climate conditions, and age of laterization. Lateritic soil contains more than 60% Fe203 and little of Al203. The chemical analysis of Indian soils shows that soils rich in iron and aluminium but poor in nitrogen, potassium, lime and organic matter.

F. Methodology

1) Sampling of Materials used for Concrete

– Characterization of Materials Used For Concrete
– Proportioning Of Ingredients before Mixing
– Mixing
– Workability

a) Slump Cone Test

Slump value for 0.45 = 30mm

b) Compaction Factor Test

Compaction factor value is 0.87

Table – 2

TESTS	*0% LATERITE SOIL*	*25% LATERITE SOIL*	*50% LATERITE SOIL*	*75% LATERITE SOIL*	*100% LATERITE SOIL*
SLUMP CONE TEST(mm)	*30*	*25*	*27*	*25*	*26*
COMPACTION FACTOR TEST	*0.87*	*0.85*	*0.85*	*0.86*	*0.86*

– Casting
– Compacting
– Finishing
– Curing
– Tests on Hardened Concrete

a) Compression Test on Concrete Cubes
b) Split Tensile Strength on Concrete Cylinders

IV. RESULTS & DISCUSSION

A. Compressive Strength of Concrete

Table – 3
0% Laterite Soil

No. of days	*Cubes no.*	*Compressive strength in N/mm²*	*Average Compressive Strength in N/mm²*
7days	*1*	*25.02*	*25.10*
	2	*25.21*	
	3	*25.09*	
14days	*1*	*28.69*	*28.76*
	2	*28.87*	
	3	*28.92*	
28days	*1*	*32.51*	*32.65*
	2	*32.70*	
	3	*32.74*	

Table – 4
25% Laterite Soil

No. of days	*Cubes no.*	*Compressive strength in N/mm²*	*Average Compressive Strength in N/mm²*
7days	*1*	*25.62*	*25.25*
	2	*25.05*	
	3	*25.09*	
14days	*1*	*29.45*	*29.32*
	2	*29.07*	
	3	*29.45*	
28days	*1*	*33.27*	*32.81*
	2	*32.89*	
	3	*33.27*	

Table – 5
50% Laterite Soil

No. of days	*Cubes no.*	*Compressive strength in N/mm²*	*Average Compressive Strength in N/mm²*
7days	*1*	*26.01*	*26.14*
	2	*26.01*	

	3	***26.39***	
14days	***1***	***29.84***	***29.96***
	2	***29.84***	
	3	***30.22***	
28days	***1***	***34.43***	***35.32***
	2	***35.96***	
	3	***35.57***	

Table – 6
75% Laterite Soil

No. of days	***Cubes no.***	***Compressive Strength in N/mm²***	***Average Compressive Strength in N/mm²***
7days	***1***	***25.62***	***25.56***
	2	***25.51***	
	3	***25.55***	
14days	***1***	***29.45***	***29.38***
	2	***29.33***	
	3	***29.38***	
28days	***1***	***33.27***	***33.21***
	2	***33.16***	
	3	***33.20***	

Table – 7
100% Laterite Soil

No. of days	***Cubes no.***	***Compressive Strength in N/ mm²***	***Average Compressive Strength in N/mm²***
7days	***1***	***25.24***	***25.38***
	2	***25.43***	
	3	***25.47***	
14days	***1***	***29.07***	***29.21***
	2	***29.26***	
	3	***29.29***	
28days	***1***	***32.89***	***33.03***
	2	***33.08***	
	3	***33.12***	

Table – 8
Comparison between Different Proportions

Proportions	***7days***	***14days***	***28days***
0% laterite soil	***25.10***	***28.76***	***32.65***
25% laterite soil	***25.25***	***29.32***	***32.81***
50% laterite soil	***26.14***	***29.96***	***35.32***
75% laterite soil	***25.56***	***29.38***	***33.21***
100% laterite soil	***25.38***	***29.23***	***33.03***

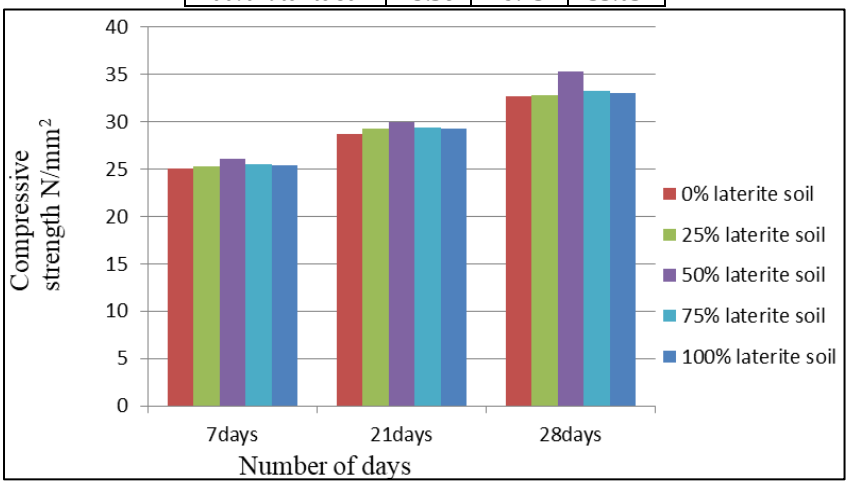

Fig. 2: Comparison between Different Proportions

B. Split Tensile Strength of Concrete

Table – 9
0% Laterite soil

SL NO.	*CURING PERIOD*	*SPLIT TENSILE STRENGTHN/mm²*	*AVERAGE SPLIT TENSILE STRENGTH N/mm²*
1	*7days*	*2.49*	*2.5*
2		*2.50*	
3		*2.51*	
1	*14days*	*2.87*	*2.88*
2		*2.89*	
3		*2.89*	
1	*28days*	*3.25*	*3.26*
2		*3.27*	
3		*3.27*	

Table – 10
25% Laterite Soil

SL NO.	*CURING PERIOD*	*SPLIT TENSILE STRENGTHN/mm²*	*AVERAGE SPLIT TENSILE STRENGTH N/mm²*
1	*7days*	*2.56*	*2.55*
2		*2.52*	
3		*2.56*	
1	*14days*	*2.94*	*2.93*
2		*2.91*	
3		*2.94*	
1	*28days*	*3.33*	*3.31*
2		*3.29*	
3		*3.33*	

Table – 11
50% Laterite Soil

SL NO.	*CURING PERIOD*	*SPLIT TENSILE STRENGTH N/mm²*	*AVERAGE SPLIT TENSILE STRENGTH N/mm²*
1	*7days*	*2.60*	*2.61*
2		*2.60*	
3		*2.64*	
1	*14days*	*2.98*	*2.99*
2		*2.98*	
3		*3.02*	
1	*28days*	*3.44*	*3.53*
2		*3.60*	
3		*3.56*	

Table – 12
75% Laterite Soil

SL NO.	*CURING PERIOD*	*SPLIT TENSILE STRENGTH N/mm²*	*AVERAGE SPLIT TENSILE STRENGTH N/mm²*
1	*7days*	*2.56*	*2.55*
2		*2.55*	
3		*2.56*	
1	*14days*	*2.94*	*2.93*
2		*2.93*	
3		*2.94*	
1	*28days*	*3.33*	*3.32*
2		*3.32*	
3		*3.32*	

Table – 13
100% Laterite Soil

SL NO	*CURING PERIOD*	*SPLIT TENSILE STRENGTH N/mm²*	*AVERAGE SPLIT TENSILE STRENGTH N/mm²*
1	*7days*	*2.56*	*2.55*
2		*2.54*	
3		*2.55*	
1	*14days*	*2.91*	*2.92*
2		*2.92*	
3		*2.93*	
1	*28days*	*3.29*	*3.30*
2		*3.31*	
3		*3.31*	

Table – 14

Comparison between Different Proportions

	7days	*21days*	*28days*
0% laterite soil	*2.50*	*2.88*	*3.26*
25% laterite soil	*2.55*	*2.93*	*3.31*
50% laterite soil	*2.61*	*2.99*	*3.53*
75% laterite soil	*2.55*	*2.93*	*3.32*
100% laterite soil	*2.55*	*2.92*	*3.30*

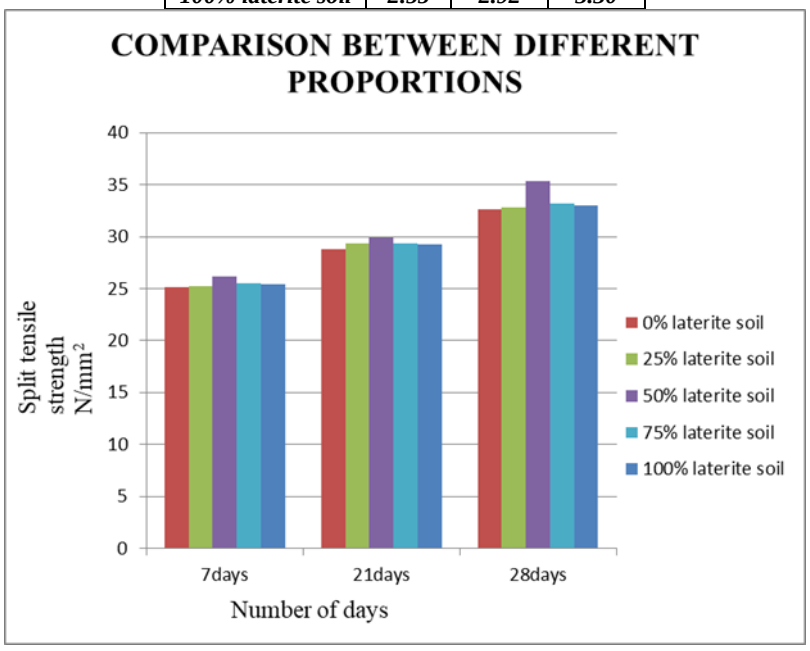

Fig. 3: Comparison between Different Proportions

V. CONCLUSION

1) From this study it can conclude that as the age increases the compressive strength of concrete increases.
2) From the results it can be seen that the maximum compressive strength is obtained at 25% replacement of laterite soil.
3) 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.
4) Compressive strength decreases with increase in the replacement level of sand.
5) Specific gravity of laterite soil and sand are nearly equal. Hence density remains same.
6) From the results it can be seen that the maximum tensile strength is obtained at 25% replacement of laterite soil.

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