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Strength Characteristics of Concrete with Partial Replacement of Coarse Aggregate By Laterite Stone and Fine Aggregate by Quarry Dust

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ABSTRACT
This paper presents the results of concrete mix with partial replacement of fine aggregate by quarry dust and simultaneous partial replacement of coarse aggregate by laterite stone aggregate respectively on compressive strength, split tensile strength, flexural strength and workability of concrete. Concrete mixes containing 0%, 10%, 20%, 25 % and 30%, replacement (by weight) of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate (by weight) with laterite stone were casted in lab and checked for compressive strength, split tensile strength ,flexure strength and workability .This replacement results in making the concrete more economically available.
Keywords: Compressive strength, Flexural strength, Split tensile strength, quarry dust, workability

I. INTRODUCTION

Concrete is the most widely used composite material today. The constituents of concrete are coarse aggregate, fine aggregate, binding material and water. Rapid increase in construction activities leads to acute shortage of conventional construction materials. It is conventional that sand is being used as fine aggregate in concrete. For the past few years, the escalation in cost of sand due to administrative restrictions in India, demands comparatively greater cost at around two to three times the cost for crusher waste even in places where river sand is available nearby. The function of the fine aggregate is to assist in producing workability and uniformity in the mixture. 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 ecologist that in the future there may be scarcity of river sand and the environment and the ecology will be distorted. Hence, the need to find materials which are affordable and available to partially or totally replaced river sand in the production of concrete. Hence we are forced to think of alternative materials. The Quarry dust may be used in the place of river sand fully or partly.

Similarly coarse aggregate resources like granite quarries are also degrading. As a result of which use of coarse aggregate become uneconomical. So there is a necessity to think about an alternative for HBG metal in concrete preparation. Based on observations made from the previous investigations, laterite stone is one of the best replacements for HBG metal.100% replacement of laterite stone is undesirable. But partial replacement of laterite stone can be done up to 30 %, [1]. Laterite stone is the most abundant material in some of the hot and wet tropical areas. So by using this as a replacing material we can reduce the cost of construction.

The climate change due to global warming is one of the greatest environmental issues we face now. In order to reduce the amount of green house gases, an attempt has been made to reuse the waste materials along with concrete in construction industries. In recent years, attempts have been made to increase the utilization of fly ash, quarry dust, granite and construction and demolition debris to partially replace the use of fine aggregate and coarse aggregate in concrete are gathering momentum.

II. MATERIALS

To study the performance of fine aggregate in partial replacement with quarry dust and also the performance of coarse aggregate in partial replacement with laterite stone as concrete.

Cement - Ordinary Portland cement of grade 53 was collected from local market. The cement procured was tested for physical requirements in accordance with IS: 12269-1987.Such as compressive strength, specific gravity, setting time etc. The details are given below table-1

Table-1 Properties of cement

Properties	values
Normal Consistency %	32
Initial(Minutes)	50
Final(Minutes)	180
Specific Gravity	3.15
Compressive strength of cement (28days) Mpa	53
Specific surface area m^2/kg	320

Fine aggregate - The locally available river sand is used as fine aggregate. The sand is free from clay, silt and organic impurities. The sand is tested for various properties like specific gravity, bulk density etc.., and in accordance with IS: 2386-1963. The test results are shown below table-2

Table -2 physical properties of sand

Property	Value
Density kg/m^3 a)Compacted b)Loose	 1752 1648
Specific gravity	2.60
Fineness Modulus	2.88
Zone	II
Particle shape	Spherical

Quarry dust - Quarry dust is collected from local stone crushing units of Pangidi, West Godavari dist., Andhra Pradesh for the investigation. The physical properties of quarry rock dust were listed in Table-3. It was initially dry in condition when collected. And material which is passing through IS: 4.75 mm and retained on IS: 150 micron sieves, was collected for mixing in concrete.

Table -3 physical properties of quarry dust

Property	Value
Density kg/m^3 a)Compacted b)Loose	 1593 1490
Specific gravity	2.52
Fineness modulus	3.39
Zone	I
Particle shape	Angular

Laterite stone - The Literate stone was used as partial replacement of coarse aggregate in this study. Laterite stone was collected from borrow pits located at chebrolu, West Godavari, Andhra Pradesh .Laterite stone is available in different sizes, But in this study we used Laterite stone which is passing through IS: 20 mm and retained on IS: 10 mm sieves. Physical properties of laterite stone were studied like specific gravity, Bulk density. And those physical properties are shown in table-4

Table -4 physical properties of laterite stone

Property	Value
Density kg/m^3 a)Compacted b)Loose	 1406 1286
Specific gravity	2.58
Fineness modulus	7.25
Mean particle size mm	4.75-20
Particle shape	Spherical

III. RESULTS AND DISCUSSIONS

In accordance with IS-516 the compressive strengths of concrete with partial replacement (by weight) of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone cured in water for 7,28, 60, days are determined by testing the cube specimens in compression testing machine.

The split tensile strength of concrete with partial replacement (by weight) of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone cured in water for 28 days are determined by testing the cylinder specimens in compression testing machine.

The flexural strength of concrete with partial replacement (by weight) of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone cured in water for 28 days are determined by testing the prism specimens in flexural testing machine.

Workability

Before casting the specimens, workability of the mixes was found by compaction factor test using compaction test apparatus as per IS: 1197. The results are tabulated in table-5

Table-5 workability

Percentage Replacement of Coarse aggregate By Laterite stone	Percentage Replacement of Fine aggregate By Quarry dust	Workability Compaction factor
25%	0%	0.798
25%	10%	0.808
25%	20%	0.812
25%	25%	0.795

25%	30%	0.790
0%	0%	0.805

Compressive strength of concrete:
Concrete with partial replacement (by weight) of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone are casted in the moulds for estimating the compressive strength values. The tests were conducted as per IS-516. Cube specimens were prepared using fine aggregate partially replaced(by weight)with quarry dust up to 30% and simultaneously 25% replacement (by weight)of coarse aggregate with laterite stone. The tests were conducted after 7,28and 60 days curing.

Split tensile strength of concrete:
Concrete with partial replacement (by weight) of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone are casted in the cylindrical moulds for estimating the split tensile strength values. The tests were conducted as per IS-516. Cylinder specimens were prepared using fine aggregate partially replaced (by weight) with quarry dust up to 30% and simultaneously 25% replacement (by weight)of coarse aggregate with laterite stone. The tests were conducted after 28 days curing in normal water.

Flexural strength of concrete:
Concrete with partial replacement (by weight) of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone are casted in the prism moulds for estimating the flexural strength values. The tests were conducted as per IS-516. Prism specimens were prepared using fine aggregate partially replaced(by weight)with quarry dust up to 30% and simultaneously 25% replacement (by weight)of coarse aggregate with laterite stone. The tests were conducted after 28 days curing in normal water.

Percentage Replacement of Coarse aggregate By Laterite stone	Percentage Replacement of Fine aggregate By Quarry dust	Compressive strength (N/mm^2)			Split tensile strength (N/mm^2)	Flexure strength (N/mm^2)
		7 days	28 days	60 days	28 days	28 days
25	0	34.67	43.71	50.73	2.73	3.40
25	10	35.61	45.32	51.52	2.82	3.61
25	20	37.96	48.96	55.14	3.13	3.74
25	25	37.20	47.80	54.45	3.08	3.66
25	30	36.56	46.54	53.15	2.87	3.58
0	0	38.93	50.62	57.42	3.24	3.89

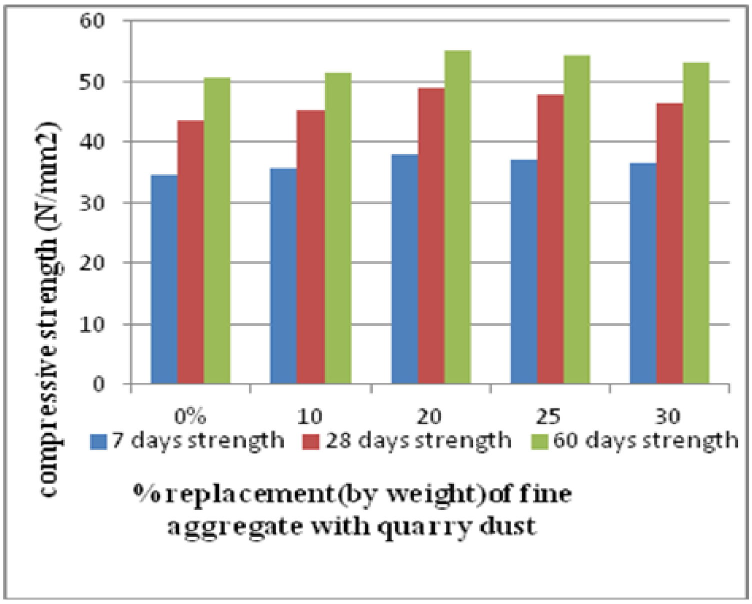

Fig-1 Variation of Compressive strength in concrete with partial replacement of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone for 7 days, 28 days and 60 days cured in normal water.

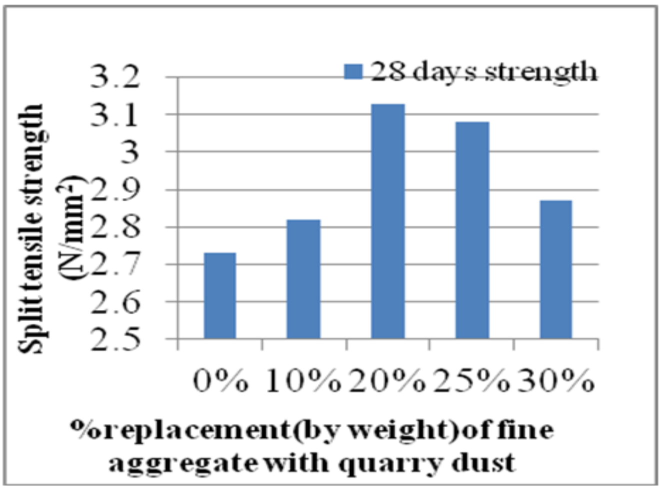

Fig-2 Variation of Split tensile strength in concrete with partial replacement of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone for 28 days and cured in normal water.

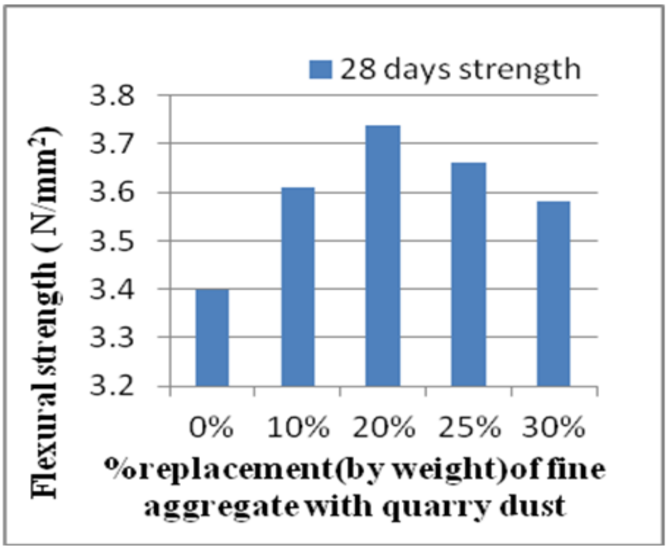

Fig-3 Variation of Split tensile strength in concrete with partial replacement of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone for 28 days and cured in normal water.

Images of mixing, casting, curing and testing of specimens

Concrete containing partial replacements with quarry dust and laterite stone have a decrease in workability as compared to normal concrete. Quarry dust are having high percentage of angular particles, thus resulting in decrease in workability. The compressive strengths of concrete with 0% to 30% replacement(by weight) of fine aggregate with Quarry dust and simultaneously 25% replacement (by weight) of coarse aggregate with laterite stone cured in normal water for 7 days, 28 days and 60 days have reached the target mean strength.

The compressive strengths of concrete with 0% to 30% replacement (by weight) of fine aggregate with Quarry dust and simultaneously 25% replacement (by weight) of coarse aggregate with laterite stone cured in normal water for 7 days, 28 days and 60 days indicates that up to 20% replacement (by weight) of fine aggregate with quarry dust there is an increase in strength and after 20% replacement (by weight) of fine aggregate with Quarry dust there is decrease in strength. This shows that 20% replacement of fine aggregate shows better results.

The Split tensile strength of concrete with 0% to 30% replacement (by weight) of fine aggregate with Quarry dust and simultaneously 25% replacement (by weight) of coarse aggregate with laterite stone cured in normal water for 28 days indicates that up to 20% replacement (by weight) of fine aggregate with quarry dust there is increase in strength and after 20% replacement (by weight) of fine aggregate with Quarry dust there is decrease in strength. This shows that 20% replacement of fine aggregate shows better results.

The flexural strength of concrete with 0% to 30% replacement (by weight) of fine aggregate with Quarry dust and simultaneously 25% replacement (by weight) of coarse aggregate with laterite stone cured in normal water for 28 days indicates that up to 20% replacement (by weight) of fine aggregate with Quarry dust there is increase in strength and after 20% replacement there is decrease in strength. This also proves that 20% replacement of fine aggregate shows better results.

The proportion of laterite that would result in maximum strength of concrete is 25% above which there could be a reduction in strength of coarse aggregate because increase in quantity beyond the optimum value results in the reduction of the cohesive property of soil. Compressive strength and specific gravity of laterite block decreases with depth within a quarry, this may be attributed to increase in clay content.

IV. CONCLUSION

Target mean strength can be achieved by replacement of fine aggregate with quarry dust up to 30% and simultaneously 25% replacement of coarse aggregate with laterite stone .

Though concrete with 0% replacement of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone has compressive strength less than 14% at 28 days compared to normal concrete, it has reached its compressive strength at 60 days.

The split tensile strength of concrete with replacement of fine aggregate with quarry dust and simultaneously coarse aggregate with laterite stone is less than split tensile strength of normal concrete.

The split tensile strength of concrete with 20% replacement of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone is 3.4% less than split tensile strength of normal concrete.

The flexural strength of concrete with replacement of fine aggregate with quarry dust and simultaneously replacement of coarse aggregate with laterite stone is less compared to normal concrete.

The flexural strength of concrete with 20% replacement of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone is 4% less compared to normal concrete.

The study observed that concrete with 20% replacement of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone can produce concrete exhibiting comparable strength with normal concrete. More compressive strength, split tensile strength and flexural strength for concrete with 20% replacement of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate with laterite stone.

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