Experimental Investigation on Properties of Concrete by Partial Replacement of Limestone as Coarse Aggregate

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Abstract-*Limestone is a sedimentary deposit. It mainly contains calcium carbonate (CaCo3) as it basic component. The waste is obtained from quarry and crushed into required size and utilised for construction works. This experimental study deals with the usage of locally available limestone aggregates in concrete as a replacement for natural coarse aggregate with river sand and manufacture sand. In this present study, concrete mix was prepared according to IS 10262:2009 and experimental studies were carried out to investigate the strength properties of M25 grade with suitable w/c ratio and Superplasticizer. Coarse aggregate replacement is done in 0%,20%,40%,60% & 80% with both river sand & m-sand. Number of specimens were casted and tested (compression strength test, split tensile strength test & Flexure strength test) for different ages. Results revealed that 40% to 80% replacement of limestone achieved good strength*.

Keywords-Limestone aggregates, Manufacture sand, Superplasticizer and Limestone concrete.

I. INTRODUCTION

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. The use of concrete is increasing widely in construction works all over the world. The conventional materials like natural coarse aggregates and river sand used to produce concrete will have depletion in the future. The scarcity of materials leads us to use unconventional materials like limestone coarse aggregates and manufacture sand in concrete mix. The limestone waste pieces cannot be disposed are collected and crushed into required size and utilized in concrete mix. It is economic and does not pollute environment. Limestone aggregates were collected from Gulbarga district.

In view of on increased awareness of the environmental impact of mining river sand and depleting supplies of the same, use of manufactured sand and other alternative fine aggregate has become essential in some parts of the world. In fact, river sand is simply not available in many areas.

Also, as a result of production of huge amounts of waste materials from various industrial activities, it is important that these wastes be utilized in other ways especially in the construction industry.Now-a-days the natural river sand has become scarce and costly, that delays the schedule of construction work. Manufacture sand can be used as alternative to the concrete mix. It is easily available and economic. To attain

sustainability it is not only imperative to use environmental friendly materials, but also economic materials.
Keeping all the above in mind and to suit the requirements of Concrete, our project involves the use of unconventional materials to produce concrete.

II. OBJECTIVES

- To design the concrete for M25 grade. The natural coarse aggregate is partially replaced by limestone coarse aggregate with river sand and manufacture sand.
- To optimize usage of percentage of limestone aggregate as replacement.
- To study the properties and compare the strength of partially replaced concrete with conventional concrete casted.

III. MATERIALS USED

A. Cement

Ultratech OPC 53 Grade was used throughout the Study. The cement was procured from the local market in Karkala, Karnataka. Initial tests for determining the basic requirements of the cement were conducted in accordance with the guidelines provided by IS: 12269-1987. The details of initial tests conducted on the cement have been listed in the following table.

Fig 1- Cement

Table 1 – Properties of cement

Property	Test results
Normal consistency	29.3%
Specific Gravity	3.15
Initial setting time	110 minutes
Final setting time	270 minutes

B. Natural Coarse Aggregates

The coarse aggregates used throughout the study have been procured from local quarry in Karkala, Karnataka. The size of the aggregates used in the present study is 20 mm. Tests were conducted on these aggregates as per the guidelines provided by IS: 2386 (Part III) 1963. The details of the tests conducted are tabulated in the following table.

Fig 2- Natural Coarse Aggregate

Table 2 – Properties of the coarse aggregates.

Characteristics	Test Results
Specific Gravity	2.7
Water Absorption	0.50%
Impact Value	18.14%
Aggregate Crushing	27%

C. Limestone Aggregates

The limestone aggregates used for the present work have been procured from the local quarry situated in Gulbarga, Karnataka. The size of the limestone aggregates used in the present study is 20 mm. The different properties of the limestone aggregates have been listed in the following table.

Fig 3 -Limestone Aggregate

Table 3 – Properties of the limestone aggregates

Characteristics	Test Results
Specific Gravity	2.63
Water Absorption	0.80%
Impact Value	27.06
Aggregate Crushing	2507

D. River sand

The locally available fine aggregates were used in present the study. The fine aggregates used were passing through 4.75 mm IS sieve. The test for determining the properties of the aggregates were conducted as per the guidelines prescribed the IS 383- 1970 and the results of the above tested have been tabulated in the following table.

Fig 4- River sand

Table 4 – Properties of the River sand

Particulars	Test Results
Specific Gravity	2.64
Water Absorption	2%
Fineness Modulus	2.804
Grading Zone	Zone- II

E. Manufacture sand

The manufacture sand used for the present work have been procured from the local quarry situated in Parapady, Karkala Karnataka. The aggregates used were passing through 4.75 mm IS sieve. The test for determining the properties of the aggregates were conducted and the results of the above tested have been tabulated in the following table.

Fig 5- Manufacture sand

Table 5 – Properties of manufacture sand

Particulars	Test Results
Specific Gravity	2.6
Water Absorption	2.2%
Fineness Modulus	2.594
Grading Zone	Zone- III

F. Superplasticizer

- Conplast SP430 DIS (Sulphonated Naphthalene Formaldehyde.
- Specific gravity is 1.145

IV. METHODOLOGY

The sequence of the work conducted in the study have been described as follows. Relevant papers were collected followed by material procurement. The initial tests were conducted on materials as per the codal specification. The natural coarse aggregates is partially replaced by limestone coarse aggregates in percentage of 0%, 20%, 40%, 60% & 80% with fine aggregates as river sand and m-sand in concrete mix for a constant w/c ratio of 0.45. Superplasticizer used is 0.6% M25 Grade concrete is casted for different ages and tested (Compression test, Split tensile test & Flexure test) for strength properties.

Mix Proportion for M-25 Grade of concrete

Cement	FA	CA
350	830	1070
1	2.3	3.05

A. Preparation and casting of specimen

The standard size specimens were casted as per IS:516-1959, cubes of 150x150x150mm are casted for compression test, cylinder of size 150mm diameter x300mm height are casted for split tensile test, and 100x100x500mm size beams are casted for flexural test.

B. Specimen testing

After the curing period of 7 days and 28 days, specimens are taken out from curing tank and surface wiped were off and test will be conducted for compression test for cubes (150x150x150mm), split tensile test for cylinders (150mm diax300mm height) and flexural test for beams (100x100x500mm) as per IS:516-1959

V. RESULTS

A. Compression test results

Table 6- Compressive strength test results of limestone coarse aggregate with river sand for 7^{th} day and 28^{th} day

Compressive strength (MPa)		
% replacement LA	7 days	28 days
0%	22	30
20%	23	31.99
40%	24.88	33
60%	26.4	35.46
80%	28	38

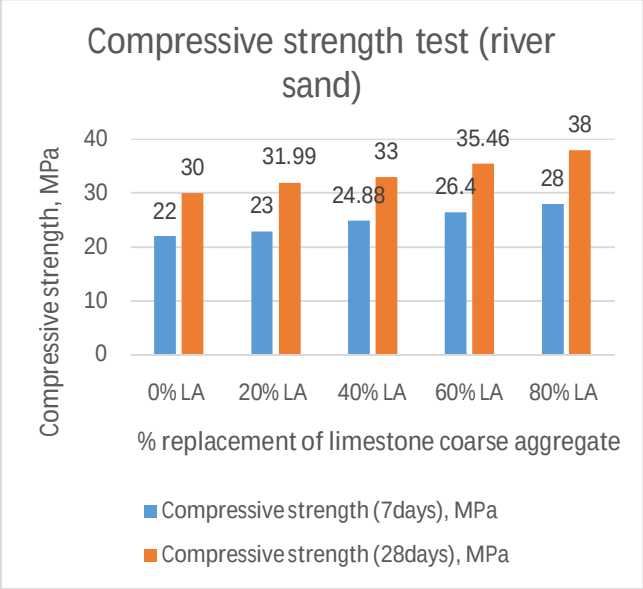

Fig 6-Compressive strength test results (river sand)

Table 7- Compressive strength test results of limestone coarse aggregate with m-sand for 7th day and 28th day

Compressive strength (MPa)		
% replacement LA	7 days	28 days
0%	27.99	37.55
20%	30.22	39.16
40%	31.99	41.35
60%	33	42.5
80%	34	45

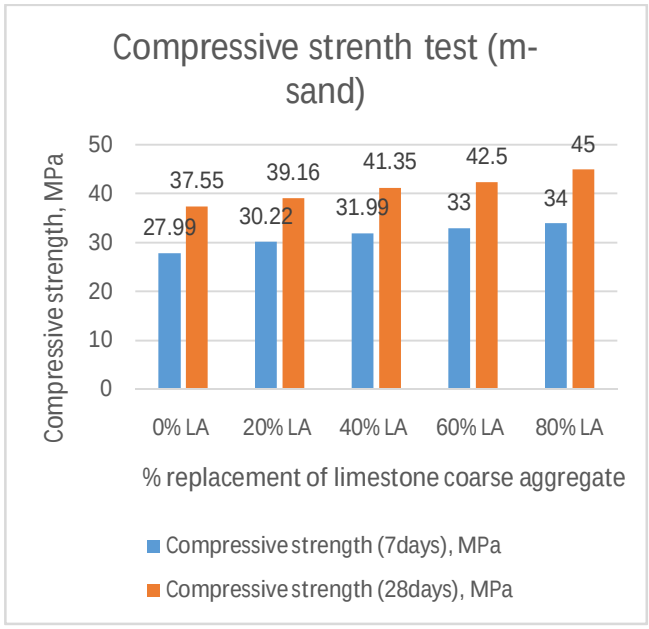

Fig 7-Compressive strength test results (m-sand)

B. Split tensile test results

Table 8- Split tensile strength test results of limestone coarse aggregate with river sand for 7th day and 28th day

Split tensile strength (MPa)		
% replacement LA	7 days	28 days
0%	2.86	3.36
20%	2.56	3.40
40%	2.75	3.27
60%	2.61	3.41
80%	2.54	3.32

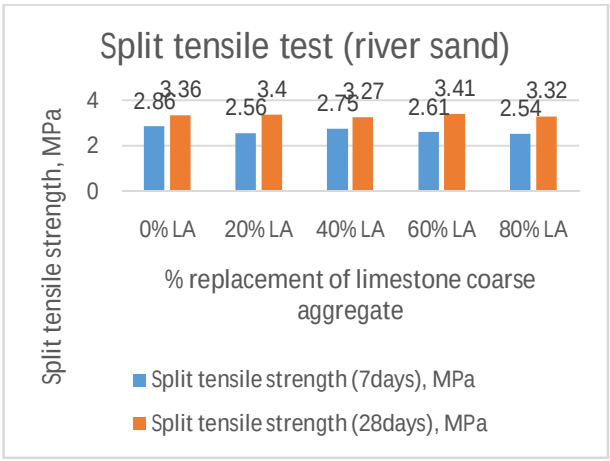

Fig 8-Split tensile strength test results (river sand)

Table 9- Split tensile strength test results of limestone coarse aggregate with m-sand for 7th day and 28th day

Split tensile strength (MPa)		
% replacement LA	7 days	28 days
0%	2.54	3.11
20%	2.26	2.68
40%	2.4	2.89
60%	2.59	2.9
80%	2.34	2.75

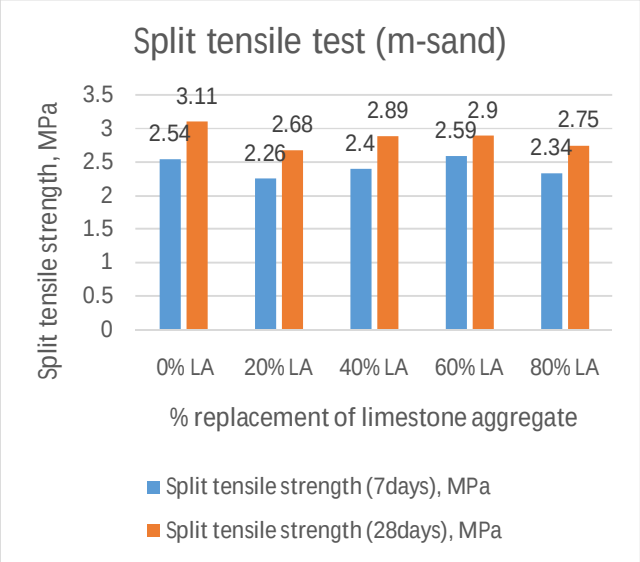

Fig 9-Split tensile strength test results (m-sand)

C. Flexure strength test result

Table 10- Split tensile strength test results of limestone coarse aggregate with river sand for 7th day and 2
8th day

Flexure strength (MPa)	
% replacement LA	28 days
0%	4.24
20%	4.13
40%	3.96
60%	3.8
80%	3.56

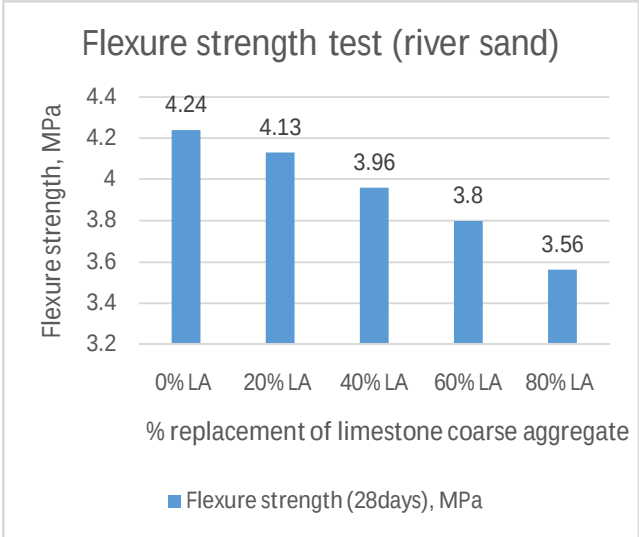

Fig 10-Flexure strength test results (river sand)

Table 11- Flexure strength test results of limestone coarse aggregate with m-sand for 7th day and 28th day

Flexure strength (MPa)	
% replacement LA	28 days
0%	4.4
20%	4.36
40%	4.24
60%	4.14
80%	4.10

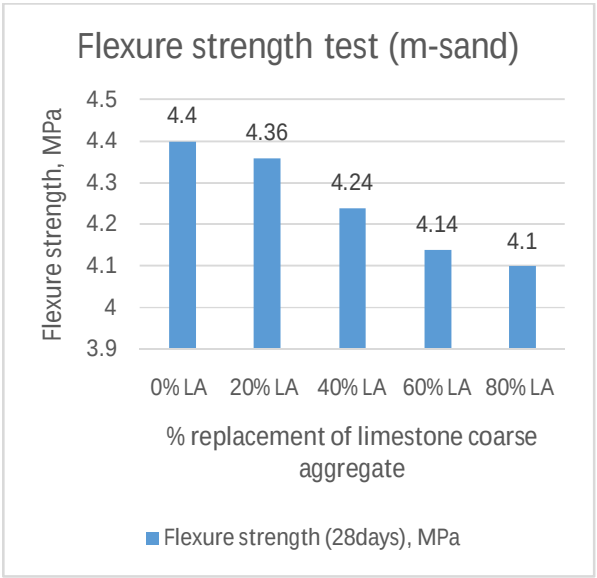

Fig 11-Flexure strength test results (m-sand)

VI. CONCLUSION

- The Limestone coarse aggregate used in M25 grade concrete with river sand and manufacture sand shown good results compared to conventional concrete.
- Concrete produced with manufacture sand and limestone coarse aggregates has higher compressive strength than concrete produced with river sand and limestone aggregates.
- The compressive strength and split tensile strength test results for replacement of 80% limestone aggregates has high strength.
- The compressive strength of concrete cubes with 80% limestone coarse aggregates and river sand showed a gain in strength from 28 MPa to 38 MPa i.e. 35.7% increase over the curing period of 28 days.
- The compressive strength of concrete cubes with 80% limestone coarse aggregates and m-sand showed a gain in strength from 34 MPa to 45 MPa i.e. 32.4% increase over the curing period of 28 days.
- Flexural strength decreases with increase in percentage of limestone coarse aggregate. This may be due to the repulsive force between aggregates and low resistant to abrasion.
- Results shows that about 80% of Limestone coarse aggregate can be used as alternate material to natural coarse aggregate in the concrete mix.
- Segregation is observed for 100% replacement of limestone coarse aggregates.
- The disposal problem of limestone waste in environment is solved by crushing it to required size utilising in construction works.

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