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EXPERIMENTAL STUDY ON THE EFFECT OF LIMESTONE (DOLOMITE) AS FINE AGGREGATE WITH STEEL FIBRE ON THE PROPERTIES OF CONCRETE

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***Abstract*- Nowadays the abnormal use of sand quarrying resulted in scarcity and significant increase in its cost. In order to fulfill the requirement of fine aggregate, some alternative material must be found. The cheapest and the easiest way of getting substitute for natural sand is obtained from limestone quarries. Research shows use of lime in concrete improved its strength and durability properties Research shows use of lime in concrete improved the strength properties. This paper summarize and discuss the effect of the limestone Filler (Fine Aggregate) $CaMg(Co_3)_2$ as a compensating material with different ratio of sand include 0%, 10%, 20%, 30% , 40% and 50% Steel Fibers are generally used as resistance of cracking and strength of concrete. The steel fibers were employed at constant volume fraction of 0.5% throughout in all mixes. Compressive and Split tensile strength were investigated and optimum percentage limestone Filler (Fine Aggregate) is found out and flexural strength for the optimum percentage limestone Filler (Fine Aggregate) concrete is found out.**

***Index Terms*- Limestone Filler (Fine Aggregate), Steel fiber, Compressive strength, Tensile strength, Flexural strength.**

I. INTRODUCTION

Concrete is the most widely used construction material in the world due to its ability to get cast in any shape and form. Concrete is a basic building block of our everyday world. It's used in almost every type of structure that we build today.

It is one of the most durable building materials since it provides superior fire resistance, compared with wooden construction and can gain strength over time. Structures made of concrete can have a long service life.

Reinforced concrete is a composite material in which concrete's relatively low tensile strength and ductility. Steel reinforcing bars (rebar) is usually embedded passively in the concrete before it sets. Reinforcing schemes are generally designed to resist tensile stresses in particular regions of the concrete that might cause unacceptable cracking and structural failure. For a strong, ductile and durable construction the reinforcement needs to have the following properties:

- High toleration of tensile strain
- Thermal compatibility, not causing unacceptable stresses in response to changing temperatures.
- Good bond to the concrete, irrespective of pH, moisture, and similar factors.
- High relative strength.

Limestone has been used in concrete production for the last 25 years, not only for the main purposes of economic and environmental load of cement productions, but also to improve the workability, increase the concrete durability and stability of fresh concrete and for a high flowable concrete such as self-compacting concrete.

When the concrete is mixed with lime, the cracks that should occur provide the necessary exposure. When the cracks form, limestone powder very close proximity to the cracks, starts precipitating calcite crystals. When a concrete structure is damaged and water starts to seep through the cracks that appear in the concrete and they seal up the cracks. The soluble calcium lactate is converted to insoluble limestone. The limestone solidifies on the cracked surface, thereby sealing it up.

Fibres are generally used as resistance of cracking and strengthening of concrete. The addition of steel fibers in concrete has a resisting effect on the initiation and propagation of crack. The amount of fibres added to the concrete mix is expressed as a percentage of volume fractions (V_f). Aspect ratio (l/d) is calculated by dividing fibre length (l) by its diameter (d).

II.PROJECT WORK

A. Materials used and its Properties:

2.1. Cement:

The Cement used in this study was Ordinary Portland cement (OPC) which is the most important type of cement. OPC cement of 53grade of cement use in this experimental work. Conforming weight of each cement bag was 50kg.The property of cement is shown in Table 1

Table 1. Properties of Cement

Physical Properties	Value observed in investigation	Standard value for OPC
Specific gravity	3.15	-
Initial setting time (minutes)	112	> 30
Final setting time (minutes)	186	< 600

2.2. Fine Aggregate:

River sand was used as Fine aggregate with fineness modulus of 2.85 and it should passing through IS Sieve 4.75mm. Physical properties of aggregates determine per IS 2386-1968. It should have fineness modulus 2.50- 3.50 and silt content should not be more than 4%. Grading limit of Fine aggregate confirming IS 383 – 1970. The properties of Fine aggregate are shown below in Table 2.

Table 2 Properties of Fine Aggregate

Property	Values
Specific gravity	2.62
Grading Zone	II
Fineness modulus	2.85

2.3 Coarse Aggregate:

The coarse aggregate are the blue granite stone of which particles greater than 4.75mm they should be hard, strong, dense, durable and clean. It must be free from vein, adherent coating, alkalis, vegetable matters and other deleterious substances. It should be conical shape. Flaky pieces should be avoided. It should confirm to IS 2386(part-1): 1963. These are obtained from nearest quarry (ie Coimbatore) with a fineness modulus of 6.81 Crushed rock Creates much better bond between cement paste and the Aggregates The properties of Coarse aggregate are shown below in Table 3.

Table 3 Properties of Coarse Aggregate

Property	Values
Specific gravity	2.76
Fineness Modulus	6.81

2.4 Super Plasticizers:

Super plastizers are known as high range water reducers are chemical admixtures used where well dispersed particle suspension is required. **Conplast SP430** complies with IS: 9103:1999 and BS: 5075 Part3. Conplast SP430 conforms to ASTM-C-494 Type ‘F’ and Type ‘A’ depending on the dosages used. The properties of Super Plasticizers is shown below in Table 4.

Table 4: Physical Properties of Super plasticizer

Properties	Description
Colour	Brown
Specific gravity	1.220 to 1.225 at 30^0C
Air Entrainment	Approximately 1% additional air is entrained

2.5 Steel Fibers

Hooked - End steel fibres of size (50mm long, 1.0 mm diameter, Aspect ratio 50) supplied by M/S. Stewols Pvt. Ltd., Nagpur were employed at constant volume of fraction of 0.50% throughout in all mixes.

2.6 Limestone Fine Aggregate

Dolomite , one of the Type of Lime stone was employed is composed of calcium magnesium carbonate $CaMg(CO_3)_2$. Which is normally available in the form of rock they crushed into required size by local mills and they graded. The details of Sieve Analysis is shown below in Table 5.

Table 5: Sieve Analysis of Lime stone F.A

IS Sieve	Lime stone F.A passing in %
4.75 mm	85.2
2.36 mm	75
1.18 mm	48
600 mm	32
300 mm	21
150 mm	6

B. Concrete Mix Proportions

The M_{25} grade of proportioning was done according the Indian Standard Recommended Method IS 10262- 2009 and with reference to IS 456-2000 .The total binder content was 425.78 kg/m^3, fine aggregate was taken 627.45 kg/ m^3 and coarse aggregate was taken 1201.75 kg/m^3. Water absorption capacity and moisture content were taken into consideration Cement, Sand and Coarse aggregate were properly mixed together in the ratio 1.00 : 1.47 : 2.82 by weight before water was added and properly mixed. Compaction of concrete in three layers is done and the concrete was left in the mould and allowed to set for 24 hours before the specimens were de moulded and placed in curing tank. Table 6 shows the details of Mix Proportion.

Table 6 :Details of Quantity of Constituent Materials per cubic meter

Materials	Quantity in kg	Ratio
Cement	425.78	1.00
Fine aggregate	627.45	1.47
Coarse aggregate	1201.75	2.82
Water	191.60	0.45
Steel fibers	11.28	0.5%

III. METHODOLOGY AND EXPERIMENTAL DETAILS

Limestone F.A will be replaced for certain quantities of cement- 0% (Mix-M1), 10% (Mix-M2), 20% (Mix-M3), 30% (Mix-M4), 40% (Mix-M5) and 50% (Mix-M6). The steel fibers were employed at constant volume fraction of 0.5% throughout in all mixes. slump test was done . The optimum percentage of Limestone F.A has been found out using 7 days and 28days compressive strength and Split tensile strength of cube and cylinder for the above mixes. Cast the concrete beam for the optimum percentage limestone F.A, After 28 days, Flexural strength for the optimum percentage limestone F.A concrete is found out following table show the details of Mixes

Table 7 : Details of Mixes

per 1 m^3

MIX	water (lit/m3)	Cement in Kg	Fine Aggregate		Coarse Aggregate in Kg
			Sand in Kg	Lime stone F. A in Kg	
M1	191.6	425.78	627.45	0	1201.75
M2	191.6	425.78	564.71	62.75	1201.75
M3	191.6	425.78	501.96	125.49	1201.75
M4	191.6	425.78	439.22	188.24	1201.75
M5	191.6	425.78	376.47	250.98	1201.75
M6	191.6	425.78	313.73	313.73	1201.75

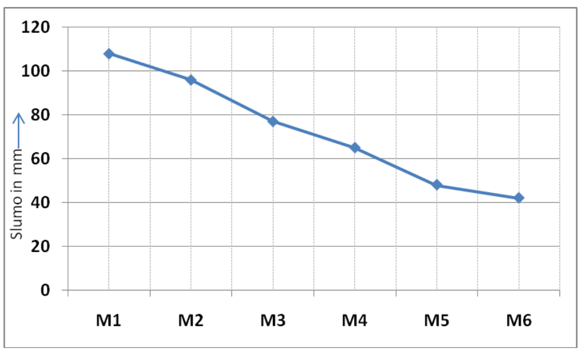
IV. RESULT AND DISCUSSION

4.1 Workability of fresh concrete

Influence of limestone F.A content on the workability of fresh concrete. The slump test was used to measure workability as a function of limestone F.A content for constant w/c ratio, the effect of limestone content on the slump is shown in Table (8) and Graph(1) respectively. The slump value seems to decrease with higher percentage of limestone filler content, this result is related to the relatively high water absorption capability which is attributed mainly to the large specific surface of limestone FA .

Table 8 : Details of Slump value in mm

MIX	Slump
M1	108
M2	96
M3	77
M4	65
M5	48
M6	42



Graph 1.Slump value of Concrete

4.2 Compressive Strength Test

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform and partly because most of the desirable properties of concrete are qualitatively related to its compressive strength. The strength of concrete is usually defined and determined by the crushing strength of 150mm x 150mmx150mm, at an age of 7 and 28days. The mould and its base rigidly clamped together so as to reduce leakages during casting. The sides of the mould and base plates were oiled before casting to prevent bonding between the mould and concrete. The cube was then stored for 24 hours undisturbed.

The maximum load applied to the specimen was then recorded as per IS: 516-1959. The testing of cube under compression was shown in figure 1.

Fig 1.Compressive Strength of Concrete

Compressive strength=Load/ Area (N/mm^2)

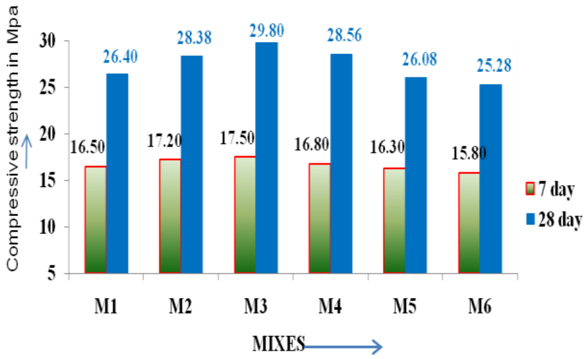
Results of compressive strength for M_{25} grade of concrete on cube specimens with different percentage of Lime Stone F.A and 0.5% of steel fibres are shown in table 9 as below.

Table 9 Test Results of Compressive Strength

Mix Reference	Average Compressive Strength (in Mpa)	
	7 day	28 day
M1	16.50	26.40
M2	17.20	28.38
M3	17.50	29.80
M4	16.80	28.56
M5	16.30	26.08
M6	15.80	25.28

Three concrete cube specimens were casted for all percentages conventional, 10%, 20%, 30% , 40% and 50%. These specimens were left for 28 days curing and test were conducted. The compressive strength for cubes increases up to 13.5%. When 20% of limestone F.A were added . ie which shows the optimum % , whereas further increasing of limestone F.A the compressive strength results started to decrease. The optimum mix ie. M3 showed 29.80N/mm^2 for 20% replacement.

Graph 2. Compressive Strength with replacement of Lime stone F.A



B. Split Tensile Strength Test

The test was conducted as per IS 5816:1999. For tensile strength test, cylindrical specimens of dimension 150 mm diameter and 300 mm length were cast. In this test three cylinders were tested and their average value was reported. The split tension test was conducted by using digital compression machine having 2000 kN capacity.

Fig 2.Split tensile strength of Concrete

Split tensile strength was calculated as follows:

Spilt Tensile strength (MPa) = $2P / \pi DL$
Where, P = Failure Load (kN)
D = Diameter of Specimen (150 mm)
L = Length of Specimen (300 mm)

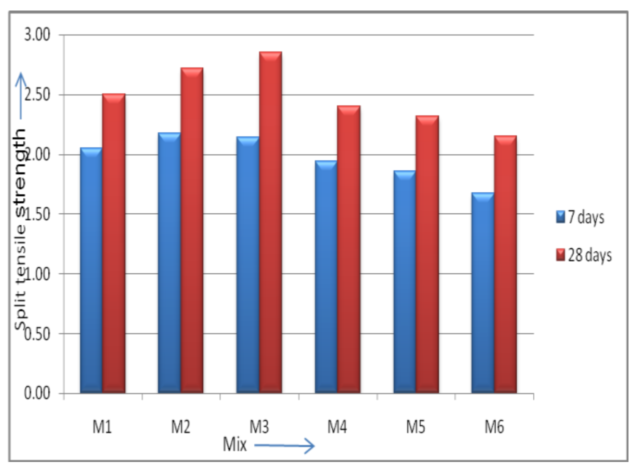
Test Results of splitting tensile strength for M_{25} grade of concrete shown in table 10 below.

Table 10. Test Results of Split Tensile Strength

Mix Reference	Average Split Tensile Strength in (Mpa)	
	7 days	28 days
M1	2.05	2.50
M2	2.18	2.72
M3	2.14	2.85
M4	1.94	2.40
M5	1.86	2.32
M6	1.68	2.15

Three cylinder specimens were casted in each percentage, in order to find the average value of split tensile strength. These cylinder specimens were left for 28days curing in a curing tank. After the course of curing, the specimens were ready for testing. All the cylinders were tested. From the split tensile strength test, it has been clear that the limestone F.A percentage of 20% (M3) has greatest strength than others. The addition of limestone F.A increased up to 14% strength, whereas more addition of limestone F.A decreased the strength of the cylinders.

Graph 3. Split Tensile Strength (N/mm2)



C. Flexural strength test

The test was conducted as per IS 5816:1999. For Flexural strength test, specimen of 150 mm X 200 mm X 1500 mm was casted. A beam specimen is placed in the ultimate testing machine of 2000kN capacity for testing. Rollers are placed at a centre to centre distance of the beam specimen. The load is increased until the specimen fails and the maximum load applied to the specimen during the test is recorded.

The Flexural strength is calculated by using the formula

$$\sigma = P\, l / bh^2$$

Where,

P = load in Newton shown in dial gauge

l = length of rectangular prism in mm i.e. 1500 mm

b = breadth of rectangular prism i.e. 150 mm

h = height of rectangular prism i.e. 200 mm.

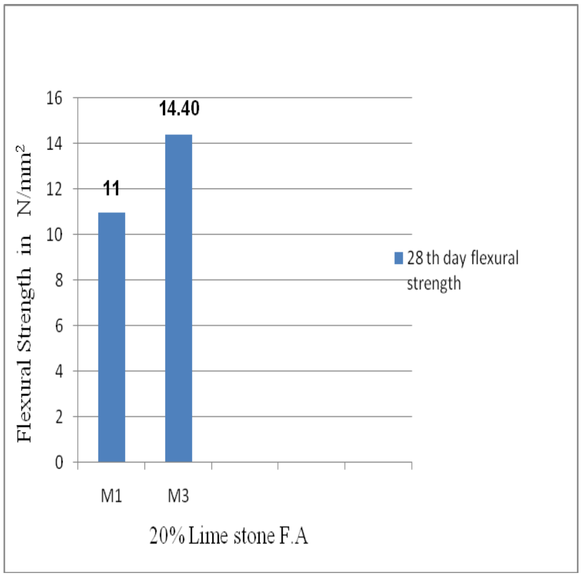
Test Results of flexural strength for M_{25} grade of concrete shown in Table 11 below.

Table 11. Test Results of Flexural Strength

S. No	Concrete grade	Flexural Strength in (Mpa) 28 days
1.	Mix- M1	11.00
2.	Mix-M3	14.40

From the table 11, flexural strength test results of beam at 28 days have been observed. It shows more flexural strength 28 days than conventional concrete. and also more than the required strength of 5.30 N/mm^2 as per theoretical calculation for beam casted.

Graph 4 Flexural Strength



V. CONCLUSIONS

In summary of the above investigations, the following conclusions are made from the experimental results indicated following:

- Slump decreases with the increase of limestone FA so water demand increases slightly with increasing limestone filler Content.
- The compressive strength and split tensile strength of concrete increase with the increase in Lime stone FA compensating, concrete made with Mix-M3 (20% Lime stone F.A compensating and 0.5% steel fibres) showed higher compressive strength.
- Partial Replacement of sand by limestone FA with 20% (Mix – M3)concrete showed higher flexural strength than the conventional concrete (Mix – M1).

REFERENCES

[1] A.Jayaraman,V.Senthilkumar, .Saravanan," Compressive and Tensile Strength of Concrete using Lateritic sand and Lime Stone Filler as Fine Aggregate" International Journal of Research in Engineering Technology (IJRET) Volume 3 Issue 1, Jan 2014, eISSN 2319 – 1163

[2] Sachin B Kandekar, Suresh S " Mechanical Properties of steel fibre used concrete paving block"

[3] Madhani bederina, Zoubit makhloufi, Tayeb bouziani "Effect of lime stone fillers the physic-mechanical properties of limestone concrete"

[4] A. Sumathi , K.Saravana Raja Mohan "Study on the strength and durability characteristics of High Strength Concrete with Steel Fibers"

[5] G. De Schutter, Ghent University, Belgium, (2011) "Effect of lime stone filler as mineral addition in self-compacting concrete." Singapore cements with limestone filler and fly ash content". U.P.B. Sci. Bull., Series B, Vol. 71, Iss. 3, 2009 ISSN 1454.

[6] Omar M.Omar , Ghada D.Abd Elhameed , Mohamed A Sherif " Influence of lime stone waste as partial replacement material for sand and marble powder in concrete properties.

[7] B. Beeralingegowda, V. D. Gundakalle (2013)"The Effect of Addition of Limestone Powder on the Properties of Self –Compacting Concrete" – IJIRSET
[8] Dale P.Bentz , Sdgardo F.Irasan, Brooks Bucher , W.Jason Weiss "Limestone Fillers to Conserve Cement in Low W/Cm concretes – An Analysis Based on Powers Model.
[9] Text book of Concrete Technology by M.S.Shetty.