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Effect of Limestone as an Additive on Properties of Concrete

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ABSTRACT
Strength consideration of concrete with ages has influence sourcing for suitable materials, which can be added to concrete in small quantities without leaving adverse effect on the properties of fresh and hardened concrete. This project examines the possibility of using limestone as an additive, replacing fine aggregate in small quantity in concrete production. The experiment includes sieve analysis which gives a well graded fine aggregate, slump test, compression test, and water absorption rate. The slump result gives a less workable concrete on the addition of limestone in concrete while the water absorption rate of concrete increases on the addition of limestone in concrete mix. The strength attained after 7 and 28 curing days shows that, limestone can be added to concrete in 5% to 10% replacement of sharp sand, in which there is tendency to achieve higher strength with age.
Keywords: *limestone, concrete, sieve analysis, slump test, compressive strength, water absorption rate*

INTRODUCTION
Limestone is a rock with an enormous diversity of uses. It could be the one rock that is used in more ways than any other. Most limestone is made into crushed stone and used as a construction material. It is used as a crushed stone for road base and railroad ballast. It is used as an aggregate in concrete. It is fired in a kiln with crushed shale to make cement [3].

Some varieties of limestone perform well in these uses because they are strong, dense rocks with few pore spaces. These properties enable them to stand up well to abrasion and freeze-thaw. Although limestone does not perform as well in these uses as some of the harder silicate rocks, it is much easier to mine and does not exert the same level of wear on mining equipment, crushers, screens, and the beds of the vehicles that transport it.

Concrete is a composite material composed of coarse aggregate bonded together with fluid cement that hardens over time [4]. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements. However, asphalt concrete, which is frequently used for road surfaces, is also a type of concrete, where the cement material is bitumen, and polymer concretes are sometimes used where the cementing material is a polymer. When aggregate is mixed together with dry Portland cement and water, the mixture forms fluid slurry that is easily poured and molded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses

An additive is a substance added in another small portion to improve desired qualities or suppress undesired properties of concrete. Concrete additives can either be liquid or powdered additives. They are added to the mixture in small quantities to increase the durability of the concrete, to fix concrete behavior and to control setting or hardening [2]. These admixtures are supplied in ready-to-use liquid form and are added to the concrete at the plant or at the jobsite. Successful use of admixtures depends on the use of appropriate methods of batching and concreting. Concrete additives have various functions depending on what the contractor wants to achieve. There are two main types of concrete additives which are chemical and mineral. [5]

2.0 MATERIALS AND METHODS

A. Materials
•Cement: Ordinary Portland cement (OPC) (43 grade) with specific gravity of 3.15 and fineness of 290 m^2/kg conforming to IS 8112:1989 is being used.

•Fine aggregate: The sand used for the experimental program was locally procured and was composed of fine particles as the sieve analysis shows a well graded sample.

•Coarse aggregate: Locally available crushed granular coarse aggregate having the maximum size of 20.5mm were used in the present work.

•Limestone powder: Locally available fine limestone powder is also used as partial sand replacement material.

•Water: Potable tap water was used for the preparation of specimens and for the curing of specimens.

B. Mixture Proportions
In the present investigation the water-cement ratio is fixed at 0.60 in weight while trials on workability test for this water-cement ratio are being investigated, the limestone powder is varied as 0%, 5%, 10%, 15%, and 20% and changes in the behavior of limestone concrete in fresh state and hardened state is being studied. The limestone powder replaces the sharp sand partially. The mix design adopted for the work is done through batching by weight. The mix proportion and the mix designation for various percentage of replacement of sand by limestone powder are shown in table 1 and 2

Table 1: Mix Proportion Of Limestone

Particulars	Quantity (kg/)
Cement	76.0
Sand	125.86
Limestone	13.99
Water	45.6
Granite	278.35

Table 2: Mix Designation.

Mix designation	% replacement of sand with limestone powder
NM	0
M1	5

M2	10
M3	15
M4	20

Necessary care is taken in proportioning the ingredients. The cement and fine aggregates were mixed dry until the mixture was thoroughly blended in the case of control mix and in the case of other mixes with limestone powder. The coarse aggregate was then added and mixed to distribute it uniformly. Initially 70% of water was added to the dry mixture to attain homogeneity and then the remaining 30% was added and the mixing was continued to obtain homogeneous mix. Cube specimens of size 150mm x 150MM x150MM were cast to determine compressive strength.

C. Testing

Test on fresh limestone concrete were determined by conducting slump flow test while test on hardened properties were determined by conducting cube compressive strength, durability test were carried out to determine water absorption rate.

3.0 RESULT AND DISCUSSIONS

A. Soil sample

The sieve analysis result of both fine aggregate samples (sand and limestone) shows a well graded fine aggregate with their coefficient of curvature both giving a value of 1 conforming to USCS specification within the range of 1 -3

Table 3: Sieve analysis of sharp sand and limestone

Sieve sizes (mm)	Percentage finer	
	Sand (%)	Limestone (%)
4.75	99.09	99.09
3.18	98.48	98.79
2.40	97.57	98.18
1.68	95.75	92.73
1.18	88.48	79.09
0.60	60.90	49.70
0.295	32.42	30.00
0.15	9.39	9.39
0.075	3.63	2.42
Pan	1.21	0.60

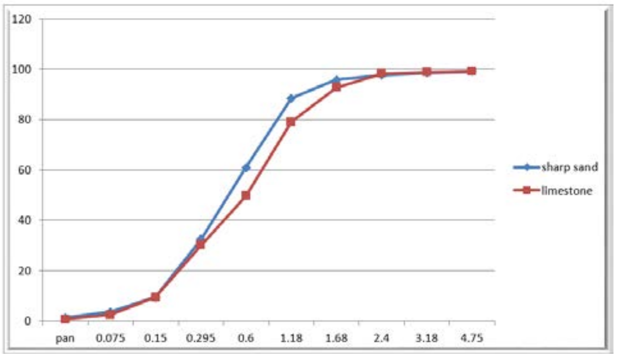

Fig 1: Graphical representation of sieve analysis test

B. Fresh properties

The workability test of limestone concrete mixes with different percentage replacement of sand with limestone powder are determined by conducting slump test for each percentage replacement. The results are tabulated for all the mixes in table 3. It is observed that up to 15% of sand can be replaced by limestone powder without affecting workability

Table 3: Fresh properties of limestone concrete

% of limestone powder	Mix	Slump(mm)
0	NM	32
5	M1	29.1
10	M2	34
15	M3	36.5
20	M4	136.2

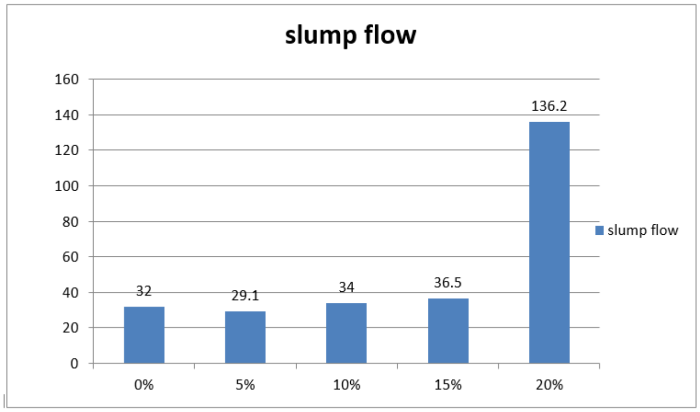

Fig 2: slump flow

C. Hardened properties

(i) Compressive strength

The compressive strength test on cube specimens is conducted as per IS 516- 1959. The test results on cube compressive strength of limestone concrete is given in Table 4 and plotted in Fig 3.It has been observed that the compressive strength increases up to 10% limestone powder content but decreases on further addition of limestone powder. Maximum increase of 12.70 percent in compressive strength has been observed at 5 percent replacement of cement by limestone powder compared with control mix after 7 curing days. Further it has been found that the increase in compressive strength observed is, when the sand has been replaced from 5 to 10 percent. Beyond 10 percent replacement the compressive strength is lower than the control mix.

Table 4: compressive strength of hardened concrete

Description of sample (%)	7 days N/mm^2	14 days N/mm^2	21 days N/mm^2	28 days N/mm^2
0	16.61	19.18	22.64	24.05
5	18.72	19.28	19.52	19.92
10	18.33	19.17	19.42	20.07
15	15.16	15.68	15.87	16.50
20	12.74	13.97	14.76	15.70

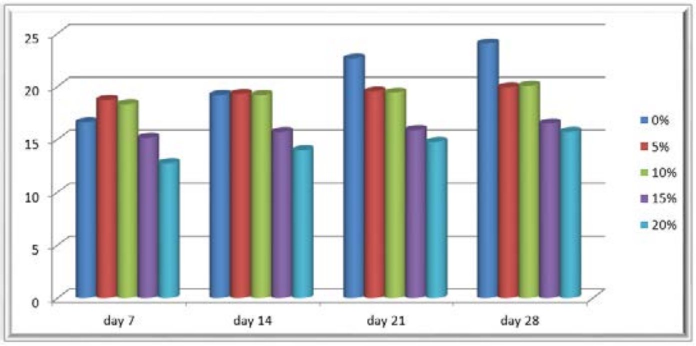

Fig 4.1: variation in compressive strength of concrete with age.

(ii) Water absorption test

Durability studies were conducted on limestone concrete through water absorption test. Table 5 and figure 4 below shows the water absorption rate of normal mix concrete as well as limestone concrete. The study shows increase in water absorption rate with increase in percentage of limestone in concrete.

Table 5: water absorption rate of concrete at different replacement level of limestone

% of limestone	Water absorption rate
0%	1.91
5%	2.16
10%	2.21
15%	2.53
20%	2.75

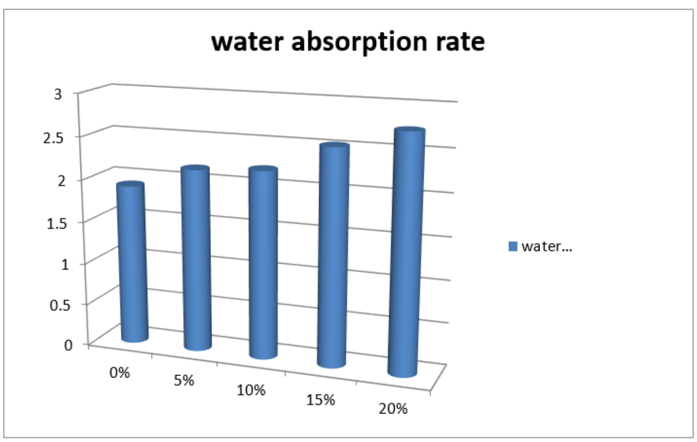

Fig 4: water absorption rate of concrete at different replacement level of limestone

4.0 CONCLUSION AND RECOMMENDATION

The study investigated the application of Limestone as partial replacement for fine aggregate. From the experimental investigation it was observed that the replacement of sand with limestone powder as mineral admixture in concrete show improved workability up to 15 percent and mechanical properties up to 10 percent. Water absorption rate of concrete increases on the addition of limestone right from the initial addition to the final stage of 20 percent but the effect is minimal at 5 percent. Compressive strength of concrete increases up to 10 percent after 7 days then decreases on further addition of limestone. The use of lime stone as admixture to concrete improves its strength; It should therefore be encouraged as an effective and modern form of improving Concrete Production.

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