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Experimental Investigation on Strength of Concrete by Partial Replacement of Cement by Dolomite Powder

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Abstract: ***In this Research work the main objective is to investigate the feasibility of using dolomite powder in concrete. As Concrete is most widely used construction materials used since hundreds of years. Concrete production needs natural resources, which is diminishing the production of natural resources and energy day by day.***
This cement manufacturing companies are one of the primary producers of carbon dioxide, a potent greenhouse gas and responsible for global warming.
The cost of concrete materials in building and civil engineering project has been a concern to the society. This requirement is drawn the attention of investigators to explore new replacements of ingredients of concrete. Several experimental studies have been carried out to find optimum replacement for these raw materials of concrete to reduce cost, effect to the atmosphere. By considering all these aspects and need of present Dolomite powder can be beneficially used as a partial replacement of cement in concrete.
The primary objective of this paper is to quantify the 7th, 14th & 28th Days desirable properties of concrete at various replacement levels. In this study, the cement is partially replaced by dolomite powder at 10%, 20% and 30%. The preliminary properties of cement, fine aggregate and coarse aggregate are studied. The cement mortar cubes and concrete specimens were prepared and tested for 7th, 14th & 28th days strength.
The Mechanical properties like compressive, flexural and split tensile strength of concrete with dolomite powder was compared with those of the reference specimens. As per the results this indicates the replacement of cement with dolomite powder increases the compressive and split tensile strength of concrete Within Certain limit. As per the result obtained 10% replacement of cement with dolomite powder has been done and which gives better result than conventional concrete. When examined for the mechanical properties.
Keywords: Dolomite Powder, Ordinary Portland cement (53 Grade), Sand and coarse aggregate.

I. INTRODUCTION

As Day by day the production of cement is getting high and the use of cement is become the need of present as binder material in concrete. Due to Globalization the consumption of concrete is increasing, Concrete is the second most thing that is widely used all over the world, after water. Concrete is known to be the most wide spread structural material due its property to moulded in any form. It is a mixture of cement, fine and coarse aggregates and water.

These materials possess problems of disposal, health hazards and aesthetic problems. The global consumption of cement is getting higher due to its extensive use in concrete. As dolomite is material which is obtained from sedimentary rock bed also known to be "Dolostone". Dolomite can be used as replacement of limestone in cement.

Dolomite has a good weathering resistance. It is well known the main component of dolomite is magnesium carbonate ($MgCO_3$) and calcium carbonate ($CaCO_3$), the decomposed temperature of $CaCO_3$ is higher about 200 °C than the decomposed temperature of $MgCO_3$. So we can obtain the mixture of reactive magnesium oxide and $CaCO_3$ according to containing calcining temperaturre and duration time of dolomite.

Dolomite is usually preferred for construction material due to its higher surface hardness, strength and density. Concrete applications prefer dolomite as a filler material due to its higher strength and hardness. By the effective utilization of dolomite powder, the objective of reduction of cost of construction as well as better durability to structure and strength can be achieved. Dolomite can be replaced with cement in order to reduce the global warming, emission of Co2 that is produced during the manufacturing process of cement.

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II. METHODOLOGY

A. Methodology

1) Assessing the physical & chemical properties of materials.

2) Mix design for concrete are made using the properties constituents of concrete. Grade of concrete is taken as M30 and the mix design are done as per IS: 10262-2009 and IS: 456-2000 for different dolomite powder percentage replacing of cement, using M-sand as fine aggregate. All mixtures are prepared for room temperature.

3) Mix design of M-30 grade concrete by partially replacement of cement with dolomite powder 10%, 20% and 30% by weight of cement.

4) Test on fresh concrete using slump test.

5) Test on hardened concrete using cube test, flexural test & split tensile test.

Flow chart

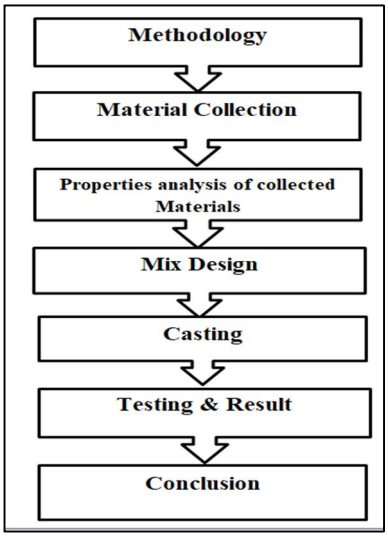

Table No.2.1, Descriptive proportion of dolomite with cement:

Mix design	Description
M_0	Mix Design of M30 Grade concrete.
M_1	Concrete mix with 10% replacement of Cement with dolomite powder.
M_2	Concrete mix with 20% replacement of Cement with dolomite powder.
M_3	Concrete mix with 30% replacement of Cement with dolomite powder.

III. TEST ON RAW MATERIALS:

1) *Cement:* Cement used for this research work is ordinary Portland cement (OPC-53 GARDE) available in the near market. For this research work, this cement is stored in dry and dark place and also covered with a poly bag to ensure the safety of cement against any types of moisture contact.

2) *Fine Aggregate:* The material which passed through I.S. Sieve No. 480 (4.75mm) is termed as fine aggregates. Function of fine aggregates is to make concrete dense, by filling voids of coarse aggregates and Natural sand is used for experimental work.

3) *Coarse Aggregate:* This chemically inert materials which when bonded by cement paste form concrete. Aggregates influence the strength of concrete to great extent. For experimental 20mm size aggregate is used.

4) *Dolomite Powder:* Dolomite powder is obtained by processing the sedimentary rock which is mineral, dolomite can be used as a replacement material for cement in concrete up to certain percentage. Dolomite powder has some similar properties as like of cement. Use of dolomite powder in concrete can minimizhe cost of concrete and may also increase the strength to some extent.

Table 3.1 Chemical composition of Dolomite Powder

Sr. No.	Composition	Dolomite Powder
1	Cao	38
2	SiO_2	1.62
3	MgO	10.19
4	Al_2O_3	0.30
5	Fe_2o_3	0.82
6	$CaCO_3$	82

Table 3.2 Physical properties of Dolomite Powder

Sr. No.	Composition	Dolomite Powder
1	Specific gravity	2.6
2	Colour	White Powder
3	fineness modulus	2.46

Table No.3.3, Result of tested raw material:

1	Cement (OPC-53 Grade)	Fineness test	2.6
		Specific gravity	3.15
		Bulk Density	1450 Kg/m^3
2	Fine Sand	Fineness test	2.75
		Specific gravity	2.68
3	Coarse aggregate	Specific gravity	2.98
		Impact value	18.6%
		Crushing value	18.57%
		Water Absorption	0.61%

IV. MIX DESIGN

Mix design for M-30 concrete is done and amount of materials needed for casting cubes are calculated. Mix proportions for varying percentages of dolomite powder are fixed.

Table No.4.1, Maximum final mix proportion of M30 Grade concrete as per IS: 10262:2009

Sr. No.	Materials	Quantity (Kg/m3)	Proportion
1	Cement	438	1
2	Natural Sand	670	1.52
3	Coarse aggregate	1247	2.84
4	Water	197	0.45

V RESULT AND DISCUSSION

Table No.4.2, According to IS: 1199 – 1959 workability test by slump cone on fresh concrete were tested at Concrete & test results are as follows.

S. No.	Samples	Dolomite Powder	Slump value (mm)
1	M_0	0%	65
2	M_1	10%	63
3	M_2	20%	62
4	M_3	30%	60

A. Compressive Strength Test

The compressive strength measurement of the concrete samples was done as per IS 516: (1959) standard practiced. The test was conducted on the three samples of each composition and the average value of all is evaluated by a sample of each composition as the result compressive strength. The compressive strength values of different compositions of Dolomite powder and Cement.

B. Observation of Compressive Strength

Days	Average Compressive strength 7,14 & 28 days		
Mix proportions	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
DP-0-100C	25.5	35.3	39.25
DP-10-90C	27	37.2	41.45
DP-20-80C	24.49	33.8	37.65
DP-30-70C	22.34	31	34.45

From the experimental results it is clear that Compressive strength of the M30 Concrete mix when cement is substituted with dolomite powder 10%, then the strength is increased compared with conventional concrete. Dolomite is substituted with cement 20% and 30% respectively, the compressive strength is found to be reducing.

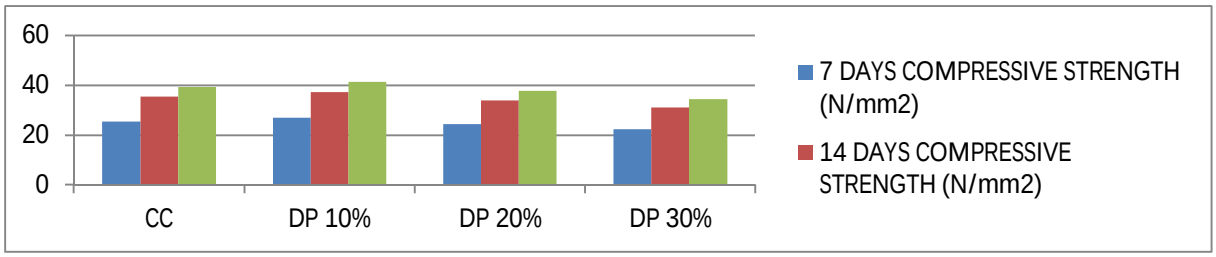

Fig shows: Comparison of Average Compressive strength

C. Flexural Strength Test

For this research work, single samples were prepared for 7 days 14 days as well 28 days testing for each configuration with one additional sample of conventional concrete.

D. Observation of Flexural Strength

Days	Flexural strength		
Mix proportions	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
DP-0-100C	3.2	4.33	4.8
DP-10-90C	3.35	4.45	4.94
DP-20-80C	3.10	4.18	4.70
DP-30-70C	3.02	4.05	4.45

Flexural strength of concrete specimen with sand and cement (control specimen) 28 days was found to be 4.3 N/mm^2. From the experimental results it is clear that Flexural strength of the M30 Concrete mix when cement is substituted with dolomite powder 10%, then the strength is increased compared with conventional concrete. Dolomite is substituted with cement 20% and 30% respectively, the compressive strength is found to be reducing.

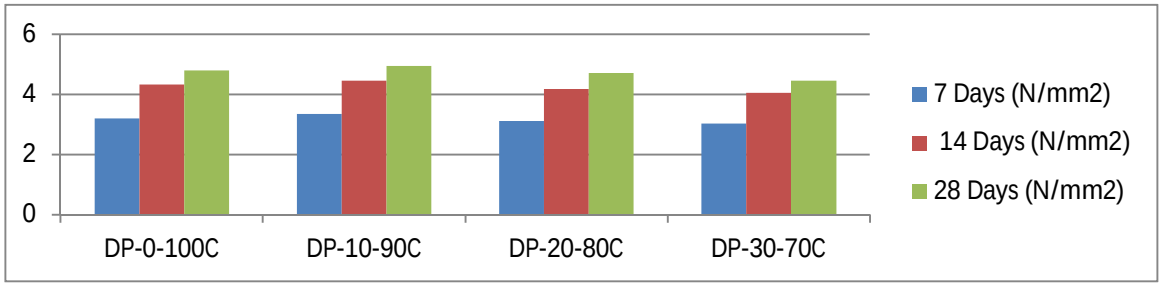

Fig shows: Comparison of Flexural strength

E. Split Cylinder Test

Tensile strength of concrete greatly affects the extent and size of cracking in concrete. Tensile strength of concrete is less when compared with its compressive strength. Cylinders of diameter 150mm and height 300mm were used to determine the split tensile strength. After curing, the specimens were tested on the compression testing machine.

F. Observation Of Split Tensile Strength

Days	Tensile strength		
Mix proportions	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
DP-0-100C	2.45	3.15	4.0
DP-10-90C	2.78	3.78	4.2
DP-20-80C	2.35	3.23	3.63
DP-30-70C	2.25	2.96	3.31

Split tensile strength of concrete specimen with sand and cement (control specimen) 28 days was found to be 4.0 N/mm^2. From the experimental results it is clear that Split Tensile strength of the M30 Concrete mix when cement is substituted with dolomite powder 10%, then the strength is increased compared with conventional concrete. Dolomite is substituted with cement 20% and 30% respectively, the compressive strength is found to be reducing.

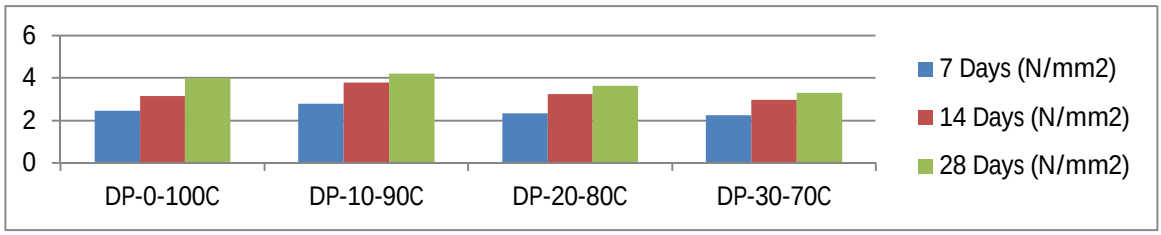

Fig shows: Comparison of Split tensile strength

V. CONCLUSION

The Compressive strength of Cubes, Split Tensile strength of Cylinders & flexural strength are increased with addition of dolomite powder up to 10% replaced by weight of cement and any further addition of dolomite powder decreases the compressive strength, tensile & flexural strength. We found out the optimum percentage of replacement of dolomite powder with cement is 10% cement for cubes, cylinders and beam. At this replacement level, the maximum increase in the 28th day compression, flexural strength and split tensile strength, were found to be 5.30%, 2.83% and 4.76% respectively. In case of split tensile strength, the optimal replacement is 10% and at this replacement level, the percentage increase in split tensile strength was found to be 4.76%. We have put forth a simple step to minimize the costs for construction with usage of dolomite powder which is freely or cheaply available. As per the chemical composition of dolomite, the material lacks to perform like cement due to variation of silica in the material.

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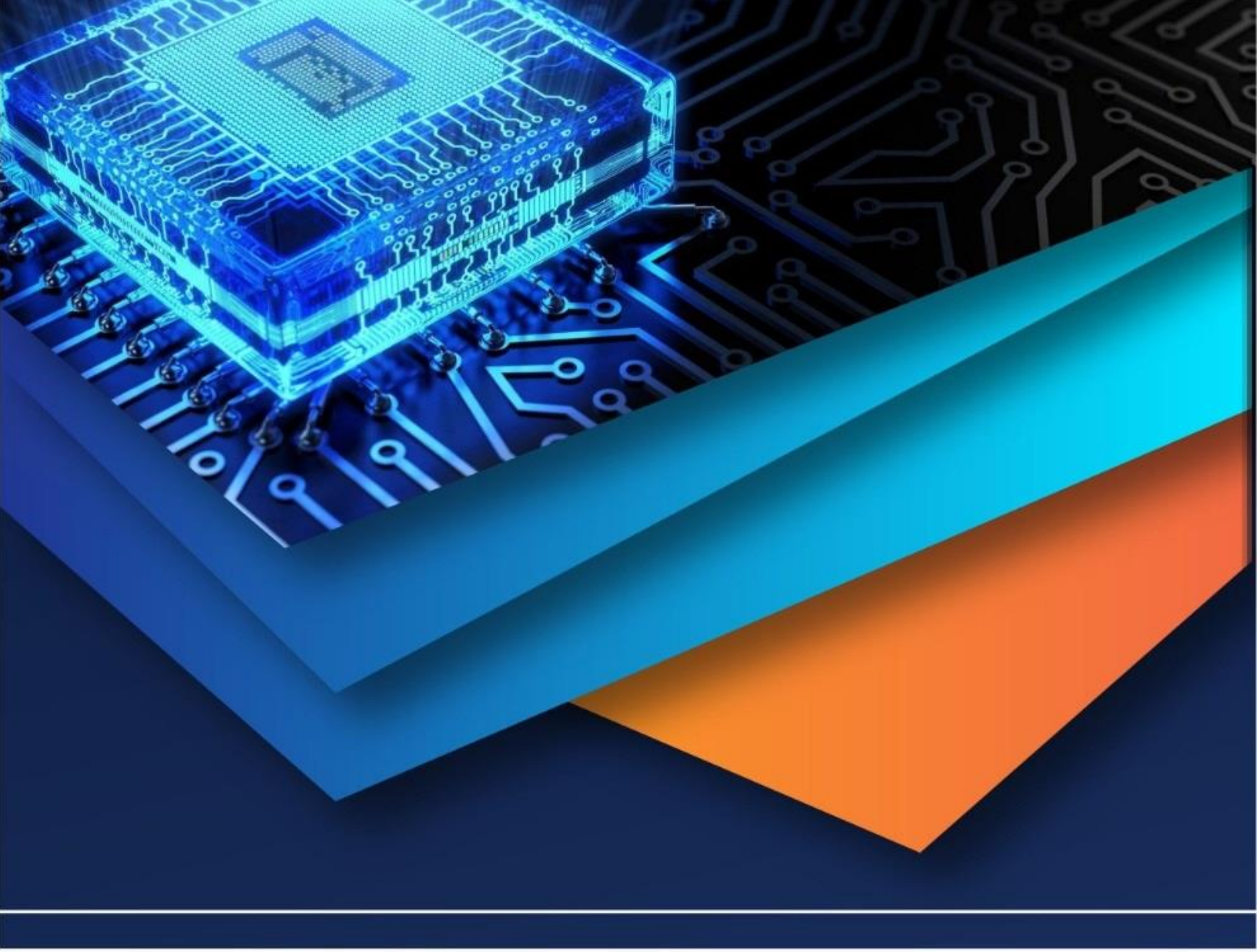

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