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Effect of Dolomitic {$CaMg(CO_3)_2$}and Calcitic {$CaCO_3$} Marble Dust Powder on OPC Cement

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Abstract: ***This paper highlights the investigation on feasibility study of utilization of calcitic and dolomitic marble dust powder as mineral additive in manufacturing cement in place of conventional limestone because MDP showed their resemblance to limestone***
This research work assessed the effect of Dolomitic Marble Dust Powder Rajsamand, INDIA and calcitic marble dust powder (MDP) Makrana ,Rajasthan, INDIA on the property of opc cement and utilization of Dolomitic and calcitic MDP as Performance Improver and achieving sustainable development.
For the countries with developed marble stone industries the waste generated in the natural marble stone processing plants pose environmental and economic problems.
Marble industry produces large amount of non-degradable waste during mining and processing stages. This MDS and MDP waste is damped on to open land which creates a lot of environmental problems.
Experimental investigations were carried out to examine the feasibility of use of Dolomitic and calcitic MDP as a Mineral Additive in cement and use in sustainable development
Keywords: Calcitic, Dolomitic, MDP, Compressive Strength, Clinkar, Setting Time, Soundness, Consistency, Fineness etc

I. INTRODUCTION

As in all industrial activities, waste production is also inevitable in natural marble stone quarries and plants, and the negative environmental impact of this waste poses a problem. Marble Dust Powder and Slurry is the waste product of marble stone which is produces from the surface finishing or stone in construction buildings or marble processing industries. For sustainable development construction industry is safe area where it can be used efficiently and economically.

The “Marble” means shining stone which has pleasant colours, smooth and uniform texture, moderate hardness, amenability to be quarried into big blocks, smooth and shining polished surface and silky feel.

Marble is a ‘minor mineral’ as defined under clause (e) of section B of mines and minerals (development and regulations) Act,1957 of India.

Rajasthan is the richest state in India with regards to marble deposits (1100 MT) both in quality and quantity. Marble production of India is 90% of world production and approximately 85 to 90% quarried from Rajasthan state of India.

Around 4000 marbles mines and 1100 marble processing units, spread over 16 districts out of 33 districts of Rajasthan. In India, Rajasthan state has more than 95%of marble processors units and its generated around 5-6 Million Metric Tons of slurry every year out of which 1.5 million tons is Marble Dust Powder .There are 3600 marble quarries in Rajasthan from which 350 quarries are fully mechanized. The slurry waste has 70% of water content and rest of marble dust. Marble dust is very fine powder has approximately 40% particles below 75 micro meter diameter of which approximately 30% are having a size less than 25 micro meter. It has Specific Gravity 2.70-3.00 gm/cm^3 .

MAKRANA {27°02’25”N Latitude,74°43’44”E Longitude}is situated at the eastern margin of the thar desert and has ancient marble mining history .Makrana marble is formed due to Metamorphism. And due to calcitic nature , it is preferred over the other marbles for monumental and sculpture work.

Makrana marble deposits belong to the Ajmer formation of kumbhalgarh Group of Delhi super Group {GSI 1997}.Five prominent bands and 15 blocks have been delineated in the area, which extend 13 km along strike and 1.6 km across the strike.The total marble reserves in makrana are 55 Million Tons, and about 120 thousand tonnes of marble are produced annually from over 400 mines.Long history of conventional and un-scientific mining poses severe threat to life, public property, environmental problems and continuation of mining in the area RAJSAMAND is situated at the southern parts of Rajasthan,India. It lies between 24°46’ to 26°01’ North Latitudes and 73°28’ to 74°18’ East Longitude.Deposits of a variety of white and grayish white marble like (Morwar,Agaria,Dholikhan,Arna,Jhanjhar and Dharmeta etc.) exceed over 387 million Tons with 2000 mining Leases.Rajsamand

has fast developing qurries using diamond Wire-Saws,Chain-Shaws and Handling equipment and has about 250 modern Gang-Saw and 20-25 Tiling Units and 125 Mineral Grinders spread over a vast stretch of 40 km^2 from Nathdwara to Kelwa and Amet

Makrana MDP is Calcitic in nature which has $MgCO_3$ less than 5 %

Rajsamand MDP is Dolomitic in nature which has $MgCO_3 \geq 5\%$ But $\leq 22\ \%$

In the manufacturing of cement minerals such as fly ash, limestone,blast furnace slag, rice husk ash, silica fume and metakaolin are permitted by BIS by 5% addition during clinker grinding.

The Physico-Chemical and mineralogical characterization of MDP collected from RAJNAGAR and MAKRANA showed presence of 27-44% CaO,6-18 % SiO_2,and 1.1-22.1% MgO.

BIS has allowed mineral addition in cement by Order/ Amendment DOC.CED2 (5894) Dec.1999 as draft Amendment No.8 may 2005 to IS:-8112-1989 and No. 7 Dec. 2003 to IS:-12269-1987.

The above Amendment state that the limestone to be used as performance improver (PI) shall contain more than 75% $CaCO_3$ when tested as per IS:-1760 (PART-III)-1992

Addition of MDP in clinker reduce CO_2 emission in atmosphere along with saving in energy.

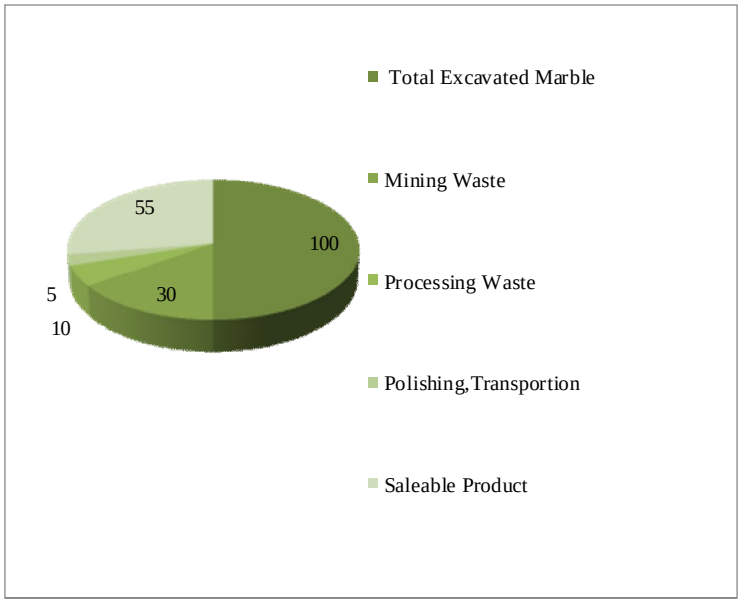
Environmental Hazards Due To Marble Waste

Soil pollution	Conservation of natural resources
Loss to flora and fauna	Wet and Dry slippery roads
Water pollution	Air pollution
Visual impacts	Accidents due to un-scientific dumping

Feasible Marble Waste Utilization

S.No.	Utilization Area	%
1	Highway Embankment Fill	10-14
2	Bricks, Tiles	10-12
3	Board, Panels	10-12
4	Ceramic Product	10-12
5	Cement	9-11
6	Concrete Roofing	5-10
7	Aggregates	2-6
8	Plaster, Pointing	2-5

Marble Waste Generation(With Mechanized mining and Processing)



II. EXPERIMENTAL,RESULTS ,DISCUSSION

For investigation cement samples were prepared by inter grinding of crushed clinker (CLK) and Gypsum 5% with 5% doses of Makrana Calcitic MDP and Rajnagar Dolomitic MDP separately . Cement / clinker 43 Grade OPC Cement Confirm to standard IS:8112-1989 BIS and OPC clinker obtained from Wonder cement plant NIMBAHERA Rajasthan INDIA

Table no. 1 chemical analysis of marble dust powder

S No.	Components	Rajnagar dolomitic MDP	Makrana Calcitic MDP	CLK From Plant
1	LOI	43.57	34.32	0.12
2	CaO	27.02	44.01	67.32
3	SiO_2	6.18	18.20	23.61
4	AL_2O_3	0.32	1.98	3.21
5	Fe_2O_3	0.72	0.71	2.23
6	MgO	22.01	1.13	2.61
7	SO_3	0.37	Nil	0.51
8	Na_2O	Trace	0.21	0.10
9	K_2O	Trace	0.21	0.31
10	Cl	Trace	Trace	----
11	$CaCO_3$	48.31	76.23	----

Table no. 2 chemical analysis of samples [clinkar + mdp]

S No.	Samples	Oxide Constituents %				
		LOI	MgO	Cl	SO_3	IR
1	CLK 95%+5% Gypsum	2.15	1.72	Trace	2.41	1.41
2	CLK 90%+5% Gypsum+ 5%Dolomitic MDP	3.90	2.91	Trace	2.02	1.41
3	CLK 90%+5% Gypsum+5% Calcitic MDP	3.12	1.52	Trace	2.41	1.91
4	IS:-8112-1989 (Limits)	5.0 Max.	6.0 Max	0.1 Max.	2.5 Max.	3.0 Max.

Table no. 3 particle size distribution of mdp

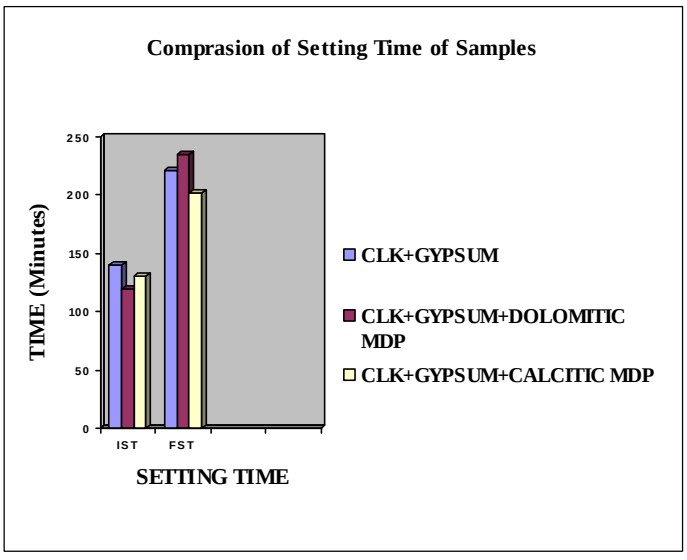
S No.	% Passing		
	Size In micron	Dolomitic Rajnagar MDP	Calcitic Makrana MDP
1	9.25	42.31	45.12
2	5.50	28.15	22.71
3	2.31	10.72	7.12
4	1.156	1.21	0.21
5	0.818	0.51	Nil

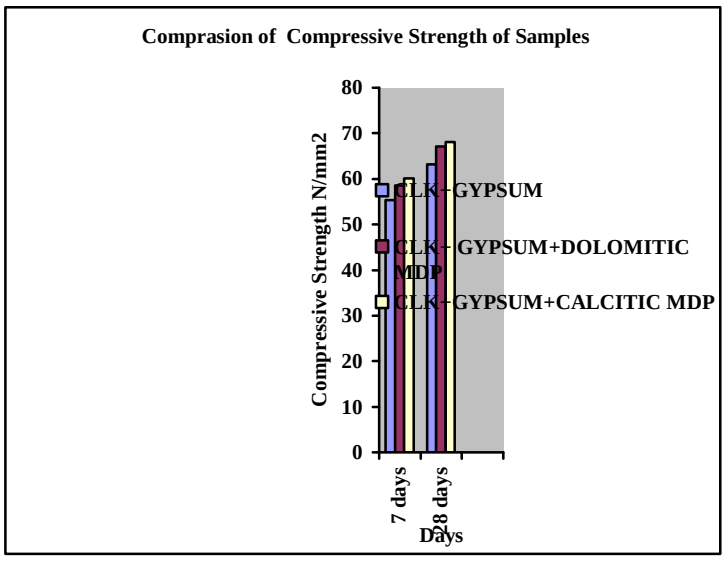
Table no. 4 particle size distribution of samples

S No.	Size In micron	% Fraction Passed		
		CLK 95%+5% Gypsum	CLK 90%+5% Gypsum+ 5%Dolomitic MDP	CLK 90%+5% Gypsum+5% Calcitic MDP
1	5.50	2.12	3.52	2.80
2	3.89	0.41	1.21	0.90
3	3.27	0.10	0.51	0.31

Table no. 5 test result of samples

S No.	Properties	CLK 95%+5% Gypsum	CLK90%+5%Gypsum+ 5%Dolomitic MDP	CLK90%+5%Gypsum+5% Calcitic MDP	IS:-8112-1989
1	Consistency % IS:-4031(4)-1998	29.12	27.3	27.9	-------
2	Fineness m^2/Kg IS:-4031(2)-1999	342	311	321	225 Min.
3	Soundness Le-Chat. In(mm) IS:-4031(3)-1988	0.5	0.5	0.5	10 Max.
4	Setting Time in Minutes IS:-4031(5)-1988				
	IST	140	120	130	>30
	FST	221	235	201	<600
5	Compressive Strength In (N/ mm^2) IS:-4031 (6)-1993				
	7 Days	55.3	58.6	60.10	>33.0
	28 Days	63.2	67.1	68.12	>43.0





III. CONCLUSIONS

A. The Dolomitic MDP has high amount of MgO (22.01 %) so addition of 5% to OPC cement there was apparently a slight tendency toward quick intial setting time by 20 minutes and slow final setting time by 14 minutes and on addition of Calcitic MDP 5% (MgO 1.13 %) a slight tendancy toward quick intial setting time by 10 minutes and decrease final setting time by 20 minutes

B. As compare to Dolomitic MDP ($CaCO_3$ =48.31 , SiO_2=6.18) the Calcitic MDP contains high amount of lime($CaCO_3$ =76.23) and less amount of silica($SiO_{2=}$ 6.18), So it increase the compressive strength of OPC cement in significant amount.

C. As compare to OPC cement On addition of Calcitic MDP 5% it increase compressive strength 4.8 N/mm^2 and 4.92 N/mm^2 at 7 days and 28 days respectively And on addition of Dolomitic MDP 5% it increase compressive strength 3.3 N/mm^2 and 3.9 N/mm^2 at 7 days and 28 days respectively

D. Particle Size Distribution of cement samples prepared using Calcitic MDP (321 m^2/Kg) and Dolomitic MDP (311 m^2/Kg) showed finer nature of samples as compare to OPC cement (342 m^2/Kg) .

E. On addition of 5% Calcitic MDP in OPC cement and 5% Dolomitic MDP in OPC cement the Soundness and Consistency obtained are comparable to the control OPC cement.

F. In nutshell the Calcitic MDP as Performance Improver (PI) in opc cement is better than Dolomitic

IV. ACKNOWLEDGMENT

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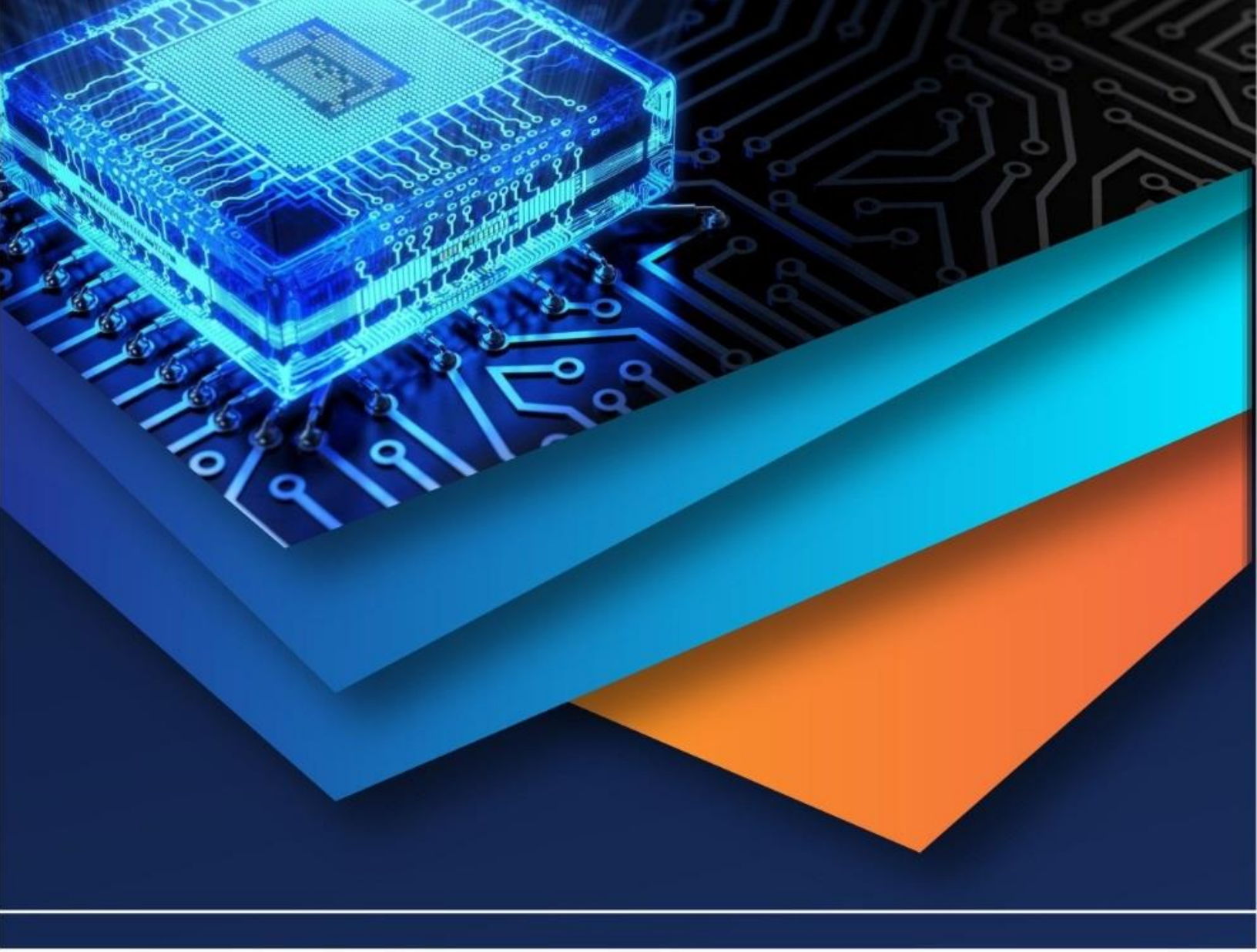

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