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Utilization and Effect of Calcitic MDP in Cement as Mineral Additive and F.A. In Concrete

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Abstract: ***This paper highlights the experimental investigation on feasibility study of utilization of calcitic and marble dust powder as mineral additive in manufacturing cement in place of conventional limestone and MDP as a fine aggregates [F.A.] in cement concrete for sustainable development because MDP showed their resemblance to limestone and property of fine aggregatesThis research work assessed the effect and utilization of Calcitic marble dust powder (MDP) Makrana ,Rajasthan, INDIA on the property of opc cement and cement concrete and utilization calcitic MDP as Performance Improver and fine aggregates [F.A.] and achieving sustainable development.For the countries with a developed marble stone industries the waste generated in the natural marble stone processing plants pose environmental, economic and health problems for mankind. 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.***

Keywords**: *Calcitic,Compressive Strength ,Clinkar, MDP, 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,stone in construction buildings,marble processing industries. For sustainable development construction industry is safest area where it can be used economically and efficiently.

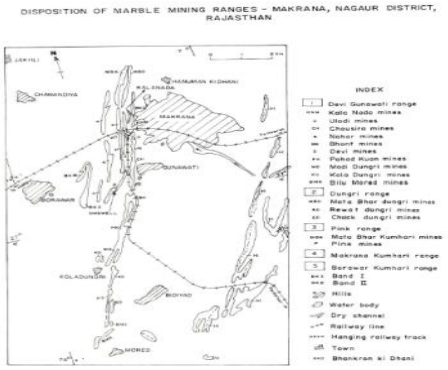
Marble is a “minor mineral” as defined under clause (e) of section B of mines and minerals {development and regulations} Act,1957 of India.

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 feel silky.

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 according to location .

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.

A. Makrana MDP is Calcitic in nature which has $MgCO_3$ less than 5 % and it is cohesion less material

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

The Physio-Chemical and mineralogical characterization of MDP collected from 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.

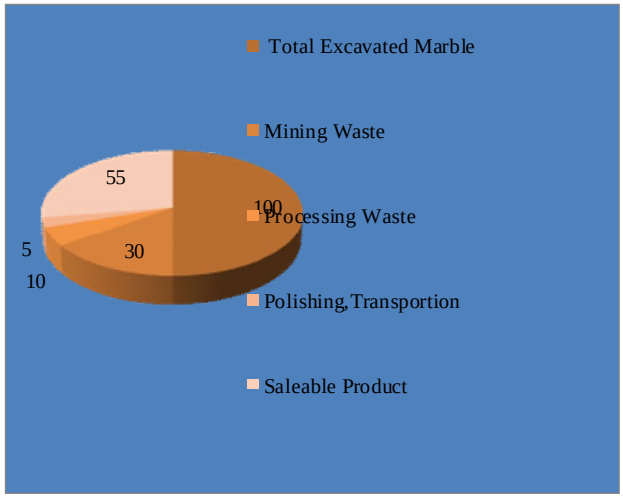
Environmental Hazards DueTo Marble Waste

1) Soil pollution
2) Conservation of natural resources
3) Loss to flora and fauna
4) Wet and Dry slippery roads
5) Water pollution
6) Air pollution
7) Visual impacts
8) 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
Mechanized mining and Processing)



Chemical Properties Of Makrana Marble , Cement , (With Natural Aggregates

S.No.	Component	Makrana marble%	Cement%	Natural aggregates%
1	LOI	34.8-43.2	0-5	5.08
2	SiO_2	0.33-1.20	17-25	53.7
3	CaO	50-60	60-67	4.83
4	MgO	0.8-1.8	0.1-4	2.01
5	Fe_2O_3	0.10-0.28	0.5-6	10.66
6	AL_2O_3	nil	3-8	Nil
7	Sulpher %	nil	1-3	nil

II. EXPERIMENTALS ,RESULTS.DISCUSSIONS

For Rearch and investigation cement samples were prepared by inter grinding of crushed clinker (CLK) and Gypsum 5% with 5% doses of Makrana Calcitic Marble Dust Powder and Cement / clinker 43 Grade OPC Cement Confirm to standard IS:8112-1989 BIS and OPC clinker obtained from Wonder cement plant NIMBAHERA Rajasthan INDIA. Compressive Strength of concrete is determine as per IS 516:1959 and splitting tensile strength as per IS: 5816-1970 . The concrete is design as per IS: 10262-1982

(25),IS:456-2000 (26) for normal concrete M20 Grade and W/C Ratio is 0.5 which is maximum for mild exposure condition. The amount of entrapped air in the wet concrete taken 2% and workability taken 0.8 (compaction factor)

CEMENT--43 Grade OPC Cement Confirm to standard IS:8112-1989 BIS Obtained from NIMBAHERA Raj India FINE AGGREGATE [F.A.]--

4.75 mm to 150 microns and conforming to the requirements of IS 383:1970 And obtained from BANAS River Raj. India Specific Gravity 2.70 and F.M 2.31

COARSE AGGREGATE--

20 mm to 4.75 mm and conforming to the requirements of IS 383:1970 and Maximum size aggregates used 20mm ,Specific Gravity 2.70 ,F.M 7.1

WATER--

It is very important factor because it actually participates in chemical reaction with cement and concrete BISLPUR DAM potable water is used for fusing concrete

TABLE - 1 Chemical Analysis Of Calcitic Mdp And Clinker

S No.	Components	Calcitic MDP Makrana	ClinkerFrom Plant
1	CaO	45.21	66.52
2	SiO_2	19.20	22.60
3	LOI	33.32	0.15
4	MgO	1.90	2.65
5	Fe_2O_3	0.65	2.30
6	AL_2O_3	2.00	3.30
7	SO_3	Nil	0.60
8	Na_2O	0.20	0.15
9	K_2O	0.20	0.35
10	Cl	Trace	----
11	$CaCO_3$	77.50	----

TABLE -2 Chemical Analysis Of Cement Samples [CLINKAR + MDP]

S No.	Cement Samples	Oxide Constituents %				
		LOI	Mg O	Cl	SO_3	IR
1	Clinker 95%+5% Gypsum	2.35	1.62	Trac e	2.25	1.50
2	Clinker 90%+5% Gypsum+5% Calcitic MDP	3.48	1.41	Trac e	2.21	1.80
3	IS:-8112-1989 (Limits)	5.0 Max .	6.0 Max	0.1 Max .	2.5 Max .	3.0 Max.

TABLE-3 Particle Size Distribution of Calcitic MDP

S No.	% Passing	
	Size In micron	Calcitic MDP Makrana
1	9.25	44.50
2	5.50	21.81
3	2.31	8.30
4	1.156	0.30
5	0.818	Nil

TABLE -4 Particle Size Distribution of Cement Samples

S No.	Size In micron	% Fraction Passed	
		Clinker 95%+5% Gypsum	Clinker 90%+5% Gypsum+5% Calcitic MDP
1	5.50	2.22	2.70
2	3.89	0.43	0.95
3	3.27	0.15	0.28

Table - 5 Sieve Analysis of fine Aggregates [f.a.]

S. No	Sieve Size	Weight Retained	Cumulative Weight Retained	Cumulative % Weight Retained	Cumulative % Passing
1	4.75mm	0	0	0	100
2	2.36mm	95	95	9.5	90.5
3	1.18mm	75	170	17	83
4	600µ	175	345	34.5	68
5	300µ	382	727	72.7	27.3
6	150µ	246	973	97.3	2.7
7	Pan	27	1000	----	0

Fineness Modulus of Fine Aggregates = 2.31

TABLE-6 Sieve Analysis of Coarse Aggregates

S.No	Sieve Size	Weight Retained	Cumulative Weight Retained	Cumulative % Weight Retained	Cumulative % Passing
1	40mm	0	0	0	100
2	20mm	553	553	13.83	86.17
3	10mm	3300	3853	96.33	3.67
4	4.75mm	147	4000	100	0
5	2.40mm	0	4000	100	0
6	1.18mm	0	4000	100	0
7	600µ	0	4000	100	0
8	300µ	0	4000	100	0
9	150µ	0	4000	100	0

Fineness Modulus of Coarse Aggregates = 7.101

TABLE - 7 Test Result of Calcitic Mdp On Cement

S No.	Properties	Clinker 95%+5% Gypsum	Clinker90%+5% Gypsum+5% Calcitic MDP	IS:-8112-1989
1	Soundness Le-Chat. In(mm) IS:-4031(3)-1988	0.5	0.5	10 Max.
2	Fineness m^2/Kg IS:-4031(2)-1999	340	319	225 Min.
3	Consistency % IS:-4031(4)-1998	30.3	28.8	-------
4	Setting Time in Minutes IS:-4031(5)-1988			
	IST	142	131	>30
	FST	227	197	<600
5	Compressive Strength In (N/ mm^2) IS:-4031 (6)-1993			
	7 Days	54.7	61.20	>33.0
	28 Days	62.3	67.45	>43.0

TABLE -8 Compressive Strength Of Concrete

S. No.	% of calcitic MDP	Stress In MPa 7 DAYS	Stress In MPa 28 DAYS
1	0%	16.31	21.40
2	5%	18.13	26.60
3	10%	20.65	29.32
4	15%	17.10	20.60
5	20%	15.10	17.48

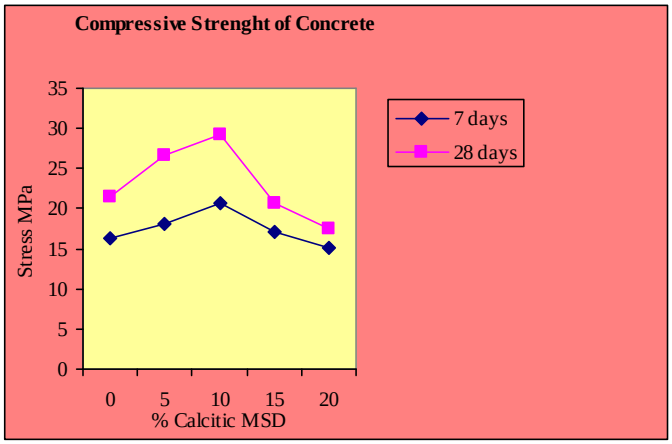
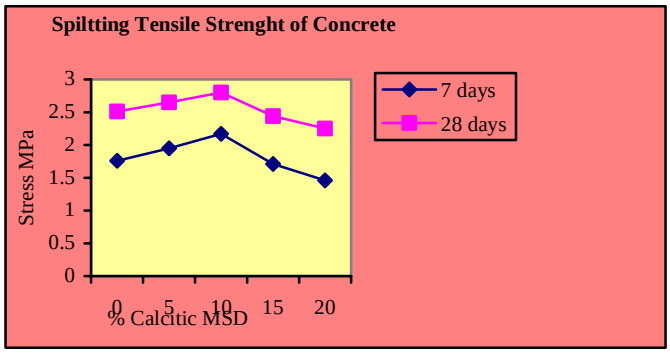
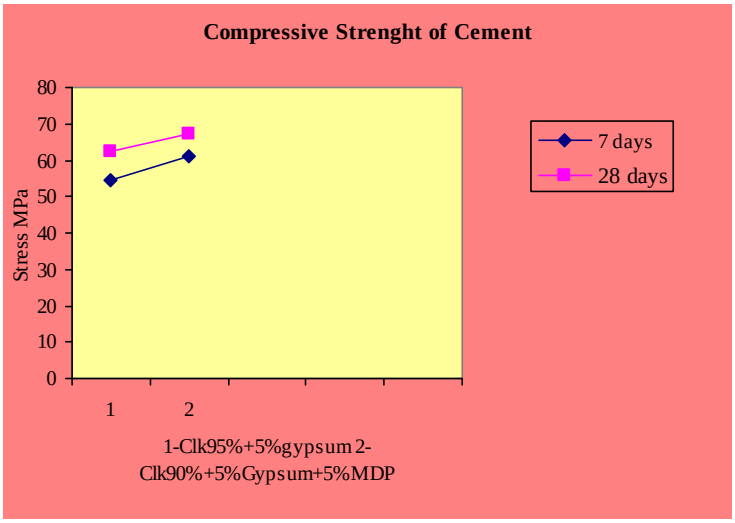


Table-9 Spiltting Tensile Strength Concrete

S. No.	% of calcitic MDP	Stress In MPa 7 DAYS	Stress In MPa 28 DAYS
1	0%	1.76	2.51
2	5%	1.95	2.65
3	10%	2.17	2.80
4	15%	1.71	2.44
5	20%	1.46	2.25





III. CONCLUSIONS

A. As compare to cement (clinker95%+5%gypsum) on addition of Calcitic MDP 5% to it, It increase compressive strength of cement 6.5 N/mm^2 and 5.15 N/mm^2 at 7 days and 28 days respectively.

B. The Calcitic MDP Makrana contains high amount of lime($CaCO_3$ =77.50) and less amount of silica($SiO_{2=}$ 19.2), So it increase the compressive strength of OPC cement in significant amount.

C. On addition of Calcitic MDP 5% (MgO 1.90 %) a slight tendancy toward quick intial setting time by 11 minutes and decrease final setting time by 30 minutes .

D. On addition of 5% Calcitic MDP in OPC cement in the Soundness and Consistency obtained are comparable to the control OPC cement but Calcitic MDP show finer nature compare to OPC cement

E. The Calcitic MDP Makrana can be used as Performance Improver (PI) in OPC Cement.

F. As compare to conventional concrete (M20),on addition of calcitic MDP 10% (optimum value) it increase tensile strength 0.41N/mm^2 and 0.29 N/mm^2 at 7 days and 28 days respectively of concrete . { As shown in graph}

G. As compare to conventional concrete (M20),on addition of calcitic MDP 10% (optimum value) it increase compressive strength 4.34 N/mm^2 and 7.92N/mm^2 at 7 days and 28 days respectively of concrete. {As shown in graph}

H. The Calcitic MDP Makrana can be used as Fine Aggregates in concrete.

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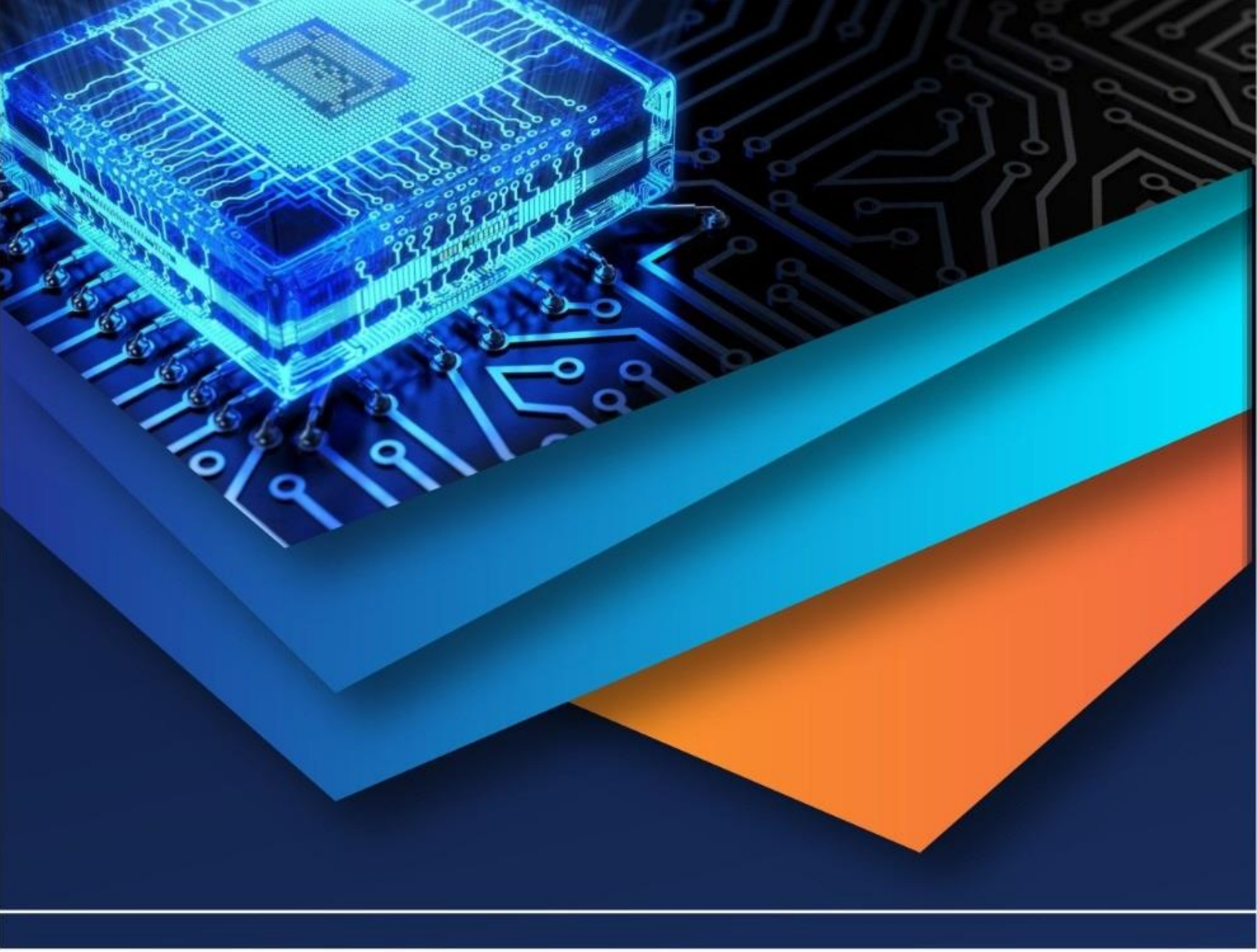

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