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Effect of Dolomitic Marble Dust Powder and Calcitic Marble Dust Powder On Cement Concrete Strength

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Abstract - *This research work assessed the effect of Dolomitic Marble Dust Powder Rajsamand, INDIA and calcitic marble dust powder (MDP) Makrana ,Rajasthan, INDIA on the compressive and tensile strength of concrete and utilization of Dolomitic and calcitic MDP as replacement of cement and achieving sustainable development.*

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.
In this research study the (OPC) cement has been replaced by Dolomitic and calcitic (MDP) accordingly in the reach in M20 cement concrete mix and tested and compared in term of compressive and splitting tensile strength of conventional concrete at 7 days and 28 days. Experimental investigations were carried out to examine the feasibility of use of Dolomitic and calcitic MDP as a substitute of cement in concrete and use in sustainable development.

***Key Words*: Marble Dolomitic, Calcitic ,Compressive Strength, Marble Dust Powder, concrete ,OPC Cement,,Sustainble Development**

1.INTRODUCTION

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 silky feel.

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% 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 MDP is Calcitic MDP which has $MgCO_3$ less than 5 %
Rajsamand MDP is Dolomitic MDP which has $MgCO_3 \geq 5\%$ But $\leq 20\ \%$

RAJSAMAND is situated at the southern parts of Rajasthan. 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 stretch of 40 KM^2 from Nathdwara to Kelwa and Amet

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. It content 98% $CaCO_3$ and only 2% impurities. It is calcitic marble so 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 and continuation of mining in the area.

1.1 Environmental Hazards Due To Marble Waste

1—Conservation of natural resources

2—Air pollution

3—Visual impacts

4—Water pollution

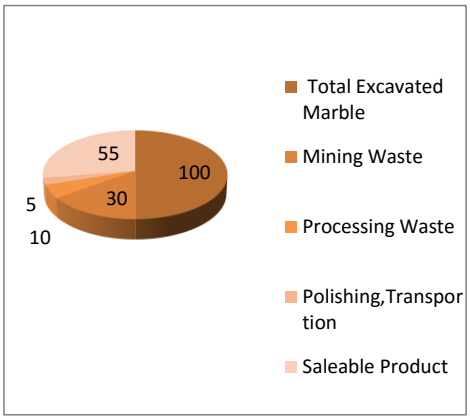
5—Accidents due to un-scientific dumping

6—Wet and Dry slippery roads

7—Loss to flora and fauna

8—Soil pollution

1.2 Marble Waste Generation
(With Mechanized mining and Processing)



1.3 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

1.4 CHEMICAL PROPERTIES OF MAKRANA AND RAJSAMAND MARBLE,CEMENT,NATURAL AGGREGATES

S. No.	Com-ponent	Makrana marble%	Rajsamand marble %	Cement%	Natural aggregates%
1	LOI	34.8-43.2	36-44	0-5	5.08
2	SiO_2	0.33-1.20	0.01-7.6	17-25	53.7
3	CaO	50-60	30-33	60-67	4.83
4	MgO	0.8-1.8	16-25	0.1-4	2.01
5	Fe_2O_3	0.10-0.28	0.12-0.95	0.5-6	10.66
6	AL_2O_3	Nil	Nil	3-8	Nil
7	Sulpher %	Nil	Nil	1-3	Nil

1.5 TECHNICAL INFORMATION OF MAKRANA AND RAJSAMAND MARBLE

Technical Information	Makrana	Rajsamand	Standards/ Guidelines
Water absorption %	0.04	0.06	C-97 ASTM/IS
Specific Gravity	2.68	2.84	C-97 ASTM/IS
Modulus of rupture, N/mm^2	14 Dry	17 Dry	C-99 ASTM/IS
	16 Wet	16 Wet	
Compressive Strength, N/mm^2	88 Dry	106 Dry	C-170 ASTM/IS
	81 Wet	102 Wet	
Abrasion resistance to wear ,mm	3.1 Min.	3.1 Min.	IS 1237
	3.2 Max.	3.2 Max.	
Flexural strength, N/mm^2	16	13	IS 4860

2. TESTING AND MIX DESIGN

CEMENT--43 Grade OPC Cement Confirm to standard IS:8112-1989 BIS

Compressive Strength MPa	28 days	Min-45
	7 days	Min-35
	3 days	Min-25
Setting Time (Minutes)	Initial	90-120
	Final	Max-200
Fineness (Blaine or cm^2/gm)		Min-2850
Soundness	Le-Chatelier expansion (mm)	Max-2.0
	Auto clave expansion (%)	Max-0.10
Specific Gravity		2.71

Source-(J.K Cement LTD. Unit Nimbahera Rajasthan India).

COARSE AGGREGATE

20 mm to 4.75 mm and conforming to the requirements of IS 383:1970

Maximum size aggregates used 20mm

Specific Gravity	2.71
F.M	6.91
Bulk density (natural condtion)	1705 Kg/m^3
Water absorption % by weight	2.1

WATER

It is important factor because it actually participates in chemical reaction with cement**. Bisalpur** potable water is used for fusing concrete.

Compressive Strength of concrete is determine as per IS 516:1959 Of 150mm cubic specimens at 7 days and 28 days at 27° temperature curing with water. The standard cylindrical specimen 150×300 mm were caste for splitting tensile strength and tested 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% .Degree of workability taken 0.8 (compaction factor)

Water content= 186Kg/m^3 and Sand content= 31.5%

(after adjustment for change in condition)

Cement=372Kg/m^3 Fine aggregates=550.3 Kg
Coarse aggregates=1219.1 Kg Ratio 0.5:1:1.48:3.27

For three specimens(Dolomitic + Calcitic) total quantity of material required

Water=10.88 litre ,Cement =21.76 Kg ,

Fine aggregates=32.22 Kg Coarse aggregates= 71.18 Kg

Dolomitic and Calcitic MDP % added to cement (0%,5%,10%,15%,20%)

COMPRESSIVE STRENGTH -7 DAYS

S. No.	Dolomitic Concrete		Calcitic Concrete	
	MDP	Stress N/mm^2	MDP	Stress N/mm^2
1	0%	14.22	0%	15.11
2	5%	15.55	5%	17.33
3	10%	16.88	10%	19.55
4	15%	18.22	15%	16.00
5	20%	16.00	20%	14.22

COMPRESSIVE STRENGTH -28 DAYS

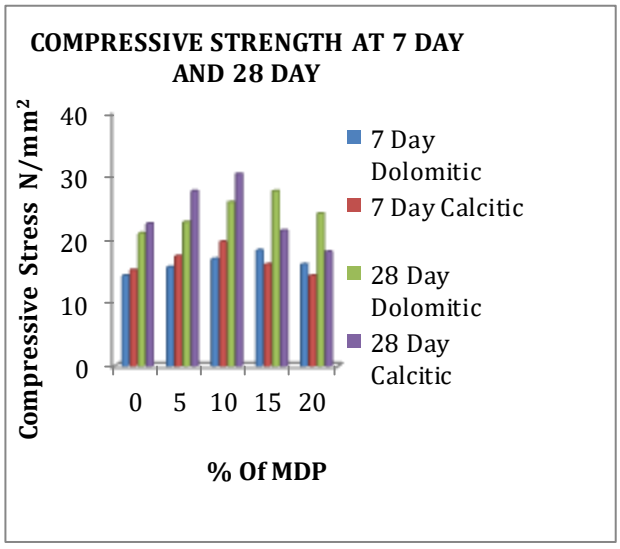
S. No.	Dolomitic Concrete		Calcitic Concrete	
	MDP	Stress N/mm^2	MDP	Stress N/mm^2
1	0%	20.88	0%	22.40
2	5%	22.66	5%	27.55
3	10%	25.77	10%	30.22
4	15%	27.55	15%	21.33
5	20%	24.00	20%	18.00

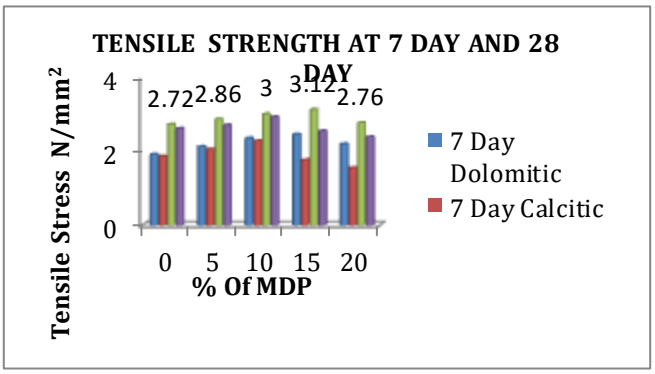
SPILTTING TENSILE STRENGTH -7 DAYS

S. No.	Dolomitic Concrete		Calcitic Concrete	
	MDP	Stress N/mm²	MDP	Stress N/mm²
1	0%	1.91	0%	1.86
2	5%	2.12	5%	2.05
3	10%	2.35	10%	2.27
4	15%	2.45	15%	1.76
5	20%	2.19	20%	1.55

SPILTTING TENSILE STRENGTH -28 DAYS

S. No.	Dolomitic Concrete		Calcitic Concrete	
	MDP	Stress N/mm²	MDP	Stress N/mm²
1	0%	2.72	0%	2.61
2	5%	2.86	5%	2.70
3	10%	3.00	10%	2.92
4	15%	3.12	15%	2.54
5	20%	2.76	20%	2.38





3. CONCLUSIONS

1- The Dolomitic MDP has high amount of $MgCO_3$ and MgO so it increase tensile strength very high comparison to compressive strength.

2- The calcitic MDP has high amount of lime (CaO) and less amount of silica (SiO_2) so it increase compressive strength very high comparison to tensile strength.

3– As compare to conventional concrete (M20),on addition of calcitic MDP 10% (optimum value) it increase compressive strength 4.44 N/mm² and 7.82 N/mm² at 7 days and 28 days respectively, and on addition of Dolomitic MDP 15% (optimum value) it increase compressive strength 4.00 N/mm² and 6.67 N/mm² at 7 days and 28 days respectively. (As shown in graph)

4 – As compare to conventional concrete (M20),on addition of calcitic MDP 10% (optimum value) it increase tensile strength 0.41 N/mm² and 0.31 N/mm² at 7 days and 28 days respectively , and on addition of Dolomitic MDP 15% (optimum value) it increase tensile strength 0.54 N/mm² and 0.41 N/mm² at 7 days and 28 days respectively . (As shown in graph)

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