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Effect of Calcitic Marble Dust Powder on Cement Concrete

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Abstract – *This research work assessed the effect of calcitic marble dust powder (MDP) Makrana ,Rajasthan, India on the compressive and spillting tensile strength of concrete and utilization of calcitic MDP as replacement of cement and achieving sustainable development.*

Marble industry produes 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In this research study the (OPC) cement has been replaced by calcitic MDP accordingly in the reach in M20 cement concrete mix and tested and compared in term of compressive and splitting tensile strength of conventional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 calcitic MDP as a substitute of cement in concrete and use in sustainable development.

Key Words: **Marble,Calcitic,Compressive Strenght, Marble Dust Powder,OPC Cement,Concrete,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.

Marble production of India is 90% of world production and approximately 85% quarried from Rajasthan state of India.

Rajasthan is the richest state in India with regards to marble deposits (1100 MT) both in quality and quantity. Around 4000 marbles mines and 1100 marble processing units, spread over 16 districts out of 33 districts of Rajasthan.

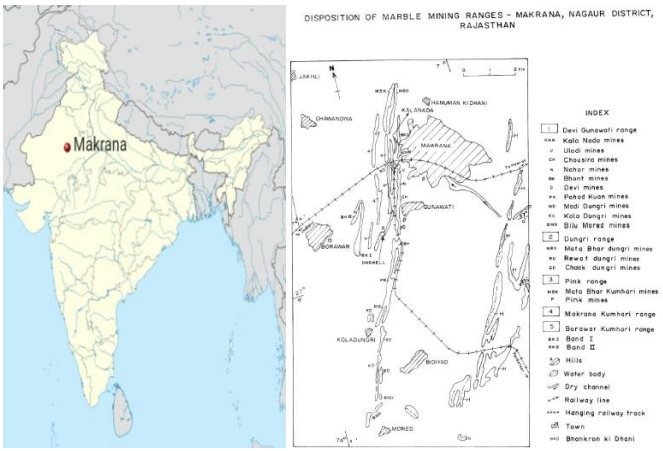
In India, Rajasthan state has more than 95%of marble processors units and its generated around 5-6 Million Metric Tons of slurry every year.There are 3600 marble quarries in Rajasthan from which 350 quarries are fully mechanized.

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.

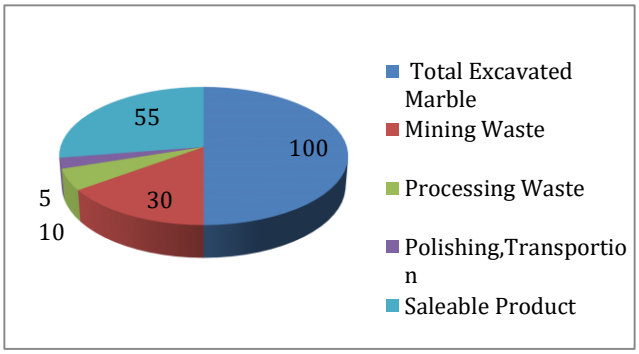
The total marble reserves in makrana are 55 Million Tons, and about 120 thousand tonnes of marble are produced annually from over 400 mines.

Long history of conventional and un-scientific mining poses severe threat to life, public property and continuation of mining in the area.



1.1 Marble Waste Generation

(With Mechanized mining and Processing)



1.2 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

1.3 Enviromental Hazards Due To Calcitic Marble Waste

1—Conservation of natural resoures

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

1.4 Chemical Properties Of Makrana Marble , Cement , 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

1.5 Technical Information Of Makrana Marble

Water absorption %	0.04	C-97 ASTM/IS
Specific Gravity	2.68	C-97 ASTM/IS
Modulus of rupture, N/mm^2	14 Dry	C-99 ASTM/IS
	16 Wet	
Compressive Strength, N/mm^2	88 Dry	C-170 ASTM/IS
	81 Wet	
Abrasion resistance to wear mm	3.1 Min.	IS 1237
	3.2 Max.	
Flexural strength, N/mm^2	16	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)

FINE AGGREGATE

4.75 mm to 150 microns and conforming to the requirements of IS 383:1970

Specific Gravity	2.66
F.M	3.25
Bulk density (natural condition)	1695 Kg/m^3
Water absorption % by weight	2.0

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 total quantity of material required

Water=5.44 litre ,Cement =10.88Kg ,
Fine aggregates=16.11 Kg Coarse aggregates= 35.59 Kg
Calcitic MDP as per % added to cement (0%,5%,10%,15%,20%)

COMPRESSIVE STRENGTH -7 DAYS

S. No.	% of calcitic MDP	Specimen 1,2,3 Average Load In KN	Stress In MPa
1	0%	340	15.11
2	5%	390	17.33
3	10%	440	19.55
4	15%	360	16.00
5	20%	320	14.22

COMPRESSIVE STRENGTH -28 DAYS

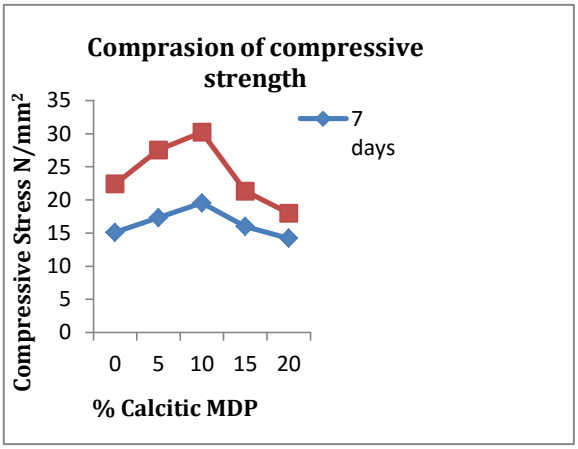
S. No.	% of calcitic MDP	Specimen 1,2,3 Average Load In KN	Stress In MPa
1	0%	505	22.40
2	5%	620	27.55
3	10%	680	30.22
4	15%	480	21.33
5	20%	405	18.00

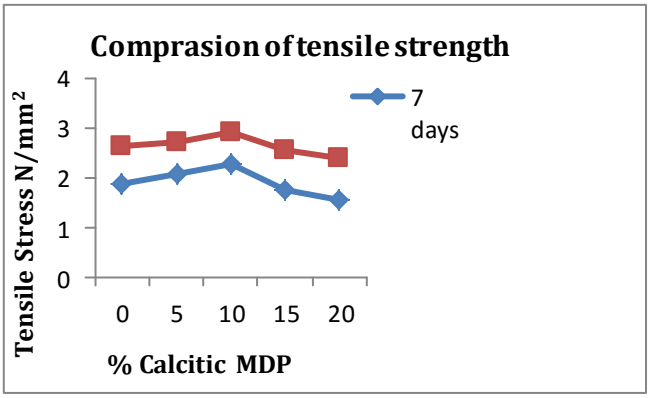
SPILTTING TENSILE STRENGTH -7 DAYS

S. No.	% of calcitic MDP	Specimen 1,2,3 Average Load In KN	Splitting tensile Stress In MPa
1	0%	132	1.86
2	5%	145	2.05
3	10%	161	2.27
4	15%	125	1.76
5	20%	110	1.55

SPILTTING TENSILE STRENGTH -28 DAYS

S. No.	% of calcitic MDP	Specimen 1,2,3 Average Load In KN	Splitting tensile Stress In MPa
1	0%	185	2.61
2	5%	191	2.70
3	10%	207	2.92
4	15%	180	2.54
5	20%	168	2.38





3. CONCLUSIONS

1- 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.

2 – 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. (As shown in graph)

3 – 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 . (As shown in graph)

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