"EXPERIMENTAL STUDY ON ENHANCEMENT OF CONCRETE USING MARBLE DUST AS PARTIAL REPLACEMENT OF CEMENT"

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ABSTRACT

According to global cement magazine, each ton of cement produced releases about the same quantity of Co_2. During the production of cement energy is consumed and consequently Co_2 is emitted to the atmosphere. There is a need to understand the nature of energy utilization in embodied energy in buildings and maintenance, since developing countries like India have limited energy resources vis-a-vis the large population. Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products. Green concrete concept of thinking environment into concrete considering every aspect from raw materials manufacture over mixture design ,construction, and service life. Green concrete is very often also cheap to produce ,because for example ,waste products are used as a partial substitute for cement ,charges for the disposal of waste are avoided energy consumption in production is lower ,and durability is greater.

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on the environment .

To overcome the above, first of all selecting the right material from natural resources and energy sources and lessen the burden of pollutants on the environment in our surrounding area to be thoroughly studied and collected.

For this study, we have taken the large amount of "marble dust" generated in natural stone processing plants which have an important impact on the environment and humans around our nearby districts . This study is to investigate the strength of concrete using the "marble dust" as partial replacement of cement.

The specimens are casted with marble dust as partial replacement of cement varying from 0% to 25%.The specimens are subjected to cube test , cylinder test, flexural test, pull out test and durability test . The strength and characteristics shall have been studied with the conventional concrete .

1. INTRODUCTION

CEMENT

Cement, or some form of cementing material is an essential ingredient in most forms of building construction. Cement is the vital binding agent in concretes, mortars and renders, and is used for the production of walling blocks and roofing tiles.

CONCRETE

TYPES & USE OF ALTERNATIVE CEMENT

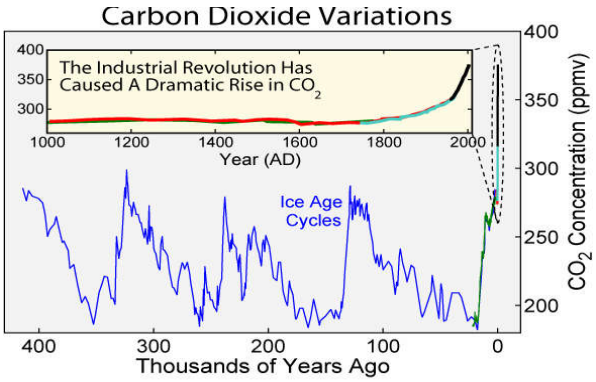
limestone, marble, chalk, shells, Volcanic- ash, Power station fly ash, Burnt clays Ash from some burnt plant materials, Silicious earths etc.,

USE

- CHEAPERTOPRODUCE,COSTLESS LESSTECHNOLOGYANDEQUIPMENT TRANSPORTATION COST LESS
- LOWPRODUCTIONCOST EVIRONMENTAL ADVANTAGETECHNICAL ADVANTAGE
- SOCIALADVANTAGE ECONOMIC ADVANTAGE

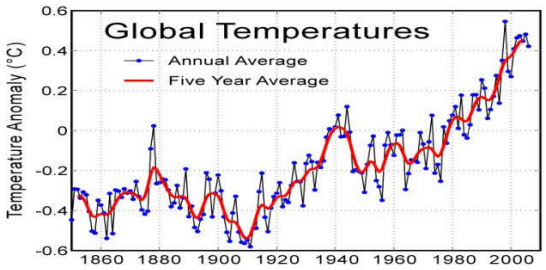
CO_2 EMISSIONS FROM CEMENT PRODUCTION

Cement is an important construction ingredient around the world, and as a result, cement production is a significant source of global carbon dioxide (CO2) emissions, making up approximately 2.4 percent of global CO2 emissions from industrial and energy sources.



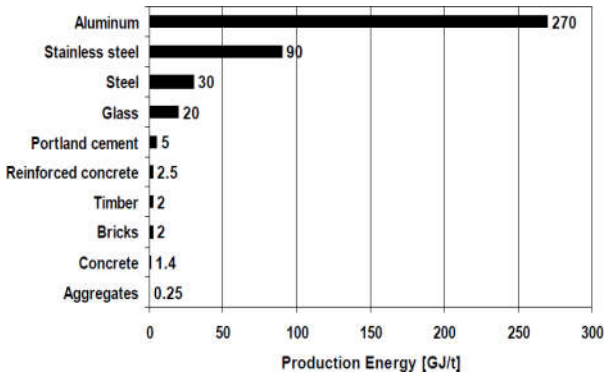
GLOBAL WARMING

Global warming is the increase in the average temperature of the Earth's atmosphere and oceans as a result of the build up of greenhouse gases in our atmosphere. Global warming is sometimes called climate change.



ENERGY SAVING TECHNOLOGIES IN THE BUILDING TECHNOLOGY

Energy-saving building technologies offer the best available opportunity to reduce GHG emissions with positive net present value and rapid payback. However, very little progress has been made in implementing them. This is a missed opportunity. There is no lack of energy-saving technologies with positive short term paybacks for both new and existing buildings.



GREEN CONCRETE

Green concrete has nothing to do with color. It is a concept of thinking environment into concrete considering every aspect from raw materials manufacture over mixture design to structural design, construction, and service life.

RECYCLING WASTE

Recycling waste as useful material is a very important environmental management tool for achieving sustainable development. On the other hand, recycling waste without properly based

scientific research and development can result in environmental problems greater than the waste itself. The successful research and development of a new building material or component using waste as raw material, is a very complex and multi disciplinary task having technical, environmental, financial, marketing, legal and social aspects

2. MARBLE

Marble is a metamorphic rock composed of re-crystallized carbonate minerals, most commonly calelcite or dolomite It is commonly used for Sculpture and as a building material. Geologists use the term "marble" to refer to metamorphosed limestone.

Marble dust is combined with cement or synthetic resins to make *reconstituted* or cultured marble. The appearance of marble can be simulated with faux_marbling , a painting technique that imitates the stone's color patterns. **Cultured marble**, now referred to in the industry as an "engineered composite", is a mix of high strength polyester resin and natural marble stone dust cast or formed in a variety of standard and custom molds to make bathtubs, whirlpool decks, shower pans and wet walls, windowsills, ADA compliant bathroom fixtures, and vanity tops with a surface that resembles marble. Though it is a less expensive alternative to real marble, it has 4 times the strength of natural stone.

MARBLE DUST

A marble dust, obtained as a by-product of marble sawing and shaping, was characterized from a physical and chemical point of view for evaluating the possibility of using it in mortar and concrete production.

PHYSICAL CHARACTERISTICS

Sample	Moisture content in % Dry	Bulk density kg/cum	Fineness modulus	Effective size in mm	Coefficient of uniformity	Coefficient of gradation
Avg. of three samples	1.59	1120	2.1	0.17	1.6	1.41

CHEMICAL CHARACTERISTICS OF MARBLE WASTE IN % WEIGHT.

Sample	Fe2O3	MnO	Na2O	MgO	K2O	Al2O3	CaO	SiO2
Avg. of three samples	11.99	0.08	2.08	8.75	2.34	4.45	1.58	64.86

Sample	Fe2O3	MnO	Na2O	MgO	K2O	Al2O3	CaO	SiO2
Average of three samples % Weight	11.99	0.08	2.08	8.75	2.34	4.45	1.58	64.86
Ordinary Portland Cement % Weight	0.55	0.85	0.85	2.15	0.85	5.5	63.5	21.5

ADVANTAGES OF USING MARBLE DUST.

- Alternate building materials and technologies.
- Global warming.
- Environment friendly.
- Cost effective.
- Energy saving building.
- Green concrete.

- Usage of wastage materials.
- Sustainable concrete.
- Recycling the industrial wastages etc..

M20 MIX DESIGN

Mix proportion

- Final mix ratio:
- 1: 1.55: 3.37
- w/c ratio = 0.50
- In weight water : cement : fine aggregate : coarse aggregate

191.6:368:571:1242

Water	Cement	Fine aggregate	Coarse aggregate
191.6	368 Kg	571 Kg	1242 Kg
0.52	1.0	1.55	3.37

M25 MIX DESIGN

Mix proportion

- Final mix ratio:
- 1: 0.1.42 : 3.1
- w/c ratio = 0.485
- In weight water : cement : fine aggregate : coarse aggregate

191.6:395:564:1225

Water	Cement	Fine aggregate	Coarse aggregate
191.6	395 Kg	564 Kg	1225 Kg
0.485	1.0	1.42	3.10

3. TEST&EXPERIMENTAL PROGRAM

EXPERIMENTAL PROGRAMME

Stone dust is naturally a potential by product of industries that incorporate raw materials with similar composition. Among those ,concrete industry presents the advantage of being capable to do so with available technology.

The studies are aimed at reusing the material accumulated in waste material. The reuse strategy presents the advantage of not involving further waste treatment as the samples were collected directly from industries. After collection the dust chosen for these experiments . It was expected that this dust was compatible with, or might even enhance, the characteristics of regular white cement concrete.

STRENGTH TESTS

To evaluate the performance of different mix used in this work, following strength test were performed.

Compressive strength

Split tensile strength

Flexural strength

Bond Strength

COMPRESSIVE STRENGTH

The compressive strength of concrete is one of the most important properties of concrete. Comparative strength if M20 and M25 grade concrete for the partial replacement of cement by crushed was found. In this test 150x150x150mm concrete cubes were cast, by using 20Mpa and 25Mpa concrete. The mixing was done by cubes were demoulded and placed under water and cured for 28days. Then the cubes were tested for their crushing strength at 3,7 and 28 days. As per IS:4031:1968, load was applied at the rate of 140kN/min.

SPLIT TENSILE STRENGTH

The test is carried out in a cylindrical specimen of 150mm diameter and 300mm length. The cylindrical specimen is placed horizontally between the loading surface of a compression testing machine and the load is applied until failure of cylinder, along the vertical diameter. The split tensile strength is given by the formula 2P / (pdl) and the stress value is in N/mm2.

Where p The ultimate load at which the cylinder fails. d, l – The diameter and length of the cylinder.

Compression test

Split tensile test

FLEXURAL STRENGTH

Concrete is relatively strong in compression and weak in tension. Direct measurement of tensile strength of concrete is difficult. Concrete beams of size 500x100x100mm are found to be dependable to measure flexural strength property of concrete. The systems of loading used in finding out flexural strength are central point loading and third point loading. The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying the load at the rate specified. Flexural strength is expressed as modulus of rupture which is given by M/Z

PULL OUT TEST

The test is used to determinate the bond strength between the steel rod and concrete. Initially the cube of size 150x150x150mm is cast with the main rod at the center and cured. After curing it is dried for a day to remove moisture from steel reinforcement. Now the specimen is ready for pull out test. Keep the specimen with Load at top and cube specimen at bottom and clamp the main road at top with anchor grip. Now the load is applied through the UTM. The maximum load at which the slip occurred is noted for calculation.

Pull out / Bond strength

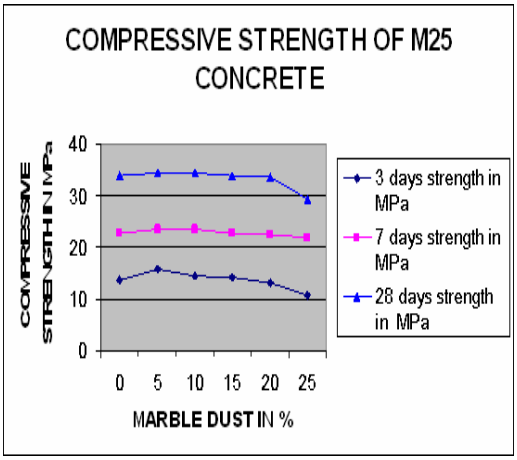
Flexural strength

4. RESULTS AND DISCUSSIONS

COMPRESSIVE STRENGTH TESTS FOR M_{20} CONCRETE

Marble dust in %	3 days strength in Mpa	7 days strength in MPa	28 days strength in MPa
0	11.00	18.51	27.72
5	12.09	22.28	28.15
10	12.65	22.17	27.93
15	11.56	21.49	28.05
20	11.09	19.46	27.42
25	10.54	19.16	24.42

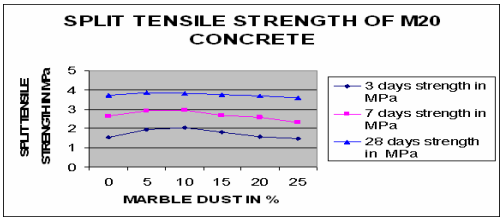
From graph, 3 rd day ,7th day and 28th day compressive strength is max for 16% marble dust replacement in cement for M25 concrete.



SPLIT TENSILE STRENGTH FOR M20 CONCRETE

Marble in %	3 days strength in Mpa	7 days strength in MPa	28 days strength in MPa
0	1.53	2.66	3.71
5	1.95	2.93	3.86
10	2.05	2.95	3.82
15	1.82	2.67	3.75
20	1.57	2.58	3.68
25	1.49	2.33	3.59

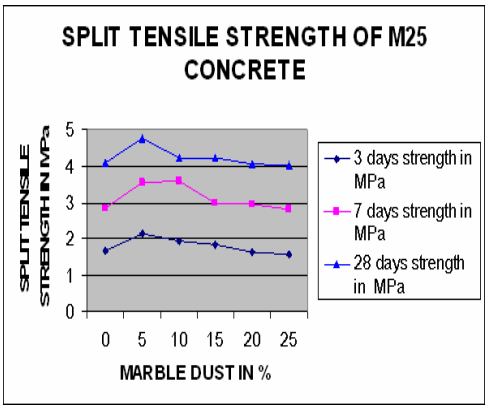
From graph, 28th day split tensile strength is max for 17% marble dust replacement in cement for M20 concrete.



SPLIT TENSILE STRENGTH FOR M_{25}CONCRETE

Marble in %	3 days strength in Mpa	7 days strength in MPa	28 days strength in MPa
0	1.67	2.86	4.11
5	2.14	3.55	4.75
10	1.95	3.59	4.23
15	1.83	2.97	4.23
20	1.66	2.94	4.06
25	1.59	2.83	4.04

From graph, 28th day split tensile strength is max for 15% marble dust replacement in cement for M25 concrete.

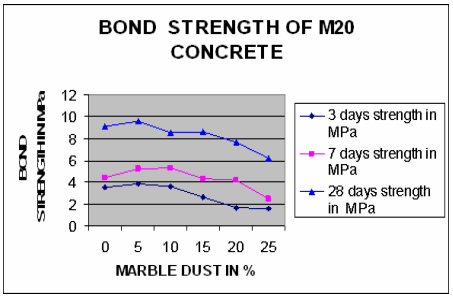


BOND STRENGTH FOR M_{20} CONCRETE

Marble in %	3 days strength in Mpa	7 days strength in MPa	28 days strength in MPa
0	3.53	4.43	9.12
5	3.85	5.25	9.55

10	3.63	5.31	8.53
15	2.65	4.35	8.65
20	1.66	4.22	7.87
25	1.59	2.52	6.17

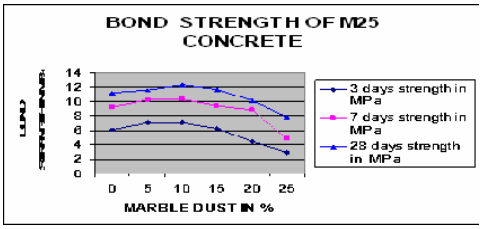
From graph, Bond strengths of concrete are optimum for 20% marble dust replacement in cement for M20 concrete



BOND STRENGTH FOR M_{25} CONCRETE

Marble in %	**3 days strength in Mpa**	**7 days strength in MPa**	**28 days strength in MPa**
0	**6.14**	**9.24**	**11.25**
5	**7.15**	**10.25**	**11.63**
10	**7.13**	**10.36**	**12.37**
15	**6.25**	**9.42**	**11.76**
20	**4.37**	**8.85**	**10.19**
25	**2.89**	**4.92**	**7.83**

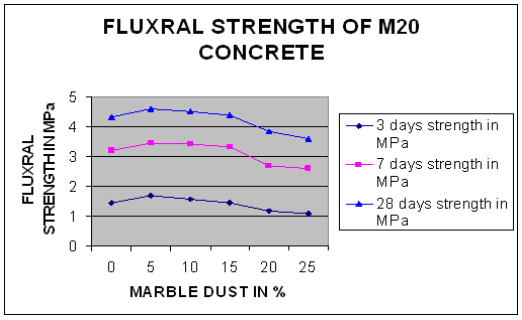
From graph, Bond strengths of concrete are optimum for 15% marble dust replacement in cement for M25 concrete.



FLEXURAL STRENGTH FOR M_{20} CONCRETE

Marble in %	**3 days strength in Mpa**	**7 days strength in MPa**	**28 days strength in MPa**
0	1.45	3.21	4.32
5	1.69	3.45	4.62
10	1.58	3.42	4.51
15	1.46	3.32	4.40
20	1.18	2.69	3.86
25	1.09	2.60	3.60

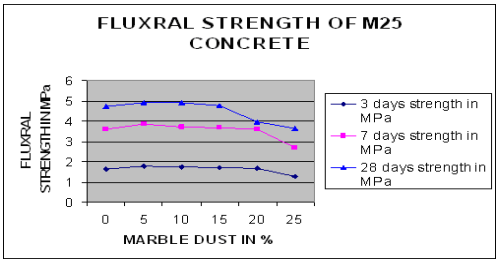
From graph, 28th day flexural strength is max for 17% marble dust replacement in cement for M20 concrete.



FLUXRAL STRENGTH FOR M_{25} CONCRETE

Marble in %	3 days strength in Mpa	7 days strength in MPa	28 days strength in MPa
0	1.67	2.86	4.11
5	2.14	3.55	4.75
10	1.95	3.59	4.23
15	1.83	2.97	4.23
20	1.66	2.94	4.06
25	1.59	2.83	4.04

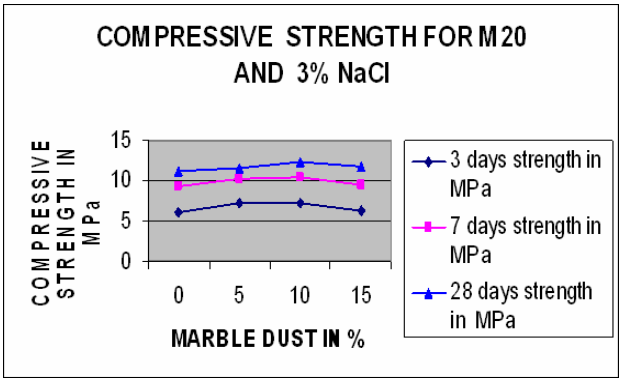
From graph, 28th day flexural strength is max for 14% marble dust replacement in cement for M25 concrete.



COMPRESSIVE STRENGTH FOR M_{20} & 3% NaCl

Marble in %	3 days strength in Mpa	7 days strength in MPa	28 days strength in MPa
0	11.00	18.51	27.72
5	11.09	19.28	27.95
10	11.65	19.17	27.93
15	10.36	18.49	27.05

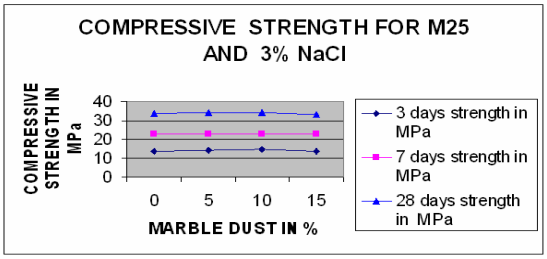
From graph, 3 rd day ,7th day and 28th day compressive strength is max for 11% marble dust replacement in cement for M25 concrete tested in different environment conditions using 3% NaCl solution.



COMPRESSIVE STRENGTH FOR M_{25} & 3% NaCl

Marble in %	3 days strength in Mpa	7 days strength in MPa	28 days strength in MPa
0	13.57	22.71	33.75
5	14.12	22.87	33.99
10	14.34	22.80	33.87
15	13.26	22.55	33.04

3 rd day ,7th day and 28th day compressive strength is max for 10% marble dust replacement in cement for M25 concrete tested in different environment conditions using 3% NaCl solution.



5. CONCLUSION

Finally, Marble dust can be used as a replacement material for cement and 10% replacement of marble dust gives an excellent result in strength and quality aspects.

The result showed that the substitution of 10% of the cement content by marble dust induced higher compressive strength, higher splitting tensile strength higher modulus of elasticity and improvement of properties related to durability .

In this project work, it is proved that in concrete made with marble dust as partial replacement of cement the required strength may be obtained. But the required workability is possible only at very low percentage marble dust.

Hence in order to improve the workability of concrete without affecting the strength, suitable plasticizers may be added and the experimental study may be made to check the workability and strength of different grades of concrete.

The workability may be improved also by adjusting the fineness of marble dust. The investigation may be done with marble dust with different fineness an partial replacement of cement for different grades of concrete.

6. REFERENCES AND ITS RESULTS

Valeria Corinaldesi, Giacomo Moriconi, and Tarun R.Naik Report No. CBU-2005-09 REP-580 August 2005.

Due to its high fineness of the marble powder, it proved to be very effective in assuring very good cohesiveness of mortar and concrete, even in the presence of super plasticizing admixture, provided that water to cement ratio was adequately low.

In terms of mechanical performance, 10% substitution of sand by the marble powder in the presence of a super plasticizing admixture provided maximum compressive strength at the same workability level.

Next step of this continuing experimental work is preparation of concretes, fluid and self-compacting, by using the marble powder.

G. Moriconi-Department of Materials and Environment

Engineering and Physics, Università Politecnica delle Marche,Ancona, Italy-2006

The fine fraction produced during the recycling process, that is the concrete-rubble powder, an excellent reuse was found, as filler in self-compacting concrete. The attempt to improve the quality of the recycled aggregates for new concretes by reusing in different ways the most detrimental fractions, i.e., the material coming from masonry rubble and the finest recycled materials, allowed to achieve surprising and unexpected performances for mortars and self compacting concretes. Other industrial wastes, such as GRP waste powder, can prove useful to be re-used in cementious products, by improving some durability aspects..

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- E-Mail: shahul68@rediffmail.com -JUNE 2009

Swaminathan Dhana pandian and Balasubramani Gnanavel and Thirunavukkarasu Ramkumar, Dept. of physics, Annamalai university,Anna malai nagar ,-608002, Dept. of earth science Annamalai university,Anna malai nagar,TN **+2009**

All the experimental data shows that the addition of the industrial wastes improves the physical and mechanical properties. These results are of great importance because this kind of innovative concrete requires large amounts of fine particles. Due to its high fineness of the marble sludge powder it provided to be very effective in assuring very good cohesiveness of concrete. From the above study, it is concluded that the quarry rock dust and marble sludge powder may be used as a replacement material for fine aggregate and cement.

Dr. Karthik Obla, P.E., The Indian Concrete Journal **APRIL 2009**

CO2 emissions from 1 ton of concrete produced vary between 0.05 to 0.13 tons. 95% of all CO2 emissions from a cubic yard of concrete is from cement manufacturing.. Doing so limits the total global CO2 reduction possible to at best 2%. Keeping a holistic cradle to cradle perspective and using LCA can help reduce CO2 by a much greater amount since there is evidence to show that most of the energy is consumed during the operational phase of the structure (heating and cooling). Concrete is very effective in reducing energy consumption due to its high solar reflectivity, and high thermal mass among other benefits. Focusing solely on CO2 emissions from cement and concrete production increases the perception that concrete is not sustainable which is inaccurate since operationally concrete has substantial sustainability benefits. An incorrect perception can lead to a less sustainable material choice.

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a Sharif University of Technology, Civil Engineering Department, Azadi Ave. Tehran, Iran. -2010

Marble Powder Dust (MPD), Paper Factory Sludge (PFK), Ferro-Silica Powder (FSP), Heated brick kiln wastes (LHB), Heated Kaolin of tile factory (MK), Cast iron mills slag (SIS) and Weld Factory Slag (WFS) show excellent pozolanic properties and can be used as cement replacement materials in concrete.

G. Marras1, N. Careddu1, C. Internicola1, G. Siotto1

1Department of Geoengineering and Environmental Technologies-2010

The sludge produced in the Orosei district is a nearly pure carbonate having a micrometer size. For this reason the waste can be considered as a product with high added value that can be applied in various industrial fields. In the specific case of this research the use of MD along with the other traditional constituents has resulted in improvement of quality of bricks. The result is very encouraging for mixing MD in the brick manufacturing; in fact it can partially replace clay, pursuing the aim of lessening waste generation and disposal and also of producing revenue for enterprises. Nevertheless the study is ongoing and needs to be supplemented with mechanical studies.

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Due to the high fineness of marble dust ,it proved to be very effective in assuring very good cohesiveness of mortar and concrete. The marble dust Can be used as a replacement material for cement and ten percentage of the cement content by marble dust gives an excellent result in strength aspect and quality aspect and it is better than controlled concrete. The substitution of ten percentage of the cement content by marble dust induced higher compressive , split tensile , elasticity modulus and durability.M20 and M30 concrete tested 5 t0 10 percent replacement of cement with marble dust in mild condition and severe conditions are suited for concrete preparation.