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Marble Waste: Opportunities For Development of Low Cost Concrete

Nutan Patel	Student of final year M.E. in Construction Engineering & Management, B.V.M. Engineering College, Vallabh Vidyanagar-Gujarat-India
Amit Raval	Student of final year M.E. in Construction Engineering & Management, B.V.M. Engineering College, Vallabh Vidyanagar-Gujarat-India
Jayeshkumar Pitroda	Assistant Professor and Research Scholar, Civil Engineering Department, B.V.M. Engineering College, Vallabh Vidyanagar-Gujarat-India

ABSTRACT

Waste management is a fundamental component to any manufacturing or production enterprise. It is estimated that there are million tons of quarrying waste are produced in each year. Although a portion of this waste may be utilized on-site such as for excavation pit refill. Waste generated at quarries and fabrication plants is quite similar. Most commonly, scrap stone must be mitigated and managed, but attention must be paid to other types of wastes, as well. These include marble sludge/slurry. Marble sawing powder wastes is widespread by-product of industrial process in India. Generally these wastes pollute and damage the environment due to sawing and polishing processes. This waste is used for making a marble waste concrete. The main aim of this waste management is to evaluate recovery and use marble waste in making a low cost concrete.

KEYWORDS: marble, marble waste, waste management, marble slurry, low cost concrete

INTRODUCTION

Marble waste use as a 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. Marble waste from quarry operations can be unsafe and environmentally detrimental. Now-a-days the cost of material is increasing so if we use the waste material in the production of the concrete so we decrease the price. In India, million tons of wastes from marble industries are being released from marble cutting, polishing, processing and grinding. Exposing the waste material to the environment directly can cause environmental problems. Therefore, many countries have still been working on how to re-use the waste materials.

PHYSICAL PROPERTIES OF MARBLE SLURRY

TABLE 1
PHYSICAL PROPERTIES OF MARBLE SLURRY

Property	Result
Bulk Density (gm/cc)	1.3-1.5
Specific Gravity	2.83-2.87

TABLE 2
PARTICLE SIZE DISTRIBUTION OF MARBLE SLURRY

Particle size (mm)	% Finer by volume
363.1	100
193.0-205.8	90

Source: Research Paper on use of "Incorporation of Marble Sludge in Industrial Building Eco-blocks or Cement Bricks Formulation" by Fakher J. Aukour

CHEMICAL ANALYSIS OF MARBLE SLURRY

TABLE 3
CHEMICAL ANALYSIS OF MARBLE SLURRY

Test carried out	Test value %
Loss on ignition	43.46
Silica	1.69
Alumina	1.04
Iron Oxide	0.21
Lime	49.07
Magnesia	4.47

Source: Research Paper on use of "Incorporation of Marble Sludge in Industrial Building Eco-blocks or Cement Bricks Formulation" by Fakher J. Aukour.

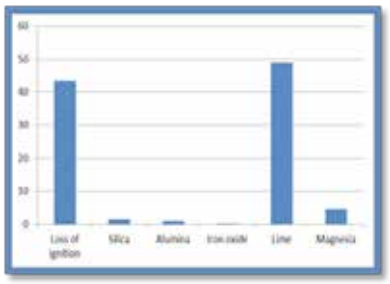


Fig 1:- Chemical analysis of marble slurry

MARBLE WASTE UTILIZATION

TABLE 4
MARBLE WASTE UTILIZATION

Sr. No	Utilization Area	Utilization %
1	Structural fill ,Soil stabilization, and road embankment work	10-15
2	Cement	10-12
3	Aggregates	2-5
4	Bricks , Blocks, Tiles	11-13
5	Paint ,Binder ,Plaster	2-5
6	Concrete roofing sheets	5-10
7	Ceramic Products	10-12
8	Particle Board, Panels	10-12

Source: Paper on "A Study of utilization aspect of stone waste in Indian context" By Mamta B. Rajgor, Prof. Jayeshkumar Pitroda



Fig 2:- Marble waste utilization

(1) Structural fill, soil stabilization, and road embankments
As marble dust is an inert material it can be mixed with certain types of soils for the preparation / raising of embankments etc. which will result in the saving of valuable soil. Unconfined Compressive Strength (UCS) have been performed to determine the strength of the mixes with soils and it has been observed that,

- In silty soil, there is 12 percent increase in UCS with 10% marble dust
- There is a 20% increase in UCS with 30% marble dust
- There is no improvement in clayey soil

(2) Cement
Limestone is the main raw material along with clay and other corrective materials for the manufacture of Portland cement. Analysis of marble waste shows that it satisfies the chemical composition requirements of cement grade limestone to a great extent. As a part replacement of limestone, marble waste can be used. By utilization of the marble waste save the limestone.

(3) Concrete
In concrete mixes there is increase in compressive strength of the concrete and save the material like cement and sand which is replace by the marble waste. There is an improvement in the density of the concrete as well. By using the marble waste in concrete save the material and make low cost concrete.

(4) Bricks
In brick manufacturing works lime as a bonding material. Marble slurry is chemically dolomitic in nature and consists of very fine particles. Considering the phusico-chemical properties, it may be used as a fine aggregate in manufacturing bricks by replace the lime as a binder.

(5) Manufacture of Ceramic Tiles
A possibility of utilizing marble slurry as a raw material for production of Ceramic Wall tiles needs to be evaluated on a pilot plant level. A leading ceramic producer in the country has undertaken laboratory scale studies on this matter, which were reported to be highly successful.

(6) Manufacture of Thermoset Resin Composites
The Macromolecular Research Centre at Jabalpur has conducted a short term programme with a view to explore the possibility of converting marble slurry into Resin Composites. The preliminary results have demonstrated the technical feasibility of such an option. However, a pilot plant level study needs to be conducted.

(7) Manufacture of lime
Limestone is the main raw material for the production of Lime. Limestone can be replaced by marble waste.

(8) Manufacture of Activated Calcium Carbonate
Limestone or combination of marble waste and marble dust (from slurry) can be used on the production of activated or precipitated calcium carbonate.

(9) Hollow Blocks and Wall Tiles
Marble slurry waste and other clay products can be used in the production of Hollow prefabricated blocks for buildings if used in the right proportion.

ADVANTAGE OF MARBLE WASTE
- Marble slurry is used for replacement of other material and saves the material.
- Marble slurry used in concrete so Increase the strength in concrete.
- Marble slurry we get in nominal or free of cost.
- Marble scrape is used to make attractive flooring in minimum cost.
- Use of the marble waste decrease the cost of construction because replace the material by marble waste.
- In Fly ash brick if lime is replace by marble waste so increase the strength of brick.
- Binding property of marble slurry is very good.

DISADVANTAGE OF MARBLE WASTE
- Marble slurry increases the soil alkalinity.
- Marble slurry affects the plants.
- Marble powder affects the human body.
- Marble slurry or powder affect the soil fertility and reduce them.
- The waste is dumped on land the dust is airborne by the wind and makes air pollution in environment.
- Marble slurry increases the accident of the slip.

CASE STUDY
"Influence of Marble powder/granules in Concrete mix" by Baboo Rai, Khan Naushad H, Abhishek Kr, Tabin Rushad S, Duggal S.K Motilal Nehru National Institute of Technology, Allahabad

Marble as a building material especially in palaces and monuments has been in use for ages. However the use is limited as stone bricks in wall or arches or as lining slabs in walls, roofs or floors, leaving its wastage at quarry or at the sizing industry generally unattended for use in the building industry itself as filler or plasticizer in concrete. The result is that the mass which is 40% of total marble quarried has reached as high as millions of tons. This huge unattended mass of marble waste consisting of very fine particles is today one of the environmental problems around the world. One of the logical means for reduction of the waste marble masses calls for utilizing them in building industry itself. Some attempts have been made to find and assess the possibilities of using waste marble powder in concretes and results about strength and workability were compared with control samples of conventional concrete. Compared to normal plain concrete of the same w/c ratio and the same cement, the concrete having high limestone filler content of suitable particle size distribution generally improves the strength characteristics.

METHODOLOGY
Based on the Indian Standard (IS: 10262-1982), design mix for M30 grade of concrete was prepared by partially replacing fine aggregate with five different percentages by weight of marble powder (0%, 5%, 10%, 15%, and 20%). The mix proportion for M30 Grades of concrete with varying percentage of marble powder is presented in Table 5.

TABLE 5
CONCRETE MIX PROPORTION

Mix	Material by Weight				
	M %	C(kg)	S (kg)	W. M.(kg)	C. A. (kg)
M30	0	423	527.0	0.0	1272
	5	423	500.6	26.3	1272
	10	423	474.3	52.7	1272
	15	423	447.9	79.0	1272
	20	423	421.6	105.4	1272

M= Marble , C=Cement, S=Sand, W.M.=Waste Marble, C.A.= Coarse Aggregate

Source: Baboo Rai, Khan Naushad H, Abhishek Kr, Tabin Rushad S, Duggal S.K Motilal ,"Influence of Marble powder/granules in Concrete mix", Nehru National Institute of Technology, Allahabad

TABLE 6
MATERIAL'S RATE PER KG

Material	Rate per kg in rupees
Cement	6.4
Sand	0.55
Coarse aggregate	0.60
Marble waste	0.20

Source: Baboo Rai, Khan Naushad H, Abhishek Kr, Tabin Rushad S, Duggal S.K Motilal ,"Influence of Marble powder/granules in Concrete mix", Nehru National Institute of Technology, Allahabad

TABLE 7
DIFFERENT MIX PROPORTION PRICE

Marble %	Cement	Sand	Marble waste	Coarse aggregate	Total rate
0	2707.2	289.85	0	763.2	3760.25
5	2707.2	275.33	5.27	763.2	3751
10	2707.2	260.86	10.54	763.2	3741.8
15	2707.2	246.35	15.81	763.2	3732.56
20	2707.2	231.88	21.08	763.2	3723.36

Source: Baboo Rai, Khan Naushad H, Abhishek Kr, Tabin Rushad S, Duggal S.K Motilal ,"Influence of Marble powder/granules in Concrete mix", Nehru National Institute of Technology, Allahabad

COMPRESSIVE STRENGTH

By increasing the waste marble powder the compressive strength values of concrete tends to increase at each curing age. This trend can be attributed to the fact that marble powder possesses cementing properties. It is also as much effective in enhancing cohesiveness due to lower fineness modulus of the marble powder. Furthermore, the mean strength of concrete mixes with marble powder was 5-10% higher than the reference concretes. However, there is a slight decrease in compressive strength value concrete mix when 20% marble powder is used as compared with that of 15% marble powder mix.

TABLE 8
COMPRESSIVE STRENGTH OF CONCRETE WITH VARYING PERCENTAGE OF MARBLE WASTE

	Compressive strength		
% Marble	7 day	14 day	28 day
0	31	33	38
5	31.5	34	39
10	33	34.5	40
15	33	35	40.5
20	33.5	35.5	39

CONCLUSION

The mean strength of all concrete mixes with marble powder was 5-10% higher than the references concrete conforming to IS: 456 2000. Compressive strength of the concrete has increased with increasing percentages of marble dust additions. The rate of the 0% marble waste 28 days strength is 38 N/mm2 at this strength of concrete rate is Rs. 3760.25. After adding the marble dust increases the strength. The highest compressive strength has been demonstrated by 15% marble dust is 40.5 N/mm2 at this strength of concrete rate is Rs. 3732.56. By using the marble dust the rate of the concrete is decrease and strength is increase.

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