Marble Slurry in Concrete: A review

Sourabh Soni[1]*, Er. R.S. Shekhawat[2]

[1]*M.Tech.student, Civil Engineering Department, College of Technology and Engineering, MPUAT, Udaipur*
[2]*Assistant Professor, Civil Engineering Department, College of Technology and Engineering, MPUAT, Udaipur*
*Correspondence Author**

Abstract: **Marble slurry is a waste material produced during the quarrying, cutting, and finishing of marble stone. The higher quantity of waste is non-biodegradable has engendered during the mining and processing operation of dimensional stone such as marble. Throughout the long term, it has become an ecumenical disturbance by harming the climate by meaning multiple. In this way, it is needed to discover the strategy for securely arrange or reuse marble squander.**

Henceforth during the last years, Various pieces of literature have been published and show huge potential. Marble slurry has been utilized in concrete with a point of substitution of concrete. A comprehensive overview of the published literature on the sustainable use of marble dust in concrete is being presented. The impact of the replacement of conventional cement by marble slurry has been studied on the properties of concrete such as in terms of Fresh, Hardened, and Durability properties of concrete.

Keywords: **Durability; cement; concrete; marble slurry; Strength**

I. INTRODUCTION

Concrete is the most general material used for construction in the whole world. The major constituents are Cement, Fine aggregate(Sand), Coarse aggregate, and water for the production of concrete. Cement acts as a binder during the whole process of concrete production but it requires a huge quantity of energy for the production. The cement production industries are major contributors to increase the carbon footprint and greenhouse emission.

According to Luhar et al.(2016), marble waste generated more than 3.95 billion tons per year and 7% of the total greenhouse gas emission on the earth.

According to Singh et al.(2019)if the situation will still going on then the annual production of cement is 4.3 billion tons, and we can expect that this number may increase to 6.2 billion tons by the year 2050.

For the production of 1 Ton cement around 0.94 Ton of CO2 is released by Sahan et al.(2016).The production of cement and the carbon emission could

be minimized by using alternatives of cementitious material which reduces the amount of energy required to produce cement, cost, and time with a reduction in environmental hazards by Rana et al.(2015).

Fig.1 Dumping of marble slurry in open area. (Udaipurblog.com)

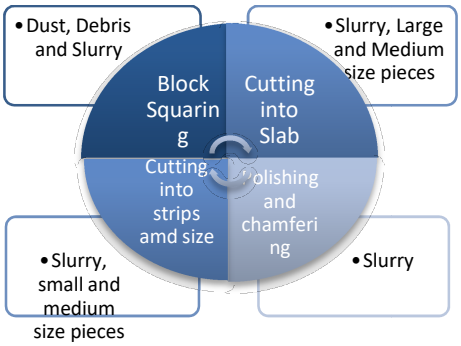
The marble slurry waste can't be removed. The dumping yards are very limited on the ground. The dumped marble waste gives a very bad look. The fertile topsoil getting degraded, vegetation cover like trees and bushed are died out and new plant and grass do not grow due to the thick deposition of marble slurry. Animals are also suffering for their resources and shelter. It equally contributes to contamination of the rivers and nearby other water bodies that directly affecting land irrigation and drinking water resources. It contaminates the air, Due to the increase in the quantity of waste the industries are dumping their mine waste and marble slurry on the roadside that is polluting air due to dust and creating less visibility, due to less visibility number of accidents occurs. During the rainy season, marble slurry getting wet and it flows over the road. Due to this road gets slippery and it may occur life-destroying accidents happen. The Indian cement industries are looking for the usage of alternate materials for concrete production and many studies have been conducted by partially replacing cement with industrial wastes such as blast furnace slag, fly ash, silica fume, stone waste, pond ash, etc. The use of waste materials in place of traditional materials results in considerable energy savings by reducing the number of manufacturing processes required for the manufacturing of the cement Ismail et al. (2013). This will reduce the number of industrial processes, improving the cost and time effectiveness, and reducing environmental pollution Ismailet al.(2013).

As per the MSME development institute report around 4600+ marble mines and 1150+ processing units are operational in the Rajasthan state of India, which contributes a huge amount of waste that is come out during quarrying and dressing of

marble stone(MSME Development Institute 2009).

Approximately 55% of waste is generated during mining operations and around 17% during the processing of marble (MSME Development Institute 2009).

1. Generation of marble waste



For the most part, there are two kinds of waste named quarry/cutting/sawing from the in-situ stone sites and cleaning waste from building areas. During the treatment of a stone, the unrefined stone square is cut as mentioned either into tiles or segments of various thicknesses (typically 2 or 4 cm), using gem sharp edges. Water is showered on front lines while stone squares are cut into sheets of moving thickness, to cool the sharp edges and acclimatize the buildup conveyed during the cutting undertaking. The measure of wastewater from this undertaking is enormous. It isn't reused as the water is so outstandingly solvent that, if re-used, it can reduce the pieces to be cleaned. In immense assembling plants, where the squares are cut into lumps, the cooling water is taken care of in pits until the suspended particles settle (sedimentation tanks), by then the slurry is accumulated in trucks and masterminded off on the ground and left to dry. This water passes on a ton of Marble powder. The cleaning action is robotized with the usage of powdered abrasives that keep scouring the outside of the stone until the point that it ends up smooth and shining.

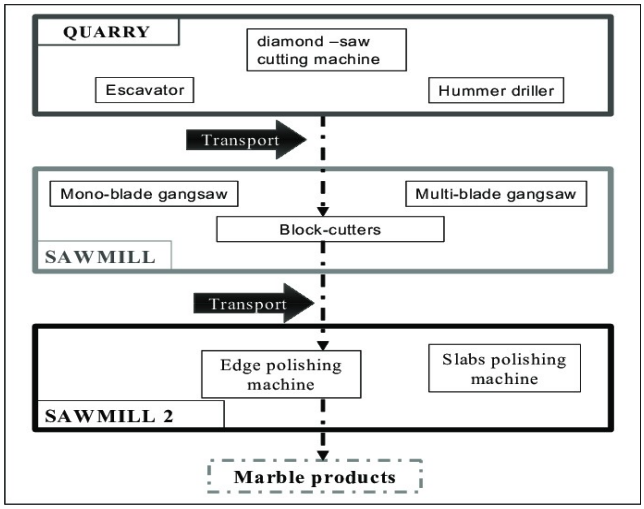


Fig. 2 Flow Chart of Marble production.

II. PROBLEMS CAUSED BY MARBLE WASTE

(a) Conservation of Natural Resources: The precious national wealth is being squandered mostly due to a lack of management and technology. If this waste is used, it has the potential to change the entire scenario of the industry.

(b) Air pollution: This is the most dangerous consequence of the marble industry. Slurry is generated in almost every operation and is a major issue. When it dries out, it causes air pollution and other problems.

(c) Water pollution: The marble industry, like any other, requires water in its various operations for cutting, cooling, and flushing. Water is polluted by marble slurry during these activities.

*(d) Visual impacts:*Abandoned mines, dumping sites, slurry waste sites, and the deposition of dried slurry over almost every structure in the surrounding area give the area a very ugly, filthy appearance and aesthetic problem.

(e) Accidents due to unscientific dumping: The dumping of mine waste and marble slurry on the roadside creates dust in the air (polluting the air) and reduces visibility, resulting in a higher number of crashes.

(f) Accidents due to slippery roads: During the winter season, marble slurry washes over highways. The road becomes slick as a result of the marble slurry, and several accidents occur.

(g) Loss to flora & fauna:Due to the deposition of marble slurry and dried slurry over plants and vegetation, existing trees and bushes die and new ones do not grow. It also raises soil alkalinity and has an effect on plants.

III. LITERATURE REVIEW

Aliabdo et al. (2014) has shown that The initial setting time and the final setting time of cement pastes are not influenced by the use of marble dust. Expansion measurements of cement paste show that the expansion value is not considerably affected. The compressive strength of concrete made with 15.0% marble dust as cement is either comparable or less than the control mix. Use of marble Dust up to 15.5% as a replacement for cement or as a replacement for sand has an insignificant effect on the ultrasonic pulse velocity test values. The maximum improvement in steel-concrete bond strength is recorded with 10.0%, compared with using it as areplacement for cement without marble dust. The use of Marble dust as sand replacement is more effective with a lower w/c ratio and a significant improvement in concrete tensile strength as well as a significant increase in concrete Tensile strength.

Mashaly et al. (2015) has reported that mix with the replacement ratio of 20% marble dust gave higher resistance in the condition of freezing and thawing, improving bulk density, gave good resistance to water penetration, and it reduced abrasive wear. These properties have been improved in the replacement range of 11– 26% as compared to control mixes.

Singh et al. (2017) have set up a relation between rebound hammer test values and compressive strength of mixesmade with marble dust.Environmental impact comparison of normal concrete with marble powder incorporated concretes shows positive signs of reduced impact of concrete because of large savings in the environmental impact of cement reduction and sand extraction.The carbon footprint of one ton of structural concrete is reduced to 350 kg/m3 (with 15% marble powder replacement of cement) as compared to 410 kg/m3 for conventional concrete.The use of marble powder in concrete in the range of 10-15% increases the compressive strength and split tensile strength of concrete in the range of 15-20%.

Ashish et al. (2016) hasassessed that whether marble dust is best appropriate for the substitution of concreted in the way of cement and sand and found that marbledust is better suited for the replacement of sand only. In microstructure investigation, control concrete and blended concrete specimens do not show any significant result which confirms that marble powder has no evident role in the hydration process. The durability parameters of marble powder showed improvement which makes it suitable as an additive in concrete.The optimal results of the study were investigated with 10% sand and 10% cement replaced by 20% marble powder.The workability of concrete was reduced due to the large surface area of waste marble powder.Waste disposal is also a financial hassle relieved with the use of marble powder which leads to better economic performance.Moreover, the reduction of cement decreases overheads as cement is an expensive component, and replacement of cement, as well as sand, can lead to the development of economical as well as sustainable concrete.

*Bostanci et al. (2020)*found that the fresh performance of laboratory mixes did not have any adverse effect on sustainability. Besides, marble dust addition reduced the compressive strength dramatically (93%) at 1 d. Strength losses were compensated at longer curing periods and reported as 7% and 15% for MD-5% and MD-10% mixes at 28 day.

Singh et al. (2019) has assessed that the mechanical and durability properties of the concrete made up with marble slurry by relacing cement to the preparation of concrete and test it on 360 days and founded that the 15% replacement ratio gives approximately equal results as a concrete sample.

Corinaldesi et al. (2010) has reported that substitution of 10% sand by marble powder provides maximum compressive strength at about the same workability and does not affect cement paste's setting time.Due to its quite high fineness, marble powder proved to be very effective in assuring very good cohesiveness of mortar and concrete, even in the presence of a superplasticizer admixture, provided that the water to cement ratio was adequately low.

Guendouz et al.(1,2) used the marble waste in flowable sand concrete as fillers. They found that the flowable sand concrete characteristics improved with the use of 200 kg/m3of marble fillers.

Pal et al. (2016) found that the addition of marble dust powder (10% by weight of cement) into the concrete improved its compressive strength by 8.54 % and 12.84 % respectively at 7 & 28 days.The Compressive strength of Concrete increases up to 10% replacement of cement by marble dust powder and further increasing of the percentage of marble dust powder leads to a decrease in compressive strength of concrete.The split tensile strength of concrete increases up to 10% replacement of cement by marble waste powder.The split tensile strength of concrete improved by 15.55 % and 17.95 % for M20 grade concrete (10% by weight of cement) respectively after 7 & 28 days.

Singh et al. (2019) have analyzed that theconcrete made up with different replacement levels of marble dust, can be concluded that up to 15% replacement, enhanced physical strength, and durability of concrete blocks has observed during testing periods of 28 days to 360 days.

*Shirule et al. (2012)*researched that the Compressivestrength of concrete is increased with the addition of waste marble powder up to 10% cement replacement ratio and further if the ratio increases the compressive strength and split tensile strength both tend to decreases.

IV. CONCLUSION AND FUTURE WORK

Conclusion

Based on the findings and then analysis, the following conclusions have arrived.

The particle size distribution of marble slurry and cement, replacement ratio between 10–15% of marble slurry has given satisfactory results and found that at 10% replacement ratio it gives equal performance to the control sample., this would result in a reduction in utilization of cement by 10% and as well asit helps us to reduce the CO2 emission.

Some literature claimed that the performancegets increases when we use marble waste to replace OPC in combined with fly ash. There is an appreciable erformance improvement that cannot be achieved if marble waste and fly ash are used separately.

From the above investigations, use of marble slurry generated from marble mining and preparing accomplished economy in concrete creation with the conservation of natural resources as well as a reduction in environmental hazards reported due to uncontrolled dumping of marble slurry.

Future Scope

Published literature establishes the feasibility of using marble slurry as a partial replacement for cement in the concrete, following are the recommendations for future research:

1. A very little literature is available on the durability properties of concrete using marble waste, it is necessary to carry out a detailed durability study of concrete produced by using marble waste as an alternative building material.

2. Very little data is available, concrete with marble aggregatecan be also used in the construction of residential superstructures in rural and semi-urban areasaway from the industrial area.
3. On the economical way, marble is very demandable as an aesthetic dimensional stone. Its quarrying and processing will inadvertently produce waste in the form of blocks, powder, and slurry.
4. Hence, instead of using cement, we have also include marble slurry in partial replacement of cement so that we can try to reduce the need for the quantity of cement in concrete manufacture. This would reduce the production cost of concrete. This would lead to the sustainability of the marble industry by reducing or even zero waste. Construction industries' carbon footprint can also be reduced by an appreciable amount.

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BIOGRAPHY

Mr. Sourabh Soniwas born in Udaipur District, Rajasthan, India, in 1995. He has received his B. Tech. degree in Civil Engineering from Rajasthan Technical University, Kota, India, in 2017 and M. Tech scholar in Structural Engineering from Civil Department of the College of Technology and Engineering, Udaipur, Rajasthan, India, from batch 2018-2020.

Er. R. S. Shekhawat was born in Shikhar, India,1972.He completedhis B. Tech degree in Civil Engineering from Mungneeram Bangur Memorial Engineering College, Jodhpur, India, and M.Tech(ConstructionEngineering &Management) from Indian Institute of Technolgy, Delhi, India. Working as Assistant Professor at Dept. of Civil Engineering in College of Technology and Engineering, MPUAT, Udaipur.