

**UTILIZATION OF MARBLE AND GRANITE POWDERS AS
GREEN BUILDING MATERIALS IN CONCRETE**

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UTILIZATION OF MARBLE AND GRANITE POWDERS AS GREEN BUILDING MATERIALS IN CONCRETE

by

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Submitted

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CERTIFICATE

This is to certify that the thesis entitled “Utilization of Marble and Granite Powders as Green Building Materials in Concrete” being submitted by **Mr. Anuj** to the Indian Institute of Technology Delhi for the award of degree of Doctor of Philosophy in Civil Engineering is a record of bona fide research work carried out by him under my supervision. The thesis work, in my opinion, has reached the requisite standard of fulfilling the requirement of the degree of Doctor of Philosophy.

The results contained in this thesis have not been submitted, in part or full, to any other university or institute for the award of any other degree or diploma.



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ABSTRACT

India is now in a stage where construction of roads, bridges, ports, factories, residential and commercial buildings, etc. is taking place at very rapid pace and will continue in coming decades as most of the cities will start building their metro construction. Concrete industry is one industry that is very important for any developing country where large amount of material is consumed. The materials are being utilized in a fast pace. Any other new material that can be used in concrete would decrease the pace of consumption of the materials making the construction little more sustainable.

On the other hand, marble and granite are in great demand as finishing material. A large amount of extraction waste is being created. A large amount of powder slurry is also being generated due to sawing and polishing processes. This powder slurry has very consistent particle size distribution and has particle size of the order on cement and fly ash.

To study the environmental effect due to the wastage created by marble and granite industries, the author visited Kishangarh, Makrana and Rajsmand in Rajasthan for marble and Khamam in Andhra Pradesh for granite. It was observed that the environmental problems in Khamam were more severe as it was more unorganised compared to the situation in Rajasthan. In both the cases, the amount of waste generation is too large and the situation is waiting for an environmental chaos. Rizzo et al. [94] had reported that these fine materials could percolate into the soil and create soil and water-related pollution with grave consequences.

The author presented and estimation of the marble and granite reserve as reported by Indian Bureau of Mines [89-90], and estimated the production of the marble slurry based on production of marble slabs. Based on the cement consumption reported by Cement Manufacturers' Association [9], author showed that it is possible to consume the slurry produced. Carrying out cost benefit, there would be direct financial benefit. Other indirect benefits that the country should recognize are the environmental benefits of such utilization and decrease of consumption of fine and coarse aggregates and thereby provide tax benefits.

Various researchers have attempted utilization of marble and granite powders. Some talked of cement replacement whereas most talked sand replacement. A few work has been done on utilization of

granite powder. Initial research work consistently reported lower strength on utilization of these materials. These problems were solved by proper estimation of water in the mix in this thesis.

This thesis presents a scientific study about the utilization of this marble and granite in normal and self-compacting concrete. Determination of SSD condition, its specific gravity, and moisture content are important. The methodology presented in this thesis can consistently achieve the design strength.

The most important contribution of this thesis are:

- a) It established a procedure of utilization of these fine materials such that it can consistently achieve strength of concrete similar to the composition without them. This is done by doing proper water correction. Till date various researchers have done research to utilize these powder materials in concrete and have confusing results. None of these researchers talked about water correction. With this single important realization, one would be able to properly design concrete with marble and granite powders without compromising the strength of concrete.
- b) It has been shown that it is abundantly available with uniform and consistent material property in various parts of India and can be used in concrete to decrease the consumption of other material thereby making the construction process sustainable.

Other contributions are:

- c) Marble and granite powders, being fine of the order of cement and fly ash, can significantly contribute to the fines and create a cohesive mix.
- d) Marble and granite powders can be consumed to the order of 200 kg/m^3 for high strength and to the order of 360 kg/m^3 for normal concrete, contributing to 8% to 15% of the volume of concrete respectively.
- e) Plasticizer demand depends on total powder content including cementitious materials and marble/granite powder used in the concrete mix.

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