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

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NEW DELHI, INDIA
FEBRUARY 2015

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by

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Submitted

in fulfilment of the requirements of the degree of

Doctor of Philosophy

to the

INDIAN INSTITUTE OF TECHNOLOGY DELHI

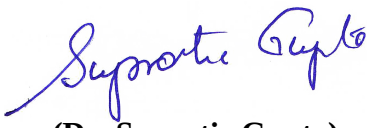
NEW DELHI, INDIA

February, 2015

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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Date: 24/02/2015
New Delhi

ACKLOWLEDGEMENTS

The author expresses his deepest sense of gratitude to his supervisor Dr. Supratic Gupta for providing him the opportunity and guidance throughout this research project. His devotion and support helped in all the time of research and writing of this thesis. He shall ever remain grateful to him for all the inspiration.

The author would like to thank the members of Student Research Committee of Civil Engineering Department, IIT Delhi: Prof. K. G. Sharma, Dr. G. S. Benipal, and Prof. S. V. Veeravalli, for their encouragement, insightful comments, and correct guidance to provide the direction for completion of this thesis. Sincere thanks also goes to Prof. Bishwajit Bhattacharjee, Dr. Shashank Bishnoi and Prof. A. K. Nema for their valuable support and critical suggestion.

The author thankfully acknowledges the time devoted and assistance rendered by his fellow Ph. D. student, Mr. Khuito Murumi. He had relentlessly worked and shared his valuable time in providing inputs and suggestions for the thesis and bringing it to present shape. The author would also like to thank B. Tech. students - Mr. Jyoti Shanker Pandey and Mr. Anshu Bansal and M. Tech. students - Mr. S. Ramakrishnan and Mr. Vimete Pusa who worked with him during their study at IIT Delhi and significantly contributed to the knowledge required for the study. The author also like to thank Mr. Goutam Barai, Mr. Pradeep Singh Negi, Late Mr. Avinesh Kumar, Mr. Navneet Kumar and other staff of concrete lab, IIT Delhi.

He acknowledges M/s UltraTech Cement Limited for permitting him for this opportunity and to pursue this research. Specifically thanks to Mr. Rajeeb Kumar for his encouragement and support. Hearty thanks for all well-wishers who have directly or indirectly encouraged for the completion of this work.

Thanks are due to the financial support received from BMTPC through Ministry of Housing and Urban Poverty Alleviation, Govt. of India, under Project No. RP01971 titled, "Study on environmental impacts of disposal of marble slurry/ marble dust and investigations on its use in concrete," jointly under Prof. A. K. Nema and Dr. Supratic Gupta.

Last but not the least; the author would like to thank his family: his wife Dr. Alka and kids Ms. Bhaavya and Master Somaay; his parents Dr. Ramesh Chand Maheshwari and Mrs. Asha Maheshwari; brothers and their families for their constant encouragement, understanding and moral support.

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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 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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