International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June-2018 www.irjet.net p-ISSN: 2395-0072

Scope of Utilization of Waste Marble Powder in Concrete as Partial Substitution of Cement

Jay N. Bhanushali[1], Dharmesh K. Mistry[2], Aaditya M. Desai[3], Mohit M. Lad[4], Ramesh D. Kumhar[5], Jaldipkumar J. Patel[6]

[12345]Student, Dept. Of Civil Engineering, GIDC Degree Engineering College, Navsari, Gujarat, India
[6]Assistant professor, Dept. Of Civil Engineering, GIDC Degree Engineering College, Navsari, Gujarat, India

---

Abstract – *Marble industry produces large amount of waste during mining and processing stages. This waste is dumped onto open land which creates a lot of environmental problems.*

Industrial wastes like fly ash , rice husk, marble dust, etc. are found to be an efficient alternative for cement as there composition are identical as that of cement & in particular they produce less heat of hydration. This review will deploy the use of marble waste powder against cement and sand at different proportions along with material like silica fume in the mix.

Key Words: **Marble waste powder, Compressive strength, Workability, Durability.**

1. INTRODUCTION

Marble is a metamorphic rock produced from limestone by pressure and heat in the earth's crust due to geological process. Marble Dust Powder is an industrial waste produced from cutting of marble stone. In INDIA, the marble processing is one of the most flourishing industry. Marble industries in India grow more than 3500 metric tons of marble powder slurry per day. Marble Stone slurry generated during processing corresponds to around 40% of the final product from stone industry. This is relevant because the stone industry presents an annual output of 68 million tonnes of processed products.

This waste slurry is dumped along road sides and near processing units, thus causing environmental degradation and escalating health problems in the surrounding areas. The very fine particulate matter in this waste slurry causes air and water pollution. Hence there is a dire need of utilizing this waste material in one or the other way to minimize its harmful impact on the environment.

The experimental investigation deals with testing the effect of partial replacement of cement by marble waste powder on properties of fresh and hardened cement concrete.

Table 1: Oxide Compositions

Oxide compounds	OPC (%)	Marble dust (%)
SiO_2	17-25	28.35
Al_2O_3	3-8	0.42
Fe_2O_3	0.5- 6	9.70
CaO	60-67	40.45
MgO	0.1- 4	16.25

2. LITERATURE REVIEW

Deepankar Kumar Ashish et. al [1] studied the property of marble powder and partial replacement of marble waste powder with sand and cement at 10% and 15% respectively. Properties tested includes, workability and split tensile strength. By slump cone test it was found that the replacement of marble powder with cement and sand has no effect on workability. It was observed that slump decreases with the replacement of cement by marble waste powder because of its higher specific area compared to OPC. The slump increases with the replacement of sand by marble waste powder due to its fine filler effect.

Table 2: Slump value n different mixes

Marble Powder (%)	Slump (mm)
Control cement concrete mix	130
10% marble powder as sand replacement	135
10% marble powder as cement replacement	125
15% marble powder as sand replacement	137
15% marble powder as cement replacement	125
20% marble powder as 10% sand & 10% cement replacement	130
30% marble powder as 15% sand & 15% cement replacement	130

Determining the split tensile values of marble powder as sand replacement, cement replacement & sand and cement amalgam replacement, it was observed that highest split

tensile strength was obtained at 10% marble waste powder replacement for sand. In marble waste powder replacement for cement, the highest split tensile strength was obtained at 10%. The 20% marble powder content is observed to be optimum as sand & cement replacement amalgam for achieving the maximum concrete tensile strength.

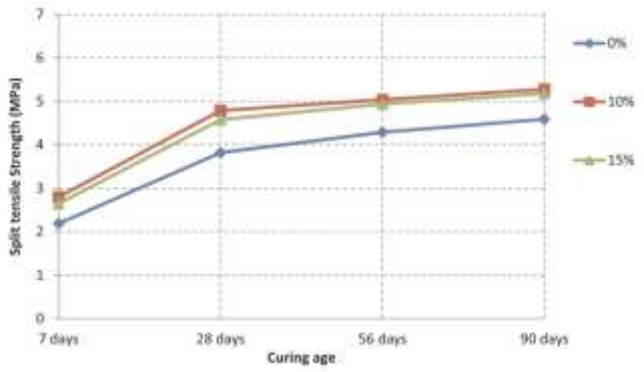

Fig 1: Effect of marble powder as sand replacement on split tensile strength of concrete.

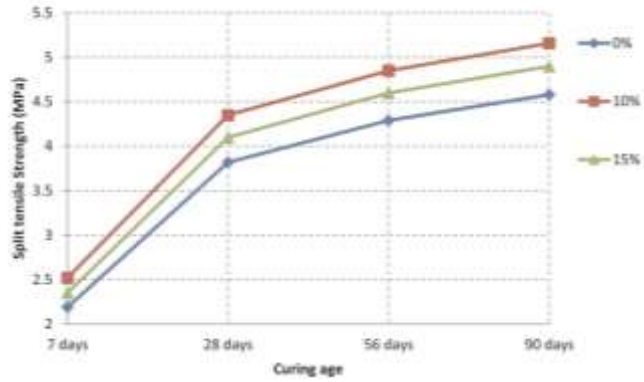

Fig 2: Effect of marble powder as cement replacement on split tensile strength of concrete.

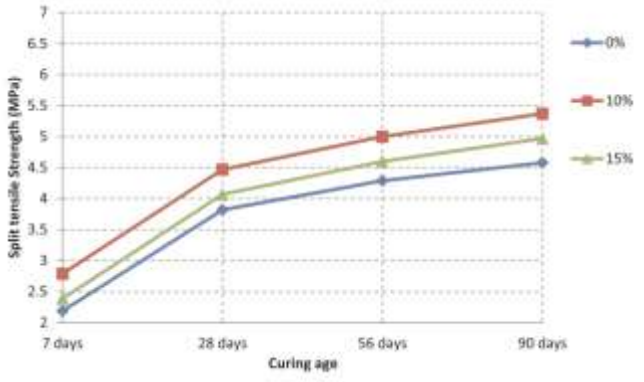

Fig 3: Effect of marble powder as sand and cement amalgam replacement on split tensile strength of concrete.

Shanu Sharma et.al [2] investigated the effect of partial replacement of cement with marble dust powder on the properties of concrete. The tests performed includes, compressive strength test, flexural strength test & durability test. The compressive strength test were performed at the age of 7, 14 & 28 days of the specimens. Specimens are placed in the test machine as per IS:516-1959 cl. No. 5.5.1 Pg no. 11, also loading is applied on the specimen as per the same IS code. Load is applied at the increasing rate of 108 KN/min. Maximum compressive strength was observed at the replacement of 14 %. The compressive strength for 28 days was 28.67 N/mm^2.

For durability test cubes of sizes of 150mm were casted and cured for 28 days. After 28 days curing cubes were taken out and allowed for drying for 24 hours and weight were taken. For acid attack 5% dilute hydrochloric acid is used. The specimen was tested in the compression testing machine under a uniform rate of loading 140 Kg/cm^2 as per IS 516.

Extreme value of durability against acid attack is obtained when cement is replaced with MDP at 3.5%.

Manpreet Singh et.al [3] studied the effects of marble slurry on hydration process. Fresh and hardened concrete properties and durability properties are also tested.

Properties tested includes consistency, soundness and settling characteristics, drying shrinkage, compressive strength, microstructure analysis, slump, % air entrained in concrete, split tensile strength, flexural strength, modulus of elasticity, ultrasonic pulse velocity, Schmidt hardness, carbonation and surface resistivity.

For carbonation three samples were exposed to CO_2 in accelerated carbonation chamber for 56 days after 28 days of water curing.

Sample with 25% marble dust content showed highest carbonation depth of around 19mm.

Hence, resistance to carbonation of mix was observed to be reducing.

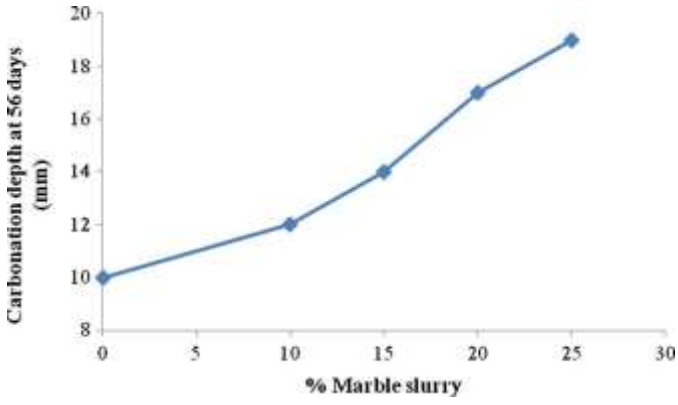

Fig.4 : % slurry replacement vs carbonation depth.

Ali Khodabakhshian et.al [4] investigated that the weight loss percentage of all mixes decreased steadily as the marble waste powder and silica fume contents increased.

The mixes with 5%, 10% and 20% marble waste powder that were immersed in sulphuric acid are more resistant to weight loss. Mixes with 20% marble waste powder replacement had the lowest weight loss with standard deviation resulting at 28 and 63 days were 1.08% and 1.71% respectively.

Better resistance of concrete mixes with marble waste powder to sulphuric acid attacks can be attributed to two important factors : marble waste powder was much finer than OPC which filled the microbes in concrete and the ability of concrete to resist sulphuric acid attacks was improved by the reduced permeability and porosity.

Table 3 shows the clear decrease in the reduction of concrete as the marble waste powder and silica fume content increased.

Table 3: Weight loss of specimens of each mix after 28 and 63 days immersion in 5% sulphuric acid solution

Mix	Weight loss (%) by sulphuric acid (28 days)	Weight loss (%) by sulphuric acid (63 days)
OC	3.08	4.61
M5	2.11	4.34
M10	2.45	3.02
M20	2.01	2.65
SF2.5	2.11	4.45
SF2.5M5	2.33	4.25
SF2.5M10	2.17	3.8
SF2.5M20	1.12	1.4
SF5	1.71	2.55
SFM5	1.53	2.48
SFM10	0.34	0.86
SF5M20	-0.12	0.07
SF10	0.54	1.55
SF10M5	0.16	0.35
SF10M10	0.02	0.11
SF10M20	-0.41	-0.19

Table 4: Designation of the mixes and definition of their meaning.

Designation	Defination
OC	Control Mix
My	Concrete with y% MWP replacement by weight of cement.
SFx	Concrete with x% SF replacement by weight of cement.
SFxMy	Concrete with y% MWP and x% SF replacement by weight of cement.

Omar M. Omar et.al [5] studied the influence of lime stone waste as partial replacement material for sand and marble powder in concrete properties. Different types of tests were carried out on the specimen like compressive strength, tensile strength, flexural strength, modulus of elasticity and water permeability.

Using limestone waste with levels 25% and 50% increased compressive strength of normal concrete $(6\%, 13\%, 8\%)_{25}$, $(10\%, 12\%, 11\%)_{50}$ at 7, 28, and 90 days respectively.

Compressive strength test results of normal concrete with marble powder with different addition percentages 5%, 10% and 15% respectively are 33.7 MPa for 7 days, 40.6 MPa for 28 days and 44.5 MPa for 90 days.

Flexural strength increase about 8% when using 15% MWP with different cement content.

Sudarshan D. Kore et.al [6] tested the impact of marble waste as coarse aggregate on properties of lean cement concrete. The concrete cubes of size 150mm were cast to determine the compressive strength and water permeability test. For determining the resistance against aggressive environment, 100mm size cube specimens were cast. The test procedure for workability was done as per BIS 1199(1999). Workability was minimum for control concrete and increase in marble aggregate resulted in increase in workability. An increase of 11% in compaction factor was observed when natural aggregate was completely replaced by marble aggregate.

The compressive strength of concrete specimens was determined at days, 28 days, 90 days and 180 days curing age as per BIS:516-59. Digital compression testing machine of 1000 KN capacity was used. From the test result it was observed that, compressive strength increased in with increase in marble content. The increase was prominent in 7 days strength and 28 days strength.

The marble aggregate have higher carbonate content than the natural aggregate, which improves the aggregate – cement paste bond that is the reason for the increase in compressive strength of concrete at different curing ages

3. CONCLUSIONS

1) Use of marble as a substitute of cement will prove out to be sustainable method of producing concrete.

2) Above literature commits that use of waste marble waste powder in concrete at its optimum content will surely enhance the strength parameters of the concrete.

3) The maximum compressive strength obtained was at 14% marble powder replacement for cement.

4) Workability of concrete was reduced due to large surface area of waste marble powder.

5) Durability parameters of marble powder showed improvement which makes it suitable as an additive in concrete.

6) Extreme value against acid attacks was obtained when cement Is replacement with marble dust powder at 3.5%.

7) Standard consistency is found to reduce where as initial and final setting times increase but not very significantly. This is good for proper setting of concrete as initial setting time should be sufficiently long for the transportation and placing of concrete.

8) 5% replacement of cement with marble waste powder led to an increase of about 4% in the compressive strength.

9) The compressive strength reduction of specimens subjected to the sulphuric acid test decreased with the increase of marble waste powder and silica fume contents.

10) The permeability of the concrete increases with the increase in percentage of replacement of natural coarse aggregate by marble aggregate. This is mainly due to presence of pores in the concrete.

As a general conclusion, it can be said that the strength and durability of concrete with marble waste powder tended to decline for replacement ratios of more than 10%. Satisfactory results were obtained for replacement ratios of marble waste powder upto 10%.

From the economic and environmental point of view this waste can be partially used with cement in production of concrete mixes.

REFERENCES

[1] Deepankar Kumar Ashish. 2017. "Feasibility of waste marble powder in concrete as partial substitution of cement and sand amalgam for sustainable growth." : journal of building engineering, pg:236-242.

[2] Shanu Sharma, Siddharth Parstariya, Gajendra Kumar Verma. 2017. "Experimental investigation on partial replacement of cement with marble dust powder on properties n concrete." :IJSHRE (ISSN – 2347-4890), VOL.5, pg:2-3.

[3] Manpreet Singh , Anshuman Srivastava and Dipendu Bhunia. 2016. "An investigation on effect of partial replacement of cement by water marble slurry." :Construction and building materials, pg:471-488.

[4] Ali Khodabakhshian, Mansour Ghalehnovi, Jorge de Brito and Elyas Asadi Shamsabadi. 2017. "Durability performance of structural concrete containing silica fume and marble industry waste powder." :Journal of cleaner production, pg:42-60

[5] Omar M. Omar, Ghada D. Abd Elhameed, Mohamed A. Sherif, Hassan A. Mohamadien. 2012. "Influence of limestone waste as partial replacement material for sand and marble powder in concrete properties." :HBRC Journal, pg:193-203.

[6] Sudarshan D. Kore, A.K. Vyas. 2016. "Impact of mable waste as coarse aggregate on properties of lean cement concrete." :Case studies in construction materials, pg:85-92.

[7] IS 516 (1959) : "Methods of test of strength of concrete".

[8] IS 10262 : 2009: "Concrete mix proportion".

[9] IS 9103 (1999): "Specification for concrete admixture".

[10] Concrete Technology by "M.S Shetty".