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Scope of producing concrete by replacing cement with marble dust & doping super plasticizer

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Abstract – *Enormous efforts have been & are being made to produce sustainable concrete by replacing the concrete ingredients by suitable wastes. Industrial wastes like fly ash, rice husk ash, marble dust, etc. are found to be an efficient alternative for cement as their composition are identical as that of cement & in particular they produce less heat of hydration. The notion of green concrete commits to nullify the hazardous efficacy of waste over environment without compromising the quality aspects. This review will deploy the use of waste marble dust against cement at different proportions along with inclusion of super plasticizer in the mix.*

Key Words: Green concrete, pozzolans, partial replacement, Marble dust, Super plasticizer,

1. INTRODUCTION

The principle of using pozzolanic wastes is not only to provide cost effectiveness but also to improve the properties of concrete, especially strength & durability. The production of ordinary Portland cement produces 7% approximately of the total greenhouse gas emitted to the atmosphere.

The improvisation in concrete technology negotiates the use of natural resources and energy sources which further lessen the burden of wastes on the environment. Presently, large amount of marble dust are generated in natural stone processing plants which turns into wastes. The waste is approximately in the range of 20% of the total marble handled. Leaving the waste materials to the environment directly can cause severe environmental problem.

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

Today super plasticizers are one of the common ingredients in the projects across the world in high raise buildings, pre stressed concrete, slender components with congested and densely packed reinforcement, beams and slabs pre-cast elements and long slender columns.

The super plasticizer enhances different properties of concrete both in fresh and hardened stages mainly due to the following phenomenon:

(i) Reduction in interfacial tension.
(ii) Multilayered adsorption of Organic molecule.
(iii) Release of water trapped amongst the cement particles.
(iv) Retarding effect of cement hydration.
(v) Change in morphology of hydrated cement.

The super plasticizers are classified as; Sulphonated Naphthalene Formaldehyde polymer based (SNF), Polycarboxylic ether polymers (PCEP), Modified Lignosulphonate (MLS), others.

2. LITERATURE REVIEW

Rohan K et.al [1] studied the properties of M30 concrete made with various mixes. Properties tested includes compressive strength, flexural strength and split tensile strength tests of hardened concrete. Marble dust used as replacement in range of 0%, 5%, 10%, 15%, 20% by weight of cement .And also strength was compared with conventional M30 concrete. This study concluded that compressive strength of specimens is increased with addition of marble dust compared to conventional concrete up to 15%, and there is a sudden declination in strength at 20% replacement. The study says split tensile strength of specimen increases with addition of marble dust up to 15%, and there is a sudden declination in strength for 20% replacement of cement. Flexural strength of specimens increases with addition of marble dust up to 15%, and there is sudden decrease in strength after replacement of 20% cement by marble dust. Thus it was found out that the optimum percentage for replacement of cement with marble dust is about 15% of the total cement for cubes, beams and cylinders.

Shilpa Jain et.al [2] carried out the proposed study of cubes of concrete with varying partial substitution of cement with marble dust at two different intervals of 7 days and 28 days. Also cubes of concrete with partial replacement of cement

with clay were casted and tested in same intervals. Their result was compared with the conventional M40 concrete properties. M40 grade concrete was induced by partially replacing the cement with marble powder and clay (POP different percentages by weight of cement i.e. 5%, 10%, 15%, 20%. It was found that Compressive strength increases at 10% replacement of cement by marble dust and clay separately. Therefore we cannot vary the quantity of cement replacement by 10% because it will give the compressive strength lower than the target mean strength of M40 concrete. Clay (POP) gives greater strength than that of the marble dust when replaced with 10% cement in the concrete.

Hassan A. Mohamadien [3]prepared Four types of mortar mixture with same workability, cement to sand ratio of 1:3 and w/c ratio of 0.4 by using marble powder and silica fume separately, Initially as a partial replacement of cement content and then as an addition to the mix proportion. Cement was replaced at 0%, 5%, 10%, 15%, 20%, 30% and 50 % by weight of cement for addition and replacement both. Compressive strength at 7 and 28 days with optimum development rate of compressive strength was observed at 15% replacement ratio for both marble powder and silica fume separately. It was found that at 15% replacement ratio with silica fume the compressive strength gets enhanced by 31.4%, 48.3% for 7, and 28 days respectively & in case of replacement with marble powder at 15%, the compressive strength gets enhanced by 22.7%, 27.8% for 7, and 28 days respectively.Fig.1 shows the trend of compressive strength at different replacement percent with marble dust.

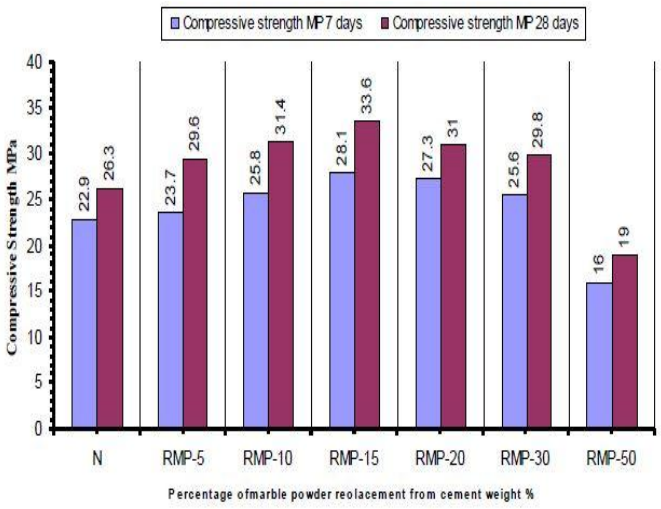

Fig 1: **7 & 28 days compressive strength of different mortar mix.**

M. Karthikeyan et.al [4] investigated characteristic properties of concrete prepared by using OPC & PPC with partial replacement of cement with marble dust. For this study, several properties of marble dust have been identified. Also to get the optimum percentage of marble dust, the marble dust replaced concrete with different percentages has been casted, cured & tested. Then with this obtained optimum percentage of marble dust specimens were casted and compared with conventional concrete. The optimum percentage of marble dust used in this study was found to be 5% for the two types cement i.e. OPC & PPC. Fig: 2 represents the results of 7 & 28 days compressive strength test.

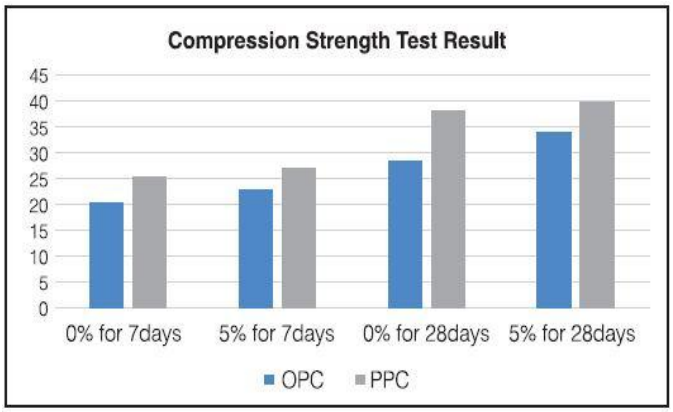

Fig 2: 7 & 28 days compressive strength of different concrete mix.

Tamrakar & Mishra [5] studied effect of super plasticizers on fresh and hardened properties of concrete. The study included tests of workability, slump loss and compressive strength. Experimental work compared the properties of super plasticizer based concrete with that of conventional concrete. Super plasticizers provided a significant water reduction in concrete production while maintaining the same workability. In this study three different categories of super plasticizers has been opted. Rheobuild 1125 (Sulphonated naphthalene polymer based) Glenium140 (Polycarboxylic ether polymers) Pozzolith225 (Modified lingo sulphate). Mix designs i.e. M20 and M40 grade were used for mix proportioning of concrete batched by weight. The w/c ratio of 0.55, 0.40 were maintained, to examine the influence of these super plasticizer on various properties of concrete. Dosages of super plasticizer were taken as 0.25% by weight of cement. On the basis of observation of the test result it was stated that properties of concrete in fresh and hardened condition have been improved with the conjunction of super plasticizers for all nominal mixes of concrete, The Glenium 140 have shown increment in the compressive strength, water reduction ,workability & cement saving requirements of concretes. From the results of the study it was stated that the workability of concrete can be enhanced by addition of super plasticizer. However, very high dosages of Super plasticizers tend to dissipate the cohesiveness of concrete.

Biswal & Sadangi [6] conducted an experimental program to study the effect of super plasticizer alone and in conjunction with silica fume on properties of fresh and

hardened concrete. Properties tested were Workability of fresh concrete, Compressive strength, Flexural strength by partial replacement of cement by 5%, 10%, 15%, 20%, and 25% of silica fumes. Investigation concluded that the w/c ratio was reduced by 23% in concrete by using super plasticizer (1% by weight of cement) for a constant range of slump 80mm to 85mm. The compressive strength of concrete is enhanced by use of silica fume up to 20% replacement of cement. The flexural strength of concrete is enhanced by use of silica fume up to 15% replacement of cement.Fig:3 is the graphical interpretation of results

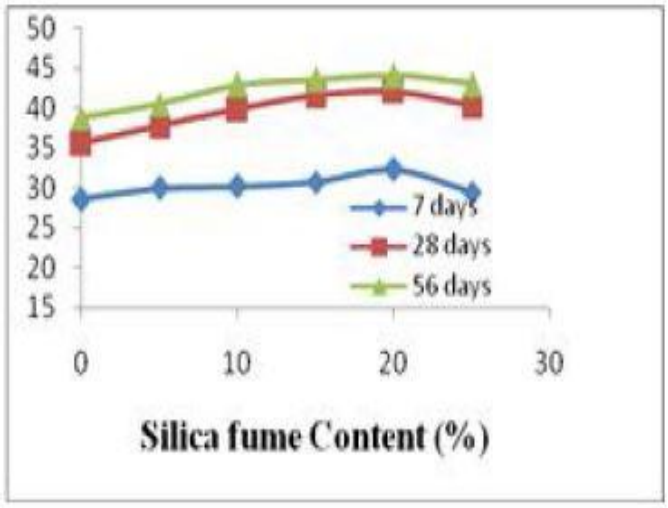

Fig 3: Variation in compressive strength at different silica fume content doped with super plasticizer.

Sahu & Gupta [7] tested properties of concrete with three different dosages of super plasticizers. In this investigation super plasticizer Sikament®170(SWP) of basically modified naphthalene/melamine formaldehyde sulphonate dispersion, having brown colour confirming to IS: 9103-1999 & IS: 2645, ASTM C 494/C494M, Type F has been used. The properties checked are workability and compressive strength on the fresh state & hardened state of concrete respectively by using three super plasticizer dosages (0.2%, 0.4% and 0.6%). Different concrete mixes (M-20, M-30 and M-40) are design by IS 10262:2009. Compressive strength at 7 and 28 days was also determined. They concluded that at a given w/c ratio, the dispersing action of super plasticizer enhances the workability of concrete, increasing the slump from 75mm to 150 mm, the concrete mix sustaining cohesiveness. Compressive strength is improved by SP when compared with control mix; On the other hand, even its ultimate strength is found to be higher than the desired characteristic strength.

Table: 2 contains values of 7 & 28 days compressive strength for different mixes at different dosages of super plasticizers. It can be easily interpreted that compressive strength gets enhanced by doping super plasticizer.

Table 2: 7 & 28 days compressive strength

Grade of Concrete	W/C Ratio	Admixture dosages in % by weight of cement	Compressive Strength (N/mm²) (Average of 3 Cube)	
			7 Days	28 Days
M 20	0.50	0.0	18.16	27.53
M 20	0.46	0.2	21.16	28.00
		0.4	21.83	29.50
		0.6	22.33	30.33
M 30	0.45	0.0	22.50	37.83
M 30	0.45	0.2	23.70	38.40
		0.4	24.66	38.70
		0.6	25.83	39.46
M 40	0.40	0.0	30.16	41.13
M 40	0.40	0.2	31.56	42.10
		0.4	32.16	43.03
		0.6	32.50	43.86

3. CONCLUSIONS

1) Use of waste 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 dust in concrete at its optimum content will surely enhance the strength parameters of the concrete.

3) Lowering W/C ratio of concrete with the help of super plasticizers helps in increasing the compressive strength & workability of concrete as it is known that compressive strength is inversely related to W/C ratio.

4) Since both marble dust & super plasticizer proved out to be efficient in improving strength characteristics of concrete, employing both material in conjunction in concrete can produce high strength characteristics.

5) Various tests of properties like compressive strength, split tensile strength, flexural strength, workability etc. Can be performed on concrete prepared by varying marble dust content in different proportions in conjunction with super plasticizers with suitable dosage. Hence finding an optimum content of combine dosage.

6) Comparing there results with that of conventional concrete will reflect the enhancement in properties of modified concrete.

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