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Experimental investigation on partially replacement of cement in concrete by marble slurry

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Abstract — The purpose of this study was to investigate the possibility of using marble slurry as cement partially with different percentage of concrete composites. The aim of this work is to study the possible use of marble cutting sludge waste in concrete production, which would reduce both the environmental impact and the production cost. The industry stone has contributed to the development of major environmental problems due to waste generation at different stages of mining and processing operation. To solve the problem of these waste generated by the stone production industry, several technical solution consider the incorporation of stone sludge in other industrial activities as a by-product. Concrete is the most widely used construction materials in civil engineering industry because of its high structural strength and stability.

In this research work, Marble slurry has replaced the cement accordingly in the reach of 15% & 20% by weight of M15 & M-20 grade concrete. Concrete mixtures were developed, tested and compared in terms of compressive strength to the conventional concrete. The purpose of the investigation is to analyze the behavior of concrete while replacing the Marble slurry with Different proportions in concrete.

Keywords- Concrete, Environmental, Strength of concrete, Marble slurry, Compressive strength, Flexural strength.

I. INTRODUCTION

Marble slurry is a semi-liquid substance consisting of particles originated from the sawing and polishing processes and water used to cool and lubricate the sawing and polishing machines. These generated wastes cause environmental, health and economical drawbacks. When Marble slurry is disposed in landfills, its water content is drastically reduced and the stone dust resulting from this, presents several environmental impacts. In other words, in dry season the stone powder dangles in the air, flies and deposits on vegetation and crop. All these significantly affect the environment and local systems. In some cases, Marble slurry disposed in the riverbank and around the production facilities cause reduction in porosity and permeability of the topsoil and results in water logging. Due to the huge amounts of stone waste generated in generation sources and plants, vast sums of money spend on its transportation to landfills. The use of industrial wastes in place of conventional raw materials will help to decrease the environmental pollution and also conserve our natural resources. The development of alternate low-cost and ecologically suitable building materials from industrial wastes is an economic necessity.

II. CHEMICAL ANALYSIS

Chemicals	Content (%)
Lime	34%
Silica	6%
Aluminum	0.20%
Iron	0.01%
Magnesium	8.14%
Sodium	0.33%
Potassium	0.12%
Acid insoluble matters	13.3%

Table 2.1: Chemical Content in Marble slurry

III. EXPERIMENTAL PROCEDURE

1) Compressive strength test:

The compression test was conducted as per IS 516–1959. Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

2.) Flexural Strength test:

The test beam 100 x 100 x 700 mm was symmetrically supported on two parallel steel rollers 38 mm in diameter and the distance between the centres of the two rollers adjusted to 40 cm. The load is applied through one rollers mounted at the centre point of the supporting span. The load is applied without shock and increased continuously at a rate of 180 kg/cm^2/minute for the specimen. The load is increased till the specimen fails and the maximum load sustained is recorded. The position of crack is observed and measured. The flexural strength is expressed as the modulus of rupture fb as per the IS 516. Observations and results recorded at 7 & 28 Days.

- **Mix Proportion of Concrete:**

Materials:	**0% M.S.**	**15% M.S.**	**20% M.S.**
1. Cement	350 kg	323 kg	303 kg
2. Marble slurry	0 kg	57 kg	77 kg
3. W/C Ratio	0.40	0.40	0.40
4. Fine Aggregate	678 kg	678 kg	678 kg
5.Coarse Aggregate(20mm)	940 kg	940 kg	940 kg
6.Coarse aggregate(10mm)	464 kg	464 kg	464 kg
7. Water	140 kg	140 kg	140 kg

Table 3.1: Mix Proportion for M20 (For Cubic meter of Concrete)

Materials:	**0% M.S.**	**15% M.S.**	**20% M.S.**
1. Cement	300 kg	280 kg	264 kg
2. Marble slurry	0 kg	50 kg	66 kg
3. W/C Ratio	0.45	0.45	0.45
4. Fine Aggregate	697 kg	697 kg	697 kg
5.Coarse Aggregate(20mm)	969 kg	969 kg	969 kg
6.Coarse aggregate(10mm)	476 kg	476 kg	476 kg
7. Water	135 kg	135 kg	135 kg

Table 3.2: Mix Proportion for M15 (For Cubic meter of Concrete)

IV. TEST RESULTS

1.) Compressive strength:

Table 4.1: Compressive strength of M20 at 7 days

Marble Slurry Replaced	Cube: 1 N/mm2	Cube: 2 N/mm2	Cube: 3 N/mm2	Avg. N/mm2
0%	19.42	17.10	18.95	18.5
15%	17.25	18.20	17.5	17.6
20%	16.10	17.75	16.45	16.75

Table 4.2: Compressive strength of M20 at 28 days

Marble Slurry Replaced	Cube: 1 N/mm2	Cube: 2 N/mm2	Cube: 3 N/mm2	Avg. N/mm2
0%	27.39	26.89	25.82	26.70
15%	26.38	26.90	24.48	25.92
20%	24.42	22.50	24.52	23.81

Table 4.3: Compressive strength of M15 at 7 days

Marble Slurry Replaced	Cube: 1 N/mm2	Cube: 2 N/mm2	Cube: 3 N/mm2	Avg. N/mm2
0%	14.50	12.75	13.90	13.75
15%	13.10	12.5	13.50	13.10
20%	12.90	12.75	11.90	12.5

Table 4.4: Compressive strength of M15 at 28 days

Marble Slurry Replaced	Cube: 1 N/mm2	Cube: 2 N/mm2	Cube: 3 N/mm2	Avg. N/mm2
0%	21.31	18.36	19.73	19.80
15%	17.75	18.95	19.64	18.78
20%	15.70	18.55	15.60	16.61

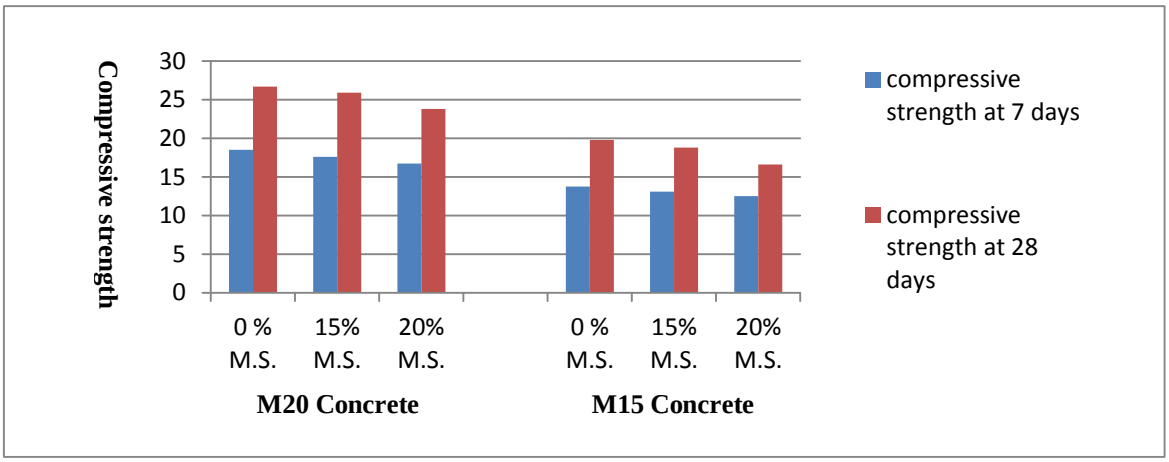

Fig 4.1: Graphical representation of compressive strength

2.) Flexural Strength:

Table 4.5: Flexural strength of M20 at 7 days

Marble Slurry Replaced	Beam: 1 N/mm2	Beam: 2 N/mm2	Beam: 3 N/mm2	Avg. N/mm2
0%	3.37	3.55	3.64	3.52
15%	3.51	3.46	3.55	3.50
20%	3.11	3.24	3.46	3.27

Table 4.6: Flexural strength of M20 at 28 days

Marble Slurry Replaced	Beam : 1 N/mm2	Cube: 2 N/mm2	Beam : 3 N/mm2	Avg. N/mm2
0%	4.93	5.06	5.15	5.04
15%	4.84	5.11	4.97	4.97
20%	4.84	5.02	4.71	4.86

Table 4.7: Flexural strength of M15 at 7 days

Marble Slurry Replaced	Beam: 1 N/mm2	Beam: 2 N/mm2	Beam: 3 N/mm2	Avg. N/mm2
0%	0%	2.44	2.31	2.13
15%	15%	2.13	2.27	2.31
20%	20%	2.08	2.27	2.0

Table 4.8: Flexural strength of M15 at 28 days

Marble Slurry Replaced	Beam : 1 N/mm2	Beam : 2 N/mm2	Beam : 3 N/mm2	Avg. N/mm2
0%	3.16	3.42	3.51	3.36
15%	3.37	3.16	3.35	3.29
20%	3.20	3.06	3.12	3.13

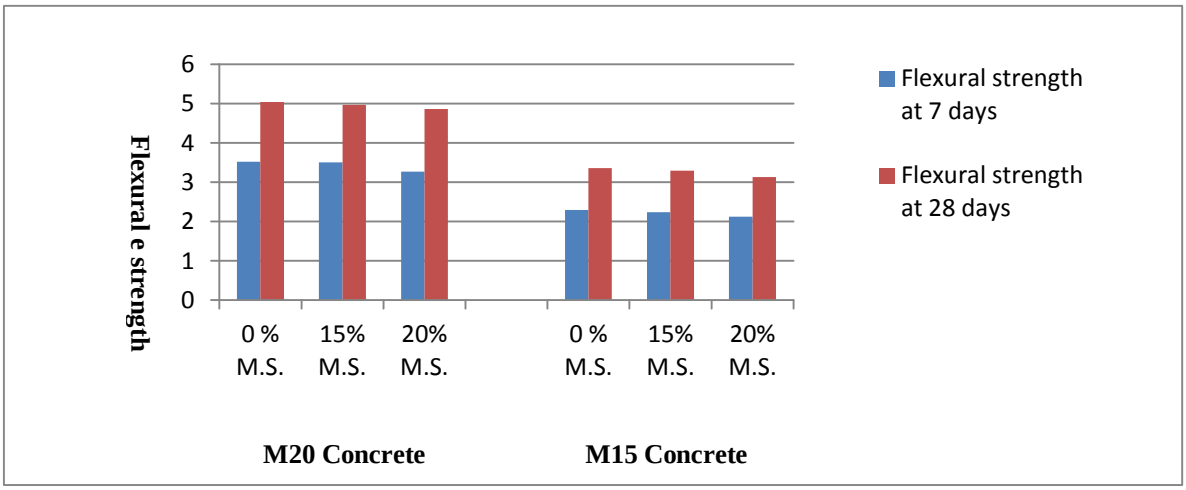

Fig 4.2: Graphical representation of Flexural strength

V. CONCLUSION

- **Compressive Strength:** The compressive strength of concrete for cubes, all mixes at 7 and 28 days of curing. 3 cubes were casted for various percentage replacements of cement by Marble slurry. The result shows that the Compressive strength of concrete decreasing with addition of waste marble slurry up to 15% and 20% replace by weight of cement. But from the result reduction of Compressive strength were very less while replacing cement with 15% of marble slurry. So we used Marble slurry as green materials in concrete up to 15%.

- **Flexural Strength**: The flexural strength of concrete for beams at 7 and 28 days of curing should be determined by three point method. The result shoes that Flexural strength of concrete beam decreasing with addition of marble slurry up to 15 % and 20% replace by weight of cement.

- Thus we found out the optimum percentage for replacement of marble slurry with cement and it is almost 15% of the total cement for cubes and beams. Using marble slurry in concrete mix proved to be very useful to solve environmental problems and produce green concrete. Therefore, it is recommended to re-use these wastes in concrete to move towards sustainable development in construction industry. The investigation was primarily to determine a resolution to the disposal problem of marble slurry by making usage of it in concrete production for sustainable construction development.

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