A Study on Performance of Concrete Containing Marble Powder and Quarry Dust

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Abstract - River sand is the most commonly used fine aggregate in concrete. Due to the vast development in construction industry and the demand of natural sand in the construction industry has increased a lot resulting in the reduction of sources and an increase in price. quarry dust, a by-product from the crushing process during quarrying activities is one such material. In this paper an attempt has been made to determine the properties of concrete by partially replacing sand by stone quart dust and cement by marble powder. It is proposed to study the possibility of replacing sand with locally available crusher waste without sacrificing the strength and workability of concrete. For this purpose we are replacing cement by marble powder to 10%. A total of six concrete mixes, containing 0%, 10%, 20%, 30%, 40% and 50% partial replacement of regular sand with quarry dust are investigated in the laboratory. These mixes were tested to determine axial compressive strength, split tensile strength, and flexural strength for 7days, 28days, and 90days. Optimum strength has been obtained at 40% replacement of fine aggregate by quarry dust with 10% marble powder as cement replacement.

Key Words: Fine aggregate, Quarry dust, Marble powder, Cement, Workability and Strength.

I. INTRODUCTION

Natural sand is the most commonly used building material in any part of the world. The use of sand in construction industry resulting in excessive sand mining which is objectionable. Due to the rapid growth of construction activity, the available sources of natural sand are getting exhausted. Also, good quality sand may have to be transported from long distances, which adds to the cost of construction. In some cases, natural sand may not be of good quality. Therefore, it is necessary to replace natural sand in concrete by an alternative material either partially or completely without compromising the quality of concrete. Quarry dust is one such material which can be used to replace sand as fine aggregate.

Marble powder is an industrial waste containing heavy metals in its constitute. Marble cutting industry produces large amounts of solid wastes. During marble processing, 30% of the stone goes to scrap because of being smaller size and/or irregular shape. The other waste material is slurry. It is basically the water containing marble powder. It can be safely estimated that 1 ton of marble stone processed in gang-saw or in a vertical/horizontal cutter produces almost 1 ton of slurry (70% water).

Quarry dust is produced during the extraction and processing of aggregates. It is produced from the full range of quarrying activities and comprise material less than (about) 6 mm. It is an essential part of many aggregate products and are intentionally produced by quarrying activities in order to provide the required product gradings. Quarry dust by its nature, is usually inert or non-hazardous. Disaggregation, mixing and moving to different locations, exposure to atmospheric conditions and to surface or groundwater, as well as segregation and the increase of surface area due to particle size reduction, may cause physical and chemical transformations with detrimental effects to the environment. Quarry fines are composed of the same mineral substances as the soil and solid rock from which they are derived, even though changes to their physical and chemical characteristics may have occurred.

II. LITERATURE REVIEW

N.S.Nadgir, S.S. Bhavikatti

Their study involves addition of silica fume and stone quarry dust for conventional concrete with no plasticizer. Fixing one suitable proportion for addition of Silica Fume, the placement of stone quarry dust is varied. The present work has been carried out to determine the physical properties of stone quarry dust, so as to ascertain its suitability for partial or full replacement for sand, to study the compressive strength characteristics of mortar mixes (1:3, 1:4 & 1:6) by partial or full replacement for sand by stone quarry dust & ascertaining its suitability as a

masonry mortar and to study various parameters of concrete like compressive strength, split tensile strength, flexural strength, durability, water absorption, alternate wetting and drying, shrinkage etc. for concrete of grade M15 & M20 with partial of full replacement of sand by stone quarry dust for ascertaining its suitability for its actual use in construction, under the guidance of available IS codes and IS specifications, directly or indirectly. Compressive strength of mortar cubes show that the compressive strength increases up to 40% of stone quarry dust and reduces beyond that, the mix was added with 2% silica fume. They have concluded that the compressive strength of concrete cubes increases up to 40% of stone quarry dust and reduces beyond that point. The experimental results show that the split tensile strength increases up to 40% stone quarry dust beyond which it reduces. The workability of the concrete mix decreased with increased percentage of stone quarry dust. The reason is due to higher surface area, which requires more water to wet the surface in comparison with the river sand. To take care of this a constant of 4% of water is added to the weight of stone quarry dust for all mixes.

III. EXPERIMENTAL DETAILS

It was proposed to investigate the properties of concrete, cast with partial replacement of fine aggregate with 0%, 10%, 20%, 30%, 40% and 50% proportions of quarry dust with 10% marble powder as replacement to cement and cured in water for 7days, 28days, and 90days. In this experimental work, physical properties of materials used in the experimental work were determined. M25 grade of reference concrete was mixed and cured in potable water.

3.1 Properties of the materials

3.1.1 Cement: Ordinary Portland Cement (OPC) of 53 Grade (Deccan cement) from a single source was used throughout the course of the investigation. It was fresh and without any lumps. The specific gravity of cement is 3.10

3.1.2 Fine Aggregate: The fine aggregate used is natural sand obtained from the river Godavari conforming to grading zone-II ofIS 383:1970. The specific gravity and fineness modulus are 2.54 and 2.75 respectively.

3.1.3 Coarse Aggregate: Crushed granite angular aggregate of size 20mm are used and the aggregates are free from dust before used in the concrete. The specific gravity and fineness modulus are 2.74 and 7.32 respectively.

3.1.4 Water: This is the least expensive but most important ingredient of concrete. A good thumb rule to follow is that if water is pure enough for drinking it is suitable for mixing concrete. Locally available portable water was used for mixing and curing.

3.1.5 Quarry Dust: It is collected from Nagasai stone crusher, Rajahmundry, Andhra Pradesh. Specific gravity and fineness modulus tests were conducted for quarry dust and the result obtained is 2.60 and 3.86 respectively.

*3.1.6 Marble Powder***:** It is collected from Sri Balaji marble industries, Guntur, Andhra Pradesh. Specific gravity test was conducted on marble powder and the result was obtained 2.62.

IV. SPECIMEN DETAILS

Cube specimens of size 150mmx150mmx150mm size for compressive strength, Cylinder specimens of 150mm diameter x 300mm height and prisms of size 100mm x 100mm x 500mm were casted to study the mechanical strength properties such as compressive strength, split tensile strength and flexural strength according to Indian standards.

V. MIX PROPORTION

The mix design is as per IS 10262: 2009, W/C-Ratio = 0.47

Table: 1 Mix proportion of different concrete mix

S.No	Mix Id.	Cement (kg/m^3)	Marble powder (kg/m^3)	Quarry dust (kg/m^3)	Total powder (kg/m^3)	F.A (kg/m^3)	C.A (kg/m^3)	Water (litrs)	W/C-Ratio
1.	M0	383	--	--	383	654	1200	180	0.47
2.	M1	344	38.3	65	447.3	589	1200	180	0.47
3.	M2	344	38.3	131	513.3	523	1200	180	0.47
4.	M3	344	38.3	196	578.3	458	1200	180	0.47
5.	M4	344	38.3	262	644.3	393	1200	180	0.47
6.	M5	344	38.3	327	709.3	327	1200	180	0.47

VI. TEST RESULTS

A total of 54 cubes, 54cylinders and 54beams were casted for the six mixes. i.e., for each mix 9 cubes, 9cylinders and 9beams were prepared. Testing of the specimens was done at 7 days, 28 days and 90 days, at the rate of 3 cubes, 3 cylinders and 3 beams for each mix on that particular day. The average value of the 3 specimens is reported as the strength at that particular age.

Table: 2 Fresh Properties of Concrete

S. No	Mix. Id.	% of Quarry dust	Slump (mm)	Compaction Factor
1.	M0	0	81.67	0.93
2.	M1	10	75.0	0.91
3.	M2	20	61.67	0.90
4.	M3	30	53.33	0.89
5.	M4	40	48.33	0.82
6.	M5	50	41.67	0.80

From the above table it was observed that the workability of concrete decreased with increase of % quarry dust. The reason is due to higher surface area, which requires more water to wet the surface in comparison with the river sand. The workability can be improved by addition of suitable super plasticizer.

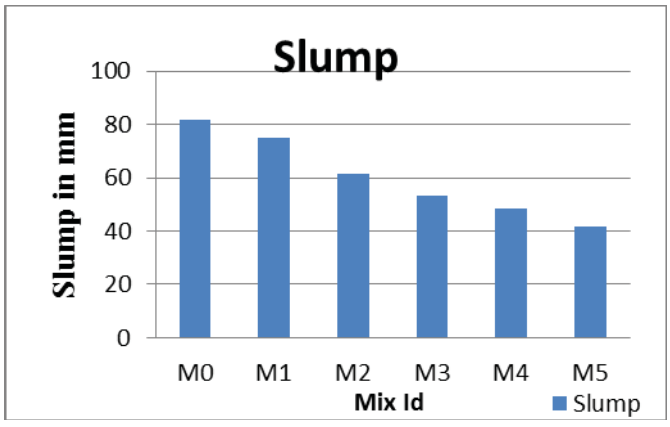

Fig. 1 Slump Cone Value Vs Mix Id

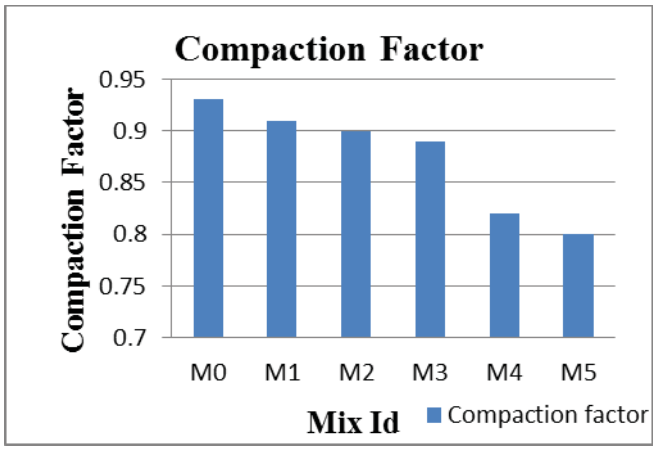

Fig. 2 Compaction Factor Vs Mix Id

Table: 3 Hardened Properties of Concrete

S.No	Mix. Id.	% of Quarry dust	Compressive strength (MPa)			Split tensile strength (MPa)			Flexural strength (MPa)		
			7d	28d	90d	7d	28d	90d	7d	28d	90d
1.	M0	0	29.81	37.78	42.71	2.08	2.55	2.77	4.53	6.00	6.68
2.	M1	10	31.10	39.09	44.85	2.17	2.71	2.86	4.67	6.26	6.93
3.	M2	20	32.41	41.27	45.73	2.19	2.83	2.98	4.8	6.61	7.46
4.	M3	30	34.15	44.32	47.49	2.29	3.06	3.19	5.06	7.07	7.73
5.	M4	40	34.88	46.65	48.52	2.40	3.31	3.42	5.60	7.33	8.13
6.	M5	50	32.40	43.30	46.19	2.13	3.24	3.33	5.07	6.93	7.33

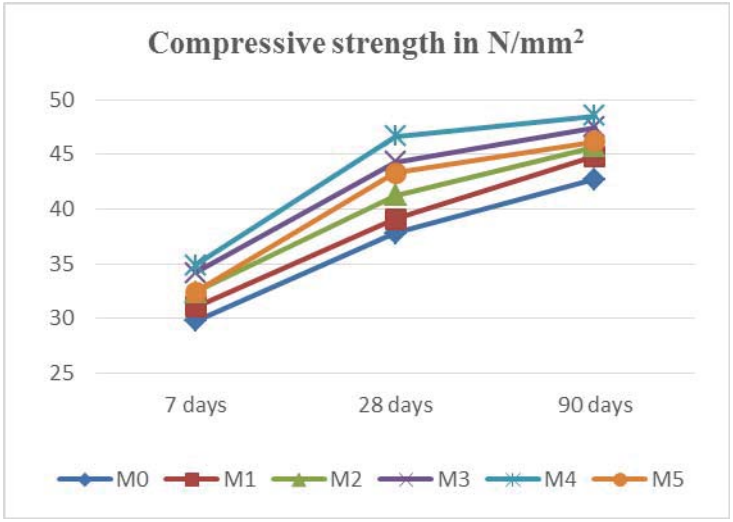

Fig.3 Compressive strength Vs age

The graph is drawn between the compressive strength Vs age of concrete at different percentage replacements of quarry dust. The results showed an optimum value of compressive strength at 40% replacement of

fine aggregate by quarry dust. It is found that the compressive strength of concrete made out of quarry dust and marble powder is 17%, 23.48% and 13.60% more than the conventional concrete at 7, 28 and 90 days respectively.

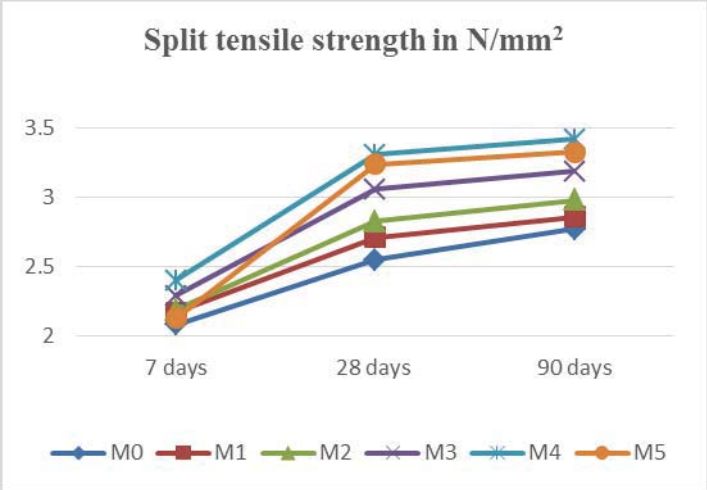

Fig. 4 Split tensile strength Vs age

The graph is drawn between the split tensile strength Vs age of concrete at different percentage replacements of quarry dust. The results showed an optimum value of split tensile strength at 40% replacement of fine aggregate by quarry dust. It is found that the split tensile strength of concrete made out of quarry dust and marble powder is 15.38%, 29.80% and 23.46% more than the conventional concrete at 7, 28 and 90 days respectively.

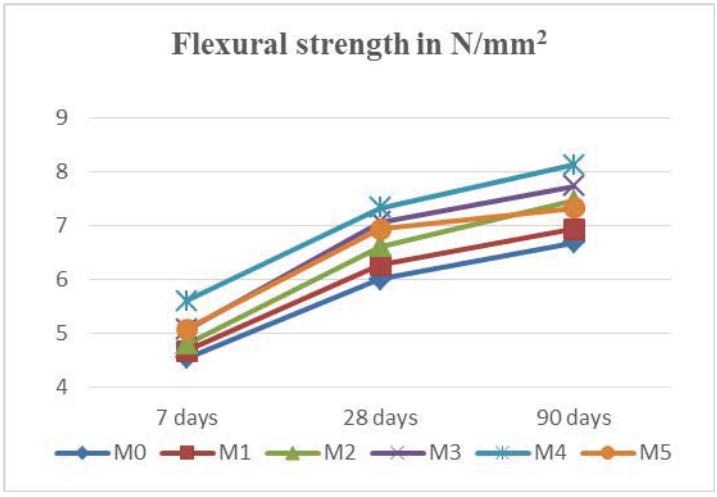

Fig. 5 Flexural strength Vs age

The graph is drawn between the flexural strength Vs age of concrete at different percentage replacements of quarry dust. The results showed an optimum value of flexural strength at 40% replacement of fine aggregate by quarry dust. It is found that the flexural strength of concrete made out of quarry dust and marble powder is 23.6%, 22.16% and 21.7% more than the conventional concrete at 7, 28 and 90 days respectively.

VII. CONCLUSION

The following conclusions are drawn from the present investigation:

- The workability of the concrete mix decreased with increased percentage of Quarry Dust. The reason is due to higher surface area, which requires more water to wet the surface in comparison with the river sand.
- The Compressive strength of 7days, 28days, and 90 days has highest value for 40% replacement and reduces beyond that, the mix was added with 10% Marble powder.
- The Split tensile strength of 7days, 28days and 90 days has highest value for 40% replacement.
- The flexural strength of 7days, 28days, and 90 days has highest value for 40% replacement.

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