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PERFORMANCE STUDY OF CONCRETE BY PARTIAL REPLACEMENT OF INGREDIENT MATERIAL

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ABSTRACT

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete plays a vital role in the development of infrastructure viz., buildings, industrial structures, bridges and highways etc. leading to utilization of large quantity of concrete. The performance of marble powder, quarry dust and marble chips combinations is expected to give better results than conventional constituents of normal mixing. Leaving the waste materials to the environment causes environmental problem. Hence the reuse of waste has been emphasized.

In this paper an experimental study has been done to investigate the use of marble powder, quarry dust and marble chips as a partial replacement for cement, fine and coarse aggregate in concrete respectively. The compressive strength, tensile strength and flexural strength test of concrete was conducted. It is proposed to conduct the above test to verify whether the above combination will improve the strength of the concrete substantially compared to normal mix concrete.

Keywords: Cement, Coarse aggregate, Concrete, Fine Aggregate and Water.

INTRODUCTION

General

Green concrete has nothing to do with color. It is a concept of thinking environment in to concrete considering every aspect from raw materials manufacture over mixture design, structural design, construction and service life. Green concrete is cheap to produce, for example waste products are used as a partial substitute for cement and aggregates. So disposal of waste is avoided, energy consumption in production is lower and durability is greater. In India the extractive activity decorative sedimentary carbonate rocks, commercially indicated as marbles and "granites" is one of the most thriving industry. Marble powder is an industrial waste containing heavy metals in constitutes.

A.Antogeetha, M.M.Metro, B.Selvakoodalingam, M.Palani Kumar is studied the influence of natural sand replacement by crushed stone by fine and medium sand on the performance of fresh and hardened. The ordinary stone dust obtained from crushes does not comply with IS: 383-1979.The presence of flaky, badly graded and rough textured particles result in high concrete for given design parameters. Use of quarry rock dust as a fine aggregate in concrete draws serious attention of researchers and investigators.

Uses of crusher powder& Marble powder

[1]. The Unwanted quarry dust is being dumped in low laying areas and also along the sides of roads.

[2]. In highways department the quarry dust is used to sprinkle over the newly laid bituminous road as filler.

[3]. The quarry dust is used in the manufacturing of hollow blocks

[4]. Some mosaic companies, used quarry dusts to replace sand.

[5]. In telephone department the quarry dust is used to refill the excavated trench after layer of telephone cables.

Replacing materials

The performance of marble powder, quarry dust and marble chips combinations is expected to give better results than conventional constituents of normal mixing. On the other side, the cost of ingredients in concrete is attributed to be scarce. More ever it is an expensive, alternative material in

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its production which proves economically. Leaving the waste materials to the environment causes environmental problem. Hence the reuse of waste has been emphasized. Waste can be used to produce new products or can be used as admixtures so that the natural resources are used more efficiently and the environment is protected from waste deposits.

The abundant production of marble powder as waste product is becoming a problem for its disposal. It is also hazardous to the environment. In order to protect the environment we can use the above waste product, instead of cement in concrete.

The demand for natural sand in the construction industry has gradually increased which results in the reduction of sources and an increase in price. In such situation the quarry dust can be used as partial alternative to the river sand which is cost efficient. The coarse aggregate was replaced by marble chips.

PROPERTIES OF MATERIALS

Cement

The ordinary Portland cement with 29% of normal consistency with specific gravity 3.05 conforming to IS: 8112.1989 was used.

Aggregates

Quarry rock dust

The specific gravity of the quarry rock dust was 2.48.

Fine aggregate

Medium size sand from Thamiraparani River with a fineness modulus of 3.65 and specific gravity 2.58.

Marble powder

Marble powder was obtained from marble factories in Rajasthan. Wetted marble powder was dried in oven to dry at a temperature of 110^0C.The specific gravity of marble powder was 2.76

Coarse aggregate

The content of flaky and elongated particle is less than 3%, the crushing index less than are equal to 6% and specific gravity is 2.64 and the finesse modulus is 3.36.

Marble chips

The content of flaky and elongated particle is less than 2%, the crushing index less than are equal to 4.5% specific gravity is 2.35 and the finesse modulus is 2.8

Water

Water having P_H Value 7 is used for manufacturing and curing the concrete.

EXPERIMENTAL INVESTIGATION

Concrete mix design

The mix proportion to be used for experimental study was arrived by doing a detailed, concrete mix design based on Indian standards recommended method of concrete mix design IS (10262-1982)

It is observed that by varying the proportion of natural sand by crusher powder and marble powder, the mix proportion of cement, fine aggregate and coarse aggregate vary significantly. The mix proportion of fine aggregate obtained from the mix design, and is replaced by quarry dust with the step of increment 10% and the proportions for testing purposes are calculated. M20 concrete grade was used.

Details of Mix Designation and Specimens

Moulds confirming to IS 10086-1982 were used to cast specimens. Since aggregate of size less than 20 mm and greater than 12.5 mm were used, cube moulds of 150x150x150 mm were used. Cylindrical moulds of size 150mm diameter and 300m height were used cast to cylindrical specimen and tested for split tension. For flexural strength, beam moulds of size 100x100x500 mm of internal dimensions were used. For compacting table vibrator is used.

TESTING PROCEDURE

Slump cone test

Slump test is the most commonly used method measuring consistency of concrete. Which can be employed either pin laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It is does not measure all factors contributing of workability; it is always representative of the place ability of the concrete. The apparatus for conducting the slump test essentially consists of a metallic mould in the form of a frustum of a cone having the internal dimensions as under.

Bottom diameter : 20cm
Top diameter : 10cm
Height : 30cm

The internal surface of the mould is thoroughly cleaned and free from superfluous moisture and any Old set concrete before commencing the test. The mould is then filled in 3 layers. Each layer is tamped 25 times by the tamping rod taking care to distribute the stroke evenly over the cross section. After the top layer has been rotted, the concrete is struck of level with a trowel and tamping rod. The mould is removed from the concrete immediately by raising is slowly and carefully in a vertical direction. This allows the concrete to subside. This subsidence is referred as slump of concrete.ie difference in level between the height of the mould and that of the highest point of the subsided concrete is measure. This difference in height in "mm" is taken as slump of concrete fixed as 60mm.

Hardened state strength

The casted specimens were remolded after 24 hours and kept for curing in curing tank till the day of testing.

Compression test

The cube specimens were tested for compressive strength at the end of 7 days and 28days.The specimens stored in water were tested after drying the specimens. While placing the cubes in the machine care was taken such the load was applied to opposite sides of the cubes as cast. The axis of the specimen was carefully aligned with the center of thrust of the spherically seated plate.

The load was applied without shock and increase continuously until the resistance of the specimen to the increasing load brake down and the greater load could be borne by the specimen. The maximum load by the specimens was recorded.

The compressive strength of the specimen was calculated by dividing the maximum load applied to the specimen by the cross- sectional area.

Split tensile test

Placing a cylindrical specimen horizontally between the loading surfaces of a compression-testing machine carries out this test and the load is applied until failure of the cylinder, along the vertical diameter. When the load is applied along the vertical diameter of the cylinder, it is subjected to a horizontal stress of $2P/\Pi Ld$

Where

P- Compressive load on the cylinder,

L-length of the cylinder

D-Diameter

The loading condition produces a high compressive stress immediately below the two generators to which the load is applied. But the larger portion corresponding to depth is subjected to a uniform tensile stress is acting horizontally. It is estimated that the compressive stress is acting for about 1/6 depth and the5/6 depth is subjected to tension.

In order reduce the magnitude of the high compression stresses near the points of application of load, narrow packing strips, of suitable such as plywood are placed between the specimen and loading plates of the testing machine. The packing strips should be soft enough to allow distribution of load over a reasonable area, yet narrow and thin enough to prevent large contact area. Normally, a plywood strip of 25mm wide, 3mm thick and 30cm long is used. Splitting strength gives 5 to 12% higher value than the direct tensile strength.

Flexural strength

The flexural strength for the concrete is determined by using loading frame. The hydraulic jack loaded the beam and the load is measure by using the proving ring. The selected span was 450mm and the 2-point loads were applied at one third span.

Table 3.1 Properties of Cement

S.No	Description	Cement	Marble powder
1.	Normal consistency	29%	28.5%
2.	Initial setting time	30 min	30 min
3.	Final setting time	230 min	230 min

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4.	Specific gravity	3.05	2.76
5.	Fineness	10%	10%
6.	Density	3.05	2.95
7.	Void ratio	2%	0.416
8.	Finesse modulus	1.56	1.56
9.	Uniformity co efficient	1.15	1.15
10.	Effective size	0.15	0.15

Table 3.2 Properties of Fine Aggregate

S.No	Description	River sand	Crusher powder
1.	Specific gravity	2.58	2.48
2.	Finesse modulus	3.65	3.53
3.	Effective size	0.36	0.12
4.	Uniformity co efficient	1.92	9.17
5.	Void ratio	0.376	0.407

Table 3.3 Properties of Coarse Aggregate

S.No	Description	Coarse aggregate Value	Marble chips
1.	Specific gravity	2.64	2.35
2.	Finesse modulus	3.36	2.8
3.	Effective size	2.67	2.25
4.	Uniformity co efficient	23 mm	22 mm
5.	Void ratio	0.953	0.85
6.	Impact value	19.84%	18.5
7.	Percentage of wear	14.1	13.5
8.	Crushing value	21.75%	20.25

Table 3.4 Bulking Effect of Sand

Sl No	% of water added	Quantity Of water (ml)	Height of sand (cm)			% increase in bulk
			From top	From bottom	Increase in height from original	
1.	2	20	9	27.5	2.8	11.34
2.	4	40	8.5	28	3.3	13.36
3.	6	60	6.7	29.8	5.1	20.65
4.	8	80	9.6	26.9	2.2	8.91
5.	10	100	10.6	25.9	1.2	4.86
6.	12	120	11	25.5	0.8	3.34
7.	14	140	11.1	25.4	0.7	2.84
8.	16	160	11.2	25.3	0.6	2.43

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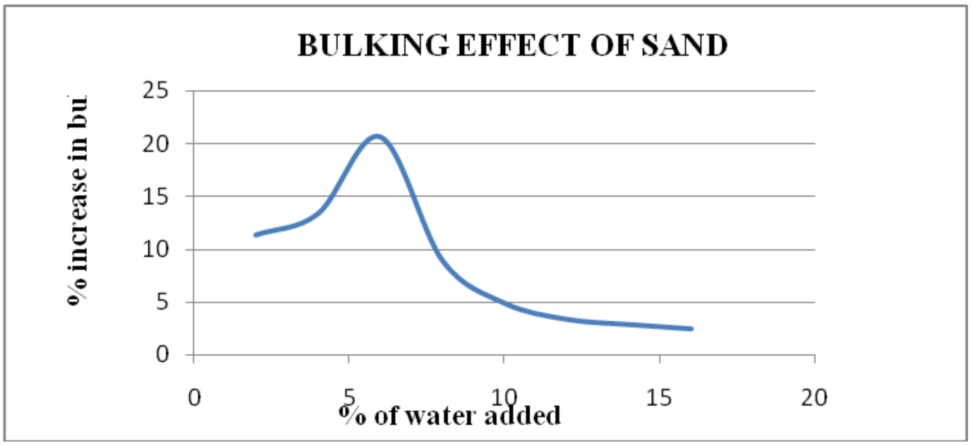

Fig 3.1 Bulking Effect of Sand

Table 3.5 Bulking Effect of Crusher Powder

Sl No	% of water added	Quantity Of water (ml)	Height of crusher (cm)			% increase in bulk
			From top	From bottom	Increase in height from original	
1.	2	20	6.8	29.7	5.1	21
2.	4	40	4.8	31.7	7.1	29
3.	6	60	3.5	33	8.4	34
4.	8	80	4.1	32.4	7.8	32
5.	10	100	5	31.5	6.9	28

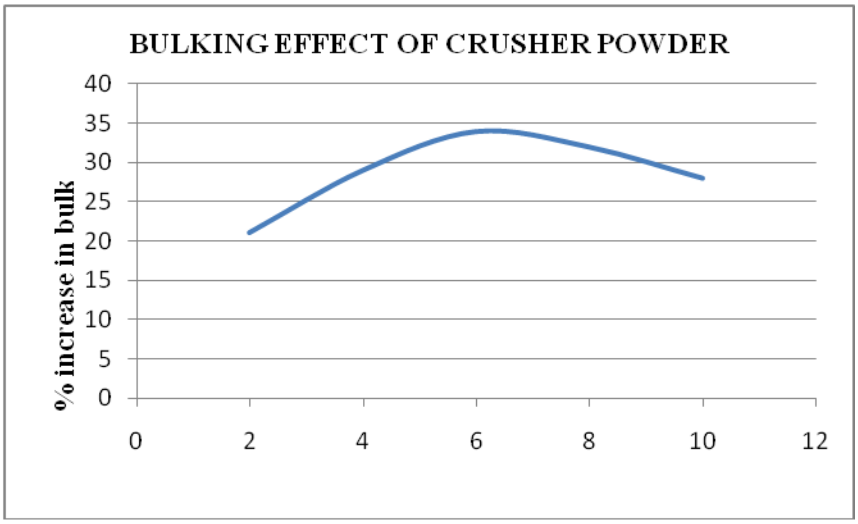

Fig 3.2 Bulking Effect of Crusher Powder

Table 3.6 Sieve Analysis of Sand

Sl No	I.S Sieve size mm	Weight Of retained gm	Retained weight of %	Cumulative % of Weight retained	% of passing
1.	4.75mm	5	0.25	0.25	99.75
2.	2.36mm	55	2.75	3	97
3.	1.18mm	385	19.25	22.25	77.75
4.	0.6mm	560	28	50.25	49.75
5.	0.3mm	880	44	94.25	5.75
6.	0.15mm	20	1	95.25	4.75
7.	Pan	95	4.75	100	0

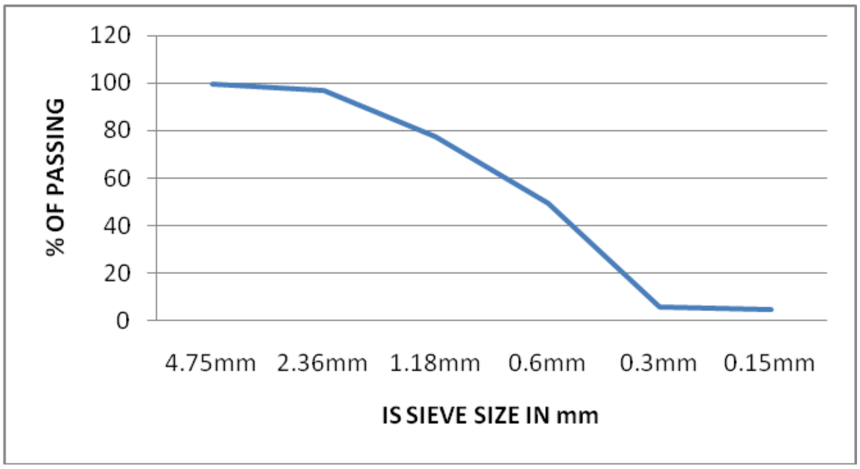

Fig 3.3 Sieve Analysis of Sand

Table 3.7 Sieve Analysis of Crusher Powder

S l No	I.S Sieve size mm	Weight Of retained gm	Retained weight of %	Cumulative % of Weight retained	% of passing
1.	4.75mm	15	1.5	1.5	98.5
2.	2.36mm	40	4	5.5	94.8
3.	1.18mm	320	32	37.5	62.5
4.	0.6mm	160	16	53.5	46.5
5.	0.3mm	175	17.5	71	29
6.	0.15mm	130	13	84	16
7.	Pan	160	16	100	0

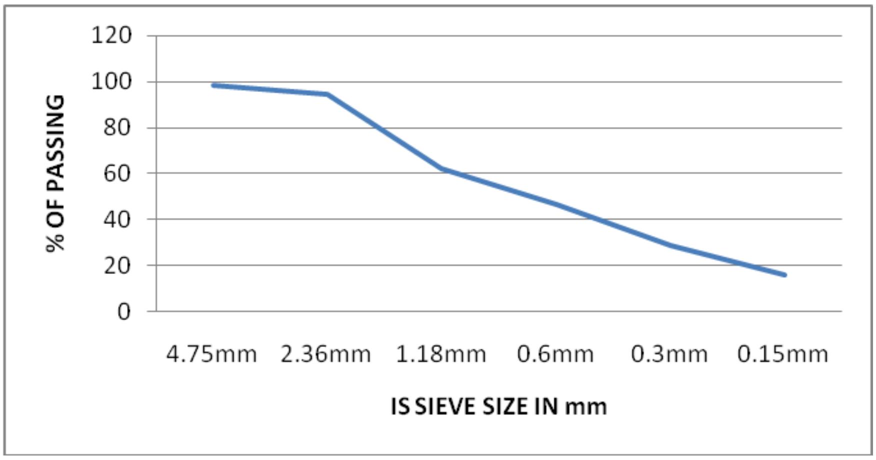

Fig 3.4 Sieve Analysis of Crusher Powder

Table 3.8 Sieve Analysis of Coarse Aggregate

Sl No	I.S Sieve size mm	Weight Of retained gm	Retained weight of %	Cumulative % of Weight retained	% of passing
1.	100mm	0	0	100	0
2.	50mm	0	0	100	0
3.	22.4mm	0.73	730	63.5	36.5
4.	4.75mm	1.27	2000	0	100
5.	2.36mm	0	2000	0	100
6.	1.18mm	0	2000	0	100
7.	0.6mm	0	2000	0	100
8.	0.3mm	0	2000	0	100

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9.	0.15mm	0	2000	0	100

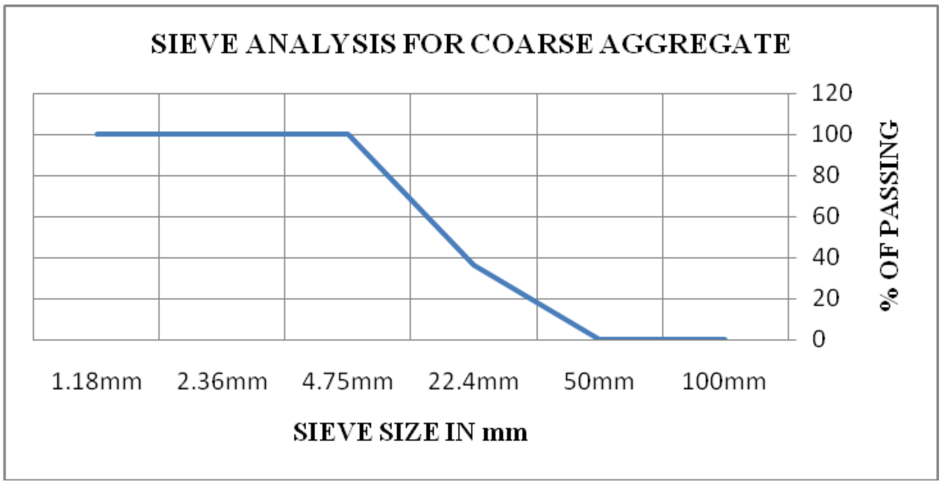

Fig 3.5 Sieve Analysis for coarse aggregate

Table 3.9 Sieve Analysis of Marble Stone

Sl No	I.S Sieve size mm	Weight Of retained gm	Retained weight of %	Cumulative % of Weight retained	% of passing
1.	100mm	0	0	100	0
2.	50mm	0	0	100	0
3.	22.4mm	0.73	730	77.5	22.5
4.	4.75mm	1.27	2000	0	100
5.	2.36mm	0	2000	0	100
6.	1.18mm	0	2000	0	100
7.	0.6mm	0	2000	0	100
8.	0.3mm	0	2000	0	100
9.	0.15mm	0	2000	0	100

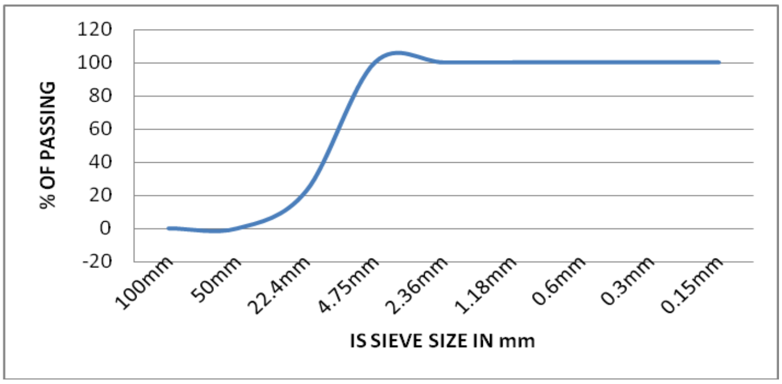

Fig 3.6 Sieve Analysis for marble stone

AVERAGE TEST RESULTS

Partially Replacement of Ingredients Materials							
CA:MS %	**RS:CP %**	**CEM:MP %**	**W/C**	**Compressive strength N/mm^2**		**Tensile strength N/mm^2** 28 DAYS	**Flexural strength/mm^2** 28 DAYS
				7DAYS	28 DAYS		
100:0	100:0:	100:0:	0.5	18.5	25.5	1.25	2.85
0:100	0:100:	0:100:	0.67	12.75	17.8	1.22	3.67

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95:5	95:5	95:5	0.65	15.75	27.85	1.20	3.35
90:10	90:10	90:10	0.45	19.85	29.95	1.15	3.78
85:15	85:15	85:15	0.48	20.25	30.5	1.10	3.75
80:20	**80:20**	**80:20**	**0.49**	**22.25**	**33.35**	**1.55**	**3.95**
75:25	75:25	75:25	0.49	21.85	33.1	1.45	3.25
70:30	70:30	70:30	0.5	21.7	32.95	1.42	3.29
65:35	65:35	65:35	0.53	21.65	32.85	1.40	3.22
60:40	60:40	60:40	0.56	20.95	32.55	1.38	3.16
55:45	55:45	55:45	0.57	20.75	32.35	1.35	3.05
50:50	50:50	50:50	0.59	20.55	32.25	1.32	2.96
45:55	45:55	45:55	0.57	20.45	32.15	1.30	2.75
40:60	40:60	40:60	0.52	20.35	32.05	1.28	2.55
35:65	35:65	35:65	0.56	19.85	31.95	1.26	2.4
30:70	30:70	30:70	0.57	19.55	31.75	1.25	2.35
25:75	25:75	25:75	0.55	19.35	30.55	1.24	2.3
20:80	20:80	20:80	0.54	19.25	29.25	1.22	2.28
15:85	15:85	15:85	0.55	18.75	28.55	1.20	2.24
10:90	10:90	10:90	0.54	18.55	27.65	1.19	2.2
5:95	5:95	5:95	0.55	18.25	26.55	1.05	2.15

CONCLUSION

[1]. The specific gravity of natural sand is more than that of crusher powder and fineness modulus is less than that of crusher powder

[2]. The specific gravity of cement is more than that of marble powder and fineness modulus is less than that of marble powder

[3]. 3 The specific gravity of marble stone is more than that of natural stone and fineness modulus is less than that of natural stone

[4]. The % of bulking of sand is more than % of bulking of crusher powder.

[5]. The compressive strength, split tensile strength and flexural strength is more for crusher powder than natural sand.

[6]. The compressive strength, split tensile strength and flexural strength is more for marble stone than natural stone.

[7]. All the ingredient materials which were replaced by 20% obtained maximum strength.

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