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Study of Strength of Concrete using Waste Marble Dust and Crushed Tiles as Partial Replacement of Fine and Coarse Aggregate

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Abstract:
With the increasing demand of construction materials and environmental degradation, there is need to find other alternatives for construction material. Use of industrial and household waste as construction material will not only decrease the demand of construction material and environmental problems but also give positive effect to the economy in construction. Crushed tiles are an industrial waste that causes environmental pollution. There is huge usage of ceramic tiles in construction purpose and its demand is increasing with time. Thus there is also increase in accumulation of waste tiles. Similarly marble is a very popularly used material and its processing produces waste such as marble dust. This study has two parts, 1st use of crushed tiles as coarse aggregate and 2nd use of marble dust as fine aggregate in concrete mix of design ratio 1:1:2. Then compressive strength at 7, 14 and 28 days are checked and compared.

Keywords: Coarse aggregate, Compressive Strength, Crushed Tiles, Fine aggregate, Marble dust

I. INTRODUCTION

Concrete is the most important material used in construction. It generally consist of Portland cement, coarse aggregate, natural sand as fine aggregate and water. Due to huge demand it is leading to exploitation of natural resources. Thus utilization of waste as construction material will be beneficial for environment as well as economically feasible. India ranks 3rd in the production of tiles, thus large amount of waste tiles are available here. These crushed tiles are hard, durable and highly resistant to any type of physical, chemical or biological changes. These crushed tiles can be utilized as coarse aggregate in concrete to some extent. Similarly, natural sand is most common used fine aggregate for construction purpose. Use of excessive sand requires excessive sand mining which is objectionable. Also, transportation of good quality of sand from long distance adds to the construction cost. Therefore an alternative for this natural sand is needed. Marble is an important construction material being used. Marble dust is produced while processing of marble blocks and about 20-25% of marbles turn into dust. This marble dust can partially replace natural sand as fine aggregate. In this study, experiment is conducted by separately using crushed tiles and marble dust in different percentage as coarse and fine aggregate respectively in a M 25 concrete mix cube and checking its compressive strength for 7, 14 and 28 days.

II. LITERATURE REVIEW

Senthamarai and Manoharan (2005)[1] suggested that the compressive, splitting, tensile and flexural strength of ceramic waste coarse aggregate are lower by 3.8,18.2 and 6% respectively when compared to conventional concrete. Fung, (2005) [2] investigated that the replacement of coarse aggregate can be raised to 50% against current practice of 30%. Sachin (2010)[3]used Marble Powder and artificial sand or manufactured sand as partial replacement for natural sand to conduct their study on mechanical behavior of concrete. Dunster (2007) [4] described the use of both natural stone waste and production waste as coarse aggregates in concrete land scaping products. Pacheco-Torgal and Said Jalali, (2011) [5] studied the behavior of strength and durability of ceramic waste based concrete. Water absorption of ceramic coarse aggregate was higher than the natural aggregate. It can be assumed that the extra water content leads to better internal curing than the controlled concrete. Sekar, (2011) [6]reported that, specific gravity of ceramic coarse aggregate varied between 2.2 to 2.56. These values were influenced the density of ceramic aggregate concrete. BabooRai, Khan Naushad, [7] the effect of marble dust was studied by replacing it partially with mortar and other components of concrete. By partial replacing the components of concrete it concludd that waste marble dust increases the compressive strength, flexural strength and workability of mortar and concrete. Information regarding use of different types of waste are available and are being practiced in large scale in present time. This study is also a part of effort to utilize waste material in construction.

III. MATERIALS

A. Fine Aggregate:

The aggregate passing through I.S. Sieve No. 480 (4.75mm) is termed as fine aggregate. Natural sand or crushed stone dust is most common used fine aggregates

TABLE.1.FINE AGGREGATE:

S.No	Property	Value
1.	Particle Size	≤ 4.75mm
2.	Sand zone	Zone 3
3.	Specific Gravity	2.606

B. *Coarse Aggregate:*

The aggregate whose particles are of such size that they are retained on I.S. Sieve No. 480 (4.75mm) is termed as coarse aggregates. Coarse aggregates which are usually obtained from crushing granite, gneiss, crystalline lime stone and good variety of sand stone etc.

TABLE.2.COARSE AGGREGATE:

S.No	Property	Value
1.	Particle Size	≤ 20mm
2.	Specific Gravity	2.65
3.	Impact Value	10.2

C. *Cement:*

Ordinary Portland cement (OPC) of Grade53 is used in the experiment. (ACC cement)

Table.3.Cement:

S.No	Property	Value
1.	Grade Used	53
2.	Fineness	92%
3.	Specific Gravity	3.15

D. *Crushed tiles as partial replacement of coarse aggregate (for 1st type of cube):*

Waste Broken tiles were collected from various sites. They were broken manually in smaller pieces using tools like hammer. Crushed tiles were passed through sieves and 20mm downsize were collected after sieving. Crushed tiles were then washed to remove dust and then dried.

Figure.1. Broken tile pieces

Figure. 2. crushed manually

Figure. 3. tiles after seiving.

E. *Marble dust as partial replacement of fine aggregate:*

Locally available marble dust is collected.

Table.4. Marble dust as partial replacement of fine aggregate

S.No	Property	Value
1.	Colour	white
2.	Odour	odourless
3.	Specific gravity	2.86

Figure. 4 .Marble dust

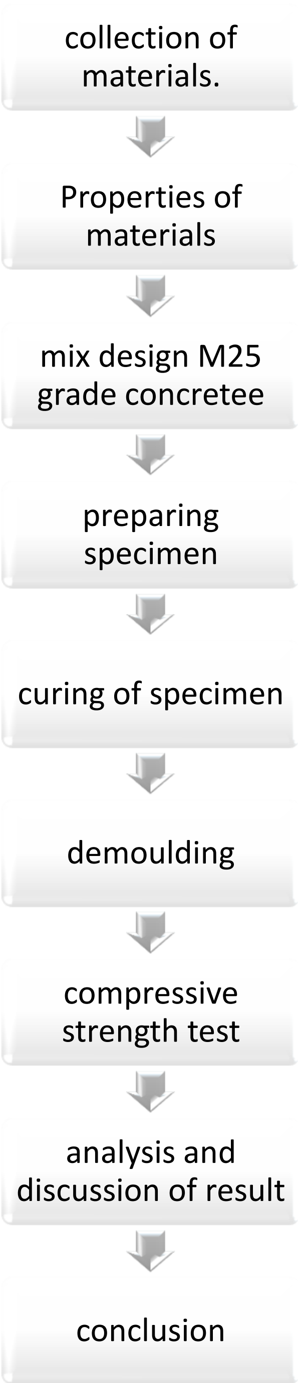
F. *Water:*

Tap water was used in mix as well as for curing.

IV. MIX DESIGN

A concrete mix ofM25 (1:1:2) was designed as per IS1026:2009 method and was used to prepare the various test samples.

V. MANUFACTURING PROCESS



A. Mixing and Moulding.

1. Different mixes were prepared by varying the percentage of replacement of coarse aggregate with crushed tiles. 10%, 25%, 50%, 75% and 100% of coarse aggregate was replaced by crushed tiles.

2. Similarly, different mixes with 10%, 25%, 50% and100% replacement of fine aggregate by marble dust were prepared. Standard 150mX150mmX150mm cube moulds were used for the purpose.

Figure .5. Mixing of materials

Figure. 6. Making concrete cubes

B. Demoulding and curing:

Cubes were removed from the mould after 24 hours of moulding, they were than immersed in water for curing to promote hydration and absorb heat of hydration till the day of test. Concrete cubes were cured for 7, 14 and 28 days.

Figure.7. 150mm comcretecube

Figure. 8. Curing of cube

C. Testing for compressive strength:

Compressive strength was tested on concrete cubes of 150x150x150 mm size, to obtain 7days, 14 days and 28 days compressive strength using compression testing machine. The max Value of compressive strength at which specimen failed was noted. The average of three samples was taken as representative of compressive strength. Then the compressive strength was calculated by dividing the max. Compressive load by cross sectional area

Fc=Failure load/ cross sectional area

Figure .9. Placing cube in compression testing machine

Figure. 10. Reading in ctm machine

VI. RESULT

A. Table.5. shows result of compressive strength of cubes by partial replacement of coarse aggregate by crushed tiles:

Table .5.

Percentage Replacement of CA by crushed tiles	7days average compressive strength. (N/mm2)	14days average compressive strength. (N/mm2)	28days average compressive strength. (N/mm2)
0	26.44	27.9	38.93
25	21.7	25.71	36.05
50	21.18	24.93	31.2
75	18.91	24.11	29.6
100	17.9	23.21	27.6

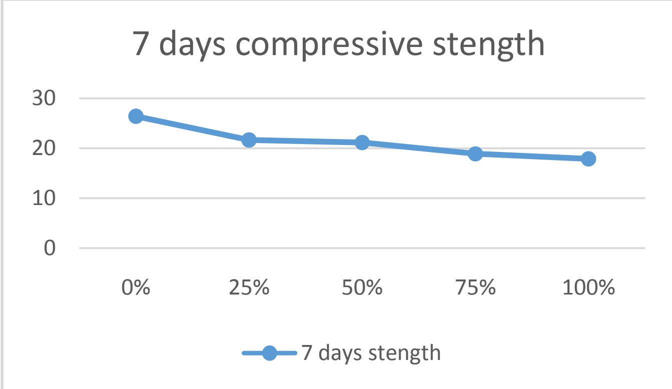


Figure.11.7 days compressive strength by partial replacement of CA by crushed tiles.

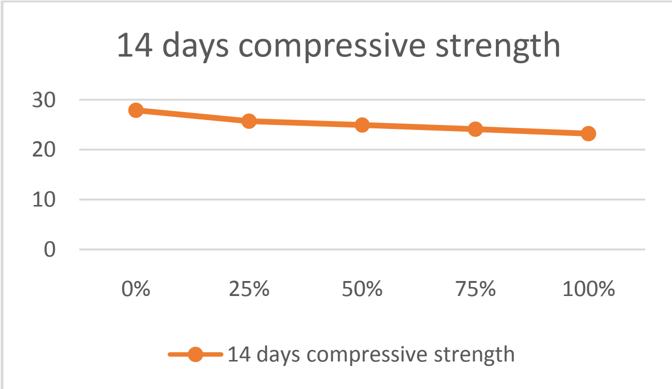


Figure.12. 14 days compressive strength by partial replacement of CA by crushed tiles.

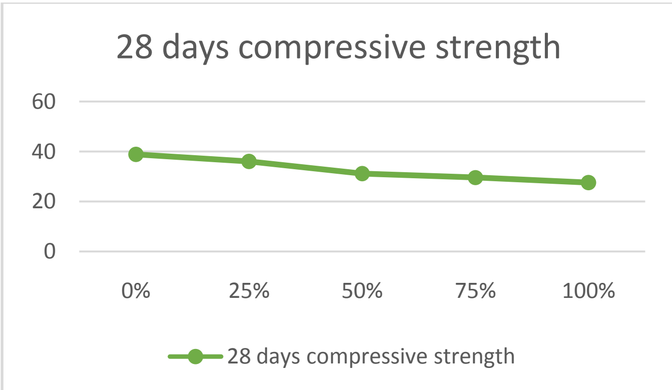


Figure.13. 28 days compressive stength of cube by replacement of CA by crushed tiles.

B. Table 2 shows result of compressive strength of cube by partial replacement by fine aggregate by marble dust

Table .6.

Percentage of marble dust in replacement of FA	7 days avg compressive strength (N/mm2)	14 days average compressive strength	28days average compressive strength
0%	21.7	24.32	31.73
25%	22.34	26.43	33.11
50%	23.11	29.25	35.54
100%	14.76	18.53	21.32

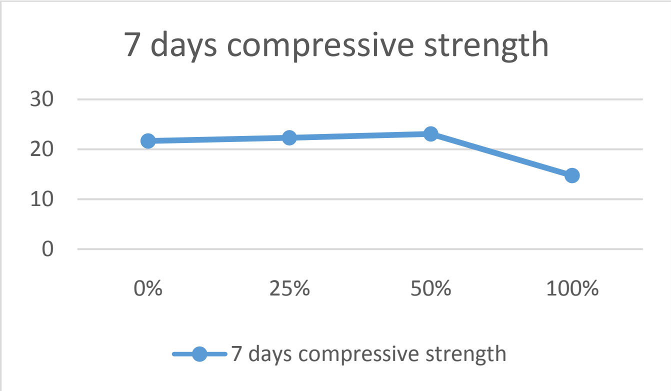


Figure.14. 7days compressive strength by partial replacement of FA by marble dust.

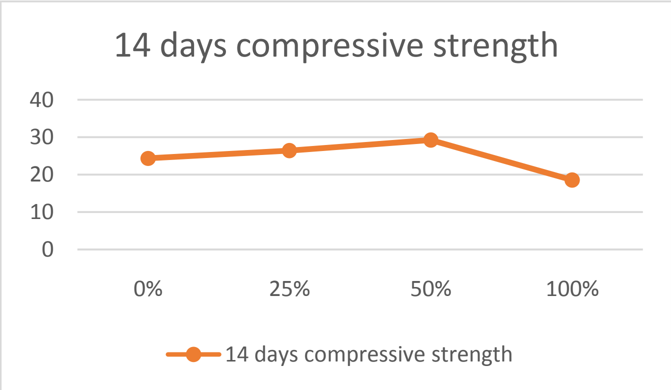


Figure.15. 14 days compressive strength by partial replacement of FA by marble dust.

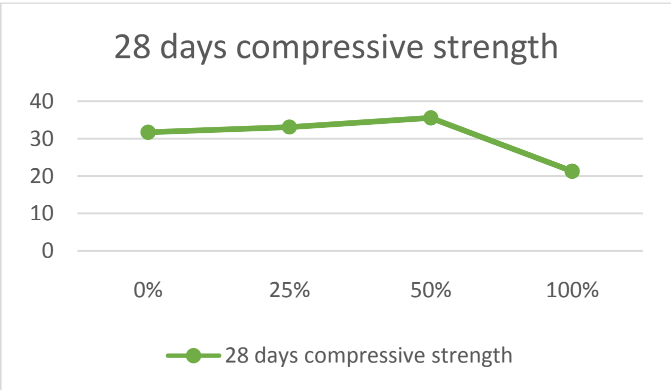


Figure.16. 28 days compressive strength by partial replacement of FA by marble dust.

VII. CONCLUSION

Crushed tiles as well as marble dust both are environmental problems and their utilization in concrete can prevent environmental degradation. Above study shows that crushed tiles and marble dust can be used as partial replacement of coarse and fine aggregate respectively upto certain percent (not more than 50%) to get satisfactory strength and reduce cost of construction considerably.

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