Study of Properties of Concrete with Partial Replacement of Conventional Coarse Aggregate by Ceramic Waste and Fine Aggregate by Stone Dust

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ABSTRACT

This study was conducted to analyze the compressive and flexural strength of concrete when natural sand was replaced with stone dust at 20%, 40 %, 60%, 80 % and 100% along with 20 % replacement of coarse aggregate by ceramic waste. To increase the workability of concrete Superplast HS, s was used as an superplasicizer. The percentage of ceramic waste is kept 20% for all specimens. It is found that at 40 % replacements of natural sand with stone dust along with 20% replacement of stone aggregate by ceramic waste, the compressive strength as well as flexural strength reached their maximum values, as compared to other proportions. It is also found that it is not feasible using ceramic waste alone as a replacement of coarse aggregate because it decreases the compressive as well as flexural strength of concrete considerably. The study concludes that the stone dust with 20 % of ceramic waste as a coarse aggregate can be employed effectively as a choice of natural sand for nominal concreting up to 40 % for M20 grade of concrete.

Keywords: compressive strength split tensile strength, M20, stone dust, ceramic waste

1. INTRODUCTION

The recent building boom has contributed to a spectacular growth in the cost of natural sand and stone aggregates. Additionally, various government agencies have set restrictions on sand and stone quarrying to conserve this diminishing natural resource. This has prompted many engineers to look for alternate materials that are cheaper while possessing similar features.

In the last decade, construction industry has been conducted various researches on the utilization of waste products in concrete in order to reduce the utilization of natural resources.T.Sekar et al (2011), suggested that the compressive strength of concrete cubes made with ceramic insulator and glass insulator were found to be 16% and 26.34% lesser respectively than that of conventional concrete[1].Veera Reddy(2010), concluded that replacement of coarse aggregate by ceramic scrap

in excess of 20%, leads to reduction of strength below conventional mix (MC)[2].Osama M. Ghazi carried out an investigation to use of crushed clay brick as aggregates in producing concrete and concluded that compressive as well as split tensile strengths of crushed clay brick aggregate concrete were always lower than the natural aggregate concrete regardless the age of concrete[3]. Khaloo used crushed clinker bricks as the course aggregate in concrete. He reported only a 7% loss in concrete compressive strength compared to concrete made with natural aggregates. In addition to this decrease in strength, there is a decrease in the unit weight of crushed brick concrete of 9.5%[4].

One such option is the use of stone dust-a byproduct of crushers as replacement of stone dust and ceramic waste as a replacement of coarse aggregate. These materials are easily available at very low monetary value as compared to natural fine and coarse aggregates. So in the present work, an effort has been constituted to evaluate the suitability of stone dust and ceramic scrap in concrete making. In the laboratory stone dust has been tried as fine aggregate in place of sand and ceramic scrap has been applied as a partial substitute to conventional coarse aggregate in concrete.

2. EXPERIMENTAL PROGRAM

An extensive experimental program has been executed to ascertain the compressive and the flexural strength of concrete when conventional coarse aggregate is replaced by ceramic waste and fine aggregate by stone dust. The experiment was conducted on six different proportions of conventional fine aggregate replaced by stone dust along with 20 percent replacement of coarse aggregate by ceramic waste and the result so obtained was compared with that of conventional concrete. The experimental program involved the evaluation of compressive strength and flexural strength of concrete.

3. MATERIALS

Cement: In this experimental study Portland Pozzolona cement of 43 grades is used.

Fine aggregate: In this study locally available sand which is free from impurities is used. The size of it is less than 4.75 mm. The specific gravity and fineness modulus of this fine aggregate where found to be 2.67 and 2.87 respectively. The percentage of passing is within the limits as per IS: 383-1970 [5].

Coarse aggregate: The coarse aggregate used here is 20mm in size, crushed angular shape and free from dust. The specific gravity and fineness modulus was found to be 2.79 and 6.93 respectively and the impact value was found to be 9.46 %. The percentage of passing is within the limits as per IS: 383-1970 [5].

Ceramic waste: The ceramic waste used as the substitute for coarse aggregate. They have been crushed manually into the required size of 20 mm approximately. The impact value was found to be 22.53%.

Stone Dust : The Stone Dust used as the substitute of natural river sand is of specific gravity 2.5 and The size of it is less than 4.75 mm.

Superplast HS : It is a is a concrete admixture based on specially selected high molecular weight organic polymers. This has high plasticising effect which is retained over a longer period and acts as a high range water reducer for concrete and mortar.

Mix Proportions

The concrete mix is designed as per IS 10262 – 2009 [6], IS 456-2000 [7] for the normal concrete. Finally the chemical admixture, Superplast HS which is 0.8%by weight of cement is added to the concrete. The grade of concrete, which we adopted is M20 with the water cement ratio of 0.48.

4. RESULTS AND DISCUSSION

After a detailed study we have obtained the following results for compression and flexure tests as shown in table.

Table : Behavioral Strengths of Concrete

Specimen Type / Properties	Conventional Concrete	0 % Stone Dust with 20 % Ceramic Waste	20 % Stone Dust with 20 % Ceramic Waste	40 % Stone Dust with 20 % Ceramic Waste	60 % Stone Dust with 20 % Ceramic Waste	80 % Stone Dust with 20 % Ceramic Waste	100 % Stone Dust with 20 % Ceramic Waste
Compressive strength (N/mm^2)	25.18	18.44	20.83	23.54	19.27	18.17	15.98
Flexural strength (N/mm^2)	4.23	3.17	3.39	4.12	3.49	2.57	2.35

Effect on Compressive strength: It is evident from the graphs that the maximum compressive strength of concrete is obtained on 40% replacement of conventional fine aggregate by stone dust along with 20 % ceramic waste which is kept constant throughout the study. It has been also found

that this maximum compressive strength is 6.5 % lower than the conventional concrete. However the replacement of fine aggregate increasing upto 40% the concrete compressive strength is significantly increased after that it is decreased. Hence the replacement of 40% fine aggregate with stone dust along with 20% ceramic waste is found to be optimum and can be effectively used in normal concreting.

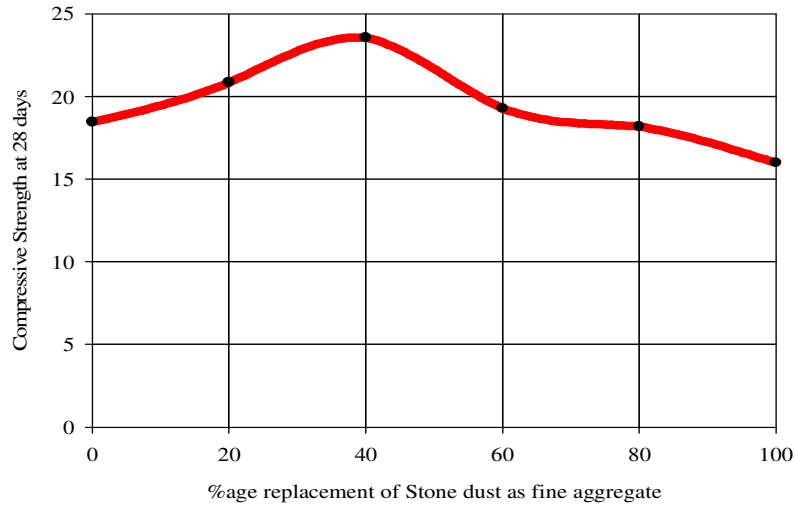

Fig. 1. Variation of compressive strength with percentage replacement of Stone dust alongwith 20 % ceramic waste as a coarse aggregate

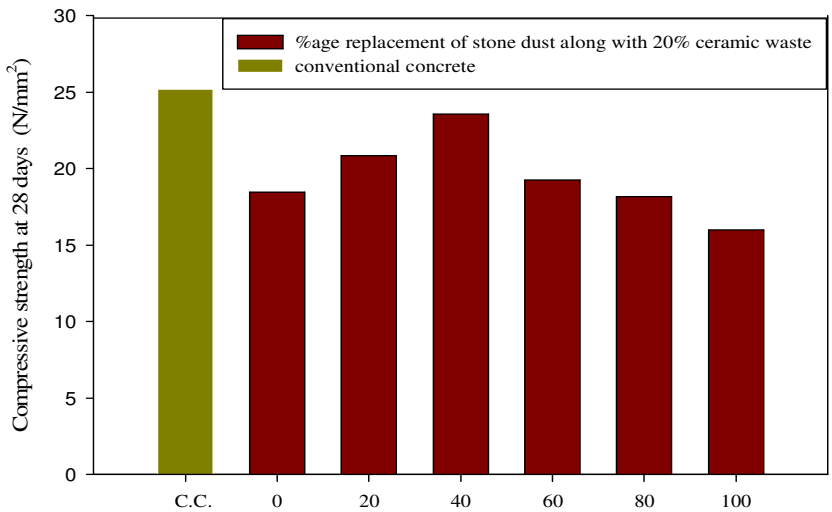

Fig. 2. Compressive strength of different types of specimens at 28 days curing

Effect on Flexural strength: the maximum flexural strength of concrete is also obtained on 40% replacement of conventional fine aggregate by stone dust along with 20 % ceramic waste which is kept constant throughout the study. The flexural strength of the conventional concrete has been found to be 4.23 N/mm^2. However when compared with conventional concrete the flexural strength has been decreased by 25 %, 20.3%, 2.6%, 17.5%,39.2% and 44.4% for 0%, 20%, 40%, 60%, 80% and 100% replacement of fine aggregate with stone dust aloing with 20% ceramic waste as a coarse aggregate.it is observed that flexural strength has increased on increasing the proportions of stone dust upto 40% after that it started to decreasing.

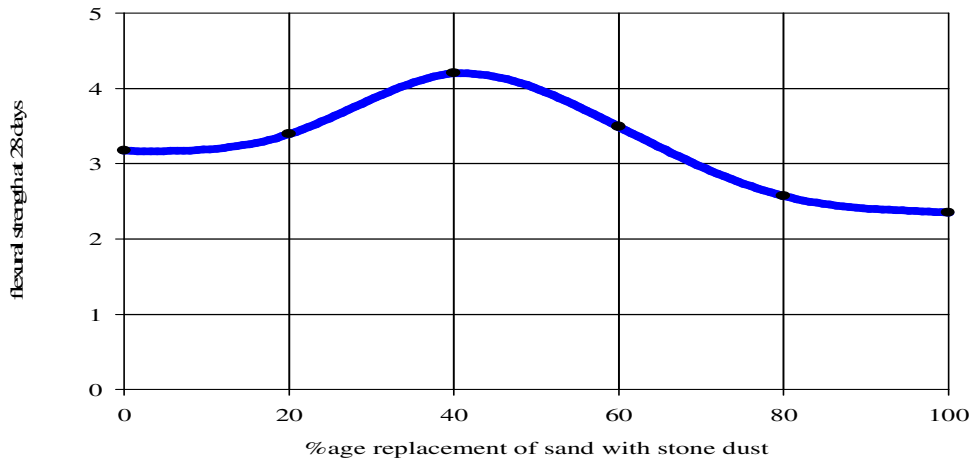

Fig 3. Variation of flexural strength with percentage replacement of Stone dust alongwith 20 % ceramic waste as a coarse aggregate

Fig 4. Flexural strength of different types of specimens at 28 days curing

5. CONCLUSION

The following conclusions are drawn from the present study:

- The compressive and flexural strength of concrete with 40% replacement of natural sand by stone dust along with 20% replacement of coarse aggregate by ceramic waste reveals higher strength as compared to 0 % replacement of natural sand by stone dust along with 20% replacement of coarse aggregate by ceramic waste.It is found that as compared to flexural strength the compressive strength greatly decreased when only ceramic waste is used as a 20% replacement of coarse aggregate (i.e.at 0% stone dust and 20 % ceramic waste) .
- So it is advised on the basis of the present study that ceramic waste alone could not be used as a replacement of coarse aggregate because it adversely effect on the properties of concrete. On the other hand, if it is used with the stone dust it gives satisfactory results on 40 % of replacement of fine aggregate with stone dust. The properties of concrete are found to be enhanced upto 40 % replacement of fine aggregate with stone dust and after that it decreases.Thus we found out the optimum percentage for replacement of stone dust with fine aggregate along with 20% replacement of coarse aggregate by ceramic waste is almost 40% .

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