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Partial Replacement of Conventional Materials in Concrete

Srinivasa Rao B[1], Gopala Raju SSSV[2], Sunil Bhagat T[3]
[1]Lecturer, [2]Associate Professor, [3]Assistant professor, Department of Civil Engineering, RGUKT-Nuzvid, Andhra Pradesh, India.

Abstract: Concrete is one of the most widely used building materials in the world due to its versatility and durability. The main ingredient of concrete is cement which releases large quantities of CO_2 into the atmosphere during its manufacturing process. Due to lack of availability of construction materials such as coarse aggregate and fine aggregate, the construction cost is increasing day by day. This problem can be solved by replacing conventional materials used in concrete with alternate materials without compromising the strength requirements. Past studies focused on individual replacement of cement with metakaolin, fine aggregates with stone dust, coarse aggregate with waste crushed glass and coconut shells etc,. In present study, performance of concrete is studied by replacing cement partially with Metakaolin, fine aggregate partially with quarry dust and crushed glass. Keeping 10% Metakaolin and 30% Quarry dust as optimum percentages from the literature, the percentage of crushed glass is varied and the performance of concrete has been studied. From the compressive strength results, it has been observed that 20% of fine aggregate replaced with crushed glass performed better and 10% of fine aggregate replaced with crushed glass was performed better against tensile strength.
Keywords: Metakaolin, Quarry dust, Crushed glass, Compressive strength and Tensile strength

I. INTRODUCTION

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementing materials, water and aggregates, and sometimes admixtures, in required proportions. The use of river sand as fine aggregate leads to exploitation of natural resources, lowering of water table. When waste glasses are reused in making concrete products, the production cost of concrete will go down. This move will serve two purposes; firstly, it is environment friendly; secondly, it sustains precious and relatively costlier natural resources. Metakaolin is a cementitious material used as mineral admixture to produce high strength concrete and is used for maintaining the consistency of concrete.

Quarry dust is a by-product of quarry crushing which can be used as fine aggregate. The use of quarry dust in concrete is desirable because of its benefits such as useful disposal of by products, reduction of river sand consumption as well as increasing the strength parameters and increasing the workability of concrete.

Iqbal Malik et. al [1] proposed partially replacement of fine aggregates with waste glass as 10%, 20%, 30% and 40% by its fine aggregate weight. Satisfactory results were observed when fine aggregate is replaced by waste glass up to 30 % by weight to increase compressive and tensile strengths. Satyendra et al. [2] proposed the use of Metakaolin as an admixture to produce high strength concrete and is used for maintaining the consistency of concrete. Mixes M1, M2, M3 and M4 were used by replacing 0,5,10 and 15 percent mass of cement by Metakaolin. It was observed that the compressive strength was increased when 10 % of cement is replaced with Metakaolin in concrete mix [M2]. Iqbal Malik et. al [3] investigated on partial replacement of fine aggregates with quarry dust as 0%, 10%, 20%, 30% and 40% by weight. It was found that maximum increase in compressive strength obtained for the concrete mix containing 30% quarry dust as fine aggregate compared to nominal mix M-25 grade of concrete. There is no detailed investigation on partial replacement of fine aggregate with quarry dust and crushed glass, and cement with Metakaolin in same mix proportion.

II. METHODOLOGY

A. Cement (C) and Aggregates

MAHA ordinary Portland cement of 43 grade confirming with IS 8112 [4] was used throughout the work. Fine Aggregate (FA) used throughout the work comprised of clean river sand of zone III confirming as per IS 383 [5] with specific gravity of 2.65. Coarse Aggregate (CA) used is crushed stone aggregates of angular in shape passing through the 20 mm IS sieve and retained in 4.75 mm IS sieve with specific gravity of 2.71. Maximum size of coarse aggregate is 20 mm confining to IS 383 [5].

B. Metakaolin (MK), Quarry Dust (QD) and Waste crushed glass (CG)

Metakaolin is pozzolanic materials which is manufactured from selected kaolin's, after refinement and calcination under specific condition. Specific gravity of Metakaolin is 2.20 and other physical properties like soundness, consistency and setting times are under permissible limits as per IS codes. Quarry dust is a by-product of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. The use of quarry dust in concrete is desirable because of its benefits such as useful disposal of by products, reduction of river sand consumption as well as increasing the strength parameters and increasing the workability of concrete. Specific gravity of quarry dust is 2.61. Use of waste glass in concrete will eradicate the disposal problem of waste glass and prove to be environment friendly thus paving way for greener concrete. Specific gravity of waste crushed glass is 2.5.

C. Mix Proportion

The concrete mix design was proposed by using IS 10262 [6]. The concrete ingredients generally are cement, water, Coarse and fine aggregate. The grade of concrete used was M-25 with water to cement ratio 0.45. In the present study partial replacement of cement with 10% Metakaolin (MK), fine aggregate with 30 % quarry stone dust (QD) and fine aggregate with waste crushed glass (CG) as 5 %, 10 %, 20 % and 30 % obtained M-1, M-2, M-3 and M-4 respectively (Table 1). Nominal Mix (N-M) considered design mix M-25 grade without replacing any conventional material (Table 2). The mix proportions used in mixes with their symbols are shown in Table 2. The ingredients used in concrete are shown in Fig.1

Table 1. Representation of Mix Proportions with symbols with replacing different % of conventional materials

Mix Type (Symbol)	Replacement of Cement with Metakaolin (MK) in %	Replacement of fine aggragate with Quarry Dust (QD) in %	Replacement of fine Aggregate with Waste crushed glass (CG) in %	Ingredients of Materials in Mix by using Symbols
Nominal Mix (N-M)	0	0	0	C + W + FA +CA
Mix-1 (M-1)	10	30	5	C+MK+FA+QD+ 5 % CG+CA
Mix-2 (M-2)	10	30	10	C+MK+FA+QD+ 10 % CG+CA
Mix-3 (M-3)	10	30	20	C+MK+FA+QD+ 20 % CG+CA
Mix-4 (M-4)	10	30	30	C+MK+FA+QD+ 30 % CG+CA

Table 2. Mix Proportions of various mixes used in the study

Mix Type	w/c ratio	Water (kg/m^3)	Cement (kg/m^3)	Metakaolin (kg/m^3)	Fine aggregate (kg/m^3)	Quarry Dust (kg/m^3)	Waste crushed glass (kg/m^3)	Coarse aggregate (kg/m^3)	Slump (mm)	Compaction Factor
N-M	0.45	170	377.77	0.00	696.22	0.00	0.00	1225.60	90	0.82
M-1	0.45	170	340.00	37.77	449.24	204.21	32.60	1216.78	75	0.75
M-2	0.45	170	340.00	37.77	414.68	204.21	65.20	1216.78	80	0.81
M-3	0.45	170	340.00	37.77	345.57	204.21	130.40	1216.78	85	0.89
M-4	0.45	170	340.00	37.77	311.01	204.21	163.00	1216.78	100	0.95

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Fig. 1. Waste crushed glass and concrete ingredients used in the mixes

D. Tests on Fresh concrete

The workability of all concrete mixes was determined by using slump test utilizing a metallic slump cone mould and compaction factor test. The difference in level between the height of the mould and that of highest point of the subsided concrete measured as slump in mm. The slump tests were conducted as per IS 1199 [7]. In this study, concrete mixes workability determined using compaction factor test is as per IS 1199 [7].

E. Tests on Hardened Concrete

From each type of concrete mix, cube of size 150mm X 150mm X 150mm and 150mm x 300 mm cylinders have been casted to determine the compressive strength and split tensile strength respectively. The concrete specimens were cured under normal conditions as per IS 516 [8] and tested at 7 days and 28 days for determining compressive strength [8] and split tensile strength determined as per IS 5816 [9].

III.RESULTS AND DISCUSSIONS

A. Fresh concrete

The slump and compaction factor of all mixes are given in Table 2. It was observed that the slump and the compaction factor values increased with increase in percentage waste crushed glass by partial replacing fine aggregate. Waste glass particles absorbed less water as compared to the sand and thus improving the workability of concrete mixes. Slump and compaction factor observed maximum in M-4 mix The slump and compaction factor values for M-1 and M-2 are found less compared to nominal mix (N-M) due to the 30 % replacement of quarry dust with fine aggregate. Quarry dust particles absorbed more water when compared to that of sand and reduction in workability was observed in M-1 and M-2.

B. Hardened concrete

The concrete is tested for compressive strength and split tensile strength at 7 days and 28 days. It was observed that there is increase in compressive strength for M-1, M-2 and M-3 and thereafter decreasing for M-4 at 7 and 28 days curing (Fig. 2). Compressive and split tensile strength of all mixes (M1, M2, M3 and M4) are found higher than nominal mix (N-M) which is given in Table 3. Compressive strength of M-3 observed 40 % more than the nominal mix at 28 days curing. Split tensile strength is found increasing for M-1, M-2 and decreasing for M-3 and M-4 (Fig. 3). Split tensile strength of M-2 observed 45 % higher than the Nominal mix (N-M) at 7 days and 28 days curing period. Compressive strength in M-3 and split tensile strength in M-2 found higher than the other mixes including nominal mix. From the results it is observed that the ideal percentage partial replacement of fine aggregate with waste crushed glass is up to 30 %, with constant replacing fine aggregate with 30 % stone dust and constant replacement of cement with 10 % Metakaolin.

Table 3. Compressive and Split Tensile strength results

Mix Type	Avg. Compressive strength (MPa)		Avg. Split Tensile Strength (MPa)	
	7 Days curing	28 Days curing	7 Days curing	28 Days curing
N-M	32.66	35.11	2.67	3.09
M-1	35.77	38.67	2.95	4.15
M-2	41.9	45.67	3.15	4.48
M-3	45.46	50.22	3.04	4.38
M-4	39.24	49.18	2.33	3.16

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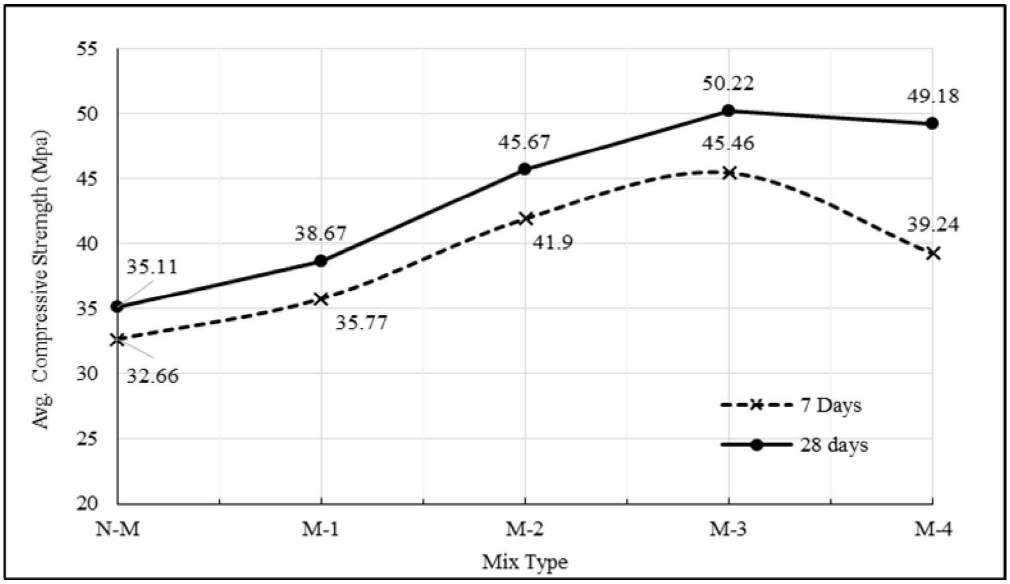


Fig. 2. Compressive strength of various mixes for 7 and 28 days curing

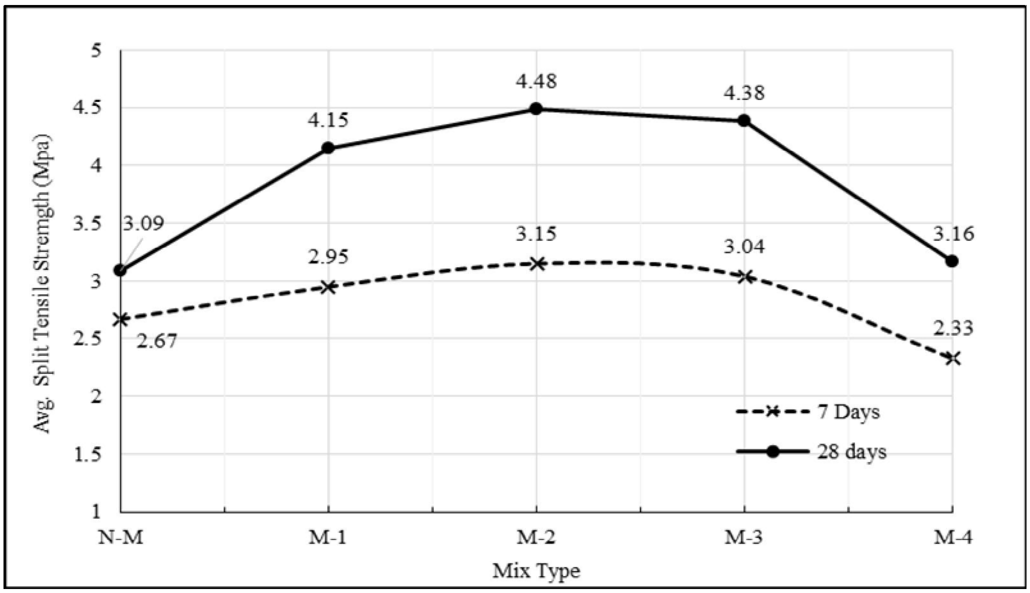


Fig. 3 Split Tensile strength of various mixes for 7 and 28 days curing

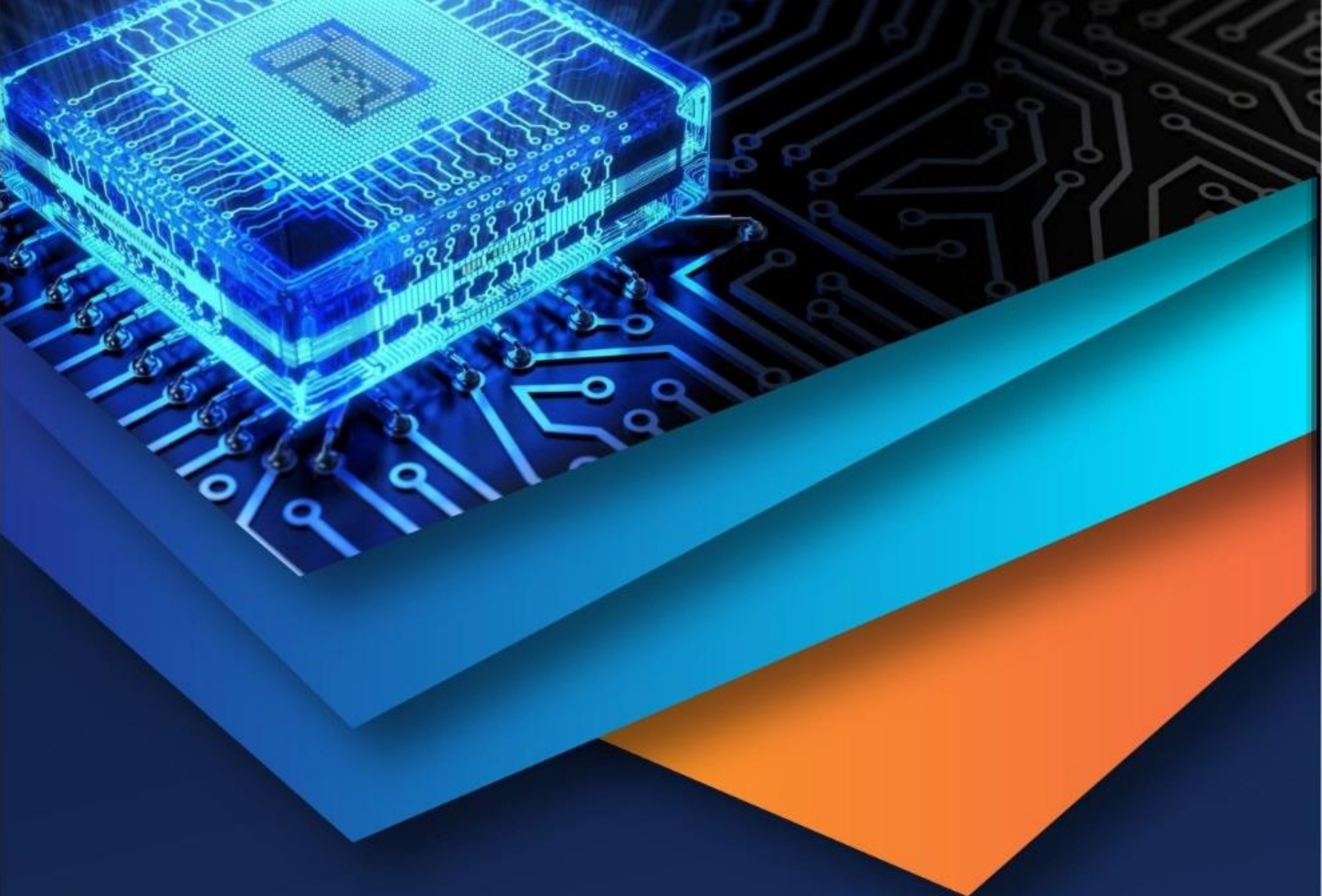
IV. CONCLUSIONS

Following conclusions are drawn from above results.

A. It was found that the quarry dust and waste crushed glass can be used as alternative materials for fine aggregate. Partial replacement of cement with Metakaolin can be used.
B. The Physical properties of quarry dust, waste crushed glass and metakaolin satisfy the requirements of the aggregate and cement respectively.
C. Compressive strength increased up to 40% compared to conventional concrete when 20% fine aggregate replaces with crushed glass.
D. Split tensile strength increased up to 45% compared to conventional concrete when 10% fine aggregate replaces with crushed glass.
E. Mix M2 (C+MK+FA+QD+ 10 % CG+CA) can be considered as ideal mix.
F. Use of quarry dust and waste crushed glass also reduces cost of concrete and sustains the natural resources particularly river sand (about 50%) compared to nominal mix.

REFERENCES

[1] M. Iqbal Malik, M. Bashir, S. Ahmad, T. Tariq, and U. Chowdary, " Study of Concrete Involving Use of Waste Glass as Partial Replacement of Fine Aggregate", IOSR Journal of Engineering, Vol. 3 (7), pp. 08-13, July. 2013.
[2] Satyendra Dubey, Rajiv Chandak, and R.K. Yadav, "Effect of Metakaolin on compressive Strength of Concrete", International Journal of Engineering Research and Applications, Vol. 5(6), pp. 80-82, June. 2015.
[3] M. Iqbal Malik, S. Rumysa Jan, J.A. Peer and S. A. Nazir, " Study of Concrete Involving Use of Quarry dust as Partial Replacement of Fine Aggregates", IOSR Journal of Engineering, Vol. 5 (2), pp. 05-10, February. 2015.
[4] IS 8112: 2013, " Ordinary Portland cement, 43 Grade- Specification", Second Revision, Bureau of Indian Standards, New Delhi, 2013.
[5] IS 383: 2016, "Coarse and Fine Aggregate - Specification", Third Revision, Bureau of Indian Standards, New Delhi, 2016.
[6] IS 10262: 2009, " Concrete Mix Proportioning- Guidelines ", First Revision, Bureau of Indian Standards, New Delhi, 2009.
[7] IS 1199: 1959, " Methods of Sampling and Analysis of Concrete ", Bureau of Indian Standards, New Delhi, 1959.
[8] IS 516: 1959, " Methods of Tests for Strength of Concrete ", Bureau of Indian Standards, New Delhi, 1959.
[9] IS 5816: 1999, " Splitting Tensile Strength of Concrete- Method of Test " First Revision, Bureau of Indian Standards, New Delhi, 1999.
[10]M.S. Shetty, " Concrete Technology: Theory and Practice", S. Chand & Company Limited, First Edition, New Delhi, 1982.
[11]M.L. Gambhir, " Concrete Technology: Theory and Practice", McGraw Hill Education Private Limited, Fourth Edition, New Delhi, 2011.



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