iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 2 **Issue:** XI **Month of publication:** November 2014

DOI:

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Strength Properties of Concrete by Replacing Coarse Aggregate with Blast Furnace Slag and Fine Aggregate with Crusher Dust

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Abstract*: The demand of river sand in the construction industry has consequently increased due to Urbanization and mass construction of housing resulting in the reduction of natural sources and also an increase in price. In such a situation crusher dust or robo sand can be an economical alternative to the river sand. Hence crusher dust was used as replacement of fine aggregate with a dosage of 10%, 20%, 30%, 40% and 50%. In order to reduce the cost of concrete the usage of pozzolan in place of cement is also proposed to use. Blast Furnace Slag is a non-metallic product consisting essentially of Silicates and Alumino silicates of calcium's developed simultaneously with iron in a blast furnace and is granulated by quenching the molten material in water or steam, and air. The present Investigation has been undertaken to study the effect of blast furnace slag and crusher dust on the mechanical properties of concrete, when coarse aggregates is replaced by blast furnace slag and fine aggregate with crusher dust in different percentages i.e. 0%, 10%, 20%, 30%, 40% and 50%. The main parameters investigated were cube compressive strength, split tensile strength and flexural strength. The tests were conducted on concrete with ratio 1:1.86:3.77.

Keywords: Blast Furnace Slag, Crusher Dust, Compressive Strength, split Tensile Strength and Flexural Strength.

I. INTRODUCTION

Sustainable construction mainly aims at reduction of negative environmental impact resulted by construction industry which is the largest consumer of natural resources. Over a period of time, waste management has become one of the most complex and challenging problem in the world which is affecting the environment. The rapid growth of industrialization gave birth to numerous kinds of waste by products which are environmentally hazard and creates problems of storage. Always, construction industry has been at forefront in consuming these waste products in large quantities.

Blast furnace slag is a non-metallic material consisting of silicates and aluminosilicate of calcium and magnesium together with other compounds of sulphur, iron, manganese, and other trace elements.

The successful utilization of crusher dust as fine aggregate and blast furnace slag as coarse aggregate would turn this waste materials that causes disposal problem into a valuable resource. The utilization will also reduce the strain on supply of natural fine aggregate, which will also reduce the cost of concrete.

The main objective of the present investigation is to evaluate the possibilities of using crusher dust as a replacement to fine aggregate and blast furnace slag as a replacement to coarse aggregate. Present investigation aimed at to study, 10%, 20%, 30%, 40% and 50%, 80 of traditional fine aggregate was replaced with quarry dust and coarse aggregate was replaced with Blast furnace slag. Compressive strength, split tensile strength and flexural strengths were found after 28 days of curing.

II. EXPERIMENTAL PROGRAM AND TEST RESULTS

Ordinary Portland cement of grade 53 conforming to the Indian standard specification, Fine Aggregate of grading zone II obtained from Godavari river bed, Coarse Aggregate, Crusher Dust and Blast Furnace Slag has been used. Fine aggregate, coarse aggregate, crusher dust and blast furnace slag were tested and found to conform to Indian Standard Codal Provisions and their physical properties are given in Table 1.

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S.No	Type of Aggregates	Specific Gravity	Crushing value,%	Fineness modulus	Water Absorption,%
1	Coarse aggregate	2.78	27.5	6.65	1.14
2	Fine aggregate	2.67	_	2.55	1.07
3	Blast Furnace Slag	3.18	_	2.93	1.76
4	Crusher Dust	2.71	_	3.17	2.11
	IS 383:1970	2.6-2.8	45%	5.5-8.0	<10

Table 1: Physical Properties of Aggregates

A. Mix design and Mix proportions

The designed concrete mix (1:1.86:3.77), for a target mean strength of 26.6 MPa, contains ordinary Portland cement, sand conforming to grading zone II, Crusher Dust as fine aggregate and Blast Furnace Slag as coarse aggregate are used respectively. The w/c ratio was 0.45 in the present control mix designated.

% of replacement	Cement kg	Coarse aggregate kg	Blast furnace slag kg	Fine aggregate kg	Crusher dust kg	Water Ltrs
0	340	1282	0	630	0	170
10	340	1154	128	567	63	170
20	340	1025	257	504	126	170
30	340	898	384	441	189	170
40	340	769	513	378	252	170
50	340	641	641	315	315	170

Table 2: Mix Proportions of Trial mixes

B. Cube Compressive Strength of concrete mixes

The compressive strength of the concrete speciemens at 28 days were illustrated in table 3. Fig. 1 depicts that the early age compressive strength of concrete specimens can be improved marginally by incorporating 30% crusher dust in place of river sand and beyond which the decreasing trend is observed. On the other hand, the strengths of concrete mixes at the age of 28 days is same as controlled concrete with increasing percentage replacement of river sand with crusher dust and coarse aggregate with blast furnace slag up to 30% and there after shows again the decreasing trend.

C. Split Tensile Strength

The split tensile strength of the concrete speciemns at 28 days were tested and the results are ahown in table 3. The tensile strength of concrete mixes are increased marginally till 30% replacement of river sand with cusher dust and coarse aggregate with blast furnace slag. Hence the crusher dust and blast furnace slag can be effectively introduced in place of river sand and coarse aggregate with blast furnace slag in concrete mix.

D. Flexural Strength

The flexural strength of concrete specimens at 28 days are given in table 3. Only marginal increase in the fluxural strength of concrete specimens were observed with a replacement of up to 30% of river sand with crusher dust and coarse aggregate with blast furnace slag.

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% of replacement C.A with blast furnace slag and F.A with crusher dust	Compressive Strength (N/mm^2)	Split Tensile Strength (N/mm^2)	Flexural Strength (N/mm^2)
	28days	28days	28days
0	27.63	3.03	5.61
10	27.04	2.95	5.63
20	27.38	3.01	5.66
30	27.98	3.26	5.68
40	20.36	2.81	5.49
50	17.04	2.73	5.19

Table 3: Average Strengths of the Concrete Specimens (N/mm^2)

III. TEST RESULTS ON HARDENED CONCRETE

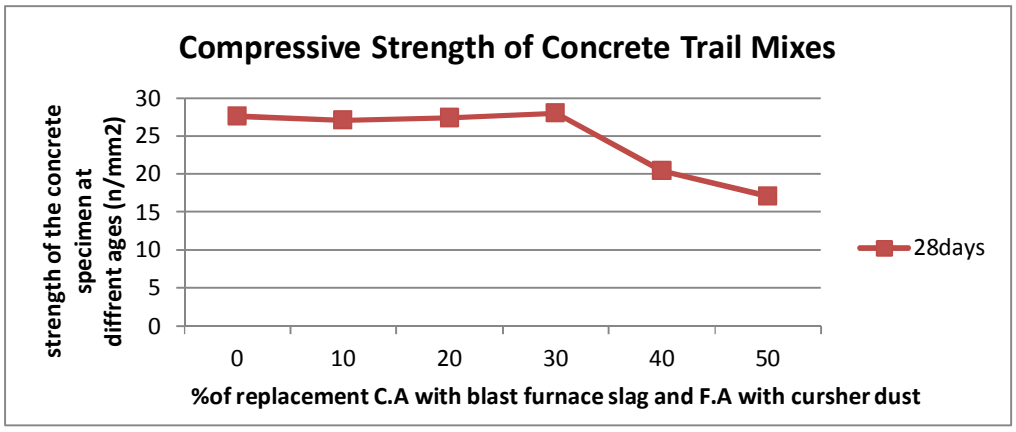

Fig 1: Compressive Strength of Concrete Trial Mixes at 28 days

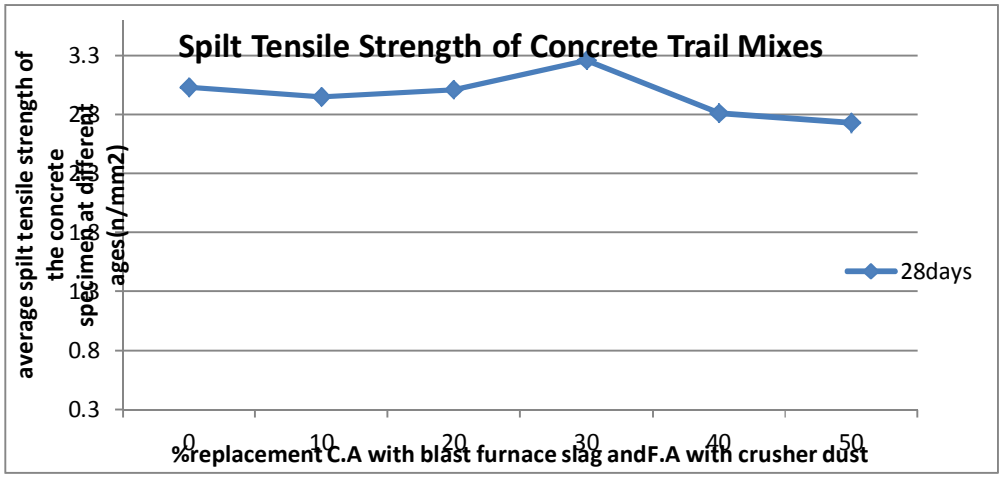

Fig 2: Split Tensile Strength of Concrete Trail Mixes at 28 days

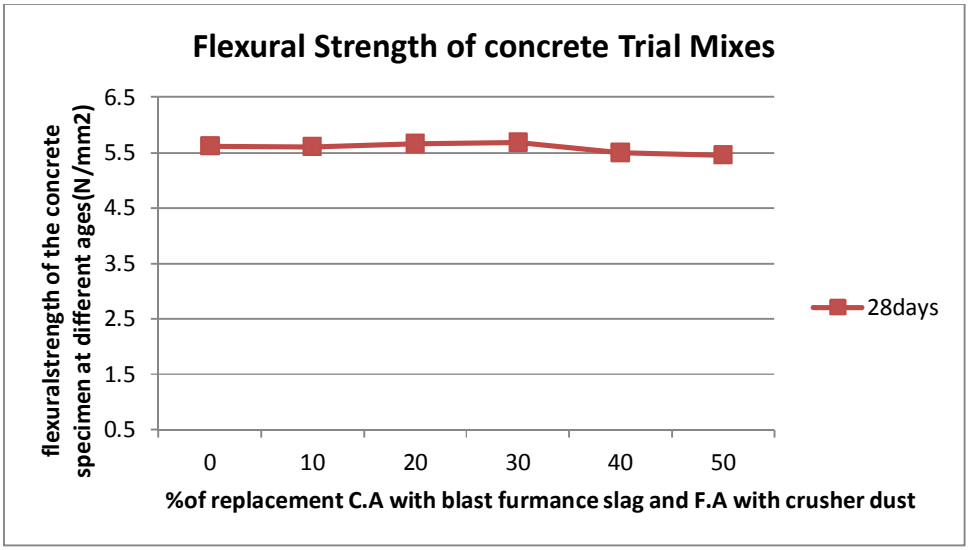

Fig 3: Flexural Strength of Concrete Trail Mixes at 28 days

IV. CONCLUSIONS

Based on the experiments performed in the laboratory, the following conclusions can be drawn with respect to M25 concrete mix

A. The physical properties of crusher dust and blast furnace slag are satisfying the requirements of fine aggregate and coarse aggregate. The cost of concrete made with blast furnace slag and crusher dust is less than conventional concrete because the crusher dust and blast furnace slag which were less cost.

B. At 30% replacement of coarse aggregate with blast furnace slag and fine aggregate with crusher dust there is no reduction in compressive strength with respect to controlled concrete.

C. At 30% replacement of coarse aggregate with blast furnace slag and fine aggregate with crusher dust that shown only marginal increase in split tensile strength and flexural strength was observed.

D. Based on this experimental investigation, it is found that crusher dust can be used as an alternative material to the natural river sand and blast furnace slag can be used as an alternative material to the coarse aggregate up to certain percentage

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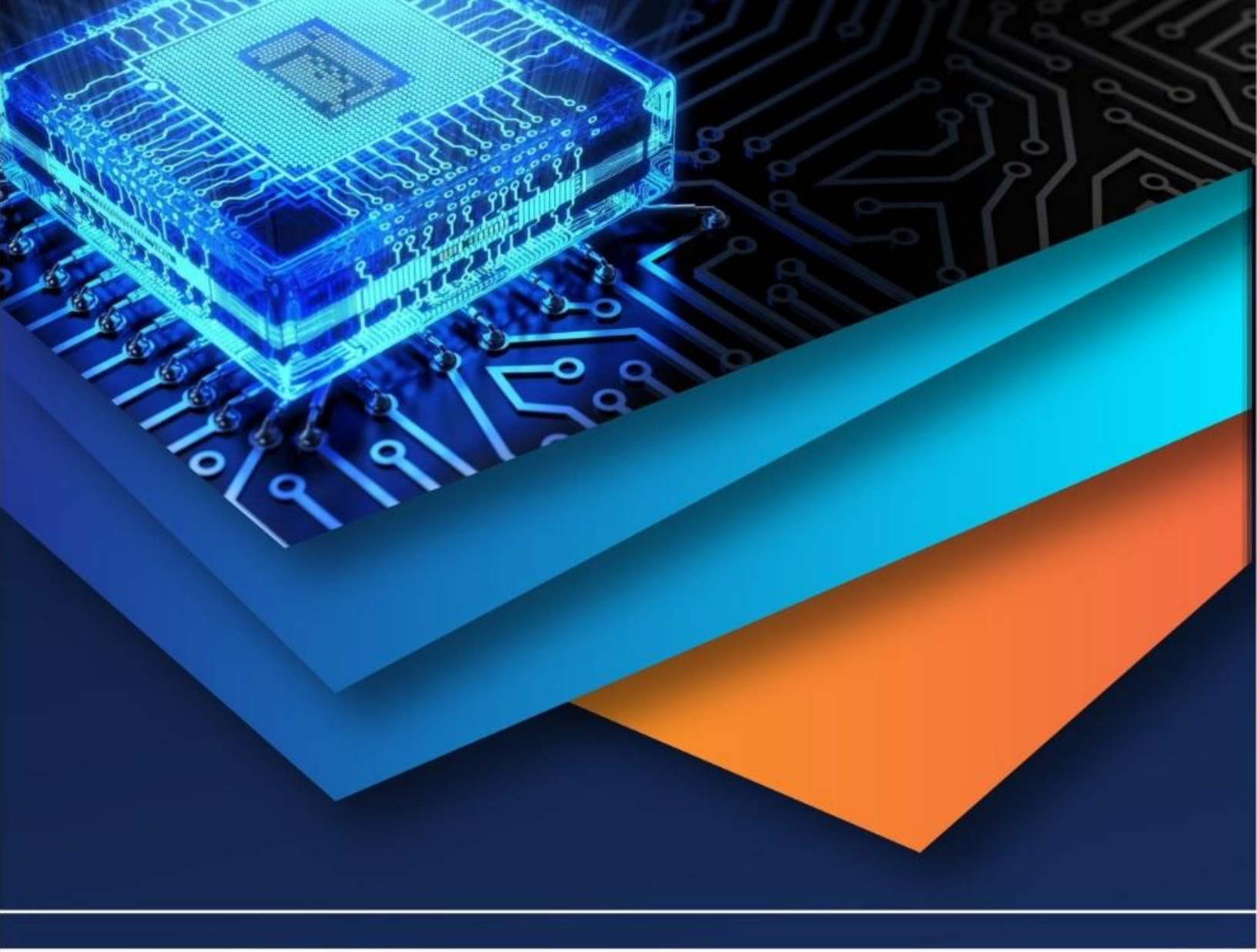

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