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AN EXPERIMENTAL INVESTIGATION ON STRENGTH CHARACTERISTICS OF CONCRETE BY PARTIAL REPLACEMENT OF COARSE AGGREGATE AND FINE AGGREGATE WITH CERAMIC WASTE AND BOTTOM ASH

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ABSTRACT

In this project, ceramic waste and bottom ash is being used as a partial replacement for coarse aggregate and fine aggregate. To reduce the industrial waste, we have taken the ceramic waste from landfills and bottom ash from thermal power plants. The maximum percentage of ceramic waste used is about 30% of the mass of coarse aggregate. The percentages in which the ceramic waste was replaced were 0%, 5%, 10%, 15%, 20%, 25%, and 30% and 10 % of bottom ash is added to the concrete as a partial replacement of fine aggregate to achieve better results. Experimental tests are carried out to determine the strength characteristics of concrete such as compressive strength, split tensile strength, flexure strength test, workability at 7, 14 ,28 days of curing were calculated and compared with ceramic waste bottom ash aggregate.

Keywords: *Ceramic Waste, Bottom ash, Compressive Strength, Split tensile strength, Flexural strength*.

I. INTRODUCTION

It has been estimated that about 30 percent of daily production goes as waste in ceramic industry. Ceramic waste which is durable, hard and highly resistant to biological, chemical and physical degradation forces is not recycled so far. The rate of growth in waste has put pressure on the ceramic industries to find a solution for its disposal and to minimize the pollution. The ash generated from Thermal power plants is about 20% of Bottom ash, & 80% is Fly ash. Ash generated below the furnace of steam generator is called the bottom ash. It is the part of non-combustible residue of combustion of coal in a furnace. It comprises traces of combustibles embedded in forming clinkers which sticks to hot side walls of a coal-burning furnace. The clinkers fall by themselves into the Bottom hopper of a coal-burning furnace and are cooled. The above portion of the ash is referred as bottom ash.

II. MATERIALS USED

In this experimental work the materials used are Cement, Fine aggregate, Coarse aggregate, Ceramic aggregate and Bottom ash.

The cement used in the present work is Ordinary Portland cement (OPC) which is of 53 grade The fine aggregate used is River sand confirming to Zone III., The coarse aggregate of size 20mm is used .The Ceramic waste is locally available at the ceramic manufactures in Vijayawada and the bottom ash is available at Narla Tata Rao Thermal Power Station in Vijayawada. The properties of Cement are shown above in table no.1

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S.No	Property	Bottom Ash	River Sand
1.	Density	2.52	2.67
2.	Specific Gravity	2.15	2.65
3.	Fineness modulus	2.80	2.72
4.	Bulk Density loose) (compact)	14160 16030	16200 18300
5.	Voids (loose) (compact)	43.2 38.42	36.52 30.71
6.	Water absorption	2.1	1.8

The properties of fine aggregates and coarse aggregates are listed below in table No.2 &3.

Table no.3

S.No	Property	Ceramic Waste	Crushed Stone
1	Density (g/cm3)	2.78	2.73
2	Maximum size	20	20
3	Fineness Modulus	6.98	6.92
4	Surface texture	Rough	Smooth
5	Water absorption (24hr)	1.26	0.71
6	Crushing Value	23	25
7	Impact Value	16	17
8	Bulk Density Loose Compact	15430 16710	14100 15230
9	Voids Loose compacted	44 39.81	48 44.32

III. EXPERIMENTAL PROGRAM

The mix design guidelines are taken from IS 10262-2009.The mix ratios that are fixed are shown in table 4

Grade	Mix ratio	$W/_C$
M30	1:1.36:2.66	0.43

The trail mixes for both the replacement are shown in table no. 5

S.No	Concrete Mix	Mix Proportion
1.	M1	M30
2.	M2	M30+5%CW
3.	M3	M30+10%CW
4.	M4	M30+15%CW
5.	M5	M30+20%CW
6.	M6	M30+25%CW
7.	M7	M30+30%CW
8.	M2B1	M30+0%CW+10%BA
9.	M2B2	M30+5%CW+10%BA
10.	M2B3	M30+10%CW+10%BA
11.	M2B3	M30+15%CW+10%BA
12.	M2B4	M30+20%CW+10%BA
13.	M2B5	M30+25%CW+10%BA
14.	M2B6	M30+30%CW+10%BA

For calculating the compressive strength cube specimens are casted in cubical moulds are of size 150mm x 150mm x 150mm. For split tensile strength cylindrical specimens are of size 300mm height and 150mm diameter are used. Flexural behaviour is calculated by casting beam specimens are of size 500mm x 100mm x 100mm.

For each trail mix, the specimens are casted and removed after 24 hrs. The removed specimens are placed in water curing in order to test for 7, 14 and 28 days strength. The concrete specimens of Cubes, Beams and Cylinders are tested after 7, 14 and 28 days curing.

IV. TEST RESULTS

The compressive strengths results are shown in table 6 and 7

1. Ceramic aggregate Concrete

Compressive Strength of CW Aggregate Concrete (N/mm^2)			
Mix	**7 Days**	**14 Days**	**28 Days**
M_1	27.12	35.48	39.14
M_2	29.66	36.91	42.14
M_3	32.41	38.48	43.36

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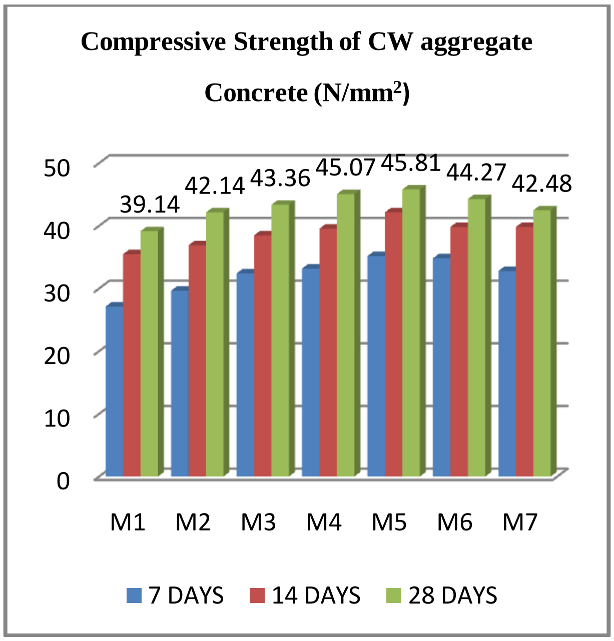
M_4	33.18	39.55	45.07
M_5	35.17	42.16	45.81
M_6	34.82	39.82	44.27
M7	32.80	39.82	42.48



2. Ceramic Waste Bottom ash aggregate

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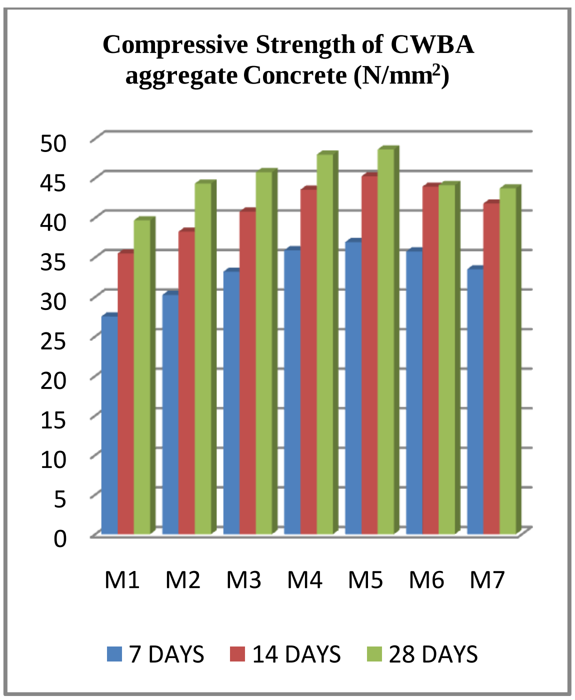
Compressive Strength of CWBA aggregate Concrete (N/mm^2)			
Mix	**7 Days**	**14 Days**	**28 Days**
M_1	27.54	35.68	39.67
M_2	30.24	38.25	44.32
M_3	33.17	40.78	45.76
M_4	35.89	43.55	47.98
M_5	36.92	45.24	48.64
M_6	35.74	43.93	44.13
M_7	33.48	41.80	43.71



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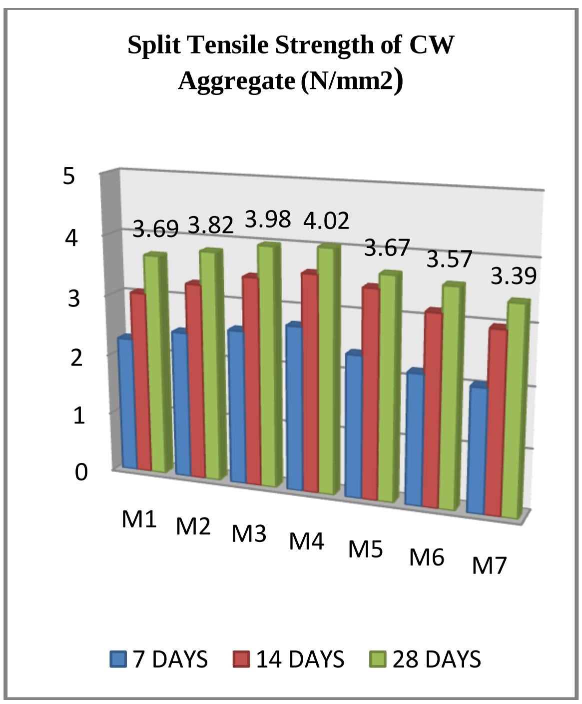
The split tensile strength results are shown in table 8 and 9

Spilt Tensile Strength of CW aggregate Concrete (N/mm^2)			
Mix	**7 Days**	**14 Days**	**28 Days**
M_1	2.26	3.05	3.69
M_2	2.45	3.27	3.82
M_3	2.57	3.46	3.98
M_4	2.73	3.59	4.02
M_5	2.36	3.44	3.67
M_6	2.16	3.14	3.57
M_7	2.04	2.97	3.39



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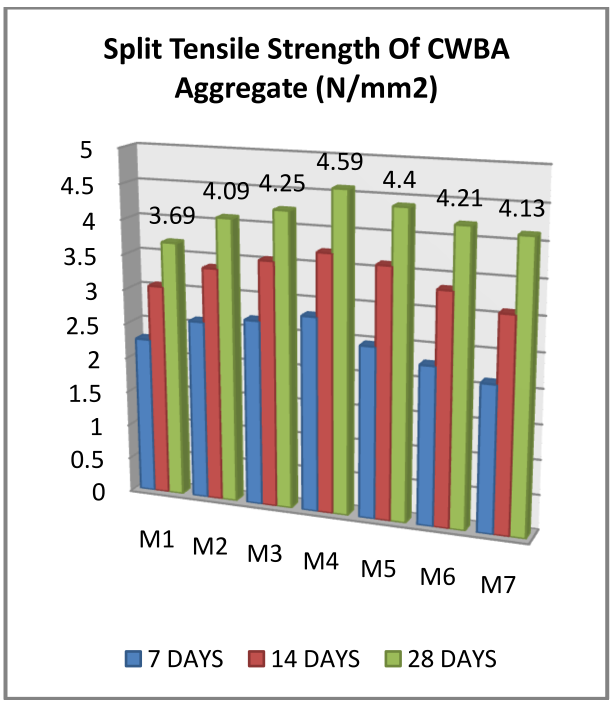
2. Ceramic Waste Bottom ash Concrete

Spilt Tensile Strength of CWBA Aggregate Concrete (N/mm^2)			
Mix	**7 Days**	**14 Days**	**28 Days**
M_1	2.34	3.15	3.76
M_2	2.59	3.37	4.09
M_3	2.68	3.54	4.25
M_4	2.81	3.71	4.59
M_5	2.47	3.60	4.40
M_6	2.28	3.33	4.21
M_7	2.11	3.08	4.13



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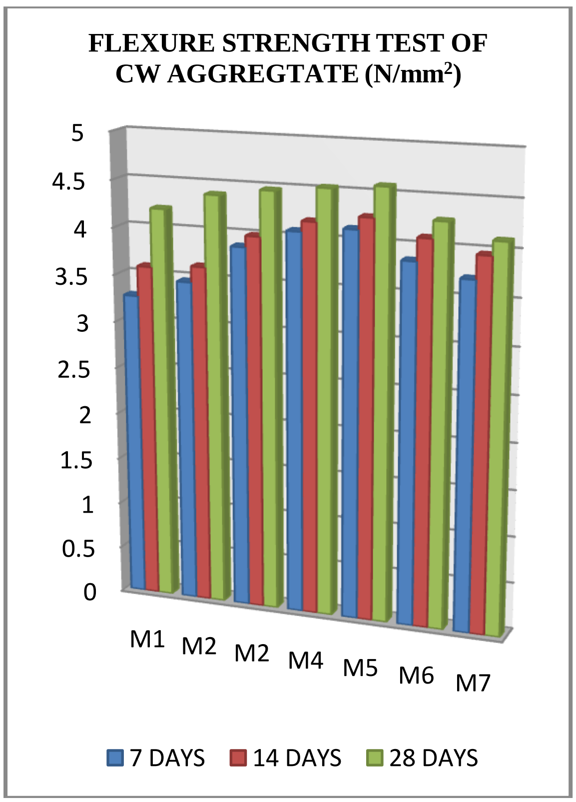
The flexural strengths of concrete are shown in table 10 and 11

1.Ceramic waste aggregate concrete

Flexure Strength Test of CW aggregate Concrete (N/mm^2)			
Mix	**7 Days**	**14 Days**	**28 Days**
M1	3.27	3.59	4.21
M2	3.46	3.63	4.39
M2	3.87	3.99	4.47
M4	4.07	4.18	4.53
M5	4.13	4.26	4.58
M6	3.85	4.09	4.27
M7	3.71	3.96	4.11



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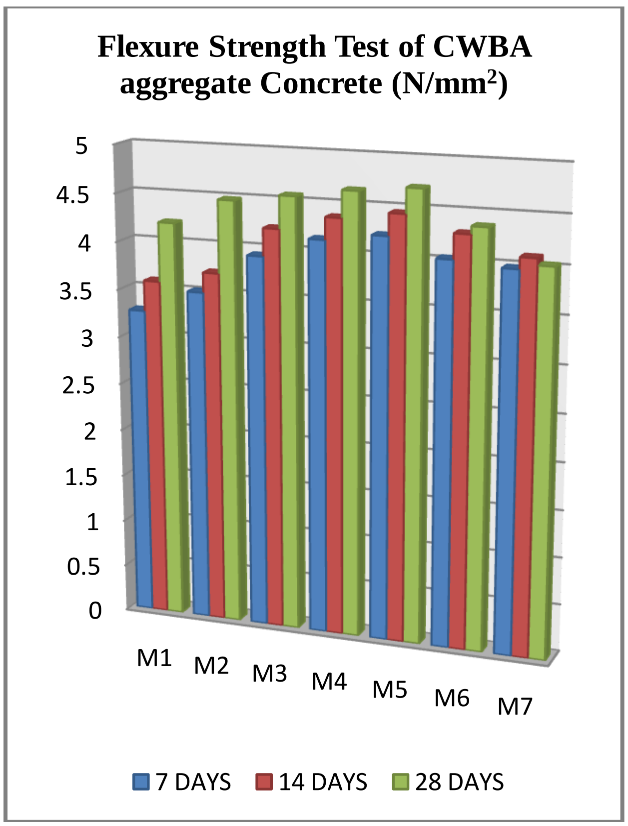
2. Ceramic Waste bottom ash concrete

Flexure Strength Test of CWBA Aggregate Concrete (N/mm^2)			
Mix	**7 Days**	**14 Days**	**28 Days**
M1	3.31	3.63	4.34
M2	3.51	3.72	4.48
M3	3.93	4.22	4.56
M4	4.14	4.37	4.65
M5	4.22	4.45	4.71
M6	4.03	4.29	4.37
M7	3.98	4.10	4.03



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The compaction factor results are listed below in table 12

S.No	Mix	Compaction Factor
1.	M1	0.984
2.	M2	0.917
3.	M3	0.893
4.	M4	0.862
5.	M5	0.857
6.	M6	0.813
7.	M7	0.789
8.	M2B1	0.989
9.	M2B2	0.961
10.	M2B3	0.930
11.	M2B4	0.911
12.	M2B5	0.883
13.	M2B6	0.846
14.	M2B7	0.821

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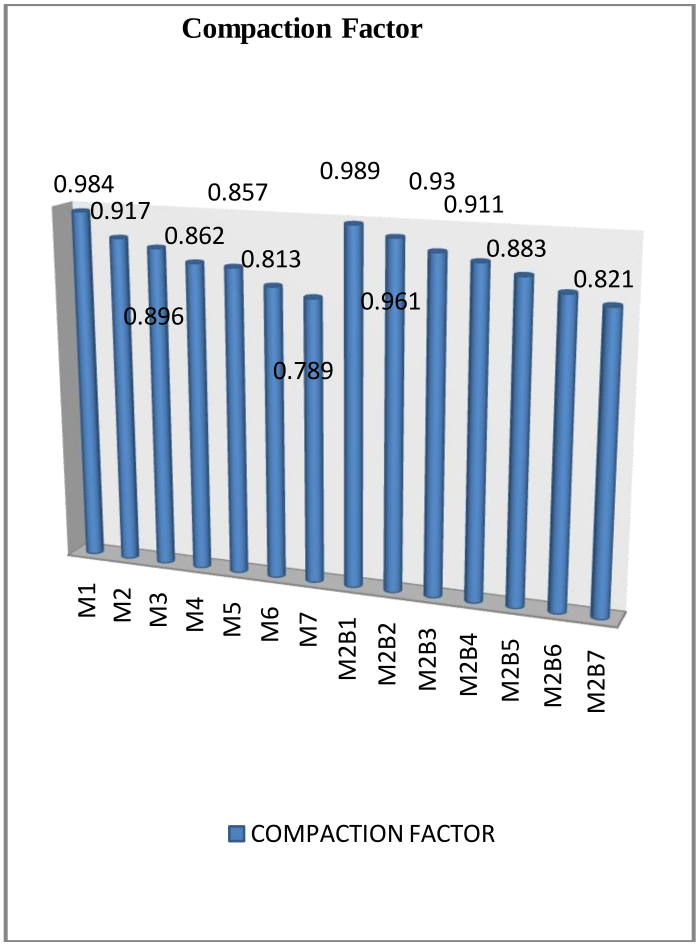
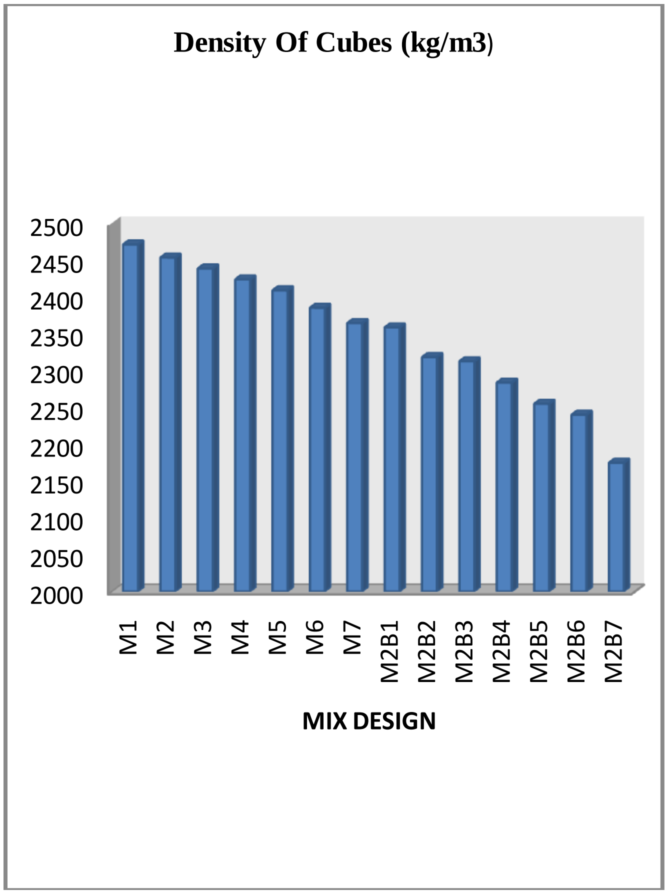


The Density of both replacements of concrete are listed below in table no.13

S.No	Mix	Density Of Cubes (Kg/m^3)
1.	M_1	2471.11
2.	M_2	2453.33
3.	M_3	2438.51
4.	M_4	2423.70
5.	M_5	2408.88
6.	M_6	2385.18
7.	M_7	2364.44
8.	M_2B_1	2358.51
9.	M_2B2	2318.22
10.	M_2B3	2312.59
11.	M_2B4	2283.55
12.	M_2B5	2254.81
13.	M_2B6	2240.00
14.	M_2B7	2174.84



V. CONCLUSION

- The Compressive Strength of Ceramic aggregate replacement was increased up to 31.25% to 36% after adding of bottom ash.
- The Split tensile Strength of Ceramic aggregate replacement after adding of Bottom Ash was increased from 55% to 64%.
- The Flexure Strength of Ceramic aggregate replacement was increased from CW concrete to CWBA concrete 11% to 15%.
- The Overall Density of the cubes decreased at a percentage of 18.14%, so the dead weight of the specimen became lighter.
- The workability is decreased because of increase in bottom ash.
- The replacement of aggregates satisfied at increasing their strengths and proved that lighter in construction and economical too

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