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UTILIZATION OF INDUSTRIAL CERAMIC SLUDGE FOR ENVIRONMENTAL SUSTAINABLE GREEN CONCRETE PRODUCTION

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***Abstract*— Ceramic Industry is the one of the Major Industry in India which comprising the present global needs of the People. In global level the ceramic sludge generated is about 22 billion tonnes. Whereas India contributes about 100 million tonnes per year. The ceramic sludge is disposing without proper treatment and dumped in low lying areas. Instead of filling in low lying areas, the ceramic sludge has good recycling value, and also the composition of ceramic sludge has similar properties of sand (Fine aggregate).**

In this project the fine aggregate is replaced with the Ceramic sludge in the proportions of 10%, 20%, 30%, 40% and 50% in producing M_{25} grade of concrete and is compared with the Nominal mix. For each mix a minimum of three cubes were casted and these cubes are water and acid- alkali curing for 28 days and then tested for compressive, tensile, flexural strength, durability of the concrete, acid and alkali attack test were performed.

The strength of the Nominal mix is obtained as 30.2 N/mm^2 and the finally the replacement mix 30% of ceramic sludge with fine aggregate is about 41.2 N/mm^2. These Green concrete has more eco friendly and less carbon emissions than the normal concrete mix. By utilizing waste as the replacement and recycling purpose we are conserving huge quantity of natural resources from destruction.

Buy Green – Go Green – Build Green for nature is a moto of this project.

***Keywords*— ceramic sludge, fine aggregates, coarse aggregates, cement, compressive strength, flexural strength, Green Technology**

I INTRODUCTION

In the present scenario concrete has been used for construction in around the most with concrete structures. The concrete have been in the use for over a century in all the constructions structures. The concrete has been labelled as the back bone of the infrastructure growth of the country. A huge amount of concrete is required to the construction, in the required field that requires most of the natural reserves in the country. In our country unfortunately, it is not independent in the manufacture of cement. Although Fine and coarse aggregate are accessible, but it is existing in minimum amount. Also reducing of natural resources for aggregate causes more effect on the environment. This creates the construction activities more costly and some are can't afford for it. At present the entire construction sector is in search for suitable and best alternative waste product that would be considerably minimize the use of materials of conventional concrete and thereby reduction in the construction cost and it should be replaced by the fine and coarse aggregate. Some of such materials have already been identified and one of the waste product is ceramic waste which is not useful for any purpose, and used as landfills.

The government policies also added as a fuel for this huge requirement of the ceramic tiles. In the ceramic industry, about 30% sludge material is produced from the manufacturing process. The reutilisation of ceramic sludge. Although the reuse of ceramic sludge has been performed, most of the waste re use in the way is still negligible and most of the ceramic sludge is dumped as landfills. By these landfills there are lot of environmental problems will occur like air pollution ground water problems etc…Hence, the requirement for ceramic sludge reuse in other industry is becoming totally vital. Concrete production in Construction industry may be the possible end user of ceramic sludge and in that way we can contribute to make a solution to this environmental problem. The ceramic sludge is generated daily is piling up and this is causing the ceramic industries a much pressurised situation from the environmental department to find a solution for its disposal. Properties of concrete cubes which are prepared with ceramic waste as a replacement of fine aggregate is compared against the properties of the concrete cubes which are prepared conventionally.

II OBJECTIVES

1. To utilize the sludge material generated from the ceramic industries in the production of economic concrete in an effective way.
2. To study of various (partially) mix proportions in manufacturing process of concrete using ceramic sludge as replacement for fine aggregates.
3. To replace the fine aggregates with ceramic sludge in different proportions of about 10%, 20%, 30%, 40% and 50%.
4. To compare the strength of the conventional concrete with concrete prepared by replacement with ceramic sludge.
5. By checking stability condition of cubes, cylinders and beams by alkalinity and acid tests.

III MATERIALS USED

The main raw materials used in preparation of concrete blocks by partially replacing fine aggregate with ceramic sludge are ceramic sludge, fine aggregates, coarse aggregates, cement and water.

A. CHEMICAL PROPERTIES OF CERAMIC SLUDGE

S.No	Parameters	units	Concentration in ceramic sludge
1	pH	-	7.2
2	Alkalinity	Mg/l as $CaCo_3$	40
3	Hardness	Mg/l as $CaCo_3$	7
4	Free Chlorine	Ppm	BDL
5	D.O	Mg/l	6.6
6	Phosphate	Ppm	5
7	nitrate	Mg/l	2
8	Nitrite	Mg/l	BDL
9	Ammonia	Mg/l	BDL
10	Nitrogen	Mg/l	

IV METHODOLOGY

In the experiment we are replacing ceramic sludge in fine aggregates with 10%, 20%, 30%, 40% and 50% in M_{25} grade of concrete. These are compared with nominal mix which is 0% replacement of ceramic sludge. We got the design mix strength was 31.6 N/mm^2.

1. Ceramic : this waste is taken from RAK ceramic industry near samalakot, Kakinada
2. Mix design: The Mix design was done for M_{25} grade of concrete.
3. Testes to be conducted:

- Compression strength test
- Split tensile test
- Flexural test
- Acid attack test
- Alkali attack test.


Fig 1: Slump cone test


Fig 2: Ceramic Sludge


Fig 3: Compression test

Fig 4: Casting of Beams and Cylinders

Fig 5: Replacement of Ceramic Sludge into cubes

V MIX DESIGN AND TEST RESULTS

The mix design was obtained 1: 2.37: 3.17, from the Indian Standard Code book of IS 456-2000 these are following test results are analysed below

TABLE I
COMPRESSION STRENGTH TEST

S. no	zero percent replacement Nominal mix	10 % replacement of Ceramic waste	20 % replacement of Ceramic waste	30 % replacement of Ceramic waste	40% replacement of Ceramic waste	50 % replacement of Ceramic waste
1	29.2	39.2	40.2	39.7	38.5	31.2
2	30.6	37.6	39.8	40.3	40.6	31.5
3	30.8	36.8	38.7	43.8	41.2	30.6
Average	30.2	37.8	39.5	41.2	40.1	31.1

TABLE 2
SPLIT TENSILE TEST

For split tensile test cylinders are casted of size 30 cms length and 15 cms diameter. These are water cured for 28 days.

S. no	zero percent replacement nominal mix	10% replacement of Ceramic waste	20% replacement of Ceramic waste	30% replacement of Ceramic waste	40% replacement of Ceramic waste	50% replacement of Ceramic waste
1	2.75	3.62	3.52	3.51	3.37	3.02
2	2.83	3.94	3.66	3.61	3.11	2.76
3	2.97	4.03	3.94	3.94	3.66	3.18
Average	2.85	3.8	3.7	3.6	3.3	2.9

TABLE 3
FLEXURAL TEST

For this test the beams are casted and the dimensions are 50 x 10 x 10 cms. These beams are water cured for 28 days.

S. no	zero percent replacement nominal mix	10% replacement of Ceramic waste	20% replacement of Ceramic waste	30% replacement of Ceramic waste	40% replacement of Ceramic waste	50% replacement of Ceramic waste
1	4.81	4.41	4.38	3.96	3.82	2.94
2	4.97	4.49	4.05	4.15	3.55	3.26
3	4.78	4.58	4.29	3.98	3.44	2.81
Average	4.85	4.49	4.24	4.03	3.6	3

TABLE 4
ACID ATTACK TEST

In this acid attack test we have used the sulphuric acid, at first the cubes are water cured for 7 days and after that it was placed in sulphuric acid for 28 days curing.

S. no	zero percent replacement Nominal mix	10 % replacement of Ceramic waste	20 % replacement of Ceramic waste	30 % replacement of Ceramic waste	40% replacement of Ceramic waste	50 % replacement of Ceramic waste
1	28.5	37.6	36.7	35.4	34.2	33.1
2	28.8	38.4	37.5	36.5	35	32.5
3	29.7	38.6	37.9	35.9	33.8	31.9
Average	29	38.2	37.3	35.9	34.3	32.5

TABLE 5
ALKALI

In this alkali test we have used the potassium hydroxide as the alkaline, the cubes are water cured for 7 days and then placed in potassium hydroxide for 28 days curing.

S. no	zero percent replacement Nominal mix	10 % replacement of Ceramic waste	20 % replacement of Ceramic waste	30 % replacement of Ceramic waste	40% replacement of Ceramic waste	50 % replacement of Ceramic waste
1	28.57	36.2	35.9	34.3	32.3	30
2	29.38	36.4	35.1	33.7	31.2	29.4
3	29.56	35.7	34.8	33.4	32.5	29.3
Average	29.17	36.1	35.2	33.8	32	29.5

Graphs are drawn between compressive strength and percentage of sludge added. On X-axis percentage of sludge and on Y- axis compressive strength values are added

1. Graph of percentage of sludge in concrete

Case 1: sludge added for compressive strength test

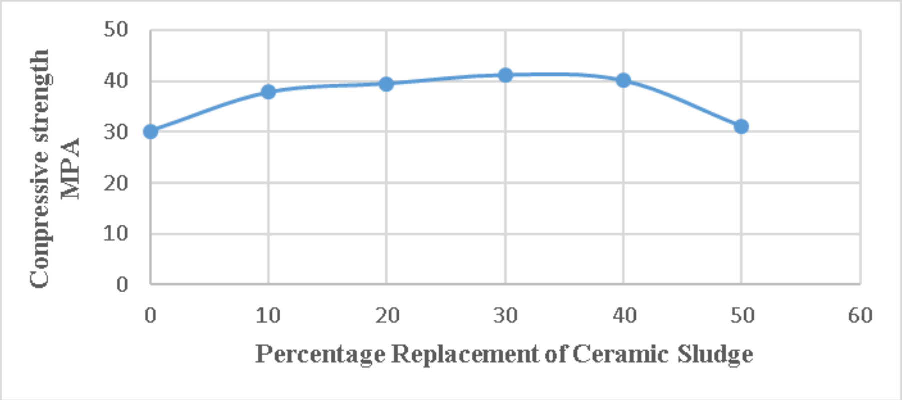

Fig. 6 variation of compressive strength values with different percentages

In the above graph the compression strength test, we observe that at 30% we get the maximum value , later on increasing the replacement of ceramic waste 405 and 50%, the strength was reduced but the values strength attained for 40% and 50% was greater than the nominal mix design value.

Case 2: Sludge added to cylinder for split tensile test

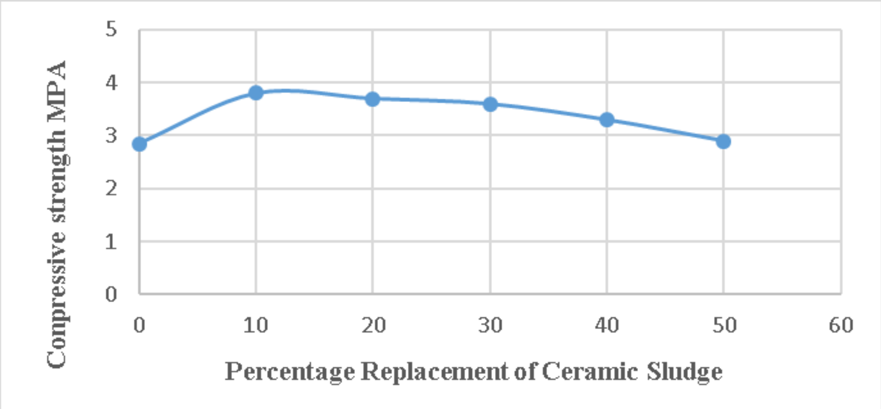

Fig .7 variation of compressive strength for split tensile test

The split tensile strength test the cylinders are placed for 28 days water curing and after that it was tested on UTM machine. The results observed that at 10% it has highest strength and later on increasing the parentage the split tensile strength was reduced.

Case 3: Sludge added to the beams for flexural test

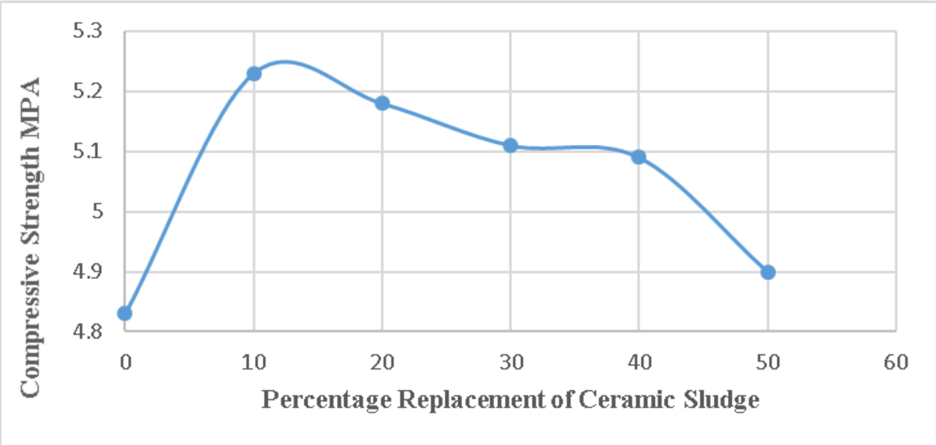

Fig. 8 variation of compressive strength for Flexural strength test

Flexural test , the beams are casted of 50cm * 10cm * 10cm size and that are also placed for 28 days water curing, after that it was tested in UTM which has one point load at the centre. In the graph we can see that at 10% the height value observed and later on increasing the percentage of ceramic waste the flexural strength was reduced.

Case 4: Test conducted for acid attack

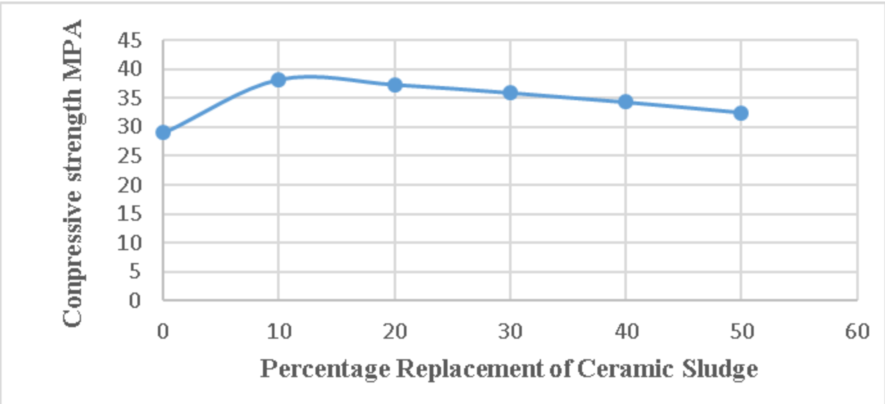

Fig. 9 variation of compressive strength for acid attack test

In the graph we see the acid attack test values that these are also shows that at 10% it shows the highest strength and later on it reduces the strength as we increasing the ceramic waste replacement. We used the sulphuric acid for acid attack test.

Case 5: Test conducted for alkali attack test

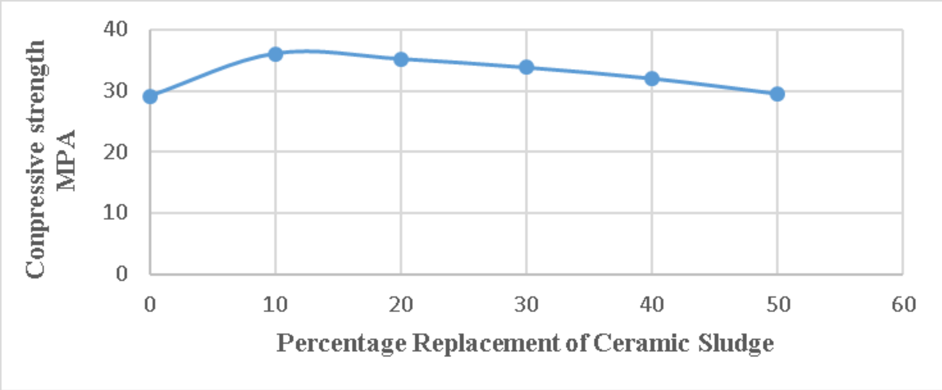

Fig. 10 variation of compressive strength for alkali attack test

In alkali attack test we used the potassium hydroxide and it was placed for 28 days. At 10% we observe the highest strength and later on it reduced at 50% it is observed that it has slightly more than the nominal mix.

VI CONCLUSIONS

The experimental results show that the ceramic sludge can be used as a replacement for fine aggregate in concrete. The concrete with 10%, 20%, 30%, replacements of fine aggregate with the ceramic waste shows a significant increase in the compressive strength of the concrete, whereas the further increase in the percentage of ceramic sludge 40% and 50% the compressive strength was reduced but it attains required strength. The maximum compressive strength is achieved at 30% replacement and it is 41.2 N / mm^2. The tensile strength and the durability tests conducted also achieved desirable results by ceramic sludge replacement. Hence we can be replace the ceramic sludge up to 30% in fine aggregate, at 30% we achieved desirable results in all tests.

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