

## **USE OF CERAMIC WASTE AS FINE AGGREGATE IN CONCRETE**

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**Abstract:-** *Aim of this paper is to study the suitability of ceramic tiles waste as fine aggregate in concrete making. The concrete control specimens were cast using Recycled coarse aggregates and natural River sand as fine aggregates. Then the river sand was replaced with Ceramic waste in 15, 30, 45, 60 and 100 percentages. The Cubes, Cylinders and Prisms were cast and tested to ultimate load to know the ultimate Compressive strength, Ultimate Split Tensile strength and Ultimate flexural strength. It was observed from the experimental results that ceramic waste can be used for in concrete making.*

**Keywords:** *Recycled coarse aggregate, ceramic waste, sustainable concrete, waste management, River Sand*

### **I. INTRODUCTION**

Concrete is a composite material composed of gravels or crushed stones (coarse aggregate), sand (fine aggregate) and hydrated cement (binder). It has been in use for over a century in all construction works. A variety of new materials in the field of concrete technology have been developed during the recent past with the ongoing demand of construction industries to meet the functional, strength, economical and durability requirements. The natural resources depleting at faster rate to meet the requirements of construction industry. To preserve the natural resources for future generations and to reduce disposal problem of waste materials, the industry by products were used in concrete making. Indian ceramic production is 100 Million ton per year. India ranks in the top 3 list of countries in terms of tile production in the world. The production during 2011-12 stood at approximately 600 million square meters. This huge production of ceramic tiles is due to the boom in housing sector coupled by government policies fuelling strong growth in housing sector. In the ceramic industry, about 15% to 30% waste material is generated from the total production. Although the reutilization of ceramic wastes has been practiced, the amount of wastes reused in that way is still negligible. Hence, the need for its application in other industries is becoming absolutely vital. Construction industry can be the end user of all ceramic wastes and in this way can contribute to solve this environmental problem. In this direction ceramic tiles waste and recycled coarse aggregate were considered in this study. The work is taken up with the four objectives stated here and the objectives are 1.To effectively utilize the waste material from ceramic industries in concrete. 2. To replace the fine aggregates with various percentage 15%, 30%, 45%, 60% and 100% of ceramic waste in concrete. 3. To conduct the mechanical strength tests for concrete with the partial replacement of fine aggregate by ceramic waste. 4. To study the effect of compressive, split tensile, flexural strength characteristic properties of ceramic waste in concrete.

### **II. Experimental work**

The following materials are used in the experimental investigations to study the objectives stated above.

**Cement:** In this present work, Birla Gold cement of 53 grade ordinary Portland cement (OPC) is used for casting cubes and cylinders and prisms for all concrete mixes. The cement is of uniform color i.e. Grey and is free from any hard lumps. The various tests conducted on cement are specific gravity, initial and final setting time and fineness. Testing on cement is done as per IS codes. The properties of Portland cement are reported in below Table-1

| TABLE-1<br>THE PROPERTIES OF CEMENT |                      |             |
|-------------------------------------|----------------------|-------------|
| S. No                               | Parameter            | value       |
| 1                                   | Fineness             | 7%          |
| 2                                   | Standard consistency | 33%         |
| 3                                   | Specific gravity     | 3.01        |
| 4                                   | Initial setting time | 105 minutes |
| 5                                   | Final Setting time   | 600 minutes |

*Fine Aggregate*

*Natural Fine Aggregate:* Locally available River sand collected and its properties were tested and reported in the Table 2.

*Ceramic waste:* Broken tiles were collected from the solid waste of ceramic manufacturing unit and from demolished building. The waste tiles were crushed into small pieces by manually as shows in Figure-1 into required sizes. After braking tile into smaller pieces sieve analysis is carried. The tile pieces which passing through 4.75 mm sieve and retained on 75 micron sieve are collected in container. Material properties are calculated for the collected tile pieces. And the properties are reported in Table 2.

| TABLE 2<br>PHYSICAL PROPERTIES OF FINE AGGREGATE |            |               |
|--|------------|---------------|
|  | Natural FA | Ceramic waste |
| Test   | Result     | Result        |
| Specific gravity                                 | 2.39       | 2.21          |
| Void ratio                                       | 2.62       | 0.821         |
| Bulk Density (kg/m <sup>3</sup> )                | 1545       | 1210          |
| Grading Zone                                     | II         | II            |

*Recycled coarse aggregate (RCA):* Crushed aggregate is less than 22mm size produced from local crushing plant was used. The aggregate exclusively passing the set of sieves confirming to IS 383-1970.the individual aggregates were mixed to induce the required combine grading. The properties of Recycled coarse aggregate are presented in Table 3.

| TABLE 3<br>PHYSICAL PROPERTIES OF RECYCLED COARSE AGGREGATE |        |
|---|--------|
| Test  | Result |
| Specific gravity  | 2.72   |
| Bulk density (kg/m <sup>3</sup> )                           | 1419   |
| Fineness Modulus  | 7.51   |

*Water:* The water available in the Campus is used for casting and curing. Which is potable and confirming to IS: 456-2000.

### III. CASTING AND TESTING

*Casting:* after finding the basic properties of materials, the mix design is carried according to IS: 10262-2009. The cube were cast and tested with trial mixes to finalize mix proportions. The final mix proportions were 1:2.00: 3.70 with water cement ratio 0.5. After getting final mix proportions the test specimens were cast in seven groups. In the 1st group natural coarse aggregate was replaced with Recycled Coarse Aggregates. And 2<sup>nd</sup> group to 6<sup>th</sup> group River sand was replaced with ceramic wastes in 0, 15, 30, 45, 60 and 100 percentages along with natural Coarse aggregate was replaced with Recycled coarse aggregate fully. The casting was completed in seven stages.

Cubes of 150mm X 150mm X 150mm for compressive strength, Cylinders of 150mm diameter X 300mm height for split tensile strength and prisms of 100mm X 100mm X 500mm for flexural tensile strength are used in this investigation. Then specimen kept in water pond for curing for the period of 28 days.

*Testing:* The test specimens are taken out from the pond after curing period, kept in the laboratory for surface dry, after surface dry of specimens are tested for ultimate load using 200T compression testing machine for ultimate compressive strength and Split Tensile Strengths , 40T capacity Universal Testing Machine was used to find flexural tensile strengths of specimens. The testing of Cube specimens is shown in Figure-2. The testing of Cylinders is shown in Figure-3. The testing of Prisms is shown in Figure-4. Then the ultimate loads are noted, from the noted data average ultimate stresses were calculated and reported in Table-4



*Fig-1 Shows making of Fine aggregates from Ceramic Waste.*



*Fig-2 Shows testing of Cubes for Compressive Strength*



*Fig-3 Shows testing of Cylinders for Split Tensile Strength*



*Fig-4 Shows testing of Prisms for Flexural strength*

| TABLE 4   |                     |               |  |               |          |
|---|---------------------|---------------|--|---------------|----------|
| ULTIMATE STRENGTHS OF CUBES, CYLINDERS AND PRISMS |                     |               |  |               |          |
| S.No  | Fine Aggregates (%) |               | Average Strength N/mm <sup>2</sup> for 28 Days |               |          |
|   | Natural             | Ceramic Waste | Compressive                                    | Split Tensile | Flexural |
| 1   | 100                 | 0             | 45.562   | 3.816         | 9.104    |
| 2   | 85                  | 15            | 56.67  | 3.886         | 10.881   |
| 3   | 70                  | 30            | 57.335   | 2.220         | 10.586   |
| 4   | 55                  | 45            | 56.035   | 2.285         | 11.322   |
| 5   | 40                  | 60            | 47.414   | 1.943         | 11.540   |
| 6   | 0                   | 100           | 46.652   | 1.908         | 11.560   |

#### IV. RESULTS AND DISCUSSIONS

On observation of material properties, the waste tiles can be used to produce light weight concrete which leads to reduction in dead load on structure. After the study of experimental results, Compressive strength increases upto 30% replacement river sand with ceramic wastage, there after the strength decreases on further incorporation of ceramic waste. The split Tensile strength increases up to 15% replacement river sand with ceramic waste , there after the strength decreases on further incorporation of ceramic waste. The flexural Tensile strength increases as river sand replacement increases with ceramic waste.

#### CONCLUSION

- i. The maximum increase in Compressive strength is 25.84% at 30% replacement of river sand with ceramic tiles waste.
- ii. The maximum increase in Split Tensile strength is 1.83% at 15% replacement of river sand with ceramic tiles waste.
- iii. The maximum increase in Flexural Tensile strength is 26.98% at 100% replacement of river sand with ceramic tiles waste
- iv. The Ceramic tile as fine aggregate and Recycled coarse aggregate are used to produce light weight concrete.

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