# A Study on Effect of Basalt Sand and Ceramic Waste on Concrete with added Recron 3s Fiber

Vallam Rajesh[1], CH Devi[2], A S Kumar[3]
[1]*PG Scholar, Civil Engineering Department, Aditya Engineering College, Surampalem*
[2,3]*Assistant Professor, Civil Engineering Department, Aditya Engineering College, Surampalem*

***Abstract*** **- A Concrete use around the world is second only to water. The production of ordinary Portland cement contributes 5-7% of total greenhouse gas emission. It also consumes large amount energy. Hence it is essential to find alternative to cement. Due to the demand of need of high amount of cement in construction it would be suggestible to reduce the consumption of cement by partially replacing the cement with another materials. The Ceramic Dust which comes from industrial waste by manufacturing tiles and bricks. It will be more economical & cheap and also gives good impact on environment. The main aim of this study represents the strength properties of concrete using Ceramic dust, Basalt powder and with addition of Recron3s fiber. In the present study, cement has been partially replaced with 20% of ceramic dust as constant and fine aggregate has been replaced by Basalt powder accordingly in the range of 0%, 10%, 20%, 30%, 40% and 50% respectively. The addition of Recron3s fiber at constant proportion of 0.3% respectively. The optimum percentage of basalt powder is 20% Compressive strength and Split tensile strength, whereas 30% for Flexural strength at 7 and 28 days for M40 grade concrete.**

***Index Terms*** **- Ceramic dust, Basalt powder, Recron3s fiber, M40 grade of concrete.**

## 1.INTRODUCTION

Now a days, Concrete is the major element and no activity done in Construction industry without concrete. The prominent reason behind this is because of its properties like Workability, Durability and High Strength. The composite material used in concrete are natural sand, coarse aggregate, and binding material such as cement and water. The Consumption of concrete per year at around world is about 1 ton for every living human being. Due to globalization and rapid increase in construction industry of important infrastructure projects like Highways, airports, bridges, dams, Nuclear plants etc., are increasing in India year by year. Such increase of consumption in development activities a rapid increase in prices and have a large demand on natural resources and materials also. In view of this, to solve this problem people have started searching alternatives to the natural resources and which could be used either as an additive or as a partial replacement to the ingredients of concrete so that the existing natural resources and material like cement could be saved to the possible extent, and could be made available for the future generation. In this process, different industrial wastes have been tried as viable substitution for conventional materials in concrete are Ceramic waste powder, fly ash, blast furnace slag, quarry dust, ceramic tiles, waste aggregates from demolition of structures, rice husk ash, marble dust, palm oil fuel ash, copper dust and waste paper mill pulp etc. In this project Ceramic waste have been used as partial replacement for cement. While due to scarcity of river sand, basalt sand which comes from natural basalt rock through quarry has been used in place of fine aggregate, and coarse aggregate, respectively.

### 1.1 CERAMIC WASTE

In India ceramic industry, in which sanitary ware, bricks, wall roof tiles and roof tiles refractory materials and ceramic materials for domestic and other use is produce about 100 million tons per year, out of which almost 15-30% material is waste. Ceramic industrial companies dump these waste powder in nearby pit or any vacant space. Ceramic waste considers as a non-hazardous solid waste and possess pozzolanic properties. By use of non-hazardous material in construction field is gaining more in India day by day. After recycling of ceramic waste, it can be used in different construction applications by

alternatives to the natural aggregates through ceramic tile.

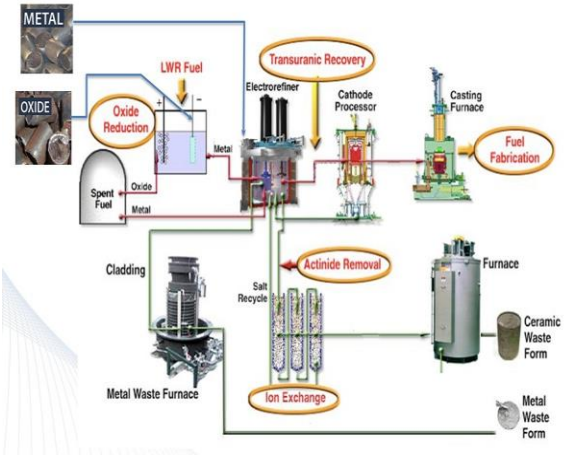


Fig: Process of manufacturing of ceramic waste.

Here in this project, we are preferably taken the Ceramic waste as a partial replacement for cement because of Researchers have found that the addition of ceramic waste to the Cement as an partial replacement gives more improved compressive strength, and flexural strength. And, it reduces the CO2 emissions and had similar chemical properties same as cement. Hence large amount of industrial wastes is coming, and different types of wastes are used as alternatives and partial replacements for cement. Out of those materials, we are taken Ceramic material which acts as a binding material and gives better properties.

## 1.2 BASALT SAND

Sand is one of the major materials used for preparation of concrete and also plays a most prominent role in Mix design. At present, consumption of natural sand is very high, due to large amount of usage of concrete. Hence due to this, demand of natural sand is very high in developing countries like India to satisfy the rapid infrastructure growth. The crisis of natural sand also happened in developing country like India and rapid usage of natural sand deposits causes serious threat to the environment and society. Extraction of large amount of natural sand from river bed causes so many problems like losing water retaining soil strata, loss of vegetation on the bank of rivers, deepening into the river beds causes bank slides, and disturbs the aquatic life and agriculture too due to the low water table in the well. In this Project, Basalt sand (crushed basalt) can be replaced partially with varying percentages by the natural sand. Basalt sand which comes under from Basalt rock defined as extrusive naturally mined igneous rock which they are dense fine-grained rocks that are of very dark color-green or black and form when molten lava from deep in the earth's crust rises up and solidifies. Here basalt sand comes from basalt rock through quarrying activities

Fig: Molten lava from deep earth's crust

Hence basalt sand powder is an artificial sand which can be replaced with natural river sand and gives better performing properties than river sand and have compatible strength.

## 1.3 HISTORY AND NECESSITY FOR THE ADDITION OF FIBERS

The use of fibres goes back at least 3000 years ago, when straw was used to reinforce sun-baked bricks in Mesopotamia. Horsehair was used in mortar and straw in mud bricks and were Asbestos fibres are used in concrete in the early 1900. In the 1950's, the concept of composite materials came into picture. Steel, Glass, and synthetic fibres have been used to improve the properties of concrete for the past 30 or 40 years. Research into new fibre-reinforced concretes continues even today.

### 1.3.1 NECESSITY

Fibres are generally used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact, abrasion, shatter resistance in concrete. It imparts more resistance to impact load and increase the ductility in concrete elements and it gives more toughness. Toughness is ability of a material to absorb energy and plastically deform without fracturing. It can also be defined as resistance to fracture of a material when stressed.

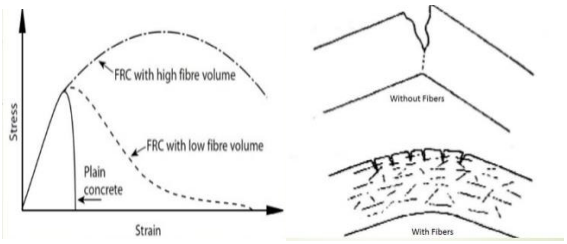


Fig: stress-strain graph of FRC & concrete buckling with or without fibres

Fibres can be in form of steel fibres, glass fibres, natural fibres, and synthetic fibres etc. In this project, we are used synthetic based fibre Recron 3s fibre is a state of art material which is used to increase in a variety of applications like automotive battery, paper, filtration fabrics, asbestos cement sheets, cement based pre-cast products and for improving quality of construction. A product of extensive R&D in Reliance's state-of-the-art Technology Centre.

Fig: Recron 3s fibre

Fig: Flexural behavior of self-compacting concrete with Recron 3s fibres

## II. OBJECTIVES OF THE STUDY

In this research work, an experimental investigation of optimum use of basalt sand, ceramic waste with added Recron 3s fibre were carried out. The amount of Ceramic waste is used with optimum efficiency by the partial replacement of cement, and basalt sand with partial replacement of fine aggregate by varying percentages. The main objective of this study is to study the strength, workability, toughness, impact resistance and durability properties of concrete in which cement has been partially replaced with 20% of ceramic dust as constant and fine aggregate has replaced by Basalt powder accordingly in the range of 0%, 10%, 20%, 30%, 40% and 50% respectively.

## III. MATERIALS

| | |
|---|---|
| Cement | DECCAN OPC 53 Grade |
| Fine Aggregate | River sand |
| Coarse Aggregate | Locally available stones of sizes 16 mm to 20 mm |
| Water | Tap water |
| Crushed Basalt sand | From M/s PKR Projects and Engineers Quarry, Yeleswaram, A P. |
| Ceramic waste powder | RAK Ceramics, Samarlakota, Andhra Pradesh. |
| Recron 3s fiber | Reliance Industries Ltd. |
| Polycarboxylate superplasticizer | B & B Specialities India pvt ltd, Vijayawada. |

## IV. PROPERTIES OF THE MATERIALS USED

Table: Chemical properties of ceramic waste

| Materials | Ceramic powder(%) | Materials | Ceramic powder(%) |
|---|---|---|---|
| $SiO_2$ | 63.29 | $Na_2O$ | 0.75 |
| $Al_2O_3$ | 18.29 | $SO_3$ | 0.10 |
| $Fe_2O_3$ | 4.32 | CL | 0.005 |
| CaO | 4.46 | $TiO_2$ | 0.61 |
| MgO | 0.72 | $SrO_2$ | 0.02 |
| $P_2O_5$ | 0.16 | $Mn_2O_3$ | 0.05 |
| $K_2O$ | 2.18 | L.O.I | 1.61 |

Table: Physical properties of ceramic waste

| Characteristics | Value obtained |
|---|---|
| Fineness modulus | 1.9 |
| Specific gravity | 2.72 |

Table: Chemical composition of basalt sand powder

| Material | Quantity% | Material | Quantity% |
|---|---|---|---|
| $SiO_2$ | 46.5-51.5 | $K_2O+Na_2O$ | 3.0-6.0 |
| $Al_2O_3$ | 15.0-19.0 | $TiO_2$ | 0.3-2.5 |
| MgO | 4.0-10.5 | $Cr_2O_3$ | 0.02-0.05 |
| CaO | 7.5-11.5 | MnO | <0.1 |
| Feno+ $Fe_2O_3$ | 8.0-12.0 | other | Up to 100 |

Table: Physical properties of Basalt sand powder

| Characteristics | Value obtained |
|---|---|
| Fineness modulus | 1.9 |
| Specific gravity | 2.72 |

Table: Tests conducted on cement

| Sl.no | Particulars of test | Test results | Standard limits |
|---|---|---|---|
| 1 | Standard consistency I.S.4031 (Part-4) | 32.33% | Minimum 23% |
| 2 | Specific gravity I.S.4031 - 1968 | 3.15 | 3.15 |
| 3 | Fineness I.S.4031 (Part-1) | 5% | 10% |
| 4 | Setting time Initial setting time I.S.4031 (Part-4) | 50 minutes | 30 minutes |
| | Final setting time I.S.4031 (Part-4) | 435 minutes | 600 minutes |
| 5 | Compressive strength I.S.4031 (Part -6) | | |
| | @ 3days | 26.00 | 23 MPa |
| | @ 7 days | 38 | 37 MPa |
| | @ 28 days | 53.3 | 53 MPa |

Table: Tests conducted on fine aggregate

| Sl. no | Particulars of test | Test results | Standard limits |
|---|---|---|---|
| 1 | Specific gravity I.S.2386 (Part-3) | 2.6 | >2.4 |
| 2 | Water absorption % I.S.2386 (Part-3) | 0.5 | 0.5%~1% |
| 3 | Bulk density ($Kg/m^3$) I.S.2386 (Part-3) | 1.550 | 1.5~1.7 |
| 4 | Fineness I.S.2386 (Part-1) | 2.73 | 2.6~3.2 |

Table: Tests conducted on coarse aggregate

| Sl. no | Particulars of test | Test results | Standard Limits |
|---|---|---|---|
| 1 | Specific gravity | 2.6 | 2.5 to 3.0 |
| 2 | Water absorption % | 0.25 | < 0.6% |
| 3 | Bulk density ($Kg/m^3$) | 1.58 | 1.5 to 1.6 $Kg/m^3$ |
| 4 | Impact value (%) | 18.95 | <30% |
| 5 | Crushing value (%) | 26.18 | <30% |
| 6 | Flakiness Index (%) | 13.25 | < 15% |
| 7 | Elongation Index (%) | 20 | < 30% |
| 8 | Fineness Modulus | 7.0 | 6.50~8.0 |

Table: Properties of Recron 3s fiber

| Sl.no | Properties | Value |
|---|---|---|
| 1 | Fiber type | Polyester CT2424 |
| 2 | Cut length | 12mm |
| 3 | Effective Diameter | 20-40 μ |
| 4 | Specific gravity | 1.34-1.39 |
| 5 | Melting point | 250-265 Deg.c |
| 6 | Elongation | 20-60% |
| 7 | Young's modulus | >5000 Mpa |
| 8 | Alkaline stability | Very good |
| 9 | Acid resistance | Excellent |
| 10 | Dispersion | Excellent |

## V. MIXDESIGN

Concrete mix proportion is created for specific and desirable properties. Mixing various amounts of Portland cement, water, sand, and coarse aggregate and admixtures produces different samples with altered characteristics of homogeneous mix.

The method adopted for identifying mix proportion was in reference to the amount of the material in an unit of fully compacted concrete. The method resulted in specifying mix constituents in terms of weights in kilograms necessary to get the required volume of concretes.

Therefore, mix proportions for concrete mix of M 40 Grade as per IS: 10262-2009 and IS: 456 -2000 is Cement: FA: CA: Water = 1: 1.86: 3.43: 0.4

## VI RESULTS

Table: Compressive strength of 7, 28 days curing

| S. No | MIX | Compressive strength ($N/MM^2$) | |
|---|---|---|---|
| | | 7 DAYS | 28 DAYS |
| 1 | Conventional concrete | 38.71 | 49.64 |
| 2 | 0% | 36.7 | 48.41 |
| 3 | 10% | 39.42 | 51.46 |
| 4 | 20% | 43.71 | 54.37 |
| 5 | 30% | 42.96 | 52.27 |
| 6 | 40% | 37.92 | 49.31 |
| 7 | 50% | 35.74 | 45.67 |

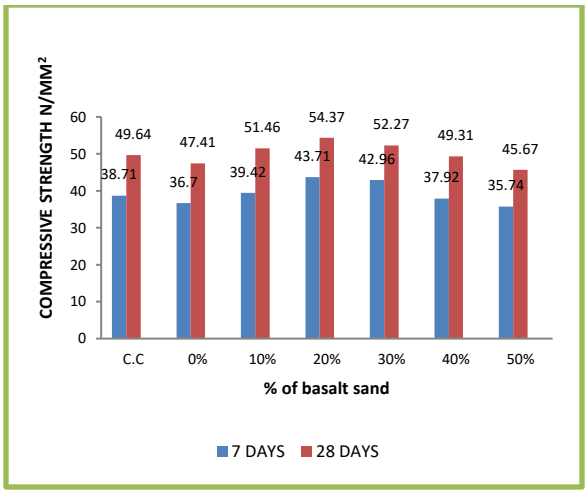


Fig Variation of compressive strength gives the higher strength for the replacement of 20% for 7, 28 days by basalt sand

Table: Tensile strength of 7, 28 days curing

| S.NO | MIX | SPLIT TENSILE STRENGTH (N/MM²) | |
|---|---|---|---|
| | | 7 DAYS | 28 DAYS |
| 1 | Conventional concrete | 2.71 | 3.69 |
| 2 | 0% | 2.40 | 3.39 |
| 3 | 10% | 2.90 | 3.97 |
| 4 | 20% | 3.84 | 4.71 |
| 5 | 30% | 3.98 | 4.25 |
| 6 | 40% | 4.04 | 4.10 |
| 7 | 50% | 3.01 | 3.48 |

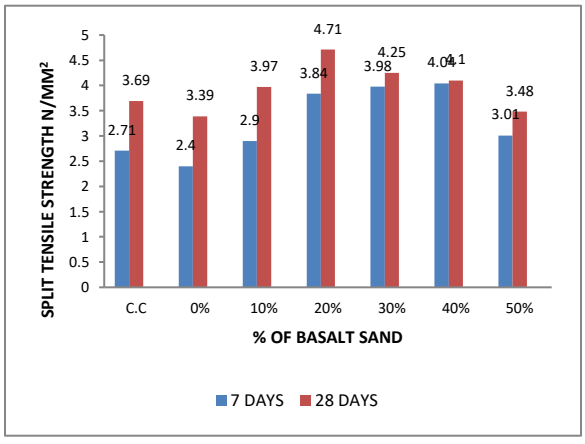


Fig Variation of split tensile strength gives the higher strength for the replacement of 20% for 7, 28 days by basalt sand

Table: Flexural strength of 7, 28 days curing

| S.NO | MIX | FLEXURAL STRENGTH (N/MM²) | |
|---|---|---|---|
| | | 7 DAYS | 28 DAYS |
| 1 | Conventional concrete | 4.7 | 5.6 |
| 2 | 0% | 4.4 | 5.32 |
| 3 | 10% | 4.82 | 5.89 |
| 4 | 20% | 5.21 | 5.99 |
| 5 | 30% | 5.46 | 6.27 |
| 6 | 40% | 4.91 | 5.87 |
| 7 | 50% | 4.55 | 5.24 |

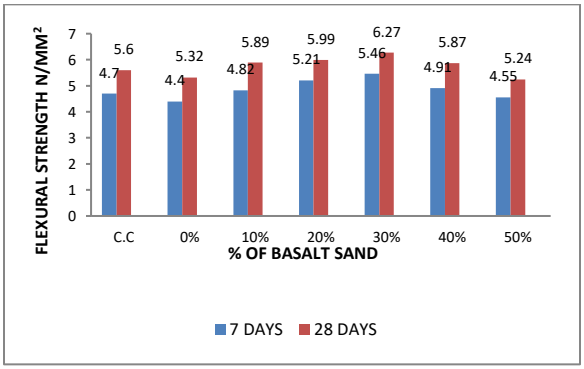


Fig Variation of Flexural strength gives the higher strength for the replacement of 30% for 7, 28 days by basalt sand

## VII.CONCLUSION

In this Project, the Compressive strength, split tensile strength and Flexural strength tests has been conducted. After going through the entire project work done some of the conclusions are made. They are:

- The Compressive strength of M40 grade concrete with 20% replacement of basalt sand with constant 20% of ceramic waste as partial replacement of cement and with added recron 3s fiber by 0.3% of weight of cement gives more strength which is 54.37 N/mm2 for 28 days when compared to conventional concrete. when basalt sand percentage increase up to 30% it gives maximum strength beyond it gradually decreases the compressive strength of concrete.
- The Split tensile strength of M40 grade concrete with 20% to 30 % replacement of basalt sand with constant 20% of ceramic waste as partial replacement of cement and with added recron 3s fiber by 0.3% of weight of cement gives more strength. And it attains maximum strength at 20% replacement of basalt sand which is 4.71 N/mm2 for 28 days when compared to conventional concrete. When basalt sand percentage is used

more than 30% it gradually decreases the split tensile strength.

- The Flexural strength of M40 grade concrete with 30% replacement of basalt sand with constant 20% of ceramic waste as partial replacement of cement and with added recron 3s fiber by 0.3% of weight of cement gives more strength which is 6.27 N/mm2 for 28 days when compared to conventional concrete. when basalt sand percentage increase up to 30% it gives maximum strength beyond it gradually decreases the Flexural strength of concrete.
- The use of basalt sand and ceramic waste as construction materials can reduce the scarcity of fine aggregate and cost of construction by replacement of cement. It helps to minimize the depletion of natural resources for construction.

## VIII.FUTURE SCOPE OF THE WORK

In Regard of project "A STUDY ON EFFECT OF BASALT SAND AND CERAMIC WASTE ON CONCRETE WITH ADDED RECRON 3S FIBER" following things can be taken for future study.

- Using Basalt sand, different curing conditions like oven curing, under various saline conditions can be used to find out the strength properties of concrete.
- And also by different mix designs by 7 days, 28 days, 56 days and 90 days of curing can be used to find out strength properties of concrete.
- A study on effect of basalt sand and GGBS or fly ash or metakaolin or other cementitious materials by replacing of cement on concrete can also be used to find out the strength properties of concrete.

## REFERENCES


[1] Simratpal Singh, Harkamal Singh, Er. Rajwinder Singh Basnsal published on" Comparative Study of Partial Replacement of Cement with Ceramic Waste Along with Addition of Polypropylene Fiber". (IJERT) ISSN: 2278-018 Vol. 8 Issue 01, January-2019.

[2] Magdalena Dobiszewska, Waldemar Pichór, and Paulina Szołdr published on "Effect of basalt powder addition on properties of mortar". MATEC Web of Conferences 262, 06002 (2019).

[3] Korrapati Anil Kumar, Ganta Shanmukha Rao, Dr. Shaik Yajdani published on "Study on Properties of Concrete using Recron 3s Fiber". IJSTE - | Volume 4 | Issue 3 | September 2017

[4] Magdalena Dobiszewska a, Anton K. Schindler b, Waldemar Pichór c published on "Mechanical properties and interfacial transition zone microstructure of concrete with waste basalt powder addition" @ Elsevier 2018.

[5] Tanveer Asif Zerdi published on "Experimental study on Concrete compressive strength made with crush basalt as fine aggregate" IJAR Volume: 6 | Issue: 5 | May 2016.

[6] Agil. R, A. Kumar published on "Experimental Study on Replacement of Cement with Ceramic Tile Powder in Concrete". (IJRASET) Volume 5 Issue X, October 2017.

[7] Revanasiddappa Madihalli, Naveen Kumar B M, Dr. H N Rajakumara, Priyanka published on "study on influence of recron polyester fibers and slag sand on the performance of concrete". International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 8, August 2017.

[8] Mr. Rasl Muhammed Rafeeq, Mr. S Rahul, Dr. T Senthil Vadivel, Dr. S Kanchana published on "An Experimental Study on The Effect of Ceramic Waste in Concrete". IJSTE - | Volume 2 | Issue 12 | June 2016.

[9] IS: 383-1970. Specification for coarse and Fine Aggregates from natural sources for concrete.

[10] IS: 10262-2009. Guidelines for concrete mix design proportioning.

[11] IS: 456-2000. Specification for plain and reinforcedConcrete.

[12] Priya A. Bhosale, Urmila. R. Kawade published on "Effect of Recron 3s Fibers on GGBS Replaced Cement Concrete". (IJSR) Volume 4 Issue 9, September 2015.

[13] Dr. A. Vijayakumar, Dr. J. Raja Murugadoss, C. Bharathi published on "ECOLOGICAL CONCRETE – A REVIEW" (IJCIET) volume 8, Issue 6, June 2017.

[14] M. A. Mashrei, Ali A. Sultan, Alaa M. Mahdi published on "Effects of Polypropylene fibers on compressive and flexural strength of concrete material" (IJCIET) volume 9, Issue 11, November 2018.