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Partial Replacement of Fine Aggregate with Ceramic Waste and Brick Dust in RAC

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Abstract: ***Society is developing concerning the development of the infrastructure and resources the word infrastructure contains the roadways, buildings, airports, runways and taxiways, and many things that make human civilization possible. Concrete is a vital element used in infrastructure projects in other words infrastructure construction is directly correlating the concrete production. Concrete is made of four basic elements water, cement, fine aggregate, and coarse aggregate where conventional coarse and fine aggregates are derived from rock and river mining from natural source that causes the natural resource depletion. Coarse aggregate and fine aggregates are chemically inert material at operational temperature. Therefore replacement of coarse or fine aggregate is possible with other inert material possess good mechanical strength and durability. In this research work we replace the conventional fine aggregate with brick dust and ceramic waste and brick dust. This experimental analysis based on two material replacement ceramic waste and brick dust up to optimum percentage to achieve maximum utilization. In this experiment, we found the optimum percentage of ceramic waste and brick dust is 20% and 15% respectively.***

Keywords: Recycled concrete, Ceramic waste, sustainability, Recycled aggregate.

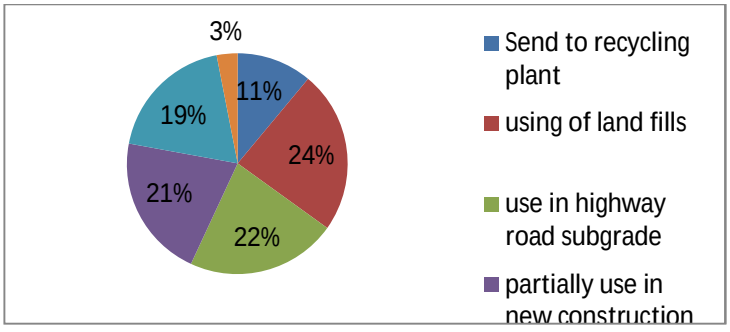
I. INTRODUCTION

Concrete plays a vigorous role in the construction industry, mainly concrete made up of four basic elements are as follows-

1) Coarse aggregate- It provides strength to concrete, in the coarse aggregate void percentage is approximately 50%.
2) Fine aggregate- It works as filling material to the voids of the coarse aggregate and makes it homogeneous nature.
3) Cement - cement also filled in the voids of the fine aggregate as well as acts as a binding material.
4) Water-Water is used for hydration of cement (Chemical process of binding of cement).

Conventional fine aggregate extracted from the river and other water bodies is the major cause of natural resource depletion.
On the other hand, solid waste accumulation due to construction and demolition waste is going to uncontrolled bay by day, building demolition waste plays a vital role in the c&d waste.
In India major part (24%) of the c&d waste is used in landfilling that increase the cost of the project.

Figure 1 Use of the c&d waste { Source: Sharma and Tiwari [1]}



Major building wastes are ceramic waste, broken bricks, used concrete, broken stones, and other wooden and metallic material, Wooden and metallic materials are not a part of solid waste accumulation because recycling wood and metals is easy but Ceramic waste, broken bricks, and concrete can not be recycled easily, therefore, these are part of solid waste.
Conventional fine aggregate is inert in nature, it can not participate in any chemical equation, so it can replace ceramic waste and brick powder due to its inert nature of ceramic waste and brick powder.

II. LITERATURE REVIEW

A. Ceramic Waste and Properties

Meena and Jain (2022)- This is a review of concrete made by ceramic waste and production of solid waste as ceramic waste. In study is collection of important data respective of ceramic waste. According to this study contribution of India in generation of ceramic waste as solid waste is 8%.

Amr S. El- Dieb (2018) -In this study white paste ceramic waste chemical composition is detected with the help of X-ray diffraction method. The white paste ceramic waste, Silica and Alumina covers more than 80% part, where Lime percentage is 1.70%, Silica percentage is 68.60%, Alumina percentage is 24.50%, Magnesium oxide percentage is 2.50%, Iron tri oxide 0.80%, and Sulfur tri oxide percentage is 0.12%. Loss in heat ignition is reported as 1.78% by weight.

F.P. Tergal and s. Jalali (2011) In this study categorization of the ceramic waste is done in two major parts as -

First is Red paste ceramic waste and second is white paste ceramic waste, red paste ceramic waste and white paste ceramic waste, red paste ceramic waste is ceramic waste produced through broken mud tiles, where white paste ceramic waste produce through porcelain material waste like ceramic tiles, wash basin etc.

Red paste ceramic waste and *White paste* ceramic waste possess different mechanical and chemical properties.

B. Brick Dust and Properties-

Gaber and Wahab (2019)

Stones or rocks are classified in 3 fundamental categories on the premise of chemical properties as taking after as Siliceous rocks - These rocks contain tall rate of silica show, these are exceptionally difficult and solid like Basalt, sand stone and quartzite etc., Argillaceous rocks - These shake mineral contains tall rate of clay Alumina, these have changing properties, Calcareous rocks - These shake minerals contain tall rate of calcium. Most of transformative rocks are in this category. Stone clean comprise with changing properties with regard to beginning shake.

C. Solid waste Accumulation and Recycling of Aggregate

Manshoor and Mehmood (2022)- This study based in the cement replacement by brick dust, in other words partially replacement of OPC cement is done with brick dust in making cement mortar, brick powder contains more silica than cement therefore replacement of cement increase the amount of silica by 41.49%, and decrease the lime percentage.

Increase in the water absorption and decrease in flow ability is seen here.

Arif and Khitab(2021)- In this study check feasibility of brick dust in utilization in the concrete, in this study replacement of cement is done with the brick powder by 5% and 10% for comparison of the properties with the conventional concrete.

In this study M20 and M25 concrete samples are produced for the mechanical and strength properties observation. Increase in the water absorption and decrease in flow ability is seen here.

Zheng and Lou (2018)- In this exploratory work customary coarse aggregate is supplanted with RCA (Reused concrete aggregate) and RBA(Recycled Brick total) at 0%,25%,50%,75%, and

100% on the review of C25(25Pa) and (50Pa) found at 100% substitution RBA concrete gives more compressive quality with compare to RCA concrete.

III. METHODOLOGY

A. Material

In this research conventional fine aggregate is replaced with ceramic waste as well as brick dust therefore the following material is used-

1) Cement- OPC cement of 43 grade (Ultratech) cement is used.

2) Fine aggregate-

- Conventional fine aggregate- river sand of zone-II (extracted from river basin).
- Ceramic waste- Broken bathroom tiles are used for making white paste ceramic waste.
- Brick powder - Broken brick powder extracted from grinding of broken bricks chunks.

3) Coarse aggregate- 20mm coarse stone is used as coarse aggregate.

4) Preparation of ceramic waste and brick dust sample as fine aggregate

- Ceramic waste sample produce by crushing of broken tiles with the help of mechanical grinder.
- Brick dust sample produce by crushing of broken bricks chunk with the help of mechanical grinder.

B. Methodology

Replacement of conventional fine aggregate with ceramic waste and brick dust is done in two steps to find optimum percentage of replacement is as following-

- In the first stage conventional fine aggregate replaced with ceramic waste by 0%, 5%, 10%, 15%, 20%, and 25% to make M25 concrete, and compare with control sample to achieve optimum replacement of ceramic waste.
- In the second stage replacement of brick dust is take place with fix value of ceramic waste (Obtained optimum in stage 1st) up to achieve optimum value of the combination.

1) Specification of the Concrete sample

Concrete sample of M25 (characteristic strength of 25Mpa) is design as per IS10262:2019 (Standard code for concrete design). Define ration of the cement : Fine aggregate: coarse aggregate = 1:1.58:2.95 .

2) Testing Procedure

Testing of the concrete sample is done for the assurance of durability and strength behavior.

Concrete Testing

Concrete cube testing is one of the most widely used test methods for establishing compressive strength of concrete. Concrete is typically tested in standard 150 mm x 150 mm x 150 mm cubes (sometimes 100 mm if a smaller aggregate is being used). The cubes are cast, cured and then tested in a Compression Testing Machine ("CTM") at various prescribed periods (7, 14, 28 days). Properties Determined: Compressive strength of concrete (main property). Quality and uniformity of concrete used in the construction. Rate of gain of strength with curing time. Durability and load-bearing capacity is indirectly indicated.

3) Raw Material Test

S.N.	Material	Tests
a)	Cement	Initial setting time Final setting time Consistency
b)	Fine aggregate Conventional Ceramic waste Brick dust	Water absorption Specific gravity Grading
c)	Coarse Aggregate	Water absorption Specific gravity Grading
d)	Water	P_H value

4) Naming of the Specimen Samples

Naming of the specimen samples are as following-

Root word "C"	First Suffix (Percentage of CW)	Second Suffix (Percentage of BD)

eg: C-10 = concrete with 10% ceramic waste

C-15-10 = Concrete with 15% ceramic waste and 10% brick dust.

Specification and size of sample-

For compressive strength test 150x150x150mm Form is utilized and 3 examples (sample) of each test taken.

IV. RESULTS

A. *Fresh Concrete*

Workability- workability analysis is done with slump cone apparatus, procedure as per IS codal prescription.

Table 2: Slump value

Name of sample	Slump Value (mm)
C-0	39
C-10	36
C-15	35
C-20	31
C-25	29
C-20-5	31
C-20-10	29
C-20-15	26
C-20-20	23

Extreme can accomplish within the routine total where droop is diminishing with regard to expansion of the ceramic squander.

B. *Hard Concrete Test*

After quiring of 14 and 28 days concrete become harden,
The following tests are performed on the harden concrete in this study as follows:
Compressive strength test
Flexural strength test
Compressive strength test is performed on the sample of 14day as well as 28days samples, results are as following-

Table 3: Compressive Strength of Cubes

Name of sample	Compressive strength(N/mm^2)	Compressive strength(N/mm^2)
	14 Days	28 days
C-0	31.00	34.44
C-10	30.24	33.6
C-15	32.50	36.11
C-20	33.00	36.66
C-25	33.04	36.71
C-20-5	33.0	34.37
C-20-10	33.5	37.2
C-20-15	34	37.9
C-20-20	31	34.44

Maximum value of strength is achieve on 20% replacement of ceramic waste and 15% replacement of brick dust.

C. Flexural Strength Test

Flexural strength test is performed on 28 days concrete beam.

Table 4 Flexural strength of the concrete

Name of sample	Flexure strength(N/mm^2) 28 days
C-0	3.5
C-10	3.4
C-15	3.6
C-20	3.6
C-25	3.5
C-20-5	3.4
C-20-10	3.7
C-20-15	3.8
C-20-20	3.2

V. CONCLUSION

1) Optimum replacement of conventional aggregate with the ceramic waste in first stage is 20%.

2) Combined optimum replacement of the conventional fine aggregate with the ceramic waste as well as brick dust is 20% CW and 15% of BD.

3) Conventional fine aggregate is well graded in nature but ceramic waste and brick dust is poor graded material therefore interlocking can be affected. And replacement makes concrete less workable, workability decreased by 33%.

4) Workability is decreasing with respect to increment of ceramic waste therefore this replacement cannot be possible in SCC (Self compacting concrete).

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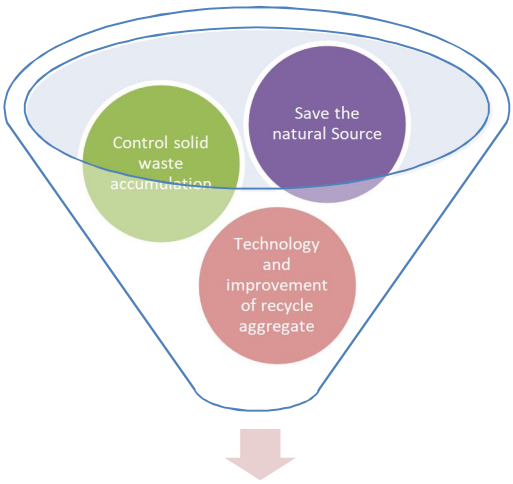

construction sustainability

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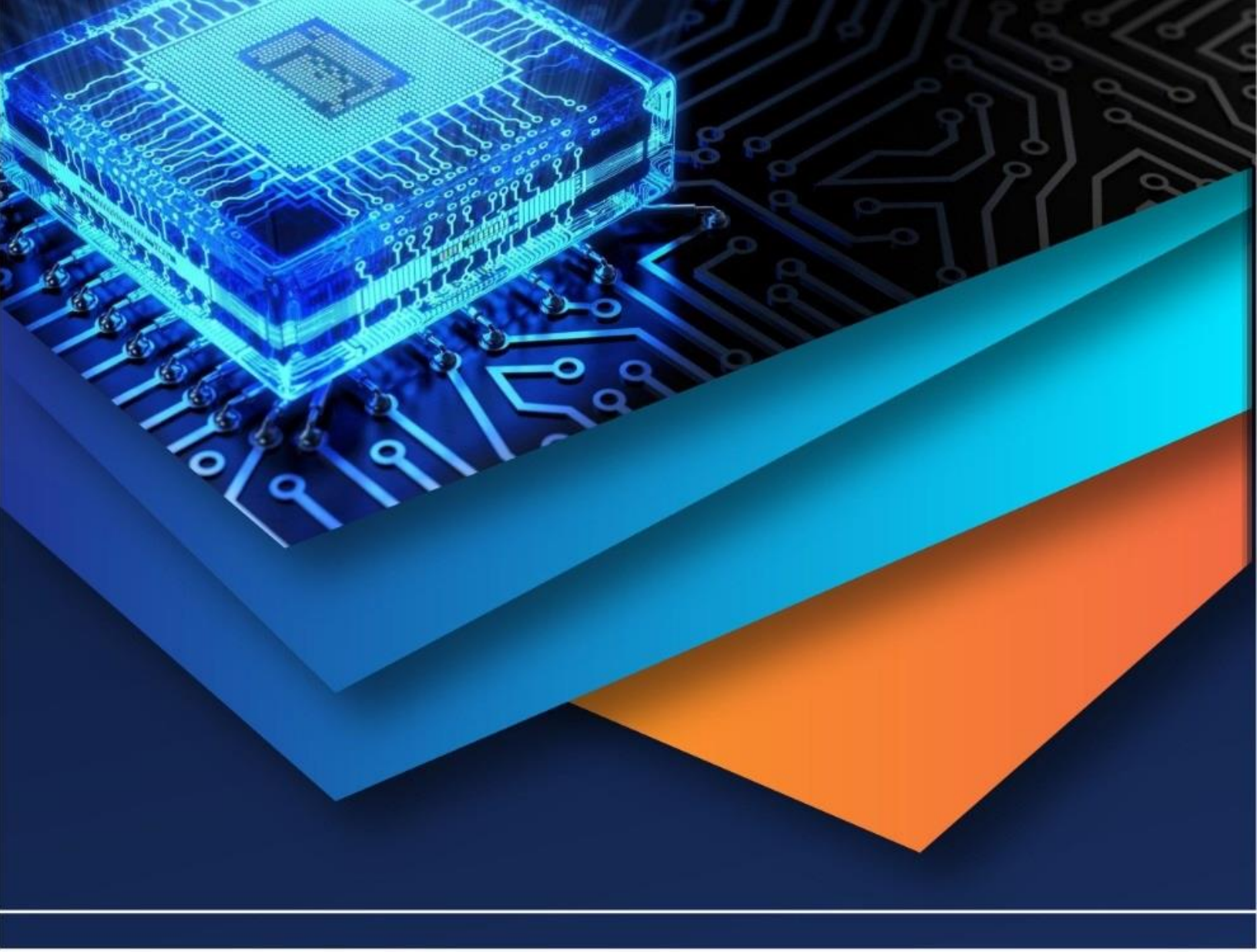

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