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PARTIAL REPLACEMENT OF CEMENT WITH RED MUD AND FLY ASH IN PREPARATION OF CONCRETE BRICKS

M. Revathi[1], Miryalkar Aishwarya[2], Koyyadi Akhil[2], Mudavath Bhaskar Naik[2], Thirukkovela Sai Vaibhav[2], Kalawala Akhil[2]
[1,2]department Of Civil Engineering
[1,2]Malla Reddy Engineering College and Management Sciences, Medchal, Telangana.

ABSTRACT
Most of the building material for construction of houses is the normal brick. The rapid growth in today's construction industry has obliged the civil engineers in searching for more efficient and durable alternatives far beyond the limitations of the conventional brick production. This project presents the experimental investigation of partial replacement of Red mud and fly ash as replacement of cement in the preparation of concrete bricks. In this study M10 grade of concrete was made for concrete bricks. Concrete mix of 0%, 10%, 20% and 30% replacement of Flyash and constant replacement of 20% of Red mud in cement were made. The brick specimen was Casted a size of 150mm x 150mm x 150mm and the Shape and size test, Compression test, water absorption test, fire ignition, Soundness test, drop test, Efflorescence test, Colour test and Structure test were conducted to analyze their suitability as a construction material.
Keywords: M10 grade of concrete, fly ash, coconut shells, Shape and size test, Compression test, water absorption test, fire ignition, Soundness test, Drop test, Efflorescence test, Colour test, Structure test.

1. INTRODUCTION

1.1 General

Waste management is typically dealt depending on the type of waste, quantity of waste generated and the degree of associated problems with the environment. It is believed that recycling of industrial wastes is technically economical and also has several environmental benefits. Wastes from the industries can be used as the constituents of concrete by replacing or partially replacing the cement or aggregates which makes it cost effective and also conserves the natural resources. Concrete is the important material in construction other than steel and timber and its main constituents are cement, sand, fine and coarse aggregates, and water. But, one of the greatest environmental concerns in construction industry are the production of cement which emits large amount of co_2 to the atmosphere. It is estimated that production of one ton of clinker/cement releases equally one ton of co_2. Therefore, the past two decades of research is diverted primarily in making concrete without cement or at least partially in low or high volumes, replacing cement by suitable alternatives like fly ash, silica fume, ground granulated blast furnace slag, rice husk ash. China, India, united states of America is the order of countries having largest cement consumption.

E-waste describes as loosely thrown-out, not needed any more, no longer useful/no longer used, broken, electrical or electronic devices. Fast technology change, low initial cost has resulted in a fast growing of electronic waste around the globe. Several tons of E-waste need to be disposed per year. Traditional place where garbage and trash are dumped method is not

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a related to surrounding conditions or the health of the Earth friendly solution and the disposal process is also very complicated. How to reuse the non-disposable E-waste becomes an important research topic. The processing of electronic waste causes serious health and pollution Problems due to electronic equipment contains serious contaminants such as lead, Cadmium, Beryllium, Poisonous metal, Mercury, Nickel, Silver, Zinc. In India, E-waste is mostly generated in large cities like Delhi, Mumbai and Bangalore. In these cities a complex e-waste handling infrastructure has developed mainly based on a long tradition of waste recycling. Sixty-five cities in India generate more than 60% of the total e waste generated in India. Ten states generate 70% of the total E-waste generated in India. Because of increment in cost of typical coarse aggregate it has constrained the civil engineers to discover appropriate other options to replace it. E-waste can be utilized as one such option for coarse aggregate. Owing to shortage of coarse aggregate for the planning of solid, incomplete supplanting of E-waste with coarse aggregate was tried.

2. LITERATURE REVIEW

The analysis of the characteristics of concrete namely the workability, strength and durability are made based on the fundamental study initiated to arrive at the feasibility and suitability of using marble powder as a partial replacement material by 0, 5, 10, 15, 20 and 25% weight of cement in M30 grade concrete. Experimentation performed and the conclusions are derived as the compactor factor increased with the increase in the level of replacement up to 15% and there after decreased for further higher level of replacement and slump value decreased with the increase in the level of replacement. The compressive strength at 7, 14 and 28 days is increasing with the increase in the replacement level of cement with marble powder up to 15% replacement at which the compressive strength 14.53% higher compared to conventional concrete.

Rathod et al (2013) replaced 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% of cement with red mud taking control mix with 0%. It was observed that the compressive strength and tensile strength decreased with the increase in the proportion of red mud. The optimum percentage of red mud to be replaced with cement was recommended as 20%.

Lamond, (1983) carried out investigation to study materials that could be used in concrete to replace a portion of Portland cement. This investigation was performed by the U.S. Army Waterways Experiment station in Vicksburg, Mississippi. Five types of Portland cements are investigated in combination with sixteen cement replacement materials. Fly ash from four different sources was among the sixteen replacement materials. Among the properties that studied included bleeding, permeability, heat rise, resistance to freezing and thawing, elasticity, compressive strength to an age of ten years and flexure strength. Sixteen reports were published between April 1955 and November 1967. He found that at ten years, the compressive strength of fly ash concrete with w/c 0.5-0.8 never equalled that of the Portland Cement Concrete mixture. At 180 days, the flexural strength of the fly ash concrete was equal to the Portland Cement Concrete.

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3. OBJECTIVE OF THE STUDY

3.1 Aim

The aim of study is to evaluate the performance and suitability of replacement of with cement with red mud and red mud in concrete bricks manufacturing.

3.2 Objective

The objectives of experimental study are:

- Study on strength characteristics of M10 grade concrete bricks with replacement of 20% cement by red mud and replacement of Fly ash of 0%, 10%, 20% and 30% in cement.
- To determine the Shape and size test, Compression test, water absorption test, fire ignition, Soundness test, Drop test, Efflorescence test, Colour test, Hardness and Structure test for E-waste - Red mud concrete bricks.

4. EXPERIMENTAL WORK

4.1 Materials Used

- Cement
- Coarse Aggregates
- Fine aggregates
- Water
- Red mud
- Fly ash

Table. 1: Physical properties of fine aggregates & coarse aggregates.

Property	CA	FA
Water absorption	0.7%	1.05%
Specific gravity	2.72	2.64

Table. 2: Physical properties of cement.

Property	Result
Standard Consistency	31%
Initial Setting Time	41min
Final Setting Time	315min
Specific gravity	3.13

4.1.1 Red mud

A solid- waste generated at the Aluminium plants all over the world. In Western countries; about 35 million tons of red mud is produced yearly. Because of the complex physico-chemical properties of red mud it is very challenging task for the designers to find out the economical utilization and safe disposal of red mud. Disposal of this waste was the first major problem encountered by the alumina industry after the adoption of the Bayer process.

Fig. 1: Red mud.

Table. 3: Physical properties of red mud.

Property	Value
Specific gravity	2.64
Fineness value	3%

4.1.2 Flyash

In this experimental work Fly ash, which has grade of low calcium or ASTM class F has taken but usually two types of grades available high calcium i.e., ASTM class C and low calcium i.e., ASTM class F. The specific gravity of flyash obtained is 2.2.

Fig. 2: Flyash (class F).

4.2 Methodology

The present study requires preliminary investigations in a systematic manner

- Selection of type of grade of mix, mix design by an appropriate method, trial mixes, final mix proportions.
- Estimating total quantity of concrete required for the whole project work.

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- Estimating quantity of cement, red mud, fly ash, fine aggregate, coarse aggregate required for the project work.
- Preparing the concrete bricks with partial replacement of cement by red mud & flyash, fine aggregates, water-cement ratio kept constants.
- Prepared bricks cure for 7days by sprinkling of water daily 2times.

4.3 Mix design

Adopted Grade was **M10** for preparation of concrete bricks

4.3.1 General

Density of cement = 1440kg/m^3
Density of sand = 1600kg/m^3
Density of aggregates = 1800kg/m^3
Dry volume = 1.54 to 1.57*wet volume
M10 =1:3:6
Sum of ratios =1+3+6 = 10
Assuming 1.54(wet volume) = dry volume.

4.3.2 Basic calculations:

For 1m^3 volume
Volume(V) = length(L)*breadth(B)*height(H)
V = 1m*1m*1m = 1m^3
Weight of cement = 1/10*1.54*1440 = 221.76kg
Weight of sand = 3/10*1.54*1*1600 = 739.2kg
Weight of aggregates = 6/10*1.54*1*1800 = 1663.2kg

4.3.3 For 150*150*150mm Cube

For 150*150*150mm size brick
Volume = 150*150*150= 0.003375m^3
Assume 10% wastage, n = 1 brick
Final volume of brick = n*[1+wastage] *0.003375
= 1*[1+10/100] *0.003375
= 0.0037125m^3
Weight of cement = 0.0037125*[1/10*1.54*1440]
= 0.0037125*221.76
= 0.37541
= 0.823kg
Weight of sand = 0.0037125*[3/10*1.54*1600]
= 0.0037125*739.2
= 1.251391
= 2.744kg
Weight of aggregates = 0.0037125*[6/10*1.54*1800]
= 0.0037125*1663.2
= 2.81563
= 6.174kg
Weight of water:

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w/c = 0.55 (assume)

w = 0.55*0.823 = 0.452 kg

4.3.4 Red mud and E-waste replacement in concrete bricks

For 1 Brick making (20% Constant replacement of cement with red mud and 0%, 10%, 20% and 30% replacement of cement with flyash.

Table. 4: Material weights requirement for making 1 brick.

<table>
<tr><th>Red mud (%) – E waste (%)</th><th>Cement (kg)</th><th>Red Mud (kg)</th><th>Fly ash (kg)</th><th>Fine Aggregate (kg)</th><th>Coarse Aggregate (kg)</th><th>Water (kg)</th></tr>
<tr><td>0 – 0</td><td>0.823</td><td>0</td><td>0</td><td>2.744</td><td rowspan="5">6.174</td><td rowspan="5">0.452</td></tr>
<tr><td>20-0</td><td>0.658</td><td rowspan="4">0.164</td><td>0</td><td></td></tr>
<tr><td>20-10</td><td>0.577</td><td>0.082</td><td></td></tr>
<tr><td>20-20</td><td>0.495</td><td>0.164</td><td></td></tr>
<tr><td>20-30</td><td>0.413</td><td>0.246</td><td></td></tr>
</table>

4.4 Sample Production

Control mix: The cement, fine and coarse aggregates were weighted according to mix proportion of M_{10}. All are mixed together in a bay until mixed properly and water was added at a ratio of 0.55. The water was added gradually and mixed until homogeneity is achieved. Any lumping or balling found at any stage was taken out, loosened and again added to the mix.

Red mud based Concrete bricks: The cement, red mud (20% of cement weight replacement), fine and coarse aggregates were weighted according to mix proportion of M_{10}. All are mixed together in a bay until mixed properly and water was added at a ratio of 0.55. The water was added gradually and mixed until homogeneity is achieved. Any lumping or balling found at any stage was taken out, loosened and again added to the mix.

E waste & Red mud based concrete bricks: The cement, red mud (20% of cement weight replacement), Flyash (0%, 10%, 20% and 30% of cement weight replacement), fine aggregates, coarse aggregates, were weighted according to mix proportion of M_{10}. All are mixed together in a until mixed properly and water was added at a ratio of 0.55. The water was added gradually and mixed until homogeneity is achieved. Any lumping or balling found at any stage was taken out, loosened and again added to the mix.

A standard 150x150x150 mm brick specimens were casted for all above various types of concrete mixes. The samples were then stripped after 24hours of casting and are then be sprinkling of water for curing 7days (daily 2 times). As casted, a total of (21) 150x150x150mm bricks specimens were produced.

4.5 Concrete Bricks Testing

4.5.1 Compression Test

- Brick specimen to be tested is placed on a horizontal surface and the specimen is to be centered between the plates on Compression testing machine.
- Apply the load at a uniform rate till the failure occurs.

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- Note down the maximum load at failure.

4.5.2 Water Resistance Test

In this the bricks first weighted in dry condition and they are immersed in water for 24 hours. After that they are taken out from water and they are wipe out with cloth. Then the difference between the dry and wet bricks percentage are calculated.

The less water absorbed by bricks the greater its quality. Good quality bricks don't absorb more than **20%** water of its own weight.

4.5.3 Efflorescence test

The presence of **alkalis** in bricks is harmful and they form a grey or white layer on the brick surface by absorbing moisture. To find out the presence of alkalis in bricks this test is performed. In this test, a brick is immersed in fresh water for **24** hours and then it's taken out of the water and allowed to dry in shade. If the whitish layer is not visible on the surface it proofs that absence of alkalis in brick.

If the whitish layer visible about **10%** area of the brick surface, then the presence of alkalis is in the acceptable range. If that is about **50%** of surface area then it is moderate. If the alkali's presence is over **50%** of the brick surface area, then the brick is severely affected by **alkalis**.

4.5.4 Shape and Size Test

Shape and size of bricks are very important consideration. All bricks used for construction should be of same size. The shape of bricks should be purely rectangular with sharp edges. Standard brick size consists length x breadth x height as 15cm x 15cm x 15cm.

4.5.5 Colour Test

A good brick should possess bright and uniform colour throughout its body.

4.5.6 Soundness test

Soundness test of bricks shows the nature of bricks against sudden impact. In this test, 2 bricks are chosen randomly and struck with one another.

Then sound produced should be clear bell ringing sound and brick should not break. Then it is said to be good brick.

4.5.7 Hardness test

A good brick should resist scratches against sharp things. So, for this test a sharp tool or finger nail is used to make scratch on brick. If there is no scratch impression on brick then it is said to be hard brick.

4.5.8 Drop test

When bricks are dropped from the height of 1 to 1.2m (4 feet), it should not crack or break. This ensures the durability and quality of bricks.

4.5.9 Structure of Bricks

To know the structure of brick, pick one brick randomly from the group and break it. Observe the inner portion of brick clearly. If there are any flaws, cracks or holes present on that broken face then that isn't a good quality brick.

5. RESULTS AND DISCUSSIONS

As per experimental programme results for different experiments were obtained. They are shown in table format or graph, which is to be presented in this chapter.

5.1 Brick Test Results

5.1.1 Compression Test

Table. 5: Compression test results.

Red mud (%)- Fly Ash (%)	Compression(N/mm2)
0 – 0	7.5
20-0	8.4
20-10	8.9
20-20	7.1
20-30	6.2

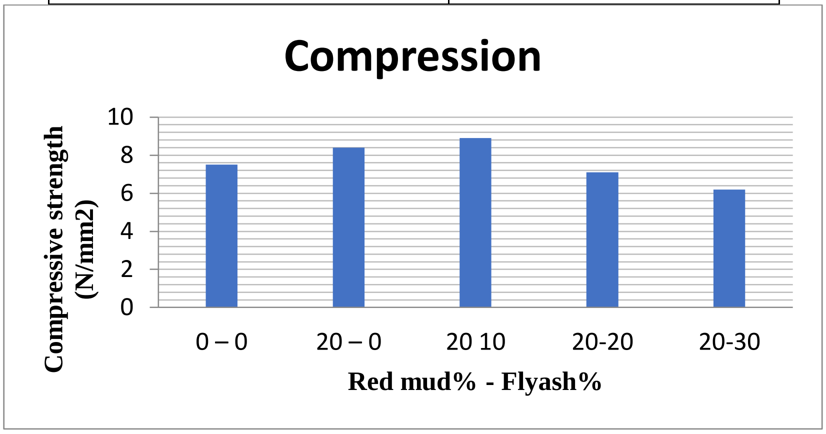

Fig. 3: Compressive strength test results graph.

5.1.2 Water Resistance Test

Table. 6: Water resistance test results.

Red mud (%)- Fly Ash (%)	Water Resistance (%)
0 – 0	8.2
20-0	8.2
20-10	7.8
20-20	7.5
20-30	7.2

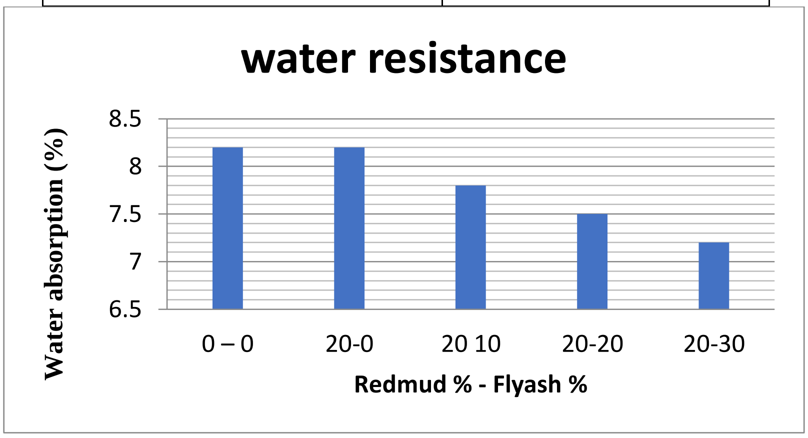

Fig. 4: Water absorption test results graph.

5.1.3 Efflorescence test

No efflorescence visible on all bricks.

5.1.4 Shape and Size Test

For all bricks are rectangular shape and size 15 cm x 15 cm x 15 cm.

5.1.5 Colour Test

All the bricks having the uniform colour for entire structure.

5.1.6 Soundness test

For all the bricks ringing sound produced and bricks are not breaked. Then the bricks are good quality bricks.

5.1.7 Hardness test

Little bit scratch visible on all bricks except concrete bricks.

5.1.8 Drop test

For all the bricks can't breaked while performed drop test, then the bricks are good quality bricks.

5.1.9 Structure of Bricks

There are no flaws, cracks or holes present on that broken face then that is a good quality brick.

6. CONCLUSIONS

1. The aggregates are vital elements in concrete Bricks. The usage of enormous quantities of aggregates results in destruction of hills causing geological and environmental imbalance. The environmental impacts of extracting river sand and crushed stone aggregates become a source of increasing concern in most parts of the Country. Pollution hazards, noise, dust, blasting vibrations, loss of forests and spoiling of natural environment are the bad impacts caused due to extraction of aggregates. Landslides of weak and steep hill slopes are induced due to unplanned exploitation of rocks.
2. Up to 20% of redmud and 10% flyash replaced with cement is good according to strength and cost wise.
3. The water resistance value is decreasing by increasing Red mud and Flyash replacement by cement. The structure test, soundness test, drop test, Colour test, Size and shape test the properties are similar to good quality bricks. And these bricks are very lesser cost compare to normal concrete and flyash bricks.

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