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# An Experimental Study on Strength of Masonry Blocks and Bricks Produced using GGBS and Red Mud

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**Abstract** – masonry is of considerable volume in most of the structures and masonry units are consumed in bulk quantities. Compressive strength of masonry greatly depends on strength of masonry units. In the present investigation an experimental study has been conducted for the development of bricks and blocks using red mud and GGBS. Red mud emerges as the major waste material during production of alumina from bauxite by the Bayer's process. Red mud bricks are eco-friendly and economical. The GGBS(Ground Granulated Blast Slag) is a waste product from the iron manufacturing industry. This has been used as a partial replacement of cement in concrete due to inherent cementitious properties.

By the utilization of GGBS, carbon dioxide emission will certainly be reduced. Also since clay is non-renewable material, it has been partially replaced with the red mud.

In the present study, bricks and blocks of different trial mix are produced and the strength properties are compared with that of conventional bricks and blocks. It is observed that, red mud & GGBS blocks possess lesser compressive strength when compared to that of conventional blocks and hence are not suitable for the construction of load bearing walls but can be used for the construction of partition walls. In the case of red mud & GGBS mixed bricks, mix with nomenclature A4possess higher compressive strength and the same can be used for the construction of load bearing walls.

**Key Words**: Cement, concrete, GGBS, Red mud, Compressive Strength.

## 1. INTRODUCTION

Masonry is the building of structures from individual units laid in and bound together by mortar. Masonry is of considerable volume in most of the structures and masonry units are consumed in bulk quantities. An investigation on concrete block masonry is carried out and a comparative study is executed with respect to masonry construction, economy and strength parameter.

GGBS is a byproduct from the blast furnaces and is a non metallic, slightly alkaline and exhibits a pH in solution in the range of 8 to 10and does not present a corrosion risk to steel in pilings or to steel embedded in concrete made with blast furnace slag cement or aggregates. It substantially improves the ability of concrete to resist deterioration from all major threats to long service life. It will even provide better fire resistance.

Red mud is the solid waste residue of the digestion of bauxite ores with caustic soda for alumina production and is usually disposed in mud lakes in the form of slurry impoundment or stack in ponds as dry alumina plants or directly discharged through a pipeline into a nearby sea. Due to the characteristics of fine particles, high alkalinity (pH 10-12.5) and trace metal content, the disposal of large quantities of red mud has caused serious environmental problems including soil contamination, ground water pollution and fine particles suspension in the sea. Moreover storage of the same in lakes or ponds leads to dust pollution which is a serious health problem. The use of red mud as a replacement for cement reduces considerably the problems associated with its storage and disposal.

## 2. MATERIALS AND METHODS

### 2.1. Materials

**2.1.1 Cement:** Ordinary Portland cement of 53 grade confirming to Indian Standards was used in the present study and the specific gravity of the sample was determined. The results have been tabulated in table2.1.

**2.1.2 Fine aggregates:** Locally available Quarry dust of fineness modulus 3.85, conforming to zone II was used in the present investigation and the specific gravity of the sample was evaluated. The results have been tabulated in table2.1.

**2.1.3 Coarse aggregates:** Crushed granite with fineness modulus 6.9 12 mm down size was used in the present investigation and the specific gravity of the sample was evaluated. The results have been tabulated in table 2.1.

**2.1.4 Water:** Drinking water was used for the experimental study.

**2.1.5 GGBS:** It is a by-product of the iron manufacturing industry. Its production requires less energy as compared with the energy needed for the production of the Portland cement. The replacement of the Portland cement will lead to significant reduction in carbon dioxide gas emission.

**2.1.6 Clay:** Locally available clay with Liquid limit 38%, Plastic limit of 24.5% and shrinkage limit of 11.9 % is used.

**2.1.7 Lime:** Hydrated lime is used in the experiment. Lime is used just to ensure proper bonding.

**Table 2.1**: Significant properties of materials used

| Materials | Specific gravity |
|---|---|
| Cement | 3.15 |
| Fine aggregates | 2.71 |
| Coarse aggregates | 2.78 |
| GGBS | 2.78 |
| Red mud | 2.83 |

**Table 2.2**: Chemical Composition of GGBS & Red Mud

| Major Minerals | Percentage in | |
|---|---|---|
| | GGBS | Red Mud |
| Lime (Cao) | 32.4 | 1.47 |
| Silica ($SiO_2$) | 34.06 | 11.4 |
| Alumina ($Al_2O_3$) | 18.08 | 21.6 |
| Iron oxide ($Fe_2O_3$) | 0.70 | 38.3 |
| Magnesium oxide (MgO) | 10.75 | - |
| Sodium oxide ($Na_2O$) | 0.31 | 6.87 |
| Potassium oxide($K_2O$) | 0.980 | - |
| Sulphur tri-oxide ($SO_3$) | 0.850 | - |

**Table 2.3** Mix Proportion for blocks

| Type of block | Lime (%) | Cement (%) | GGBS (%) | Red mud (%) |
|---|---|---|---|---|
| **Conventional block** | **0** | **100** | **0** | **0** |
| **Mixed block** | **10** | **50** | **20** | **20** |

**Table 2.4:** M40 Mix proportion for bricks

| Mix | Lime (%) | Clay (&) | GGBS (%) | Red mud (%) |
|---|---|---|---|---|
| **N1** | **0** | **100** | **0** | **0** |
| **A1** | **5** | **50** | **5** | **40** |
| **A2** | **5** | **50** | **15** | **30** |
| **A3** | **5** | **50** | **25** | **20** |
| A4 | **5** | **50** | **40** | **5** |
| **A5** | **5** | **65** | **10** | **20** |
| **A6** | **5** | **55** | **20** | **20** |

## 3. Experimental Program and Results

The experimental program consisted of casting and testing of block specimens of size (400 X 200 X 150 mm) after a normal curing for 28 days and 4 days burnt brick specimen of standard size. The results for compressive strength and water absorption are tabulated below.

**Table 3.1** Test results for blocks

| Type of block | Compressive strength (N/mm2) | Water absorption (%) |
|---|---|---|
| **Conventional block** | **3.34** | **2.54** |
| **Mixed block** | **2.45** | **2.84** |

**Table 3.1** Test results for blocks

| mix | Compressive strength (N/mm2) | Water absorption (%) |
|---|---|---|
| N1 | 3.89 | 12.5 |
| A1 | 1.74 | 24.1 |
| A2 | 1.43 | 26.62 |
| A3 | 2.2 | 25.17 |
| A4 | 4.405 | 20.77 |
| A5 | 1.805 | 25.89 |
| A6 | 1.02 | 22.9 |

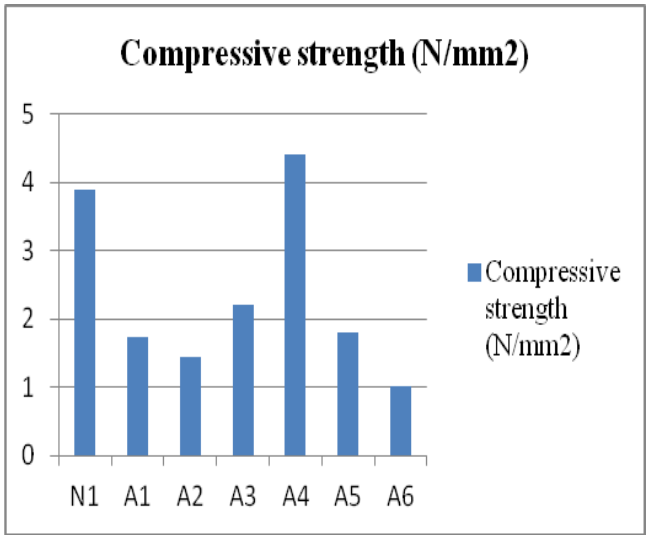


**Fig. 3.2 Compressive strength results**

**4. Discussion:** Red mud & GGBS blocks possess lesser compressive strength when compared to that of conventional blocks and hence are not suitable for the construction of load bearing walls but can be used for the construction of partition walls. In the case of red mud & GGBS mixed bricks, mix with nomenclature A4possess higher compressive strength and the same can be used for the construction of load bearing walls.

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