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EXPERIMENTAL INVESTIGATION OF BRICKS USING CERAMIC POWDER, MARBLE DUST AND WOOD ASH

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ABSTRACT - *The scope of our project is to utilize the waste products in the manufacturing process of bricks, it effectively reduces the cost as well as the waste production. Generally, the building bricks are typically rectangular in shape, solid in structure and made from a suitable type of clay. Bricks can also be manufactured from other types of materials. In this project, we are going to use Wood ash, Ceramic powder and Marble dust as partial replacement of clay for the manufacturing of bricks. The proportion of raw materials are as follows, wood ash at 20%, ceramic powder varies at 5%, 10% and 15% and marble dust varies at 5%, 10% and 15%. These raw materials are mixed in correct proportion and wet bricks are dried for 10 to 12 days in the sunlight and fired at brick kiln at 900 to 1000. The process of testing of bricks like compression test and water absorption test can be done as per Indian Standard codes 3495 part 1 & 2, 1077. Ceramic powder has high strength and durability hence it increases the strength of the bricks. Marble dust has high durability and workability which increases the durability of the bricks. Wood ash has less water absorption which reduces the flow of water into the bricks. From the results, it is observed that the usage of these raw materials reduces the waste production and increases the strength and durability of the bricks.*

KEYWORDS: Bricks, Waste production, Wood ash, Ceramic powder, Marble dust.

1. INTRODUCTION

Bricks are rectangular blocks used as an important building material and it should be in uniform size, obtained by burning and drying of clay in moulding. The common bricks are one of the oldest building materials and even now, used as important material. The Great Wall of China (210B.C.) was built with both burnt and sundried bricks. The collection of clay which is suitable for preparation of bricks from the depth of 200mm and rejection of impurities in the clay is essential. The clay is dried in the atmosphere for softening. After softening the tempering process is made to bring out the hardness and moulding is done. Hence the clay plays an important role in the brick production. About 30% of daily production of ceramic powder in the ceramic industry goes as a waste in India. Hence the disposal of ceramic waste powder in landfills will cause significant environmental problems. Ceramic should contain the properties of heat resistant, great hardness and strength, considerable durability, low electrical and thermal conductivity, chemical inertness. Wood ash is collected from the burning process of wood, which is collected from hotels, marriage halls etc. At the end of 80's, an estimated quantity of 45000 tons of wood ash was produced at Canada from the paper and pulp industry. In 2007, 150000 tons of residue ash were used as fertilizers in Canada. In the marble industry about 7 million of the waste is generated in the form of powder mainly in India in the process of sawing and polishing. When on exposure they can pollute and even damage the environment. During this cutting process, 20-30% of a marble block becomes waste marble powder. Marble dust gives high durability, high workability, increase 10% weight of the water absorption. However, the utilization of waste material like wood ash, marble dust and ceramic powder in the production of bricks can help in the conservation of natural resources like clay. The main objective is to investigate the properties of bricks produced by partial replacement of clay with ceramic powder, marble powder and wood ash.

2. COLLECTION OF RAW MATERIALS

2.1. Clay material

The collection of clay materials for the brick sample is taken from one of the brick manufacturing plant in Trichy district. These clay materials mostly contain phyllosilicate materials that traps more amount of water. Due to the particle size and the water content, clay is said to be plastic and are hard and brittle. When on drying or when fired in a

kiln, they are non-plastic. Generally, clay is available in various colors from white to dull grey and brown to deep orange-red.

Fig -1: Clay material

2.2. Ceramic powder

The ceramic powder can be collected from ceramic waste at ceramic industry which is located at Trichy district. Basically, Ceramic is an inorganic and non-metallic material which are prepared by heating the particles and they can withstand high temperatures. They are obtained from the heat treatment of various hydrated crystalline and dry amorphous particles which changes the structure of the powder and its composition. After heating, the natural cooling is done at the rate of 10℃ per min ute.

Fig -2: Ceramic powder

2.3. Marble dust

The marble chips are crushed by machine or by hand to form a marble dust. Since the surface of the marble powder is crystalline, they reflect light with some white sparkles. They are widely used in the civil engineering purposes such as paints, sculptures etc. The marble dust has variety of color due to the presence of the mineral impurities like clay, slit, sand, iron oxides, chert etc.

Fig -3: Marble dust

2.4. Wood ash

The wood ash is obtained from the burning process of pulp, wood, paper mills and other thermal power generation plants. They are the renewable sources of energy and an environmentally friendly material. The wood ash is used in the gardens because it has a good potash source. The main constituent of wood ash is calcium carbonate and they are alkaline in nature. The amount of wood ash obtained depend upon the type of wood burnt.

Fig -4: Wood ash

3. TESTING OF RAW MATERIALS

3.1. Fineness test

The fineness of the raw materials is calculated by using IS 90-micron sieve. First the 100 gm of raw materials is taken and are sieved for 15 minutes. The retained weight of the raw materials is noted and the fineness of each raw material is calculated. The same step is repeated for testing other raw materials. The fineness of soil is found out to be 5.95%. The fineness of wood ash is found out to be 4.13%. The fineness of ceramic powder is found out to be 3.59%. The fineness of marble dust is found out to be 3.52%.

3.2. Specific gravity test

The specific gravity of raw materials is calculated by using pycnometer. First the empty weight of the pycnometer is taken. The empty weight with 200 gm of raw material is added and weight is taken. The empty weight with wood ash and water up to the top of the lid is poured and weight is taken. Then the pycnometer is cleaned and water up to top of the lid is poured and weight is taken. Finally, the specific gravity of each raw material is calculated. The same step is repeated for testing other raw materials. The specific gravity of soil is found out to be 2.70. The specific gravity of wood ash is found out to be 2.68. The specific gravity of ceramic powder is found out to be 2.545. The specific gravity of soil is found out to be 3.26.

3.3. Bulk density test

The bulk density of the raw material is calculated by using the cylinder. First the empty weight of the cylinder is taken. The raw material is filled in the cylinder for three layers and are compacted by using tamping rod for 15 times. The weight of the compacted raw material is taken with the empty weight of the mould. Then the compacted weight is subtracted with the empty weight to get weight of the compacted raw material. The height and diameter of the cylinder is calculated. Finally, the bulk density of each raw material is calculated. The same step is repeated for testing other raw materials. The bulk density of the soil is found out to be 1646 kg/m^3. The bulk density of the wood ash is found out to be 811.81 kg/m^3. The bulk density of the ceramic powder is found out to be 924.88 kg/m^3. The bulk density of the soil is found out to be 1166.28 kg/m^3.

4. METHODOLOGY

4.1. Raw materials

The clay material used for making bricks is collected from the brick manufacturing unit, totally 40 kg of clay material is collected. The wood ash is collected from the combustion of wood from various places like hotels, marriage halls etc., Totally 11 kg of wood ash is collected. The marble dust is collected from the marble manufacturing unit, totally 4 kg of marble dust is collected. The ceramic powder is collected from the ceramic waste in the ceramic industries, totally 4 kg of ceramic powder is collected.

4.2. Mix proportion

The allocation of mix proportion for bricks by partial replacement of wood ash, ceramic powder, marble dust with clay are as follows.

Table -1: Mix proportion

SAMPLE	CLAY MATERIAL (%)	WATER ABSORPTION (%)	CERAMIC POWDER (%)	MARBLE DUST (%)
1	100	0	0	0
2	80	20	0	0
3	70	20	5	5
4	60	20	10	10
5	50	20	15	15

4.3. Preparation of mould

The standard size of the brick 190 x 90 x 90 mm is chosen for making bricks. During burning process of bricks, the size of bricks gets reduced from 8% - 12%. So, the size of wooden mould is prepared in the dimension 230 x 100 x 100 mm.

4.4. Quantity separation

According to the mix proportion the quantities of ceramic powder and marble dust separated in the percentage of 5%, 10% and 15%. The quantity of Wood ash is separated in the percentage of 20% for four samples except sample 1 bricks. Finally, the quantity of clay is separated in the percentage of 100%, 80%, 70%, 60% and 50%.

4.5. Dry mixing

The dry mixing is done as per mix proportion for 5 samples by hand mixing method.

4.6. Wet mixing

The required amount of water is added for each sample by observing the mix proportion and the wet mixing is done in the desired manner.

4.7. Moulding

The separate allocation of moulding for 5 samples is done at accurate shape by using the wooden mould.

4.8. Drying of bricks

The sun drying method is used for drying of bricks for 5 samples to remove moisture. The drying is done in 12 days.

4.9. Burning of bricks

The burning is carried out at 1100□ in the brick kiln for 6 days.

5. TESTS ON BRICKS

5.1. Compressive strength test

The compressive strength test is done on the bricks to determine the strength of the bricks as per IS: 3495 (1 to 4) - 1992. The compressive testing machine is used for this test for 5 samples. The bricks are collected from each sample for this test. Remove the uneven shape on all the sides of the bricks to get smooth surface and the dimensions of the bricks are measured. The bricks are immersed in the water for 24 hours and keep the bricks in the room temperature to remove the moisture. Apply cement mortar in the ratio 1:3 to fill the frog and cover the bricks with wet jute bags for 24 hours. The bricks should be placed in clean water for 3 days. Wipe out any excess moisture present on the bricks. Place the bricks between two plywood which has thickness of 3 mm and place the brick in the compressive testing machine. The load is applied at 14 N/mm^2 per minute till the failure occurs. Finally, the failure load reading is noted for each sample. The compressive strength of the bricks is calculated by using the formula,

$$\text{Compressive strength of bricks} = \frac{\text{Maximum load due to failure (N)}}{\text{Average area of bed face (mm}^2\text{)}}$$

Table -2: Compressive strength of bricks

SAMPLE	COMPRESSIVE STRENGTH (N/mm^2)
1	6.97
2	5.41
3	5.69
4	4.97
5	4.40

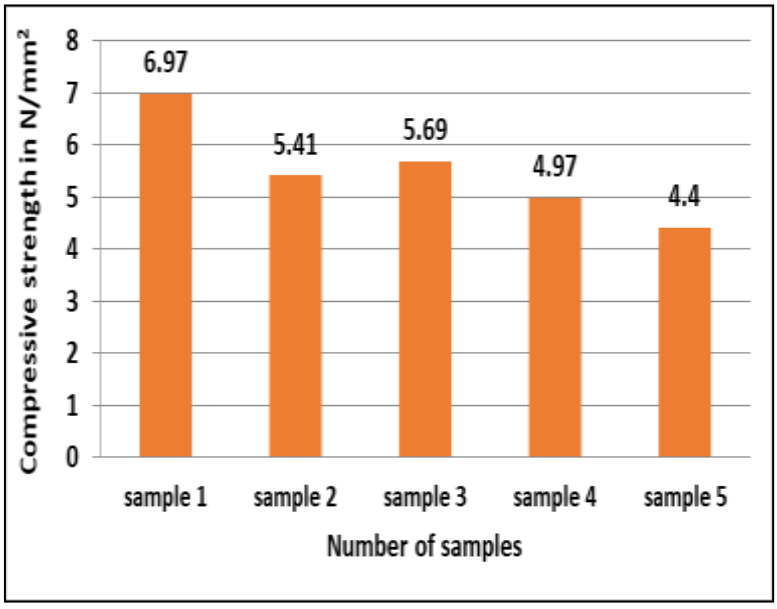

Chart -1: Compressive strength of Bricks

5.2. Water absorption test

The water absorption test is done to determine the durability property of the bricks as per IS: 3495 (1 to 4) - 1992. The bricks are collected from each sample for this test. Initially the dry weight of the brick is taken (W_1) and kept it in a clean water for 24 hours. After removing the bricks from the water, clean the surface without any presence of moisture. The wet weight of the brick is taken (W_2). The percentage of water absorption is calculated by using the formula,

$$\text{Water absorption (\%)} = \frac{W_2 - W_1}{W_1} \text{ X } 100$$

Table -3: Water absorption test on bricks

SAMPLE	WATER ABSORPTION (%)
1	17.60
2	20.56
3	18.20
4	20.43
5	19.70

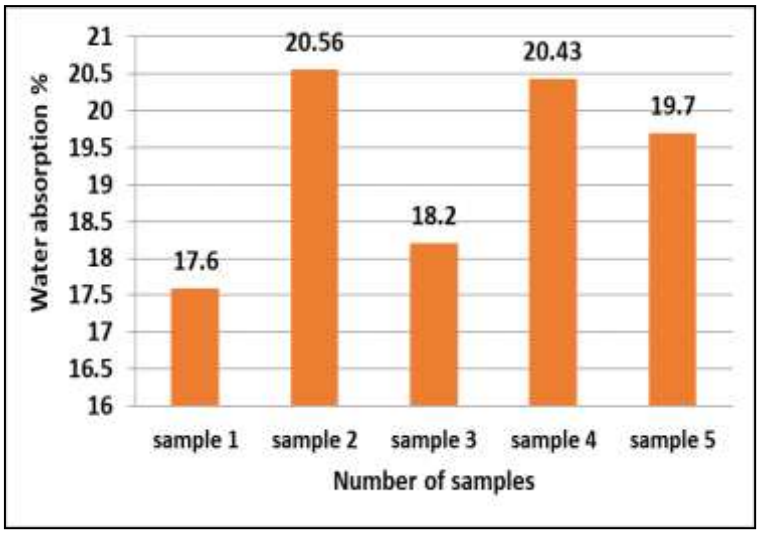

Chart -2: Water absorption test on bricks

5.3. Efflorescence test

The efflorescence test is done to determine the presence of any soluble salts in the bricks as per IS 5454:1976. The bricks are collected from each sample for this test. The Rectangular tray is taken and filled with distilled water for 2.5 cm height. The bricks are placed on the tray to absorb the distilled water. After first absorption the efflorescence is noted and the distilled water is poured for 2.5 cm height again. After the final absorption the Efflorescence of the brick is noted.

Table -4: Efflorescence test on bricks

SAMPLE	EFFLORESCENCE
1	Nil
2	Slight
3	Slight
4	Slight
5	Moderate

5.4. Hardness test

The hardness test is done to determine the hardness in bricks as per IS: 3495 (1 to 4) – 1992. The bricks are collected from each sample. The finger nail is used to make impression on bricks. No impression is created on the brick samples.

5.5. Soundness test

The soundness test is done to determine nature of bricks as per IS: 3495 (1 to 4) - 1992. The bricks are collected from each sample and are selected at random and strike against each other. Metallic or bell sound is produced for all bricks.

5.6. Shape and size test

The shape of the brick is rectangular and uniform. The Size of the bricks from each sample in 190 x 90 x 90 mm.

6. CONCLUSION

From the above tests it concluded that compressive strength reduces when adding marble dust more than 5%. Ceramic powder increases the strength when compared to marble dust. The increase in wood ash reduces the strength and also increases the water absorption of the bricks. The partially replaced bricks show slight efflorescence, but it does not affect the appearance of building. It is observed that the highest compressive strength is obtained in sample 1 and sample 3. The partial replacement of wood ash 20%, Ceramic powder 5% and marble dust 5% gives the strength and less water absorption when compared to other partially replaced bricks. The clay material is highly reduced at 30% and utilization of wood ash, ceramic powder and marble dust proved to be economical. Hence these bricks are easy to make and manufacturing process is simple.

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