Influence of Marble and Aluminium Waste Powder on the Performance of Bricks

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***Abstract* - Clay brick is the first man made artificial building material and one of the oldest building materials known. Its widespread use is mainly due to the availability of clay in most countries. Its durability and aesthetic appeal also contribute to its extensive application in both load bearing and non-load bearing structures. Now a day's most of the companies generates wastes at the end of making final product which are harmful to the society and environment. Recycling of such waste as raw material alternatives may contribute in the exhaustion of the natural resources; the conservation of not renewable resources; improvement of the population health and security preoccupation with environmental matters and reduction in waste disposal costs. In this study an attempt has been made to manufacture bricks from the waste material mainly generated from aluminum industry and marble industry the effects of those wastes on the bricks are studied their effects on the bricks properties such as physical, mechanical properties have been reviewed by adding marble powder and aluminum powder individually, Compressive strength of the individual mix proportions shows better results, nevertheless it doesn't show satisfactory by blending aluminum and marble powder but the bricks weight are reduced and found to be light weight**

***Key words* - Marble powder, aluminum powder, recycle wastes, performance, bricks**

I. INTRODUCTION

Bricks are one of the oldest known building materials dating back to 7000BC where they were first found in southern Turkey and around Jericho. The first bricks were sun dried mud bricks. Fired bricks were found to be more resistant to harsher weather conditions. Bricks are more commonly used in the construction of buildings manufacture of many different types of bricks of all shapes and colours with modern machinery. Growth of population, increasing urbanization and living standards have contributed to an increase in types and amounts of solid wastes generated by industrial, mining, domestic and agriculture activities. India produces around 960 million tons of solid wastes which pose a major environment and ecological problem.

1.1 Ingredients of Good Brick Earth

The clay used for making brick mainly consist of silica and alumina mixed in such a proportion that he clay becomes plastic when water is added to it. It also consists of small proportion of lime, iron, manganese, sulphur, etc. The proportions of various ingredients are given in table below

Silica	50-60□
Alumina	20-30□
Lime	10□
Magnesia	< 1□
Ferric oxide	< 7□
Alkalis	< 10%
Sulphur trioxide	Very small
Carbon dioxide	Very small
Water	Very small

Table 1 Proportion of ingredients in brick clay

1.2 Function of various ingredients

1.2.1 Silica:

The presence of this constituent prevents the shrinkage, cracking and warping of raw bricks. It thus imparts uniform shape to the bricks. The durability of bricks depends upon proper composition of silica in brick earth. The excess of silica destroys the cohesion b/w particles and brick become brittle.

1.2.2 Alumina:

It is the chief constituent of a good brick earth. A content of about 20% to 30% is necessary to form the brick earth of a good quality. It imparts plasticity to the earth so it helps in the moulding of the brick earth. If alumina is present in excess with inadequate quantity of sand then the raw bricks shrink and warp during drying, on burning they become too hard. So it is important to have an optimum content of alumina.

1.2.3Lime:

A small quantity of lime not more than 5% is desirable in good brick earth. It should be present in very fine state, because even small particles of size of a pin-head can result in the flaking of the brick. The lime prevents shrinkage of the raw bricks,

sand alone is infusible, but it slightly fuses at kiln temperature in presence of lime. Fused sand acts as a hard cementing material for brick particles.

1.2.4 Magnesia:

It is used to provide a yellow tint to the bricks. Its content is only about 1% or less.

1.2.5 Iron Oxide:

Iron oxide performs two functions, first it helps in fusing of the sand like lime and second it provides the red color to the bricks. It is kept below 5 to 6% because excess of it may result in the dark blue or black color of brick.

1.3 Harmful Substances in Brick Earth

1.3.1Lime:

The excess of lime causes brick to melt and therefore its shape is lost. The lumps of lime turns into quick lime (CaO) after burning and this free lime can later react with water to form slaked lime. This process is called slaking it may result in splitting of the brick into pieces.

1.3.2 Pebbles, Gravels, Grits:

They do not allow the clay to be mixed thoroughly and spoil the appearance of the brick. Brick with pebble and gravel may crack while working.

1.3.3 Iron Pyrites:

The presence of iron pyrites in brick earth causes the brick to get crystallized and disintegrated during burning, because of the oxidation of the iron pyrites. Pyrites discolourise the bricks.

1.3.4 Alkalis (Alkali salts):

These are exist in the brick earth in the form of soda and potash. It acts as a flux in the kiln during burning and it causes bricks to fuse, twist and warp. Because of this, bricks are melted and they lose their shape. The alkalis remaining in bricks will absorb moisture from the atmosphere, when bricks are used in masonry. With the passage of time, the moisture gets evaporated leaving grey or white deposits on the wall surface (known as **efflorescence**). This white patch affects the appearance of the building structure.

1.3.5 Organic matter:

Organic matters like roots, leaves etc. burn while the brick is burnt producing CO2. This Carbon dioxide creates porosity in bricks affecting the strength of bricks. Hence, organic matter should be avoided in brick-earth.

1.3.6Water:

A large proportion of free water generally causes clay to shrink considerably during drying, whereas combined water causes shrinkage during burning.

1.3.7 Manufacturing of Clay Bricks

The operation involved in the manufacture of clay brick are represented diagrammatically

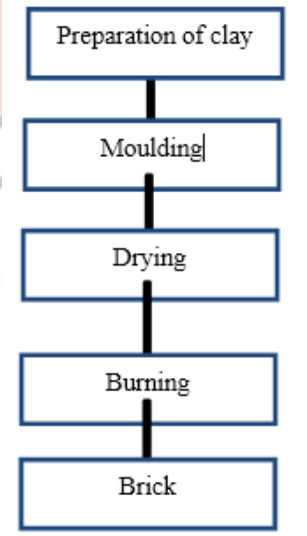

Fig 1. Operation Involved in Manufacturing of clay bricks

1.4 Dimension of Bricks

Bricks are made in traditional size and also in metric size prescribed by bureau of Indian standard. The bricks of latter sizes are also called modular bricks. Depression made at the top of a brick is called the frog. The prescribed actual and nominal dimension as per I.S. is given in the following table

Size	Ordinary bricks	
	Metric Cm	FPS
Actual	19×9×9	8.87 x4.37 x 2.75
Nominal	20x10x10	9x4.5x3

Rajkot	23x10.5x7	9x4x3.75

Table 2 Size of the Bricks

Notes:

1. Nominal size of bricks is the size including the thickness of the mortar. The thickness of the mortar in brickwork should not increase 10mm.
2. We need approximately 500 metric bricks for one cubic meter of brick work.

1.3.8 Replaced Materials

The first replacement material is a waste "Marble Slurry", the waste is generates from the marble industries. During the cutting of marbles the white grey dust produces and that was mixed with water in the machine. That slurry has the most important ingredients like Lime and Alumina which is responsible for the higher strength in the bricks. The marble slurry is mixed with a the black cotton soil, red soil, fly ash and water with the different proportion 5%, 10% and 15% of the weight of Red soil.
There are basic two materials: The second replacement material is "Aluminum powder", generated from the Aluminum Hardware Industries. This waste generates during the process of cutting of Aluminum. It is in solid form. The Aluminum waste is mixed with a the black cotton soil, red soil, fly ash and water with the different proportion 1%, 2% and 3% of the weight of black cotton soil .

The third type of waste is the mixture of both first and second waste with the different proportion by weight of black cotton soil and red soil. Mixture of both gives the higher bonding between materials and gives higher strength in the bricks. This is because of the ingredients presents in the wastes.

1.4.1 Mixing

We have used three types of mix proportion for the manufacturing the bricks. In the first mix we have used marble slurry with red soil, black cotton soil and fly ash. The proportion of marble slurry in mix-I is 5 %, 10 %, 15% of the weight of red soil.
In the second mix proportion we have replaced black cotton soil with the Aluminum powder. The amount of aluminum powder used is 1 %, 2%, 3%.
In the third type of waste is the mixture of both first and second waste with the different proportion by weight of black cotton soil and red soil.

Black Cotton Soil (gm)	Red Soil (gm)	Fly Ash (gm)	Marble Powder (gm)	Aluminum Powder (gm)
MIX – I (ONLY MARBLE POWDER)				
4500	1200	1000	600	-
4500	900	1000	1200	-
4500	600	1000	1800	-
MIX – II (ONLY ALUMINIUM POWDER)				
4455	1200	1000	-	45
4410	1200	1000	-	90
4365	1200	1000	-	135
MIX – III (MARBLE POWDER + ALUMINIUM POWDER)				
4455	1200	1000	600	45
4410	900	1000	1200	90
4365	600	1000	1800	135

Table 3 Content of Mix Proportion in Bricks

Fig 2 Mixing of powder

1.4.2Moulding

It is a process of giving a required shape to the brick from the prepared brick earth. Moulding may be carried out by hand or by machines. The process of moulding of bricks may be soft mud (hand moulding), the stiff mud (machine moulding) or the dry process. The method opted by us for making bricks is ground moulding.

In this process, the ground is leveled and sand is sprinkled on it. The moulded bricks are left on the ground for drying. Such bricks do not have frog and the lower brick surface becomes too rough. To overcome these defects, moulding blocks or boards are used at the base of the mould. The process consists of shaping in hands a lump of well pugged earth, slightly more than that of the brick volume. It is then rolled into the sand and is dashed into the mould with a jerk. The moulder then gives blows with his fists and presses the earth properly in the corners of the mould with his thumb. The surplus clay on the top surface is removed with a sharp edge metal plate called strike or with a thin wire stretched over the mould. After this the mould is given a gentle slope and is lifted leaving the bricks on the ground to dry.

Fig 3 Bricks Specimen

1.4.3 Drying

Green bricks contain about 7-10% moisture depending upon the method of manufacture. The object of drying is to remove the moisture to control the shrinkage and save fuel and time during burning. The drying shrinkage is dependent upon pore spaces within the clay and the amount of water mixed. The addition of sand or ground burnt clay reduces shrinkage, increases porosity and facilitates drying. The moisture content is brought down about 3 % under exposed condition within 3 to 4 days. Thus the strength of the green bricks is increased and the bricks can be handled safely.

1.4.4 Burning

The bricks and fuel are placed in alternate layers. The amount of fuel is reduced successively in the top layers. Each brick tier of 4-5 layers of bricks. Some space is space left between bricks for free circulation of hot gases. After 30% loading of the clamp, the fuel in the lowest layer is fired and the remaining loading of bricks and fuel is carried out hurriedly. The top and sides of the clamp are plastered with mud. The production of bricks is 2-3 lacs and the process is completed in six months. This process yields about 60% first class bricks. The temperature is maintained around 500°C to 600°C.

Fig 4 Burning Process

1.4.5 Compressive Strength Test IS 3495 Part

- S p e c i m e n bricks are immersed in water for 24 hours.
- T h e frog (if provided) is filled flush with 1:3 mortar and bricks is stored under damp jute bags for 24 hours followed by immersion in clean water for three days.
- T h e specimen is then placed between plates of compression testing machine.
- L o a d is applied axially at uniform rate till failure. Maximum load at failure at failure divided by average area of bed face gives compressive strength.

Fig 5 Compressive strength set up

1.4.6 Efflorescence Test

- 24 hours immersion cold water test.
- Dry bricks are oven dried at 105°± 5° C.
- Room temperature cooled bricks weighed W1.
- Bricks immersed in water at 27° ± 2° C for 24 hours.

- Soaked bricks weighed W2.
- Water absorption in % = (W2 – W1)/ W1 * 100\

II. COMPRESSIVE STRENGTH

The compressive test results are shown in table for the normal bricks, marble powder and aluminum powder for the various mix proportions

Brick Type	Weight (gm)	Comp. Strength (kN)	Average(kN)	N/mm^2	Kg/cm^2
Normal Brick	2500	83			
	2480	84			
	2505	88	85	4.97	50.68
Only Marble Powder					
Mix-I (5%)	2068	124			
	2033	120			
	2041	126	123.33	7.21	73.91
Mix-II (10%)	2035	148			
	2110	143			
	2090	150	147	8.59	87.66
Mix-III (15%)	1985	280			
	2035	290			
	2021	286	285.33	16.66	170.09
Only Aluminum powder					
Mix-I (1%)	1988	92			
	1963	107.5			
	1971	111	103.5	6.05	61.69
Mix-II (2%)	2000	97			
	2014	105			
	2011	118	106.66	6.26	63.58
Mix-III (3%)	2013	112			
	2019	105			
	2001	114	110	6.43	65.57

Table 4 Compressive Strength of various mix proportion

2.1 Water Absorption Test

The water absorption test results are shown in table for the normal bricks, brick + marble powder and brick + aluminum powder for the various mix proportions

Brick Type		Weight Before Dry(gm)	Weight After Dry(gm)	Water absorption (in %)
Normal Brick		2480	1995	24.31
Marble Powder	Mix-I (5%)	2313	1930	19.84
	Mix-II (10%)	2335	1924	21.36
	Mix-III (15%)	2351	1935	21.49
Aluminum Powder	Mix-I (1%)	2285	1876	21.80
	Mix-II (2%)	2331	1902	22.55
	Mix-III (3%)	2350	1910	23.03
Marble Powder + Aluminum Powder	Mix-I	2376	1906	24.65
	Mix-II	2438	1960	24.38
	Mix-III	2480	1988	24.74

Table 5 Water Absorption Text

2.2 Efflorescence Test

Brick Type	Nil	Slight	Moderate	Heavy	Serious
Normal	-	-	Yes	-	-
Mix-I	-	Yes	-	-	-
Mix-II	-	Yes	-	-	-
Mix-III	-	-	Yes	-	-

Table 6 Efflorescence Test

2.3 Structural Test

Result of this test is that all the bricks are homogeneous, compact and free from lumps, voids and defects.

2.4 Soundness Test

By striking two specimen bricks with each other clear ringing sound was produced.

2.5 Hardness Test

By making a scratch on bricks surface with the help of finger nail, no impression is left on surface, the brick is considered to be sufficiently hard.

III. CONCLUSION

From the a fore mentioned test results of normal bricks vs addition of marble powder vs addition of aluminum powder vs mixing of both marble and aluminum powder,

1. Adding marble powder in the composition of brick, the qualitative tests like compressive strength test and water absorption test give better results ranges from 30- 400 % of rise in the compressive strength of bricks which is quite appreciated.
2. Aluminum powder mix in the composition shows moderate increase in compressive strength ranges 10-50 % as comparable to normal bricks
3. Adding blend of aluminum and marble powder individually in the composition of bricks, decrease the weight of the brick by 500 gm in average which is also big accomplishment that can reduce the dead load on the building but it fails to improve the compressive strength of the bricks.
4. Mild decrease in water absorption percentage is observed in the only marble and only aluminum powder addition , no changes were observed when addition of marble plus aluminum powder as compare to normal manufacturing bricks

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