

Experimental Investigation on the Replacement of Clay by Metal Powder and Sawdust in Unfired Bricks

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ABSTRACT: Currently there is a growing pressure on energy efficiency for new buildings in India and worldwide. This has arisen partly due to the increasing awareness of the public for sustainable building construction. In addition, there is pressure on building materials manufacturers, due to new government regulation and legislations that are targeting energy usage and carbon dioxide emissions in new buildings. This research work reports on unfired brick materials technology for sustainable building construction. The technology aims at the reduction of the high energy input, especially that arising from firing clay bricks in kilns. So the method is going to be used in the study on the replacement of clay by metal waste powder and sawdust in unfired bricks. Mechanical tests were carried out on unfired brick test specimens and optimum solution was given to solve the problem on achieving higher strength values.

KEYWORDS: Steel slag, Sawdust, Clay soil.

I. INTRODUCTION

In order to boost environmental technologies while strengthening economic growth and competitiveness, the development of products, techniques, services and processes that reduce carbon dioxide emissions and promote resources efficiently is on the increase worldwide. This has accounted for the usage of wastes from the metal and sawmill industries. Nowadays more industries are specializing in the integral management of waste and by-product materials in new environmentally friendly manner. Because of the scarcity of land and high costs associated with the disposal of these secondary wastes, research studies have been done to tackle these problems.

II. OBJECTIVE

- To study the behaviour of the unfired metal waste powder added in bricks has suitable strength or not under given test.
- To identify a correct brick material with suitable proportion.

III. MATERIALS

3.1 CEMENT

Ordinary Portland cement of 53 Grade is used. The cement used and has been tested for various properties having specific gravity of 3.14.

3.2 SAWDUST

Sawdust used in this investigation was collected from the sawmill located in Tirunelveli. The major contribution of the sawdust admixture is the reduction in the dry density.

3.3 CLAY SOIL

For this work, a fine grained plastic soil with high clay content was used throughout. This greatly limits its applications in Civil Engineering. It was supplied by a brick kiln located in Cuddalore.

3.4 STEEL SLAG

Steel slag is generated during the cutting process of mild steel rods in lathe. It is specialized in the manufacture of moulded die presser for tablet manufacturing company.

3.2.5 BRICK MOULD

Here the brick mould is designed in the standard size of brick size. The internal dimensions of the Brick mould is

Length x Breadth x Height 190
mm x 90mm x 90mm

Mould was prepared by using plywood material laminated with mica sheet.

IV. MIXING PROPORTION

Table 4: Material proportion

MATERIAL	B 1	B 2	B 3
Steel slag	32	48	16
Clay soil	48	32	64
Cement	8	8	8
Sawdust	2	2	2
Water	10	10	10
Mixing	Manually	Manually	Manually

V. TESTS CONDUCTED

5.1 Specific Gravity test

Specific gravity is the ratio of the density of a substance to the density of a reference substance. The experiment is done with the help of the pycnometer. The fine aggregates like river sand, coarse aggregates and cement used for investigation are tested to determine the specific gravity. Water is used in pycnometer for testing the fine aggregates and coarse aggregates, but in case of cement water is replaced with kerosene.

Table 5.1: Specific gravity

Contents	Specific gravity
Cement	3.14
Clay Soil	2.7625

5.2 Compressive Strength Test

Compressive Strength of each test specimen was determined from its failure load. Compressive strength is calculated by dividing the maximum load by the original cross-sectional area of a specimen in a compression test. The test specimens were loaded in their normal orientation as pressed using a 1,00,000 kgf capacity testing machine. Before testing for the strength, the weight of each test specimen was recorded to monitor any excessive loss of moisture during

the sun drying period.

Fig 5.2 Compressive Strength Test



Table 5.2: Test Results of Compressive strength

S.NO	BRICK	COMPRESSIVE STRENGTH (N / mm ²)	
		For each brick	Average of 2 bricks
1	B 1	5.55	5.88
		6.20	
2	B 2	4.1	4.25
		4.39	
3	B 3	1.1	1.2
		1.3	

Compressive strength of bricks:

- First class brick – 10.5 N/mm² and above.
- Second class brick – 10.5 N/mm² to 7 N/mm²
- Third class brick – 7 N/mm² to 3.5 N/mm²
- Sun dried brick – 1.5 to 2.5 N/mm²

From the above table, the Compressive strength values we obtained are

- Maximum Compressive strength = 5.88 N/mm²
- Minimum Compressive strength = 1.2 N/mm²
- Contact area during testing = 190 mm x 90 mm
- With our results, the brick test specimens are in the range of third class brick

5.3 Water Absorption Test on Bricks

Water Absorption test indicates the permeability of bricks and also shows the degree of reaction. It does not necessarily indicate the behaviour of a brick in weathering. Low absorption (<7%) usually indicates a high resistance to damage by freezing. The specimens to be tested were placed in a water tank that has the capacity to submerge the whole specimen, at a room temperature of 18^o to 30^o C for 24 hours. After 24 hours, the specimens were to be removed from the tank, and weighed within 3 minutes after taking from the water tank. The water absorption of each test specimen was calculated by the equation given below:

$$\text{Water Absorption (Ww)} = [(M_w - M_d) / M_d] \times 100 \%$$

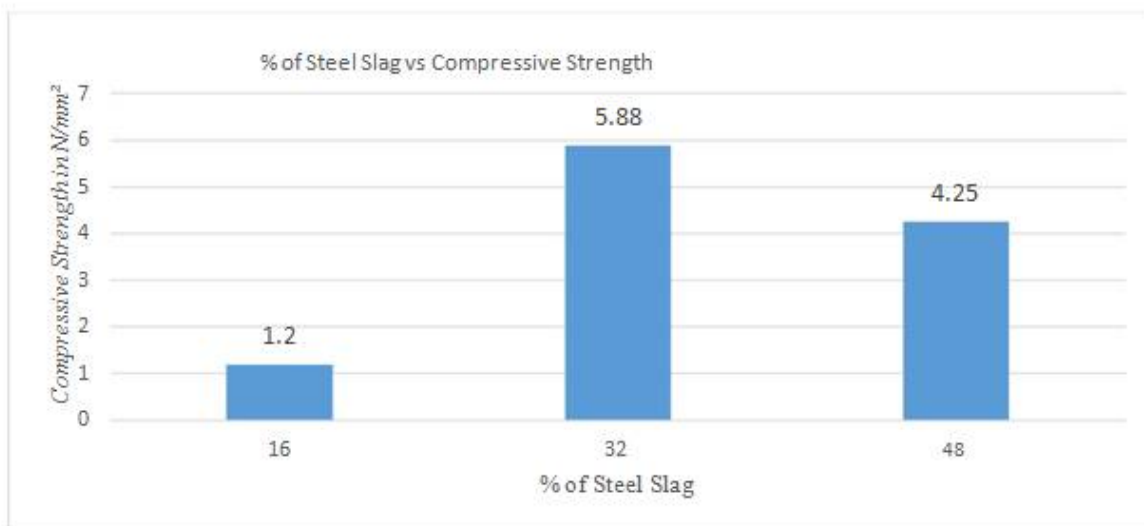


Table 5.3: Test Results of Water Absorption

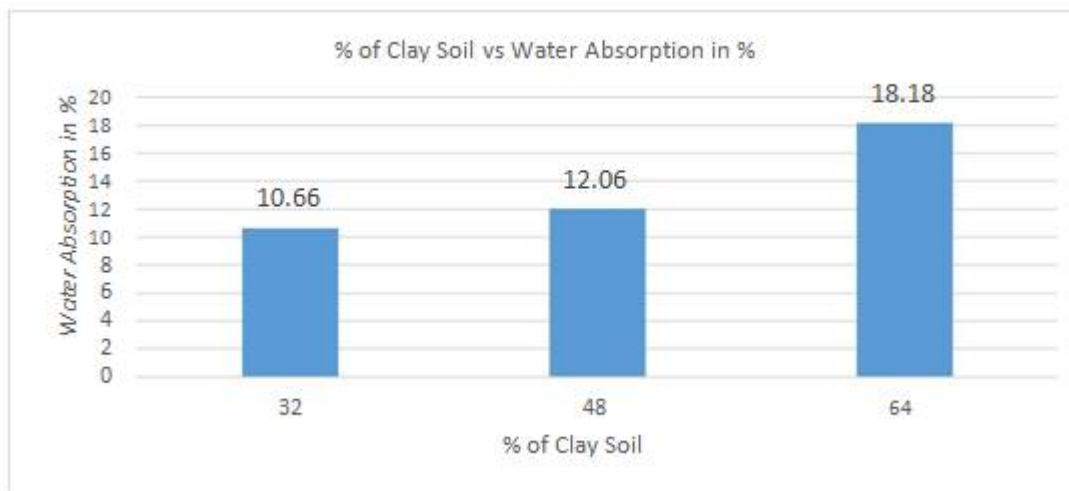
S.NO	SPECIMEN TYPE	M _d (Kg)	M _w (Kg)	WATER ABSORPTION (in %)
1	B 1	3.150	3.530	12.06
2	B 2	3.461	3.830	10.66
3	B 3	2.623	3.100	18.18

5.4 Shape and Size Test on Bricks

The test is performed to check whether the bricks are of required shape and size or not. In this loose particles of clay and projecting blisters are to be removed first. Arrange the bricks on a smooth level surface in a straight series in such a way that the adjoining surfaces are in contact with each other. The arrangement will be done in accordance with the dimension of bricks that is being checked.

The overall length of the brick rows, is then measured in each case. These shall be within the specified limits for different classes of bricks. Tolerances should be acceptable in the range of ± 3 mm to ± 5 mm.

Tests done on the brick specimen are found to be within the acceptable limits.



5.5 Soundness Test on Bricks

In this test, the two bricks are selected and they are struck together. Take one in each hand, and they are struck with each other lightly. A brick of good quality should not break and a clear ringing sound should be produced or generated when the bricks are struck.

Test done on the brick specimen of three types should have generated the soft bell sound or clear ringing sound when they are rub or struck against each other.

5.6 Visual Inspection Test on Bricks

In this test, bricks are closely inspected for its shape. The bricks should be of good quality should be uniform in shape and should have rectangular shape with sharp edges.

From the visual inspection from the brick specimens we used, the result shows the bricks are uniform in shape and have truly rectangular in shape with sharp edges.

5.7 Efflorescence Test on Bricks

The Efflorescence test is mainly done to detect the salts present in the clay soil used for the manufacturing of bricks. The results of efflorescence test shall be reported as 'nil', 'slight', 'moderate', 'heavy' or 'serious'.

NIL : when there is no noticeable deposit of efflorescence

SLIGHT : when thin deposit of salts is covered over exposed area of the bricks is less than 10%

MODERATE: Covering up to 50% of the exposed area of brick surface but unaccompanied by powdering or flaking of the surface.

HEAVY : when there is a heavy deposit of salts covering 50% or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

SERIOUS : when there is heavy deposit of salts accompanied by powdering or flaking of the surface.

Fig 5.7 Efflorescence Test on Bricks



From the results of efflorescence test, the bricks specimens of B1, B2, and B3 have a thin deposit of salts covered over exposed area of the specimen is less than 10%.

So, the efflorescence test is reported as 'slight'.

5.8 Hardness Test on Bricks

In this test, a scratch is made on the bricks surface with the help of a finger nail. If no impression is left on the surface, brick is to be treated as sufficiently hard.

The result obtained from the specimen indicates there is no impression on the specimen during the scratching with nail. So, the brick specimen is sufficiently hard.

VI. CONCLUSION

- There is potential in using steel slag as a strengthening material for unfired brick production.
- The strength resistance and water absorption values were within the acceptable limits for masonry unit.
- It is clear that there are undoubted environmental benefits of using waste material.
- The compressive strength values results in third class bricks.
- Water absorption percentages are in the range of high class bricks especially in B1 & B2. Its percentage gets increased to 18.18% when the metal slag percentage is reduced.
- The soundness test shows that the brick specimens generate the clear ringing sound when struck two brick specimens.
- Visual inspection test reveals the specimens are in correct rectangular and uniform in shape.
- Efflorescence test resulted in the category of 'slight' for the specimens.
- Hardness test reveals there is no impression formed on the brick specimen and it has sufficient strength.

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REFERENCES

- 1) Heath. A, Walker. P, Fourie. C and Lawrence. M (2008), "Compressive Strength of Extruded Unfired Clay Masonry Units", Thomas Telford Publishing Pg.No. PP. 105-112.ISSW1747-650X.
- 2) Demir Ismail (2008), "Effect of Organic Residues Addition on the Technological Properties of Clay Bricks", Waste management 28 pg.no-622-627.
- 3) Dondi. M, Guarini. G, Raimondo .M, Zanlli .C (2009), "Recycling PC and TV Waste Glass in Clay Brick and Roof Tiles", Waste management 29 pg.no. 1945-1951.
- 4) Oti. J.E, Kimuthia. J.M, Bai. J (2009), "Unfired Clay Bricks From Laboratory to Industrial Production", Engineering Sustainability-Dec 2009.
- 5) Miqueleiz. L,Ramirez. F,Oti. J.E, Seco. A, Kiruthia. J.M, Oreja. I,Ormeneta. P (2013), "Alumina Filler Waste Clay Replacement Material for Unfired Brick Production", Engineering Geology 163 pg.no.68-74.
- 6) Oti. J.E, Kimuthia. J.M, Robinson. R.B (2014), "The Development of Unfired Clay Building Materials Using Brick Dust Waste and Mercia Mudstone Clay", Applied Clay Science 102 pg.no. 148-154.
- 7) Nislam Mohammad. K, Sridhar. M.B, Kumar Vignesh. V (2016), " Experimental Study on Class Flyash Cement Bricks Using Partial Repacement of Flyash by Metakalin", Int.j.chem.sci.14(SI)227-234 ISSW 0972-2768X
- 8) IS 2386-1963(part-III)" Determination of Specific gravity, voids, Absorption" Bureau of Indian Standards New Delhi India.
- 9) IS 3495 – 1 to 4 (1992)" Methods of test of burnt clay building bricks" Bureau of Indian Standards New Delhi India.