Experimental investigation on bricks by using various waste materials

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Abstract- Majority of the people prefer burnt bricks for the construction purpose which emits nearly about 1 ton of CO_2.The usage of environmental friendly, structurally sound and in expensive materials was used in the ancient centuries. The stabilized bricks are the one which have a low embodied energy of 0.42 MJ/kg and low carbon foot print. This paper presents the strength of the bricks by using different recyclable materials like coconut fiber, granite waste and egg shell powder.

Keywords – ***Environmental friendly, recyclable, Coconut fiber, Granite waste and Egg shell powder.***

I. INTRODUCTION

Hybrid material are material from two or more constituent material with significantly different physical or chemical properties, that when combined, produce a material with characteristics different form the individual component In this study, a new alternative concept for brick manufacturing is introduced.

Bricks made by shaping a plastic mass of clay and water, which is then hardened by drying and firing, are among the oldest and most enduring of mankind's building materials. Until comparatively recent times the clay was dug, the bricks were made and the kilns set or drawn by manual labour with help from animal power. About 100 years ago, the first effective machines for brick production appeared, and the trend towards mechanisation of clay winning, making and handling operations has continued at an increasing pace to the present day.

Brick is the simplest and most ancient of all building materials. Few other fabricated building units have enjoyed such widespread and continuous popularity. This enduring public acceptance is based on the unique combination of the properties offered by brick to the owner and builder. This single material can be used to enclose a structure with a decorative, load-bearing wall, which is exceptionally durable and, if properly constructed in the first place, requires practically no maintenance.

Because of the versatility of the raw material, which can readily be moulded into a great range of shapes and sizes, and the flexibility that this gives to design and construction, building in brick has remained cost-effective.

Secondary clay materials are compounds of alumina, silica with minor amounts of lime, magnesia, soda or potash. Iron compounds, usually the oxides, hydroxides or carbonates, are nearly always present as impurities in brick clays, and they account for most of the wide range of colours found in the finished product.

Modern brick manufacture involves high speed processing at extrusion rates of up to 25000 bricks per hour. Solid bricks of the size traditional in South Africa (222 x 106 x 73 mm) weigh 3kg to 3,5kg.

II. LITERATURE SURVEY

Alonso et al developed a comparative study to produce ceramic bricks from clay with two types of foundry sand (green and core sand). Clay/green sand bricks with 35% green core and 25% green sand fired at 1050°C have the better physical properties values, while the mineralogy is not significantly affected.

Mohamad et al. (2005) carried out experimental tests on masonry prisms subjected to compression. The failure mechanism of the masonry depends on the difference of elastic modulus between brick unit and mortar. The mortar governed the non-linear behavior of masonry Oliveira et al. (2000) carried out the test on prisms under cyclic loading and the stress and strain behavior of the brick prism showed a bilinear pre-peak behavior.

Gumaste et al. (2007) Studied at the properties of bricks masonry using table moulded bricks and wire-cut bricks from India with various type of mortar using lean mortar failed due to loss of bond Another waste that can be utilised in clay bricks according to Demir et al (2005) is Kraft pulp production residues. Increasing amounts of the waste have been incorporated in clay bricks by 0%, 2.5%, 5% and 10%. All samples were fired at 900°C with another group being left unfired. The required water content and drying shrinkage increased with the increased amount of Kraft pulp residue.

Sarangapani et al [2002] compared the characterization and properties of local low modulus bricks, table moulded bricks and wire cut bricks, mortars and masonry. Leaner mortars such as 1:6:9 cement – soil mortar showed very ductile behavior which was indicated as the stress-strain curve becoming horizontal after reaching a peak strain value. This indicated that the 9 presence of a significant amount of soil gave rise to ductility with low strength mortars. Stress-strain characteristics of masonry were examined through prism tests. The modulus of elasticity of brick masonry was found as 265MPa.

It is learnt that different of waste material are used in the manufacture of brick. The important points derived are as follow:

- The construction bricks made from co-generation ashes and other raw material had a water absorption rate lower than 15% compressive strength greater than 150 kg/cm²
- Ceramic composition with the addition of granite waste production water absorption lower then 3%
- Compressive strength of brick from granulated blast furnace slag ranged in (80-150) kg/cm²

III. MATERIAL PROPERTIES

1. *CLAY*

Clays containing up to 3% of iron oxide give white to cream or buff colours, which change to pinks and reds as the iron oxide content rises to between 8 and 10%. By adding manganese dioxide in proportions from 1 to 4%, a range of grey and brown colours can be produced.

More important than their chemical composition are the facts that: when mixed with water, the clay minerals give a plastic mass that can be shaped by pressure to form a brick; at economically practical temperatures ranging between 1 000˚ to 1 200˚C, the clay particles can be fused into a cohesive mass of great compressive strength controlled evaporation of the free water surrounding the particles in plastic clay minimises excessive shrinkage and defects in the structure of the brick.

Replacing materials

- Granite powder(GP)
  - Feldspar (65 to 90%), Quarts (10 to 60%) ,Biotite or other accessory mineral (10 to 15%)
  - 70-77% silica, 11-13% alumina, 3-5% potassium oxide , 3-5% soda, 1% lime , 2-3% total iron and less 1% magnesia and titannia
- Eggshell powder(EGP)
  - Bird eggshells contain calcium carbonate and dissolve in various acids, including the vinegar used in cooking. While dissolving, the calcium carbonate in an egg shell reacts with the acid to form carbon dioxide.
  - Eggshell powder .in very small amount, is used in some part of the world as a calcium supplement since eggshell contain a lot of calcium carbonate ($CaCO3$).
  - The shells are dried , pasteurized and ground into powder comprising of ashes containing proteins and minerals.
- Coconut fiber(CF)

- Coconut fiber cells are narrow and hollow, with thick walls made of cellulose. They are pale when immature, but later become hardened and yellowed as a layer of lignin is deposited on their walls. Each cell is about 1 mm (0.04 in) long and 10 to 20 µm (0.0004 to 0.0008 in) in diameter. Fibers are typically 10 to 30 centimeters (4 to 12 in) long.
- The coir fiber is relatively waterproof, and is one of the few natural fibers resistant to damage by saltwater. Fresh water is used to process brown coir, while seawater and fresh water are both used in the production of white coir.

Fig1: COCONUT FIBER

Fig2: EGGSHELL POWDER

Granite powder physical properties

Specific gravity (g/cc)	2.77 – 2.82
Chemistry	Felsic
Density	166.5
Melting point	Approx.3,000
Solubility in water	Insoluble
Boiling point	Approx.4,000
Thermal conductivity(k)	2.2
Particle shape	Irregular
Mohr's hardness	7.0
Odour and colour	Black and white speckled rock. No odour. pink, light gray or dark gray

The composition of eggshell powder

Water	0 to 5 g
Protein	1 to 2 g
Ashes	9 to 96 mg
Calcium	38 mg
Potassium	6 to 41 mg
Sodium	87 mm
Phosphorus	3 to 99 mg
Iron	0 to 5 mg
Magnesium	375mg

Physical Properties of Coconut / Coir Fiber:

Length in inches	6-8
Density(g/cc)	1.40
Tenacity(g/Tex)	10.0
Breaking elongation%	30%
Diameter in mm	0.1 to 1.5
Rigidity of Modulus	1.8924 dyne/cm2
Swelling in water (diameter)	5%
Moisture at 65% RH	10.50%

Chemical Properties of Coconut / Coir Fiber:

Lignin	45.84%
Cellulose	43.44%
Hemi-Cellulose	00.25%
Pectin's and related Compound	03.00%
Water soluble	05.25%
Ash	02.22%

IV. CLAY PREPERATION

Steps involved in clay and waste material preparation

- Tempering
- Mixing
  - Wet mixing
  - Dry mixing
- Mouldings
  - Slop moulding
  - Sand moulding
- Drying
- Firing of bricks in the clamp

Brick Details:

Weight of un-burnt brick	= 3.2 kg
Weight of burnt brick	= 3.1kg
Size of the brick	=21 cmX10 cmX8 cm
Area of the brick	= 210 cm^2
Volume of brick	= 1680cm^3

The percentage of waste added is 0, 3, 6, 9, 12, 15% (for all 3 types of waste)

Fig3: Dry Mix

Fig4: Wet Mix

Fig5: Casting of bricks

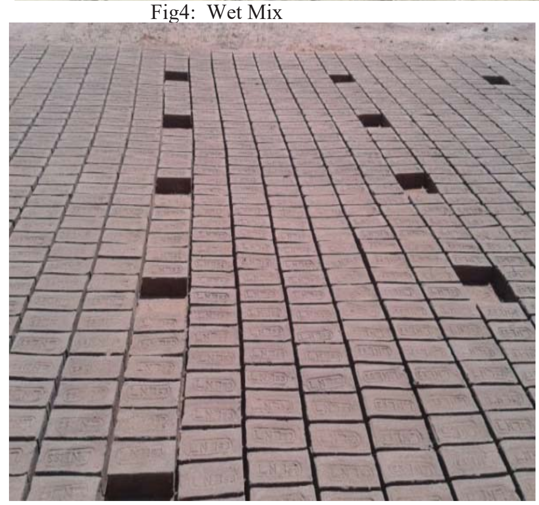

Fig6: Drying of bricks

Fig7: Firing of bricks in the clamp

V.TEST ON BRICKS

1. Compression Test

The compressive strength of a brick is done by preparing the specimen adding suitable recycling waste of granite waste egg shell powder and coconut fiber in various proportions such as 3%, 6%, 9%, 12%, and 15%.

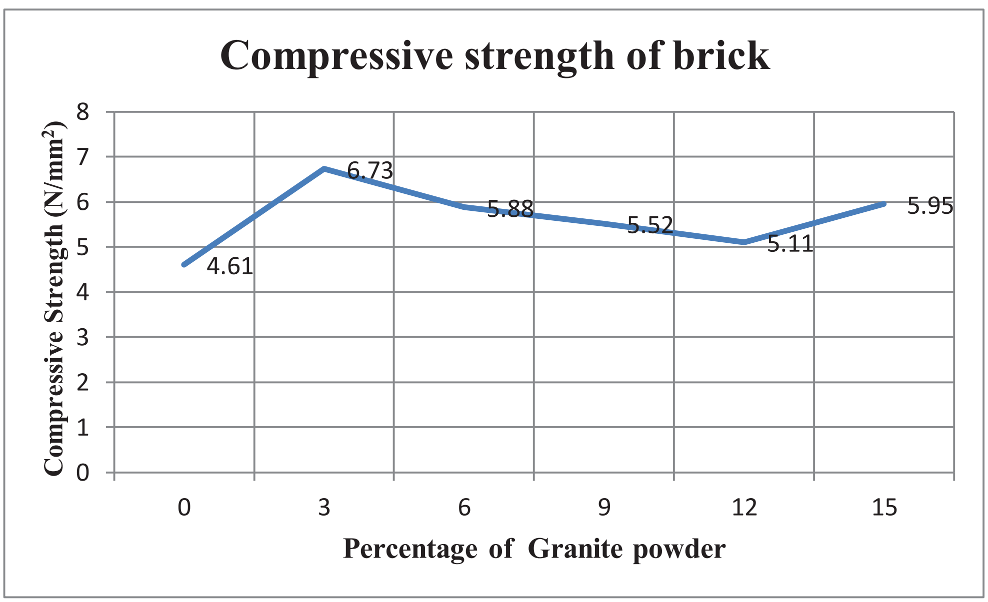

Fig7: compressive strength of bricks with respect to variation in GP

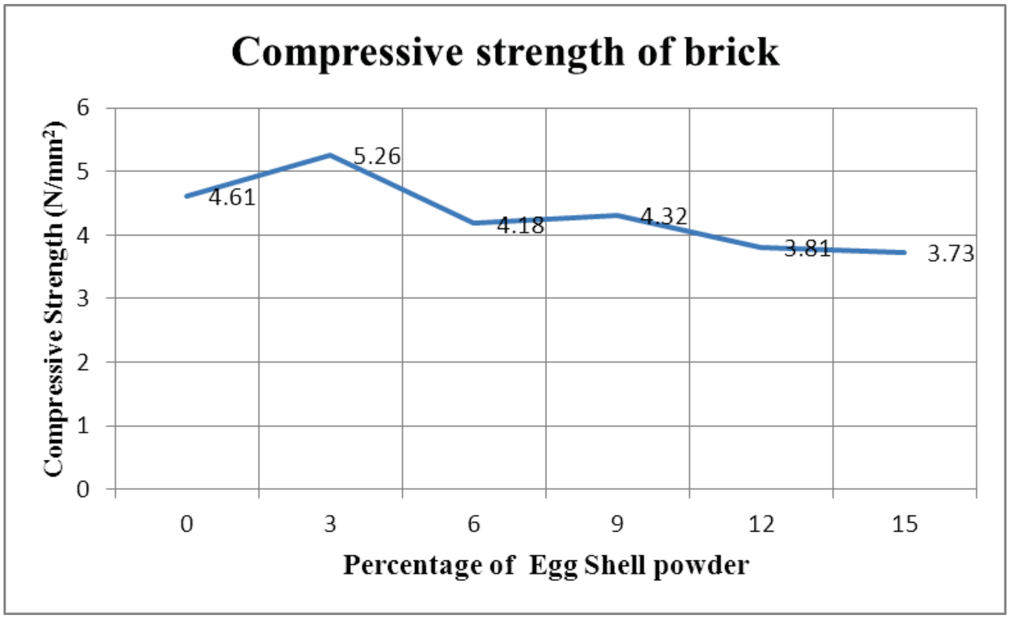

Fig8: compressive strength of bricks with respect to variation in ESP

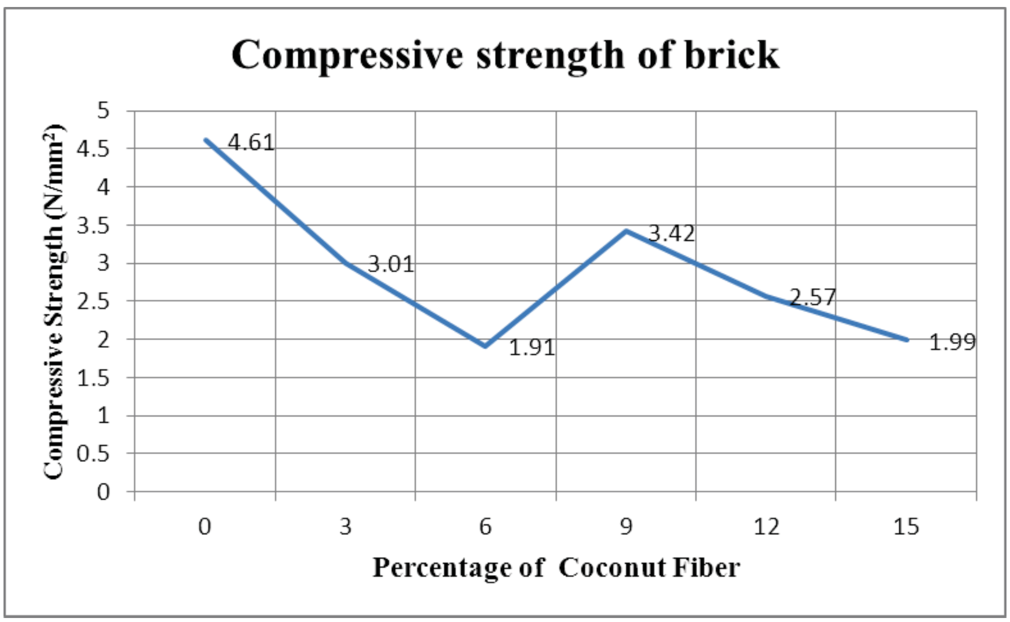

Fig9: compressive strength of bricks with respect to variation in CF

2. Prism test

Short prisms have been tested under axial compressive load using two type of masonry units. The type of prism is called as stacked bonded prism. Here the mortar thickness used is 12 mm between two bricks.The walls is constructed in four layers of bricks and three layer of mortar. The ratio of mortar is 1:4.

This test is done with bricks made of Granite Powder waste (12% and15%) since they have high compressive strength when compared with other two.

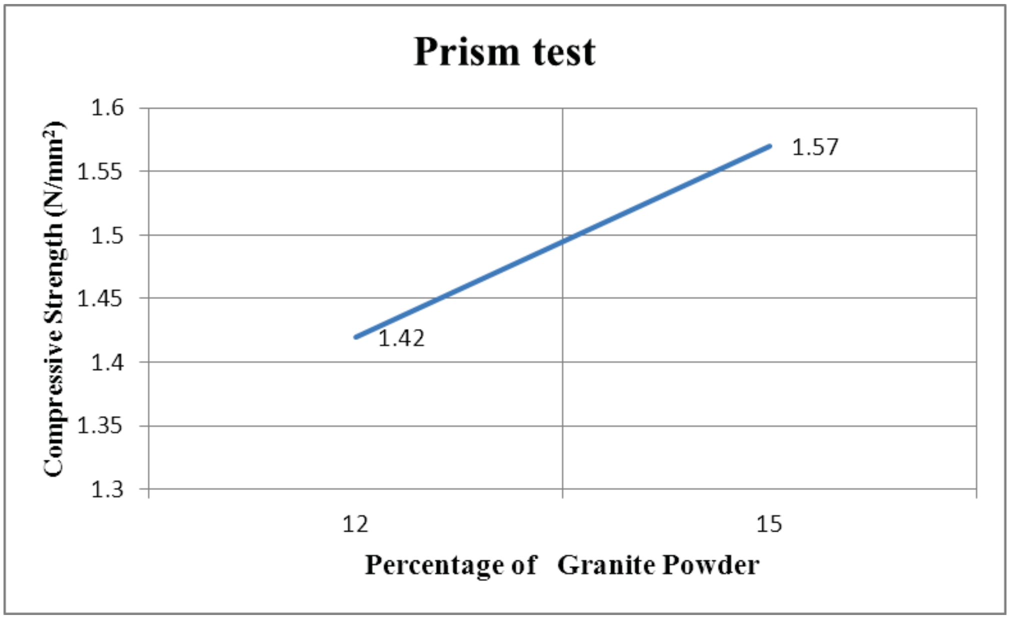

Fig10: compressive strength of bricks by prism test

Fig11: Prism test

VI.RESULT AND CONCLUSION

The characteristic study of brick manufactured by earth (clay) material with granite waste, eggshell powder and coconut fiber shows the following results

- The possibility to use the granite wastes and eggshell as an alternative raw material in the production of clay –based products leads to relief on waste disposal concerns
- The bricks are sufficiently hard in 4%,8% and 12% replacement of granite waste and the percentage of granite waste increases with increase in the hardness of the brick
- The value of compression strength is increased up to 6% of granite waste beyond that it will gradually decrease .Since the % difference in compressive strength is only 2.5 between 0 and 12% addition of granite waste .It is concluded that up to 12% granite waste can be added to earth material
- The bricks are sufficiently hard in 4%,8% and 12% replacement of granite waste and the percentage of granite waste increases with increase in the hardness of the brick

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