Utilization of waste material in Burnt clay bricks

Vilas M. Patil, Rahul Bhoge
NMKC Collage of Engineering, Jalgaon
Patil.vilas@rediffmail.com Rahulbhoge8@gmail.com

Abstract

Since the large demand has been placed on building material industry especially in the last deade owing the increase in infrastructure development which causes a chronic shortage of building materials. In this concern many research going on worldwide and the researchers have been always challenged to convert waste material to useful building and construction material. Recycling of such waste as raw material alternatives may contribute in the exhaustion of the natural resources; the conservation of non-renewable resources; improvement of the population health and security preoccupation with environmental matters and reduction in waste disposal costs. This project presents a parametric experimental study, by utilization of waste in brick manufacturing which investigates the potential use of fabric, hair, plastic, and rice husk, bagasse of sugarcane and soy sludge with increasing amount of said waste material for producing innovative building material. In this research the effects of those wastes material on the bricks properties are investigated. This approach for utilization of waste material in clay bricks reflects some positivity for using these innovative bricks in construction industry as well as reduces harmful effect on environment and useful to provide potential and sustainable solution.

Keywords: Clay Brick, Waste Material, Density, Water Absorption, Compressive strength.

1. Introduction

Bricks are laid in horizontal courses, sometimes dry and sometimes with mortar. When the term is used in the sense, the brick might be made from clay, lime- sand, concrete, or shaped tone .In a less clinical or more colloquial senses, bricks are made up from dry earth, usually from clay-bearing subsoil .In some cases, such as adobe, the brick are merely dried. More commonly it is fired in a kiln of some sort to form a true ceramic. In general sense a brick is standard size weight bearing building unit. Bricks are laid in horizontal courses, sometimes dry and sometimes with mortar. When the term is used in the sense, the brick might be made from clay, lime- sand, concrete, or shaped tone. In a less clinical or more colloquial senses, bricks are made up from dry earth, usually from clay-bearing subsoil. In some cases, such as adobe, the brick are merely dried. More commonly it is fired in a kiln of some sort to form a true ceramic. Burnt clay bricks are most utilizing brick in construction world. Since the large demand has been placed on building material industry especially in the last decade owing to the increasing population, which causes a chronic shortage of building materials the civil engineers have been challenged to convert the industrial wastes to useful building and construction materials. Accumulation of unmanaged wastes especially in developing countries has resulted in an increase environmental concern. Bricks are available in different shapes and sizes. They are extremely light weight and hence aid in faster construction. Bricks are good in compression and hence can be used to make load bearing structures. The tensile strength of brick is less and hence to counteract this, they are made hollow just like concrete units to include reinforcement. The other Properties that make bricks highly useful in construction are aesthetic appeal, thermal and Acoustic insulation, zero maintenance cost, fire resistance and flexibility in application. It is reported that the requirement of bricks for construction activity amounts to be more than 140 billion numbers annually.

2. Literature Review

Rahul V. Ralegaonkar in there review paper various physical, mechanical properties of the construction building materials are studied in accordance with reviewed literature and relevant standards. Accumulation of unmanaged agro waste especially from the developing counties has an increased environmental concern. Recycling of such wastes into sustainable, energy efficient construction materials is a viable solution for the problem of pollution and natural resource conservation for future generation. Lianyang Zhang in his paper based on the review of the various studies on production of bricks from waste materials. A wide variety of waste materials have been studied for production of bricks. The different methods studied for producing bricks from waste materials can be divided into three general categories: firing, cementing and geopolymerization. Although much research has been conducted, the commercial production of bricks from waste materials is still very limited. The possible reasons are related to the methods for producing bricks from waste materials, the potential contamination from the waste materials used, the absence of relevant standards, and the slow acceptance of waste materials-based bricks by industry and public. A. Mana investigated the effect of rice huck and rice huck ash to properties of bricks more adding rice husk less compressive strength and density of specimens. Otherwise the porosity increases when adding rice husk. By adding 2 % of rice husk ash by weight is the best of bricks properties which 6.20 MPa of compressive strength, 1.68 g/cm3 of density, and 15.20% of water absorption. S.P. Raut in there paper the various methodologies to design and development of WCB have been reviewed. Various physic-mechanical and chemical properties of the bricks incorporating different waste materials are studied in accordance with the reviewed literature and the standards. Certain WCB are produced without firing which is an advantage over other manufacturing of bricks in term of low embodied energy material. Penchi Chiang studied the bricks manufactured from dried sludge collected from an industrial wastewater treatment plant were investigated. Results of tests indicated that the sludge proportion and the firing temperature were the two key factors determining the brick quality. Increasing the sludge content results in a decrease of brick shrinkage, water absorption, and compressive strength. Results also showed that the brick weight loss on ignition was mainly attributed to the organic matter content in the sludge being burnt off during the firing process. Aeslina Binti Abdul Kadir review the utilization of different types of sludge waste into fired clay brick always obtain various advantages in terms of physical and mechanical properties such as low density, lightweight bricks, better strength and even reducing energy consumption during firing even though some drawbacks were also demonstrated. In addition, these investigations also have shown a significant lower impact towards the environment by incorporating these wastes into fired clay brick. Xu Lingling results indicate that the plasticity index of mixture of fly ash and clay decrease dramatically with increasing of replacing ratio of fly ash. Additive A can be chosen to improve the plasticity index of mixture to meet plastic extrusion used in most brick making factories. The sintering temperature of bricks with high replacing ratio of fly ash was about 1050 _C, which is 50–100 _C higher than that of clay bricks. Gokhan Gorhan a, Osman Simsek investigate the effects of rice husk addition on the porosity and thermal conductivity properties of fired clay bricks. Therefore, brick raw material and rice husk obtained from Çorum, Turkey were used. Rice husk was substituted by volume (5%, 10% and 15%) to brick raw material in two forms as ground rice husk and coarse rice husk. It has been determined that samples added coarse rice husk have lower thermal conductivity than samples added ground rice husk. Rafael Alavez-Ramirez study analyses the use of lime and sugar cane bagasse ash (SCBA) as chemical stabilizers in compacted soil blocks. The blocks were tested for flexure and compression in a dry and a saturated state. It was also concluded that the combination of SCBA and lime as a replacement for cement in the stabilization of compacted soil blocks seems to be a promising alternative when considering issues of energy consumption and pollution. D.Eliche-Quesada studies the application of a variety of waste materials in the production of lightweight bricks: sawdust, spent earth from oil filtration, compost and marble.). These bricks were fired at 950 and 1050^{o}C. These percentages produced bricks whose mechanical properties were suitable for use as secondary raw materials in ceramic brick production.

3. Material and Method

3. Material:

Clay, Fly Ash, Rice Husk, Sugarcane Bagasse, Plastic, Hair Fibre, Fabric, Soy Sludge

3.1 Fabrication of bricks

Table 1. Mix proportion

Sr. no.	Types of waste material	Weight % (gm)	Indication	No. Of bricks
1	Bagasse of sugarcane	5	S1	4
		10	S2	4
		15	S3	4
		20	S4	4
		25	S5	4
		30	S6	4
		35	S7	4
2	Soy sludge	50	T1	4
		100	T2	4
		150	T3	4
		200	T4	4
		250	T5	4
3	Fabrics	5	F1	4
		10	F2	4
		15	F3	4
		20	F4	4
		25	F5	4
4	Plastics	3	P1	4
		6	P2	4
		9	P3	4
		12	P4	4

		15	P5	4
5	Rise husk	5	R1	4
		10	R2	4
		15	R3	4
		20	R4	4
		25	R5	4
6	Hair fibre	5	M1	4
		10	H1	4
		15	M2	4
		20	H2	4
		25	M3	4
		30	H3	4
		35	M4	4
		40	H4	4
		45	M5	4
		50	H5	4

3.2. Brick Making

- Thirty different types of mixture are prepared at site, Trials out of them once it was regular without waste material prepared.
- Four sample of each mix were prepared at site and brought to laboratory for testing's.
- All bricks are according to the specification of IS 1077.
- The mixes were prepared with increasing weight in each mix.
- The blended bricks are burnt at site that the fabric material burnt/melt and try to get mixed homogenously with clay.

Fig 3.2.1.Mixing of clay And Waste Material

3. 3. Procedure

Clay, Fly ash, Water, Bagasse, Fabric, Hair Fibre, Plastic, Rice husk
↓
Weighing
↓
Mixing
↓
Making
↓
Kept as it for 7 days for setting
↓
Transported for burning
↓
Burning at 415^{o}C for 7 days
↓
Sorting and Testing
↓
Dispatch

Fig 3.3.1.Naming of Each Brick

4. Testing of brick

4.1 Physical Testing

Sound Test

The sound of brick are tested by hammering a rod on the surface of brick.

Breakage Test

These test is carried out by thrown down the brick from one meter height on the surface of ground.

Mechanical Testing

The series at test are carried out according to IS 3495(Part 1-2) (9).The compressive test, Water absorption and density test were performed at laboratory.

4.2.1 Compressive strength (As per IS 3495 Part 1)

A compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centre of which coincides with the centre of the plate, shall be used. Remove unevenness observed in the bed faces to provide two smooth and parallel faces by grinding. Immerse in water at room temperature for 21 hours. Remove the specimen and drain out any surplus moisture at room temperature. Fill the frog and all voids in the bed face flush with cement mortar (1 cement, clean coarse sand of grade 3 mm and down). Store under the damp jute bags for 24 hours followed by immersion in clean water for 3 days. Remove, and wipe out any traces of moisture. Place the specimen with flat faces horizontal, and mortar filled face facing upwards between two 3-ply plywood sheets each of 3 mm thickness and carefully centred between plates of the testing machine. Apply load axially at a uniform rate of 14 N/mm* (140 kgf/cm2) per minute till failure occurs and note the maximum load at failure. The load at failure shall be the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

Fig 4.2.1. Compressive strength testing machine

4.2.2. Water Absorption (*As per IS 3495 Part 2*)

Dry the specimen in a ventilated oven at a temperature of 105 to 115°C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (MI).

Specimen warm to touch shall not be used for the purpose. Immerse completely dried specimen in clean water at a temperature of 27 f 2°C for 24 hours. Remove the specimen and wipe out any traces of water with a damp cloth and weigh the specimen. Complete the weighing 3 minutes after the specimen has been removed from water (Mz).Water absorption, percent by mass, after 24-hour immersion in cold water is given by the following formula:

$$\underline{\quad M2-M1 \quad} \times 100$$

M1

5. Result and Discussion

5. Result and Discussion:

5.2.1. Compressive strength

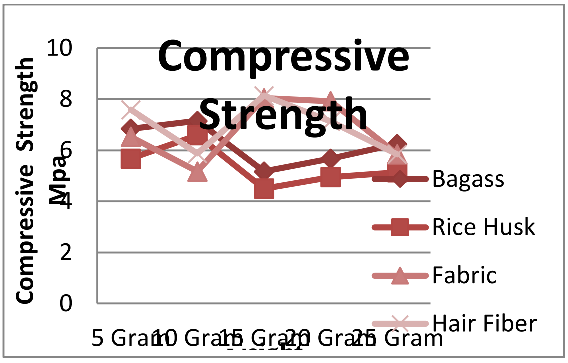

Fig. 5.2.1 Compressive Strength of Bricks

From fig. 6.2.1 it is observed that the compressive strength goes with increasing amount of waste material as compared with conventional brick. But it is acceptable values as per IS1077.

5.2.2. Water Absorption

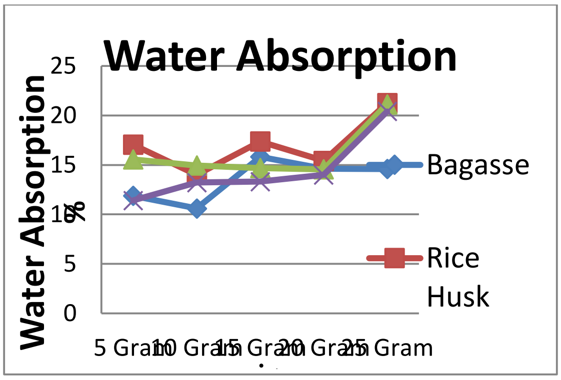

Fig. 5.2.2.1 Water Absorption of Bricks

From fig no. 6.2.2.1 It is observed that the water absorption of waste fabricated brick is less than conventional brick but with increasing waste materials the water absorption found more. As per IS1077 water absorption should not more than 20%.

5.2.3. Dry density

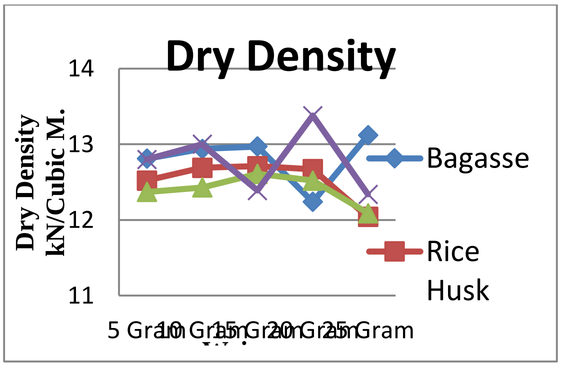

Fig. 5.2.3.1 Dry Density of bricks

From fig no. 6.2.3.1. The identity is not very much affected by utilisation of waste material.

6. Conclusion

The various wastes that is currently recycled in bricks manufacturing. Bagasse of sugarcane is possible in production of burnt clay brick which is gives the better solution for the disposal of waste material and reforming new innovative and sustainable building material. The strength of bagasse brick occurring more by increasing the amount of waste material in brick. Compressive strength obtain maximum at 10 gm use of rice husk in brick and improve their workability properties. Dry density of rice husk brick is minimum at 25 gm use of rice husk. Water absorption is found more at the use of 10gm rice husk but when the proportion will be increases then the increasing of water absorption found. By using the 15 gm of fabric the compressive strength of fabric brick is found more. With the use of same 15 gm proportion the water absorption found less of fabric brick. The dry density is minimum at 10 gm. Strength of hair fiber brick, at 15gm it found more and the increasing amount of hair it give less. Water absorption is found more by increasing amount of hair in brick. Dry density of hair fiber brick is varying in graph it gives zig-zag type graph if increasing amount of hair.Bricks with 0.1% of plastic fibres made from carry bags showed a small increase in strength of 3 to 10% with comparison with original clay brick as per IS CODE required. Water absorption capacity found less by utilizing 3 gm of plastic in plastic bricks. In same proportion the dry density is found less of plastic brick. In soy sludge brick, the strength is found increase by increasing the amount of proportion in soy sludge brick. The water absorption is found varying by the use of different proportion in soy sludge brick. The dry density is found less at the use of 100 gm of soy sludge. The strength of bagasse brick occurring more by increasing the amount of waste material in brick. Compressive strength obtain maximum at 10 gm use of rice husk in brick and improve their workability properties. Dry density of rice husk brick is minimum at 25 gm use of rice husk. Water absorption is found more at the use of 10gm rice husk but when the proportion will be increases then the increasing of water absorption found. By using the 15 gm of fabric the compressive strength of fabric brick is found more. With the use of same 15 gm proportion the water absorption found less of fabric brick. The dry density is minimum at 10 gm. Strength of hair fiber brick, at 15gm it found more and the increasing amount of hair it give less. Water absorption is found more by increasing amount of hair in brick. Dry density of hair fiber brick is varying in graph it gives zig-zag type graph if increasing amount of hair.

References

[1]. Mangesh V. Madurwar, Rahul V. Ralegaonkar, Sachin A. Mandavgane. Application of agro-waste for sustainable construction materials: A review. Construction and Building Materials, Vol. 38, 2013, 872–878.
[2]. Lianyang Zhang, Production of bricks from waste materials – A review, Construction and Building Material, Vol. 47, 2013, 643–655.
[3]. J. Sutas, A. Mana, L. Pitak, Effect of Rice Husk and Rice Husk Ash to Properties of Bricks, Procedia Engineering, Vol. 32, 2012, 1061 – 1067.
[4]. S.P. Raut, R.V. Ralegaonkar, S.A. Mandavgane, Development of sustainable construction material using industrial and agricultural solid waste: A review of waste-create bricks, Construction and Building Materials, Vol. 25, 2011, 4037–4042.
[5]. Chih-Huang Wenga, Deng-Fong Lina, Pen-Chi Chiangb. Utilization of sludge as brick materials, Advances in Environmental Research, Vol. 7, 2003, 679–685.
[6]. Aeslina Binti Abdul Kadir, Ahmad Shayuti Bin Abdul Rahim, An Overview of Sludge Utilization into Fired Clay Brick, International Journal of Environmental, Ecological, Geological and Mining Engineering, Vol.8, 2014.
[7]. Xu Lingling, Guo Wei, Wang Tao, Yang Nanru, Study on fired bricks with replacing clay by fly ash in high volume ratio, Construction and Building Materials, Vol. 19, 2005, 243–247.
[8]. Gökhan Görhan a, Osman S_ims_ek b, Porous clay bricks manufactured with rice husks, Construction and Building Materials, Vol. 40, 2013, 390–396.
[9]. P. P. Kolte and A. M. Daberao, Agave Americana: The Natural Leaf Fiber, Textile Review, 2012, 23.
[10]. Rafael Alavéz-Ramírez, Pedro Montes-García, Jacobo Martínez-Reyes, Delia Cristina Altamirano-Juárez, Yadira Gochi-Ponce, The use of sugarcane bagasse ash and lime to improve the durability and mechanical properties of compacted soil blocks, Construction and Building Materials, Vol. 34, 2012, 296–305.
[11]. Eliche-Quesada, D., Corpas-Iglesias, F.A., Pérez-Villarejo, L. and Iglesias-Godino, "Recycling of sawdust, spent earth from oil filtration, compost and marble residues for brick manufacturing." Construction and Building Materials, Vol. 34, 2012, 275-284.
[12]. Prof.R.N.Turukmane, Prof.A.M.Daberao, Prof.P.P.Kolte, Dr.V.G.Nadiger, A Review -Nano Technology in Textile Composites" in International Journal on Textile Engineering and Process, Vol. 2(3), 2016, 19-22.