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Using Waste Material for Making Light Weight Bricks

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Abstract:- Bricks are a widely used construction and building material around the world Generally conventional bricks are produced from clay with high temperature kiln firing or from ordinary Portland cement (OPC) concrete, and thus required huge energy and have large carbon footprint. In many areas of the world, there is already a shortage of natural source material for production of the conventional bricks. For environmental protection and sustainable development, extensive research has been conducted on production of bricks from waste materials. This paper presents a review of research on utilization of waste materials to produce bricks. A wide variety of waste materials have been studied to produce bricks with different methods. The research can be divided into three general categories based on the methods for producing bricks from waste materials: firing and cementing. 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, absence of relevant standards, improper guidance, lack of awareness, and the slow acceptance of waste materials-based bricks by industry and public. For wide production and application of bricks from waste materials, further research and development is needed, not only on the technical, economic and environmental aspects but also on standardization, government policy and public education related to waste recycling and sustainable development.

Index Terms: *Bricks, waste material, cementing, firing, sustainable development.*

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1. INTRODUCTION

Bricks have been a major construction and building material for a long time. The dried-clay bricks were used for the first time in 8000 BC and the fired-clay bricks were used as early as 4500 BC. The worldwide annual production of bricks is currently about 1391 billion units and the demand for bricks is expected to be continuously rising. Conventional bricks are produced from clay with high temperature kiln firing or from ordinary Portland cement (OPC) concrete. Quarrying operations for obtaining the clay are energy intensive, adversely affect the landscape, and generate high level of wastes. The high temperature kiln firing not only consumes significant amount of energy, but releases large quantity of greenhouse gases. Clay bricks, on average, have an embodied energy of approximately 2.0 kWh and release about 0.41 kg of carbon dioxide (CO2) per brick. It is also noted that there is a shortage of clay in many parts of the world. To protect the clay resource and the environment, some countries such as China have started to limit the use of bricks made from clay. The OPC concrete bricks are produced from OPC and aggregates. It is well known that the production of OPC is highly energy intensive and releases significant amount of greenhouse gases. Production of 1 kg of OPC consumes approximately 1.5 kWh of energy and releases about 1 kg of CO2 to the atmosphere. Worldwide, production of OPC is responsible for about 7% of all CO2 generated. So the production of OPC concrete bricks also consumes large amount of energy and releases substantial quantity of CO2. In addition, the aggregates are produced from quarrying and thus have the same problems as described above for clay. For environmental protection and sustainable development, many researchers have studied the utilization of waste materials to produce bricks . A wide variety of waste materials have been studied, including fly ash, mine tailings, slags, construction and demolition waste, wood sawdust, cotton waste, limestone powder, paper production residue, petroleum effluent treatment plant sludge, Kraft pulp production residue, cigarette butts, waste tea, rice husk ash, crumb rubber, and cement kiln dust. Different methods have been used to produce bricks from waste materials. This paper presents a review of the research on utilization of different types of waste materials to produce bricks.

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2. REVIEW OF RESEARCH ON UTILIZATION OF WASTE MATERIALS FOR MAKING BRICKS

A. Production of bricks from waste materials through firing and cementing. These methods uses waste material(s) to substitute a portion or entire amount of clay and follow the traditional way to kiln fire the material(s) to produce bricks. Many researchers have studied the production of bricks from waste materials based on firing as well as cementing. Alonso-Santurde et al. studied the production of bricks by mixing green and core foundry sand with clay in proportions 0 – 50% and firing at 850–10500C. Brick specimens were prepared and evaluated physically and minerlogically. It was found that the clay foundry sand bricks fired at 1050 0C had better physical property values while the mineralogy was not significantly affected. The optimum amount of foundry sand to produce bricks was found to be 35% green sand and 25% core sand.Demir et al. [10] investigated the potential of utilizing kraft pulp production residues in clay bricks. Different amounts of residues were mixed with raw brick clay to produce bricks.Shaped brick samples were dried at laboratory conditions (210C and 40% relative humidity) for 72 h and then dried to constant weight at 1050C in the oven. The dried samples were fired in a laboratory type electrically heated furnace at a rate of 20C/min until 6000Cand then at a rate of 50C/min until 9000C for 30min. The effect of including the sludge on shaping, plasticity, density, porosity, water absorption and mechanical properties were investigated. The results indicated that 2.5–5% residue additions were effective for the pore forming in clay body with acceptable mechanical properties. It was concluded that kraft pulp residues can be utilized in brick clay as an organic performing agent.

Demiretal. studied the utilization of processed waste tea (PWT) together with clay to produce bricks. The effects of PWT addition on the durability and mechanical properties of bricks were investigated. Due to the organic nature of PWT, pore-forming (fired body) and binding (unfired body) ability in clay body was investigated. Different amounts of PWT were added to the clay to produce bricks. The test brick specimens were produced by the extrusion method. The specimens were tested following the standard test methods. The results indicated that the inclusion of PWT significantly increased the compressive strength of the unfired and fired brick samples. As a result, it was concluded that PWT can be utilized in unfired and fired building bricks by taking advantage of low cost and environmental protection. Faria et al. Investigated the recycling of sugarcane bagasse ash waste as a method to provide raw material for claybrick production. Brick samples were produced by using up 20% of sugarcane bagasse ash waste to replace natural clay, and then tested to determine their physical and mechanical properties. It was found that the sugarcane bagasse ash waste was mainly composed of crystalline silica particles and could be used as filler in clay bricks.Wengetal.Investigated 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. With up to 20% sludge added to the bricks, the strength measured at temperatures 960 and 10000C met the requirements of the Chinese National Standards. Toxic characteristic leaching procedure (TCLP) tests of brick also showed that the metal leaching level is low. The conditions for manufacturing good quality bricks is 10% sludge with 24% of moisture content prepared in the moulded mixtures and fired at 880–9600C.Rautetal made fired bricks using clay–sand mixes with different percentages of rice husk ash. The firing durations at10000C were respectively 2, 4 and 6 h. The effects of rice husk ash content on workable mixing water content, Atterberg limits, linear shrinkage, density, compressive strength and water absorption of the bricks were investigated. The results indicated that (1) the inclusion of rice husk ash increased the compressive strength of bricks, (2) the optimum firing duration was 4 h at 10000C, and (3) the bricks made of clay–sand–rice husk ash mixes could be used in load bearing walls. Rautetal studied the utilization of recycled paper mill waste (RPMW) together with OPC to produce light weight bricks. Brick specimens were produced by mixing RPMW and cement at different proportions, compressing the mixture using a hand operated hydraulic press and then solar drying the formed bricks. The brick specimens were tested following ASTM C 67-03 a standards. The results showed that bricks prepared using RPMW–cement combination was light weight, shock absorbing and met the ASTM C 67-03a compressive strength requirement.

Sr. No.	Waste Material (wt%)	Size of brick in mm	**Drying/ Firing Condition**	**Tests Conducted**	**Reference**
1	Foundry by products (0-50%)	150x30 x15	Fired in a laboratory muffle at 20C /min up to 850,950 or 10500C for 3.5 h	Flexural strength, water absorption,density,apparent porosity	[5]
2	Paper production residues (0%,10% ,20%,	85 x 85 x10	Held overnight at room Temperature followed By drying at 450C for	Compressive strength, Water absorption, bulk density, apparent	[10]

	and30%)		1h in an oven,then fired in an electrical furnace at 2.50C/min until 6000C and then at100C/min until 11000C,for 1h	porosity, thermal conductivity	
3	Waste tea (5%)	100 x 70 x40	Dried at 210C for 72h and then at1050C in the oven, and subsequent ntly fired at 20C/min until 6000Cand then at 50C/min until 9000C for2h	Compressive strength, water absorption, density	[9]
4	Sugarcan e Bagasse ash waste (up to20%)	25 mm (diamet er)	10000C withvariatio ns in heating rate and holding duration at the maximum temperature 24	Linear shrinkage,wat er absorption,ap parent density,tensil e strength	[7]
5	Organic sludge	various	Proportion of sludge in brick is10%, with a 24% optimum moisture content, prepared in the moulded mixtures and fired between 8800C and 9600C	Compressive strength, Water absorption, density	[11]
6	Recycle paper Mill waste (80–95%)	230x 105x 80	Solar dried	Compressive strength, water absorption, specific weight, void age ,moisture content	[8]
7	Rice husk ash (0%,5%, 10%, 15% and 20%)	50 x 50 x50	Dried in the sun at 300C for 8 days, at 1050C for 24h in an oven, and then fired in a furnace continuousl y at250, 500,7500C for 2h each and finally at 10000C for 2, 4 or 6h	Compressive strength, Water absorption, density	[4]

3. DISCUSSION

It is evident from the above table that researchers have used various types of waste materials in different proportions and adopted different methods to produce bricks. Different tests were conducted on produced bricks to evaluate their properties following the various available standards. Compressive strength and water absorption are two common parameters considered by most researchers as required by various standards. It is noted that although many of the studied bricks made from waste materials meet the various standard requirements and a number of patents have been approved, so far commercial production and application of bricks from waste materials is still very limited.

4. CONCLUSION

Based on the review of the various studies on production of bricks from waste materials, the following conclusions can be drawn:

1. A wide variety of waste materials have been studied for production of bricks

2. .The different methods studied for producing bricks from waste materials can be divided into categories like firing and cementing. The firing and cementing (especially cementing based on added cementing materials) methods for producing bricks from waste materials still have the drawbacks of high energy consumption and large carbon footprint as the conventional brick production methods.

3. Although much research has been conducted, the commercial production of bricks from waste materials is still very limited. The possible reasons 4are 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

4. .For wide production and utilization of bricks from waste materials, further research and development is needed, not only on the technical, economic and environmental aspects but also on standardization, government policy and public education.

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