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A Compressive Strength and Water Absorption Test on Brick Made of Wood Ash, Charcoal with Clay Bricks: A Comparative Study

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Abstract:
In India, bricks are usually made up of clay, and are generally produced in traditional, unorganized small scale industries. Bricks are important building material and about 140 billion bricks are annually produced by these industries. Brick making consumes larger amount of clay which leads to top soil removal and land degradation. Large areas of lands are destroyed every year especially in developing countries due to collection of soil from a depth of about 1 to 2 m from agricultural land. An important step in brick making is firing of bricks in brick kilns which causes serious environmental pollution and health problems. Brick burning largely influence the concentrations of greenhouse gases in the atmosphere. This causes serious air pollution and also workers in brick industries are prone to respiratory diseases such as silicosis, pneumonocosis and musculo-skeletal disorders. To avoid all this environmental threats an attempt was made to study the behaviour of bricks manufactured using, different waste materials like Biochar (charcoal) and wood ash with sand and cement are used to manufacture bricks. The main aim of this project was to compare the compressive strength and water absorption of the bricks, so for this purpose different percentage of materials were separately added 5%, 10% & 15% by weight and then the compressive strength and water absorption of the bricks was established. Then with the help of graph a comparison between both compressive strength and water absorption of bricks, made out of Biochar (charcoal) and Wood Ash was determined. After that bricks were made & sun dried and then cured for 7 days with the help of Compression Testing Machine, finally their compressive strength was calculated. from this test in this project work it was concluded that the wood waste from timber depot, furnitures, waste, construction waste are converted into biochar by pyrolysis method (charcoal) which gives the highest compressive strength and less water absorption.

Keywords: *Biochar, wood ash, pyrolysis, pneumonocosis compressive strength, water absorption*

1. Introduction

Production of burnt clay bricks requires consumption of coal leading to green house gas emissions. The primary raw material used for bricks is the soil, which is often taken from prime agricultural land, causing land degradation as well as economic loss due to diversion of agricultural land. Use of traditional technologies in firing the bricks results in significant local air pollution. The burnt clay brick industry in India produces over 180 billion clay bricks annually with a strong impact on soil erosion and unprocessed emissions. To address this situation attention has been made to develop the Eco friendly building material. Therefore we have taken wood chips which are largely generated as a waste. These wastes are then converted into usable building material by using pyrolysis method called biochar. This biochar is used for manufacturing Eco-friendly brick by using different proportion of cement and sand. These bricks are comparatively lighter in weight and stronger than common claybricks. Since, they are being accumulated as waste material in large quantity and creating serious environmental pollution problems, its utilisation as main raw material in the manufacture of bricks and useful disposal but also help in environmental pollution control toagreaterextentin the surrounding areas. In view of superior quality and eco-friendly nature we have chosen these Bricks. This Biochar brick is used in green buildings to absorb some of these green house gasses. It can be used as screen for purification of air entering into buildings .This brick regulates humidity indoors; the emissions from indoor toilets are absorbed. Temperature is regulated through insulation, as a light weight material suitable for high raise buildings and reduces cost of construction. Biochar is resistant and repels termites and ants. Biochar is the source of negative

ions, prevents oxidization, emit far infrared radiation, and dissipate electromagnetic fields from many electronic and electrical devices in a house, these characteristics improve the living conditions in a house.

2. Biochar

Biochar is a name from charcoal when it is used for particular purposes, especially as a soil amendment. Like most charcoal, biochar is created by pyrolysis of biomass. Biochar is under investigation as an approach to carbon sequestration to produce negative carbon dioxide emissions.There are various types of biochar rice husk, wood ash, bamboo, sugarcane bagasse biochars.In this we are using rice husk biochar and wood biochar in some merits in construction buildings especially inside walls and higher walls. Ideal for bedrooms to remove obnoxious smell.Even when the building is demolished the biochar would benefit the soil. Insulation – cool in summers and warm in winter. Light weight, good for high storey buildings for creatings inside walls

Figure 1: Biochar with pyrolysis of biomass

2.1. Woodash

Wood ash is a by-product created during the combustion of wood products for energy production at pulp and paper mills, sawmills and wood- product manufacturing facilities. Wood ash is composed of both organic and inorganic compounds. The physical and chemical properties of wood ash, which determines its beneficial uses, are influenced by species of the wood and the combustion method. Due to high strength, practically no breakage during transport & use and to uniform size of bricks mortar required for joints & plaster reduces almost by 50%. Due to lower water penetration seepage of water through bricks is considerably reduced. These bricks do not require soaking in water for 24 hours only sprinkling of water before use is enough.

Figure 2: Wood ash by-product during manufacturing

3. Material Properties

- Sand: Sand is a naturally occurring granular material, composed of finely divided rock and mineral particles. The major composition of sand is silica. The composition of sand is variable depending on the local rock sources and conditions.
- Lime: Quick lime or hydrated lime or both can be mixed in the composition. Lime should have minimum 40% Cao content.
- Cement: In the most general sense of the word, cement is a binder, a substance that sets and hardens independently, and can bind other materials together. The chemical reaction that results when the anhydrous cement powder is mixed with water produces hydrates that are not water-soluble.
- Water: Water is an important ingredient of brick as it actually used for manufacturing of brick.since it helps to bind all the raw material for giving proper mix.water used or making brick should be free from impurities.

4. Experimental Investigation

The comparative study of woodash and biochar bricks are begins with brick testing. The raw material of bricks are woodash, charcoal, sand, lime and cement.These bricks are made with different proportion of charcoal & wood ash at 5%,10%,15% with cement & sand. The bricks were cast having size of 230x110x75mm. The manufacturing process of bricks consist of various steps such as mixing,moulding and curing. First,the materials are mixed in pan mixture and then Water is added to its required proportion. After mixing, the mixture is put into the mould boxes. Then the mould is removed with careful attention. After that, the green bricks

are dried up under sun lightfor 24 to 48 hours. The dried up bricks are stacked subjected for water spray curing once or twice a day, for 7days.The bricks are tested for both compression and water absorption and sorted before dispatch

Figure 3: Preparion of Charcoal Bricks

Figure 4: Removal of Charcoal Bricks and wood ash bricks in mould

Figure 5: Curing Charcoal Bricks and wood ash bricks in tank with water

5. Testing On Bricks

Compressive test: Three numbers of whole bricks from sample collected should be taken .the dimensions should be measured to the nearest 1mm. Remove unevenness observed the bed faces to provide two smooth parallel faces by grinding .Immerse in water at room temperature for 24 hours .Remove the specimen and drain out any surplus moisture at room temperature. Fill the frog and all voids in the bed faces flush with cementmortar (1cement, 1 clean coarse sand of grade 3mm and down). Store it under the damp jute bags for 24 hours filled by immersion in clean water for 3days. Remove and wipe out any traces of moisture. Place the specimen with flat face s horizontal and mortar filled face facing upwards between plates of the testing machine.

Figure 6: Compression Testing Machine

Apply load axially at a uniform rate of 14 N/mm^2 per minute till failure occurs and note maximum load at failure.The load at failure is maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine. The crushing strength is theratio of crushing load to the area of brick loaded. Average of three specimens is taken as the crushing strength.

5.1. Water Absorption

Three numbers of whole bricks from samples collected for testing should be taken. Dry the specimen in a ventilated oven at a temperature of 105 °C to 115°C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (W_1) specimen too warm to touch shall not be used for this purpose Immerse completely dried specimen in clean water at a temperature of 27+2°C for 24 hours. Remove the specimen and wipe out any traces of water with damp cloth and weigh the specimen after it has been removed from water (W_2). Water absorption, % by mass, after 24 hours immersion in cold water in given by the formula,

$$\mathbf{W} = \frac{W_2 - W_1}{W_1} * \mathbf{1006}$$

6. Comparison of Results

Percentage of materials	Compressive strength (N/mm^2)	
	Charcoal	Wood ash
5%	16.60	5.93
10%	16.60	13.83
15%	11.07	7.91

Table 1: Compressive Strength of Bricks with charcoal and wood ash

Percentage of materials	% of Water absorption	
	Charcoal	Wood ash
5%	1.71	9.00
10%	1.75	12.10
15%	4.45	15.80

Table 2: Water Absorption of Bricks

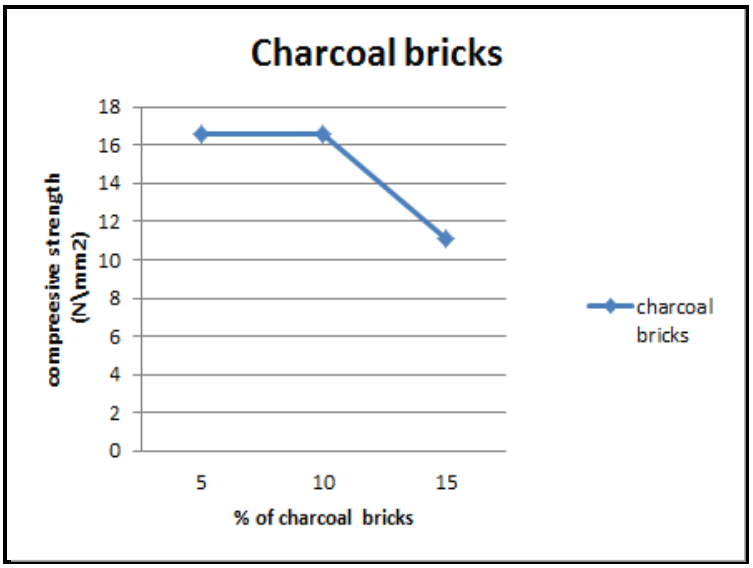

Figure 7: Compressive Strength of charcoal Bricks

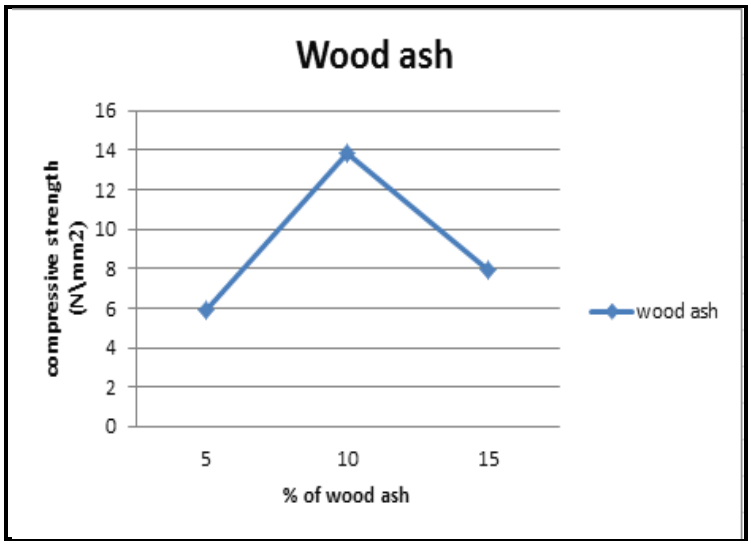

Figure 8: Compressive Strength of Wood Ash Bricks

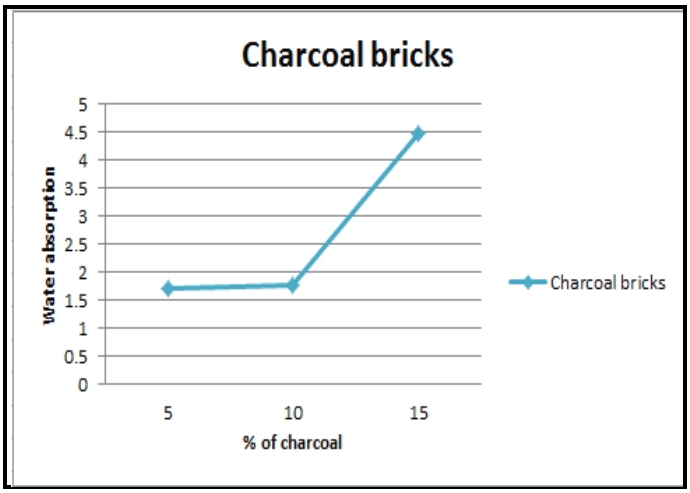

Figure 9: Water absorption of charcoal Bricks

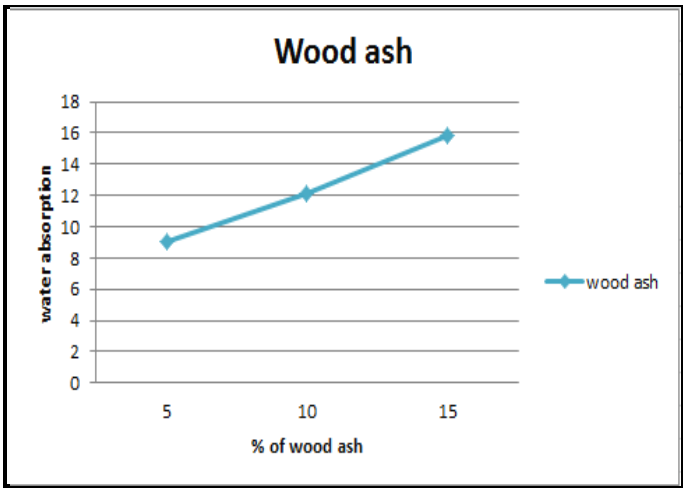

Figure 10: Water absorption of Wood Ash Bricks

7. Conclusion

Based on experimental investigations concerning compressive strength and water absorption of the Brick, the following results were obtained, Compressive strength decreases on increase in percentage of wood ash as compare to charcoal brick. The different percentage of wood ash and charcoal (5%, 10% & 15%) are added with cement and sand. The compressive strength for both bricks are decreased. In that charcoal brick has maximum compressive strength ie.,(11.07 N/mm^2 for 15 % of charcoal) than wood ash brick (7.9 N/mm^2 for 15% of wood ash).The water absorption for both the bricks are increases with percentage of (5%,10%,15%).In that the charcoal brick has less amount of water absorption ie.,(4.45% for 15% of charcoal) than wood ash brick(15.80% for 15% of wood ash).Thus from above study, this project concluded that, with the addition of charcoal in the cement and sand, the compressive strength of bricks increases and water absorption decreases than wood ash bricks. A better measure by an innovative Construction Material is formed through this research This study helps in converting the non-valuable wood chips into charcoal bricks which makes it valuable. From this research we hope that this brick will be act as an eco-friendly bricks for present construction field.

8. References

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