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Utilization of Industrial Waste

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1. Abstract

The most basic building material for the construction of houses is conventional brick. The rapid growth in today's construction industry has obliged civil engineers in searching for more efficient and durable alternatives far beyond the limitations of conventional brick production. Several studies had taken serious steps in manufacturing bricks from several waste materials. However, the traditional mean of brick production which has brought hazardous impacts to the context has not yet been changed or replaced by a more efficient and sustainable one. This paper aims to compile the state of the artwork of manufacturing bricks in the past and the current trend in the bricks industry concerning the raw materials, ways of manufacturing, and the out- comings. Moreover, the hazardous impacts of conventional brick manufacturing will be wholly covered as well as the attempts of the previous research in treating the problem properly. This paper is an attempt to fill the gap in past studies and suggest more sustainable and sophisticated methods of brick manufacturing in the future. (Shakir, 2013). Bricks are the main construction component and constitute clay cement and concrete. Method of making bricks from waste material- firing, cementing, geopolymerization. For a better environmental aspect, further development and research should be carried out to produce bricks. The focus should be on the economical, technical, and environmental aspects. And also on government policies, standardization, waste recycling, and sustainable development. This study gives a comparative study of normal bricks and bricks after the addition of industrial waste. The study shows that industrial waste can be utilized in the making of brick with more durability and strength.

The experimental results show a higher compressive straight of 25 N/mm^2 and the radio of Cement: Sand: Red earth: industrial waste is 30:5:5:5:20:35 the temperature is 800° C fulfilling the requirement of national standards.

2. Objectives

- Preparation of Brick using industrial waste
- Replacement of natural river sand with Industrial waste
- Increasing the strength of the brick
- Reducing the use of fuel consumption

3. Keywords

Compressive strength, water absorption, kiln, quarry dust, sand

Introduction

8000 BC Dried clay was used to make bricks. Fried clay was used in 4500 BC. introduced. Conversation method uses more temperatures due to kiln firing and concrete-like (OPC). Fuels such as coal, wood, and biomass are used to generate this temperature. Coal usage will increase to 24 million tons/year. Modernization is taking place in many areas, but the sector still needs research and development of new technologies to produce less harmful and cheaper bricks. The traditional method of making bricks causes a lot of air pollution and emits gases such as carbon monoxide, carbon dioxide, ammonia, chlorine and fluorine.

Sludge from sewage treatment plants poses problems during disposal. Some coastal towns may dump mud into the sea, but the practice is now being seriously questioned. is the cheapest method of sludge disposal if available as the number of sludge increases, the problem of sludge disposal is exacerbated. Ultimately, finding a suitable dumping site becomes a major problem. Recently, the use of dried sludge as a material for brick manufacturing and fuel manufacturing has been considered.

In a recent paper, Zhang published a relevant review of the state-of-the-art on the use of waste wood to make bricks. Readers were presented with an extensive list of publications on different types of waste and an overview of the corresponding treatment methods and main outcomes. Zhang divided the brick manufacturing methods into three categories: calcination, cementing, and geopolymerization, and described the specific advantages and disadvantages of each. The firing process in particular, which is most often associated with conventional brickmaking, has the advantage of being easy to carry out using known traditional methods and equipment. In contrast, as Zhang points out, the manufacture of bricks by firing consumes a large amount of energy, consuming an average of 2.0 kWh per brick, and emitting a large amount of greenhouse gases (about 0.41 kg CO2). There are drawbacks. Jagadish. Another environmental problem the authors point out is the lack of sound in many parts of the world. This has led countries such as China to restrict the use of clay bricks.

Finally, Zhang pointed out that geopolymerization methods, which are said to use much less energy and have a lower carbon footprint, appear to be the trend of the future. As a long-term prediction for the future, we do not contradict Zhang's conclusions. However, many aspects of his review work deserve a second opinion on how he writes. The reader should pay attention to two points about him in this work. First, Chan's proposal to "make bricks from waste" may seem limited to a particular process of making rectangular blocks, but it certainly has to do with recycling waste. Regardless of the type of ceramic work being fired (bricks, tiles, pipes, blocks, etc.), a key issue is the feasibility of incorporating a particular waste material.

The focus of Mr. Zhang's review was not on product geometry, but on his findings on the pros and cons of fired ceramics versus cementation and geopolymerization. A second point to note is that some of the articles cited in this book are written in Portuguese. Rather than trying to cause problems for the reader, it is intended to highlight the incorporation of waste into fired pottery as a more appropriate recycling practice in Portuguese-speaking countries. In particular, the reasons for Brazil are detailed in this presentation. Unlike some other countries, today and over the next two decades, the benefits of recycling waste by incorporating it into fired pottery have been shown to be strongly justified.

4. Literature survey

A mixture (70-90 wt%) of incinerated paper mill sludge (up to 60 wt%) and glass cullet (up to 40 wt%) in clay pottery (uniaxial press / 1100-1140 C) and The properties of the mixtures were compared. (Monteiro, 2014). The results show that clay ceramics incorporating 70% by weight of a 60/40 mixture of slurry/cullet fired at 1120°C or higher exhibit stable firing properties associated with good hardness (5.7 GPa) and strength (54 MPa). It has been shown to show the tying process. These ceramics showed free quartz, anorthite and diopside structures by XRD analysis. They may therefore be suitable for industrial production of tiles. Lin and Luo studied the incorporation of catalyst waste (up to 50 wt%) into clay pottery (uniaxial press/900-1200 C) to produce paving slabs. The authors state that the pottery's water absorption (20%) and porosity (30%) increased with the amount of waste, and the ignition loss decreased. The hardness of pure clay pottery and waste-incorporated clay pottery is highly dependent on the amount of waste and firing temperature.

Scholars and Smetanova reported the incorporation (70 wt%) of lignite fly ash into clay ceramic tiles (uniaxially compressed/1000-1150 C). The authors showed that grinding fly ash to 63 µm improved the sinterability of fly ash-loaded clay bodies. 1.3 wt% peptizes/flux increased the flexural strength of the green body and decreased the water content. Fired tiles made from ground fly ash had low water absorption at 1150 C (8%) and high bending strength (34.1 MPa). A denser microstructure of deflocculated tiles was observed by her SEM. Clay bodies containing fly ash are frost tolerant with a water absorption greater than 10% due to a positive pore size distribution. Andreola reported the incorporation (up to 20 wt%) of washed cathode ray tube glass from disassembled TVs and PCs into clay pottery (press-sintered/1210 C). Glass waste replaces both the feldspar and inert ingredients needed to strengthen the body of traditional clay pottery. The resulting embedded ceramics exhibited key properties of water absorption (15%) and strength (10%) similar to commercial ceramic materials used in floor and wall tiles.

The incorporation (up to 90% by weight) of electric arc furnace steel dust containing high levels of iron and zinc and significant amounts of lead, chromium, and cadmium into structural ceramics (compression molding/800 and 1100 C) was studied. At a maximum content of 90 wt% and 1100 firings, water absorption (7.5%), porosity (23.8%), density (3.19 g/cm3), linear shrinkage (11.5%) and flexural strength (0.44 MPa) changes significantly. observed). Structural analysis by XRD revealed the formation of diopside by Ca and Mg in the iron powder. The authors state that clay pottery containing up to 20% by weight dust can be used in the manufacture of bricks and roofing tiles with less risk of cadmium contamination. Hojamberdiev is kaolin (60-65% by weight) and grist (up to 10% by weight), bentonite (0-5% by weight), loess (0-10% by weight). The authors concluded that the waste resembled conventional non-plastic materials and could be beneficially used in the production of ceramics for floors and decorative tiles. A ceramic floor tile sample containing 30 wt% waste and fired at 1150 C showed higher deflection (32.04 MPa) and compression (54 MPa).

Furlani reported on the characterization of various clay matrices (uniaxial press/1040-1140°C) incorporated into waste consisting of a constant 60/40 ratio of incinerated paper mill sludge
to 90% by weight. The authors observed that ceramics containing kaolin in the matrix exhibited the best overall performance in terms of flexural strength (43 MPa) and Vickers hardness (5.1 GPa). The best properties for embedded ceramics using red or yellow clays as matrices were obtained for products fired above 1080°C. Ceramics with 60 wt% waste showed in his SEM prismatic elongated structures attributed to diopside, akermanite, or augite. Some glass phase was also observed. Ceramic performance and optimum temperature are affected by the type and amount of clay added.

Temperature is affected by the type and amount of clay added. Sokolar and Vodok investigated the effect of two different fly ash additives (brown coal and fluidized bed) (60 wt%) on the technical properties of clay pottery (uniaxially pressed/1080 C). The authors found that incorporating 60 wt% fluidized fly ash reduced the S.N. Monteiro, CMF Vieira / Construction and Building Materials 68 (2014) 599–610 603 reduced the firing shrinkage (3%) and at the same time increased the porosity of the ceramic (44.4%). Also, water absorption increased (30.3%) and bending strength decreased (8.9 MPa). A higher pore volume was observed by his SEM. In summary, up to 20% fly ash can still meet ceramic tile requirements. Regarding the environmental impact, the addition of fluid fly ash dramatically increases the SO2 content in the flue gas during ceramic firing. We used natural granite (up to 35% by weight), sieved to 200 mesh, to completely replace fluxes and inert found in clay pottery (uniaxially pressed/1220 C). The authors demonstrated technical advantages in terms of reduced water absorption (2.47%) and increased bending strength (31.81 MPa) at a higher granite content of 35% by weight. Based on SEM observations, the authors suggested that the increased intensity was associated with coarse acicular secondary mullite. Both environmental and economic benefits validated the feasibility of adding granite to clay-ceramic formulations.

Cardas reported that clay pottery (press-molded/850 and 1050 C) contained flat glass waste (cullet) (up to 10% by weight). The authors found no significant difference in the microstructure of both pure clay and pottery containing 10% cullet by weight. However, the glass particles observed by SEM indicated a possible flux effect. In fact, firing embedded ceramics at 1050°C is associated with microstructural evidence of vitrification. Furthermore, optical dilatation images show that the glass fragments have a softening point of 810 °C. Above this softening point, viscous flow penetrates the pores of the ceramic and closes them as a glassy phase.

Lafhaj presented results on the incorporation of Novosol-treated river sediments from northern France (up to 45 wt%) into clay bricks (extrusion/1010 C). For bricks incorporating 45 wt% treated (phosphating and 650 °C fired) sediments, the plasticity index decreased (10.55), water absorption increased (40%) and strength decreased. (25.58 MPa). Based on these properties and French criteria for freeze-thaw resistance, efflorescence, and heavy metal leachability, the authors concluded that a 35% by-weight mixture was the most effective.

5. Experiment

The constituents are clay, sand, red earth, and industrial waste. The constituents are mixed properly in a dry state then water is added to it then transfer to the mold where the brick takes its shape it is dried in different stages first it is dried in the shade for up to 3 days then it is dried under sunlight for about 5 days and then burned in the muffle furnace for about 3 days. After the drying process gets over the brick is sent to measure the compressive straight and water absorption of the brick.

5.1. Materials

The various materials used to make the brick are the clay, sand, red earth, quarry dust, glass powder, and industrial waste.

Fig 6.1.1. Clay

Clay: The fine rock combined with traces of quartz, metallic oxide, the organic matter they are hard and brittle, and non-plastic once it gets hard after drying and firing.

Fig 6.1.2. Sand

Sand: The composition is of silica in the form of quartz the cost of natural sand is going high because of

Fig 6.1.3. Red Earth

the difficulty in the availability of natural sand.

Red earth: It is a crystalline rock formed in the deciduous forest it consists of ferric oxide, iron, aluminum, organic matter, magnesium, lime, carbon dioxide, potash, soda, phosphorus, and nitrogen.

Quarry dust: It is used to enhance the quality of the material it consists of silica found in natural sand .and is also used instead of natural sand because of its low cost and similar properties

Glass powder: Glass powder also consists of silica and its glass powder is disposed of in the ground which is not decomposed glass powder in bricks can reduce the use of sand in the bricks.

Fig 6.1.4. Quarry Dust

Fig 6.1.5. Glass Powder

Fig 6.1.6. Industrial Waste

Industrial waste: The waste which has been used here is Pharmaceutical industrial waste which contains compounds like ether, secondary amines, and compounds of carbon-hydrogen bond aromatic compounds.

5.2. Method

This study is to increase the compressive straight and suitable water absorption between 12-20% the size of the brick is 8×4×4 cm and the ratio of the material used is 30:5:5:5:20:35 where the 30 is clay,5 is sand, red earth, quarry dust, 20 is glass power, and 35 is industrial waste. The novel work here is the addition of pharmaceutical industry waste in the manufacturing of brick which makes the brick more durable.

The casting of the samples: Mixing of clay, sand red earth, glass powder, quarry dust, and industrial waste are done in a dry state until it gets to a uniform color after that water is added to get a consistent material for molding.

Drying of brick sample: The brick is kept in a shade for 3 days this is done to evaporate the water from the surface of the brick which prevents the brick from cracking.

Then this brick is directed in the direct sunlight for 5 days after this the brick is transferred to the muffle furnace where it is burned for 3 days.

Testing the brick sample: The strength of the brick is measured by an instrument called a compression testing machine. The compressive straight of the brick should be more than 5 N/mm^2 and the water absorption should be 12-20%.

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Fig 6.2.1 Absorption of water

Fig 6.2.2. Compression testing machine

After the brick is ready the weight of the brick is measured then it is submerged in water for 12 hours here the absorption of water will increase the weight of the brick, and the water absorption is calculated as the final weight – the initial weight of the brick.

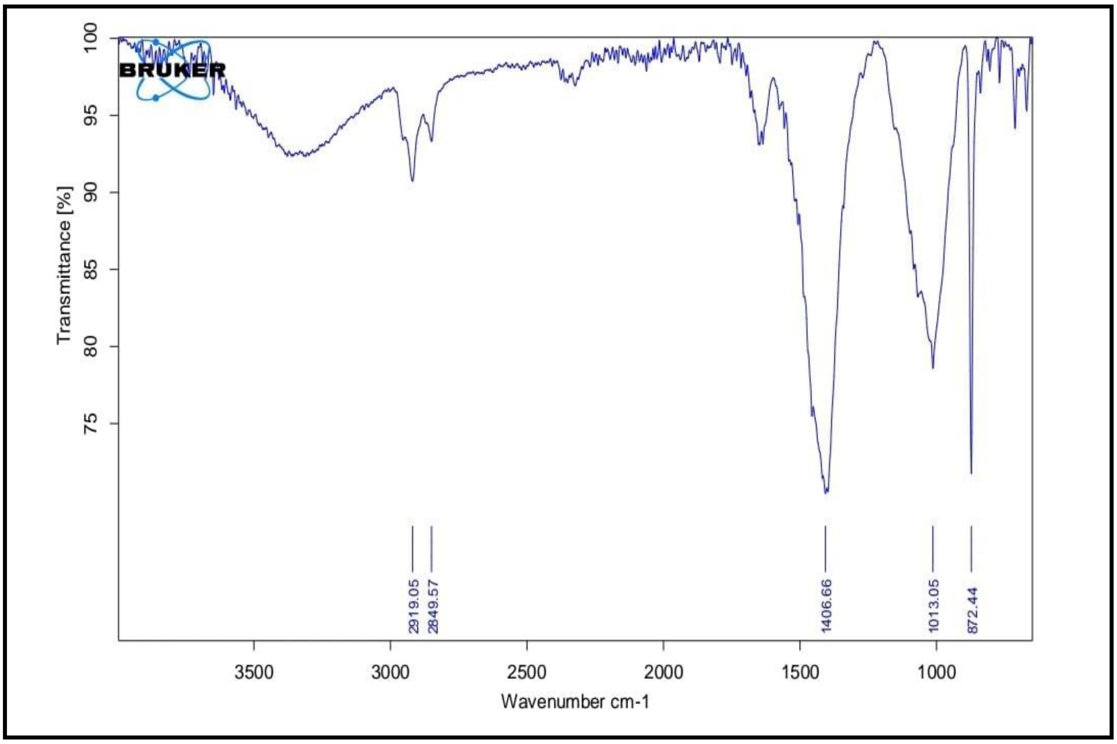

Fig 6.2.3. FTIR of Industrial waste

The graph of FTIR shows the representation of the functional group, here the 2919.05 cm^{-1}, 2849.57 cm^{-1}, 1406.66 cm^{-1}, 1013.03 cm^{-1}, 872.44 cm^{-1} show the presence of carbon-hydrogen bond, ether, aromatic C-C bond, C-O bond, and a secondary amine.

FTIR is used to determine the organic components and chemical bonds there are two types of graphs of FTIR absorption vs wavenumber and transmittance vs wavenumber
The absorption and transmittance are in percentage and the wavenumber is in cm^{-1}.

Generally, the graph representing the wavenumber below 1500 cm^{-1} is considered incorrect because there is a limitation of FTIR that it is less accurate when the wavenumber is below 1500 cm^{-1}.

6. Result and Discussion

The size of the brick is 8x4x4 cm and the weight is uniformly kept to 1000g (1kg)

7.1. Without Industrial waste

SAMPLE	*CLAY*	*SAND*	*RED EARTH*	*QUARRY DUST*	*GLASS POWDER*	*COMPRESSIVE STRENGTH*
A	400g	100g	100g	350g	50g	14.41N/mm^2
B	400g	100g	100g	250g	150g	13.85 N/mm^2
C	400g	100g	100g	150g	250g	11.96 N/mm^2
D	400g	100g	100g	100g	300g	15.38N/mm^2

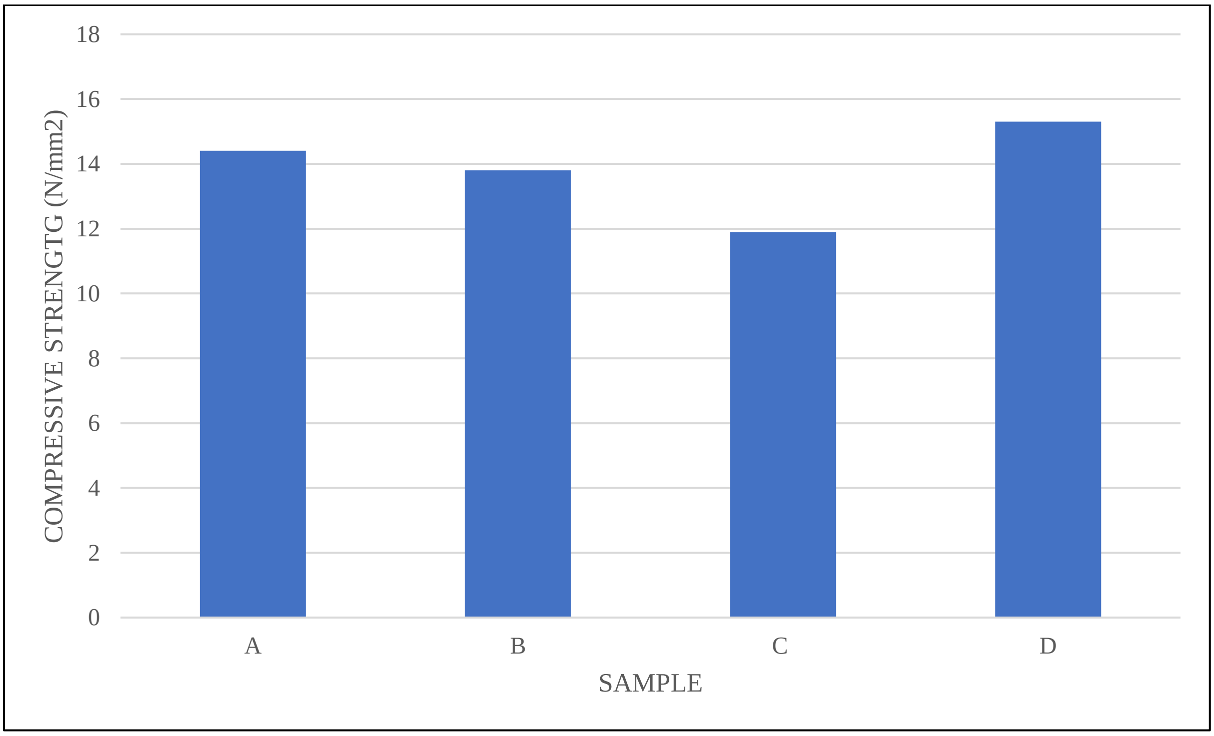

Fig 7.1.1. graph of compressive strength without industrial waste

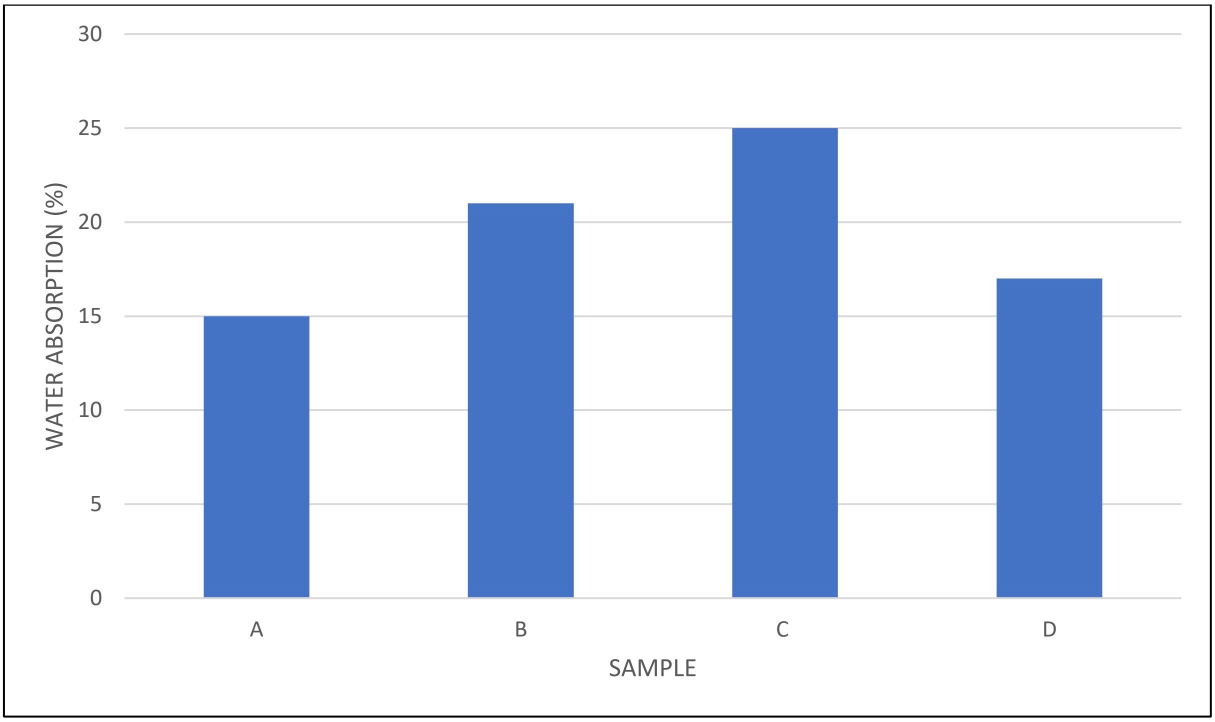

Fig 7.1.2. graph of water absorption without industrial waste

- Here the brick is made without the addition of industrial waste.
- There are 4 samples taken with different Quarry dust and Glass powder but the quantity of the clay, sand, and red earth is consistent in each sample.
- Sample D has the most compressive strength which is 15.38 N/mm^2 and water absorption of 17%.
- The ratio of the Composition of brick is 4:1:1:1:3 where 4 is clay, 1 is sand, red earth, quarry dust and 3 is glass power.

SAMPLE	*CLAY*	*SAND*	*RED EARTH*	*QUARRY DUST*	*GLASS POWER*	*INDUSTRIAL WASTE*	*COMPRESSIVE STRENGTH*
A	400g	50g	50g	100g	100g	300g	15.71 N/mm^2
B	400g	50g	50g	50g	150g	300g	18.23 N/mm^2
C	300g	50g	50g	50g	200g	350g	25.01 N/mm^2
D	300g	100g	50g	25g	200g	325g	17.5 N/mm^2
E	400g	50g	50g	50g	50g	400g	11 N/mm^2

7.2. With Industrial waste

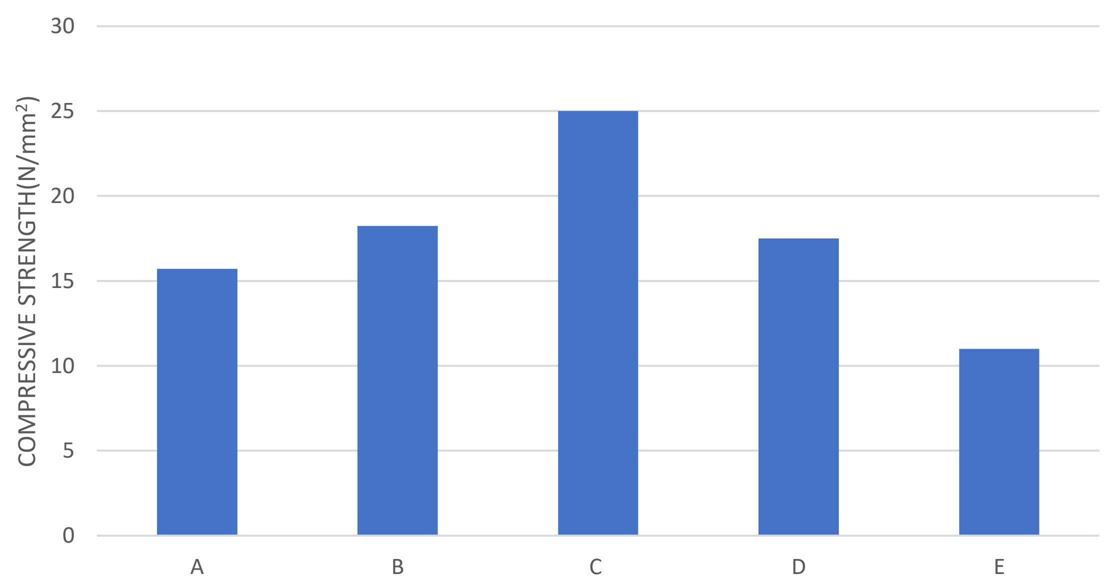

Fig 7.2.1. Graph of compressive strength with industrial waste

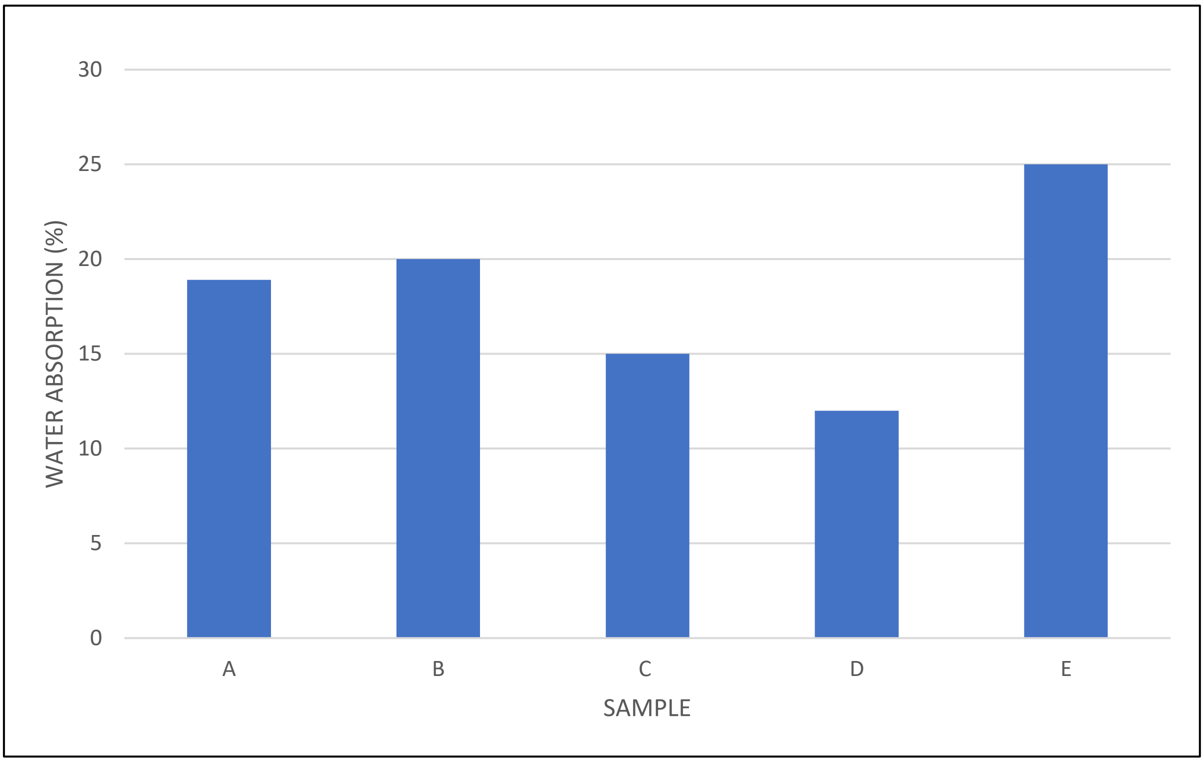

Fig 7.2.2. graph of water absorption with industrial waste

- In this case the brick is made with the use of industrial waste.
- There are 5 samples taken in which only red earth has a consistent value of 10 and another component has variation in their values.
- Sample C has the most compressive strength with 25.01 N/mm^2 and water absorption of 15%.
- The ratio of the Composition of brick is 3:0.5:0.5:0.5:2:3.5.

The Best proportion of the brick made without industrial waste is 400g clay, 100g sand, 100g red earth,100g quarry dust, and 300g glass power which gives out a compressive strength of 15.38 N/mm^2.

The best proportion of the brick made with individual waste is 300g of clay, 50g of sand, 50g of red Earth, 50g of quarry dust, 200g of glass powder, and 350g of industrial waste which gives 25.01 N/mm^2 of compressive strength.

This shows that the addition of industrial waste increases the compressive strength of the brick.

7. Conclusion

The proposed method for the manufacturing of processing industrial waste utilizes brick using industrial waste, here the industrial used is pharmaceutical waste, and glass waste, and in an effective manner also reduces the disposal of waste into a dump yard.

This work focuses on the reduction of the use of natural river sand and the use of fuel in the kiln. Generally, the bricks get manufactured under 1400 degree Celsius but in this method, the temperature provided for manufacturing the bricks are 800 degree Celsius which reduces the fuel consumption.

The compressive strength of this brick is 25 N/mm^2 where generally the criteria are 5 N/mm^2 and the water absorption is about 15% whereas the normal bricks have 12-25 % of absorption.

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