Experimental Study of Cigarette Butt Brick

Ms. Vaishali Somnath Mhaske[1], Mrs. Nikita Rahul Kadu[2]

[1] Lecturer, Civil Engineering Department, Padmashri Dr. Vitthalrao Vikhe Patil Institute of Technology & Engineering, Polytechnic, Loni
[2] Lecturer, Civil Engineering Department, Padmashri Dr. Vitthalrao Vikhe Patil Institute of Technology & Engineering, Polytechnic, Loni

Abstract: **Several trillion cigarettes are produced worldwide annually, resulting in tonnes of cigarette butt waste. Billions of cigarette butts (CBs) were discarded by smokers directly into the environment. It is known that CBs are one of the environmental pollution. Cigarette butts accumulate in the environment due to the poor biodegradability of the cellulose acetate filters that could cause contamination on the street, sidewalks, waterways, beaches and public areas.**
Due to its small size but large in volume, CBs cannot be collected easily and most of it will be disposed directly to the landfill. Moreover, there is no easy mechanism to ensure the separation of the chemicals trap inside the CBs which is toxic to the environment Results from a study on recycling cigarette butts into fired clay bricks are presented. In this study, different percentages of CBs (0%, 2.5% and 5.0%) were incorporated into fired clay brick.

Keywords: **Cigarette, Cellulose, Brick.**

1. INTRODUCTION

Cigarette butts (CBs) are the most common type of waste material discarded in the world. In 2016, an estimated 5.7 trillion cigarettes were consumed around the globe. While, in Australia, 24 billion cigarettes were consumed, of which seven-billion were disposed of incorrectly. That is, up to two-thirds of every smoked cigarette is littered to the environment. Numerous countries have implemented strong tobacco control regulations, and a significant decline in cigarette consumption has been observed. Despite this, it is estimated that the number of tobacco smokers is set to increase by seven- and 24-million in Nigeria and Indonesia, during the period 2015 and 2025. This is due to further growth in the market and population growth there are over 4000 chemicals present in a cigarette, seventy-two of which are known to be cancer-causing carcinogens. The main toxic agents include carbon monoxide, argon, aromatic hydrocarbons, hydrogen cyanide, phenol, nitrogen oxides, formaldehyde, acetaldehyde, acetone, benzene, ammonia, and pyridines. The filter of a cigarette is made of cellulose acetate fibers, where by the filter modifies the particulate smoke contents through retention.

2. METHODOLOGY

The incorporation of organic matter in clay mixtures assists in the firing process of clay bricks and, hence, the recycling of waste materials in fired clay bricks is an area of wide ranging research. The calorific value of CBs must be considered to determine the energy saving benefits of the addition of CBs in bricks. The calorific value of a material determines the amount of heat (energy) that is produced by the complete combustion of that material. Materials with high calorific values (e.g., petrol) produce more energy when combusted than materials with low calorific values (e.g., wood). Consequently, utilising a high calorific value material as a partial replacement in a mixture with a low calorific value will reduce the overall required firing energy for bricks, as, when compared to a standard mixture, additional energy is produced by the materials' constituents when combusted. An investigation into the calorific value of cigarette butts was undertaken. Samples of used CBs with remnant tobacco and used CB filters were tested with the aim of determining the calorific value of each. The results showed that the average gross calorific value of CBs with remnant tobacco (representing the typical used CBs found discarded on the ground) was 16.53 MJ/kg. A higher value of 16.99 MJ/kg was recorded for the cellulose acetate filter in isolation. However, the lower value of 16.53 MJ/kg has been used in this study.

The cellulose acetate content from CB filters reduces the required firing energy for clay bricks, due to it possessing a higher calorific value than clay. The energy that was required for the successful firing of bricks was taken as 2 MJ/kg, as it lies within the range of values stated by Prasetsan (1995) and other investigators. By utilising the tested CB calorific value and Equations (1)–(4), the estimated energy savings from the incorporation of 1% CB content into clay bricks is 9.3%.

Energy required to fire control brick (MJ),
Q1 =q x m1
Energy required to fire CB brick (MJ),
Q2 =q m2- CV x m3
Energy saved (MJ),
Q1 Q2=q m2 (q m2- CV x m3)
Energy Saved (%),
E =Q1 Q2/Q1 100%
where
m1 =mass of control brick (no CB content)
m2 =mass of clay in brick containing CBs
m3 =mass of CBs in brick
q =2MJ/kg energy required for firing clay
CV=Measured calorific value of used CBs, 16.53 MJ/kg

It is estimated that, if 2.5% of all the bricks produced annually around the world include 1% CB content, the energy consumption of the process can be reduced by approximately 20 billion MJ (from the calorific value of 1% CBs with 9.3% energy saving). This approximately equates to the power used by one million homes every year in the State of Victoria, Australia. Therefore adding 1% CBs (about 20 kg/m3) to the brick clay results in significant energy savings, solves the CB pollution globally, and tangibly reduces the environmental impact of the brick manufacturing industry whilst providing financial savings to manufacturers through the reduction of energy for firing bricks.

3. RESULTS AND DISCUSSION

3.1. COMPRESSIVE STRENGTH TEST:

The brick specimens are immersed in water for 24 hours. The specimen is placed in compression testing machine with 6 mm plywood on top and bottom of it to get uniform load on the specimen. The load is applied axially at a rate of 14 N/mm2.The crushing load is noted. Then the crushing strength is the ratio of crushing load to the area of brick loaded. Average of five specimens is taken as the crushing strength

3.2 WATER ABSORPTION TEST:

Five brick are taken and it is weighted dry. It is then immersed in water for 24 hours. It is weighed again and the difference in weight indicates the amount of water absorbed by the brick. It is should not be exceed 20 percent of weight of dry brick.

3.3 HARDNESS TEST:

In this test, scratches are made on the surface of the brick by a one-rupee coin. If it does not leave any impression the brick surface then it will be considered as good quality bricks. The hardness test for bricks involves assessing their resistance to scratching or indentation. A simple method is to scratch the brick surface with a sharp object, like a nail or a knife. If the brick doesn't show any marks or impressions, it's considered hard and of good quality. Bricks that are more resistant to damage from scratching or hitting are considered harder and more durable.

4. CONCLUSION

The results found in this investigation are very promising. It is concluded that cigarette butts can be regarded as a potential addition to the raw materials of new types of lightweight fired bricks, for non-load-bearing as well as loadbearing applications, providing the mix is appropriately designed and prepared for the required properties. Considering the number of bricks produced around the world every year, recycling CBs into bricks could contribute significantly to a sustainable solution of one of the serious environmental pollution problems on our planet. Cigarette butts into bricks could not just help solve a global littering problem, but cut brick production costs.

If 2.5 percent of the world's annual brick production incorporated 1 percent cigarette butt content, it would be possible to completely offset annual worldwide cigarette production. Adding butts to the mix allows to cut the energy needed to fire bricks by up to 58 percent. The added material also resulted in lighter bricks, with better insulation properties, reducing household heating and cooling costs, while maintaining properties very similar to those of normal bricks. When the bricks are fired, the heavy metals and other pollutants in the cigarette butts are trapped and immobilized in the bricks, reducing the problems caused by leaching and contamination. As the amount of cigarette butt content increased in the bricks, they became cheaper. The tested bricks content up to 10 percent cigarette butt. At that level, the dry density of the bricks decreased by up to 30 percent, and the compressive strength decreased by 88 percent. While greater cigarette butt content reduced the suitability of the resulting bricks for load-bearing purposes, it is possible to adjust these levels depending on the intended purposes of the bricks.

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