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Plastic Waste into Reusable Bricks for Green Building and Landscaping Materials

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ABSTRACT

Today's world is seeing an increase in waste that is causing damage to the earth. The earth is exposed to the extremely polluted environment if the waste is not properly managed. The main objective of this innovation is to reduce the current plastic waste that is rising rapidly throughout the years while producing a material that can be use in the landscaping and construction industry. This work uses Polypropylene (PP) which is a type of thermoplastic that can easily be found in plastic waste. It can be re-moulded and recyclable to create other materials which in this case a prototype plastic brick. The plastic brick was processed to mix with other materials as fillers. These include waste rubber powder, and calcium carbonate ($CaCO_3$). From previous research papers and articles, it is found that these fillers can significantly improve the properties of polypropylene (PP). In this study, coconut ash was added to strengthen the bricks. Therefore, it is concluded that, these plastic bricks have the potential to meet market needs to replace standard clay bricks. To support the government's call for recycling of waste, this innovation has the potential to help reduce plastic waste, resulting in a product that can be categorized as a green technology product.

Keywords: Polypropylene; calcium carbonate; bricks; landscaping; coconut ash

1. INTRODUCTION

Over the years, the number of natural pollution cases are increasing significantly. The air, water, and surroundings, all of them were polluted by the behavior of irresponsible human being. This situation threatens our earth a lot and we must act to provide a more suitable place for all the living things to live on. The most common cases are water pollution. Materials such as metals, plastics, bottles, glass, poly bags, chemicals, batteries, etc. are called non-biodegradable substances always being thrown in the water, causing harm to the environment.

The main objective of this work is to develop an efficient way to effectively utilize the waste plastic which is great threat for the ecological balance. Plastic has numerous uses; plastics do pose disposal problems. The motive being reduction of environmental related hazards from plastic. Next, to reduce the water pollution, all the harmful substances to the water needs to be recycled, not being thrown away like

that. In our study, we will be discussing about how to recycle plastic bags into a useful object; that are bricks. Bricks are commonly made of clay-bearing soil, sand, and lime, or concrete materials.

To fully make use of plastic waste, thermoplastic known as polypropylene (PP) is used. PP is mixed with calcium carbonate ($CaCO_3$) to act as fillers. When heat is applied to Calcium Carbonate ($CaCO_3$), it will decompose. These plastic bricks have a great potential to be marketable and have high demand in construction and landscaping industries. Hopefully, plastic bricks can become the great challenger with the industry of clay bricks-making.

2. INNOVATION DEVELOPMENT

To fully make use of plastic waste, thermoplastic known as Polypropylene (PP) is used as it is one of the most common thermoplastics that can be found. PP is completely recyclable and can be moulded to be used in other materials. It is the lightest polymers among a variety of plastics and has excellent chemical resistance to acids, alcohols, and bases. Most importantly, PP has good resistance to environmental stress cracking [9]. PP is mixed with Calcium Carbonate ($CaCO_3$) to act as fillers. Instead of extracting $CaCO_3$ from limestones which can increase the cost of making the bricks, we decided to extract $CaCO_3$ from eggshells. This can greatly reduce the cost of making the bricks while still using the properties of $CaCO_3$ which can increase both impact strength and flexural modulus (stiffness) [11]. When heat is applied to Calcium carbonate ($CaCO_3$), it will decompose to produce carbon dioxide (CO_2) which does not support combustion [10]. Thus, the addition of $CaCO_3$ can act as a good filler that can contribute to flame retardant property.

$$CaCO_3 \rightarrow CaO + CO_2$$

Waste rubber powder can also contribute as a good filler as it enhances the properties of PP [12]. With all these excellent properties that are added to our plastic bricks, we believed that it is a good alternative to clay bricks. Besides that, coconut ash is added to strongly 'hold' the bricks.

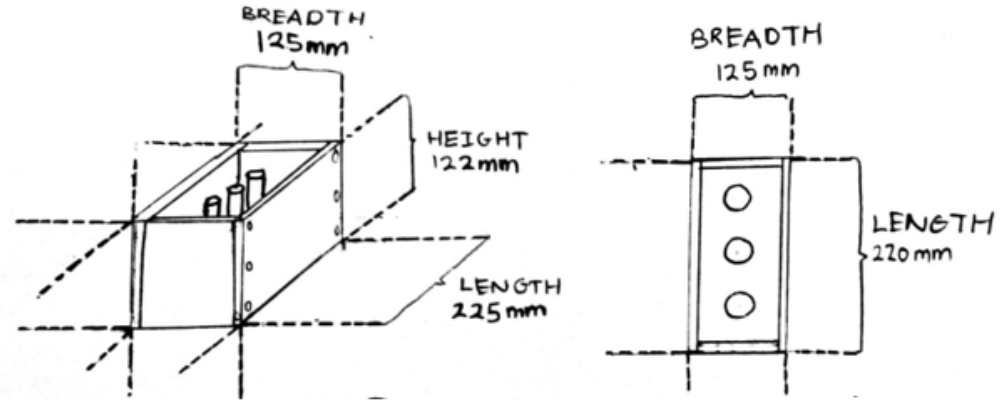

Figure 1: Prototype mould

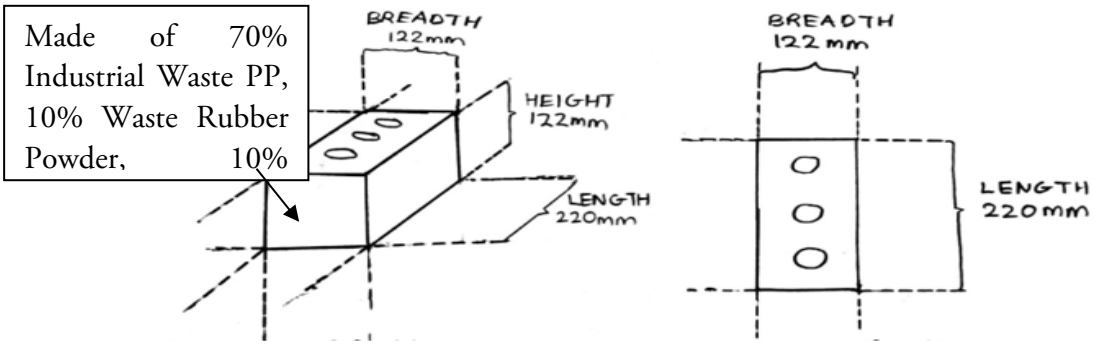

Figure 2: Plastic brick

Figure 4: Plastic melter

Figure 3: Example of 3 holes brick

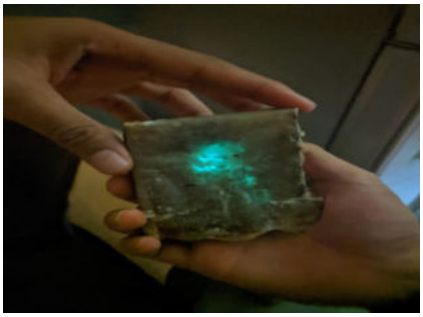

Figure 5: Sample of bricks

Figure 6: Sample of brick in mould

Figure 7: Mixed of calcium carbonate from egg shell and coconut ash

3. COMMERCIAL POTENTIAL

By creating the plastic bricks from the plastic waste, it become an initiative to make sure human reduce the plastic waste that is released to the environment. Based on research on 2015, it is calculated that 275 million metric tons (MT) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million MT entering the ocean [1]. This show how critical the plastic waste that made by humans' hand. Thus, it is believed that this innovation has a great potential to be marketable and have high demand in landscaping industries as it is not just can save the environment, but it also can fulfil the market of landscaping's materials. As can see in this half of century, the application of green building/landscaping become necessary and obligatory specification in the construction field. Green building is the criteria that focusing on increase the efficiency of resource use – energy, water, and materials – while reducing its impact on human health and the environment during the building's lifecycle. As example, the Green Building Index (GBI) is introduced in Malaysia. The Green Building Index (GBI) is Malaysia's industry recognised green rating tool for buildings to promote sustainability in the built environment and raise awareness among Developers, Architects, Engineers, Planners, Designers, Contractors and the Public about environmental issues and our responsibility to the future generations [2]. Thus, the idea of plastic bricks is an ideal material that can fulfil the criteria of green building in developing better surrounding. As to adapt with this rule, developers must find out anything that low in cost and high in quality. It is believed that plastic bricks can become the great challenger with the industry of clay bricks-making. By comparing them with their physical matter, it seems that plastic PP (polypropylene) have more advantages than clay. By comparing both of their specific heat capacity, PP got 1250 J/kg°C while clay got 1381 J/kg°C [3]. It means that PP will consume less preparation time than clay and fewer heat energy needed for make the plastic bricks. In the terms of thermal conductivity, PP seems have less thermal conductivity [4] that clay [5] and we can say in the future usage plastic bricks is better insulator than clay, thus it means the future user does not have major problem in temperature of the inner building. In addition, plastic bricks only use the waste material that easily can be found from the tyre, plastic waste and eggshell. It can simply say that the usage of plastic bricks is more economic than the clay bricks. As conclusion, plastic bricks just not solve the environment problems, but it can also become crucial in the civil and construction department if its usage is commercialized. If a clay brick is sold with RM 2.60 per piece (based on ewarehouse.my) [6], it only needs less than RM 1/pc as a capital of plastic bricks preparation and RM 1.50 is the reasonable price for plastic bricks.

Table 1: Compositions of bricks prepared [6]

Sample Brick	Composition in weight (%)	Density (kg/m^3)
Plastic Brick	70% Industrial Waste PP, 10% Waste Rubber Powder, and 10% $CaCO_3$	599.32
Clay Brick (Commercialized)	100% Clay Brick	1791.63

Table 2: Results of the compressive test on the bricks sample [6]

Sample Brick	Clay Brick (Commercialized)	Plastic Brick
Length of Brick, L (mm)	225	220
Breadth of Brick, B (mm)	110	122
Area of Brick, A (mm^2)	24750	26840
Load at Failure, P (N)	900000 (9.03 Tons)	170000 (17.06 Tons)
Compressive Strength, P/A(N/mm^2)	3.636	6.333

4. CONCLUSION

In conclusion, this work can effectively convert plastic waste into useful bricks that can be use in the building and construction industry. These prototype plastic bricks does not only help decrease the problem of plastic waste going into landfills and causing environmental pollution, but it also managed to reduce the cost of making bricks while still possessing properties of a standard brick. From the compression results, the prototype plastic brick that is made of 70% PP, 10% waste rubber powder,10% coconut ash and 10% $CaCO_3$ managed to have a greater compressive strength when compare to a standard brick made of clay. However, there are many other fillers in the market that can help improve the properties of these plastic bricks other than $CaCO_3$ and waste rubber powder. More experimentation must be done with different functional fillers as it might improve the properties of these plastic bricks. A good functional filler would have low cost, safe, inert, stronger than the polymer and readily available world-wide. Furthermore, the use of extruder can ease the making of these plastic bricks rather than heating the plastic waste manually.

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