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Research Article

DESIGNING BUILDING MATERIALS OF PLASTIC WASTE PANEL

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ABSTRACT

Plastic problems have become complicated problems because the recycling process is not easy. Plastic causes pollution and requires a lot of energy for processing. Plastic cannot be easily decomposed. The accumulation of plastic waste and poor plastic processing which produces toxic air pollution are not easily resolved. A simple idea to utilize this plastic waste is to make plastic into massively produced building materials or panel boards. In the future, these building materials will help solve the problem of the plastic waste accumulation. In addition, they will help decrease air pollution from plastic processing. The process of making panel boards from plastic waste is relatively safe and does not require a lot of energy.

The method used in this study is to produce panel boards that can be used as wall materials of 60 cm x 60 cm, in accordance with the module of building materials. This production can accelerate the development process. This test is done to determine the amount of additive materials to produce plastic waste panel boards that can be used as wall building materials.

INTRODUCTION

The main problem related to plastic waste is the growing number of products that use plastic packaging. The use and development of plastics have contributed a significant amount to negative effects on the environment from the aspects of human health, habitat, and space-usage (Ayers, M., 2008).This triggers massive plastic production. On the other hand, plastic cannot be destroyed by organism (non-biodegradable); therefore, it is durable. As it is non-biodegradable, it can stay in the environment for a longer time causing severe environmental degradation (P. Rajkumar, 2015).

Out of manyplastic wastes, only a few types of plastic can be recycled, such as polyethylen terephtalate (PETE) that is used for soft drink and juice bottles. Another example of recyclable plastic is high-density polyethylene (HDPE) that is commonly used for water and milk packaging. To recycle plastic, we also have to be careful because if the plastic waste is burned, it will cause the toxic substance from waste to be released into the air and be inhaled by humans. Data obtained from the Deputy of Contamination Prevention in the Ministry of Environment (MOE) show that each individual produces an average of 0.8 kilogram of waste in a day in which 15 percent of it is plastic. Assuming there are about 220 million people in Indonesia, the accumulated plastic waste reaches 26,500 tons per day, whereas the amount of landfill waste is estimated to reach 176,000 tons per day.

Meanwhile, data from the Ministry of Environment in 2007 show the volume of landfill waste in 194 regencies and cities in Indonesia reached 666 million liters, equivalent to 42 million kilograms, of which the plastic waste is 14 percent or 6 million tons. Based on the data from the Ministry of Environment in 2008, of the total national landfill waste, the amount of the composted or recycled garbage was nearly 5 percent, equivalent to 12,800 tons per day. Of the total amount of trash, 2 percent, or 204.16 tons per day is “biodegradable “organic waste which has the potential to produce methane gas.

RESEARCH METHODS

This study employed experimental method to address the research question. Plastic waste from beverage bottles were cut into flakes with the size of 0.5 cm x 5 cm and 0.25 cm x 2.5 cm. Plastic flakes would then be printed on 60 cm x 60 cm molds and will be bound with resin and other additives. Of the two types and sizes, it will be determined which one is the most appropriate, malleable, and easy to do.

DISCUSSION

In this study, the type of plastic used was plastic bottles for mineral water since this type of plastic cannot be reused as food

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and beverage packaging. Plastic bottles for mineral water are made of Polyethylene Terephthalate (PET). This kind of plastic can be recycled but is not reusable because it has less quality (Mills, N., 2005).

The experiment to create a panel board is an alternative to make wall materials by processing the waste of plastic bottles. The first step of this activity was to collect beverage plastic bottles of different shapes. The next step was to bring together all those plastic bottles and bind them with a binding agent mixture consisting of:

- Resin
- Methyl Ethyl Ketone Peroxide (MEKP),a clear, liquid catalyst with a pungent odor. It functions as a catalyst to harden the resin faster.
- Cobalt, bluish liquid chemical substance that serves as an active ingredient to mix the catalyst so that it can dry fast.
- Kaolin, a filler to save production costs.

The above materials were processed to make epoxy compound. Epoxy is a copolymer, made of two different chemicals. This is referred to as "resin" and "hardener". This resin consists of monomers or short-chain polymers with epoxide groups at both ends. The most common epoxy resins are produced from a reaction between epichlorohydrin and bisphenol-A. Hardener consists of polyamine monomers, for example Triethylenetetramine (Teta). The composition of the hardener is as follows:

- 1000 cc Resin: 10 cc catalyst.
- In the experiment, 100 g Kaolin, 800 cc 2 cc Resin and catalyst (MEKP and Cobalt) were used. Kaolin was added as filler to make more epoxy mixture without increasing the amount of resin, MEPK, and cobalt. Thus the addition of kaolin added the volume, but did not increase the price. The addition of kaolin will save costs in making epoxy mixture. Next, the epoxy was mixed with plastic flakes from the waste of plastic bottles. The mixture was placed on the mold and solidified to make the mixture of the plastic and epoxy. The plastic flakes of 0.5 cm x 5 cm and a mixture of 100 grams of Kaolin, 800 cc 2 cc Resin and catalyst (MEKP and Cobalt), the obtained panel was less strong and not solid, because the plastic flakes were too large. The epoxy bond that was formed wasnot strong enough to bind the plastic flakes.

Figure 1 Plastic of 0.5 cm x 5 cm with epoxy plus kaolin

To strengthen the bonds and generate strong panel boards, the researcher used a mixture of plastic flakes of 0.5 cm x 5 cm and 1200 cc of Resin and 3 cc of the catalyst (MEKP and Cobalt). The produced panels had a stronger bond but could not become solid because the plastic flakes were too large to be compacted. While it needed more epoxy mixture, this mixture could not equally bind all the surface of the plastic flakes.

Figure 2 Plastic of 0.5 cm x 5 cm with epoxy without kaolin

The experiment was continued by making the plastic flakes smaller (0.25 cm x 2.5 cm).

Figure 3 Plastic flakes of 0.25 cm x 2.5 cm in the plywood mold

Figure 4 Plastic flakesof 0.25 cm x 2.5 cm with epoxy without kaolin

The result of the experiment showed that the density of the panel was higher and less epoxy was needed. The result is more evenly distributed. It takes only a mixture of 800 cc of Resin and 2 cc of the catalyst (MEKP and Cobalt) and this mixture can make plastic flakes blend and bond evenly.

Panel boards made of plastic waste may be expanded to a larger size, such as 60 cm x 120 cm with a thickness of 5 cm. These panel boards can be made into partition boards with unique surface textures. The clear partition boards resemble glass block panels and can be used for interior design. They can also be painted. Panel boards made from plastic flakes is porous in nature. According to Attenborough, K., 1996, porous wall panel can be used as an acoustic damper wall. However, because the plastic material is a hard material, only a few acoustic frequencies can be muted (Avilola, G. M., 2001).

Figure 5 Texture of panel material before and after painted

The panel board was tested for its adhesion to plaster to find out its flexibility variation in terms of its usage as a wall building material. The result shows that its adhesion to plaster was good; therefore, it can be used as a non-bearing wall building material, especially for areas that have low ground bearing capacity due to the nature of this light panel wall.

To make the panel boards as partition boards, wood clamps are needed. To save costs, aluminum clamps can be used. Wood clamps can also be used. However, wood moldings are necessary to keep the wall panels.

To install the partition boards, a wood frame with a through dado (a slot or trench cut into the surface of a piece of machinable material) is needed. Plastic panel boards are then inserted in the dado. These panels can be painted to make them more attractive.

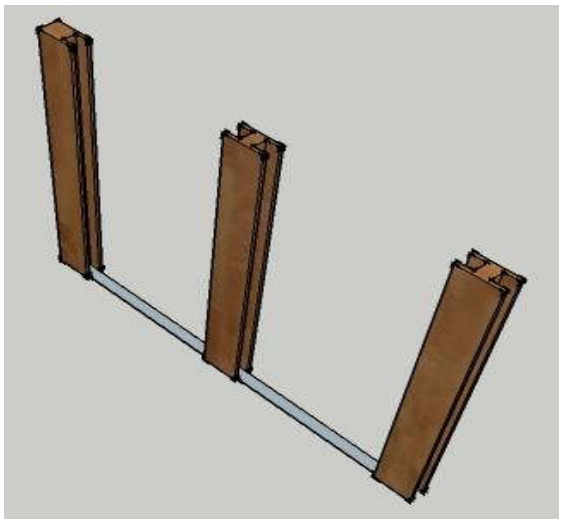

Figure 6 Frame of partition for wall panels made of plastic waste

Figure 7 The Panel mounted on the frame

As a non-bearing wall, these panels can be tied by using iron concrete bars with the diameter of 8 mm or 10 mm. Then these bars are made into a U shape iron concrete bar like this with a dimension of 5 cm x 20 cm x 5 cm. The wall panels will then be inserted into the grooves in the wood. To strengthen the structure, each panel should be joined with decorative clamps. Afterwards, those panels will become non-bearing wall that can be plastered with cement.

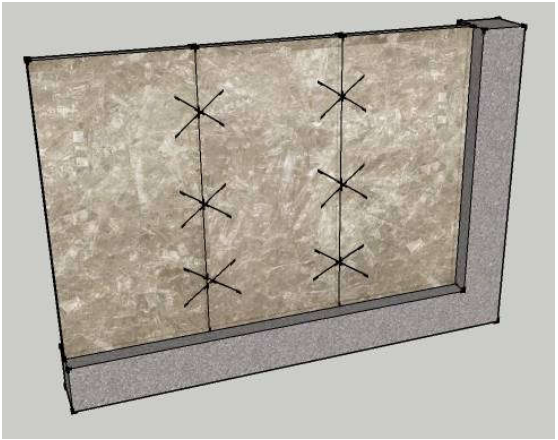

Figure 8 Panel plastic as a non-bearing wall

Plastics are poor electrical insulators and poor thermal conductor (Henning, O. and Knofel, D., 1997), except when metal powders/other carbons are added. In the original form, resin epoxy is hard and brittle, but when mixed with plastic, its mechanical nature can be altered. Its mechanical nature is very much influenced by the modification of its nature, both in terms of strength, resilience, tenacity, and tear direction. It is commonly known that chemically plastic is inert. In the long term, ultraviolet light affects the chemical structure of the plastic.

CONCLUSION

Panel materials made from plastic waste can be used as an alternate solution to decrease plastic waste and pollution. Plastic recycling often requires energy and the pollution and waste from the process is very dangerous for human health and the environment. In addition, plastic recycling process can lower the quality. These panels can be manufactured easily, even by people who have no special expertise on chemistry or wood carpentry, into partition boards or walls as an alternative building material. To make plastic waste into partition boards, resin is needed as binding agent. The composition of resin needs to be measured carefully in order to avoid failure. Otherwise the panel boards will become brittle because there is too much hardener and dryer (cobalt). The amount of filler must be accurate to prevent long drying time and the weakening of the binding agent which can result in poorer panel board quality. Therefore, it is suggested that the composition of the mixture examined in this study is used.

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