

Research article

Processing Plastic Waste Into Grass Blocks to Support the Zero Runoff Concept in Malang City, Indonesia

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Abstract.

Plastic is a polymeric food wrapping material. It is projected to increase in use and has the potential to become a raw material for recycling plants and incinerators in the future. However, decomposing plastic is difficult. This will cause complex problems if not addressed immediately. The purpose of this article was to describe the process of making grass blocks from plastic waste to implement the concept of a 'zero runoff green city' in Malang City in particular and Indonesia in general. An experimental analysis design was used which explained the stages of making grass blocks. It was shown that grass blocks can be made from plastic waste and a mixture of sand and cement with a ratio of 1:3 (37% sand). The grass block had a compressive stress of 17.2 Mpa with a length of 20cm and a height of 60mm.

Keywords: grass block, plastic waste, technology, green city, zero waste

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1. Introduction

Waste that is not managed properly causes a lot of losses. Some countries, both developed countries and developing countries, spend at least 40% of the annual budget to address environmental problems due to waste [1]. One of the wastes of global concern is plastic waste. Plastic is a material that contains one or more heavy polymers with large molecular weights. so it takes a long time for decomposition to occur [2]. From 2009 to 2017, demand for plastics on a global scale increased by 4% for a year [3]. Plastic waste is difficult to decompose, so special handling is needed to overcome the pile of plastic waste so that there is no severe environmental damage.

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Several countries have the problem of increasing the amount of plastic waste. The majority of people are still reluctant to leave the culture of using plastic in their daily activities, so that plastic and bottle waste still has a large amount. In fact from the research, there are about 8 million tons of plastic wasted into the oceans due to poor waste management on land [4]. This obstacle is motivated by traditions and lifestyles and low economic potential [5].

Plastic waste is still something Concerned. The scientists, governments, and communities should pay attention to the problem of solid waste and the need for a holistic approach to its management. The benefits obtained from proper waste management are benefits for the community, financial economy, environment, industry, and interested parties [6]. Practice of waste management also faces several obstacles. These obstacles can occur in the macro environment example politics and social culture, and meso and micro environment example industry and stakeholders. One of the cities experiencing Plastic waste problems is Malang city, Indonesia.

Malang city is called Education City because it has a big population. The Population in Malang City is 874.890 People [7]. The population of Malang City is the second highest in East Java and always increases from year to year [8]. The pile of waste in the city of Malang reached 659.88 tons for a day. This figure shows that the increase in population is directly proportional to the increase in waste [9]. Waste management costs a lot of money. The Malang City Government requires funds of around 18 billion to 19 billion rupiah for TPA operation [10].

In 2020, the Indonesian Waste Statistics by the Ministry of Environment and Forestry (KLHK) stated that 47.3% of waste was not managed. This percentage represents 17.7 tons of waste for a year. Plastic waste is the second largest type of waste after food waste with a percentage of 17% and 37% of waste comes from household waste [11]. This raises several problems caused by the policies and financial support weakness, low private involvement, low public awareness, and inefficiency [12]. According to Government Regulation Number 81 of 2012, waste management is a systematic, comprehensive and sustainable activity with others. Waste management consists of reducing waste and handling waste. Waste reduction consists of the 3R, namely reduce, reuse, and recycling [13]. Proper utilization and management results in the emergence of economic value in waste [14].

Waste management efforts to achieve zero waste have been carried out in various parts of the world. Their communities strive to strive for zero waste status [15]. Recycling efforts can be applied in the green city concept which has an approach in the form of zero waste and zero run off concepts. Zero runoff is an effort so that green open spaces

can be disposed of independently without draining it to other places. The suggested hardscape in the development of green space is in the form of paving blocks and grass blocks. Several literature studies and trials show that various types of plastic waste can be processed into more useful materials. One of them is a grass block. So this article will explain the process of making grass blocks as an effort to realize the concept of zero waste and zero runoff in a green city

2. Method

The method used is the experimental method. Experiments were carried out to create grass blocks with the basic ingredients of plastic waste with the types of plastics PET, PVC, and LDPE [2]. The implementation method is described in the following picture:

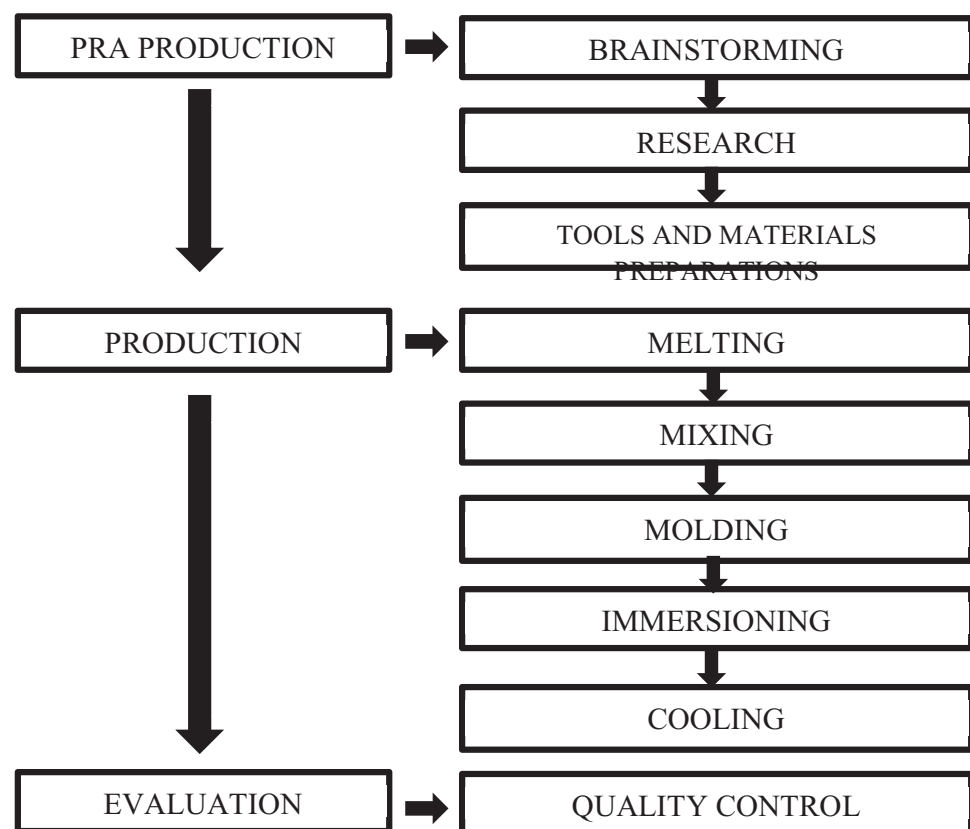


Figure 1: FlowChart Processing Grass Block From Plastic Waste.

3. Result and Discussion

TABLE 1: Tools and material for making grass block.

Tools	Materials
Combustion tube Furnace Stirrer Immersioning place Grass block Mold Measuring tools Matches	Plastic PET (Polyethylene Terephthalate) Plastic PVC (Polyvinyl Chloride) Plastic LDPE (Low Density Polyethylene) Sand Cement Used oil Firewood

Source: Experiment result

3.1. Green City Concept

Green city is one of the implementations of the ecological approach in the smart city concept. Green City is a metaphor for achieving the ideals of a sustainable city. The economic, environmental, and socio-cultural aspects must be balanced and sustainable for realization. A green environment is believed to increase social interaction activities and reduce crime. Because, spatial planning will have an impact on human resources [16]. This concept is one response to various efforts to help cities become more sustainable [17].

A green city or commonly known as an ecological city is a city whose development and development is balanced with natural preservation. This city is a healthy city where the condition of the city can be clean, safe, and comfortable due to the optimization of the community's potential from a social and economic perspective. These efforts are carried out with community forums, adequate facilities from agencies related to urban planning, and the participation of all community components. In realizing a green city, there are 8 approaches, namely (1) City development in accordance with the law (2) Zero Waste concept (3) Zero Run off concept, (4) Green infrastructure, (5) Green transportation, (6) RTH (Green Open Space) 30% of the city area with a composition of 20% public green open space and 10% private, (7) Green Buildings, and (8) Community participation.

Zero waste is one of the concepts of preventing the depletion of sustainable consumption, global resources, and a strategic waste management system [18]. Plastic waste is one of the global environmental issues that needs more attention. In modern society, Plastic waste is a symbol of efficiency and a representation of misallocated resources [19]. In the modern era, many industries, especially food and beverage, use plastic as packaging because it is considered more practical and attractive. However, the use of plastic now exceeds the reasonable limit with minimal management, causing environmental problems.

Zero waste applies the 3R principle, namely reduce, reduce, reuse, and recycle. These principles are intended to reduce the transport burden on waste. Then, in

implementing a green city, it also applies the concept of zero run off. This concept is a concept that applies the existence of green open spaces that are able to absorb waste water independently without having to drain out of the area. The minimum percentage for green open space is 30% from an area. With this portion, it is hoped that the softscape can absorb effectively, especially with the help of infiltration wells and biopori. Hardscape green open space is recommended to use materials that support water absorption such as grass block and paving block.

3.2. Grass Block

Grass Block is a type of paving block that has a hole in the middle as space for grass to grow. Grass Block is made like paving blocks in general, which is the result of a mixture of sand, cement, and water which is then printed in a mold. The compressive stress of the paving block is 9.8 to 39.2 Mpa. The higher the quality of a paving block, the paving also has a higher stress. The use of grass blocks for hardscape yards and gardens is considered to have a higher water absorption capacity than ordinary paving blocks because there is room for grass growing media in the middle so that it also produces greener gardens.

3.3. Implementation

The implementation of making Grass blocks is divided into 3 parts. Namely Pre-Production, Production, and evaluation.

3.3.1. Pre-production Stage

The Pre-Production Stage is a series of activities carried out to finalize the concept of planning and product manufacturing. The series of activities include:

A. Brainstorming. Brainstorming is done to find the right concept to solve a problem. The purpose of this stage is to overcome the problem of plastic waste that has accumulated in Malang city, Indonesia. Through this stage the Grass block produced is a hexagonal shape with a length of 20cm and a thickness of 60mm. This selection is used to increase the water absorption capacity because it has a larger space.

B. Research. The research was conducted by means of literature studies and interviews with resource persons who are experts in their fields. The thing being studied is the method of making grass blocks from recycled plastic waste which is simple but has

good quality. Through this research, it can be concluded that the simplest method is through melting with a mixture of sand.

C. Preparation of tools and materials. The tools are adjusted based on the results of the research that has been done. The materials that need to be prepared are plastic waste with the types of PET (Polyethylene Terephthalate), PVC (Polyvinyl Chloride), and LDPE (Low Density Polyethylene). While the tools that need to be prepared are iron tubes, water tanks, stirrer, furnace, and molds.

3.3.2. Production Stage

Production is carried out in 5 stages which are described in the following table:

TABLE 2: Production Stages.

Stage	Process
<i>Melting</i>	Cut the PET waste into small pieces Sorting dry and clean PVC and LDPE waste Heat the iron tube to more 100°C Insert plastic waste Stabilize the fire so that the temperature is above 100°C Close the jar and open it when the plastic waste is expected to melt Stir the melted plastic until it melts evenly
<i>Mixing</i>	Mix cement and sand in a ratio of 1:4 Mix into the melted plastic little by little with a ratio of sand and plastic 1:3 Stir until evenly distributed and there are no lumps
<i>Molding</i>	Take the dough with a hot stirrer and put it in the mold Press with a pressing iron so that it has a flat surface
<i>Immersioning</i>	Put it in warm water and make sure everything is submerged so that the inside is solid and no cavities appear Put it in cold water and leave it for a while
<i>Colding</i>	Lift the grass block and let it air out in the open. This process aims to cool the inside of the paving.

Source: Experiment's Result

3.3.3. Evaluation

Evaluation is carried out as a form of quality control over the grass blocks that have been made. This is done to test how the pressure points on the grass block. The strength and density of compressive stresses in grass blocks are inversely proportional to the size of the sand particles [20]. This shows that less sand will produce stronger grass blocks. Based on the experiments that have been carried out, the grass block criteria that have been generated are shown in the following table:

TABLE 3: Indicators and Results.

Indicator	Result
Compressive stress	17,2 MPa
Long	20cm
high	60mm
Shape	Hexagonal
Properties against water	Water resistant
Comparison with mixed materials	3:1

Paving Block Experimental Results



Figure 2: Grass Block from plastic waste.



Figure 3: Grass Block from plastic waste.

4. Conclusion

Plastic waste requires intensive handling due to the very large amount. In this implementation, it can apply the 3R principle (reduce, reuse, recycle) in the concept of zero waste. Green City is one of the city planning concepts that applies the concept of zero waste and zero run off. Zero run off requires hardscape material that supports maximum water absorption. One of the materials that can be used is grass block. In realizing the 3R principle, experiments were carried out on making grass blocks made from plastic waste. In this experiment the grass block is the result of mixing plastic waste with cement and sand in a 3:1 ratio through the processes of melting, mixing, molding, immersing, and cooling. The result is a grass block with a hexagonal shape, length 20cm and high 20mm, with a compressive stress of 17.2 MPa for gardens and yards.

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