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ANALYSIS OF DIFFERENCES IN STRENGTH OF BRICKS MADE FROM PAMPERS WASTE AND PACKAGING PLASTICS THROUGH A CIRCULAR ECONOMY CONCEPT APPROACH

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Abstract

Waste management in Indonesia is still very undirected and we are still looking for the right solution regarding alternative solutions. One alternative solution for waste management is to manage the waste by turning it into useful items that have selling value. The alternative solution offered is to make brick products made from diapers and plastic packaging waste. This research aims to make 2 products with different compositions, then carry out composition test specimens and test the two brick products through compressive strength tests in the laboratory. After carrying out the process of making bricks with different compositions, a comparative study can be carried out using the One Way ANOVA method, and the F count or Critical F result is 4.00687, so F count ≥ F table means that H_1 is accepted (Composition A has a significant difference between Composition B). Composition A has a compressive strength test result for concrete bricks that is by SNI-15-2094-2000, namely 50 Kg/cm^2.

Keywords: pempers, Anova, waste, circular economy, bricks

1. Introduction

Issues related to public awareness of waste management are still very low in Indonesia. Waste management in Indonesia is still very undirected and we are still looking for the right solution regarding alternative solutions. One alternative solution for waste management is to manage the waste by turning it into useful items that have selling value. The implementation of this alternative solution is carried out so that the amount of community waste can be reduced in final disposal sites (TPA) and the waste components can be used repeatedly. This concept is commonly known as the 3R concept (Reuse, Reduce, Recycle) and uses a circular economy approach (Kristianto, et al., 2022).

This circular economy concept prioritizes methods for recovering existing waste and the productivity of that waste. The circular economy is also known as the circular economy, an alternative to the conventional linear economy which focuses on take, use, and waste. This cycle has a purpose (Karimah, et al., 2023). Having a circular economy can reduce negative impacts on the environment. The implementation of a circular economy in Indonesia aims to increase environmental resilience and the possibility of progress in understanding science and technology by utilizing human resources for global sustainability (Tessalonika & Sutjipto, 2023). Sustainable development is defined in the form of a three-pillar paradigm which shows aspects of life so that sustainability is achieved. These three pillars are economic, social, and environmental which are the keys to achieving goals.

The circular economy concept aims to target the efficient use of resources by utilizing waste and producing products that can be used over a long period while increasing economic growth in line with sustainable development goals. The circular economy is used as an effort to minimize waste and improve the environment by maximizing benefits between the economy and the environment (Kristianto & Nadapdap, 2021). This method also supports Sustainable Development Goals (SDGs) in increasing zero waste. The circular economy is very influential on the environment, one of which is knowing the productivity of waste and how it is recovered so that there will be several changes regarding the waste management system and waste cycle.

Baby diaper waste is one of the most common types of marine waste found. Based on data taken by Common Seas Indonesia, the proportion of inorganic waste thrown into rivers and oceans is 50% of baby diaper waste. Baby diapers occupy the largest amount of waste in the world, reaching 21% based on the 2020 Marine Plastic Debris survey. This baby diaper waste has many negative impacts on the surrounding environment and human health. Baby diapers contain human feces and urine so they can pollute sea and river water with Escherichia Coli (E. Coli) bacteria (Budiarto, et al., 2023).

Baby diapers are a primary need in caring for babies aged 0 – 3 years according to 71% of mothers in Indonesia. Disposable diapers are the biggest waste in developed countries where people still don't understand

how to manage baby diaper waste. The time used to decompose baby diaper waste is very long, namely 250 - 500 years for it to decompose completely (Prasetyo, et al., 2021).

It can be seen in Figure 1 that the composition of organic waste occupies the largest place, namely around 74%, after that plastic waste is 13%, paper is 0.5% and baby diaper waste is 7%. This data was taken directly at the Tempur Village Hall, Keling District, Jepara Regency (Rimantho, et al., 2022). On the other hand, the plastic in baby diaper waste will decompose into microplastics which are dangerous for the human body. This pollution will be found in the human body because it has polluted sea and river ecosystems, then the impact will reach the human body through baby diaper waste which can be eaten by fish and will be eaten again by humans through the food chain.

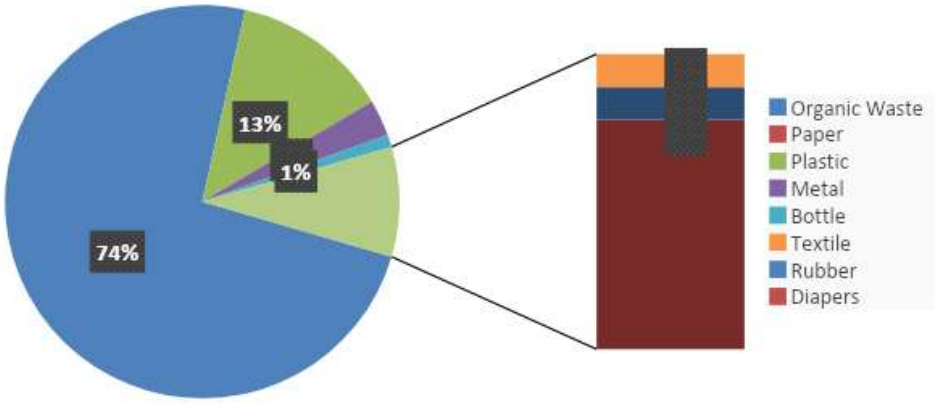

Figure 1. Composition of Waste in Tempur Village, Jepara Regency (Rimantho et al., 2022)

The basic material of the outer layer of baby diapers is coated with polyethylene, which is a synthetic polymer. Meanwhile, the inside of baby diapers is made from polypropylene. The absorbent part of this baby diaper is made from wood pulp treated with a polymer absorbent, so it has high absorbency. The absorbent part of baby diapers also contains polymer material, namely sodium polyacrylate, this material can interfere with breathing if inhaled (Perangin-angin et al., 2023)

From the problems above, it can be seen that Indonesia needs an alternative solution to recycle baby diaper waste which is still not paid enough attention by the public into products that provide added value. One way to use baby diaper waste as filler material for making bricks. From this alternative, it can reduce baby diaper waste scattered in the sea and rivers and can improve infrastructure in Indonesia by making environmentally friendly houses using filler material for making bricks from baby diaper waste (Perangin-angin et al., 2023).

According to the General Requirements for Building Materials in Indonesia (PUBI) article 6, brick is a brick composed of cement, water and sand and is usually used to make building walls. The brick making process greatly influences the strength of the brick. The bricks that are usually used in the construction of houses and buildings are box-shaped, the process of making these bricks is molded using a hand or a machine press. Bricks can be classified into normal and light bricks (Syauqiah et al., 2021).

This alternative solution for using baby diaper waste and plastic packaging waste is useful and profitable, apart from the free filler material used, this product also makes a big contribution to reducing the surge in plastic waste that pollutes the environment and can save human health. This product also does not produce waste again, because it uses all components from baby diapers. Thus, this research paper aims to present the idea of "using waste into value" from diapers and plastic packaging waste as material for making bricks as an implementation of a circular economy.

2. Material and methods

2.1. Material

The tools used in the brick-making process include cement spoons, molds, buckets as containers, gloves and masks as personal protective equipment (PPE), and sand filters. The process of making bricks can be divided into several stages, namely sorting the outer layer of baby diaper waste from baby diaper filling material, collecting plastic packaging waste, washing the two wastes that will be used, and then continuing with the process of making the bricks.

The raw materials include baby diaper waste, plastic packaging waste, water, sand, and cement. In the initial process, the raw materials in the form of waste will first be sorted out of the outer layer of baby diapers from the filling material for baby diapers, waste in the form of plastic packaging and the outer layer of baby diapers will be washed until clean. Then the waste that has been cleaned is cut into small pieces which can facilitate the process of mixing the raw materials. A comparison of the raw materials used in making bricks is in Table 1.

Table 1. Raw Material Composition

Material	Brick Composition A	Brick Composition B
Plastic packaging waste	1 kg	1 kg
Baby Diaper Waste	1 kg	1 kg
Cement	2 kg	1 kg
Sand	1 kg	1 kg

The next stage is that the raw materials are mixed together according to the composition ratio in Table 1. After being mixed together, the materials are put into a brick mold. Next, the mold will be naturally dried in the sun for 20 days to obtain the appropriate level of brick hardness. When the hardness level of the two bricks is appropriate and the raw material has dried, a concrete crushing test is carried out using the services of the Pancasila University Civil Engineering Laboratory.

2.2. Methods

The methods section following the introduction should clearly describe the experimental procedure and the rationale behind a particular experimental method (Setiawan et al., 2023). The methods section should be sufficiently complex that the reader can repeat the experimental procedures and reproduce the results . The scientific rigor of the paper is judged based on your materials and methods sections, so make sure you outline all the fine details of your experiments. Explain the procedure step by step by dividing the main section into subsections. Chronological order of procedures with subheadings. Use the past tense to describe what you did since you reported the completed experiment (Dermawan et al., 2022a). The methods section should explain how the research questions were answered and explain how the results were analyzed. Clearly explain the various statistical methods used for significance testing and the rationale behind the choices (Kuo et al., 2020).

The method used in this research is a literature study that looks for theoretical references relevant to the problem case or solution found. Furthermore, this literature study was developed into conducting research such as making composition test specimens and testing brick products through compressive strength tests, then the data was processed using the one way Analysis of Variance (ANOVA) method.

After making the brick product, it is continued by carrying out the Concrete Crushing Test thirty times. The results obtained in this concrete crushing test are the tension (Kg/Cm2) between the two materials using different ratios of raw material composition and weight. Then, the two stress data (Kg/Cm2) are compared to see which bricks comply with the minimum requirements for compressive strength of bricks SNI-15-2094-2000.

The One-way ANOVA method used is a comparative study, namely comparing the two compositions of brick A and brick B. The testing rules for one way Analysis of Variance (ANOVA) generally consist of the following two statements:

- If Fcount ≤ Ftable, then H_0 is rejected
- If Fcount ≥ Ftable, then H_1 is accepted

Where:
H0: Composition A is not significantly different from Composition B
H1: Composition A has a significant difference between Composition B

3. Results and discussion

3.1. Result

The following are the results of making the bricks and the characteristics of the two bricks have been obtained which can be seen in Table 2.

Table 2. Results of Batako Characteristics

No.	Test Date		Code	Age (Daysi)	Shape and Cross-sectional Area (Cm2)	Weight (gram)	Pressure load (Kn)
	Cast	Tested					
1.	11/08/2023	09/11/2023	A	90	Cube 4x4x4 L = 1600 mm^2	130	10,786

No.	Test Date		Code	Age (Daysi)	Shape and Cross-sectional Area (Cm2)	Weight (gram)	Pressure load (Kn)
	Cast	Tested					
2.	11/08/2023	09/11/2023	B	90	Cube 4x4x4 L = 1600 mm^2	152	9,806

Figure 2. Brick Product Results
Source: Personal Documentation

After the two brick products were made with different compositions, the concrete crushing test was carried out by taking samples thirty times. The parameter measured in this test is voltage (Kg/Cm2) which can be seen in Table 3.

Table 3. Concrete Crushing Test Results

	Voltage (Kg/cm^2)	
No.	Composition A	Composition B
1.	81,37	58,45
2.	81,25	58,31
3.	81,39	58,33
4.	81,27	58,38
5.	81,22	58,38
6.	81,39	58,45
7.	81,39	58,35
8.	81,35	58,43
9.	81,31	58,37
10.	81,24	58,32
11.	81,37	58,36
12.	81,23	58,43
13.	81,33	58,43
14.	81,39	58,31
15.	81,28	58,42
16.	81,37	58,32
17.	81,30	58,37
18.	81,28	58,44
19.	81,28	58,33
20.	81,22	58,30
21.	81,31	58,34
22.	81,27	58,36
23.	81,38	58,41
24.	81,25	58,34
25.	81,29	58,35

Voltage (Kg/cm^2)		
No.	**Composition A**	**Composition B**
26.	81,37	58,45
27.	81,25	58,31
28.	81,39	58,33
29.	81,27	58,38
30.	81,22	58,38

After obtaining the concrete crushing test results in Table 3, a statistical test was carried out using the one way Analysis of Variance (ANOVA) method to see and test the level of difference between composition A and composition B bricks. The results of the ANOVA test can be seen in Table 4 as follows.

Table 4. ANOVATest Results

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Composition A	25	1459,248	58,36992	0,002245
Composition B	25	2032,729	81,30916	0,003571

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6577,611	1	6577,611	2262011	8E-114	4,042652
Within Groups	0,139577	48	0,002908			
Total	6577,75	49				

Based on the results obtained from the One Way ANOVA test, it can be seen that the calculated F or Critical F is 4.00687. It can be seen that Fcount ≥ Ftable, then H1 is accepted, meaning that Composition A has a significant difference between Composition B. Composition A has a compressive strength test result for concrete blocks that is in accordance with SNI-15-2094-2000, namely 50 Kg/Cm2. The long-term advantages of the alternative solution of using baby diaper waste as filler material for making environmentally friendly bricks include:

a. This brick product is made from baby diaper waste so this product has the potential to provide economic benefits at the production process stage.
b. This brick product does not produce waste because the product will be used to make building foundations, and the gel from baby diapers will be used as a planting medium.
c. This product can be one of the newest ideas and innovations for infrastructure in Indonesia.
d. Availability of manufacturing fillers that are easy to obtain and available in sufficient quantities.

Apart from that, the long-term impact of this alternative solution for processing baby diaper waste into filler material for making bricks creates the availability of bricks that are more easily accessible at an economical price and with easy access to accommodation too. This method of utilizing waste will also encourage the emergence of small-scale economic activities that can help society from an economic perspective and economic activities will always develop over time so that they can solve the problem of increasing baby diaper waste in Indonesia.

3.2. Discussion

Conventional materials that are widely used in the construction process, such as concrete bricks, hollow blocks, solid blocks, pavement blocks and floor tiles, are produced from naturally available natural resources. This results in environmental defragmentation due to massive exploration and leads to the depletion of existing natural resources. In addition, various types of harmful substances such as high concentrations of carbon monoxide, sulfur and nitrogen oxides, and suspended particulates are released excessively into the open

atmosphere during the operation and manufacturing stages of materials. These emissions have a toxic impact on the environment and disrupt the function of the air environment, natural water resources, large areas of land, large flora species, fauna species and aquatic biota, and have an impact on human health and their standard of living (Dhanalaxmi, et al., 2019).

Therefore, varying concentrations in the environment can cause atmospheric degradation. To improve sustainability and environmental conservation and has become important in society in recent years. Due to the greater increase in the use of sustainable, low cost, environmentally friendly and lightweight construction materials in civil works it has been emphasized to be investigated as the need increases, to improve environmental quality and to maintain material requirements according to standards.

The world is facing a serious overpopulation crisis. In recent years, various types of by-products produced from various sources such as commercial, household, industrial, hospitals, public places, etc. have accumulated in very large quantities. Due to the explosion and pollution is generated. To improve the problem of environmental degradation and regular disposal of large quantities of solid waste.

The unprecedented increase in demand for a limited supply of resources calls into question our current economic system, which is largely linear. In a linear resource consumption model, new resources are continuously extracted and used as input for the production of goods, which are taken out of the cycle and discarded at the end of their productive use. To remain within planetary boundaries, economic activity must be separated from resource extraction and environmental degradation, requiring substantial improvements in resource performance.

In this context, the concept of a circular economy (CE) is rapidly attracting attention as a way to decouple growth from resource constraints. This aims to minimize material input and waste generation by recycling and reusing products and materials as well as by product design that saves resources. Through recycling, waste is transformed into a resource and production input. This approach looks at the entire life cycle of a resource – from raw material extraction to product design, production and consumption, to waste management, such as collection and recycling. In reducing resource consumption, there are two main strategies: using fewer materials by increasing resource efficiency and waste prevention through better environmentally friendly design of products and processes, and using materials more than once by increasing the use of secondary raw materials through improved sourcing. power and recycling.

Some aspects such as material damage testing have not been investigated based on the results of material testing that has been carried out. If physical and mechanical qualities are markedly reduced due to aging, weathering, or use, additional studies and testing are required. Textiles experience damage in the field and the use of post-consumer goods results in fluctuations in the quality of textile waste. This variability may impact component characteristics and require additional investigation. In addition, special use situations should have less stringent limitations. These incidents are non-structural in nature and do not cause concern within the building or have the ability to injure anyone. The glue used in this research is to increase the adhesion of textile waste to other materials used in panels or bricks.

Further studies are needed regarding complementary elements to improve the composition of construction materials. Pampers and plastic packaging waste can be used in cement formulations as a substitute for cement binders. Additional investigations can be carried out into alternative binders that do not reduce the characteristics of the building material.

4. Conclusion

Baby diaper waste and plastic packaging are one of the most common types of marine waste found. Therefore, one alternative solution is to use this waste as a filler for bricks that is environmentally friendly and has easily accessible materials for making it. After carrying out the process of making bricks with different compositions, a comparative study can be carried out using the One Way ANOVA method and the F count or Critical F result is 4.00687, so F count ≥ F table means that H1 is accepted (Composition A has a significant difference between Composition B). Composition A has a compressive strength test result for concrete bricks that is in accordance with SNI-15-2094-2000, namely 50 Kg/Cm2. The long-term impact of this alternative solution for processing baby diaper waste into filler material for making bricks creates the availability of bricks that are more easily accessible at an economical price and with easy access to accommodation too. This method of utilizing waste will also encourage the emergence of small-scale economic activities that can help society from an economic perspective and economic activities will always develop over time so that they can solve the problem of increasing baby diaper waste in Indonesia.

Credit authorship contribution statement

Donna Mayvinasari: Conceptualization, Writing – review & editing. **Leonita Prita Eliza**: Supervision, Writing – review & editing. **Kristina Maharani**: Conceptualization, Writing – review & editing. **Dino Rimantho**: Supervisor, Conceptualization, Writing and review.

Declaration of Competing Interest

The authors hereby declare that there are no financial needs or personal relationships between members that could influence the creation of this article. In creating this article the authors worked collaboratively.

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