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USE OF CONSTRUCTION WASTE IN MANUFACTURING ENVIRONMENTALLY FRIENDLY CONCRETE BRICKS

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ABSTRACT

The purpose of this research is to evaluate the potential of construction waste generated by the construction industry as an alternative raw material in the manufacture of environmentally friendly concrete bricks. Research the method and process of concrete brick production using construction waste as the main raw material. Analyze the physical and mechanical properties of concrete bricks produced from construction waste and compare them with conventional concrete bricks. The approach used in this research is an integrated qualitative-quantitative approach. The qualitative approach was used to identify the characteristics and physico-chemical properties of the construction waste used. Meanwhile, the quantitative approach was used to test the quality of the concrete bricks produced. This research used an experimental design. Experiments were conducted in a construction laboratory with strict control of the variables that can affect the quality of concrete bricks. The result of this study is that the utilization of construction waste in the manufacture of environmentally friendly concrete bricks has been shown to enable a reduction in the use of natural raw materials and reduce the environmental impact of concrete brick production. The use of construction waste affects the quality of concrete bricks, including strength, durability, and other physical properties. This research provides an in-depth insight into how to optimally utilize construction waste without compromising product quality. The use of construction waste in concrete brick production can reduce the carbon footprint and other environmental impacts, helping to promote more sustainable construction practices.

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1. INTRODUCTION

Construction development is an important activity in the development of a country. However, the construction process also generates waste that can have a negative impact on the environment. Construction waste such as concrete powder, stone powder, and other wastes are generally thrown away, causing an increase in the amount of waste and environmental pollution.

In recent years, awareness of the importance of environmental protection has increased. Environmentally friendly building materials are becoming a major concern in the construction industry. One approach that can be taken is to utilize construction waste as raw materials for making concrete bricks.

The use of construction waste in making concrete bricks can provide multiple benefits. First, it reduces the amount of construction waste disposed to landfills, thereby reducing the negative impact on the

environment. Secondly, using construction waste as raw material can reduce the use of additives that are potentially damaging to the environment.

However, there is still a lack of research that comprehensively examines the utilization of construction waste in the manufacture of environmentally friendly concrete bricks. Therefore, this study aims to investigate the potential use of construction waste as a raw material in the manufacture of environmentally friendly concrete bricks. The research will involve analysis of the composition of construction waste, characterization of the concrete bricks produced, and evaluation of the performance of the concrete bricks in terms of strength, durability, and sustainability.

This research is expected to provide further understanding of the potential and advantages of utilizing construction waste in the manufacture of environmentally friendly concrete bricks. The results of this study are expected to serve as a reference for the construction industry in developing sustainable solutions to reduce negative impacts on the environment.

According to Yahya and Boussabaine (2004), waste is defined as unused material that results from the construction process. Construction projects are huge generators of solid waste. Construction waste is leftover materials, unused materials or materials that are no longer needed during the construction, renovation or demolition of a work or infrastructure. Construction waste can be a variety of materials, such as concrete, stone, wood, metal, glass, plastic, building materials, ceramics and more.

Construction waste can be divided into two main categories, namely new construction waste and demolition waste. New construction waste includes leftover materials that are not used during construction, such as leftover concrete, ceramics, and bricks. Meanwhile, demolition construction waste is material arising from the demolition or renovation of buildings, such as concrete rubble, scrap wood, or construction debris. Construction waste can become an environmental problem if not managed properly. Waste that is not disposed of properly can pollute the soil, water and air. Therefore, it is important to implement responsible construction waste management practices, such as recycling usable materials, selecting environmentally friendly materials, and disposing of waste in accordance with applicable environmental regulations.

Some studies have different definitions of construction waste depending on the type of construction work and sampling method. According to Khairulzan Yahya, & A. Halim Boussabaine (2004), construction material waste refers to materials from construction sites Construction work that cannot be used for construction purposes should be liquidated for the following reasons. Construction waste is defined as anything that is unused and is the result of a large number of construction processes negatively impacting the environment. These materials can be stone, concrete, coal, roofing, electrical installations and so on. Waste construction materials are generated in every construction project, both construction projects and demolition projects (construction and collapse). As also pointed out by Firmawan (2006), most of the indicators influencing the cause of material cost differences are the purchasing process, not including transportation, storage or use of materials.

Construction waste can have a significant impact on the environment if not managed properly. Here are some of the impacts that can arise from poorly managed construction waste:

1. Soil and water pollution: If construction waste is disposed of carelessly or not managed properly, soil and water pollution can occur. Hazardous chemicals, such as hazardous paints or construction waste containing toxic substances, can seep into the soil and contaminate ground or surface water sources. This can disrupt aquatic ecosystems, threatening plant, animal and human life that depend on these water sources.
2. Damage to natural ecosystems: Disposal of construction waste in natural areas such as forests, rivers, or wetlands can cause damage to natural ecosystems. Non-degradable construction materials, such as plastic, metal, or concrete, can impede water flow, disrupt wildlife, or destroy natural habitats.
3. Increased greenhouse gas emissions: The production and disposal of construction waste can lead to increased greenhouse gas emissions. For example, the production process of cement used in concrete produces significant CO2 emissions. In addition, poorly managed incineration of construction waste can also result in toxic and hazardous gas emissions.

Concrete brick as a building material for wall masonry is made by compaction of a mixture of aggregate and Portland cement (Heinz Frick and Ch. Koesmartadi, 1999). Concrete brick is a kind of brick-like building element made from the main ingredients of Portland cement, water and aggregate for wall use.

The molding is done so that it meets the requirements and can be used for wall mounting (SNI 03-0349-1989). According to SNI 03-0349-1989, concrete bricks are divided into 2 types, namely:

4. Solid concrete bricks are concrete bricks with a solid cross-section width of 75% or more of the total cross-section and solid volume makes up more than 75% of the total brick volume.
5. Hollow concrete brick is a concrete brick with a large cross-section of the hole cross-section greater than 25% of the brick cross-section and has a hole volume of more than 25% of the total brick volume. Based on solid concrete brick or perforated concrete SNI 03-0349-1989 classified according to quality level

Concrete bricks are construction materials made from a mixture of fine aggregate, coarse aggregate, cement, and water. The following is the general composition and properties of concrete bricks:

1. Composition.
    - Fine aggregate: Concrete bricks generally use sand as fine aggregate. This sand acts as a filler and provides structural strength to the concrete bricks.
    - Coarse aggregate: Coarse aggregate in concrete bricks can be gravel, broken stone, or similar materials. Coarse aggregate provides mechanical strength and dimensional stability to the concrete brick.
    - Cement: Portland cement is the main binding agent in concrete bricks. Cement is used to connect fine aggregate and coarse aggregate into a solid structure.
    - Water: Water is used in the stirring and hardening process of concrete bricks. The right proportion of water should be considered to achieve the desired consistency and strength.

2. Properties
    - Mechanical strength: Concrete bricks have high compressive strength, which provides good structural bearing capacity. The strength of concrete bricks depends on the proportion and type of materials used in the mix.
    - Resistance to pressure: Concrete bricks have good resistance to compressive loads. This makes it suitable for use in the construction of structures that require high stability and strength.
    - Weather resistance: Concrete bricks generally have good resistance to extreme weather and temperature changes. This makes it suitable for use in a wide range of climatic conditions.
    - Fire resistance: Concrete bricks have good fire resistance properties. This makes it a safe choice for use in areas with high fire risk.
    - Dimensional stability: Concrete bricks have good dimensional stability, meaning they tend to maintain their shape and size over time.
    - Thermal and acoustic insulation: Concrete bricks have good thermal and acoustic insulation properties. They are able to reduce heat and sound transfer between rooms.

The properties of concrete bricks may vary depending on the proportion of materials, processing methods, and other special treatments during production. Keep in mind that the composition and properties of concrete bricks can be adjusted and optimized to meet specific needs in various construction applications.

Eco concrete bricks have several advantages that make them a good choice for sustainable construction. Here are some of the advantages of eco-concrete bricks:

1. Recycled raw materials: Concrete bricks can be produced using recycled raw materials, such as concrete construction waste or building debris. This reduces the use of limited natural resources and reduces the amount of construction waste that goes to landfills.
2. Energy efficiency: Concrete bricks have good thermal insulation capabilities, which means they can help keep indoor temperatures stable. This reduces the need for additional heating or cooling, thereby reducing energy consumption and associated greenhouse gas emissions.
3. Durable: Concrete bricks have a long service life and are resistant to extreme weather, moisture, pest infestation and fire. Due to good durability, concrete bricks require little maintenance and replacement, reducing construction waste and resource consumption associated with repairs and renovations.

The utilization of construction waste in the manufacture of concrete bricks is an environmentally friendly and sustainable approach. By using construction waste as raw materials, it can reduce the use of limited

natural resources and reduce the amount of waste disposed of in landfills. Here are some ways of utilizing construction waste in concrete brick making:

1. Utilization of concrete waste: Concrete waste, such as concrete fragments, broken concrete blocks, or used concrete, can be used as coarse aggregate in concrete brick making. These coarse aggregates will be mixed with cement and water to form strong and durable concrete bricks. Thus, concrete waste is not only recycled, but also reused in construction.
2. Utilization of ceramic waste and bricks: Ceramic waste, such as broken tiles, and used bricks can be crushed into powder or fine aggregate which is used as filler material in concrete bricks. This helps to reduce the amount of ceramic and brick waste being disposed of and adds value to the concrete bricks produced.
3. Utilization of wood waste: Wood waste, such as scrap boards, pallets, or construction timber, can be crushed into wood powder that is used as filler material or reinforcing fibers in concrete bricks. These wood powders can improve the thermal and acoustic insulation of concrete bricks and reduce the need for other fillers.

The utilization of construction waste in the manufacture of concrete bricks can affect the quality of the concrete bricks. This effect can vary depending on the type of waste used, the proportion of waste in the mix, and the treatment method used. The following are some of the effects that can occur:

1. Mechanical strength: The utilization of construction waste in concrete bricks can affect its mechanical strength. In general, construction waste such as broken concrete or used bricks can be used as coarse aggregate in concrete brick mixes. The proportion and quality of waste used will affect the compressive strength and tensile strength of concrete bricks. In some cases, the use of construction waste can increase the strength of concrete bricks, especially if the waste has good mechanical properties.
2. Dimensional stability: The utilization of construction waste in concrete bricks can also affect the dimensional stability of the final product. The composition of waste in the mix can affect the dimensional changes of concrete bricks during the drying and hardening process. Therefore, it is necessary to carefully test and adjust the proportion of waste to ensure good dimensional stability.
3. Thermal and acoustic properties: Certain types of construction wastes, such as wood powder or glass powder, can be used as filling materials in concrete bricks. The utilization of these wastes can affect the thermal and acoustic properties of concrete bricks. Wood powder can improve the thermal and acoustic insulation of concrete bricks, while glass powder can improve the density and sound resistance. In this case, the utilization of construction waste can improve the quality of concrete bricks in terms of insulation and environmental comfort.

2. RESEARCH METHOD

In this section, the researcher will discuss in detail the research design used to investigate the utilization of construction waste in the manufacture of environmentally friendly concrete bricks. The research design is key to ensuring the validity and reliability of the research results. The approach used in this research is an integrated qualitative-quantitative approach. The qualitative approach was used to identify the characteristics and physico-chemical properties of the construction waste used. Meanwhile, the quantitative approach was used to test the quality of the concrete bricks produced. This research used an experimental design. Experiments were conducted in a construction laboratory with strict control of the variables that can affect the quality of concrete bricks. The population in this study was all types of construction waste commonly used in construction projects. Samples were taken from two different locations considering the different characteristics of construction waste. Data were obtained through direct observation of the construction waste and the resulting concrete bricks. In addition, data was also collected through laboratory testing using compressive strength and water absorption testing equipment. Data obtained from laboratory testing will be analyzed using descriptive statistics. The results of the analysis will be presented in the form of graphs, tables, and diagrams to facilitate interpretation.

3. RESULTS AND DISCUSSIONS

Construction waste can consist of various types of materials such as concrete, wood, metal, plastic, glass, and others. These types of materials will affect how the waste is managed. Construction waste is often large in volume, especially if the construction project is large-scale. This can require efficient management and removal. Construction waste is often a mixture of different types of materials, requiring separation and treatment before it can be recycled or disposed of. Some construction waste can be potentially hazardous if not managed properly, such as hazardous waste like lead-based paint, asbestos, or hazardous chemicals. Many materials in construction waste can be recycled, such as concrete and metals. This can help reduce environmental impact and disposal costs. Construction waste can vary greatly in weight and size, ranging from small fragments to large structures such as beams and panels. If not managed properly, construction waste can contaminate soil and water, especially if there are hazardous chemicals in the waste. Transportation of construction waste from construction sites to disposal sites also requires special attention to ensure safety and legal compliance.

It is important to properly manage construction waste to minimize environmental impacts and human health risks. This involves segregation, collection and disposal in accordance with applicable regulations and best practices. In addition, efforts to recycle construction waste can help reduce the amount of waste that ends up polluting the environment.

In the production of eco-friendly concrete bricks, several types of construction waste can be used as the main raw material. The following are some of the types of waste that are commonly utilized in the manufacture of Eco-Friendly Concrete Bricks:

1. Concrete Rubble and Used Brick.Concrete debris and used bricks in question are debris waste resulting from renovated and demolished buildings or used brick waste that can still be reused after the separation and cleaning process can also be used as raw materials in the manufacture of these environmentally friendly concrete bricks.
2. Replacement of construction materials. Construction materials such as bricks, tiles, or wooden beams that are no longer used in construction projects.
3. Concrete powder and mortar. Leftover concrete powder and mortar from previous projects can also be reused as raw materials for making eco-friendly concrete bricks.
4. Unused concrete.
5. Used asphalt
6. Composite Materials. Composite materials are a set of materials made of two or more materials that remain separate and distinct at the macroscopic level while forming a single component. The composite material used in the process of making eco-friendly concrete bricks is concrete mix plastic.
7. Recycled waste materials. Recycled waste materials are construction materials that have gone through a recycling process, such as recycled bricks or recycled concrete that can be reused as raw materials for the manufacture of environmentally friendly concrete bricks.

The important thing in the production of green concrete bricks is to select the right construction waste and ensure that it is properly treated and prepared before being used in the production of concrete bricks. This will ensure that the raw materials used meet the quality standards required to create high quality environmentally friendly concrete bricks.

Making eco-friendly concrete bricks involves a series of steps designed to reduce the environmental impact of concrete brick production. Here are common ways to make eco-friendly concrete bricks:

1. Selection of Environmentally Friendly Raw Materials. Choose raw materials that have a lower environmental impact. This includes using more environmentally friendly types of cement, such as carbon-reduced cement or using recycled industrial waste in the mix.
2. Concrete Mix Optimization. Concrete mix design should be optimized to reduce material and energy use. This involves using environmentally friendly additives, such as fly ash or slag as a partial replacement for Portland cement.
3. Use of Recycled Aggregates. Recycled aggregates from construction waste or other industries can be used as a partial replacement for natural aggregates.
4. Reduced Water Use. Optimizing concrete mixes to reduce water demand can help reduce environmental impact.

5. Use of Efficient Production Technology. Choose production machinery and equipment that are more efficient in the use of energy and resources.
6. Environmental Monitoring and Measurement. Implement a monitoring system to measure the environmental impact of concrete brick production. This involves monitoring CO2 emissions and other impacts.
7. Recycling Production Waste. The concrete brick production process can generate waste, such as dust and debris. Make sure to recycle or manage these wastes properly.
8. Waste Water Management. The wastewater management of the concrete brick production process must meet environmental standards to avoid water pollution.
9. Environmental Certification and Standards. Ensure that the concrete brick production process complies with applicable environmental standards and certifications.
10. Staff Engagement and Environmental Education. Involving staff in sustainability efforts and providing training on green production practices can help ensure optimal awareness and engagement.

The testing and analysis of concrete bricks in the context of the thesis "UTILIZATION OF CONSTRUCTION WASTE IN THE MAKING OF ECO-FRIENDLY CONCRETE BRICKS" can involve various parameters and testing methods to ensure that the concrete bricks produced meet quality standards and are environmentally friendly. The following will explain a little about the testing and analysis used in this thesis:

1. Testing the Compressive Strength of Concrete Bricks:
   a. Test method: Standard compressive tests are performed on concrete brick specimens to determine the characteristic compressive strength. The standard normally used is ASTM C39 or equivalent.
   b. Objective: Ensure that the concrete brick meets or exceeds the established compressive strength requirements for the particular application.
2. Raw Material Composition Analysis:
   a. Method of analysis: Use of chemical or spectroscopic analysis techniques to determine the composition and concentration of raw materials, including construction waste used.
   b. Objective: To understand the contribution of raw materials to the physical and mechanical properties of concrete bricks.
3. Water Absorption Testing:
   a. Test method: Water absorption test to determine the ability of concrete bricks to absorb water. Standards such as ASTM C140 can be used.
   b. Objective: To assess the extent to which concrete bricks can retain water and prevent damage due to excessive absorption.
4. Testing of Compressive Strength After Aging:
   a. Test method: Testing compressive strength after the concrete brick has undergone aging or freeze-thaw cycle or others.
   b. Objective: To understand how concrete bricks perform after being subjected to extreme environmental conditions or aging.
5. Repeated Heating and Freezing Testing:
   a. Test method: Tests to determine the extent to which concrete bricks withstand repeated changes in temperature.
   c. Objective: To ensure that concrete bricks will not suffer significant degradation or damage due to temperature fluctuations.
6. Microstructure Analysis:
   a. Analysis method: Use of electron microscope or polarizing microscope to examine the microstructure of concrete bricks.
   b. Objective: To understand the relationship between microstructure and mechanical properties of concrete bricks.
7. Analysis of Environmental Characteristics:
   a. Evaluate the environmental impact of the concrete bricks produced using life cycle analysis methods or other environmental assessment methods.

8. Economic and Social Analysis:
    a. Examine the economic and social aspects of the production and use of green concrete bricks, including production costs, profits, and social benefits.

Green concrete bricks have a number of special characteristics that distinguish them from conventional concrete bricks. Here are some of the main characteristics of green concrete bricks:

1. Use of Construction Waste: The main raw material of eco concrete bricks is construction waste or recycled materials, such as waste concrete, bricks, or other unused construction materials.
2. Reduction of Environmental Impact: The production of green concrete bricks reduces the consumption of natural raw materials and reduces construction waste, which can reduce environmental impact and help reduce carbon footprint.
3. Better Indoor Air Quality: Eco concrete bricks tend to have lower VOC (volatile organic compound) emissions than conventional bricks, which can affect indoor air quality.
4. Heat and Sound Insulation: Depending on the mix formulation and production method, green concrete bricks can have good thermal and acoustic insulation properties.
5. Buildable Strength and Durability: Despite being made from construction waste, eco concrete bricks should still meet the strength and durability requirements needed for specific construction applications.
2. Limited Water Usage: The production process of green concrete bricks can require less water than conventional brick production, reducing water consumption and its impact on the environment.
3. Sustainable Production Process: Production methods should consider sustainable practices, including low energy use, waste reduction, and scrap management.
4. Compatibility with Environmental Standards: Green concrete bricks should meet or exceed applicable environmental standards and regulations in the region or country where they are produced and used.
5. Continuous Innovation and Research: The industry should continue to conduct research and development to improve the performance and properties of green concrete bricks, including the discovery of new mix formulations and more efficient production methods.
6. Recyclability and Reuse: Green concrete bricks should be designed to be recyclable or reusable after use, reducing construction waste and extending their useful life.

These characteristics are important aspects that should be considered in the development and use of green concrete bricks to ensure that they meet sustainable and environmental goals.

The following is a comparison between eco-friendly concrete bricks and conventional concrete bricks. Eco-friendly Concrete Bricks:

1. Raw Materials. Using construction waste or recycled materials, such as waste concrete, bricks, or other unused construction materials.
2. Environmental Impact. Reduced environmental impact due to using recycled raw materials, reduced use of natural resources, and reduced production of construction waste.
3. Indoor Air Quality. Tends to have lower VOC (volatile organic compound) emissions than conventional concrete bricks.
2. Thermal and Acoustic Insulation. Can have good thermal and acoustic insulation properties, depending on the mix formulation and production method.
3. Strength and Durability. Can meet the strength and durability requirements needed for specific construction applications.
4. Water Usage. Requires less water during the production process compared to conventional concrete bricks.
5. Production Process. Requires sustainable production methods, including low energy use, waste reduction, and residual production management.
6. Compatibility with Environmental Standards. Meet or exceed applicable environmental standards and regulations in the region or country where they are manufactured and used.
7. Recycling and Reuse. Designed to be recycled or reused after use, reducing construction waste and extending their useful life.

Conventional Concrete Bricks:

1. Raw Materials. Uses conventional concrete raw materials, such as Portland cement, sand, and gravel.

2. Environmental Impact. Requires the use of significant natural resources and may generate more construction waste.
3. Indoor Air Quality. Can have higher VOC emissions, depending on the type and formulation of the mixture.
4. Thermal and Acoustic Insulation. May have lower thermal and acoustic insulation properties compared to eco concrete bricks.
5. Strength and Durability. Meets the strength and durability requirements needed for specific construction applications.
6. Water Usage. The production process may require more water.
7. Production Process. The production process may involve using more energy and generating more waste.
8. Compatibility with Environmental Standards. Must comply with applicable environmental standards and regulations.
9. Recycling and Reuse. Not always designed to be recycled or reused easily.

Taking these differences into account, eco concrete bricks have the potential to provide a more sustainable and environmentally friendly alternative in construction. However, it is important to consider the requirements and needs of a particular construction project before choosing which type of concrete brick to use.

Environmental Analysis with Economics

1. Environmental Efficiency. Green concrete bricks can show better environmental efficiency compared to conventional concrete bricks. This can be seen in the more efficient use of natural resources and the reduction of carbon emissions during production.
2. Long-term Cost Savings. In the long run, the use of green concrete bricks can result in operational cost savings through higher energy efficiency and reduced maintenance and upkeep costs.
3. Economic Benefits of Energy Efficiency. Green concrete bricks can provide economic benefits from higher energy efficiency, reducing utility costs in the long run.
4. Reduction in Overall Environmental Impact. Analysis can show that green concrete bricks have a lower overall environmental impact, especially when their entire life cycle is considered.
5. Positive Return on Investment (ROI). Although the initial investment may be higher, the ROI from using green concrete bricks may be higher in the long run, especially when considering the operational cost savings.
6. Improved Reputation and Regulatory Compliance. Using green concrete bricks can enhance a company's reputation and meet stricter environmental regulatory requirements.
7. Positive Social Impact. The use of green concrete bricks can also provide additional social benefits, such as creating jobs or improving the quality of life of local communities.
8. Risk Factors and Management Measures. The analysis may also identify associated risk factors, such as price fluctuations of recycled raw materials or untested product performance. Management actions may be proposed to address these risks.

4. CONCLUSION

The result of this study is that the utilization of construction waste in the manufacture of environmentally friendly concrete bricks has been shown to enable a reduction in the use of natural raw materials and reduce the environmental impact of concrete brick production. The use of construction waste affects the quality of concrete bricks, including strength, durability, and other physical properties. This research provides an in-depth insight into how to optimally utilize construction waste without compromising product quality. The use of construction waste in concrete brick production can reduce the carbon footprint and other environmental impacts, helping to promote more sustainable construction practices. This study highlights the need for continued research and development to improve mix formulations, production techniques, and final product quality in an effort to maximize environmental benefits.

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