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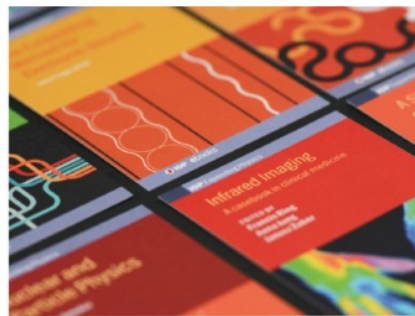
The Utilization of Bamboo Innovation as Aggregate Substitute for Paving Block

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Abstract. The paving block is part of pavement system that is widely used by people in Indonesia. Paving blocks are common in urban and rural communities. Paving blocks are very easy to make and easy to apply. Standard way of making a paving block based on SNI 03-0691-1996 method is a mixture of cement, sand/gravel and water. Excessive use of natural materials has an impact on the sustainability of the natural environment. This problem can be solved with various innovations without having to reduce the quality of paving and the pavement itself. Wiwoho, M. S., et. al., [1][2] has conducted preliminary research using bamboo materials instead of aggregates. Whilst Bamboo trees are fast-growing plants and are widely used as merely buffer buildings. So, Bamboo waste materials have not been used optimally enough. The methodology used is that unused bamboo materials being cut in to the size of the required model. The use of bamboo material as a mixture in paving block has adjusted the size, and its composition. The result of this research is that paving blocks made from bamboo trees can meet SNI 03-0691-1996 standard with D quality. Thus, paving blocks can meet eligibility requirements, reasonably enough.

1. Introduction

Indonesia is one of the developing countries and has the largest population in the world. Housing needs are a problem for the people. Creativity and skills become one of the capital to answer challenges. Increasing population and increasing the need for vehicles as a means of transportation. Transportation facilities require road infrastructure. Road infrastructure consists of flexible pavement and rigid pavement. While in housing there are many pavements in the form of paving blocks. There are three types of pavement design systems, flexible pavements, paving blocks and rigid pavements. these three pavement systems have their own advantages and disadvantages. Paving blocks are part of road pavement that have been widely used in Indonesia. Paving blocks are easy to make, easy to apply

and prices are quite affordable among the public. Various uses of paving blocks, ranging from parks, yards, sidewalks, roadways and highways according to the quality of SNI standards. Various kinds of innovations have been made in the manufacture of paving blocks[3]. This research aims to make the innovation of Bamboo paving blocks with Bioaditive additives.

2. Literature Review
1. Paving Block
Paving blocks are generally used for small roads or road vehicles and if their use for many services, fractional or surface recovery problems can be minimized[4].
2. Classification of Block Paving based on the way it is made
Based on the way of making Paving block can be classified into several types, namely:
a. Manual Press/ Hand
Pavingblock Press Manual / Hand produced manually by hand. This type of paving block includes class D concrete type (K50-100). In accordance with its low quality, this type of paving has a low selling value. While for its use, manual press paving blocks are generally used for non-structural stresses, such as yard, sidewalk, and environmental damage with low loads[5].
b. Press the Vibras / Vibrating Machine
Paving block type is produced with press machine Getard system and generally have concrete cement class C-B (K150-250). In its use Paving Block Press Vibration Machine is widely used as an alternative to pavement plate in the house and land parking lot.
c. Press Machine Hydraulic
Paving type is produced with the manufacture of using hydraulic press machines with compressive strength above 300kg / cm². Paving block press hydraulic can be categorized as paving block with mutton grade B-A (K300-450). The use of paving type can be used for nonstructural purposes or for structural purposes which function for heavy weight blocks above, such as: road area up to a heavy terrain over a container in the port[6][7].
Classification of Paving Block Based on Mutudan its use
Based on SNI 03-0691-1996 paving block (concrete brick) [8][9] is a composition of building materials made from a mixture of portland cement or similar hydraulic adhesive materials, water and aggregate with or without other materials that do not reduce the quality of concrete brick.

Table 1. Standard SNI paving block

Type	StrongPress (mPa *)		ResilientAus		Water Absorption
	Average	Minimum	average	Minimum	(Average Max.)
A	40	35	0,090	0,103	3
B	20	17	0,130	0,149	6
C	15	12,5	0,160	0,184	8
D	10	8,5	0,219	0,251	10

Paving blocks with good quality are paving blocks which have high pressure strength (MPa units), as well as a low absorption rate (percentage of water absorption) (%). Therefore, the type of quality characteristics studied is larger the better for strong pressure, and smaller the better for the percentage of water uptake.

The higher the value of the strong pressure, then the better paving block will be. Whereas, for the percentage of water absorption (absorption), the lower the absorption value, then the stronger of the paving block product is. Based on SNI 03 - 0691 – 1996 [8], paving blocks with the lowest quality (quality D) at least have a strong pressure of 8.5 MPa and a maximum percentage of water absorption - an average of 10%. Through the design of the level setting on the top layer paving block with additional ingredients of rice husk ash is expected to increase the strong pressure value and reduce the percentage value of its water uptake[10][11][12]–[14].

4. Based on SNI 03-0691-1996, the requirements of the subatablon paving blocks as follows:
a) Visible Character
Concrete bricks are required to have a flat surface, there are no cracks and defects, the corners and ribs are not easily trimmed with the strength of the fingers
b) Size
The shape and size of concrete brick for the floor can depend on the agreement between the consumer and the manufacturer. Minimum nominal thickness size of 60 mm with a tolerance of ± 8%
c) Physical properties
Concrete brick for the floor must have physical strength as shown in the table below.
d) Resistance to sodium sulfate
Concrete bricks are tested. Not allowed to be disabled, and maximum allowable weight loss of 1%

Bamboo

Bamboo is a bundle of grass (perennial grass) with woody stems[15][16], in other words, anatomy is very thick with wood. Tissue tissue consists of cells in the vascular cavity (which are rich in reeds). They are composed of reeds, fiber fibers with thick walls and pipes which are fibers that provide strength to the leaves. The use of aggregates can give the consequence of reduced strength and pressure, because they have a number of uses and the ability to expand shrinks the high strength of the structure to a lesser extent than conventional aggregates. In order to anticipate the decline of the farther due to the limitation of the strength of the power, the size of the beak is made with a small shape to have a more volume[17][18].

Bamboo has a water absorption rate of around 15-20% and the ability to expand and shrink so that it needs to be taken into account the amount of water in the paving mixture, which does not damage the chemical process of cementing water with water during the hydration process[1][19].
On the test of the stress used in the formula:
Compressive strength = P / L (1)
Information :
P = compressive load, N
L = area width press mm2
Water absorption is calculated as follows
Water absorption = (A-B) / B × 100 (2)
Information :
A = weight of ordinary concrete brick
L = weight of dry concrete bric

3. Methodology

This research is an experiment, by doing different techniques and types of treatment in each variable group of research, The initial implementation with inspection on the material of paving block making consists of sand, cement, Bio-additive, and water. The results are analyzed to determine the proportion of concrete mixture[20][21].
Smooth Aggregate Gradation

Figure 1. Sand

The aggregate gradation is the grain size distribution of the aggregate. If aggregate grains have the same size (uniform) pore volume will be large. Conversely, if the grain size varies, there will be a small pore volume. This is because small grains fill the pores between large grains, so that the pores are small, in other words, the density is high. In the study the fan will be used to be combined in a normal position in normal circumstances. The water content for the SSD condition was obtained at 4.2%.

Cement

Figure 2. Cement

The cement used is the Gresik Portlandtozzolan Cement (PPC) brand cement.
According to Arnoldus[5], cement that is commonly used is Portland cement, namely hydraulic cement produced by grinding clinker consisting of hydraulic silicates which are hydraulic and cast material as a useful additive as a cement reaction retarder.

Bamboo

Figure 3. Bamboo

In the process of making bamboos, bamboo waste is obtained from unused former formworks. The cuttings are cut as needed with a length of 1 to 1.5 cm, thin about 5 mm.

Bio-additive (bioconc)

Figure 4. Bio-additives (bioconc)

The use of bio-additives is the Bioconc Brand bio-enzyme from the Bioconc Foundation Center.

Customized needs

Table 2. Normal Paving Mix Design (PN)

Material	Composition (%)
Sand	69,5
Cement	30
Water	0,5

Table 3.Paving Mix Design with Bambu + Bioconc (PB)

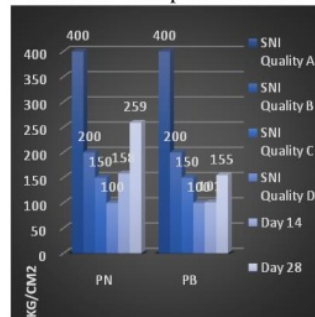| Material	Composition (%)
Sand	69
Cement	30
Bioconc	0,1
Bamboo	0,4
Water	0,5

4. Result and Analysis

Figure 5. Paving block

Figure 6. Pressure Test

Table 4: Comparison Chart

1. Effect of Aggregate Percentage of Sand Against Strong Press
In the manufacture of normal paving blocks done manually, the amount of sand aggregate in Paving Normal (PN) shows a value of 158kg / cm2 at the age of 14 days and 259kg / cm2 at the age of 28 days.
2. Effect of Aggregate Percent of Sand, Bamboo + Bioconcter on Strong Press
In the manufacture of block paving with a mixture of Sand, Bamboo + Bioconc done manually has a value of 101 kg / cm2 at 14 days of age, and 155 kg / cm2 at 28 days.

5. Conclusion
As a result the test of Paving Block with mixed additions of Microbus + Bioconc (PB) has a value of 155 kg / cm2 while the lowest NI level is 100 kg / cm2. Based on the compressive strength value generated, Bioconc Bamboo Paving is worthy of classifying C. quality standards. It can be applied to non-structural parts in construction as land cover in city parks, home yards and other places.

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