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CENTRAL KALIMANTAN'S LOCAL BAMBOO MATERIALS FOR CONSTRUCTION COMPONENTS (COLUMN, RINGS, & WALL COVER) OF SIMPLE HEALTHY SUSTAINABLE HOUSE

BAHAN BAMBU LOKAL KALIMANTAN TENGAH UNTUK KOMPONEN KONSTRUKSI (KOLOM, RING, & PENUTUP DINDING) RUMAH SEDERHANA SEHAT BERKELANJUTAN

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ABSTRACT

Slums always can be found in big cities in Indonesia, as a result of the impact of urbanization. This slum settlement is identical to the conditions of inadequate environmental infrastructure including the condition of houses that are almost uninhabitable. Physically, most of the house buildings use used materials. Materials such as wood / used beams for house frame structures, used boards mixed with used zinc and rust for walls, and used zinc (metal or plastic) and straw for roof coverings. The cumulative impact of the existence of these slums is a decrease in the visual quality of the urban built environment and a decrease in the quality of the health of the urban built environment. as a solution, it was stated that the model of the Simple Healthy Sustainable House of Local Bamboo Construction in this case bamboo that grows in Central Kalimantan. At present most of the design of cheap bamboo-based houses is using Petung Bamboo (Dendrocalamus Asper), while on the island of Kalimantan this type of bamboo has very little population. For this reason, it has been researched and modeled for sustainable healthy simple houses using local bamboo species whose populations are widely available in Central Kalimantan such as Suluk Bamboo (Gigantochloa Levis (Blanco)), Tamiang Bamboo (Schizotachyum Blumei Nees) and Yellow Bamboo (Bambusa Vulgaris Schard). The three types of bamboo are determined as a component of the Sustainable Healthy Simple Houses Construction, namely as Main Column component, Supporting Columns, Frame and Wall Coverings, and also as Ring Balk.

Keywords: *Simple Healthy House Model; Bamboo House; Bamboo Building Construction; Sustainable Architecture; Green Architecture; Green Building*

PRELIMINARY

Slums always can be found in big cities in Indonesia, as a result of the impact of urbanization. This slum settlement is identical to the conditions of inadequate environmental infrastructure, including the condition of houses that are almost uninhabitable. Physically, most of the house buildings use used materials. Materials such as wood / used beams for house frame structures, used boards mixed with used zinc and rust for walls, and used zinc (metal or plastic) and straw for roof coverings. The cumulative impact of the existence of these slums is a decrease in the visual quality of the urban built environment and a decrease in the quality of the health of the urban built environment. For this reason, it is necessary to provide a solution, in this case architecturally, that is by conducting research and modeling of a Simple and Sustainable Healthy House Bamboo Construction.

This research is a continuation of a previous study in which a model of bamboo constructed houses using local bamboo materials from Central Kalimantan has been obtained. As for most of the bamboo-based low-cost house designs at the moment is using Petung Bamboo (Dendrocalamus Asper), where on the island of Kalimantan this type of bamboo has almost no population. This modeling research of healthy simple houses has made use of local bamboo species whose population is widely available in Central Kalimantan such as Bambu Suluk (Gigantochloa Levis (Blanco)), Bambu Tamiang (Schizotachyum Blumei Nees) and Yellow Bamboo (Bambusa Vulgaris Schard). The three types of bamboo have been tested each as a construction component of the simple house, namely as Column, Wall Frame and Cover, and Ring Beam.

THEORY APPROACH

Simple Healthy Sustainable Home

Very Simple House based on the Decree of the Minister of Finance No. 393 / KMK.04 / 1996 is a non-compartmentalized house with a maximum floor area of 36 M2 which is built on a maximum size of land 54 M2. Furthermore, by the Decree of the Minister of Settlement

and Regional Infrastructure No.24 / 2003 concerning Procurement of Housing and Settlements with the Support of Housing Subsidy Facilities, the term simple house and very modest house was changed to a Simple Simple Home (RSH). RSH is intended for low-income people, but RSH must be feasible, affordable, meet health, safety and comfort requirements and be environmentally sound (Putranto, 2013).

In the General Guidelines for Simple and Healthy Houses, there are 4 (four) types of Simple Houses, namely: Wall House; ½ Wall House; Unstaged Wooden Houses; and the Stage Wooden House. The floor area of the building ranges from 21-36 M2, and the site area ranges from 54-200 M2. In the regions of Central Kalimantan, West Kalimantan, East Kalimantan, and South Kalimantan, it is recommended to be used for the Wooden Stilts Houses considering its natural conditions that tend to be Wet and Clay Soils.

Healthy Simple House aims to enable its residents to live a healthy life and carry out their daily lives properly. These activities include sleeping, eating, working, sitting, cooking, bathing, washing, and latrines. The standard of regulated space is 6 m2 / person with a ceiling height of 2.8 meters (Kepmen Kimpraswil, 2002).

There are 3 (three) aspects that must be fulfilled to obtain conditions in a healthy home, namely Lighting, Insolence, and Humidity (Taur et al, 2009). The lighting here that is most influential for health is the use of sunlight, natural ventilation to maximize wind movement across buildings, as well as adjusting the humidity level so as not to endanger health.

For security and safety aspects, it is related to the use of the building components studied, namely columns, frames and walls of buildings as well as rings balks. The building frame commonly used for Simple Healthy Houses can use cast concrete, wood, and bamboo, depending on the potential of the material available at the location. As a wall cover can be used brick, wooden planks, and bamboo plaits (Mediastika, 2005).

The goal of providing Simple Healthy Houses is for low-income groups, therefore the use of building materials and materials is as much as possible using the materials and technologies that are cheap and affordable by these groups.

Bamboo As Building Construction Material

Physical Properties Bamboo is a strong, resilient, straight, flat, hard trunk, easy to split, easy to form and easy to work and light so easy to be transported (Purwito, 2008). Besides that, bamboo is also relatively cheap compared to other building materials such as wood. While the weakness is physically, its size is variable and not uniform, the length of the segment and easily attacked by pests that destroy wood powder, termites and fungi (Shen, 2013). However, these weaknesses can be overcome by preservation, (reinforcement / plugin), and the use of steel joints (Phanratamala, 2013).

For Mechanical Properties of Bamboo, sample is taken from the type of Petung Bamboo (*Dendrocalamus Asper*), namely (Chaowana, 2013):

1. Modulus of Rupture: 85.7 MPa;
2. Modulus of Elasticity (Elasticity): 6300 MPa;
3. Strength of parallel shear fibers: 5.4 MPa; and
4. Press Strength Fiber Line: 31.5 MPa.

From the mechanical properties above, it is known that Petung Bamboo has a ruptured modulus of 85.7 MPa or 866.8 Kgf / cm2. Based on the properties above, Bamboo's mechanical strength is more than enough to be applied to the Simple Healthy House building.

Utilization of Bamboo as a building material according to the scope of research that has been carried out can be described as follows (Grewal, 2009):

1. As a Building Frame
   The most extensive use of Bamboo as a building material is as a frame and wall covering. The Bamboo is use as column and beam (Sloof and ring balk) forming the structure of the building and also able to withstand workload and occupants therein. As an example based on its mechanical properties, a Petung Bamboo stick can holds vertical loads weighting ± 850kg / cm2 or ± 8.5 Kg / m2. It is also taken into account with 4 sticks of Petung Bamboo which are able to withstand a vertical load of ± 34 Kg / m2.
2. As a Wall Cover
   The wall serves as a visual barrier and also as the protection from the weather, including rain and sunlight so the whole activities in the building can be well functioned. In this case Bamboo as a Wall Cover can be made by weaved and also bamboo bar arranged in a row vertically or horizontally.

Bamboo Connection Techniques for Building Construction

Bamboo has many advantages in its use as a material for building houses, bridges, residences, and others. Besides cheap, it is fast growing, it also has very adequate mechanical strength statistics. However, one thing that is quite difficult to do with regard to the use of bamboo as a construction material, namely its connections (Rottke, 2004). This is caused by:

1. Bamboo has a round section, making connections on profiles that require special designs;
2. Bamboo fibers only grow in the longitudinal direction;
3. Bamboo stems are hollow, no material becomes an amplifier in the middle part of the cavity;
4. The surface of the Bamboo stem is very hard and slippery;
5. Bamboo is not suitable for application in transverse loads because there is no transverse fiber; and
6. Bamboo is a natural material, varies greatly in diameter, length, and quality depends on the climate.

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There are several bamboo connection techniques that are known today, namely (Hogan et al, 2011):

1. Strict Friction Rope Connection
   This rope connection is often found in traditional buildings that use bamboo materials. Natural rope commonly used is Coconut Fiber, Sago Fiber, Bamboo, and Rattan. In order to be able to bind tightly, then the rope used will be moistened first and then installed so that when dry the rope becomes shrinking and the bond becomes tight. But by using modern materials, this bond can be made using fabricated wire or plastic straps.
2. Pegs and Nuts – Bolts
   This type of joint uses wood or metal pegs reinforced with a bolt-nut pair.
3. Linking connection
   This type of bamboo connection uses additional metal plates and ball-joints to unify many bamboo blades in various directions of the construction distribution.
4. Combination Connection
   This connection combines the connection techniques above so that the construction becomes stronger.

Previous Research About Bamboo Material Building Construction

Widyowijatnoko et al (2013) in his research utilizing bamboo materials for Rumah Bambu Prototype in Pasir Impun, Bandung. Bamboo material is used as a house frame material and wall coverings, which are reinforced with plaster to obtain concrete wall expressions. The entire wall uses woven sasak, adopted from a Dutch heritage bamboo house that can last up to 90 years.

Tanuwidjaja (2011) then examined the use of bamboo materials for the Bamboo House design for the people of Jatiwekas Hamlet, Kedawung Village, Kediri Regency. From the results of his research it was found that bamboo material has the nature of "Sustainable Material", namely: material can be broken down by nature; material can be produced locally so that it does not require energy and a large cost to send to the construction site; material does not have a negative impact on the environment; the level of toxicity in the material that affects humans and ecosystems is almost non-existent; method installation of environmentally friendly construction; work methods are easy and can be done by local residents; maintenance costs are very low; and thermal comfort in space is good enough to reduce energy consumption.

Sukawi (2010) also examined Bamboo as a component of building construction in earthquake-prone areas in Central Java and DIY. The results of the research were that the Earthquake Resistant Bamboo House had principles: the bamboo material used was bamboo that was old enough, had been preserved, and was dry; the foundation and sloof surround the house plan; using ringbalk around the edges of the columns of the house; reinforcement around door and window openings; the walls are anchored in columns; the roof frame uses a simple pedestal construction (rollers) and is anchored in a column; and the wind ties on the roof must be installed between the sawhorses.

Krostch (2012) conducted a study of local bamboo species found in Kenya, namely the Yushania Alpina type. This type of bamboo is tested for its mechanical strength by pressing, pulling, and bending in the Munich University mechanical test laboratory. From the test results it was proven that the local bamboo has very good quality as a building material. But bamboo has a weakness in the hollow area, so it needs to be reinforced at meeting points between construction fields.

Sharma et al (2014) examined the application of bamboo materials for Rumah Bambu designs in Haryana, India. Rumah Bambu is a simple house for the lower class in the city of Haryana. The results showed that bamboo materials can be fully applied to construction components, namely: Foundation, Floor Coverings, Wall Coverings, Roof Frames and Roof Coverings, Scaffolding, and Home Furniture.

METHODOLOGY

In this advanced research an experimental methodology was used to utilize these local bamboo species as column components, frames and wall coverings.

Research Process

The phases carried out in the research process to obtain the construction components referred to from Simple Healthy Sustainable Houses are as follows:

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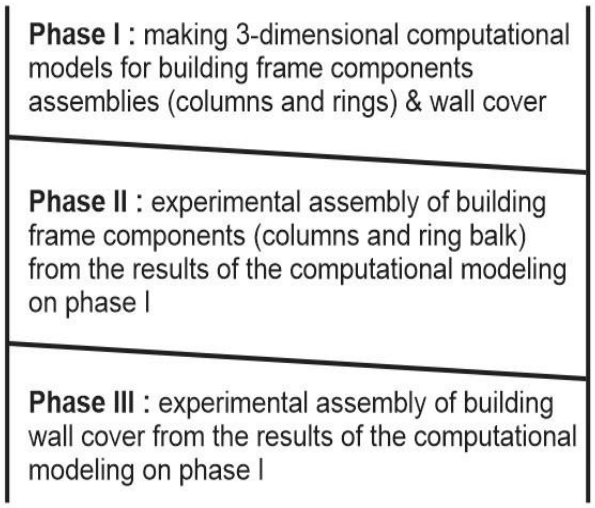

Figure 1. The Central Kalimantan's Local Bamboo Construction Research Process

RESULTS AND DISCUSSION

Application of Simple Healthy Sustainable Home Construction Component Model

Based on the results of previous studies, a Simple Healthy Home model was computationally designed and carried out by a local bamboo experiment in Central Kalimantan as the construction component, namely foundation, stage column, sloof, and floor covering (Harysakti et al, 2017). Furthermore, in this advanced research the results of the research are as follows:

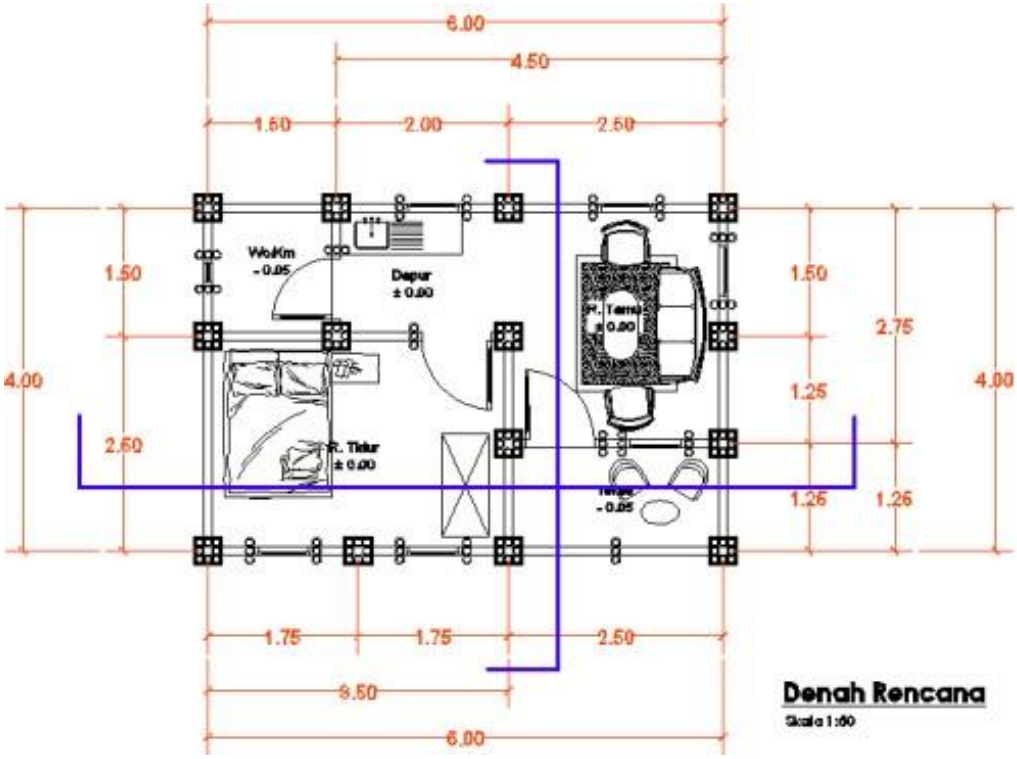

Figure 2. Floor Plan for a Simple and Healthy Sustainable Home Model Made from Central Kalimantan's Local Bamboo (Source: Personal Documentation, 2024)

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Figure 3. 3D Model of Construction of Sustainable Healthy Simple Houses Made from Central Kalimantan's Local Bamboo

1. Local Bamboo as a Construction Column

Plan a column plan based on Figure 2 above where the placement of the main column uses a column module of 2.5 x 1.5 meters and 1.5 x 1.5 meters. Determination of the size of the main column module is obtained by considering the bamboo material has an advantage on the compressive strength of the parallel fibers (bamboo in a standing position) but on the compressive strength is not parallel to the fiber (bamboo in a transverse position) the performance of its strength decreases drastically. To overcome this, the distance between columns must be short and each helat between the main columns must be reinforced again with supporting columns to provide extra strength so that the resistance of bamboo construction as a component of the column and frame of the wall becomes even stronger.

As a material of Column and Wall Frame, Local Bamboo, Central Kalimantan, whose mechanical properties can provide optimal strength is the type of Suluk Bamboo. However, considering the ratio of parallel compressive strength test that has been carried out where a 10 cm diameter Suluk Bamboo with the largest diameter of 28.83 MPa is only producing half of the parallel compressive strength of Petung Bamboo with a diameter of 12 cm which is often used by people to build buildings today. To overcome the comparison of this strength in order to obtain the same compressive strength as Petung Bamboo, then Bamboo Suluk application is designed as a column component with the logic of the construction of "Sapu Lidi", which combines 4 bamboo sticks into one entity using the connection of nuts - bolts as in the following figure:

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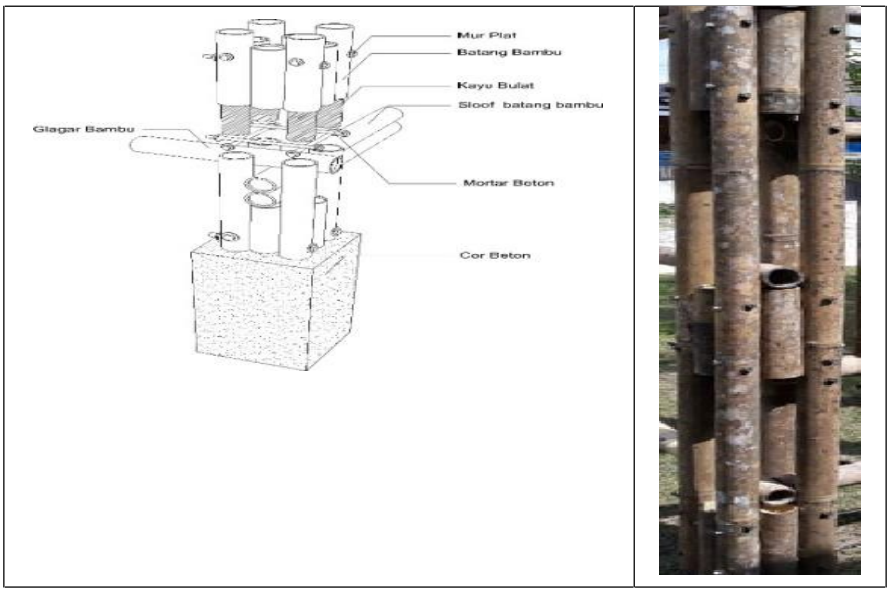

Figure 4. Detailed Images of Construction Applications for Main Columns of Simple Healthy Sustainable Houses Made of Central Kalimantan's Local Bamboo.

In the design of the construction of the main column of the building of the Simple Healthy House above using 4 stems of Suluk Bamboo Ø 7cm which is united into one sturdy strength using a nut-bolt clamp. By using this type of construction, the main column is obtained with parallel compressive strength of ± 100 MPa / main column point. On the bamboo section in the position of the bolt is reinforced by filling the sections using mixed cement mortar 1pc: 1ps (Bamboo Filler) and the alternative uses scaffold round filling. To further strengthen the structure entity, a supporting column is also designed that is placed between the main columns as shown below:

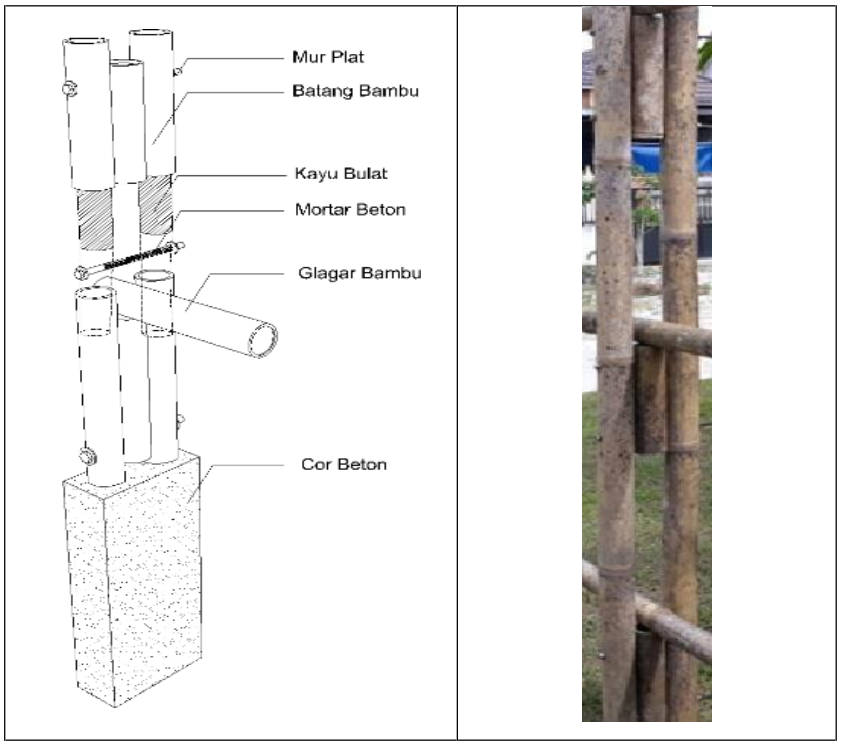

Figure 5. Detailed Images of Construction Applications for Supporting Columns of Simple and Healthy Sustainable Houses Made of Central Kalimantan's Local Bamboo.

2. Local Bamboo as a Ring Beam Construction

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The ring beams function to bind between columns at the top and become a place to stand from the roof frame later. The design of local bamboo Ring Balk construction is using Bambu Suluk with Ø 10 cm diameter placed across the center line of the main column and supporting column. Furthermore, to provide structural stability, the Ring Balk is reinforced with nuts in the main column. Ring Balk detail application can be seen in the following picture:

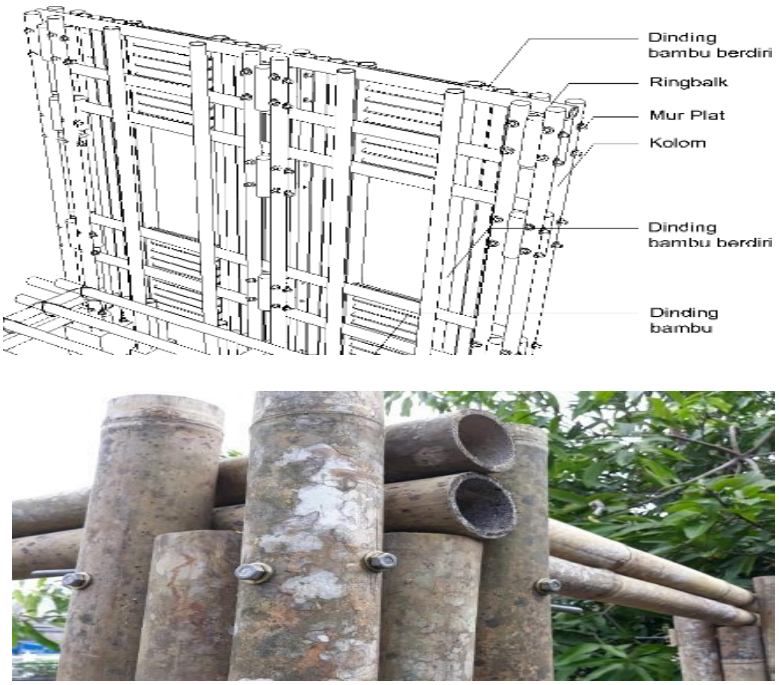

Figure 6. Detailed Images of Ring Balk Construction Applications Simple and Healthy Sustainable Houses Made of Central Kalimantan's Local Bamboo.

3. Local Bamboo as a Wall Cover Construction

The Wall Cover design is using local bamboo material in from Bambu Kuning in the form of bamboo blades with a size of 1 cm x 2.8 meters. These blades are obtained by splitting yellow bamboo in diameter Ø 3-4 cm, and mounted in a vertical direction using a small nail on the wall frame. Wall Cover Application can be seen in the following picture:

Figure 7. Detailed Images of Construction of Simple and Sustainable Wall Covering Houses Made of Central Kalimantan's Local Bamboo.

CONCLUSION

Local bamboo from Central Kalimantan, based on the results of the research above, has been proven in practice and performance to be applicable as building components of simple healthy sustainable house model for columns, ring beams, and wall coverings.

REFERENCES

Chaowana, Pannipa (2013). *Bamboo: An Alternative Raw Material for Wood and Wood-Based Composite*. Canada: Journal of Materials Science Research, Vol. 02. No.2, 2013, pp. 90 – 102.

Grewal, Jaspreet (2009). *Bamboo Housing in Pabal*. Southampton: The Royal Institute of Enfineering, University of Southampton. EWB-UK Research Conference, February 20, 2009, pp. 1 – 21.

Hogan, Lucas & Graham Charles Archer (2011). *Development of Long Span Bamboo Trusses*. San Luis: California Polytechnic

Kepmen Kimpraswil No. 403/KPTS/M/2002. Pedoman Umum Rumah Sederhana Sehat.

Krostch, Stefan (2012). *Bamboo as a Building Material in Kenya*. Muenchen: Technische Universitat Munchen.

Mediastika, Christiana (2005). Menuju Rumah Ideal Nyaman dan Sehat. Yogyakarta: Universitas Atma Jaya Yogyakarta.

Phanratamala, Susira (2013). *The Study of Design and Potential Bamboo Practical Joints and Frame Truss System*. Kashiihama: University of Kyushu.

Purwito (2008). Standarisasi Bambu Sebagai Bahan Bangunan Alternatif Pengganti Kayu. Bandung: Prosiding PPI Standarisasi, 25 November 2008, pp. 1 – 17

Putranto, Ary Deddy (2013). Pengembangan Rumah Sederhana Sehat (RSH) Menjadi Rumah Sederhana Sehat Berwawasan Lingkungan di Kabupaten Malang. Jurnal RUAS. Volume 11 N0 2, Desember 2013.

Rottke, Evelin (2004). *Construction with Bamboo: Bamboo Connections*. Aachen: RWTH Aachen University, Institute for Structural Design.

Sharma, P., K. Dhanwantri, & S. Mehta (2014). *Bamboo as a Building Material*. India: International Journal of Civil Engineering Research, Vol.5, No.03, July 2014. Pp. 249-254.

Shen, Chen (2013). *A Research of Sustainable: Temporary Bamboo Structure*. Delft: University of Delft.

Sukawi (2010). Bambu Sebagai Alternatif Bahan Bangunan dan Konstruksi di Daerah Rawan Gempa.Semarang: Jurnal Teras, Vol.X No.01, Juli 2010, pp. 1-10.

Tanuwidjaja, Gunawan (2011). Sosialisasi Desain Bambu Plester Kepada Warga Dusun Jatiwekas, Desa Kedawung, Kabupaten Kediri. Surabaya: Universitas Kristen Petra.

Taur, Rinku & Vidya Devi (2009). *Low Cost. Housing*. Pilani: Advance in Concrete, Structural, and Geotechnical Engineering (ACSGE) International Conference. November, 04, 2009, pp. 1–11.

Widyowijatnoko, Andry, & Mustakim (2013). Modul Pelatihan Dinding Bambu Plaster. Bandung: Institut Teknologi Bandung.