

## **STUDY BAMBOO HOUSE TYPE 36**

**Aventi<sup>1</sup>**

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### **ABSTRACT**

*Global crisis prolonged is unsettling society in the world. Basic need prices rise up along change unstable Indonesia money value in market world. Including building material price certainly cause price to build a house increased anyway. Previously, to build a house with approximately price 1 million rupiah per meter square still can be done. While now, least to build a house with good quality standard and representative can reach approximately 2.5 - 3 million rupiah per meter square.*

*Therefore, should need find the exact way to reduce price construction living house that will be built. That is by using appropriate materials, efficient, and affordable. For example by using the potential of Indonesia as tropical countries that rich in natural resources, especially as building material which most encountered such as bamboo. Bamboo can easily grown and developed. The price was cheap and affordable. Bamboo's strength when used as main structure have strength almost same if compared with the strength of wood. Even in some certain cases bamboo its strength more pliable than wood.*

*From the various studies, structure bamboo proved to have many advantages. The fiber is pliant and elastic, very good in holding the load (either pressure load or tensile, shear, or bending). The Faculty of Forestry IPB (Institute Agriculture Bogor) expresses the fact that pressure strength of bamboo (qualified) is equal to wood, even the tensile strength better than wood. In fact, with the strength like this, a certain type of bamboo can substitute steel as reinforcement of concrete. This study expected to be able to prove that in addition bamboo having several advantageous, bamboo house construction can also be cheaper than concrete house. This is to help people in difficulty handled cost in terms construct a house that fulfills the requirements of safety to earthquake hazard.*

**Keywords:** bamboo house type 36, price.

## INTRODUCTION

Bamboo in botanists can be classified in family *Gramineae* (grasses), divided into five tribes, that is *Dendrocalaminae*, *Melocanninae*, *Bambusinae*, *Arundinaiinae*, and *Puellinae*.

Based on its growth, bamboo can be distinguished in two major groups, namely simpodial bamboo and monopodial bamboo. Simpodial bamboo grown in clumps form, each rhizome will only produce one stem bamboo, young bamboo growing around old bamboo. Simpodial bamboo grown in tropics and subtropics region, so that only this type of course that can be found in Indonesia. Monopodial bamboo developed with rhizome through in different directions in underground and surface ground as the stands of bamboo that are individually.

Of  $\pm 1,000$  species of bamboo in 80 genera, about 200 species of 20 genera are found in South East Asia (Dransfield and Widjaja, 1995), whereas in Indonesia found about 60 types.

Basic bamboo plants in tropics region called as rhizome root, which is a kind of knot (bamboo shoots) that is not roots or bunches. The rhizome roots will tie stem bamboo on the ground.

Kinds of bamboo common marketed in Indonesia, that is bamboo rope, petung, spines and wulung.

Bamboo rope /apus (*Gigantochloa apus*). Bamboo very pliant with distance internode until 65 cm and with diameter 40 - 80 mm, and length stem 6 - 13 m.

Bamboo petung (*Dendrocalamus asper*). Bamboo is very strong, with distance internode short, but with thick walls so that wasn't so pliant. Diameter bamboo petung 80 - 130 mm, length stem 10 - 20 m. This bamboo often planted and grown on regional elevation 1,900 m above sea level.

Bamboo spines /ori (*Bambusa blumeana*). Bamboo is very strong and large same with bamboo petung, distance internode short with thick walls, the outside (skin) finer and slippery compared with other bamboo, also harder. Diameter 75 - 100 mm, length stem 9 - 18 m.

Bamboo wulung /black (*Gigantochloa verticillata*). Bamboo with distance internode long same with bamboo rope /apus, the thick up to 20 mm and not pliant (brittle), striped light yellow. Diameter 40 - 100 mm, length stem 7 - 18 m.

Mechanical properties of bamboo depends on :

- a. Kinds of bamboo pertaining to herbs.
- b. Age of bamboo at the time of logging.
- c. Moisture (water content equilibrium) on stems bamboo.
- d. The stem of bamboo that is used (bottom, middle or head).
- e. Location and distance internode (internode less resistant to pressure strength and tensile strength).

## LITERATUR REVIEW

### Bamboo

Bamboo used in the construction is building material dry by water content 12 % (water content equilibrium) on air humidity 70 %.

Density bamboo in Indonesia averages  $700 \text{ kg/m}^3$ . Tensile strength in Indonesia, which permitted parallel direction fiber is  $29.4 \text{ N/mm}^2$ . Pressure strength in Indonesia, which permitted parallel direction fiber is  $7.85 \text{ N/mm}^2$ . Shear strength in Indonesia, which permitted parallel direction fiber is  $2.45 \text{ N/mm}^2$ . Tensile strength in Indonesia, which permitted is  $9.80 \text{ N/mm}^2$ . Modulus elasticity in Indonesia can be calculated by  $20 \text{ kN/mm}^2$ .

### **Construction Bamboo**

Fire resistance construction bamboo varies according to burned and reaction of the bamboo. Stem bamboo splitting by hot press and reduced material that receives load due to fire and stem press will be fold. The strength of stem bamboo especially one thin-walled somewhat rapidly disappearing its strength if conflagrate. Bamboo have density fibers on outer wall and high levels of acid kersik resulting in bamboo somewhat hard lighted.

Bamboo construction can made more resistant to fire by using coating paint certainly somewhat fire retardant, or preserving bamboo with 25 % boraks (natrium tetraborat) that dissolved in water at the time of preservation by submersion.

### **RESEARCH METHODS**

This research will calculate cost of build one bamboo house type 36.

### **ANALYSIS AND DISCUSSION**

Bamboo is natural building material that can be used immediately after harvested. An acre of bamboo plants can absorb 9 tons CO<sub>2</sub> (carbon dioxide), considerable capacity in tackling climate change.

Its growth is very rapid, ranging between three and five years can already harvest, without fertilizer or pesticides. After harvesting no longer need replanting process, because the process of bamboo's growth continuously which emerges from the branching roots.

Bamboo can grow up to 1 meter per day, depending on system roots that are unique and depend also on conditions of soil and climate where growth.

Harvesting bamboo requires precision in choosing stem bamboo that old enough, because one year old bamboo, although it reaches full size, but not exactly ready and not as strong as bamboo that has grown.

Felling bamboo should be done in dry season, because at that time the levels of substance sugar and water on bamboo low. After the base of bamboo are cut, do not directly taken, but let the first bamboo stick in the colony to hang the leaves dry up, so can reducing the levels of sugar in stem bamboo through absorption by the leaves. When cleared, beetles powder will soon infection bamboo, therefore it is highly recommended to immediately preserve bamboo.

Bamboo has been felled, then made preservation by means of :

- Non chemical preservation method (traditional) have been used since a long time in rural areas. The advantages of this method that do not require big cost and can be done alone without use special tools. Non chemical methods such as : curing, fogging, resurfacing, submersion in water, and boiling.
- Traditional soaking (in pond, river, sea) for several months. Soaking can facilitate sugar substance that is brewing in the bamboo so not endeared by beetle powder. On soaking bamboo, bamboo given ballast to be submerged in water fully. Soaking the bamboo in water can also be done by entering the bamboo into water tank made from used drum. Soaking the bamboo in water will result biological process that lead to the onset of fermentation of the starches contained in the bamboo, so this fermented are soluble in water. Thus soaking the bamboo in water can decrease the levels of starch bamboo.
- Soaking with chemicals, that is sodium pentaborate and boric acid. Mix 3 : 2 these ingredients and make 10 % solution and then soak the bamboo for 14 days. Both these ingredients functioned can effectively stop attack beetle powder against bamboo.
- Methods preservation by chemical using preservatives ingredients, famous is Copper-Chrome-Arsenic (CCA). The chemical method relative expensive but produce better

protection. The success of this method depends greatly on the accuracy concentration solution of preservatives that are given. Other chemical methods such as : Butt Treatment method, open tank method, Boucherie method, and fumigation (with metilbromida compound).

- Dr. Boucherie from France in 1838 did wood preservation by placing a container containing a solution of preservatives in the tree is still standing or have just been cut, still complete with bark, branches, and leaves. The preservative solution put into wood via sap flow duct (water in bamboo). Evaporation water content through the leaves will result in liquid preservative absorbed up to the tip.
- Boucherie method has been modified by Morisco (1998), preserving using tubes, operated without electric power, making it suitable for rural areas. A preservative is a chemical solution insert by air pressure. Process insert solution on bamboo diameter 8 cm, length 6 m takes times about 20 minutes.

Fresh bamboo more easily given preferential treatment compared to bamboo is already dry. The higher density of bamboo and the older age of bamboo, then it will be more difficult for preserved bamboo. Bamboo preservation in small amounts will raise cost preservation. A method of preservation is to be economical when age wear bamboo can reach 10 - 15 years (to open in bamboo), and 15 - 25 years for bamboo who were given certain protections.

After preserved, the bamboo should be drained by using drying in the room, to get bamboo that fulfill drying requirement for use in building construction.

### **Bamboo Painted**

Coating bamboo with sufficient finishing ingredient to avoid bamboo from excessive moisture and make bamboo look more beautiful and not easily dirty. For parts that are exposed sunlight continuously, coated with vernish every 6 months.

After bamboo pass through a right process of felling, preservation that meet the requirements, drying perfect and coating good , then to be able to build bamboo house earthquake proof, must consider things as follows:

- Use bamboo the old one, have preserved and in a dry condition.
- Bamboo houses built above the ground level.
- Foundation and sloof (sloof anchored to foundation in any distance 50 - 100 cm) surrounds house design.
- The lower end of a column bamboo entered foundation, anchored and inner the lower end of a column filled with reinforcement and mortar.
- Do not use bamboo which has been stricken with powder or other insects. Bamboo should be preserved first to extend the age of buildings.
- Do not use bamboo which has been cracked because it can diminish in strength of the building structures.
- Used right technique of cutting and connection when make bamboo building.
- If bamboo worn to stanchion, the buttresses below which into splints cut squarely leaves internode bamboo, not cut in the middle internode bamboo. This is to maintain strength, otherwise fiiled then pressure will cause internode bamboo become cracked and breaks.
- If we must cut in the middle internode, use reinforcing by means of inserting wood in the middle of the internode to replace the position of internode and keep the strength of bamboo.
- Element wall that connection with sloof or column must anchored in some areas.
- At the upper end column given beam ring around building design, elements wall must also anchored with beams ring.

- If any openings the wall like ventilation, doors and windows, should be given the openings around the perimeter of reinforcement purposes.
- At each connection between wall with other wall, there must be column and walls anchored column.
- Roof truss could constructed with simple object (joint-roll), where any holder roof truss must be placed in its position, and need anchored with column.
- Bond wind on the roof should be installed in each between roof truss. This bond wind is mounted on the field of roof slope under roofing, and in the vertical plane between two roof truss.

Bamboo that used as building material in making bamboo house earthquake proof, because bamboo has its advantages, such as:

- Bamboo known as building material that can be renewed of being easy grown and does not require maintenance specifically.
- To do bamboo cultivation, not required big investment, once plants have been steadily, the results can be obtained in indefinitely without plant again.
- Bamboo cultivation can be done just any person, with simple equipment and does not require support high knowledge.
- Quite comfortable living in bamboo house.
- Construction cost is cheap, because bamboo as building material with the lowest price.
- In a period of growth, bamboo certain can grow vertical 5 cm per hour, or 120 cm per day.
- Bamboo can be utilized in many ways. Different with timber tree forest were ready felled with good quality after 40-50 years, then bamboo with good quality can be obtained at the age 3-5 years.
- Bamboo plants have tremendous endurance. Clumps bamboo that has been burned, were still able to grow again.
- Bamboo have high strength, tensile strength can be compared with steel. Notwithstanding the foregoing, this bamboo's strength has not been put to good use because usually stems structure bamboo connected to pegs or rope that have low strength.
- Bamboo pipe-shaped so that have high moment moisture, hence bamboo good enough to carry moment flexural. Addition with bamboo's properties are elastic, structure bamboo have high resistance either to wind or earthquake.
- When using good architecture, then bamboo house can be beautiful, luxurious and also lightweight, making it suitable for prone-earthquake region.
- Bamboo is plant that can planted on dry land /wet and not need special maintenance.
- Bamboo plants having value conservation high because capable of affording bracing ground level, through the ability affect retention water in layers topsoil, that can improve the flow of soil water.
- Bamboo is lightweight material because a circular shape and having hollow, so make easy to handle, transport and storage, allow the construction of structure faster.
- Because the physical characteristics making it strong materials but elastic, many dependability bamboo, anti-seismic high, bends without rupture, can also be used in all kinds of structure.
- Bamboo has fibers, that allowing cut longitudinal or transverse into pieces of various sizes, by using very simple tools.
- Bamboo has very attractive tone and smooth skin and does not require scrapping or polishing.

- Building materials bamboo allow for modified by using wood, metal or other building materials.
- As building material, bamboo has an advantage because its structure and also because comparison of its strength and weight. Bamboo's fiber are length increase the strength of bamboo and even exceed wood in general, and even beat steel. The other side, bamboo has low levels of lignin, component of the main substance is salicylic acid, which gives elasticity and strength on bamboo.
- Utilization of bamboo the longer known is increasing, in terms of building material for example, utilization of panels or bamboo lamination. Because of its beauty texture bamboo, strength, pliability and ability material bamboo adaptation with moisture.
- Bamboo is not polluting, all parts of bamboo can be used and nothing is wasted. (stems bamboo can be used for construction, smaller peak in the section can be marker or buffer plant, bamboo leaves can be made into animal food and compost, the young shoots of bamboo can be eaten as vegetables are delicious). Even the remnants of industrial furniture /building bamboo can be made into charcoal that high quality and high economic value.
- The outer surface of bamboo is naturally sleek and clean with natural colors and interesting anyway. So the bamboo does not require painting or emery.
- Material bamboo has cultural value and high aesthetic and gives the feel of natural and environmentally friendly nature. A variety of types, sizes, colors and distinctive characteristics of bamboo can produce unique product and interesting to see.
- Bamboo plants efficient in absorbing carbon from the atmosphere.
- Building material bamboo can be available continuously.
- Bamboo trail carbons lower than steel, pvc, concrete, etc.
- Bamboo has potential to develop into fuels alternatives or biofuel environmentally friendly.
- Bamboo tree also functioned as water purifier. The riverbanks are many bamboo tree, the river water was seen clearly.
- Bamboo plants can be utilized to prevent landslides. Because bamboo will form clumps, not single plant. Bamboo root is also root fibres that grew very close. Bamboo roots are dead because of its vegetation has been felled, it will still form fibres, so the land became very loose and absorb water very quickly.
- System truss stems bamboo is very efficient building structures to decrease and vibration ground (earthquake) and against dynamic pressure (wind as horizontal strength). As lightweight construction (weight of construction floors, walls, and roofs became a bit) and with knot point on system truss of stem which works as hinge, all stems can move little without affecting stability construction. Building materials bamboo and its structure can vary widely in shape and thus will result in destruction energy.
- System truss stems bamboo can be applied to frame house in areas earthquakes prone, the construction of stage house, the construction of truss wall, floor plates, or roof. Bamboo can be used as concrete reinforcement (bamboocrete). In addition for building materials main structure, bamboo can be used as building material supporting structure such as doors, windows, protection peel off walls against sunshine, pipe and water pump, as well as fence construction.

But in addition to these advantages, bamboo buildings have deficiencies, that is :

- Have not loss the connotation of community that bamboo known as building materials for poor people. To overcome these barriers it is necessary good architecture, so the houses are made of bamboo can be interesting.

- Almost no credit facility from banks, because of lacking confidence from the bank.
- There is no national standard about bamboo house.
- Bamboo has lowest durability, because it's easy to struck by beetle powder, so the buildings are made of bamboo are not durable. Therefore the pillar house of bamboo, which is not preserved, only seen as building components while only hold not more than 5 years.
- When cut down, beetle powder will soon infection bamboo, therefore, it is advisable to direct preserve bamboo.
- Bamboo are in direct contact with the ground in a long time, will be weathering and inviting insect attack, this also happened on wood. Therefore structure bamboo should avoid direct contact with the ground.
- Same as wood, dry bamboo very inflammable, therefore, it is advisable to preserve bamboo with preservatives that can increase the rate of fire retardant bamboo.

Design bamboo house are good, exact, and right preservation, can make bamboo house will be able to persist for decades. With to endeavor that material bamboo sheltered from rain water and sunshine directly. Water can make bamboo fast doty and moldy, while blazing sunshine making color bamboo be faded and even can make bamboo be broke.

In designing bamboo house, almost all its parts can be made from bamboo except its connection tools (rope, etc.).

Bamboo house is able to dampen earthquake because the properties of material is lightweight, as well as the structure of connection that not stiff, could move following shocks, absorbs energy of earthquake.

Construction traditional bamboo house does not require foundation planted. Bamboo only placed on batch or placemat from stone surfaced flat-concrete can also used as batch. This is done to avoid weathering, i.e. when the parts of bamboo direct contact with the ground. On traditional house bamboo-floored, usually elevated floor surface about half meter.

That used in building this bamboo house type 36 is bamboo rope /apus, with considerations there are many in Java Island especially in West Java, have properties very tough so good for the strength of house, long stretches up to 65 cm and long stems 6 - 13 m with diameter 40 - 80 mm so that many parts of bamboo that can be used as material in house construction.

The price of bamboo rope in Bandung at this moment is ± IDRp. 16.000,- /stem. One stem bamboo can be cut into four parts, where each part can be made ± three layers of pounded bamboo.

Bamboo house type 36 was designed using five doors and eight windows. Door size 80 cm x 200 cm and window size 60 cm x 100 cm. Door was designed using plait bamboo slats, that doors are open to the side.

Assumptions are taken from one stem bamboo 10 m with Ø 80 cm. To make one piece door slide plait bamboo measured length 200 cm width 80 cm, need 400 cm length bamboo slats and 160 cm width bamboo slats. One bamboo house type 36 was designed using 5 doors slide plait bamboo. Then to make one layer bamboo slats for 5 doors need 2,000 cm length bamboo and 800 cm width bamboo. For length = 2,000 cm can be filled with 3 stems bamboo (multiplied correction factor 0.5), and width = 800 cm can be filled with 1.25 stems bamboo. So overall for 5 layers bamboo slats for doors need = 3.75 stems bamboo or = Rp 16.000,- x 3.75 stems = IDR. 60,000,-. That is for one layer bamboo slats for door. The door is made from two layers of bamboo glued using halved bamboo reinforcement. For reinforcement one door need 120 stems bamboo. So for reinforcement 5 doors need 600 stems bamboo. Assumptions adhesive price = IDR. 40.000,-/kg and can be used to binds bamboo ± 100 m<sup>2</sup>. Two layers plait bamboo need

3,200 kg adhesive (overall doors). Overall 5 doors need 607.5 stems bamboo and 3,200 kg adhesive. Total price for 5 doors is IDR. 137.720.000,-.

Upper door construction equipped tralis plait with length 40 cm width 80 cm, need 80 cm length bamboo slats and 160 cm width bamboo slats. One bamboo house type 36 was designed using 5 pieces tralis plait bamboo upper door construction. Then to make one layer plait bamboo 5 tralis plait bamboo need length 400 cm and width 800 cm bamboo. For length = 400 cm can be filled with 0.6 stems bamboo, and width = 800 cm can be filled with 1.25 stems bamboo. So overall for 5 pieces bamboo plait for tralis door need = 0.75 stems bamboo or = IDR 16.000,- x 0.75 stems = IDR. 12.000,-. That is for one layer plait bamboo for tralis upper door. Tralis upper door are made from two layers of bamboo glued using halved bamboo reinforcement. For reinforcement one piece tralis upper door need 24 stems bamboo. So for reinforcement 5 piece tralis upper door need 120 stems bamboo. Two layers plait bamboo need 640 kg adhesive (overall tralis upper door). Overall tralis upper door need 121.5 stems bamboo and 640 kg adhesive. Total price for 5 piece tralis upper door is Rp. 27.544.000,-.

To make one piece sash window plait measured length 100 cm width 60 cm, need 200 cm length bamboo slat and 120 cm width bamboo slat. One bamboo house type 36 was designed using 8 pieces window plait bamboo. Then to make 8 pieces window plait bamboo need 1,600 cm length and 960 cm width bamboo. For length = 1,600 cm can be filled with 2.4 stems bamboo, and width = 960 cm can be filled with 1.5 stems bamboo. So overall for 8 pieces windows need = 3.6 stems bamboo or = Rp 16.000,- x 3.6 stems = IDR. 57.600,-. That is for one layer plait bamboo for window. The windows are made from two layers of bamboo glued using halved bamboo reinforcement. For reinforcement one piece window need 45 stems bamboo. So for reinforcement 8 pieces windows need 360 stems bamboo. Two layers plait bamboo need 3,072 kg adhesive (one window). Overall 8 pieces windows need 367.2 stems bamboo and 3,072 kg adhesive. Total price for 8 pieces windows is  $IDR\ 05 \times 600\ cm^2 + (295 \times 300)\ cm^2 + [(100 \times 300)\ cm^2\ for\ terrace]$  floors plait bamboo, or wide floors total = 301.500 cm<sup>2</sup>. Then to make floors plait bamboo 301.500 cm<sup>2</sup> need bamboo slats 1.206.000 cm<sup>2</sup>. Overall the bamboo slats need 3 stems bamboo or Rp 45.226,-. That is for one layer plait bamboo for floors. The floors are made from two layers bamboo glued using halved bamboo reinforcement. For reinforcement one piece floor need 565.31 stems bamboo. Two layers plait bamboo need 2,412 kg adhesive (overall floor). Overall floor for one bamboo house need 571.31 stems bamboo and 2,412 kg adhesive. Total price for floor is Rp. 105.621.000,-.

One bamboo house type 36 was designed using  $[(305 \times 240 \times 3) - (80 \times 200 \times 1) - (40 \times 80 \times 1) - (60 \times 100 \times 2)]\ cm^2 + [(295 \times 240 \times 2) - (80 \times 200 \times 1) - (40 \times 80 \times 1)]\ cm^2 + [(300 \times 240 \times 3) - (60 \times 100 \times 4) - (80 \times 200 \times 1) - (40 \times 80 \times 1)]\ cm^2 + [(300 \times 240 \times 2) - (60 \times 100 \times 2)]\ cm^2 + [(120 \times 240 \times 4) - (80 \times 200 \times 2) - (40 \times 80 \times 2)]\ cm^2$  walls plait bamboo, or wide walls total = 692.400 cm<sup>2</sup>. Then to make walls plait bamboo 692.400 cm<sup>2</sup> need bamboo slats 4.802.400 cm<sup>2</sup>. Overall the bamboo slats need 10.01 stems bamboo or Rp. 160.080,-. That is for one layer plait bamboo for walls. The walls are made from two layers bamboo glued using halved bamboo reinforcement. For reinforcement wall need 1,298.25 stems bamboo. Two layers plait bamboo need 9,604.8 kg adhesive (overall walls). Overall walls for one bamboo house need 1,318.27 stems bamboo and 9,604.8 kg adhesive. Total price for walls is IDR. 405.284.320,-.

One bamboo house type 36 was designed using  $(305 \times 600)\ cm^2 + (295 \times 300)\ cm^2 + [(100 \times 300)\ cm^2\ for\ terrace]$  ceiling plait bamboo, or wide ceiling total = 301.500 cm<sup>2</sup>. Then to make ceilings plait bamboo 301.500 cm<sup>2</sup> need bamboo slats 1.206.000 cm<sup>2</sup>. Overall the bamboo slats need 3 stems bamboo or IDR glued using halved bamboo reinforcement. For reinforcement one piece ceiling need 565.31 stems bamboo. Two layers plait bamboo need 2,412 kg adhesive



(overall ceilings). Overall ceilings for bamboo house need 571.31 stems bamboo and 2,412 kg adhesive. Total price for ceilings is IDR. 105.621.000,-.

One bamboo house type 36 was designed using 337.5 stems bamboo and 270 kg adhesive for roof = IDR. 16.200.000,-, and using 75 stems bamboo for truss roof = IDR. 1.200.000,-.

One bamboo house type 36 was designed using  $\pm$  54 stems bamboo for pillar house = IDR. 864.000,-.

Connection between bamboo use nails, one bamboo house type 36 need 17.1 kg nails = IDR 50 kg = IDR. 102.050.000,-

So to build one bamboo house type 36, overall need 607.5 stems bamboo and 3,200 kg adhesive = IDR. 137.720.000,- for door ; 121.5 stems bamboo and 640 kg adhesive = IDR. 27.544.000, – for tralis upper door ; 367.2 stems bamboo and 3,072 kg adhesive = IDR. 128.755.200,- for window ; 571.31 stems bamboo and 2,412 kg adhesive = IDR. 105.621.000,- for floor ; 571.31 stems bamboo and 2,412 kg adhesive = Rp. 105.621.000,- for ceiling ; 1,318.27 stems bamboo and 9,604.8 kg adhesive = Rp. 202.642.160,- for wall ; 337.5 stems bamboo and 270 kg adhesive = Rp. 16.200.000,- for roof ; 75 stems bamboo = Rp. 1.200.000,- for truss roof ; 54 stems bamboo = IDR. 864.000,- for pillar house ; 17.1 kg nails = IDR 564.300,- ; 20 kg plamur = IDR. 1.020.000,- ; 13 gallon paint contents 50 kg = IDR. 102.050.000,-.

To build one bamboo house type 36 need 4,023.59 stems bamboo ; 21,610 .8 kg adhesive ; 17.1 kg nails ; 20 kg plamur ; 13 gallon paint contents 50 kg ; total = IDR 1.032.443.820,-. Assumption bamboo house done by 2 workers as long as 6 days, wages IDR. 100.000,- /day, then total price bamboo house = IDR. 1.033.643.820,- or IDR. 287.123,28 per m<sup>2</sup>. The price is still cheaper than the price of traditional concrete house for Rp 2.4 million per m<sup>2</sup>.

## **CONCLUSION**

Total price bamboo house type 36 = IDR. 1.033.643.820,- or IDR. 287.123,28,- per m<sup>2</sup>. The price is still cheaper than the price of traditional concrete house for IDR 2.4 million per m<sup>2</sup>. Bamboo house price not including price making foundation and process preserving bamboo.

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