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# Development of laminated beams for furniture from industrial waste house on stilts in Woloan Tomohon city

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**Abstract**
Wood waste in Woloan Village, Tomohon City can be divided into several types, including small pieces of wood and wood chips from sawing and cutting from the manufacture of houses on stilts in Woloan Village, Tomohon City. Most of the waste from the stilt house industry in Woloan, Tomohon City, is just thrown away and burned. The waste from the stilt house industry is utilized by making laminated beams, laminated beams are made of furniture in the form of chairs and tables. This study aims to utilize wood waste by developing laminated beams and laminated beams that can be made Furniture in the form of tables and chairs. This research also helps create jobs for the community in Woloan, Tomohon City. After testing, the product is feasible to use.

**Keywords:** waste, laminated beams, table and chair furniture

## Introduction

Wood waste in Woloan Village, Tomohon City can be divided into several types, including small pieces of wood and wood chips from sawing and cutting from the manufacture of houses on stilts in Woloan Village, Tomohon City. The wood waste has not been properly utilized by producers into goods that have economic value, such as bark for handicrafts, pieces of wood to be used as miniature houses, pieces of wood or waste made for tables and chairs, sawdust which is processed into decorations. Walls, and so on.

Wood waste in Woloan Village, Tomohon City can be recycled and can be used for various other crafts. In the context of efficient use of wood, efforts should be made to utilize wood waste into more useful products. However, those who work on the home wood industry are mostly small and medium-sized entrepreneurs. Although it has been marketed outside the city, the craftsmen admit that they have not been able to export. The obstacle is the quality and knowledge that is still minimal.

Wood waste in Woloan, Tomohon City, is simply thrown away by the processing factory, piled up wildly in waste dumps around the factory or in waste disposal sites which are increasingly loaded with similar waste. Wood waste processing is the remains of pieces of wood or parts of wood that are considered no longer of economic value in a certain process, at a certain time and in a certain place that may still be used at a different process and time.

So far, these pieces of wood have not been used optimally. In fact, the solid waste of wood can still be used to manufacture products that have artistic and economic value. Utilization of wood scraps which were originally solid waste or waste is not only an effort to manage solid waste, but also for optimizing wood as a renewable natural resource.

One of the uses of wood waste is by making laminated wooden blocks. In Woloan Village, Tomohon City, it is still rare to find any furniture that uses the laminated beam method in producing furniture, this is due to the lack of socialization and lack of knowledge about the laminated beam method. Along with the increase in population, the demand for materials produced by the Funiture industry is increasing, so is the need for labor to meet the large number of consumer demands, but the lack of availability of equipment used in making houses on stilts in Woloan Village, Tomohon City.

The production of stilt houses in Woloan Kota Village produces a lot of wood waste. The wood waste is often disposed of and used by the community as firewood for cooking. One of the uses of wood waste is by making laminated wooden blocks where the thickness of each layer of laminate according to PKKI NI-5 1961 article 18 is between 25-30 mm while according to Breyer (1999) the maximum thickness of one-ply wood laminate is 50 mm (2 inch) and the nominal thickness of laminated wood which is usually made is 25-50 mm (1-2 inch). Laminated beams can be made Furniture in the form of chairs and tables can also be made jewelry making Furniture with an easy lamination method to make the desired motifs or textures.

In the Tomohon area and its surroundings, it is still rare to find furniture products that use the laminated beam method in producing furniture, this is due to the lack of socialization and the lack of knowledge about the laminated beam method. Along with the increase in population, the demand for materials produced by the Funiture industry is increasing, so the need for labor is also increasing to meet the large number of consumer demands. Products made of laminated wood are tables and chairs. In Woloan Village, Tomohon City, tools or machines are needed to support the business of adequate laminated wood furniture so that the production results are good so that they can meet the availability of consumers through wood waste products in the form of tables, chairs and other souvenirs with production. Funiture is proportional to the needs of the

work, making many of the furniture industry only limit the number of employees.

## Research Methods

### Development Procedure

The product that will be produced begins with an analysis of the needs of the Woloan stilt house industrial waste from the research location, the product produced is in the form of laminated beams from the waste of the stilt house industry and made furniture products in the form of tables and chairs. In general, the Research and Development (R&D) model has been developed by Borg & Gall (1983) through the following stages of development

1. Research and Information Collecting The first step is needs analysis, literature study and small research.

a. Needs analysis, which is done by looking for information related to the problems faced by the location or area that is the target of product development.

b. Literature study, small-scale research, this is intended as a result of the identification that has been carried out by researchers regarding products that are needed to ensure that the product that researchers will develop can actually be a product that can solve problems in the Woloan Village 1 of Tomohon City as a research location. .

2. Research Planning (Planning) Planning includes: formulating research objectives, estimating things that are needed in research, formulating qualifications in research and forms of participation in research.
3. Design Development (Develop Preliminary of Product). These stages include:

1. Designing products to be developed, product designs for tables and chairs.
2. Determine the facilities and infrastructure. needed during the study:

4. Initial Field Testing.
5. Revise the Main Product Revision.
6. Field Testing (Main Field Testing).
7. Revision of Field Test Results (Operational Product Revision).
8. Feasibility Test (Operational Field Testing).
9. Final Product Revision.
10. Product Dissemination and Implementation (Dissemination and Implementation) Publish the results of the developed product so that it can be implemented in general or in a wider scope.

1. Product Design Test

1. Trial Design
2. Trial Subject
3. Trial Time

2. Compressive Strength Test of wood

Wood Compressive Strength Test (SNI 03-3958-1995)

The compressive strength parallel to the fiber is calculated by the load per unit area of compression:

$$fc// = \frac{P}{bxh}(MPa)$$

fc//: compressive strength parallel to fiber
P: maximum test load
b: width of test object
h: the height of the test object

1. Calculation of Compressive Strength

The compressive strength perpendicular to the fiber and the compressive strength parallel to the fiber is calculated by the load per unit area of compression:

$$fc \perp = \frac{P}{bxh}(MPa)$$

Information
Fc: compressive strength perpendicular to fiber
P: maximum test load
b: width of test object
h: the height of the test object

### Data collection technique

**Data collection methods are as follows**

**1. Primary Data**

**Live Observation**

Visual data from direct observation is very supportive of understanding the written data obtained. The data obtained from direct observation of the gluing of wood waste laminates.

**Laboratory Test**

Laboratory tests were conducted to obtain data on the compressive strength of solid wood and the compressive strength of laminated beams used in the analysis.

## Results and Discussion

Development Research Results

1. Testing the Compressive Strength of Wood (SNI 03-3958-1995)

The results of testing the compressive strength of laminated beams of local aliwowos wood and mahogany wood with test objects measuring 50mm x 50 mm x 200 mm (5 cm x 5 cm x 20 cm)

**Table 1:** Calculation of the compressive strength of laminated beams of local Bopasa wood and Mahogany wood

| No | Date of manufacture | Test date | Weight (g) | Field Size | | Area $cm^2$ | Crushing Load (kg) | Compressive Strength $kg/cm^2$ |
|---|---|---|---|---|---|---|---|---|
| | | | | Length | Width | | | |
| 1 | 7 June 2021 | June 14, 2021 | 382 | 5.00 | 5.00 | 25.00 | 12000 | 480 |
| 2 | 7 June2021 | Juni 14, 2021 | 377.5 | 5.00 | 5.00 | 25.00 | 8000 | 320 |
| 3 | 7 June 2021 | Juni 14, 2021 | 365 | 5.00 | 5.00 | 25.00 | 8000 | 320 |
| 4 | 7 June 2021 | Juni 14, 2021 | 382.9 | 5.00 | 5.00 | 25.00 | 8000 | 320 |
| 5 | 7 June 2021 | Juni 14, 2021 | 383 | 5.00 | 5.00 | 25.00 | 10000 | 400 |
| | | | | | | | ∑x | 1.480 |
| | | | | | | | Average | 296 |

Testing the Compressive Strength of Wood (SNI 03-3958-1995)

**2. Test Results of Solid/Whole Beams Local Mahogany Wood With Test Objects Size 50mm x 50 mm x 200 mm (5 cm x 5 cm x 20 cm)**

**Table 2:** Calculation of Compressive Strength of solid wood/solid wood beams in the direction of the wood grain

| No | Tanggal Pembuatan | Tanggal Pengujian | Berat (g) | Ukuran Bidang | | Luas $cm^2$ | Beban Hancur (kg) | Kuat Tekan $kg/cm^2$ |
|---|---|---|---|---|---|---|---|---|
| | | | | Panjang | Lebar | | | |
| 1 | 7 June 2021 | Juni 14, 2021 | 337.8 | 5.00 | 5.00 | 25.00 | 8000 | 320 |
| 2 | 7 June 2021 | Juni 14, 2021 | 325 | 5.00 | 5.00 | 25.00 | 8000 | 320 |
| 3 | 7 June 2021 | Juni 14, 2021 | 326.9 | 5.00 | 5.00 | 25.00 | 7000 | 280 |
| 4 | 7 June 2021 | Juni 14, 2021 | 346.7 | 5.00 | 5.00 | 25.00 | 8000 | 320 |
| 5 | 7 June 2021 | Juni 14, 2021 | 350.7 | 5.00 | 5.00 | 25.00 | 8000 | 320 |
| | | | | | | | ∑x | 1.560 |
| | | | | | | | Average | 312 |

Average compressive strength = 312 $kg/cm^2$

The results of making laminated blocks into furniture products in the form of tables and chairs.

3. The result of making laminated beams to make chairs Wood waste materials from the production of stilt houses in Woloan Village, Tomohon City, waste materials, namely mahogany wood waste and Aliwowos wood waste. Wood waste is chosen so that the quality of wood waste is maintained, wood waste is cut according to the required size to make one table and two chairs.

Waste wood sheets are cut according to the required length and also in accordance with the amount needed to make tables and chairs. Furthermore, the waste material of the wood sheets is glued together with epoxy glue. Wood waste 2 pieces of mahogany wood waste 3 pieces of Aliwowos wood waste, a total of 5 pieces of wood waste to be glued into blocks with a patterned color of wood waste. 4 pieces of mahogany wood waste and 3 aliwowos wood waste, a total of 7 pieces of wood waste to be glued into blocks with a color patterned wood waste. The wood waste sheet is glued and clamped with a wood clamp tool, three hours of hard dry wood epox glue. The maximum adhesion of epoxy glue is within sixteen hours. After finishing the glue, the wood clamps were opened and a wooden laminated beam with a thickness of 4 cm, a width of 5 cm and a length of 35 cm was made for the support for the four beams, there are also 4 cm thick, 5 cm wide and 80 cm long. The chair has four beams. The seat threshold is 4 cm long, 7 cm wide and 80 cm long.

4. Laminate beams are planed on a drawstring machine with each size measuring the same thickness, namely 3.5 cm, finished shaved, cut into pieces with a length of 30 cm for the chair post/column, the material needed is 4 beams, for the legs/column the long chair is 74.5 cm, the material needed is 8 pieces of blocks, for the upper threshold of the left and right side chairs, the length is 66 cm, the material needed is 4 pieces, for the lower threshold, the left and right sides are 61 cm long. 4 ingredients needed.
5. Wood waste measuring 3.5 cm thick, 3.5 cm wide, ± 75 cm long, is crushed in a shaving machine with a thickness of 3 cm, width 2.5 cm, after being shaved, it is cut into pieces with sleeves measuring 5 and 10 cm long.

The waste material is glued by making a texture, the color of the wood is made crosswise so that the wood color looks attractive. The wood waste is glued one by one, top and bottom, with aliwowos waste material measuring 3 cm x 1.5 cm x 51 and the glue used is epoxy glue, the wood waste material is made of 3 cm x 18 cm x 51 cm backrest panels, two panels for two chairs, after being glued, the laminated material is drawn and made with a size of 2.5 cm x 18 cm x 51 cm with a flat surface and the same size.

There are laminated beams that are in the tray, made of purus, made of purus places and after that they are assembled they are made into shapes according to the working drawings.

**Results of making table Laminate**

Making table laminate panels with a diameter of 50 cm. The waste materials used are mahogany wood waste and Aliwowos wood waste with the size of wood waste. Furthermore, for the table leg support material, it is taken from the rest of the table leaf panel material.

6. Product Trial in the Initial Field (Prelimenary Field Testing) Stages related to

1. Conduct initial testing at the Laboratory of the Department of Building Engineering Education, Faculty of Engineering, Manado State University on chair and table products.
2. The test is limited to chairs and tables by means of several students who are tested by sitting on the chair products that have been made. The unit testing of the chair product was carried out in the wood laboratory of the Faculty of Engineering, Manado State University, this test involved students of Building Engineering Education.
3. Trials are carried out many times in order to get a design that suits your needs. Through repeated trials, no change in shape was found, the results were very good with gathering information through interviews.

7. Revising the Main Product Revision This stage is an improvement from the results of the initial trial. At this initial product refinement stage, more is done with a qualitative product approach. Laminate products from industrial wood waste from Woloan Village, Tomohon City, the results are very good because they have a good texture and the chairs have good strength.
8. Main Field Testing This resistance relates to product testing more broadly, which includes:

a. This test is very effective because it can utilize industrial waste in Woloan Village, Tomohon City and the product design is very good. This test also involves several wood craftsmen.
b. Test the effectiveness of the design using a repetition model experiment technique.

c. Chair and table products from waste
The result of the field test is an effective design, both in terms of substance and methodology. Data related to product use is collected to see the effectiveness and efficiency of chair and table products.

9. Revision of Field Test Results (Operational Product Revision) Product revisions were obtained from inputs given by experts and users as testers of wood waste products in the form of tables and chairs. The input given is in the form of comments and suggestions obtained, revisions are made to the stage of the product being developed to make it even better and suitable for use.
10. Feasibility Test (Operational Field Testing) The results of the product feasibility test are obtained from an overall assessment that has been carried out with several stages of testing the feasibility of industrial waste products on stilts in Woloan Village, Tomohon City. Waste products in the form of chairs and tables are suitable for use and application
11. Final Product Revision
Development of laminated beams for furniture from industrial waste from houses on stilts in Woloan, Tomohon City.

The last testing stage is acceptance testing to test usability aspects with product testing techniques. Product testing is done by asking experts for consideration or validity. Product Dissemination and Implementation (Dissemination and Implementation)
The results of the table and chair products are published and developed so that they can be implemented in general or in a wider scope

**Discussion**

**1. Testing the Compressive Strength of Wood (SNI 03-3958-1995)**

From table 4.1 the results of the calculation of the compressive strength of laminated beams of local wood, Aliwowos wood and mahogany wood, the maximum compressive strength test is 480 kg/cm². Weight (g) 382 length 5.00 width 5.00 cm² area 25.00 crushing load (kg) 12.000 compressive strength kg/cm² 480. The average compressive strength is =296 kg/cm².

**2. Testing the Compressive Strength of Wood (SNI 03-3958-1995)**

From table 4.2 Compressive Strength Calculation Results for solid wood/whole wood beams in the direction of wood grain, the maximum compressive strength test is 320 kg/cm² compressive strength for each 1) Weight (g) 337.8 length 5.00 width 5.00 cm² area 25.00 crushing load (kg) 8.000 compressive strength kg/cm² 320 2) Weight (g) 325 length 5.00 width 5.00 cm² area 25.00 crushing load (kg) 8.000 compressive strength kg/cm² 320 3) Weight (g) 346.7 length 5.00 width 5.00 area cm² 25.00 crushing load ( kg) 8,000 compressive strength kg/cm² 320 4) Weight (g) 350.7 length 5.00 width 5.00 cm² area 25.00 crushing load (kg) 8,000 compressive strength kg/cm² 320 with average compressive strength = 312 kg/cm²

**3. The results of making laminated blocks into furniture products in the form of tables and chairs.**

1. The result of making laminated beams to make chairs

**Laminate beam size**

- Backrest pole size: 3.5 cm x 5 cm x 25 cm = 4 pieces
- Poles/columns: 3.5 cm x 5 cm x 74.5 cm = 8 pieces
- Upper threshold: 3.5 cm x 7 cm x 66 cm = 4 pieces
- Lower threshold: 3.5 cm x 7 cm x 61 cm = 4 pieces
- Threshold face: 3.5 cm x 7 cm x 51 cm = 4 pieces

**Backrest lamination size**

- Mahogany waste: 3 cm x 2.5 cm x 5cm = 2 pieces
- Aliwowos waste: 3 cm x 2.5 cm x 5cm = 3 pieces
- Mahogany waste: 3 cm x 2.5 cm x 10 cm = 11 pieces
- Aliwowos waste: 3 cm x 2.5 cm x 5cm = 10 pieces

**Laminate seat**

- Mahogany waste: 3 cm x 2.5 cm x 5cm = 6 pieces
- Aliwowos waste: 3 cm x 2.5 cm x 5 cm = 5 pieces
- Mahogany waste: 3 cm x 2.5 cm x 10 cm = 21 pieces
- Aliwowos waste: 3 cm x 2.5 cm x 5cm = 22 pieces

The waste material is glued by making a texture, the color of the wood is crossed to make it look attractive. The wood waste is glued one by one, the wood waste is made into a backrest panel with a size of 2.5 cm x 30 cm x 51 cm.

- Aliwowos waste: 3 cm x 1.5 cm x 51 = 2 pieces

Wood waste material is made of a backrest panel with a size of 3 cm x 18 cm x 51 cm

**Results of making table laminate**

Making table laminate panels with a diameter of 50 cm. The waste materials used are mahogany wood waste and Aliwowos wood waste with the size of wood waste:

- Size of mahogany wood waste: 3.5 cm x cm x 5 cm = 5 pieces
- Size of mahogany wood waste: 3.5 cm x cm x 10 cm = 28 pieces
- For table poles only one pole with a clean size that has been shaved and cut to a size of 10 cm x 10 cm x 51 cm, the poor threshold for the net size after being shaved and cut to a size of 4 cm x 5 cm x 40 cm = 2 pieces, Malang bottom after being shaved and cut with a size of 5 cm x 5 cm x 45 cm = 2 pieces.
- Next for the table leg support material is taken from the rest of the table leaf panel material.

**4. Product Trial in the Initial Field (Prelimenary Field Testing) Stages related to:**

1. Conduct initial testing at the Laboratory of the Department of Building Engineering Education, Faculty of Engineering, Manado State University on chair and table products.
2. The test is limited to chair and table products by means of several students who are tested by sitting on the chair product that has been made.

1. Trials are carried out many times in order to get a design that suits your needs. Through repeated trials, no change in shape was found, the results were very good with gathering information through interviews.

1. Revising the Main Product Revision This stage is an improvement from the results of the initial trial. At this initial product refinement stage, more is done with a qualitative product approach. Laminate products from industrial wood waste from Woloan Village, Tomohon City, the results are very good because they have a good texture and the chairs have good strength.

1. Field Testing (Main Field Testing) This resistance relates to product testing more broadly, which includes:

a. This test is very effective because it can utilize industrial waste in Woloan Village, Tomohon City and the product design is very good. This test also involves several wood craftsmen.
b. Test the effectiveness of the design using a repetition model experiment technique.

**Chair and table products from waste**

C. The result of the field test is an effective design, both in terms of substance and methodology. Data related to product use is collected to see the effectiveness and efficiency of chair and table products.

3. Revision of Field Test Results (Operational Product Revision)

Product revisions were obtained from inputs given by experts and users as testers of wood waste products in the form of tables and chairs. The input given is in the form of comments and suggestions obtained, revisions are made to the stage of the product being developed to make it even better and suitable for use.

4. Feasibility Test (Operational Field Testing)

The results of the product feasibility test are obtained from an overall assessment that has been carried out with several stages of testing the feasibility of industrial waste products on stilts in Woloan Village, Tomohon City. Waste products in the form of chairs and tables are suitable for use and application

5. Final Product Revision

The final product of this research is the development of laminated beams for furniture from industrial waste from houses on stilts in Woloan, Tomohon City. To produce quality table and chair products from wood waste, a standard is needed for testing the feasibility of products from industrial waste made into tables and chairs.

6. Product Dissemination and Implementation (Dissemination and Implementation). The results of the table and chair products are published and developed so that they can be implemented in general or in a wider scope.

**Conclusion**

This laminated beam development model is very good and has advantages such asbeautiful texture and attractiveness to consumers. The texture of the laminated beam can be made in various motifs as desired. Innovation is desperately needed in the development of laminated beams.

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