LAPORAN PENELITIAN

“Penerapan Desain dan Pengembangan Limbah Kayu Pinus untuk Komponen Interior Bangunan”

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Research Report

APPLICATION OF DESIGN AND DEVELOPMENT OF PINE WOOD CONE FOR MATERIALS CONSTRUCTION OF BUILDING AND FURNITURE INTERIOR COMPONENTS

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Abstract

Pine merkusii Jungh et de Vriese is a member of the Pinaecae family that has no flowers or fruit. But in the form of a gymno ovule, it is tucked in between a series of circular strands upward forming a wooden cone which some people use for: briquettes and handicrafts. Potential pine cambium is mostly processed into: furniture, matches, wall panels, pulp, and sap for gondorukem and turpentine solutions. Utilization of pine cone waste, especially for supporting materials for the construction of interior components and furniture, has never been examined.

Pine wood (strobilus) cones have fiber characteristics: hard, tough, termite resistant, brown in color, little moisture content as well as abundant waste, especially during the dry season. This potential is the basis for a study entitled 'Application of Design and Development of Pine Wood Cones (Strobilus) for Construction Materials for Building Interior Components'.

The research method will use the method of solving: quantitative and experimental to pine cone waste that is milled into aggregate then to increase its resistance to organism attack will be modified by impregnation. The next process is the aggregate extracted with an adhesive solution and then poured into a mold panel that is shaped according to design. The purpose of this research is to produce alternative materials for the construction of interior components such as insulation, flooring and decorative lighting.

Key words: wood cone, pine merkusii, adhesive, aggregate, impregnation

INTRODUCTION

1. Background

Pine wood has an average specific gravity of 0.55, including strong class III and durable class V (Pandit & Kurniawan 2008). Pine is a type of wood which is quite available in Indonesia, in the production forests of Perum Perhutani on Java itself, which covers 483,272 ha (Perum Perhutani 2012). Utilization still prioritizes the sap, while the wood is used for charcoal, pulp and paper. Pine wood has the potential as a furniture raw material because of its beautiful pattern but has a weakness in its durability, so modifications are needed to increase its resistance to organisms. Modification of the properties of wood can be done one of them by impregnation. Impregnation is the filling of wood with monomers followed by the polymerization of free radicals into the lumen and cell walls. Plastic material impregnated into wood will fill cell cavities and form bonds with cellulose chains from wood (Ibach et al. 2005). Impregnation technology in wood is a modification technique that can increase the durability of wood (Hill 2006). One material that can be used for wood modification is methyl methacrylate (MMA). MMA is included in the acrylic compound which has good UV stability characteristics so that it is suitable to be applied in the use of interior construction.

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Pine wood has a characteristic scented sap and also the surface form of a certain aesthetic cambium skin surface, so that its utilization has always been stricken and used from traditional to modern buildings. Thus in order to maintain a balance between the availability of material from industrial forests and the fulfillment of the needs of users and producers, in many developed countries designers and material experts endeavor to continue to conduct research on non-wood origin materials to be used as alternative materials but still have natural fiber surfaces. Exploration of wood is based on the thoughts of experts who state: "That technological innovation offers the possibility and role of designers in finding ways to exploit and maximize the unexpected potential of those who make technological innovations but the results can only be validated by those who might choose to use them" (Sam Booth and Drew Plunkett, 2014). Starting from the view above, the author intends to propose hypotheses and experiments, as stated that each design is a hypothesis and a practical experiment. By its nature, design aims to solve problems in a certain way in an environment. (Cindy Coleman, 2002).

Types of Pinus merkusii Jungh et. de. Vriese is a tree species that thrives in the forests of Indonesia. Ecologically Pine merkusii is a wood species that has characteristics such as: a. Growth is relatively fast when compared to other types, b. Does not require a place to grow with certain conditions, and can grow from 200 - 2000 m above sea level. (Budiman Mampi, 2018). Forests have important benefits for life, namely the presence of forest products in the form of wood and non-wood. Non-Timber Forest Products (NTFPs) are a very abundant natural resource in Indonesia and have excellent prospects for development. Non-Timber Forest Products have a far more economic value than the value of wood which is still considered a main product. Non-Timber Forest Products are important for sustainability because the harvest process can usually be done sustainably and without damage to the forest. One of the ways to reduce the dependence on wood originating forest products (HHAK) is by utilizing non-wood forest products (HHBK), namely pine cone waste (cones, strobilus).

The wood cone **will be observed its characteristics through the following stages: first, each strand / fiber arranged in a circle from the base to the top of the pine cone-forming peel and remove the seeds attached to the bottom end. Second, the strands / fibers clean from dirt and dried for 1 hour. Third, each strand of fiber is ground / broken / cut into granules measuring: 3 - 10 mm. Fourth, the granules mixed with an adhesive solution are stirred until they soak into each grain of pine cone fiber. Fifth, prepare a mold with a design size in accordance with the planned *prototype model.* Seventh, the entire surface of the mold is coated with heat mirror (glass mirror) with water spray or brush until evenly distributed. Eighth, pour the aggregate mix with the adhesive solution into the mold (valve) in the form of patterns according to the design of the drain to dry. Ninth, do the opening on each mold of the product and then rinse with water can also be with ND thiner to peel off the attached mirror glass. Tenth, do the finishing process on the panel surface for interior components such as: floor, wall, ceiling and furniture.**

The purpose of this experiment is to produce alternative materials that are not derived from wood (cambium) and become a commodity as non-timber forest products in the forestry sector and to provide benefits for the material industry for building construction. Until now, the use of non-pine forest products has been used more in pine resin as a base material for making gondorukem and turpentine solutions. The use of gondorukem is as a varnish material, soap making material, batik making material, solder material, printer ink, paint and others. Turpentine can be used as a thinner for paints and varnishes, waxy solvents and ingredients for making camphor synthesis (Budiman Mampi, 2018).

Utilization of non-timber forest products as already described is more focused on the use of pine resin, but the use of non-wood elements to be used as other functions has never been done. The author observes pine cones found in the forest conservation area of Cikole Village, Lembang Subdistrict, the presence of pine cones so far is considered as rubbish, sometimes burned and left to rot between rows of pine trees. Based on the ability of the community to treat the wood cone, the researcher will try to do more in-depth research on the other potential of the pine cone, especially if it is processed into an alternative raw material for the construction of interior components such as walls, floors, ceilings and furniture. To find out how many other benefits of pine wood, the author tries to conduct more in-depth research on wood cone material that is the focus of research, which proposes the title: Application of Design and Development of Wooden Cones (strobilus, cones) Pine for Interior Components of Buildings and Furniture.

A. Purpose and Use

This study aims to find out how much utilization of the potential of non-wood pine and sap. The usefulness of this research is expected to provide information on the additional potential of pine wood, namely pine cone waste scattered around the Protected Forest in Cikole Village, Lembang District, North Bandung Regency, which will serve as the basis for the Application of Pine Cone Design and Development for Interior Components of Buildings and Furniture. More on the material origin of non-wood (cambium) namely the cone of wood (strobilus, cones) pine which will be focused on how to apply the appropriate design when using pine cone material that is processed into aggregate granules measuring 3-10 mm in size. The next process will be observations and experiments on adhesives that are suitable as adhesives for pine cone aggregates.

The questions will be looked for answers before doing material research. The author may find it difficult to express design in this way, because much of the design process is intuitive and unconscious, relying on pictures, metaphors, and tacit knowledge rather than explicit knowledge and logical thinking. However, these steps are very important for research. Mention the design hypothesis (this is derived from the design goals and objectives).

- If we observe the characteristics of the texture of the material processed from pine cones applied to interior components and furniture, what happens? and what change of treatment is expected?
- What would be the solution to get this result (e.g. Dimension reduction, smaller furniture, more visual appearance)?

B. Expected Results.

- What other treatments or results will tell that the hypothesis has a response?
- Why did the researcher choose this indicator?

Example : the selection of building materials by designers and manufacturers that are applied based on consideration in aspects of meeting technical requirements such as durability, moisture content, flexural strength and aesthetic functions such as texture shape. In response to this, designers are concerned with innovation and new ideas, because the application of materials for the construction of interior components can improve the quality of interaction between users and the atmosphere of space.

C. Design hypothesis.

The material used for the interior components of various building types includes the following features and intended purposes such as: walls, floors, ceiling and furniture, is a good visual access in space and room facilities, so visitors / users / managers can interact by seeing and feeling a certain atmosphere that is happening in the area.

D. Expected Results.

This design component is usually not well articulated. However, to assess the impact of a design, the expected results need to be clearly stated because this serves as a measure of success. For example, indicators of the potential success of *pine cone* aggregate materials can be increased for use in building interior components such as walls, floors, ceilings and furniture. an increase in the aesthetic value of the material felt by the user, increased knowledge about the application of the design by using aggregate material from *pine cones*.

E. Research Methods

The method used in this research is observation and experiment on pine cone material which is extracted with an adhesive solution with the aim of becoming an alternative natural textured material to replace the original natural origin material (wood from forest products). Further research will use the following methods: quantitative methods, quantitative data also includes size, length, thickness, width, height, surface area of the field, the level of effectiveness of use. Thus, quantitative data can include subjective and objective actions. (Cindy Coleman, 2002).

F. Measurement.

Objective technique, studying things that are independent of the mind - that is, features and characteristics of objects. For example, one's feelings about the amount of privacy experienced in a place where construction uses certain natural or artificial materials is a subjective measure. Physical measurements of space (for example: partition height, area thickness), surface treatment of materials and acoustics, all of which affect the perception of privacy, are objective measures. Subjective assessments use techniques such as rating scales, while objective assessments use physical measurements that are translated into numbers (length, width, height, etc.).

G. Survey

Survey, observing at the Pine Forest Conservation location Cikole Village, Lembang District, North Bandung Regency. Some of the main issues to consider in developing a survey are as follows: identify what you want to know and why. Many design evaluation surveys ask respondents to rate both overall satisfaction with specific environmental features as well as their level of importance. (Interior Design Handbook of McGraw-Hill's Professional Practice Cindy Coleman, Editor-in-Chief)

2. Experiment

Pine cone is a part of a pine tree that is manifested from the arrangement of circular fibers from the base to the tip that resembles a cone measuring in diameter: 3-5 cm, height 7-12 cm. At each base of the *pine cone* fiber contains a larger female gamete called the *pine cone*, and can also be called a female cone or strobilus megasporangiate. Also on some strands of fiber containing the male "gamete cone" gamete is rightly called strobili microsporangiate, which is not an easy general use term. Also the term "catkins" (from cat tail).

To find out the good quality of aggregates produced from ground pine cones can be seen from the results of fiber testing how much: water content, hardness, hardness while physical testing by sensory testing of texture, color and durability. Basically, the aggregate of the pine cone wood cone extracted with an adhesive solution that has a strong adhesive power, then stirred evenly and cast into the mold (matres) that has been provided according to the desired design. To unify the aggregate into a solid material the writer has tested several types of adhesive materials and it was decided that the most suitable adhesives for gluing pine cones, namely with Epoxy type. Adhesives are natural or synthetic binders that are used by coating the two surfaces to be bonded.

Epoxy Adhesive is a 2 component adhesive consisting of Resin and Hardener. Both are placed in separate places and if used will be mixed and stirred until smooth. This 2 component Epoxy glue has high adhesion, strength / strength and is more resistant to high temperatures.

If it is to be used, the mixing of resin and hardener is affected by the accuracy of the ratio of the number (mix ratio), temperature and humidity.

Epoxy Adhesive 2 component solution with a comparison composition, H: R = 1: 1 (volume / volume). Allowable tolerance limit if one is over is a maximum of 5% excess Resin. (SENTRA POLIMER, Polymer Information Media - Year VII Number 30 - August 2009 Edition - ISSN 1693 6132)

Tabel 1. Epoxy Product Data

No.	Weber Epoxy			
	Product name	***Physical Properties***	***Technical Data***	***Application data*** ***Mix ratio, H: R = 1: 1***
1	▪ Weber Epoxy ▪ Type: General ▪ Basic Solvents: Bisphenol (Resin) and Polyamide (Hardener) ▪ Solvents: Toluene / Xylene	▪ Color: Resin: clear ▪ Color: Hardener: clear-brown ▪ Phase: Gel - Liquid ▪ Smell: Typical sting	▪ Solid Contain: 97.47% ▪ Viscosity: Resin: 3,400 - 3,800 (cps), (BF, sp6-rpm10) ▪ Viscosity: Hardener: 5,000-6,000 cps (BF, sp6-rpm10)	▪ Dry touch: 2 hours ▪ Dry Wipe: 3 hours ▪ Fingerprint free: 4 hours ▪ Dry hard: 12 hours ▪ Perfect Hard Dry: 72 hours ▪ Gel time: 90 minutes

Epoxy, is a liquid adhesive that has high strength, pore / gap filling capacity is quite wide, the structural ability to glue materials that are difficult to stick and waterproof properties, epoxies are definitely high-performance adhesives in the wood industry. Epoxy consists of epoxy resin and amine hardener. The resin and hardener parts that are usually the same are mixed to activate the adhesive and start the evaporation process, which works by chemical reactions rather than evaporation of the solvent. The right proportion of mixing is important; too many components will affect the strength of the bond. Because of the lack of solvents, epoxy has the ability to fill extraordinary gaps. (The Art of Woodworking - Beginners Guide., Brought To You by http://www.woodworkweb.com).

Panel products from Pinus mercusii wood cone is one of the material innovations for supporting interior components such as: sky, walls, floors and furniture. Also as an alternative material conventional material derived from wood (cambium). The advantages obtained from these panels from pine cones include: 1) Can produce natural textured artificial materials, 2) wood cone panels produced are more waterproof than conventional panels such as: gypsum, grc, plywood, hard board, MDF so it is suitable used to support construction in the tropics, 3) The shape can be made with a special design (custom), and a typical form that is produced using a printing tool (matres), 4) The process of milling and casting raw materials of pine cone aggregates does not cause problems, even with the presence of pine cone waste extraction activities can reduce environmental pollution around pine forests, 5) Ages of pine cones can be treated according to the shape of the design needed, 6) More cheap compared to the original wood material, 7) pine wood waste material is abundant especially in the dry season.

A. Panel products from Pinus merkusii wood cones (strobilus)

1. Material

   a. Wood cone (stobilus);

   b. Resin or Epoxy, as a cone adhesive aggregate for wood;

   c. transparent melamic laquer, as an aggregate filler filler;

2. Tool

   a. Aluminum griddle size 40x40 cm, used as a container for drying and drying pine cone strands;

   b. Ram wire hole size of 0.5 x 0.5 cm or to filter the aggregate that has been ground;

   c. Grinding machine, used to break wood cone fibers into aggregates;

   d. Scoop, used to stir epoxy resin dough;

   e. CC measuring tube, used to measure chemical solutions;

   f. The cup, used to stir the adhesive solution with aggregate;

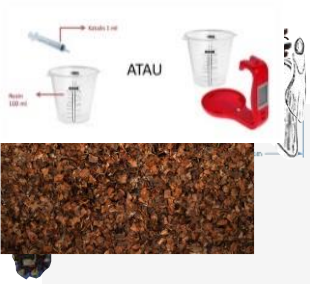
   g. Prints of 60x60 cm, 30x30 cm (panel color as desired), for printing aggregate dough;

   h. Fan, used to fan the odor of resin solution;

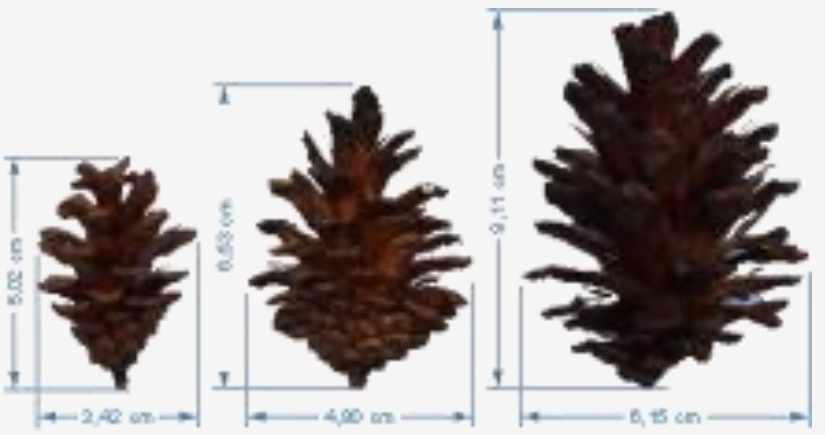
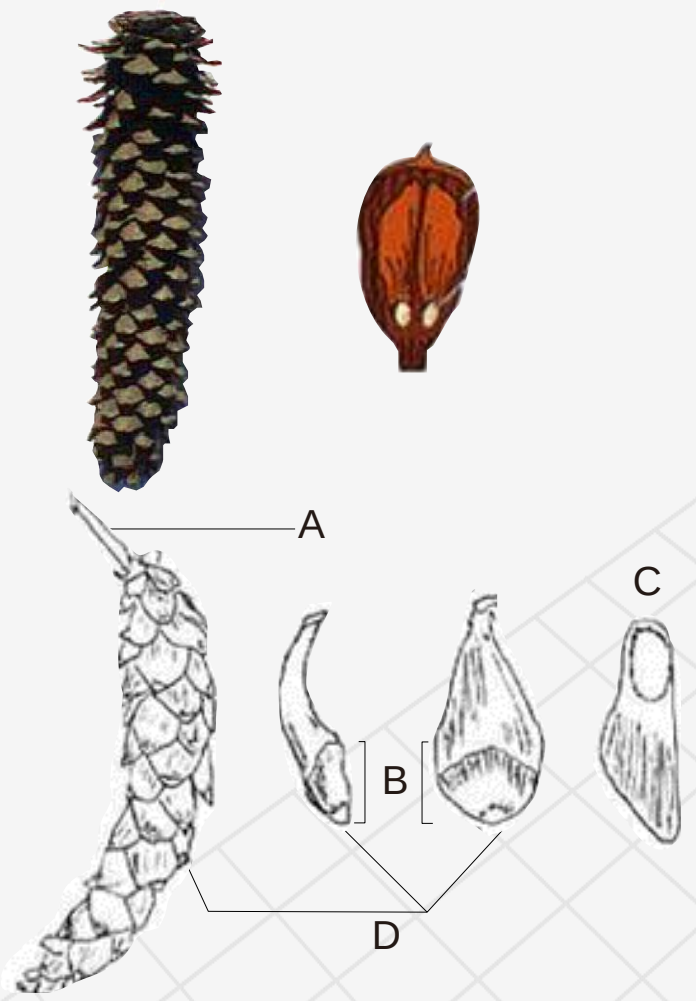
   i. Clam, to clamp the product mold

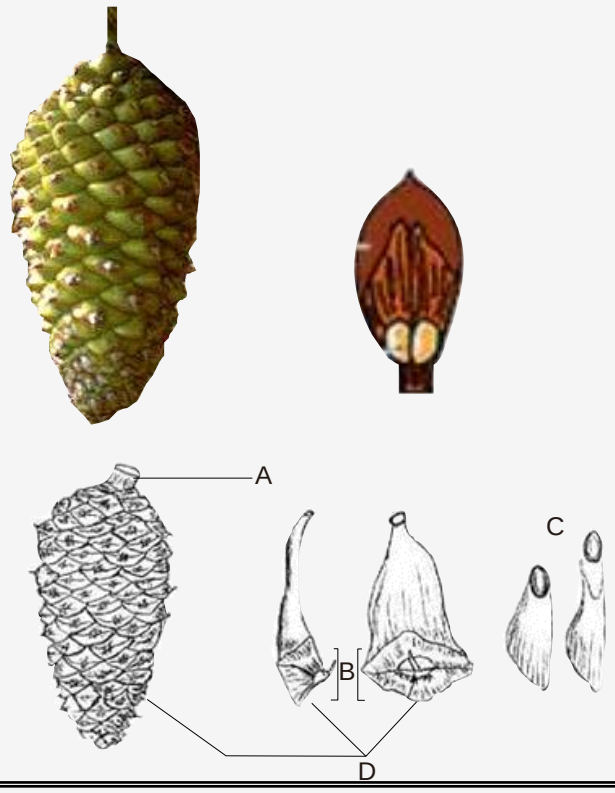
B. Making Process

a. Put 1 kg of pine cone granules / aggregate into a container, pour ¼ lt (25 cl) resin on the measuring cup and add 2.5 cl catalyst then stir until evenly distributed, then add pine cone and mix with resin solution = catalyst stir until evenly distributed, keep stirring for 3 minutes but still the entire surface of the pine cone aggregate can be covered;
b. After that, pour the pine cone aggregate mixture + resin + catalyst in a model mold with the entire surface polished with mirror glass (wax), wait for about 5-10 minutes, then the surface of the dough is covered with granite or iron plate and then clamped with clamps so that the during chemical heating the printed form is not curved; Setelah 1 jam lalu hasil pengecoran pada cetakan dibuka dengan alat obeng atau pisau cater;
c. Clean the entire surface of the printed product by applying a ND thiner solution then wiping it with a brush or a plastic brush;
d. The next process, rinse with water + a little soap molds then drain with stacked in a horizontal position in a place that is not exposed to direct sunlight.



Tabel 2. Data Kerucut Kayu (stobilus) Pinus

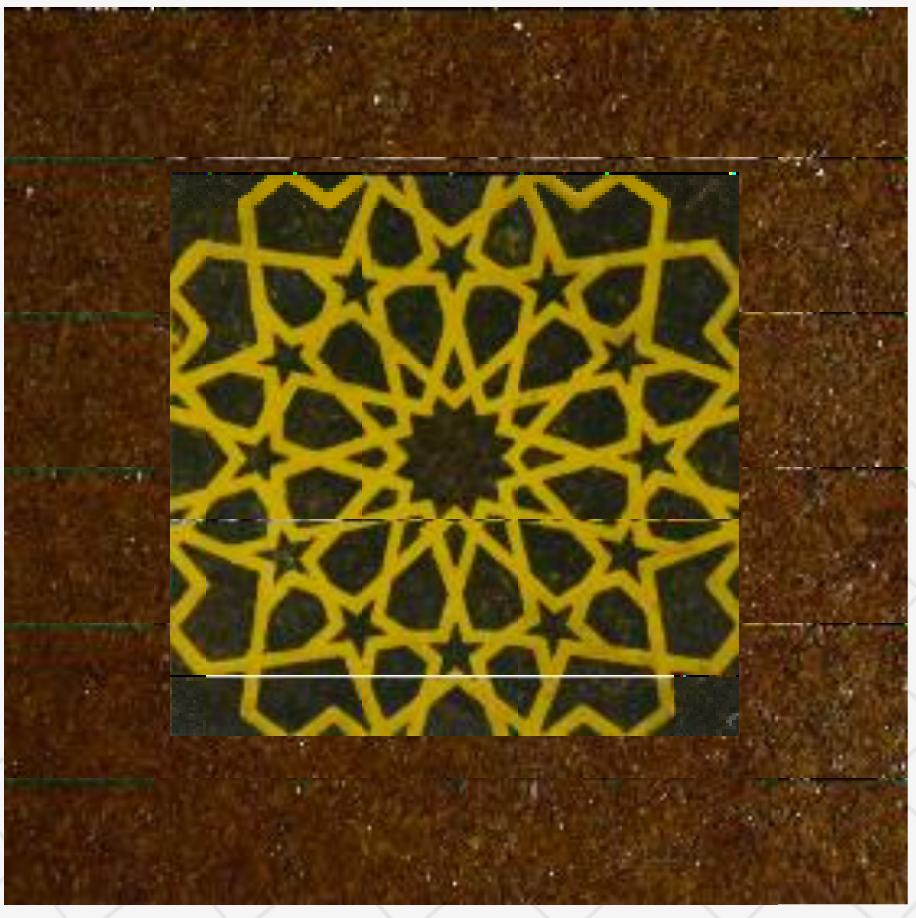
No.	Wood Cones (Cones, Strobilus) Pine		
	Name - Objek	***Dimensi mm***	***Information***
1		Ø : 30,5 – 50 High : 50 - 140	Wood Cones (Cones, Strobilus) Pine
2		Ø : 20,5 – 30 High : 100 - 140	**Cone Haploxylon** A.Peduncle B.Seed scale apophysis C.Seed (adnate) D.Terminal umbo

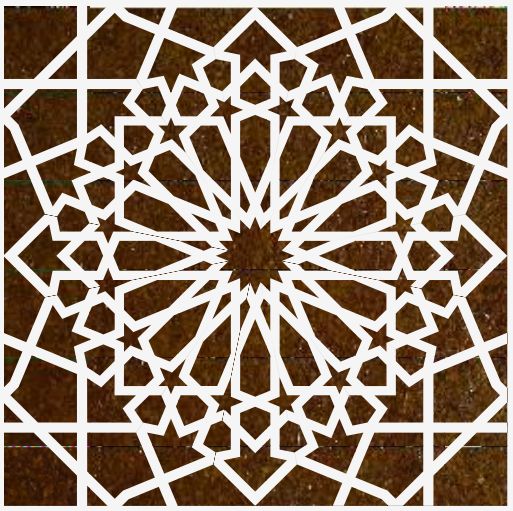
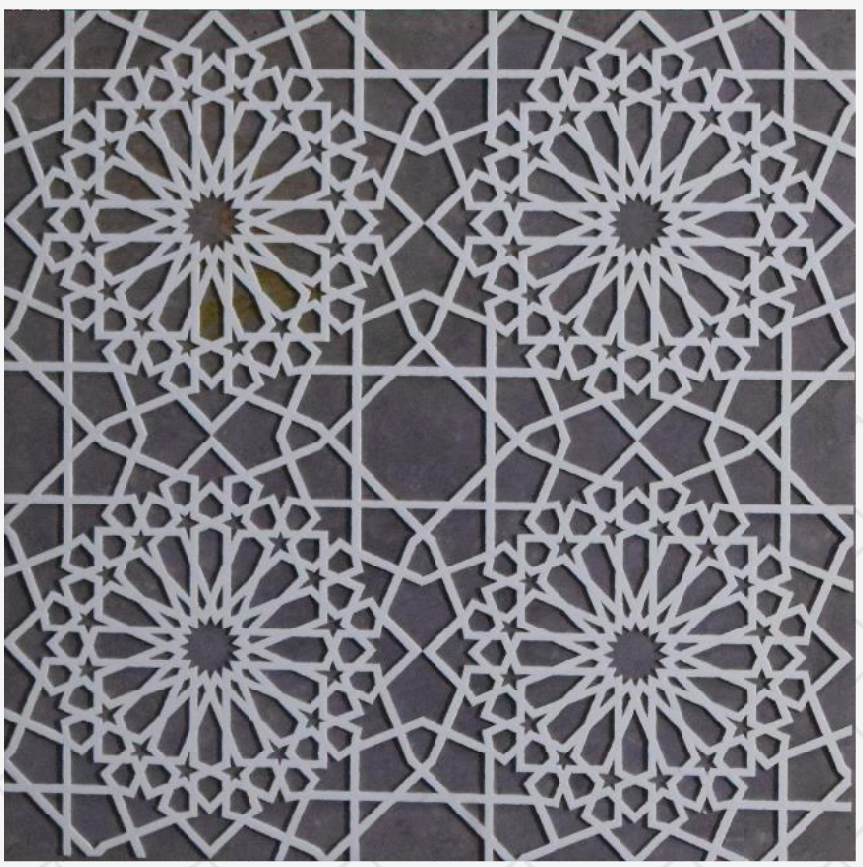
3		Ø : 40,5 – 50 High : 50 - 80	**Cone Diploxylon** A. Peduncle B. Seed scale apophysis C. Seed (articulate) D. Dorsal umbo with prickle
	 	Agregat : 3 - 10	Wood Cone Aggregate (strobilus)
5	 Image copyright: Excite Shop	Measuring cup : volume 1 liter	The cup where you mix the epoxy resin solution

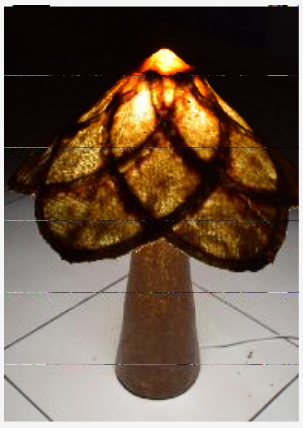
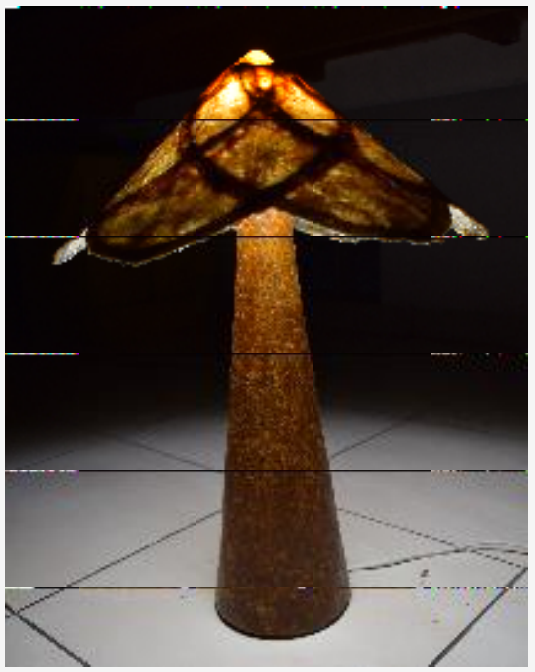
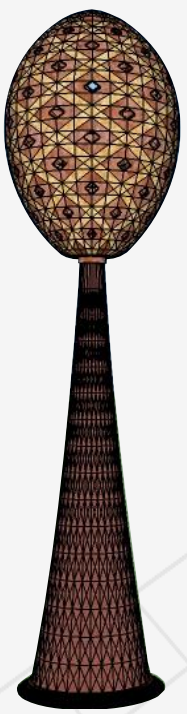
C. The superiority of artificial panels from the *pine cone Merkusii* compared to other processed materials with the following considerations:

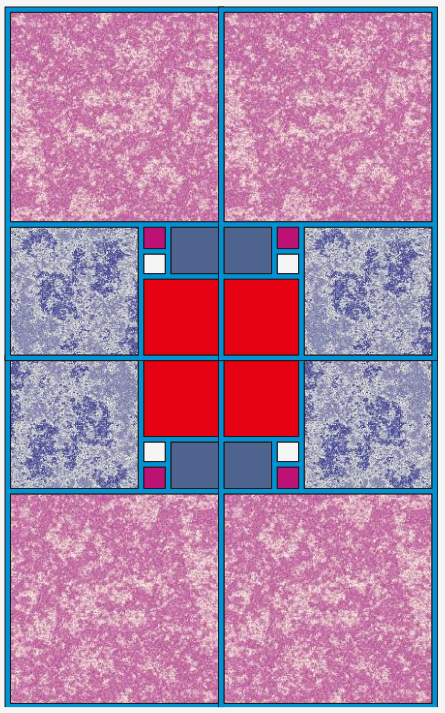
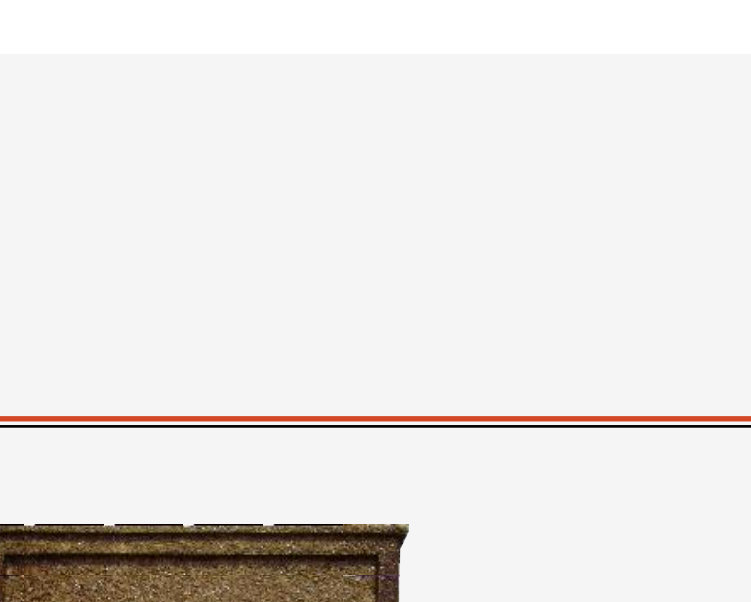
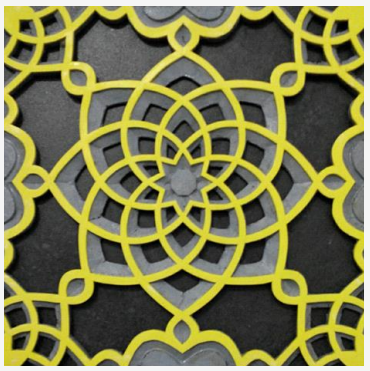
1) Being an alternative material for building construction materials and furniture interiors.
2) Raw material is easy to get, because it is a large amount of scattered waste around the protected forest area.
3) Can be mass produced with medium technology such as for Panel products: Walls, Floors, Ceilings
4) Safe and environmentally friendly because it is processed with adhesives made from pine.
5) Pine Cone Aggregate is not fly and when it is burned it smells of smoke and can neutralize air pollution.
6) Natural Scented Pine Wood Cone Panel that can support work activities and the interior atmosphere of certain buildings.

Tabel 3. Pine Cone Panel Product Data

No.	Pine Wood (Strobilus) Panel Products		
	Name - Objek	***Dimensi mm***	***Information***
1	 	600 x 600	Floor Products (indoor)

2	 	300 x 300	Wall Products (indoor)
3		600 x 600	Ceiling products

4	  	300 x 600	Night table lamp
	  	300 x 900	Standing lamp

5	  	600 x 1400	Work area product dividers
6		600 x 600	Wall products (tile)

D. Socialization and Advocacy of Cones Pinus merkusii Wood Cone Panel

1. Dissemination of the use of pine cone panels.

Responding to the logging and scaffolding of wooden branches that are rife by the community around the forest, we conduct socialization and advocacy to the community precisely in the area of the Pine Forest Cikole Village, Lembang District. The response of the people living around the village was very positive with the use of pine wood cone waste into an artificial panel as an alternative to wood-based materials.

2. Advocacy for communities around the forest.

Advocacy is carried out as a form of assistance and training for wood scaffolding to move to the collection of pine cone (konus) wood cone waste. There are still many people who consciously or not, more often cut branches for firewood at home and some are sold. This condition then needs to be anticipated by giving awareness that conducting checks is part of the form of forest destruction.

E. Potential Development

1. Utilization of cone wood (conus) Pine merkusii into artificial wood panels, has the potential to be an alternative material that is easily made and environmentally friendly. The panel of wood cone aggregate (conus) is also an added value in the economy through the collection of pine cone waste for the village community around the forest. When calculating the Budget Plan for Making a Pine Wood Cone Panel measuring: 242 x 122 x 18 CM, the details are as follows: 10 kg of pine cone valued at Rp. 1000, -, the wage of pemipilan becomes an aggregate of Rp. 100, - / kg., For drying clothes Rp. 50, - / kg. 1 Liter resin Rp. 120,000, - 1 Centiliter catalyst Rp. 20,000, - Mirrorglass / wax Rp. 75,000, Supporting materials Rp. 75,000, - Employment 4 people Rp. 300,000, - others Rp.50,000, - The total cost of raw materials and supporting equipment is Rp.852,000, - if calculated based on the unit Panels that are spacious: 142x122x18 cm = 311,832 cm^3, the production costs = Rp. 27,322 / m^2, so the production cost per panel measuring 142x122x18 cm is Rp.85,198 / sheet, - this will be a business opportunity for collecting pine cones, especially for rural communities around the forest area.

3. Closing

A. Conclusion

Panels for the construction of building interior components and furniture that utilize raw materials derived from wood cones (conus) Pinus merkusii, can be used as an alternative material substitute for wood originating wood products which are constrained by long planting periods, even reaching 50-100 years of harvest time, constrained fire and logging disasters so that their sustainability is threatened and wood products from forests are increasingly difficult to find. Pine cone (strtobilus) is organic waste from existing forests and has not yet been utilized. Utilization of the pine cone (strobilus) Pine merkusii will not have an impact on environmental or forest damage, precisely can be a diversion of activities from scaffolding, log forest trees to the activity of collecting pine wood cone (strobilus) pine which is sold to be processed into artificial wood panels for interior construction such as: walls, floors, ceilings and furniture. The manufacturing process can be done through intermediate techniques to technology for mass production. Do not use dangerous chemicals or high-tech equipment so that it becomes a product that is easily applied, environmentally friendly and priced by the public.

B. Suggestion

Pine cone panels (cones) are an inexpensive and easy alternative material to be made as well as potential construction materials for: Walls, Floors, Ceilings and furniture. However, the main obstacle is the willingness of the community to want to switch from building materials from wood from forest products to artificial materials that are processed from natural materials and learn how to make them. forest areas to become more productive and efficient communities so as not to damage the environment.

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