DECO FRECASE (drywall eco-friendly from eggshell and cane bagasse) as an innovation of eco-friendly interior construction

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Abstract. The number of factories and home industries, both upper and lower middle class certainly adds waste generated, resulting in environmental pollution. The development of buildings is one of the largest contributors to global warming. For that, it takes technological innovations that lead to the criteria of green building. The application of green material is important aspects of environmentally friendly development, the selection of materials on the green material criteria of both roles should be applied continuously in order to realize the environmental sustainability of the material. Utilization Waste eggshell and bagasse which is a community waste, has the potential to become innovative environmentally friendly building materials. The eggshell is composed of 94% calcium carbonate, 1% magnesium carbonate, 1% calcium phosphate, and 4% organic material, especially protein, while the bagasse has a high content of silica (SiO2). In this study, the compounds are used as raw material for making alternative drywall in the form of DECO FRECASE. DECO FRECASE is an innovation of environmentally friendly building materials as an interior wall construction. Through DECO FRECASE, it is expected that building material innovation in Indonesia can be improved and of course environmental problems can be minimized by utilizing it as raw material for building construction.

1. Introduction
The national development of Indonesia aims to create a just and prosperous society. Implementation needs to consider the balance of the three pillars of sustainable development, namely social, economic and environmental. With so the development will be in accordance with the rules of the environment, namely increasing the value and function of the environment. The implementation of environmental management involves all stakeholders, so it needs the carrying capacity, capacity and reserve aspects and spatial so as not to cause various environmental disasters such as environmental pollution. The number of factories and home industries, both upper and lower middle class certainly adds waste or waste generated, resulting in environmental pollution. For example, the expansion of sugarcane production in the state of São Paulo has been shown to cause an increase in the local abundance of rodents and result in the emergence of infectious diseases such as hantaviruses and leptospirosis in human[1]. The large number of food companies and sugar mills in Yogyakarta produces an abundance
of waste that pollutes the environment and in the absence of innovations to utilize waste, so that people feel uncomfortable with the surrounding environment and concern for the environment is declining. Therefore, we take the initiative to innovate from this waste into valuable and environmentally friendly materials. Maintenance of the environment must be comprehensive, such as in the process of infrastructure development. The development of buildings is one of the largest contributors to global warming. For that, it takes technological innovations that lead to the criteria of green building. The application of green material is important aspects of environmentally friendly development, the selection of materials on the green material criteria of both roles should be applied continuously in order to realize the environmental sustainability of the material. Utilization Waste egg shells and bagasse is a community waste that has the potential to be innovative building materials that are environmentally friendly.

1.1 Drywall
Drywall is an indoor partition or wall system consisting of a gypsum board mounted on a frame with the help of special couplers. Its installation does not use a mixture of cement and air, hence it is called drywall. Very different from conventional walls in general that use bricks, mixture of cement, sand, and air.

2. Problems
1. How does the DECO FRECASE concept as an innovation of waste pollute the environment into eco-friendly interior construction?
2. How SWOT analysis of DECO FRECASE as innovation of environmentally friendly interior construction?

3. Objective
The main objective of this research is to innovate waste that pollute the environment into a valuable and environmentally friendly building material through the creation of DECO FRECASE.

4. Material
This research was to combine eggshell and bagasse as an environmentally friendly building material and reduce environmental pollution.

4.1 Eggshell
The eggshell structure consists of three layers, namely the cuticle layer, sponge layer, and lamellar layer. The cuticle layer is the outermost surface containing a number of proteins. The layers of sponges and lamellar form a matrix formed by protein fibers bound by calcium carbonate in an eggshell. The eggshell represents 11% of the total egg weight and is composed by calcium carbonate (94%), calcium phosphate (1%), organic material (4%), and magnesium carbonate (1%) [2].

The content of calcium carbonate from dried chicken eggshells with albumin paste can be seen in the table below.

| Nutrition    | Content (% weight) |
|--------------|--------------------|
| Water        | 29-35              |
| Protein      | 1,4-4              |
| Calcium      | 35,1-36,4          |
| CaCO         | 90,9               |
| Magnesium    | 0,37-0,40          |
| Potassium    | 0,10-0,13          |
| Sulfur       | 0,09-0,19          |

4.2 Bagasse
Sugarcane is one of the silicone collecting plants (Si) which is its Si uptake plant exceeds its absorption to water. During the growth (1 year), the cane absorbs Si about 500-700 kg per ha higher
than other elements. For comparison, within the same time the cane absorbed between 100-300 kg K, 40-80 kg P, and 50-500 kg N per ha[4].

The forming structure of bagasse fiber consists of Cellulose, Hemicellulose, Pentosans and Lignin which composition as follows

Table 2. Structure of bagasse (Lacey, J. The Microbicology of the Bagasse of Sugar Cane - Proc. of XVII Congress of ISSCT)

| No | Component | Percentage of Dry Weight |
|----|-----------|--------------------------|
| 1  | Cellulose | 26%-43%                  |
| 2  | Hemicellulose | 17%-23%                |
| 3  | Pentosans | 20%-33%                  |
| 4  | Lignin    | 13%-22%                  |

Looking at the composition of bagasse at table 2, the bagasse fiber has the most cellulose content and cellulose is a sugar-containing content.

5. Method

Our research held on Special Region of Yogyakarta which takes place within 3 weeks. Starting from the first week until the third week of May 2017. Our research stages are started from research planning, research preparation, material collection, product making, drying product, product testing, writing preparation. The materials used in this study are eggshell, ashod bagasse, dry sugar cane fiber, white portland cement, water, and additional adhesives (optional). Variables in this study are variation of eggshell addition as gypsum substitute and variation of addition of bagasse material. While the test parameters include density, water uptake, and compressive strength.

Preparation The samples used in the manufacture of DECO FRECASE consist of egg shell, bagasse ash, dried sugar cane and cement fiber. To know the composition of raw materials refers to the combination of the proportion of gypsum board (drywall) in general with partition walls. So to facilitate the mixing process then all the composition of the raw material is determined in the percentage of volume. In this study, the matrix used was eggshell powder, cement adhesive mixture, and bagasse ash while aggregate consisted of dried sugarcane fiber as a replacement material around.

Table 3. Sample Composition of Sample Preparation Sample3

| Sample | Percent Composition |
|--------|---------------------|
|        | Eggshell | Bagasse Ash of Sugar Cane | Cane Fibers | Cement |
| A      | 25%      | 75% | 0% - 30% | 10% - 30% |
| B      | 50%      | 50% | 0% - 30% | 10% - 30% |
| C      | 75%      | 25% | 0% - 30% | 10% - 30% |

The DECO FRECASE research stage starts from the shell collection and egg shell. Egg shell is a production raw material that can affect the strength of DECO FRECASE. Therefore, the collection of large amounts of eggshell waste is needed in the manufacture of DECO FRECASE. To collect this eggshell, we get from bakery which is base of industry in Yogyakarta. The eggshell is then washed clean to avoid the stench and bacteria in DECO FRECASE. The purpose of this shell's shell is to facilitate the process of smoothing the egg shell into a powder that is completely dry and non-sticky.

Furthermore collection and burning of sugarcane. Sugarcane luggage is partial replacement of White Portland cement in our products. In addition, bagasse makes heavy DECO FRECASE lighter so it can be used for earthquake prone areas. Therefore, the collection of bagasse in large quantities greatly affects the weight of DECO FRECASE. We get this bagasse from sugar cane factory waste in Yogyakarta which the waste is left alone, thus polluting the environment. Bagasse is collected, dry for 7 days. The dry sugarcane bagasse is for the fulfillment of the needs of bagasse ash and dried sugarcane fiber. After bagasse pulp is dried, bagasse is processed into 2 stages. Some of the
combustion process is done while the other half is separated between the sugarcane fibers with the skin to be taken his fiber as a replacement material.

The combustion process begins with burnt bagasse or forming coal by placing enough dregs of waste into the fuel barrel. Once the embers are formed, add little by little dried bagasse to the barrel by pushing it with a stick so it is rather dense. Burning is done for 4-5 hours so that bagasse becomes ash. The next step is to wait for the cold ash and then filter the ashes to separate ash and other solid particles to get the same ash and particle size. Next is egg shell refinement. Egg shell refinement aims to get a less rough DECO FRECASE texture. Egg shell refinement is done by colliding the eggshell in the form of large fractions to a fine powder. After being smoothed, sieving with a tea filter to separate fine powder with a coarse shrapage so that the fraction can be roughened again.

DECO FRECASE dough making of each raw material is measured according to the predetermined composition. Once tested, bagasse ash, eggshell powder, dried sugarcane fiber, and cement are mixed in a container and stirred evenly using a cement spoon or mixer. Then add water until the mixture is mixed. The good dough texture in the making of DECO FRECASE is not very fluid and sticky. It is intended that the drying stage is not too long because the evaporation of water that is not too much and facilitate the printing.

In the manufacture of DECO FRECASE dough using adhesive in the form of white portland cement because the material is more affordable. Although adhesives continue to use cement white portland, the use of bagasse as a substitute for portland cement as the main ingredient can reduce portland cement use by up to 50%.

In DECO FRECASE printing stage, the DECO FRECASE dough is applied to the block mold. Prior to printing, the mold is first smeared with oil to facilitate the release of the dough from the mold after the drying step. The sample test mold used in this research is a 6 x 6 x 3 cm beam aluminum foil mold. First, pour the dough until it fills half the mold and flatten the DECO FRECASE dough. After that, pressed to the dough to make the dough more dense and not easy to crack. Printing of DECO FRECASE should really be noted because printing affects the durability of DECO FRECASE.

Next stage Drying DECO FRECASE. The treatment of the printed drywall was carried out by the drying process naturally at room temperature for 7 days, then the test sample was dried in the oven kitchen at 250°C with a holding for 1 hour. The DECO FRECASE drying is done to obtain a strong DECO FRECASE texture so that even if it has light weight it can be used as a partition wall.

Last Step is DECO FRECASE Testing. After the specimen is subjected to hardening process, then the test is done. To know the characteristics of the concrete, it is necessary to measure or test the physical and mechanical quantities. Testing of DECO FRECASE characteristic in this research include: density, water absorption, and compressive strength. The density measurements of each of the prepared DECO FRECASE sample compositions, observed using the object type mass principle.

6. Discussion

6.1. Drywall Eco-Friendly From Eggshell and Cane Bagasse (DECO FRECASE)

Drywall Eco-Friendly From Eggshell and Cane Bagasse (DECO FRECASE) is an alternative eco-friendly drywall product made from raw eggshells integrated with bagasse as an interior wall construction. The alternative understanding in DECO FRECASE is to innovate environmentally friendly building materials and reduce environmental pollution by reducing organic waste.

The test results prove that the DECO FRECASE product in the water-absorption test is proven that DECO FRECASE products tend to increase with the increase of eggshell composition and bagasse ash. In contrast, the compressive strength test and density test tend to decrease as the eggshell composition and bagasse ash are added. Therefore, proper composition is required for DEFFEC density to reach drywall standard with composition according to sample A.

6.2. SWOT Analysis
Based on the SWOT analysis approach, DECO FRECASE has an internal analysis including an assessment of the strength factor (Strength) and weakness (Weakness). Meanwhile, external analysis includes opportunity (Opportunity) and challenge (Threats). Here's the assessment:

**Table 4. SWOT analysis approach based on Strength and Weakness**

| No. | Strength                                                                 | Weakness                                      |
|-----|--------------------------------------------------------------------------|-----------------------------------------------|
| 1.  | Production raw materials are easy to obtain because they come from wastes that are rampant in the community so have a relatively cheap price | Long drying due to the strong ash bagasse binds water |
| 2.  | More environmentally friendly because it utilizes the existing waste.     |                                               |
| 3.  | Easily manufactured without the need for special skills..                |                                               |
| 3.  | Applicative as partition wall.                                           |                                               |
| 4.  | Great market opportunity because of the construction material in the form of drywall is one of the products needed by the community. |                                               |
| 5.  | Can reduce the use of bricks and portland cement in the main building materials. |                                               |
| 6.  | Lighter than the drywall in general so it can be used in earthquake prone areas. |                                               |

Solutions to take are work with drywall producers, architects, and experts in determining suitable materials to accelerate drying at DECO FRECASE and conducting further research on appropriate techniques in drying DECO FRECASE so that obtained the process of rapid drying and target results.

**Table 5. SWOT Analysis approach based on Opportunity and Threats**

| No. | Opportunity                                                                 | Threats                                       |
|-----|-----------------------------------------------------------------------------|-----------------------------------------------|
| 1.  | Being a product of innovation technology that is in demand by the community because along with the growth of the population the need for interior wall construction is increasing as it is practical and efficient | The DECO FRECASE is in the marketing stage.   |
| 2.  | Optimizing the productivity of society because it can be used as an opportunity for entrepreneurship and open employment. |                                               |
| 3.  | Being innovated building materials that utilize waste but according to standards. |                                               |
| 4.  | Reduce waste problems in the environment due to the efforts to utilize waste egg shells and bagasse into a more economical product. |                                               |

Solutions to take are governments and research institutes and academics are seeking the introduction and promotion of DECO FRECASE on a wider scale to better recognize the wider community and cooperate with bakeries and communities to collect eggshells and bagasse so as to obtain the optimal waste of eggshells and bagasse every day.

7. Conclusion

From the problems and discussions that have been described above, it can be concluded that Drywall Eco-Friendly from Eggshell and Cane Bagasse (DECO FRECASE) is an alternative eco-friendly drywall product made from raw eggshells integrated with bagasse as an interior wall construction that has the potential to become an economic product that can improve the innovation technology. DECO
FRECASE also through the density, water absorption, and compressive test proves that DECO FRECASE with composition according to sample A meets the drywall standard. DECO FRECASE has many advantages, such as drywall designed more environmentally friendly because it utilizes existing waste, can reduce the use of bricks and portland cement in the main building materials, easy to apply in the manufacture of building barriers, easy to produce without the need for special skills, and Production raw materials are easy to obtain.

References
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