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LIVING TOWER CONSTRUCTION AS FISH APARTMENT WITH GLASS POWDER/PET COMPOSITE BASIC TECHNOLOGY

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Abstract

Inorganic waste cannot decompose easily by nature, plastic bottles takes about 50-100 years while the glass bottle takes about 1 million years. At the moments, it will causes serious *contamination into soil, water, or air if not treated properly. In addition, Indonesia has a coral reefs area reaching about 18% of the world coral reefs area. Fish populations and other marine biota Lived In coral reefs and recorded 2,200 or 31% species of reef fish in the world are in Indonesian waters. However, water pollution is the reason for about 70% of damaged coral reefs. Living Tower as a fish apartment made from glass and plastic bottle waste can overcome the amount of garbage that accumulates and provides a home for the existing marine fish population. Living Tower design has a unique shape, in which this Living Tower has 4 structural building poles around it made from glass powder/ PET composite technology with melting processes arranged so as to suit marine conditions, and has a main pole as a gathering place for fish made from natural fibers as a place to attach fish eggs. Making Living Tower is able to reduce the waste of glass bottles, and plastic bottles as much as 6.6 kg for every 1 unit produced. From this research we have publication and patent. In the future this technology will be needed because waste around us must be utilized, and there are several research that discuss about making concrete from this composite*

Keywords

Composite, Glass Powder, Living Tower, PET

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1. Introduction

Indonesia is the 4th largest population in the world approximately 225 million, who's every day produce waste both organic and inorganic with equal to their amount. Based on data from Jambeck, 2015 Indonesia produce plastic wastes at least 1.29 million tons per year. In human life, the use of plastic bottles and glass bottles has a lot of influence and can't be separated. Its use as a place of food and beverages causes the number of plastic waste increase per year. In addition, with the lack of innovation in waste management in this country and the many people who have not aware and tend not to care about the environment, so the waste is usually just dumped into the nearest river from their house or just stacked in landfill (TPA). In fact, according to Petungsewu Wildlife Education Center, 2007 the bottles cannot decompose easily in landfill, plastic bottles need 50-100 years to decompose while the glass bottle takes 1 million years.

From Kementrian Kelautan dan Perikanan (Ocean and fisheries ministry) (KKP), 2013 Indonesia is also a country with 95,181 square kilometers of coastline, the longest in the world after Canada, the United States and Russia. 65% of the total 467 cities in Indonesia are located on the coast, indicating that most of its area is sea. The number of marine areas in Indonesia does not reflect the state of the sea and the potential that exists. According to marine campaigner Greenpeace Indonesia, Nugraha, 2015 2/3 of Indonesia is an ocean with threatened conditions by various unsustainable management activities. "About 70% of coral reefs are damaged. Mangrove 40% lost. This indicates something is wrong". The world's oceans continue to experience tremendous pressure from the threats of pollution, overfishing and climate change. The state of the sea in Indonesia is also threatened, whereas the sea is an ecosystem of providers of food and medicine, or the source of life for humans. The Indonesian sea consists 50-80% of the world's biodiversity, while Indonesia has 50,875 square kilometers of coral reefs, or about 18% of the world's total. Wilkinson, 2008 Mostly in the eastern part of Indonesia or commonly called the coral triangle which became one of the world's biological wealth. Therefore, marine ecosystem health must be maintained.

In these two ways, the Living Tower as a fish apartment made from plastic waste bottles, glass bottles, and coconut shell fibers is able to overcome both problems. The Living Tower design has a unique shape, in which this Living Tower has four pillars surrounding edges made of glass powder/ PET composite technology arranged to suit ocean conditions, and has one main pillar as a gathering place for fish and fish spawning places with the addition of coconut fiber waste as a place to attach spawns. So as to reduce the waste of glass bottles, plastic bottles, and coconut shell. Moreover, it can preserve the marine ecosystem and fish habitats.

In order to increase its performance, during last years, nanocomposites were prepared and studied, especially that containing silica nanoparticles (SiO_2). Fumed silica is a non-crystalline, fine-grain, low density and high surface area silica. Zheng and Wu (2007) in their study have shown that nanosilica do not behave as a nucleating agent but rather retard the appearance of the microcrystalline phase that enhances spinnability. Liu et al. (2004) have found that the addition of nanoparticles increases the crystallization temperature and the melting point of the polymer. Additionally, nanoparticles do not affect very much the process of pure PET synthesis. Yang et al. (2006) demonstrated that it is possible to control the crystallization behavior of PET by inorganic nanoparticles. Wang et al. (2004) studied the non-isothermal crystallization behavior of pristine PET and PET/clay nanocomposites with a differential scanning calorimeter (DSC), and found that the introduction of clay into PET matrix weakens the dependence of the non-isothermal crystallization exotherm peak temperatures on the cooling rates. Additionally, they verified that the absolute value of activation energy for PET is lower than that of PET/clay nanocomposites. Jeziorny (1978) calculated the parameters that are characterizing the kinetics of non-isothermal crystallization on the basis of DSC thermograms and he concluded that, by changing the cooling rate, the morphology of the crystalline structure can be determined in a controlled manner as a result of the non-isothermal crystallization. Bikiaris et al. (2006) found that solid-state polycondensation can act as a facile method to prepare poly (ethylene terephthalate)/silica (PET/SiO_2) nanocomposites with high molecular weight and an adjustable degree of branching or crosslinking. He et al. (2006) prepared PET–SiO_2 nanocomposites by in situ method, and found that the PET crystallization rate increases significantly with increasing the silica content. The silica nanoparticles can act as an efficient nucleating agent to facilitate PET crystallization. Zhu et al. (2006) presented a thorough study of the thermal behavior of the cryomilled PET/SiO_2 nanocomposites, and found that cryomilling resulted in amorphization of crystalline PET matrix and simultaneously, in the fracturing of molecular chains and the decrease of the molecular weight, and consequently, it is concluded that the SiO_2 particles have an additive milling effect. Ke et al. (2007) investigated the nucleation, crystallization and dispersion behavior of silica particles in PET matrix and found that in non-isothermal crystallization, the crystallization activation energy for PET/silica nanocomposites was lower than that for PET while the nucleation rate of silica particles was increased with the decrease in size, the 35 nm SiO_2 particles producing most obvious nucleation effect.

From previous research Antoniadis (2010) it is known that From DSC studies it was found that the melting point of the nanocomposites was shifted slightly to higher temperatures by the addition of SiO_2 till 3 wt% while for PET–4 wt% SiO_2 nanocomposite the melting point was reduced. As the amount of SiO_2 was increased the crystallization became faster, and there was, also, a shifting of the temperature of the crystallization peak to higher values, this being evidence that SiO_2 can act as nucleating agent.

The objective of this project is to know and understand the process of making fish apartment as well as to produce an effective, cheap, and environmentally friendly fish apartment design. The output of this project is the constructed Living Tower so as to reduce the amount of waste plastic bottles, glass bottles, significantly and mass-produced and can conserve the marine ecosystem. The expected benefits of this project are as follows: Improving fish population, having a certain point for fishing, developing the potential of the surrounding area with the diversity of biota marine. Improving and conserving marine ecosystems, ranging from plants to their biota and reducing the amount of glass and plastic waste around us. Can be a reference in the development of tourist areas and the preservation of marine areas in Indonesia.

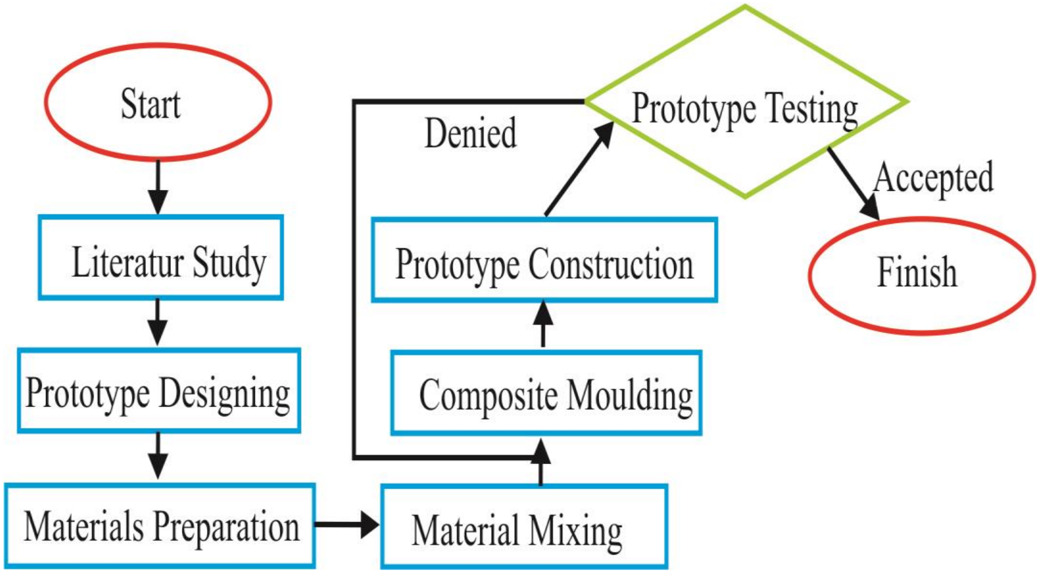

Figure 1: *Living Tower construction flow chart*

2. Method/Procedure

2.1 Flow Chart

Fig. 1 shows the flow chart of making Living Tower, begin with literature study, designing prototypes, material preparation, mixing materials, composite moulding, constructing prototype then testing prototypes. In this process if the test results the prototype is not feasible then the process will start again from composite moulding until its accepted after testing then the prototype will be evaluated periodically.

2.2. Literature Study

The literature study is conducted by searching and reviewing relevant and reliable sources in collecting information and become references in this projects that comes from books and online media. The literature we use is emphasized on the principle of composite, glass bottle waste processing, plastic bottle waste processing, and the design of fish apartments. We use a lot of different literature in order to get complete information.

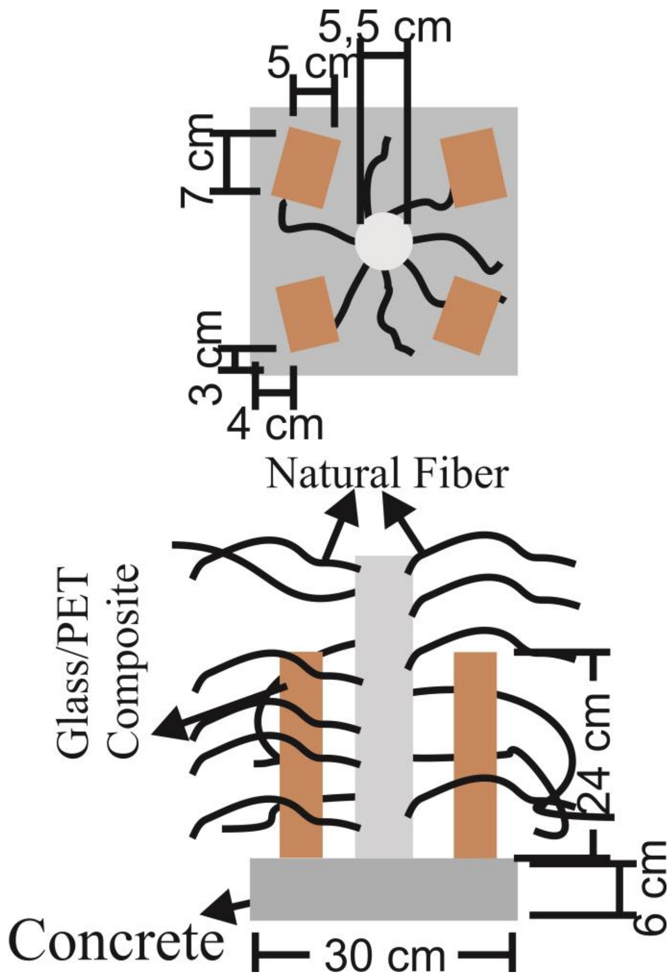

Figure 2: *Living Tower design*

2.3 Prototype Designing

The prototype is designed according to the condition of Probolinggo's ocean by observing the ocean currents, the weight ratio of the prototype with the composite force so that the prototype can reach the seabed and not easily to move. The prototype design is as follows: The composite result will be cube-shaped as in figure 2. Cubes are given a foundation of concrete that serves as a weight when drowned into the sea. Then the other cubes are stacked on top of it as shown in Figure 2 as a fence.

2.4 Materials Preparation

The materials used in Living Tower are plastic bottle waste (PET) and glass bottle waste (SiO_2). The plastic and glass bottle is grinded to become flakes and powder. Arranged the mold using ceramic on rectangular shape. The coconut fibers spinned until become a rope, then cut every 10 cm.

2.5 Materials Mixing

The PET then poured to the mold then melt it, molten PET in the mold is the first layer of the mold and then melting the second and third PET for the second and third layer. Any layers have to been frozen before the next melting is done. In the fourth layer, the glass powder (SiO_2) is inserted at the feed then flattened on the surface of the third layer. Then, the fifth, sixth, and seventh layers are made and the eighth layer is glass powder (SiO_2). In making this composite, every three layers glass powders (SiO_2) is inserted in the molten PET.

2.6 Composite Moulding

The mold is glued with a silicon rubber. It has the shape suitable with the prototype. In the upper and bottom side molds open, but bottom of the mold is given a slab of ceramic, so it won't leak during mould process. Then we burn PET and glass powder with torch, until the mold is full. After that we wait the composite until frozen, the frozen composite then removed from ceramic mold.

2.7 Prototype Construction

After designing and planning, the prototype productionis started use predetermined standards to produce the appropriate prototype with the desired design, the component is connected by using the torch gas until the melting point of the composite so each component can stick together.

(a) (b)

Figure 3: *Constructed Living Tower (a) on land (b) below water*

2.8 Prototype Testing

Testing is done to determine the reliability of the system that has been designed. At this stage it is tested to see if the prototype can sink at sea, can hold the ocean currents and the fish want to live prototype, hardness test, and bending test.

3. Result

3.1 Living Tower

Figure 3 (a) is the result of Living Tower prototype, the black bar which is a composite that serves as a fence to guard fish eggs, and behind it there is fiber as a place fish eggs. The number of materials used to create a Living Tower is: PET 6.6 kg; 0.6 kg glass powder, and 4 meters of fiber, after the process of forming a series of towers of life with a weight of 5 kg so that at the time of testing drown or not, this tool sinks.

(a)

(b)

Figure 4: *Composite (a) testing (b) speciment*

At ocean currents capability test, sea current velocity is applied 150 cm / s to the resistance of composite fence. The results show that the composite is not broken after the treatment so that Living Tower is ready to be drowned in the real sea like on figure 3 (b).

Furthermore, by doing a comparative study between the nature of freshwater fish and sea. In freshwater fish culture there are kaka ban which made from fibers as a place to spawn fish. In marine fish, ordinary fish lay eggs on coral reefs or anemones, due to the similar nature of coral reefs and fiber, fish will lay their eggs on the Living Tower, when their coral habitat is damaged.

$$\sigma f = \frac{3FL}{2bd^2} \quad (1)$$

3.2 Bending Test

The composite moulded shown on figure 4 (b) Its color is black because of the heating process takes much time, it has dimensions of 5 x 5 x 29 cm. Then we do bending test to the composite manually based on ASTM D7264, because of limited tools and time. We use two tables that separated 25 cm, brick that has 1 kg each and we place the weight at the center of the composit, then we increase the brick one by one until the composite break. We use Formula 1 to equate the value from this bending test. Where σ_f is fracture strength, F means force that makes fracture, L is length of the specimen, b is the width of test beam, d is depth of tested beam. After calculation, the bending value of this composite is 2.8 MPa.

4. Conclusions

The Living Tower is made by melting PET that has been mixed with glass powder as a fence pole and making a core pole with a PVC pipe that has been hollowed and given fiber then casted with cement. This Living Tower can reduce waste for about 6,6 kg per unit. Fences and core poles are arranged according to the design that has been made. Living Tower has an effective design for a fish house is have a fence for fish shelter and a fiber for the fish to lay eggs. It has the power about 2,8 MPa that can sustain on 10 meters below the water surface. Some limitation have been made in this researc there are ignoring the cavities, the process done in open field, using 225 ml vessels as measurement, the bending test is done manually. This research will be very usefull for future research in making composite from PET and silica, because there are many deficiency in this research, especially in the process.

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