

# Construction of Fiberglass Boat in Padang City with Hand Lay up Method

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**Abstract:** Wooden fishing boats gradually began to be abandoned by fishermen. Now, many fishermen have switched to using ships from materials fiberglass. This is because the amount of wood that has been increasingly limited, and the price is also very expensive. In addition, wooden ships require a lot once treatment and lifespan are also limited. While the advantages of fiberglass boats, among others, age or lifetime of the ship more durable, maintenance is much easier and cost-effective (cost). Fiber ships are also much lighter, and more leverage in the production of fish catch. Fiberglass shipbuilding process that many made, using Fiberglass Reinforced Plastic (FRP) technique. In the manufacture of fiber boats, there are two frequently used lamination methods, namely Hand Lay Up and Chopper Gun. This method is the easiest and simplest method of lamination. Hand Lay Up is an open mold method. This method is carried out by applying resin to the reinforcing material using brush/roll. Usually this method is done for the manufacture of hull, swimming pool, and others. The research was conducted in Muaro Beach fishing area Padang. There are five units of fiberglass fishing vessels that are sampled. The purpose of this research is to assist fishermen, especially producing ships fiberglass is much better to maximize the catch of fish.

## 1 INTRODUCTION

Padang City is the capital of West Sumatra province located on the west coast of Sumatra island, with a coastline of 84 km long. Almost a third residents of Padang City, amounting to 900,000 people, depend on fishing life. Fishing boats in the city of Padang, generally made of wood. As is known, wooden and fiberglass ships have a different weight of 20 Kg/m<sup>2</sup> for wood and 14 Kg/m<sup>2</sup> for fiberglass. Heavy factor this greatly affects the displacement and stability of the ship. Of course also against the catch.

In addition, the problem is that if there is scarcity of wood. Therefore, the use of fiberglass is expected to replace wood as the main material of shipbuilders, especially for small and medium sized fishing boats. In general, fishing boats use timber very good quality, like old teak wood. However, now teak has become rare. Even if there is, the price is very expensive. This all caused the fishermen to have difficulty in making the ship.

Therefore, now fishermen are starting to think of switching to fiberglass as the raw material for shipbuilders. In addition to its sufficient availability, the price even less expensive than wood. Not only

that, the fish catch is much more. Because the fiberglass ships are much lighter, more flexible inside catching fish.

The purpose of this research is for fishermen and Pemko Padang. Especially for fishermen, this study aims to help fishermen to increase productivity catches of fishermen and fishermen's welfare. As for the local government, this research can be used as a reference in the preparation of the Budget

Regional Expenditure (APBD) to assist the procurement of fiberglass boats for fishermen. The benefits of this research to improve economic growth of the real sector of the people of Padang City, especially in maritime field (maritime).

## 2 LITERATURE REVIEW

Padang city is the most developed city compared to other cities located in the waters of the western edge of the island of Sumatra. This city borders directly with the Indonesian Ocean. The city of Padang evolves as its strategic position, so it has been one of the longest a port on the western edge of Sumatra, in addition to its position as the provincial capital. With

such a position, there should be many efforts marine that has the potential to develop, especially marine and fishery business. In the city of Padang, in addition to Muaro Beach, fishing boats as well many operating in Pasia Nan Tigo, Air Tawar, Purus, Gauang, Bungus and Sungai Pisang.

### 2.1 Construction Process of FRP

Fiberglass shipbuilding process that many made, using Fiberglass Reinforced Plastic (FRP) technique. This FRP process is very different from ship building process made from other materials such as steel, aluminum, and wood. FRP ship production process is much lighter than the ship steel. This is because the construction of FRP construction vessels starts with the preparation of mold making. While the production process of steel vessels consists of welding process, assembly, cutting and bending. The FRP ship is only made with the initial capital of a mold to form the vessel. Mold making usually uses FRP materials that have a certain thickness and tensile strength, such as using CSM 600 or also can be made with wood and plywood.

FRP design technology consists of design stage, material selection, and strength calculation (construction). The design of FRP must also be pay attention to basic design criteria such as spatial / space use coefficient, comfort factor and performance. This fiberglass vessel is effective to increase the productivity of fisherman catch and to reduce the cost of fishing. Age of life longer, high strength, corrosion resistance, light weight, production cost and maintenance is much cheaper than wooden vessels, does not require repeated painting.



Figure 1: Design of fiberglass fishing vessel with FRP technology

### 2.2 Construction Material

In the construction of FRP construction vessels, there are major material elements. Among them are reinforcement, resin, and core materials. Reinforcement or amplifier is widely used ie FRP. This is because the cost is cheaper than other boosters. Resin is one of the basic ingredients used in

the shipbuilding industry of FRP construction. The catalyst is a material that has the same function as the hardener that is for accelerate the reaction of the polymerization process, but is used as a polyester resin pair and vinyl esters resin. Gelcoat is the material used as the outermost layer of the ship's hull to be built.



Figure 2: The processing of fiberglass fishing vessel with FRP technology using permanent mold making model role.

### 2.3 Lamination Method

In the manufacture of fiber boats, there are three frequently used lamination methods. Here is an explanation of the laminate method:

#### 1) Hand Lay Up Method

The basic method of building a fiber boat. This method is the easiest and simplest method of lamination. Disadvantages of this method; not maximally the result of pooling of layers or arrangement between fiber and resin on ship body formed.

#### 2) Chopper Gun Method

This method requires a gun-shaped tool that will fire fiber pieces with resin to all layers of mold (mold) which are then put together with a roll. In coating using chopper gun technique, can only use fiber in the form of yarn roll (Spray Gun Roving).

#### 3) Vacuum Infusion Method

This method is either a closed printing method or a Resin Transfer Molding (RTM) system. The resin is injected into a certain mold, then the top is covered in a rigid mold. However, in vacuum infusion, the top mold is replaced with plastic film. Advantages of the vacuum infusion method; laminate results are thinner, evener, and stronger. This study discusses only shipbuilding with vacuum infusion printing patterns.



Figure 3: FRP mold permanent and non permanent.

### 3 METHODOLOGY

Stages performed in this study started from the analysis of damage, such as the emergence of cracks in the body of the ship or paint that has begun to fade [5]. Materials and tools used for the maintenance and repair of fiberglass boats are:

#### I. Raw materials

- Resin - Woven Roving
- Katalist - Talk (powder)
- Reinforcing Mat - Kubalt / Accelerator
- Roving - Pigment
- Gelcoat - Mirror Glaze Wax
- Poly Vinyl Acid (PVA).

#### II. Supporting material

- Rubber sheets 10 cm x 15 cm x 1 cm
- Paper sandpaper
- Envelope cloth number 0
- paint thinner A
- Thinner A (oil diluent)
- Cloth / majun
- Blue detergent soap / acetone
- Wood stirrer
- Freshwater.

#### III. Equipment used

- Hand grinders / grinding wheels
- Palm-fiber broom
- Brush
- Scales
- Measuring cup
- Bucket of water
- Knives / scissors
- Marker
- Ruler / meter
- Compressors
- Spray gun
- Wooden / rubber blocks

## 4 RESULTS AND DISCUSSION

### 4.1 Design

For the design process, the total length (LOA) length, long water line (LWL), maximum width (beam maximum / Bmax), beam water line width, depth of hull (Depth / D), full of water (draft / d), displacement, maximum speed (speed max), ship type / function and material type.

### 4.2 Construction Phase (drawing)

It consists of lines plan and off-set drawings, hydrostatic curve drawings including calculations, weight and weight calculations, trim and stability calculations, construction profile drawings, middle cross-sectional drawings, installation drawings (electricity, plumbing, steering, machinery, navigation, communication), interior pictures and other detail images.

Based on the drawings, the production process can begin. Initial stage, mold making (mold). Mold consists of two types, semi permanent and permanent mold. semi-permanent molds are usually made for orders in relatively few quantities. Conversely, permanent prints are made for orders in relatively large quantities (mass production). For making this permanent mold, first made a prototype ship that will be made.

The semi-permanent and permanent mold comprises a female mold method, ie a mold that the inner side is slippery and the outer side is rough. The semi-permanent mold making stage is the preparation of the molding stand, the sections, the interlinking of sections, the installation of the mold closure, the installation of the surface layers of the mold and the finishing.

While the stage of making permanent mold is the making of prototype ship FRP ship from semi-permanent mold. After the molding phase is complete, the production process can begin. To determine the construction and strength of the FRP ship structure can be used regulations such as Lloyd Register of Shipping 78 (UK).

The determination of the thickness of FRP ship structure layers can be determined based on the speed of the vessel and the length of the flow line. Repeats and bulkheads (girder, frames and bulkhead) can be used marine plywood which is then covered / casted with fiberglass layer so it is a unity with the hull of the ship. Engine stand or transom ship outboard engine can be used double marine plywood coated with FRP.

As for the inboard engine ship, the foundation of the engine can use strong and durable wood. Where possible, first-class timber and FRP coated and bound to the hull of the ship are used. The merging of the hull, the deck, the pavilion, etc. is tied with stainless steel screws and inside it is foamed and casted with FRP so that it does not leak.



Figure 4: Fiber boat after gelcoat

### 4.3 Making Resin

Commonly called polyester resin is a solid or semi-solid type of nature or synthetic, generally with high molecular weight. Resin is one of the main components of manufacture of FRP, as an adhesive and solvent material of fiberglass sheet. The reinforcement material depends on the number, type and arrangement of fiberglass in the material. The more fiberglass, the stronger the product. The FRP reinforcement types are:

1. Continuous roving, is a combination of parallel fibers into a single strand with little or no winding, available in the form of cylindrical packaging for further processing. Continuous rovings have good mechanical properties and are generally dismembered for spray ups.
2. Woven roving, is a strong and heavy type of reinforcement, in the form of flexible sheets woven from continuous roving, available in wide, thick and heavy alternatives. Woven roving is mainly used in hand lay up process.
3. Reinforcing mat, can be made from chopped strand or continuous strand.

There are three kinds of reinforcing mat:

1. Continuous strand mat, is a reinforcing mat made from continuous strand woven, commonly used for the strength of the product being.
2. Chopped strand mat, is a reinforcing mat made from a strand piece and randomly combined with a certain binder, thin random fiber sheet such as mat 300/mat 450, first layer/basic FRP used for the

manufacture of products with medium strength and usually for hand lay up.

3. Combination mat, is a combination of chopped strand mat and woven roving, both mechanically and chemically, forming a strong reinforcement, woven-shaped fiberglass sheets such as roving 600/roving 800. The use of combination mat speeds up the hand lay up time.



Figure 5: Fiberglass boats that are ready to be produced

## 5 CONCLUSIONS

FRP is a resin-composed material, a reinforcing material of fiberglass and additive. Fiberglass reinforcement materials as well as the FRP printing process are various, depending on the type of fabric to be made and the desired specifications. Advantages of using FRP:

- a. High strength, FRP has a high strength to weight ratio, flexural strength and impact strength FRP is generally the same, even stronger than metal.
- b. Corrosion resistant and chemicals, these properties cause FRP to be a suitable material for seawater.
- c. Lightweight, FRP has a high strength, but still lightweight than metal.
- d. The stable shape, the perfect curing form of FRP, will not change greater than its tolerance. The higher fiberglass content or fiberglass combination with inorganic filler, the coefficient of expansion of heat and contraction will decrease, so that the shape of the object is maintained.
- e. Reducing equipment costs, FRP can be made efficiently in many ways, both for large and limited production. Equipment for manufacturing FRP products is cheaper than equipment for manufacturing the same type of products made of metal. This makes FRP profitable, both for large and small industries.

- f. Flexible in design, FRP can be used for various types of usage.
- g. Hold electricity because the conductor is weak.
- h. Can be directly printed in color so that the final product does not require painting anymore.

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