A STUDY ON FIBERGLASS CONSTRUCTION AS LAMINATION FOR BOAT ACCORDING TO STANDARD RULES

Shahrin Febrian[1*]
[1]*Lecturer Marine Technology Faculty – Ship System Engineering Majors*
University of Darma Persada, Jakarta

*Koresponden : shahrin_febrian@ftk.unsada.ac.id

ABSTRACT

Indonesia as a maritime country has a dependency on marine vessels for the transport and conveyance economic functioning. In this regard Boat used for many years made of wood, but because of the nature of the weathered wood that easily weather and chemical factors and requires an adequate treatment with the course of time it came in the form of laminated fiberglass FRP (Fiber Reinforced Plastics) as a substitute timber in which the material is mepunyai many advantages not possessed by the wood so that the ship was made of FRP from a place in the world shipbuilding in particular the producers of the ship. However, in a survey conducted at several shipyards in 2009 showed that the design, construction and fiberglass hull lamination process generally do not have clear standards that would pose a significant risk of an accident. To minimize these conditions, the production vessel is based on the FRP laminate should refer to existing standards that BKI rules that involves strict requirements such as tensile testing, bend testing, and so forth.
Keywords: *ship production, FRP lamination, tensile test, bending test*

1. Introduction

Indonesia is a maritime country with abundant natural resources. Even if we look further, Indonesia's flora and fauna is the largest in the world. Therefore, the exploitation of these resources is excessive and almost uncontrollable, especially the wood used as raw material for fishing boats in rivers and at sea. In the current state of highly developed human needs, it is very unwise when we all depend too much on nature. In a certain period of time nature will be damaged by humans if it continues. In meeting the needs of life, a company or producer must have a smart breakthrough in order to produce products that do not interfere with the stability of nature. Industrial raw materials are very important, of course, in human survival, both to meet human needs and to preserve nature. Therefore, producers are required to be able to create industrial raw materials that do not depend on and do not interfere with the preservation of nature or renewable energy. Fiberglass (glass fiber) is one of the breakthroughs that can be applied in the raw material for making a product, especially on the ship's hull. Because besides being relatively easy, fiberglass also does not cause pollution and damage nature.

Fiberglass is often translated as glass fiber is molten glass that is drawn into thin fibers with a diameter of 0.005 mm – 0.01 mm. This fiber can be spun into yarn or woven into cloth, which is then impregnated with resin so that it becomes a strong and corrosion-resistant material so that it can be used as lamination on car bodies, ship buildings, tanks and so on. layered elements or composites (composites) also known as Glass Reinforced Plastic (FRP) and Glass Reinforced Epoxy (GRE) or also known as fiberglass in general.

********** Resin rich layer
++++++++++++++++++++++++++++++++ “E” Glass mat
********** Resin rich layer

Fig.1.1 Example of Simple Composite

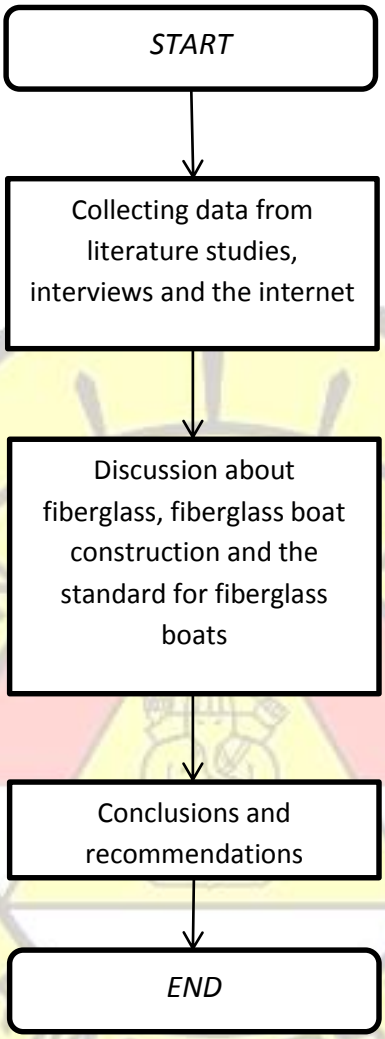
In Figure 1.1 is a layered element or simple composite consisting of 2 layers of resin and 1 layer of glass where “E” Glass Mat adds flexural strength and toughness and Resin Rich Layer provides UV resistance and weathering performance. In addition to the explanation above, for reinforcement can be analogous to glass as "bone" and resin as "meat". In this case, the “E” Glass Mat is a chopped strand mat arranged randomly, which means that fiber glass is cut into mats or sheets by a binder to provide the same physical properties in each part regardless of the direction of the material to be applied so that provides good adhesive properties between resin and glass.

The term fiberglass is a simplification of a term consisting of two words, namely 'fiber' which means fiber and 'glass' which means glass. In fact, fiberglass is one type of composite material which is an alloy of two materials that have different physical and chemical properties where the differences can still be seen microscopically and macroscopically in the final alloy of the composite material. Some of the names for Fiberglass that are generally used today are as follows:

- Fiberglass Reinforced Plastic (FRP), which translates as plastic reinforced by glass fiber.
- Glass-fiber Reinforced Plastic (GRP), which translates as glass-fiber-reinforced plastic.
- Fiber-reinforced Plastic or Fiber-reinforced Polymer (FRP), which translates into plastic or polymer reinforced by fibre.

Looking at the use of composite materials on boats, actually the most appropriate term is the term FRP which means Fiber Reinforced Plastic or Fiber Reinforced Polymer. To make it simpler and easier to understand, the term FRP that will be used is for Fiber-reinforced Plastic because in general polymer materials are also widely known as plastics because even though rubber, for example, is also a polymer material, the use of the term is less specific. The plastic in this FRP construction is in the form of liquid resin (generally polyester, vinylester and epoxy types), while the fibers can be made of glass (generally E-glass type), carbon, Kevlar (aramid synthetic fiber), and others. other. While the term fiberglass on a boat should only be used if the composite material does consist of glass fiber and plastic.

2. METHODOLOGY



3. ANALYSIS

As a composite material, FRP consists of the following main base materials:

• Reinforcing fiber: glass (E-glass), carbon, Kevlar (aramid synthetic fiber), bamboo, etc.
• Resin (liquid) : polyester, vinylester and epoxy
• Resin (liquid) gelcoat : polyester, vinylester and epoxy

With the following supporting materials:

• Catalyst (MEKP, methyl ethyl ketone peroxide)
• Hardener for epoxy resin
• Colorant (pigment)
• Thickener (filler)

In FRP construction, it can be seen that resin is a function of form stiffness (and also watertightness on boats) as well as cement in steel reinforced concrete construction and the reinforcing fiber layer serves as a strength function as well as steel reinforcement in steel reinforced concrete construction. Regarding the shape, FRP construction can be shaped according to the mold as desired. Regarding the shape of the reinforcing material from the FRP construction, it can be in the form of:

- Chopped Strand Mat (CSM); in the form of a relatively short and random distribution of fibers. Usually present in the code that mentions three numbers behind the CSM, for example CSM 300. This means CSM with a density of 300 grams per square meter (300 gr/m^2).
- Woven Roving (WR); shaped like woven with groups of long fibers that are relatively thick. Usually present in the code that says three numbers behind WR, for example WR 600. This means WR with a density of 600 grams per square meter (600 gr/m^2).
- Multi Axial; shaped like woven with fiber direction lengthwise, transverse and also cross.
- Fiber Cloth; shaped like a thin cloth. So for the next in this paper, the term fiberglass will be replaced with FRP for more precise use.

The standard / rule that can be applied in this case is the 2006 BKI Rules where the required tests are bending tests and tensile tests with the number of samples for each test is 6 pieces. These rules refer to the International Standard (ISO) 14125 (1998) and ISO 527-4 (1997), where the tensile test aims to determine the value of tensile strength, fracture strain and modulus of elasticity, while the buckling test aims to determine the value of bending strength. and the modulus of elasticity. For fiberglass specimens using mat-shaped fibers, the minimum values required by the BKI Rules for the two types of tests are as follows:

Tensile Strength

$$R_z = 1278\Phi^2 - 510\Phi + 123\ (MPA) \quad (1)$$

Bending Strength

$$R_B = 502\Phi^2 + 106,8\ (MPA) \quad (2)$$

For samples using roving fiber, the minimum values are as follows:

$$X_{min} = \alpha \left[X_{ref} \left(\frac{\phi}{0,4} \right) \right] \quad (3)$$

Where: Xmin = minimum value required Xref = reference value for fiber volume content F= 0.4 a = factor for lay-up And for samples using carbon fiber the minimum values are:

Table 1. Minimum Tensile Value and Bending Strength For Carbon Fiber

Fiber	Property	X_{ref} [Mpa]	α			
			0^O	$0^O/90^O$	$0^O/\pm45^O$	$0^O/90^O/\pm45^O$
Carbon	Tensile strength	800	1.00	0.55	0.50	0.45
	Bending strength	725	1.00	0.55	0.45	0.42

4. CONCLUSION

1. Boats made of fiber are relatively easy to apply, but without meeting the applicable requirements or standards it can cause defects in the resulting ship.
2. Due to the lack of knowledge of the shipbuilding industry in general, there is a need for socialization from BKI so that the ships to be produced can meet the desired standards

REFERENCES

1. International Organization for Standardization (ISO) 14125, 1998, ***Fiber Reinforced Plastic Composites Determination of Flexural Properties***.
2. International Organization for Standardization (ISO) 527-4, 1997, ***Plastic Determination of Tensile Properties***.
3. **BKI** *Rules For Classification and Surveys (Vol. I), 2012*
4. **BKI** *Rules For Rules For Hull (Vol. II), 2009*
   BKI *Rules For Fiberglass Reinforced Plastic Vessels, 1996*
5. Callister J.r, William D., 1997, ***Materials Science and Engineering Fourth Edition***, John Wiley & Sons, Inc. New York
6. **BKI** *Rules For Non-Metallic Materials, 2006*
7. http://dephub.go.id/
8. http://www.klasifikasiindonesia.com/ajax/home.php