Training of Fiberglass Boat Repair for Gresik's Fisherman to Improve Fiberglass Boat Quality of Boat Construction following the Indonesian Classification Regulations

Dedi Budi Purwanto[1], Mohammad Sholikhan Arif[1] and Nurul Hidayati[2]
[1]*Institute Teknologi Sepuluh Nopember (ITS), ITS Sukolilo Campus, ITS Raya Street, Sukolilo, Surabaya, East Java 60111, Indonesia*
[2]*Department of Naval Architecture and Shipbuilding Engineering, Indonesia*

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Abstract: There are several types of damage to the fiberglass boat, including holes, cracks, and deformation on the fiberglass boat hull. At this time, fiberglass boat's damages are repaired by fishermen with their knowledge without considering classification regulations. Therefore this paper will explain training on repairing fiberglass damage using a syllabus and methods by Indonesian classification bureau (BKI) regulations.

1 INTRODUCTION

Gresik Regency is between 7 degrees and 8 degrees south latitude and between 112 degrees and 113 degrees east longitude. Most of the area is lowland with an altitude between 0-12 meters above sea level, except a small part in the north (Panceng District) has a height of up to 25 meters above sea level. The Java Sea borders the northern part of the Gresik Regency; the Madura Strait and Surabaya City-bound the eastern part; the southern part is bordered by Sidoarjo Regency and Mojokerto Regency, while Lamongan Regency borders the western region.

Gresik Regency has an archipelago of Bawean Island and several smaller islands around it. The total area of Gresik is 1,192.25 km2 consisting of 996.14 km2 land area plus 196,11 km2 area of Bawean Island while the area of the waters is 5,773.80 km2 which is very potential from the marine fisheries subsector.

Gresik Regency is one of the buffer cities of Surabaya. Where the city of Surabaya is the capital and economic center of East Java and East Indonesia. Nearly one-third of the Gresik Regency is a coastal area. As a coastal area that has also been facilitated by a large port, Gresik Regency has access to regional, national, and even international trade.

The mapping of the marine fisheries sector in Gresik has the second-highest potential of marine fisheries from the mapping of the marine fisheries sector in East Java with the acquisition of catches of 362,624 tons per year with this development the movement of the economic industry of the Gresik district community leading to the fisheries sector is also increasing (Norromadani Y, 2016).

With the use of boat for fishing activities, some damages caused by collisions or the age of the boat, so the boat needs to get maintenance and repairs. In general, repairs activities are replace the entire damaged part, but it will take a long time by reviewing the damages for hull repairs effectively. Repairing fiberglass boats usually still traditional way based on limited knowledge about fiberglass boat repair. Therefore, as an institution engaged in maritime, ITS is doing community service to develop and improve the welfare of the community with a form of training support for maintenance and repair of ships following the standards used by the Indonesian Classification Bureau for resistance to fiberglass ship structures.

2 LITERATURE REVIEW

2.1 Fiberglass Boat

FRP ships are generally made of fiberglass or glass fiber. This is because fiberglass is relatively cheaper when compared to other reinforcing materials.

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Fiberglass also has a relatively strong strength with a light weight. Additionally fiberglass has chemical resistance and is easy to process. However, the strong tensile strength of this fiberglass decreases when it receives a continuous load over a long period of time.

Table 1: Composition of E-Glass and S-Glass per unit weight.

Composition	***E-Glass***	***S-Glass***
Silicone Dioxide	52-56 %	64-66 %
Calcium Dioxide	16-25 %	0-0,3 %
Aluminium Oxide	12-16%	24-26 %
Boron Oxide	5-10 %	-
Sodium Oxide & Potassium Oxide	0-2 %	0-0,3 %
Magnesium Oxide	0-5 %	9-11 %
Iron Oxide	0,05-0,4 %	0-0,3 %
Titanium Oxide	0-0,8 %	-
Fluorides	0-1 %	-

The table 1 shows the ratio of E-glass and S-glass composition by weight. In marine use applications, E-glass (lime aluminum borosilicate) is the most commonly used reinforcement material because it has good tensile strength, is resistant to water degradation, and is cheap. S-glass (silicon dioxide, aluminum, and magnesium oxides) has 33.33% better tensile strength and generally has more resistance to fatigue. (Ship Structure Committee, 1990).

Reinforcement fiberglass material is divided into several types, namely Chopped Strand Mat (CSM), Woven Roving (WR), and Multiaxial:

• Chopped Strand Mat (CSM)
  Chopped Strand Mat (CSM) is a type of fiberglass made of glass fibers that are placed and arranged randomly between one another, as in Figure 2.4. A comparison of the use of resin against fiberglass Chopped Strand Mat is 2.5 ~ 3 Resin: 1 CSM. CSM Fiberglass is generally distinguished by weight per square meter. For example, CSM 300 means that each square meter of fiberglass weighs 300 grams.
• Woven Roving (WR)
  Woven Roving (WR) is fiberglass made of glass fiber that is woven in two directions continuously at an angle of 90 °. Fiberglass WR is the reinforcement material most often used for the construction of marine structures. It is because WR fiberglass is available in quite a significant weight (24 ounces per square yard or around 800 grams per square meter is the most commonly used weight) so that the thickness of the structure can be met quickly. Besides fiberglass, WR also has resistance to impact because the material is woven.
• Multiaxial
  Multiaxial fibers consist of two or more layers of fibers with different direction orientations (0 °; 90 °; 45 °; -45 °), each report is sewn with fine polymer yarn. Multiaxial fibers can be combined with Chopped Strand Mat (CSM) and Woven Roving (WR). Multiaxial fiber is usually applied to wind turbines, fast boats, recreational products, racing cars, aerospace and defense system (defense equipment). (Baskoro, 2018)

2.2 Types of Fiberglass Boat Damage

Various reasons can cause damage caused to fiberglass vessels. Based on Greg Davis's survey in 1996, from 3000 respondents 61% damage to fiberglass boats owned by respondents occurred due to exposure to foreign objects submerged in the sea, 17% occurred due to collisions, 14% occurred due to lack of ship maintenance, 5% occurred due to aground and 3 % occurred due to manufacturing problems. Following are the types of damage that can occur to fiberglass vessels. (Greene, 2006)

a. Tear on Boat Skin
   Tear damage generally occurs when a ship collides with another boat or foreign object when the boat is at sea or the dock. Grounding or aground of the boat can also be a cause of this type of damage. This type of damage needs to do a visual inspection to find out how severe the injury and delamination that occurs. Tear damage was initially inspected visually. After the investigation carried out and the need for repairs is made, holes are built around the area of damage. The hole is what will be re-laminated during the repair process.
b. Delamination
   Delamination is damage that occurs when the loss of bond between the lamination of the skin of the ship and its core material. Delamination damage generally cannot be identified visually. To determine this damage, ultrasonic evaluation or tap testing is necessary. In the tap testing evaluation, a part of the delamination is suspected to be knocked using a metal or plastic hammer and listen to the sound it makes. Areas that occur delaminated will cause a higher tone.
c. Cracks on the Gelcoat Layer
   These cracks only occur on the surface of the gel coat layer, and rarely this damage causes

structural failure. However, cracks in the gel coat layer can cause water to seep into the fiberglass laminate layer. To detect, it can be done the visual evaluation and dye penetrant test.

2.3 Indonesian Classification Bureau Regulations

In Indonesia, the bereau that regulates fiberglass ship regulation is the Indonesian Classification Bureau (BKI). BKI published two regulations about fiberglass ships, namely BKI 2016, Rules for Fiberglass Reinforced Plastic Ships, and BKI 2014, Rules for Non-Metallic Material. BKI in 2016 regulates the calculations performed on the construction of fiberglass ships while BKI in 2014 regulates the manufacturing process, inspection, and repair of fiberglass vessels.

The rules used as a reference for the repair of FRP ships are the 2014 edition of the Indonesian Classification Bureau (BKI), Rules for Non-Metallic Material. According to (BKI, 2014), there are several conditions for repairing FRP vessels. Some of them are:

- The reparation process should only be carried out by personnel who have sufficient experience in this field, generally carried out by staff who have training certificates.
- The resin used for the repair process must be the same as the resin used in the production process. This is done to prevent residual stresses in the repair area.
- The reinforcement materials used are the same as those in the production process.

3 METHOD

Stages that need to be done in community service begins with communicating with fiberglass boat builders in the Lumpur Village, Gresik District, Gresik Regency. Next, a visit to the location of the people's boat port and fiberglass shipbuilding was made.

The meeting held with the fiberglass shipbuilders produced several things that needed to be used as information and input for community activities. Some of these include a) Obtained the location of community service for the repair of fiberglass vessels, namely at the community port of the Lumpur Village, Gresik District, Gresik Regency. b) The shape of the ship that is commonly used in the Lumpur area, ship construction, and the type of fiberglass material used. c) The process of maintaining fiberglass fishing boats. d) Damages that occur as well as the location of damage to the ship. e) Plan for the operation of ship repair.

The method offered in this community service is to provide information transfer and training on fiberglass ship repair by the Indonesian Classification Bureau standards. The activity is carried out by providing material and interactive discussions so that the trainees can understand and facilitate the understanding of the content provided.

Evaluation of the implementation of the activities carried out after the ship repair training event is completed. Matters evaluated include a) The method of preparing the ship before repairs are made. b) Methods for preparing tools and materials for ship repair c) Methods for repairing vessels that are good and right. As for the analysis of the data used to assess the success of the training through a descriptive study based on participant responses to the process and results of the training activities carried out.

4 RESULTS AND DISCUSSION

Community service activities related to the maintenance and repair of fiberglass fishing vessels by following the regulations of the Indonesian Classification Bureau in the context of increasing the strength of the structure of fishing vessels in Gresik Regency are carried out through the following stages:

4.1 Preparation

The implementation of the training program was initiated by coordinating with the chief fisherman members in the Lumpur harbor area of the Lumpur Village to inform the members of the fishermen's association that there would be a training activity to repair fiberglass fishing boats.

Figure 1: Discussion with the chief fisherman.

4.2 Training Implementation

After purchasing materials that will be used in fiberglass boat training activities, the next event is to carry out fiberglass boat repair training. Fifteen participants were attending the training activities from fishers who participated in the activities of the local community. The ship used in training is also one of the training participants. During the training, participants were guided directly to carry out the stages in the fiberglass boat repair process.

Before the ship repair work is carried out, the ITS team briefs and explains the reparation process and stages that will be carried out. The trainees were divided into three groups to simplify and share the work to be done to save repair time. The first group was tasked with cleaning all ships to be given layers of fiber using a grinder. The second group is in charge of preparing the fibers that will be used. The fibers used are WR 600, CSM 350, and CSM 450. The third group is tasked with developing putty, which will be used to patch the hole in the ship and also to prepare the resin mixture to be used.

Figure 2: Briefing of participants before the repair process.

Figure 3: Cleaning of the hull before the repair process.

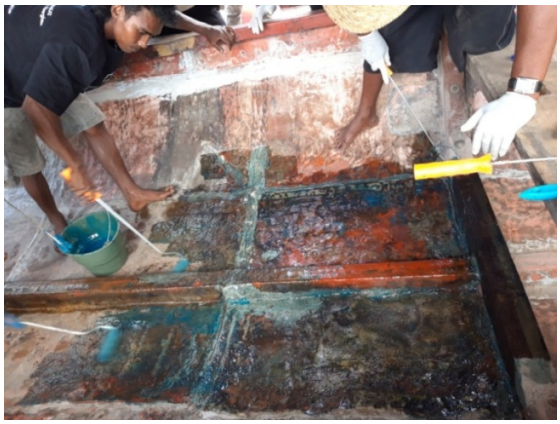

Figure 4: Provision of resin on the surface of the boat.

Figure 5: Installation of WR 600 at keel of the boat.

Figure 6: Photo group after the training.

4.3 Training Evaluation

Evaluation is carried out during the process and at the end of the activity. During the ship repair training process, participants were able to see extraordinary enthusiasm.

Before getting this training, they did not know how to mix resins and catalysts properly, did not know what percentage of catalysts had to be given and how to process the coating between fiberglass and resin properly. After attending this training, they can carry out the above work well.

Many participants held discussions with presenters while the training was taking place to solve problems they found during the ship repair training process. The results of an evaluation of 15 participants in the repair of fiberglass fishing vessels on a scale of 1 to 5 can be presented as follows:

Table 2: Evaluation table for training implementation.

No	Questions	Average	Criteria
1	Material given is needed by participants	4.53	Good
2	Achieve the objectives of the training program	4.00	Good
3	Ship repair methods used	4.66	Good
4	The ability of the speaker in delivering material	4.66	Good
5	Participation of participants in fish boat repair training	4.00	Good
6	Ship repair training materials can be applied for further improvements	4.86	Good
7	Adequate training facilities (tools and materials, places)	4.33	Good
8	Benefits of training for participants	4.80	Good
	Average	**4.48**	**Good**

5 CONCLUSIONS

The fiberglass fish boat repair training in the Lumpur Village, Gresik District, was well implemented, and the participants who attended the training showed high satisfaction. This activity can also improve the abilities and skills of fishers in the process of repairing their vessels when damaged.

Participants' responses to training activities based on the results of quantitative evaluations are in the outstanding category with an average rating of 4.48 seen from the aspects of the material needed by the participants, program objectives, improvement methods, ability of speakers, facilities, and benefits for participants.

The results of the evaluation indicate that fiberglass fishing boat repair training activities are needed by the fishermen so that later, they can be used as a provision for boat repair knowledge if there is damage to their boat.

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