TEST Engineering & Management

January-February 2020
ISSN: 0193-4120 Page No. 11006 - 11009

The Effect of Matrix on the Mechanical Properties Fiber Reinforcement Plastic Wall Rails

[1]Akbar Zulkarnain, [2]Willy Artha Wirawan, [3]Fadli Rozaq, [4]Liesta Apricillya Putri

[1,2,3,4]Mechanics Technology for Railways, Railways Polytechnic Indonesia Madiun Jalan Tirta Raya I, Nambangan Lor, Mangu Harjo, Madiun, East Java 63129
[1]akbar@ppi.ac.id, [2]willy@pengajar.ppi.ac.id, [3]fadli@pengajar.ppi.ac.id, [4]Illaliesta480@gmail.com

Article Info
Volume 82
Page Number: 11006 - 11009
Publication Issue:
January-February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 19 February 2020*

Abstract

Along with the development of science and technology today, one of the ways that can be done to find a material with better properties is to combine two or more substances with different properties or phase. This kind of material is called composite material. In this study, a composite material made with E-Glass fibers with a corresponding number of layers used in the process is an artificial product INKA train wall. Composites made using hand lay up with a variety of types of matrix epoxy, polyester, bisphenol, and repoxy. Mechanical properties observed that the tensile strength and bending strength which refers to standard ASTM D638 and ASTM D790. The results of tensile testing showed repoxy matrix has the highest strength of 181.67 MPa with0.02872 strain mm, while the polyester matrix having the lowest strength of 154 MPa and a strain of 0.02184 mm.

Keywords*:* Wall Rails, Fiber Reinforcement Plastic

1. Introduction

The development of the manufacture of composite materials began to train with many developed, the use of composite materials on the train is usually used for the manufacture of body carriage, the carriage door, and much more. In order to create security and comfort than passenger trains. The use of composite materials with the main ingredient of E-Glass, still need further research to determine the strength and durability of composite, using several methods such as bagging, hand lay-up and vacuum infusion. This method of manufacture will also affect the quality produced from such composites.

General Composite consists of two constituent materials are fiber and matrix each have different properties. In this distinction, it will cause some influence on the composites have been made. The matrix is the material used to bind or unite the filler material without participating react chemically with the filler material, the use of glass fiber for reinforcement (reinforcement) which has a fairly high tensile strength, chemical resistance, is a good insulator, and is resistant to high temperatures [1]. The resulting composite also has a strength ratio with a high density resulting in a lighter composite [2].

Based on the nature of glass fiber has 4 kinds type A (Alkaly), E (electrical), C (chemical), and S (strength). This study used glass fiber is the type of E-Glass. *E-Glass* made of lime-alumina-borosilicate which can be easily obtained from the abundance of raw materials such as sand. Strength and modulus of the glass fiber can decline with increasing temperature change. Glass fiber itself is considered as an isotropic material and has a thermal expansion coefficient that is lower than that of steel [3].

The first prerequisite for obtaining a composite good that is the good bonding, this occurs when the liquid bonding material (matrix) with a solid material (amplifier) occurs adhesion force and cohesion resulting in absorption of molecules so that the matrix can wet the

January-February 2020
ISSN: 0193-4120 Page No. 11006 - 11009

surface of a solid object (amplifier). After drying the adhesive hardens mechanical and interlocking mechanisms occur [4].

Composites wide range of matrix and fiber have been carried out, among others by Nurdin et al. (2011) by replacing the E-Glass fibers with leather fibers hibiscus with the process of alkaline treatments using 5% NaOH solution for 120 minutes can improve tensile strength and bending on bio composite that has been made [5].

Willy et al (2017) conducted a study on the effect of the type of matrix tensile properties of the natural fiber composites, manufacture natural fiber composite using resin infusion vacuum pressure [6]. The resulting composite nature of leather fibers hibiscus (Hibiscus tiliaceus) and polyester matrix having the highest strength of 378.84 MPa.

The purpose of this research discusses the influence of various types of matrix (polyester, epoxy, ripoxy, bisphenol) thus found that both types of matrix in the manufacture of E-Glass fiber composites and train applied to the walls of PT. INKA. The results of research that has been done is expected to be a reference composite materials technology development that has a stronger mechanical properties of composites that already exist, especially in the railway industry.

2. Research Methodology

In this study is an experiment by creating a continuous fiber composites using the composition consists of 4 layers with various types of matrix and compared with those of the trains wall that has been made and obtained from PT. INKA Indonesia.

The material used is E-Glass Fiber to the size of the mess as much as 2 layers 300 and 450 measure the mess as much as 2 layers. Variations in the type of matrix used is a polymer matrix: epoxy, polyester, bisphenol and ripoxy. Sourced from PT. Justus Kimiaraya Indonesia.

Composites made using hand layup method consists of 4 layers. Tensile test specimens moulded in accordance with ASTM D638 and ASTM D790. The composite nature observed by tensile test and bending test using test equipment universal testing machine pull of 10 tons at a speed of 10 m /s.

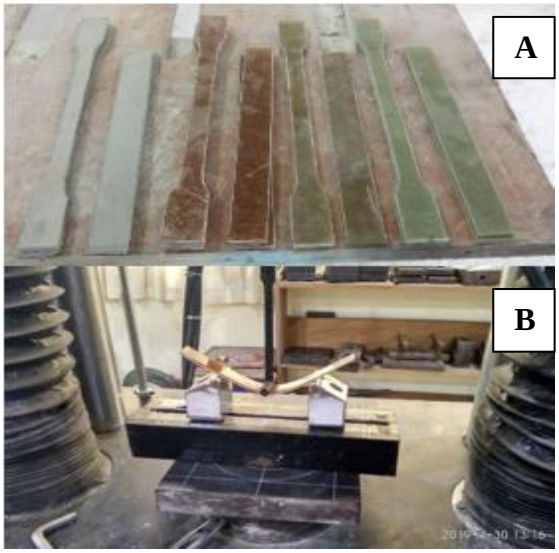

Figure 1: (a) Bending Tensile Test Specimens and (b) Bending Test

3. Result

Based on the testing data can be known composite tensile properties of E-Glass fiber composites with various types of matrix and the tensile properties of composite interior of the train (INKA) is described by a stress-strain graph as shown in the following figure.

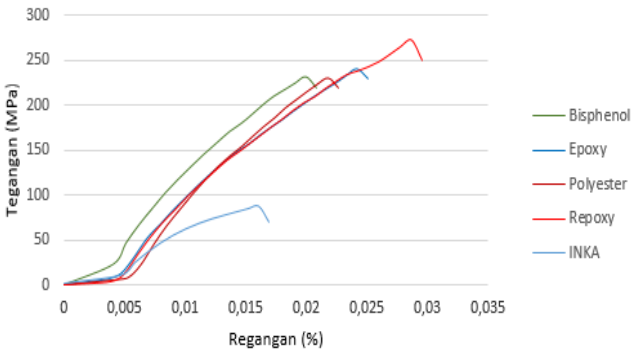

Figure 2: The Stress-Strain Composite

A wide variety of matrices having different strengths, if collated by the highest tensile strength up to the lowest then use the matrix repoxy composite has a value of the highest strength of 181.67 MPa with 0.02872 strain mm, composites with epoxy matrix has a strength of 160.67 MPa with a strain 0.02416 mm, bisphenol matrix composites having 155 MPa stress with a strain of 0.01992 mm, while the use of composite polyester matrix having the lowest voltage of 154 MPa and tensile 0.02184 mm.

Differences in tensile properties to the composite caused by the nature of the matrix is capable of binding to the fiber. In matrix repoxy has the highest strength, the matrix repoxy a matrix of development of the matrix epoxy that is characterized as a strong adhesive, has high

strength, and has a high viscosity so that the resin can glue the fibers with strong because the liquid matrix is very thick, the adhesion force greater than the cohesion which raises the molecular absorption process easier, when dried mechanically hardened adhesive matrix composite has a power stronger than the other matrix. While the polyester matrix composite has the lowest strength compared with the matrix composite repoxy on this matrix has a relatively low viscosity. In the epoxy matrix viewed from the voltage has lower strength than the matrix repoxy because this matrix has a viscosity lower than that matrix repoxy is the development of epoxy matrix so that its strength is not much different from the matrix repoxy. In the matrix of bisphenol seen has the power voltage is lower than repoxy and epoxy matrix because the matrix has a viscosities a little high. While the type of matrix used INKA with the same type of polyester matrix, but has a lower strength than the testing that was done, this could be caused in the manufacturing process were found many voids which can reduce the strength of the composite.

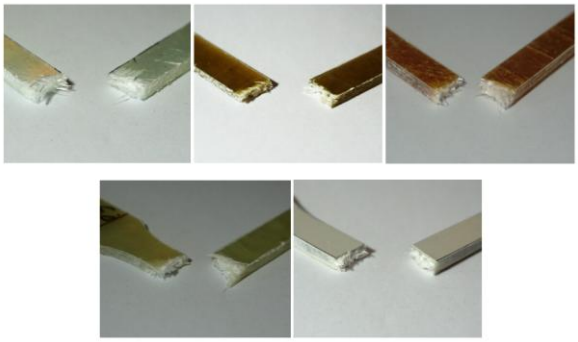

Figure 3: Fracture of Composite Epoxy, repoxy, Bisphenol, Polyester, INKA

Analysis of fault that occurred after the composite tensile test is shown in Figure 3. In the polyester matrix is dominated by the type of fracture splitting in multiple areas and very visible that the area is very irregular fracture. Polyester matrix has a tensile strength that is the lowest compared to other matrix, whereas the polyester matrix is used in a composite matrix produced INKA and composite fracture seen in its test results almost look like a single fault. This can be due to poor manufacturing processes and raises a lot of voids in the composite and causes a very irregular fracture. While in the matrix *epoxy* and bisphenol also suffered fractures *splitting in multiple areas* but the cross section slightly narrower than the polyester matrix. While in the matrix repoxy own fault bit harsh or brittle due repoxy matrix shrinkage becomes denser. Fault look more tidy, spacious area narrows and almost be regarded as a single fault.

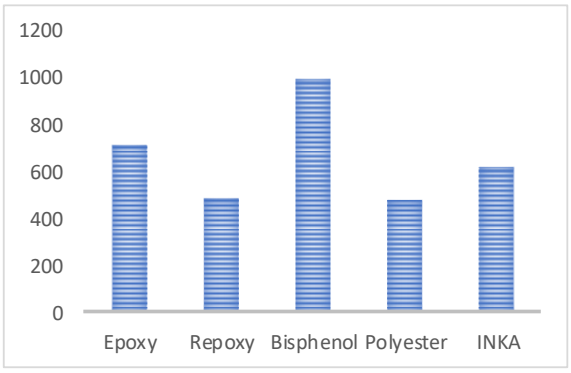

Figure 4: Composites Bending Strength

INKA owned bending strength is equal to 616.61 N. When composed of high bending strength through the lowest composite matrix using bisphenol has the highest bending strength of 995.6 N, composites with epoxy matrix has a strength of 712.15 N, composite repoxy matrix has a strength of 486.35 N. While the composite using polyester matrix having the lowest bending strength of 474.5 N. matrix used INKA and the specimen matrix composites with polyester has a similarity matrix used, but composite used INKA has a higher bending strength compared with the test results, this can be caused in the manufacturing process were found many voids in specimens can cause reduced strength of the composite.

4. Conclusions

The composite nature given different types of matrices in terms of tensile strength can use the matrix *repoxy* because it has the highest strength of 181.67 MPa, while in terms of bending strength can use bisphenol matrix because it has the highest strength of 995.6 N but the need for further research relating to the manufacturing process that causes many voids found in the test specimen which leads to reduce the strength of the composite.

References

[1] Begum & AM Islam (2013). Natural as A Substitute to Synthetic Fiber in Polymer Composites, Review, Research Journal of Engineering Science Vol.2 (3), 46-53

[2] DJ Akshaykumar, V N Vivek Bhandarkar, M. R Haseebuddin, ‘’ Study on Two Body Wear Behaviour of Graphene Filled E-Glass Fabric Epoxy Composites’’, IJRET September 2016

[3] Kumar Shashi, M.E. (2019). Effect of Cryogenic Treatment on Bbisphenol Based Poliymer Composite on Mechanical Propoerties. International Journal of Rescent Technology and Engineering (IJRTE), Volume 8(3).

[4] Pizzi, A. (1994). "Advanced Wood Adhesives Technology. Marcel Dekker, inc. New York

[5] Nurudin Arif, Ahmad As'ad Sonief and Winarno Yahdi Atmodjo. (2011). "Characteristics of Mechanical Strength Composite Continuous Fiber Leather hibiscus laminate with Polyester

January-February 2020
ISSN: 0193-4120 Page No. 11006 - 11009

bermatriks alkali treatment". Journal of Engineering Machinery. ISSN: 0216-468X. Vol.2 No.3.

[6] Willy Artha Wirawan, Sofyan Arief Setyabudi, and Teguh Dwi Widodo. (2017). "Influence on Personality Type Matrix Drag on Natural Fiber Composites". Proceedings SNTT. State Polytechnic of Malang. ISSN: 2476-9983. Vol.3.

[7] Willy Artha Wirawan, Sofyan Arief Setyabudi, and Teguh Dwi Widodo. (2017). "Surface Modification with Silane Coupling Agent on Tensile Properties of Natural Fiber Composite". Journal Journal of Energy, Mechanical, Material, and Manufacturing Engineering. ISSN: 2548-4281. Vol 2. No 2