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Impact Strength of Ganoderma Boninense Composites with Variation in Volume and Mesh

Muhammad Rafiq Yanhar

[1]Universitas Islam Sumatera Utara, Faculty of Engineering, Medan, North Sumatra, Indonesia
Email: *rafiq[at]ft.uisu.ac.id*

Abstract: ***This study aims to determine the relationship between volume variation and mesh variation of the composite reinforcing particles. In this study the fiber used came from the fungus ganodermaboninense, a fungus that can damage and kill oil palm trees. The mushrooms were dried in an oven and then made into particles with meshes of 20, 30, 40 and 50, then impact specimens were formed with various volume and mesh variations. The test results show that the addition of filler volume from 5% to 20% in the polyester resin matrix causes an increase in impact strength of 38.51%, further research can still be done by adding filler volume above 20% to determine the maximum impact strength of the material. The addition of filler mesh sizes from mesh 20 to mesh 50 in the polyester resin matrix causes an increase in impact strength of 58.22%. This data also shows that the smaller the filler size, the higher the impact strength. The addition of filler volume from 5% to 20% in the epoxy resin matrix causes a decrease in impact strength of 25.83%. While the impact strength from mesh 20 to mesh 50 on epoxy resin there was an increase in impact strength of 39.26%. Compared to polyester resin, the increase in impact strength of this epoxy resin is still smaller. It can also be concluded that overall the matrix performance of polyester resin is better than that of epoxy resin.***

Keywords: Impact strength, Ganoderma Boninense, Volume Variation, Mesh Variation

1. Introduction

Composite is a structure on a macro or micro scale made from different materials, the characteristics of which are still carried over after the components are fully formed. Therefore there is always an interface between the two materials, and the properties of this interface have a marked influence on the properties of the composite [1]. The use of composite materials is currently growing. Their use ranges from simple ones such as household appliances to the industrial sector, both small-scale and large-scale industries [2]. In the United States alone, the growth of the composites industry has grown 25 times since 1960, while the steel industry has only grown 1.5 times and the aluminum industry has only 4.5 times. In 2016 sales of composites in America reached 8 billion dollars and in 2022 is expected to jump to 10.6 billion dollars [3]. Synthetic fiber as a composite reinforcement is still the most widely used material today. Globally, the use of fiber worldwide in 2016 amounted to 99 million tonnes, and synthetic fibers ranked first with a percentage of 62.7% or nearly 63 million tonnes [4]. Among the various types of synthetic fibers, glass fiber is the most widely used as a composite reinforcement because it provides good strength and stiffness, impact resistance, chemical resistance, and thermal stability [5]. However, this glass fiber itself has several drawbacks such as the price which is quite expensive, cannot be decomposed naturally, limited in number, and dangerous to health. Therefore, researchers have tried to find a substitute for synthetic fiber from natural fiber which has several advantages, namely easy to obtain, can be decomposed naturally, is not harmful to health, is available in large quantities in nature, and is cheap [6]. In this study, the natural fibers used were particles from the fungus Ganoderma boninense, which is a weed on oil palm trees.

2. Method

Impact test specimens are made according to ASTM E23 standard with dimensions as below:

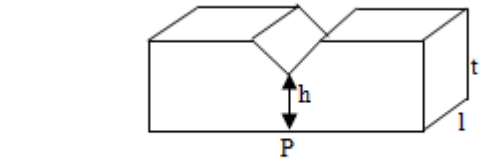

Figure 1 : Specimen dimension

The matrix used in this study was BQTN 157 EX Polyester Resin and Epoxy Resin, while the filler was taken from ganodermaboninense mushroom powder, a fungus that can damage or even kill oil palm trees. The method of making composite specimens can be seen as below:

1) Ganoderma boninense mushrooms are washed thoroughly with water, then soaked in 5% NaOH solution for 1 hour to remove sap and dirt that can reduce the bond between the matrix and filler. After that, the mushrooms are dried by placing them in the oven for 12 hours to remove the water content.
2) After the dried mushrooms are then made into particles and sieved with the desired mesh, then the volume is measured to be used in making specimens. This composite is made using variations in particle volume, namely:
   a) 5% Fillers.
   b) 10% Fillers.
   c) 15% Fillers.
   d) 20% Fillers.
3) Molds made of metal are smeared with wax so that after hardening the specimens can be easily removed from the mould. Meanwhile, the bottom of the mold is covered with glass which is also smeared with wax.

4) Filler and resin that have been mixed with hardener by stirring until evenly distributed and then poured into the mold.
5) Let the specimen harden for 12 hours, after the mold is opened the specimen has been formed.

3. Result and Discussion

Impact test aims to determine the impact strength of composite materials. The following is an impact test tool with the Charpy method used in this research.

Figure 2: Impact test tool

3.1 Variation of Filler Volume and Polyester Resin

Table 1: Impact strength of volume – polyester resin

Filler Volume (%)	Specimen (n)	Impact Strength (J/cm2)	Impact Strength Average (J/cm2)
5	Specimen 1 Specimen 2 Specimen 3	32,74 28,78 25,27	28,93
10	Specimen 1 Specimen 2 Specimen 3	35.03 32,08 28,51	31,87
15	Specimen 1 Specimen 2 Specimen 3	35.85 36,55 32,48	34,96
20	Specimen 1 Specimen 2 Specimen 3	40,44 39,76 37,53	39,24

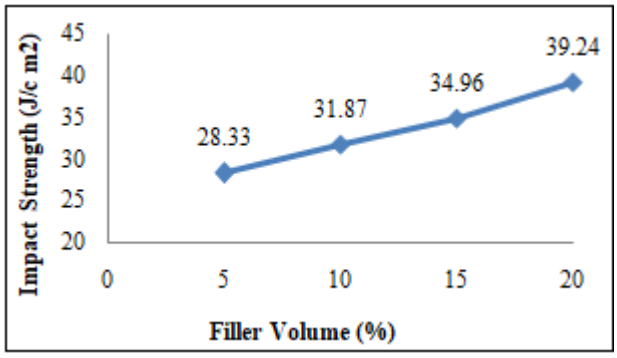

Figure 3 : Variation filler volume – polyester resin

From the table and graph it can be seen that the lowest impact strength is in 5% filler at 28.33 J/cm2 while the highest impact strength is in 20% filler. The addition of filler volume to 10% increased the impact strength of the composite to 31.87 J/cm2. While the addition of filler to 15% and 20% increased the impact strength to 34.96 J/cm2 and 39.24 J/cm2. This shows that the addition of filler causes a higher impact strength of the composite. Further research can also be carried out by adding filler volume above 20% to determine the maximum impact strength of the material.

When observed the percentage increase in impact strength was 12.49% from 5% to 10% filler. From 10% to 15% filler it increased by 9.7%, while from 15% to 20% it increased by 12.24%. If the filler volume is observed from 5% to 20%, the increase in impact strength that occurs is quite high, namely 38.51%.

3.2 Variation of Filler Mesh and Polyester Resin

Table 2: Impact strength of mesh – polyester resin

Filler Mesh	Specimen (n)	Impact Strength (J/cm2)	Impact Strength Average (J/cm2)
20	Specimen 1 Specimen 2 Specimen 3	25.57 28,01 22,32	24,63
30	Specimen 1 Specimen 2 Specimen 3	24.31 24,18 25,4	25,3
40	Specimen 1 Specimen 2 Specimen 3	35.89 35,42 35,22	35,51
50	Specimen 1 Specimen 2 Specimen 3	39,04 38,83 39,06	38,97

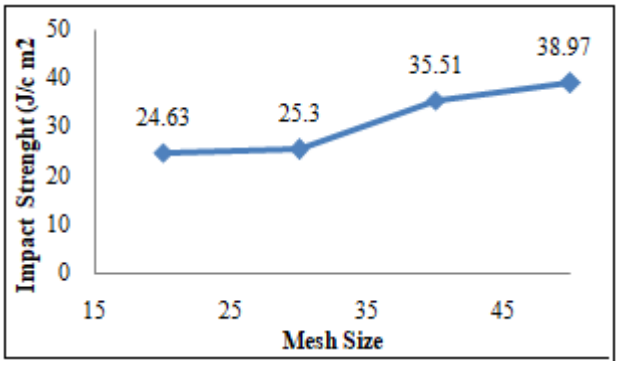

Figure 4 : Variation mesh – polyester resin

From the test data it can be seen that the lowest impact strength is in filler mesh 20 which is equal to 24.63 J/cm2 while the highest impact strength is in filler 50. Increasing the filler mesh to 30 makes the impact strength increase to 25.3 J/cm2. Meanwhile, increasing the mesh to 40 and 50 increased the impact strength to 35.51 J/cm2 and 38.97 J/cm2. This shows that the increase in mesh causes the impact strength of the composite material to be higher. Further research can also be carried out by increasing the mesh above 50 to find out the maximum point of the impact strength.When observed the percentage increase in impact strength from mesh 20 to mesh 30 is 2.7%. From mesh 30 to mesh 40 it is 40.35%, while from mesh 40 to mesh 50 it is 9.74%. If the filler volume is observed from mesh 20 to mesh 50, the increase in impact strength that occurs is quite high, namely 58.22%. This data also shows that the smaller the filler size, the higher the impact strength.

3.3 Variation of Filler Volume and Epoxy Resin

Table 3 : Impact strength of volume – epoxy resin

Filler Volume (%)	Specimen (n)	Impact Strength (J/cm2)	Impact Strength Average (J/cm2)
5	Specimen 1 Specimen 2 Specimen 3	30.05 28,03 29,15	29,08
10	Specimen 1 Specimen 2 Specimen 3	25.82 26,05 22,47	24,78
15	Specimen 1 Specimen 2 Specimen 3	21.21 23,8 26,1	23,7
20	Specimen 1 Specimen 2 Specimen 3	21,78 25,2 22,35	23,11

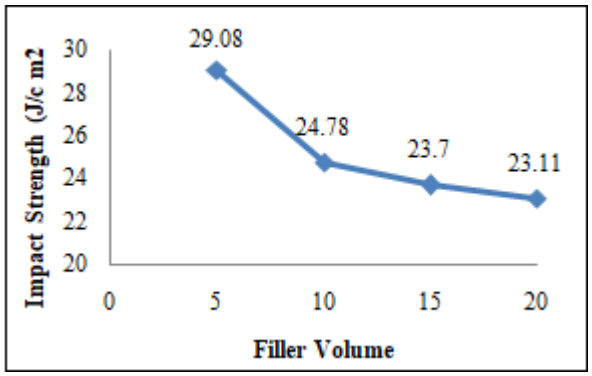

Figure 5 : Variation filler volume – polyester resin

From the test results it can be seen that the lowest impact strength is in 20% filler at 23.11 J/cm2 while the highest impact strength is in 5% filler. The addition of filler volume to 10% reduced the impact strength to 24.78 J/cm2. While the addition of filler to 15% and 20% reduced the impact strength to 23.7 J/cm2 and 23.11 J/cm2. This shows that the addition of filler causes the impact strength of the composite to be lower.The decrease in impact strength from 5% to 10% filler was 17.35%. From 10% to 15% filler, the decrease was 4.55%, while from 15% to 20% it was 2.55%. When observed from the filler volume of 5% to 20%, the decrease in impact strength that occurs is 25.83%.

3.4 Variation of Filler Mesh and Epoxy Resin

Table 4: Impact strength of mesh – polyester resin

Filler Mesh	Specimen (n)	Impact Strength (J/cm2)	Impact Strength Average (J/cm2)
20	Specimen 1 Specimen 2 Specimen 3	18.96 22,81 17,22	19,66
30	Specimen 1 Specimen 2 Specimen 3	17.87 23,37 30,99	24,08
40	Specimen 1 Specimen 2 Specimen 3	28.58 28,9 16,07	24,52
50	Specimen 1 Specimen 2 Specimen 3	30,56 27,73 23,88	27,38

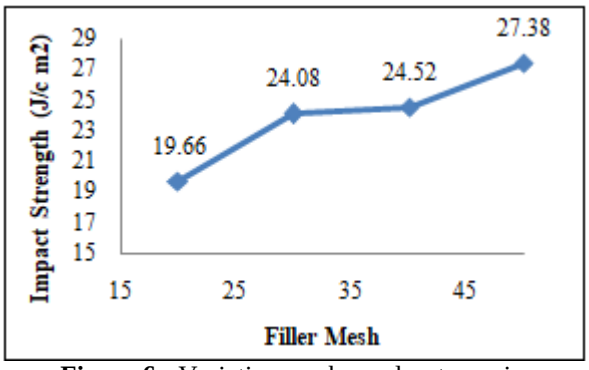

Figure 6 : Variation mesh – polyester resin

From the test data it can be seen that the lowest impact strength is in filler mesh 20 which is 19.66 J/cm2 while the highest impact strength is in filler 50. Increasing the filler mesh to 30 makes the impact strength increase to 24.08 J/cm2. While increasing the mesh to 40 and 50 makes the impact strength increase to 24.52 J/cm2 and 27.38 J/cm2. This shows that the increase in mesh causes the impact strength of the composite to be higher. Further research can also be carried out by increasing the mesh above 50 to find out the maximum point of the impact strength.When observed the percentage increase in impact strength from mesh 20 to mesh 30 was 22.48%. From mesh 30 to mesh 40 it is 1.8%, while from mesh 40 to mesh 50 it is 11.66%. Meanwhile, from mesh 20 to mesh 50, the increase in impact strength that occurs is 39.26%. This data also shows that the smaller the filler size the higher the impact strength of the composite.

3.5 Conclusion

1) The addition of filler volume from 5% to 20% in the polyester resin matrix causes an increase in impact strength of 38.51%. Further research can still be done by adding filler volume above 20% to determine the maximum impact strength of the material.
2) The addition of filler mesh sizes from mesh 20 to mesh 50 in the polyester resin matrix causes an increase in impact strength of 58.22%. This data also shows that the smaller the filler size, the higher the impact strength.
3) The addition of filler volume from 5% to 20% in the epoxy resin matrix causes a decrease in impact strength of 25.83%.
4) Meanwhile, from mesh 20 to mesh 50, the epoxy resin causes an increase in impact strength of 39.26%. Compared to polyester resin, the increase in impact strength of this epoxy resin is still smaller.

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