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Pineapple Leaves Fibers Composite Mechanical Properties

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Abstract: *This research was conducted to identify the mechanical properties of pineapple leaves fibers composites. Pineapple leaves fibers composites use polyester resin as the matrix. Pineapple leaves that was used in this research was fibers obtained from harvested pineapple leaves. The samples were made with two methods, blending and rubbing methods and by varying the concentration of fibre used (10 %,20%,30%,40% and 50%). From the results of test conducted, there were differences in mechanical properties of pineapples leaves fibre composite material on tensile test and bending test performed. From the tensile test performed, it is found that the best Longitudinal Tensile Strength 25,31 Mpa is found at sample with 30% Blended Fiber and 70% matrix, and the highest Longitudinal Tensile Strain 0,0349 is reached by the sample with 20% rubbed fiber and 80% matrix and the biggest Longitudinal Modulus of Elasticity 2673,4 Mpa is obtained from the sample with 10% blended fiber and 90% matrix. While from the bending test performed, it is known that the highest Transverse Tensile Strength 71,55 Mpa is obtained from the sample with 30% blended fiber and 70% matrix, and the biggest Transverse Tensile Strain 0,0178 is found at sample with 30% rubbed fiber and 70% matrix, the highest Shear Strength 5,2393 Mpa is found at sample with 30% rubbed fiber and 70% matrix and the biggest Transverse Modulus of Elasticity 8447,1 Mpa is obtained from sample with 30% blended fiber and 70% matrix.*

Keywords- *Blended Fiber, Rubbed Fiber, Composite, Pineapples Leaves, Mechanical Properties.*

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I. INTRODUCTION

Lombok is one of the island at West Nusa Tenggara province with sub tropic climate where many fruits can grow well such as durian, mangoes, star fruits, pineapples, rambutans, ect. Pineapple is an herbaceous plant that consists of a rosette of stiff succulent leaves on massive upright stem. The tropical perennial pineapple is a member of the family *Bromeliaceae* [1]. Pineapples are harvested once in one planting season and it's trees cannot produce fruits anymore. The waste from pineapple's leaves is used for cattle's foods but still much waste. There are so many kinds of pineapples trees and not all of them have good tastes to be eaten. When the pineapple is not eaten by human, it produces more waste because it's leaves is larger and longer than the other pineapples.

Many people try to find the other advantages of pineapple's leaves, in the ancient time, people use pineapple's leaves as string. They got the string from the leave's fibre because at that time there still no technology to produce string from cotton as well as today.

Today, people tries to conduct some researches about the pineapple's leaves advantages such as to make a composite board from pineapple's leaves fibre. It is known that the fibre from pineapple's leaves can reduce the noise so that composite board can be used as sound absorber and also it has good mechanical properties. Properties of pineapple fibres have been studied and reported as shown in table 1 below [2].

Table 1. Properties of Pineapple Fibres

Tensile strength, kg/N	17,14
Fineness, denier	13,4
Moisture content, %	5
Total cellulose, %	75,20
Residual gum, %	31 : 17
Lignin, %	5

II. METHOD

Pineapple Leaf Fibre (PALF) is one such fiber source known from a long time obtained from the leaves of pineapple plant (Ananascomosus) from the family of Bromeliaceous.[3] In this research, the pineapples fibers are made in two ways or technique such as blended technique and rubbed technique. Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components [3]. The pineapples fibers are then mixed with resin as matrix with different concentrations. All the processes are explained in detail below.

Materials

Pineapple Leaves (from Langko Village, Lingsar Sub district- West Lombok, Indonesia), Water, Resin and Hardener.

Tools

Blending machine, knife, light bulb 100 watt, ruler, digital weighing instrument, universal testing machine, grinder, glass cup, stirrer bar and molding / casting devices.

Preparations

The steps to prepare the composite board sample

1. choose the good pineapple leaves and clean it with clean water
2. separate the leaves in two part, one part for blended fibers and the other for rubbed fibers.
3. cut the leaves in to 1 cm long to produce the blended fiber and up to 40 cm long to produce rubbed fibers
4. for the blended fibers, clean it with clean water and then add some water to blend it with blending machine.
5. after blending process, add more water let the fibers separated from it's leaves.
6. pick up the fibers from the water and idles it until it is separated from the water.
7. while for rubbed fibers, the 40 cm leaves
8. both the rubbed and blended fibers are warmed for 3 to 7 days until it dry.
9. the dried fibers are then mixed with resin and hardener based on the percentage determined before.
10. the impurities is then molded in the form of rectangle with size 20 cm long, 8 cm wide and 1.5 cm of thickness.

Both the rubbed and blended fibers are mixed with resin and hardener with 5 concentrations (comparation between fibers and matrix) :

Figure 1. Blended Fibers

Figure 2. Rubbed Fibers

Table 1. The Number of Samples and each Concentration of Samples

NO	SAMPLE	CONCENTRATIONS	
		FIBER	MATRIX
1	PB	50	50
2	PB	40	60
3	PB	30	70
4	PB	20	80
5	PB	10	90
6	PR	50	50
7	PR	40	60
8	PR	30	70
9	PR	20	80
10	PR	10	90

PB = blended pineapples leaves fiber composite sample
PR = rubbed pineapples leaves fiber composite sample

Figure 3. Molding Device

Figure 4. The Composite Board

Figure 5. Tensile Test Specimen

Figure 6. Bending Test Specimen

Parameters

a. Tensile test (Longitudinal Tensile Strength, Longitudinal Tensile Strain, Longitudinal Modulus of Elasticity)
b. Bending Test (Transverse Tensile Strength, Transverse Tensile Strain, Shear Strength and Transverse Modulus of Elasticity).

III.   RESULT AND DISCUSSIONS

1. Results

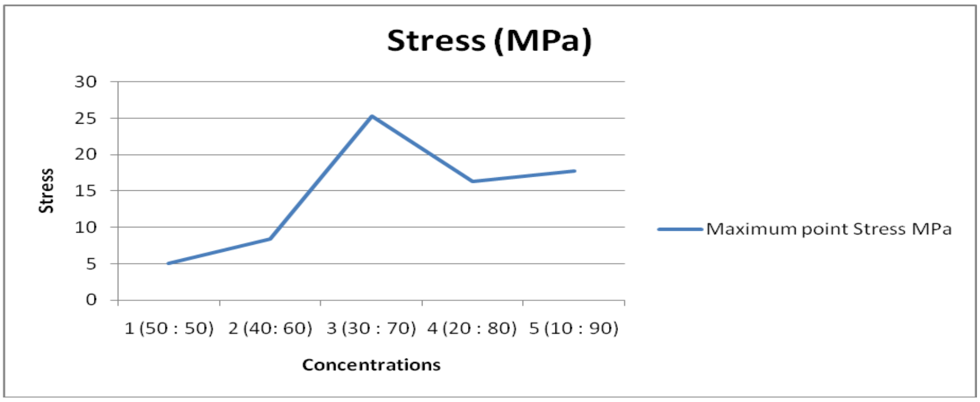

Figure 7. Longitudinal Tensile Strength for blended fiber composite tensile test samples

Based on figure 7 above, it is known that the sample with 30% of blended fiber and 70% matrix composite sample has the highest longitudinal tensile strength 25,31 Mpa and the lowest tensile strength 5,07 Mpa is obtained from the sample with 50% fiber and 50% matrix for the blended fiber composite tensile test sample.

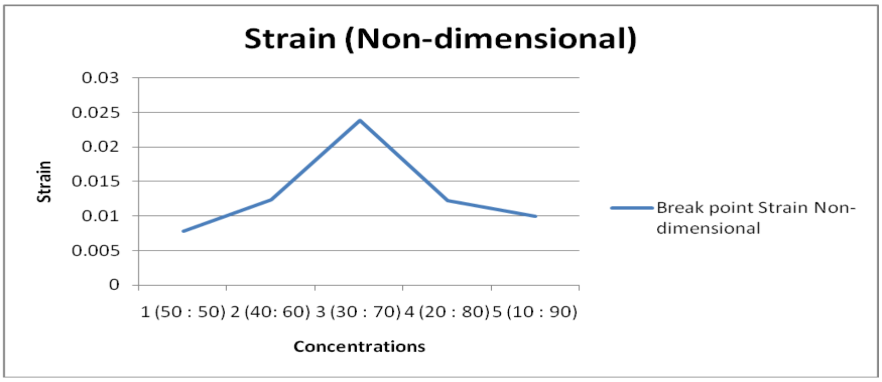

Figure 8. Longitudinal tensile strain for blended fiber composite tensile test samples

Based on figure 8, it can be seen that the sample with 30% blended fiber and 70% matrix has the highest longitudinal tensile strain 0,0239 while the lowest strain gained by the sample with 50% matrix and 50% blended fiber 0,01 for the blended fiber composite tensile test sample.

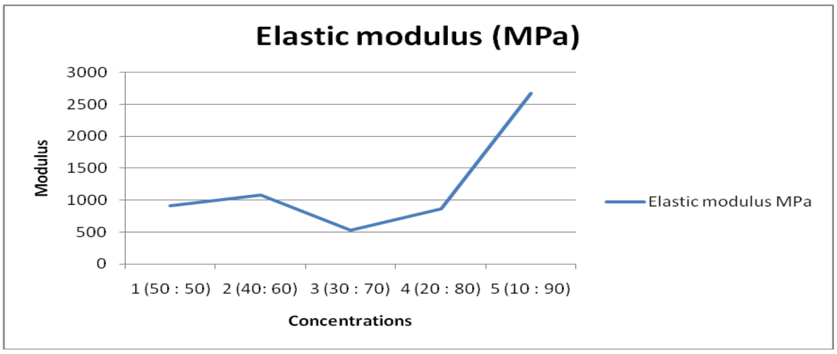

Figure 9. Longitudinal modulus of elasticity for blended fiber composite tensile test samples

From the figure 9, it is found that the highest longitudinal modulus of elasticity is obtained from the sample with 10% blended fiber and 90% matrix 2673,4 Mpa, while the lowest modulus of elasticity is reached by the sample with 30% blended fiber and 70% matrix 524,04 Mpa for the blended fiber composite tensile test sample.

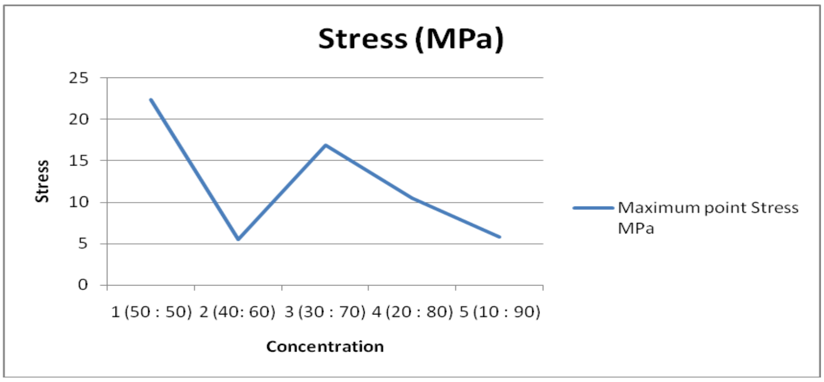

Figure 10. Longitudinal tensile strength for rubbed fiber composite tensile test samples

According to the figure 10, it is seen that the sample with 50% rubbed fiber and 50% matrix has the highest longitudinal tensile strength 22,324 Mpa while the lowest tensile strength 5,48 Mpa is obtained from the sample with 40% rubbed fiber and 60% matrix for the rubbed fiber composite tensile test sample.

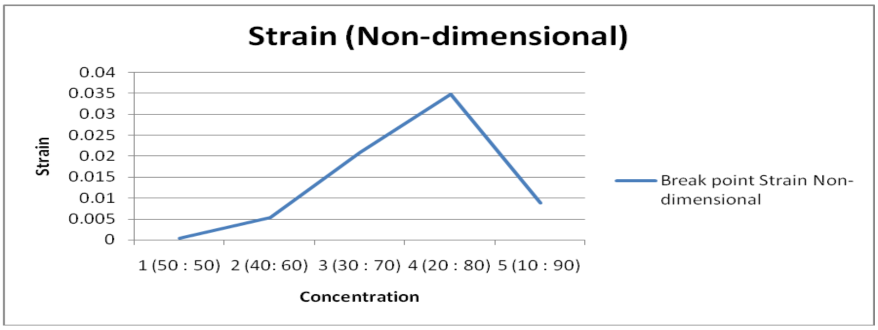

Figure 11. Longitudinal tensile strain for rubbed fiber composite tensile test samples

Based on figure 11, it is known that the highest longitudinal tensile strain 0,0349 is reached by the sample with 20% rubbed fiber and 80% matrix, while the lowest strain 0,0004 is obtained from sample with 50% fiber and 50% matrix for the rubbed fiber composite tensile test sample.

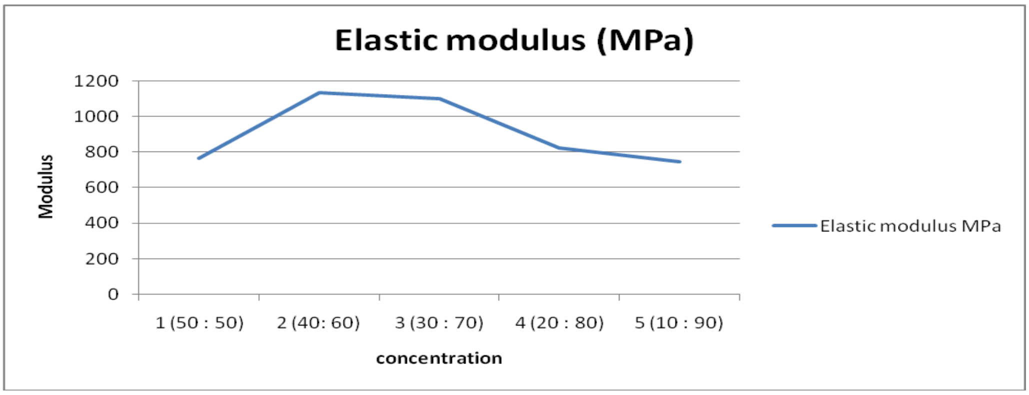

Figure 12. Longitudinal modulus of elasticity for rubbed fiber composite tensile test samples

According to figure 12 above, it is found that the highest longitudinal modulus of elasticity 1136,4 Mpa is obtained from the sample with 40% rubbed fiber and 60% matrix, while the lowest modulus of elasticity 747,46 Mpa is gained from the sample with 10% fiber and 90% matrix for the rubbed fiber composite tensile test sample.

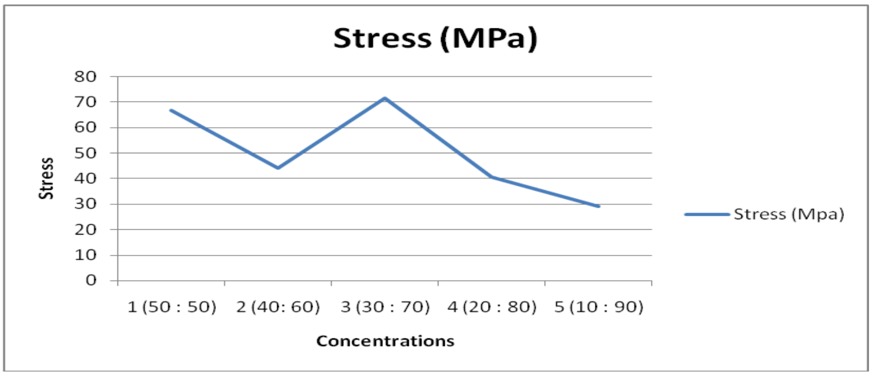

Figure 13. Tranverse tensile strength for blended fiber composite bending test samples

Figure 13 shows that the highest transverse tensile strength 71,55 Mpa is produced by the sample with 30% blended fiber and 70% matrix, while the lowest tensile strength 28,96 Mpa is obtained from the sample with 10% fiber and 90% matrix for the blended fiber composite bending test sample.

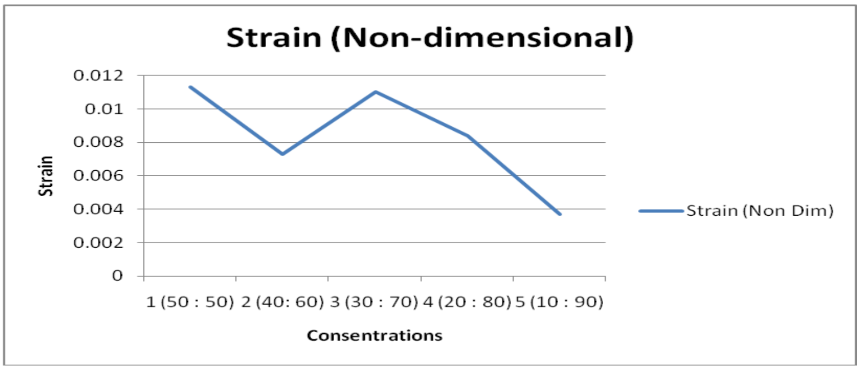

Figure 14. Tranverse tensile strain for blended fiber composite bending test samples

It is shown from the figure 14 that the highest transverse tensile strain 0,013 is found in sample with 50% blended fiber and 50% matrix, while the lowest strain 0,0037 is obtained from the sample with 10% fiber and 90% matrix for the blended fiber composite bending test sample.

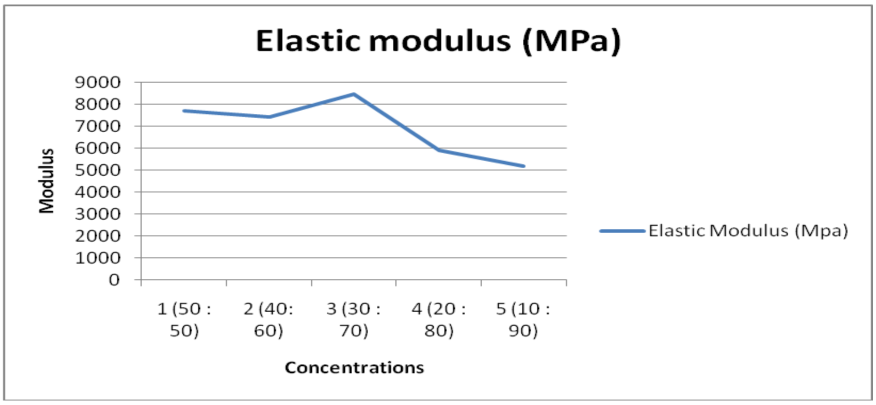

Figure 15. Tranverse modulus elasticity for blended fiber composite bending test samples

The highest transverse modulus of elasticity 8447,1 Mpa for the blended fiber composite bending test sample is obtained from the sample with 30% blended fiber and 70% matrix, while the lowest modulus of elasticity 5197 Mpa is obtained from the sample with 10% fiber and 90% matrix based on the figure 15.

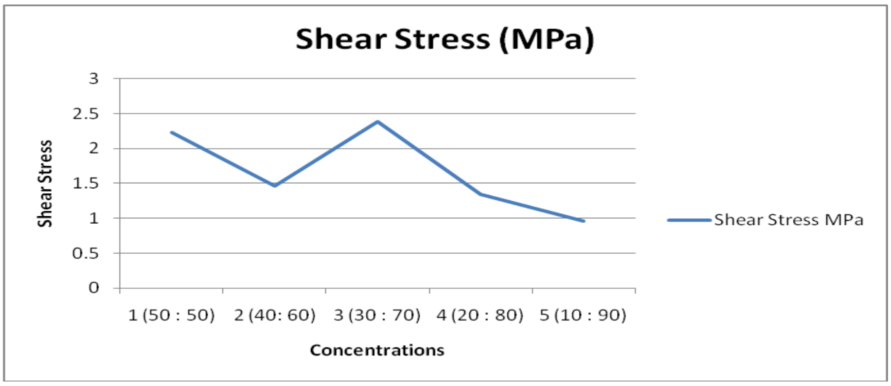

Figure 16. shear strength for blended fiber composite bending test samples

The highest shear strength 2,385 Mpa for the blended fiber composite bending test sample is found in the sample with 30% blended fiber and 70% matrix, while the lowest shear strength 0,9656 Mpa is obtained from the sample with 10% fiber and 90% matrix according to the figure 16.

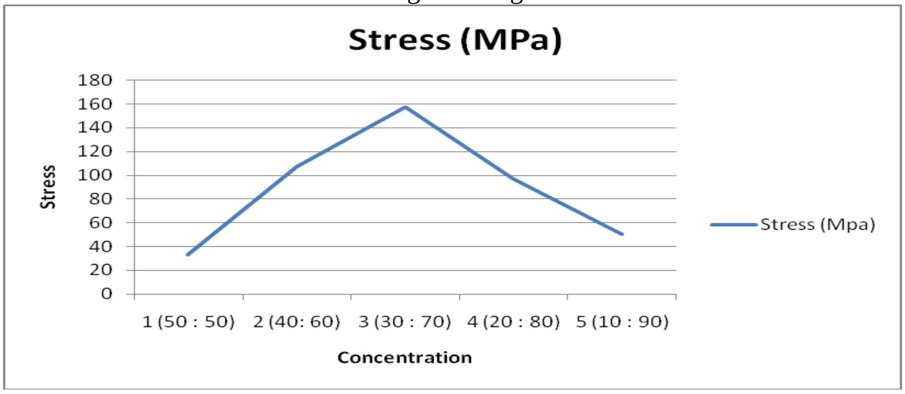

Figure 17. Tranverse tensile strength for rubbed fiber composite bending test samples

From the figure 17 above, it is known that the highest transverse tensile strength 5,2393 Mpa is obtained from the sample with 30% rubbed fiber and 70% matrix, while the lowest tensile strength 1,1048 Mpa is obtained from the sample with 50% fiber and 50% matrix for the rubbed fiber composite bending test sample.

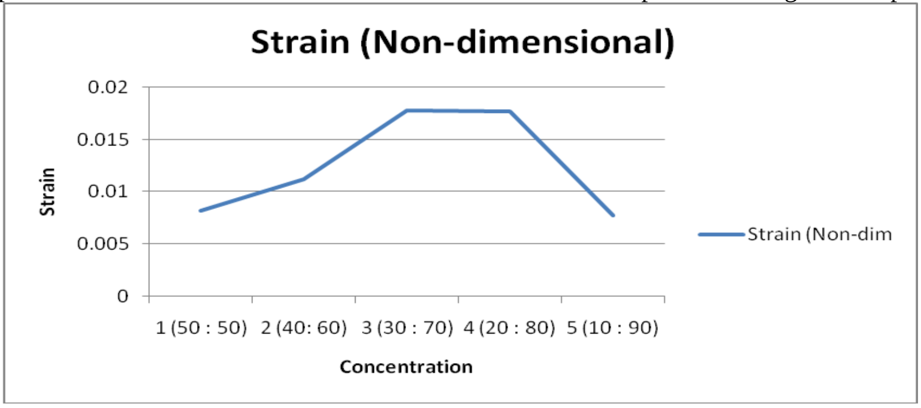

Figure 18. Tranverse tensile strain for rubbed fiber composite bending test samples

Besed on the figure 18 above, it is found that the highestTransverse tensile strain 0,0178 is obtained from the sample with 30% rubbed fiber and 70% matrix, while the lowest strain 0,0077 is obtained from the sample with 10% fiber and 90% matrix for the rubbed fiber composite bending test sample.

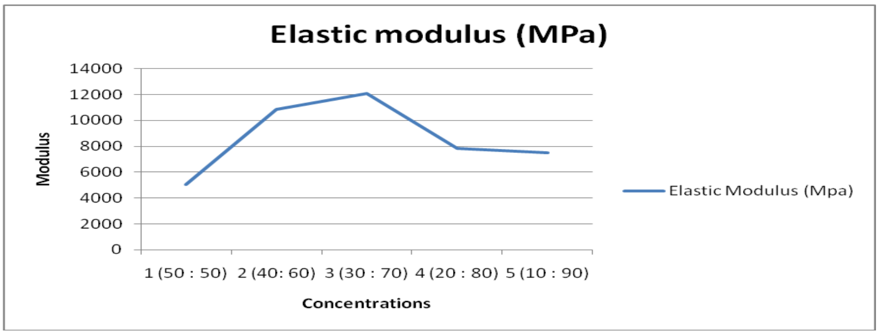

Figure 19. Tranverse modulus elasticity for rubbed fiber composite bending test samples.

According to the figure 19 aboive, it is found that the highest transverse modulus of elasticity 12063 Mpa is obtained from the sample with 30% rubbed fiber and 70% matrix, while the lowest modulus of elasticity 5034,3 Mpa is obtained from the sample with 50% fiber and 50% matrix for the rubbed fiber composite bending test sample.

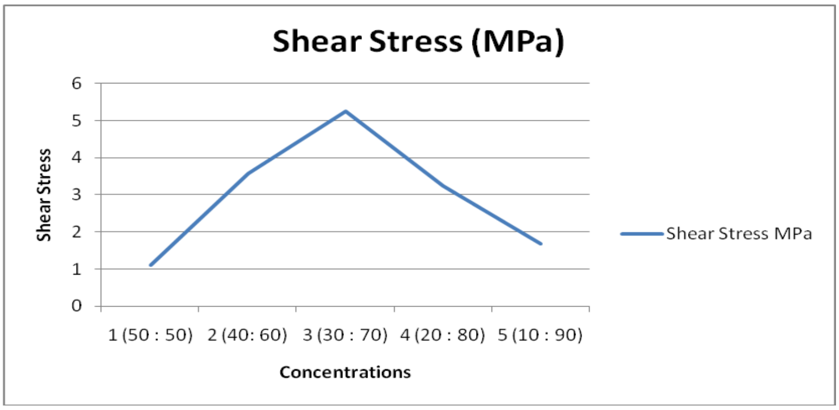

Figure 20. shear strength for rubbed fiber composite bending test samples

From the figure 20 above, it is found that for the rubbed fiber composite bending test sample the highest shear strength 5,2393 Mpa is obtained from the sample with 30% rubbed fiber and 70% matrix, while the lowest shear strength 1,1048 Mpa is obtained from the sample with 50% fiber and 50% matrix.

2. Discussion

From the tensile test performed, it is found that the best Longitudinal Tensile Strength 25,31 Mpa is found at sample with 30% Blended Fiber and 70% matrix, and the highest Longitudinal Tensile Strain 0,0349 is reached by the sample with 20% rubbed fiber and 80% matrix and the biggest Longitudinal Modulus of Elasticity 2673,4 Mpa is obtained from the sample with 10% blended fiber and 90% matrix. While from the bending test performed, it is known that the highest Transverse Tensile Strength 71,55 Mpa is obtained from the sample with 30% blended fiber and 70% matrix, and the biggest Transverse Tensile Strain 0,0178 is found at sample with 30% rubbed fiber and 70% matrix, the highest Shear Strength 5,2393 Mpa is found at sample with 30% rubbed fiber and 70% matrix and the biggest Transverse Modulus of Elasticity 8447,1 Mpa is obtained from sample with 30% blended fiber and 70% matrix.

IV. CONCLUSION

Based on the tensile and bending test performed for every samples and concentrations, it can be concluded that every sample with different concentrations and methods have differences in the mechanical properties. Every samples with blended or rubbed fiber it contains has it's favor and weaknesses for example the best mechanical properties in Longitudinal Tensile Strength, Longitudinal Modulus of Elasticity, Transverse Tensile Strength, and Transverse Modulus of Elasticity is obtained with blended fiber while the best Longitudinal Tensile Strain, Transverse Tensile Strain and Shear Strength is found at samples with rubbed fibers.

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