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Research on Mangrove Fibre as a Reinforced Material for Particle Board

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Abstract

This research is conducted to study the mechanical and physical properties of mangrove fiber and epoxy resin for the purpose of producing environmentally friendly composite particle board. Mangrove tree are found mainly along the west coast of Peninsular Malaysia, at the mouth of the Sarawak river, Rejang and Trusan-Lawas river, Sarawak and along the east coast of Sabah. Mangrove swamp covers less than 2% of the total land area in Malaysia. The particle board reinforced by mangrove fiber are produced by mixing with epoxy resin using the cold pressing. To determine the mechanical and physical properties of this board, several test are conducted such as tensile tests, impact tests and water absorption. The results of the study show that average maximum stress of tensile test results is 11.57 kN/mm² for sample 1 (80%:20%) follow by sample 2 (60%:40%) with an average maximum stress 8.7 kN/mm² and the lowest was 7.13 kN/mm² sample 3 (50%:50%). The impact test results found that the highest maximum average charpy is 7.56J that is in the sample 3 (50:50). Sample 2 (60:40) has an energy absorb of 7.18J. Meanwhile, the minimum average energy absorb is 5.50J on sample 1 (80:20). The highest water absorption test was 3.78% in the 50% epoxy sample and the lowest was 1.68% in the 80% epoxy sample. Based on the results of this study, the best sample is sample 2 which is (60% epoxy and 40% mangrove fiber) due to its balanced mechanical and physical properties. It can be concluded that the presence of reinforcedmangrove fiber in epoxy resin can produced a good composite board.

Key-word: - Fibreboard, Medium density fibreboard (MDF), Mangrove

1. Introduction

1.1 Background of the research

Mangrove swamp forest is a buffer zone located between the coastal and marine environment. It serves as a protector and stabilizes the coast, enriches coastal waters, produces forest products and supports coastal fishing activities. It can also act efficiently as a sediment trap and much depends on the tidal flow whether transported in or out of the mangrove swamp forest area. Many argue that the existence of grooves in mangrove forests is only a morphological feature and has a role as a channel for water to reach the back of mangrove forests during high tide. In terms of biological and chemical aspects, mangrove forests are identified as areas with high productivity. Meanwhile, for geologists, mangrove swamps are identified as good sediment trap places. It is described as a continuous sediment deposition process between mangrove swamp roots and also in the area around the coast. Although mangrove swamp forest ecosystems have been identified as important sediment trap areas, not many relevant studies have been conducted. Some scientists have introduced several methods of determining sedimentation rates but have not been able to provide an overview.

Spenceley and Shahbudin et al have introduced simple sedimentation determination methods by using the pneumatophore root method and the horizontal artificial marker method. Meanwhile, for long-term methods using radionuclides have been done a lot but this method is not much practiced in the area of mangrove swamp forest. In this study, two methods of determining the rate of deposition in mangrove swamps have been used, namely radionuclide method and horizontal artificial marker method. The first method of determining the sedimentation rate is based on the assumption that sediment settles in the sediment and while the second method is based on the sediment thickness which increases over a specified time interval.

1.1. Problem statement

1.1.1. Mangrove tree are cut down for aquaculture and rice field purposes

A Yangon-based environmental organization has said that only 20 percent of the remaining mangrove in the Irrawaddy Delta has been cleared for aquaculture or paddy fields.

In Myanmar, mangroves have disappeared at an unprecedented clip. The rate of deforestation in the country is the highest in Southeast Asia, according to research published in the *Proceedings of the National Academy of Sciences* in 2016. U Htay Lin, secretary of the Mangrove Service Network, an environmental organization based in Yangon, Myanmar's commercial capital, estimates that only 20 percent of the mangroves in the Irrawaddy Delta remain; most have been cleared for aquaculture or rice paddy fields. Those that survive are in forest and wildlife reserves near the city of Bogale just a three hour boat ride from Chaungbyaegyi. This has happened in the last three decades, 40 percent of Indonesia's mangrove forests have been damaged, as a result of aquaculture where every year, 52,000 Indonesian mangrove forests disappear equivalent to New York city area in the US within 18 months

1.1.2. Wood tree from chemical pollution coming from land and sea

Heavy metals such as copper, zinc, cadmium, lead and iron have been said to be metallic materials. Due to tin activity in Perak for example, the tin content in mangrove leaves and on the mud surface of mangrove forest areas and river estuaries is relatively higher than usual as reported in the journal The Science of the Total Environment 1979.

Since the 70s because they want to see the effects of tin mining and the importance of agricultural activities but cannot be clearly seen and the content is still low although there are samples that show high content and need to be given attention in terms of pollution sources and impact on mangrove forest ecosystems and plans its management.

Metal enrichment contributed from urban waste and runoff, industrial effluents, boating activities, domestic garbage dumps, agricultural runoff, mining activities and sewage treatment plant. The most concern metals are copper, lead and zinc because they accumulated in aquatic organism consumed by humans (Luoma 1990; MacFarlane & Burchett 2000). Heavy metals are regarded as severe pollutants due to their toxicity, persistent and bioaccumulation problem (Tam & Wong 2000). They are not chemically or biologically degraded; thus the pollutant stays for longer period in the environment.

1.1.3. Cut down for development

Widespread development has caused most of the mangrove swamps in our country to be destroyed and has caused pollution in the environment and the livelihoods of fishermen who depend on mangrove swamp resources have been threatened. His catch has declined to 60 per cent over the past three years due to sand dredging activities and development around the coast. In Indonesia, Indonesia's mangrove swamp forest plays an important role in the world. 15.2 million hectares of mangrove forests in 124 tropical and subtropical countries, 21 percent of which are in Indonesia. In Malaysia between 1980–1990 an estimated 12 percent of mangrove forests were lost, while in Johor from 1955–1998 alone about 46 percent of mangrove forests were destroyed.

1.2. Objective

The objectives of this study are:

i. To evaluate the mangrove fiber as reinforced material in composite board.
ii. To determine the mechanical and physical properties of mangrove particle board.

1.3. Scope

The scopes of this study are:

i. Using epoxy and hardener as matrix and mangrove fiber as reinforced material.
ii. Produce mangrove fiber composite board with epoxy resin in weight ratio (% weight) from 0% weight 100%.
iii. To determine the mechanical properties of mangrove fiber composites as tensile, flextural and impact

1.3.1. Quantity of epoxy resin (600gm) and mangrove particle

Table 1.4.1.1 Quantity of epoxy resin and mangrove

Sample	Epoxy (g) + Hardener (g)	Mangrove
1	60% (360g) + 20% (120g)	20% (120g)
2	45% (270g) + 15%(90g)	40% (240g)
3	40% (240g) + 10%(60g)	50% (300g)

1.4. The importance of the study

Studies conducted in several interests. Among them are:

i. Ensure the effectiveness of the use of mangrove fiber and epoxy.
ii. Ensure the resistance of materials to destructive ecosystems such as forests.
iii. Save on the use of materials in construction and furniture.
iv. Foster the community to be wise in choosing custom wood in construction and furniture.

1.5. Literature Review

1.5.1. Introduction

Mangrove Tree (Rhizophora spp) is a plant from the Rhizophoraceae family that grows in the estuary area where the place is a meeting between freshwater from land and salt water from the sea. Many of us are familiar with mangrove forests in Malaysia because they grow a lot in the coastal areas of the estuary in Sabah, Sarawak and some others in Peninsular Malaysia. When I was working in the Muar District of Johor before, my rental house was located near the mangrove forest in Kesang which is only 1 km away from the house. The area of mangrove forests in Malaysia is around 580,000 hectares where almost 60% are in Sabah, 26% in Sarawak and the rest in the Peninsula. There are many species of mangrove trees in our country and there are some popular species such as R. mangle, R, apiculata, R. racemosa, R. mucronata and R. stylosa. Tonight's article I wrote a little information in 'Anim Agro Technology' about mangrove plants and their importance in agriculture and the environment.

1.5.2. Epoxy resin

Epoxy for any basic component or final product of cured epoxy resin, as well as the language name for the functional epoxide group. Epoxy resins, also used as polyepoxides, are a class of prepolimers and reactive polymers that accumulate epoxide groups. Epoxy resins can react (interconnected) either by self through catalytic homopolymerization, or by various reactants with polyphonic amines, acids (and acid anhydrides), phenols, alcohols and thiols (commonly referred to as mercaptans). These joint reactants are often referred to as hardening or healing, and reactions are called healing. Polyepoxide reactions by themselves or by polymer hardeners form thermoset polymers, often having good mechanical properties and high thermal and chemical resistance. Applications of various epoxy, including metal coatings, use in electronic / electrical / LED components, high voltage electrical insulation, manufacture of paint brushes, fiber reinforced plastic materials, and adhesives for structural purposes and others.

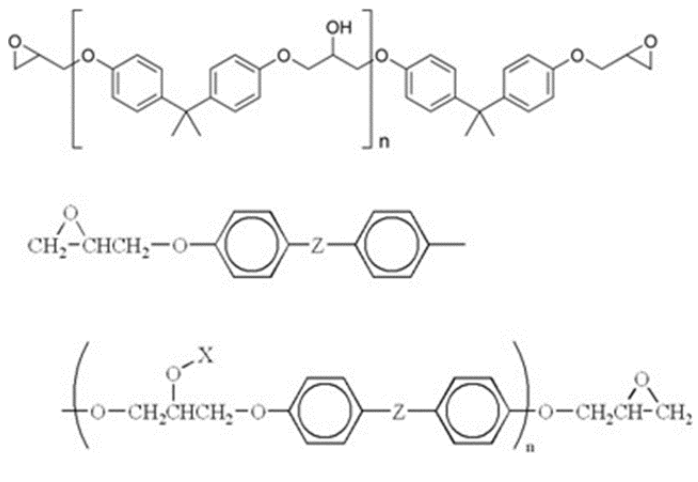


Figure 1.6.2.1 Epoxy coating system

1.5.3. Comparison between epoxy resin and polyester resin

	Epoxy resin	Polyester resin
Produced by	Condensation polymerization	Free-radical polymerization
Shrinkage	Low	High

Environmental durability	High	Low
Glass transition temperature	40 – 300 ºC	40 – 110 ºC
Toxicity	Less toxic	Highly toxic
Bonding strength	High	Low
Odor	Weak	Strong
Shelf life	Longer (24 months)	Shorter (12 months)
Cure time	Generally has a slower cure time	Generally has a faster cure time
Cost comparison	More expensive (due to its strength and formulation requirements)	Lower
Resistance to wear	More resistance to wearing, cracking and peeling, and corrosion or damage from chemical and environmental degradation	More fragile (useful for temparory fixes, or low-stress use)

1.5.4. Hardener

Hardeners are almost always needed to make epoxy resins useful for their intended purpose. Without hardeners, epoxy cannot be achieved near the remarkable mechanical and chemical properties they would perform with hardeners. The correct type of hardener must be selected to ensure that the epoxy mixture will meet the application requirements. Research should always be done on resins and hardeners to ensure that the final epoxy mixture will work satisfactorily. Common examples of epoxy hardeners are anhydride-based, amin-based, polyamide, aliphatic and cycloaliphatic-based. Hardeners are used to cure epoxy resins. However, simply adding a hardener to the epoxy resin should not cause the epoxy mixture to heal quickly. If this happens, a different hardener may be needed. Also, hardeners with certain additives can be used. These hardening additives serve as a catalyst that speeds up the curing process.

1.5.5. Tensile test

Tension test is a form of stress test and is an engineering science test and destructive material where controlled pressure is applied to the sample until it fails completely. This is one of the most common mechanical testing techniques. It is used to find out how strong the material is and also how much the material can be stretched before breaking. This test method is used to determine the yield strength, main tensile strength, ductility, tensile hardening characteristics, Young modulus and Poisson ratio.

1.5.6. Impact test

Impact tests are used in studying the toughness of material. A material's toughness is a factor of its ability to absorb energy during plastic deformation. Brittle materials have low toughness as a result of the small amount of plastic deformation that they can endure. The impact value of a material can also change with temperature. Generally, at lower temperatures, the impact energy of a material is decreased. The size of the specimen may also affect the value of the Izod impact test because it may allow a different number of imperfections in the material, which can act as stress risers and lower the impact energy.

Impact testing most commonly consists of Charpy and Izod Specimen configurations. The Charpy Impact Tests are conducted on instrumented machines capable of measuring less than 1 foot-pound to 300 foot-pounds at temperatures ranging from -320°F to over 2000°F. Impact test specimen types include notch configurations such as V-Notch, U-Notch, Key-Hole Notch, as well as Un-notched and ISO (DIN) V-Notch, with capabilities of impact testing sub size specimens down to ¼ size. IZOD Impact Testing can be done up to 240 foot-pounds on standard single notch and type-X3 specimens. Also known as the Charpy V-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's notch toughness and acts as a tool to study temperature-dependent ductile-brittle transition.

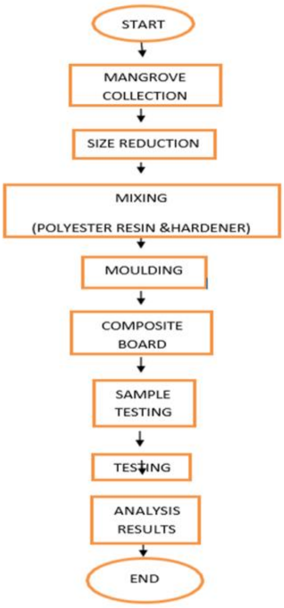
1.5.7. Water absorption

Water absorption refers to the ability of material to absorb water when immersed in it and is represented with water absorbing capacity. Water absorbing capacity is defined as the ratio of the weight of water absorbed by a material in saturated state over the weight of the dry material.

2. Methodology

In research methodology, methods and techniques for material preparation, analyzing data and designing projects need to be collected in order to produce evidence that supports a study (summarizing what is being studied). The methodology also describes how a problem is studied and why particular method and technique is used. It also includes estimated costs that will be used to purchase all project requirements for the preparation process. The purpose of the methodology is to help you understanding the process of a project more clearly and in more details about the application of techniques in used.

2.1. Flowchart



2.2. Mangrove polymer composite preparation

Table 2.2.1 Ratio of Epoxy resin and mangrove particle

Sample	Epoxy(g) + Hardener (g)	Mangroves plant
1	75%(450g)+25%(150g)	0%
2	67.5%(405g)+22.5%(135g)	10%(60g)
3	60%(360g)+20%(120g)	20%(120g)
4	45%(315g)+15%(105g)	40%(180g)
5	37.5%(225g)+12.5%(75g)	50%(300g)
6	30%(135g)+10%(45g)	60%(420g)
7	15%(90g)+5%(30g)	80%(480g)

After mechanical testing, each sample was processed to find out which samples is the best. It is because the good sample are those with less resin(epoxy) but more fiber because this project is to test the durability of mangrove fibers with epoxy resin. It’s also because the cost of using the epoxy resin is quite high. It’s quite good when the sample can minimize the use of epoxy resin.

The composites composed of the fibers and Epoxy resin were mixed. The mixing were mixed up until well by hand drill mixer (Bosch CSB 550 RE, Germany). The finished mixture will be setup into the mould with the dimension 280 mm of the length, 230 mm of the width and 10 mm of the thickness which are capable of fabricating specimen according to the standard size. The mould will wiped by release moud wax. The mixtures of epoxy resin and mangrove fibers were put into the mould and the mould will pressing under pressure around 15-20 minutes. The finished composite board has been formed and make sure the composite board were in curing temperature.

Figure 2.2.1 The fibers and resin were mixed by hand drill mixer

Figure 2.2.2 Mixtures were put into the mould and pressed

2.3. Raw material preparation

Mangrove tree fiber is obtained and collected from Kong Kong Laut, Pasir Gudang, Johor. After collecting the mangrove fiber, the mangrove will be cleaning and dried for a week. After drying, the size of mangrove will be reducting by crusher machine to smaller size.

Figure 2.3.1 Mangrove collected

Figure 2.3.2 Mangrove trees are reduced in size and dried for a week

Figure 2.3.3 Size reducing by crusher machine

2.4. Grain size reduction process

Grain size is the diameter of individual grains of sediments. The term may also be applied to other granular materials. A single grain can be composed of several cyrstals. Granular material can range from very small colloidal particles, through clay, silt, sand, gravel and cobbles to boulders.
There is a few steps to complete this process:

Figure 2.4.1 Mangrove have been weigh of 50g.

Figure 2.4.2 The sample was placed into nine stage of the sieve of a Nest of ISO

Figure 2.4.3 Weight in each stage of sieve has been recorded.

Grain size identification process

The adoption of the ISO matric sieve means that the old AFS grain fineness number can no longer be calculated. Instead, the average grain size, expressed as micrometers is now used. This determined as follows:

- Weigh 50g sample of mangrove.
- Place the sample into the top of a nest of ISO.
- Remove the sieve and beginning with the top sieve, weigh the quantity of mangrove remaining on each sieve.
- Collect the weight of the mangrove remaining on each sieve.

Table 2.4.1 Grain size identification data.

5. 50g of mangrove		
ISO sieve (mm)	Weigh (g)	Percentage (%)
13.20	4.3	8.6
9.50	4.5	9.0
5.60	6.0	12.0

3.35	7.0	14.0
1.18	36.3	72.6
0.850	10.5	21.0
0.500	10.0	20.0
0.365	5.1	10.2
0.106	5.3	10.6

3. Results and analysis

3.1. Mechanical testing

For mechanical testing, there are two testing that are conducted which is tensile test and impact test(charrpy). The sample of ratio used is (epoxy: fiber)

Sample 1 (80:20)

Sample 2 (60:40)

Sample 3 (50:50)

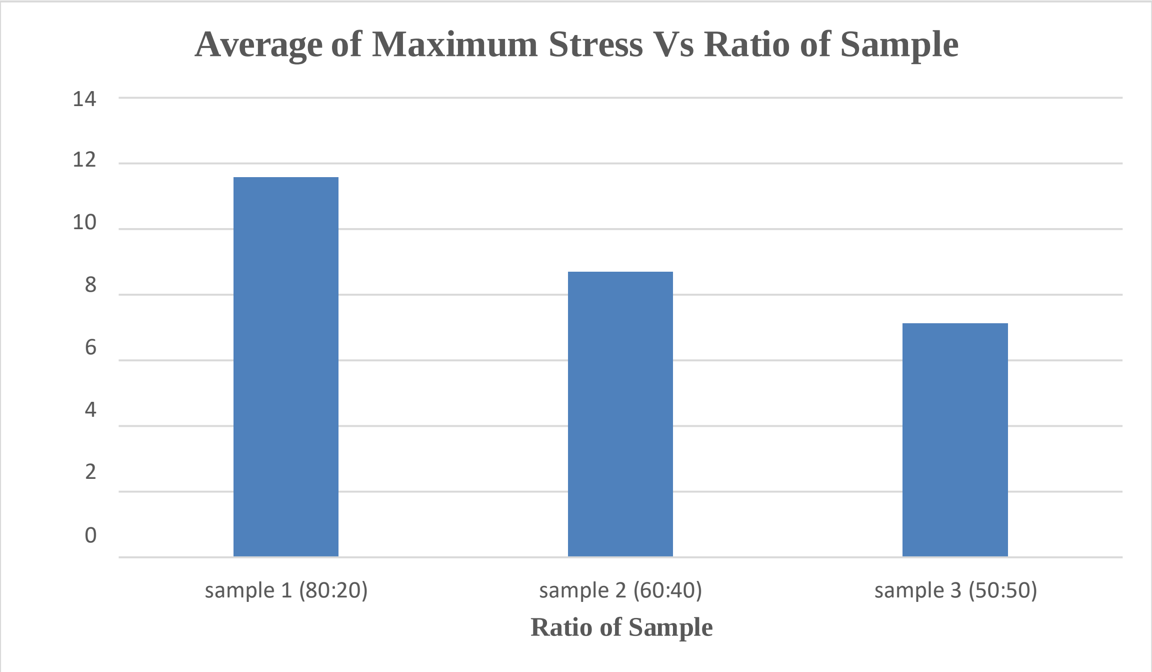
3.1.1. Tensile test

Table 3.1.1 Result of tensile test

RATIO SAMPLE	RESULT OF TENSILE TEST							
	Lo(mm)	Lu(mm)	So(mm)	Su(mm)	Max Load	Max Stress	Time to Rupture	Average of Max stress
	175	177	108.6	108.6	1.210	9.618	54.926	
Sample 1 (80:20)	175	175	108.6	108.6	1.680	15.470	100.262	11.57
Ave. of Maximum	175	176	125.8	117	1.210	9.618	54.926	
	175	173.5	97.6	97.6	0.490	5.020	39.141	
Sample 2 (60:40)	174	174	86.8	86.8	0.925	10.657	42.939	8.7
	173	175.5	78.5	89.64	0.810	10.318	29.351	
	172	173	109.8	109.8	1.760	6.922	72.91	

Sample 3 (50:50)	172	172	105	100.92	0.850	8.095	62.52	7.13
	172	172	109.8	109.8	0.700	6.375	48.932	

Based on the above information data, describe the maximum amount of composite material pressure from each specimen. The maximum amount of pressure received through a mangrove fiber composite material with epoxy resin is from sample 2 which is sample 2.3 with the ratio 80 percent of epoxy resin and 20 percent of mangrove fiber is11.57 kN / mm². The lowest tensile stress on the test specimen was 7.13 kN / mm² which is 50 percent of the epoxy resin used. All specimens were categorized according to a predetermined percentage of epoxy resin. This shows that the mangrove composite material is a good tensile strength. The tensile test is shown in graph below which states the tensile strength of the material through the mangrove fiber composite.
Observations of graph show the value maximum stress for each sample and every ratio that occurs on the sample which is ***sample 1.3, sample 2.3 sample 3.3***. The tensile strength of each specimen occurs because the bagasse fiber material is reinforced with epoxy resin. The test results show that the tensile strength of the composite material affects the mangrove fiber material.



3.1.2. Charpy test

Table 3.1.2 Result of charpy impact test.

Ratio Sample	Energy Absorb			
	Sample	Angle (º)	Charpy (J)	Average
80:20	Sample 1.1	110	5.32	5.50
	Sample 1.2	109	5.87	
	Sample 1.3	110	5.32	
60:40	Sample 2.1	107	6.99	7.18
	Sample 2.2	106	7.55	
	Sample 2.3	107	6.99	
50:50	Sample 3.1	106	7.55	7.56
	Sample 3.2	109	5.87	
	Sample 3.3	103	9.26	

Based on the data and information above, shows the energy absorbed for the impact test (charpy) on all samples used. The charpy test used is to determine the amount of energy absorbed by the material during fracture. The value of the charpy has different values on all the different samples which it is based on the angle that was obtained when performing the test. The results of the study found that the highest maximum average charpy is 7.56J that is in the sample 3 (50:50). This indicates that the sample has a lot of energy absorbed by the material compared to other samples. Sample 2 (60:40) has an energy absorb of 7.18J. Meanwhile, the minimum average energy absorb is 5.50J on sample 1 (80:20). The amount of energy absorbed can determine the strength and position of the material depending on the ductile-brittle transition. It is widely used in industry, as it is easy to carry out and results can be obtained quickly.

4. Physical testing on mangrove polymer composite

For physical testing, only water absorption test conducted. The sample of ratio used is (epoxy: fiber)

Sample 1 (80:20)

Sample 2 (60:40)

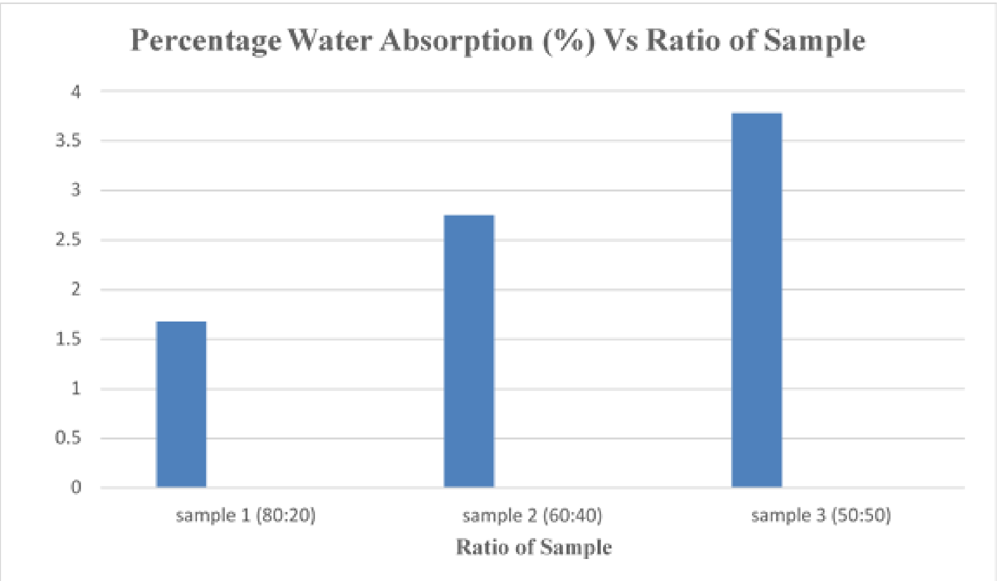
Sample 3 (50:50)

4.1. Water absorption test

Table 4.1.1 Result of water absorption test.

Ratio	Initial weight (g)	1 Hour	2 Hours	3 Hours	4 Hours	Different weight (g)	Percentage (%)	Average (%)
80:20	10.4	10.5	10.5	10.6	10.6	0.2	1.92	1.68
80:20	8.7	8.7	8.7	8.8	8.8	0.1	1.15	
80:20	10.1	10.2	10.3	10.3	10.3	0.2	1.98	
60:40	13.3	13.4	13.5	13.5	13.7	0.4	3.01	2.75
60:40	13.5	13.7	13.7	13.8	13.9	0.4	2.96	
60:40	13.1	13.2	13.2	13.2	13.4	0.3	2.29	
50:50	10.7	10.9	10.9	11.1	11.2	0.5	4.67	3.78
50:50	10.4	10.5	10.6	10.6	10.8	0.4	3.85	
50:50	10.6	10.7	10.8	10.9	10.9	0.3	2.83	

Based on the data and information above, shows the percentage of water immersion within 4 hours for all samples performed. The percentage value of water immersion varies according to different sample ratios. The highest percentage of water absorption is 4.67% which is absorbed at the ratio 50:50. Meanwhile, the lowest percentage of water absorption is 1.15% which is absorbed at the ratio 80:20.



5. Discussion and conclusion

The results of the study show that average maximum stress of tensile test results is 11.57 kN/mm² for sample 1 (80%:20%) follow by sample 2 (60%:40%) with an average maximum stress 8.7 kN/mm² and the lowest was 7.13 kN/mm² sample 3 (50%:50%). The impact test results found that the highest maximum average charpy is 7.56J that is in the sample 3 (50:50). Sample 2 (60:40) has an energy absorb of 7.18J. Meanwhile, the minimum average energy absorb is 5.50J on sample 1 (80:20). The highest water absorption test was 3.78% in the 50% epoxy sample and the lowest was 1.68% in the 80% epoxy sample. Based on the results of this study, the best sample is sample 2 which is (60% epoxy and 40% mangrove fiber) due to its balanced mechanical and physical properties. It can be concluded that the presence of reinforced mangrove fiber in epoxy resin can produced a good composite board.

References

Tam & Wong (2000), "Spatial variation of Heavy metals in surface sediments of Hong Kong mangrove swamps" Journal of Environmental Pollution, 110(2), 195-205

MacFarlane & Burchett (2000), "Cellular distribution of copper, lead and zinc in the grey mangrove" Avicennia marina (Forsk.) Vierh

A.I. Robertson, D.M. Alongi (1992), "Tropical Mangrove Ecosystem" American Geophysical Union, U.S.A

B.F.Clough (1992), "Primary Productivity and Growth of Mangrove Forest" Coastal and Estuarine Studies, U.S.A

Luzhen Chen (2009), "Recent progresses in mangrove conservation, restoration and research in China" Journal of Plant Ecology, Volume 2, Issue 2, 45-54