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Research Paper

Reprocessing Of Low-Density Polyethylene (LDPE) Waste Materials for The Formation Of Pvc Ceiling Tiles Using Sawdust As A Reinforcement

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***ABSTRACT:**. Globally, the main challenges of waste plastic materials are that it's not readily biodegradable, non eco-friendly and thus accumulates and cause serious environmental problems, such as pollution and depletion of landfill space. This research study was carried out to determine the effect of particle size and percentage weight of the reinforcement on the strength properties of the plastic ceiling and recycling of waste pure water sachet made from Low-density polyethylene (LDPE), for the production of plastic ceiling tiles using sawdust as a reinforcement. The plastic ceiling tiles of 30 samples were produced with resin ratios of 0:200, 10:200, 20:200, 30:200, 40:200:50:200% weight and 29 of the samples was reinforced with sawdust, one of the sample was without reinforcement and was also used as a control experiment for the research The pure water sachet material was pre- melted and solidified, weighed to be 800 grams and divided into equal 200 g by weight. The sawdust particles have five different particle sizes, 850µm, 1.18 mm, 1.70 mm, 2.36 mm and 3.35 mm, which was measured into five different percentage weights of 10, 20, 30, 40, 50 grams. The result showed that when the particle size of the sawdust decreases, the strength properties of the recycle plastic ceiling tiles increases, and when the particle weight of sawdust increases, the strength properties of the plastic ceiling tile also increases.*

***Keywords**: Compressive strength test, none- biodegradebale, pollution, tensile, polyethylene.*

I. INTRODUCTION

Almost every nook and cranny in Nigeria is littered with polyethylene water bags, which constitutes pollution and constant environmental degradation. This is as a result of millions of used polyethylene being thrown on a daily basis onto the streets of virtually every city, town and villages in Nigeria [1]. About 70% of Nigerian adults drink at least a sachet of water per day resulting to almost 50 to 60 million used polyethylene sachets disposed of daily across the country [2].Plastic production worldwide now exceeds 80 million tonnes a year, with Australia contributing almost 1.3 million tonnes to that total [3]. In Japan, getting rid of plastics in an environmentally friendly way was the major problem discussed until the Fukushima disaster in 2011[4]. It was listed as a $90 billion market for solutions. Since 2008, Japan has rapidly increased the recycling of plastics [4]. Americans use 100 billion plastics bags a year, made from about 12 million barrels of oil; instead, the use of 10 billion paper bags each year means cutting down 14 million trees [5]. Similarly, when oil, gas, and coal are used in the production process they emit dangerous greenhouse gasses, landfills, and plastic incineration also generates toxic emissions such as carbon dioxide and methane.

Accordingly, [6] asserted that these greenhouse gases contribute to worldwide climate change, and empty plastic has even been found on uninhabited in South Pacific islands [7]. It is estimated that plastic kills up to 1 million seabirds, 100,000 sea mammals, and countless fish each year, with many getting entangled in plastic six-pack rings, plastic strapping, and nylon ropes [7]. More so, plastics had played a significant role in the environmental, societal and economical dimensions of sustainable development [8]. Plastics are light, durable, clean and versatile and therefore have been increasingly used to make packaging, automotive, building, electronic and electrical products [9].

In recognising the importance of plastics and the fact that plastics are made of scarce resources, there have been a lot of efforts in research and development to make plastics reusable and recyclable. Waste generally is defined as the generation of undesirable substances which are left after they are used once [15]. According to the Department for Environment, Food and Rural Affairs (Defra)'s Waste Strategy 2007, the UK government set out to achieve 45% recycling target in 2015. Between 2008-2009, 27.3 million tonnes of municipal waste was collected by UK local authorities but 50.3% was sent to landfill, 36.9% was recycled or composted, 12.2% was incinerated for energy recovery [9]. The benefits of effective recycling of wastes help in reducing the quantity of waste sent to landfills and combustion facilities and enhanced the conservation of natural resources including minerals, water and further prevents pollution by reducing the desire to collect raw materials.

The management of plastics waste is one of the major problems facing modern society as it nondegradable and toxic when burned. It is observed that 45-50 percent of original wood (timber) taken for mechanical processing end up as waste (Sawdust wood) [16]. Sawdust is defined as powdery particles of wood produced by sawing, cutting, grinding, drilling and sanding with a saw which is composed of fine particles of wood [18, 19]. It is, therefore, very important for everyone's concern to seek for the best possible solution to reduce the emission, pollution, and constant environmental degradation as a result of used pure water sachet and sawdust, [10, 11, 12, 13, 14]. Recycling offers the solution for this. Several reasons exist as to why we should promote recycling [19]. Recycling is the process of converting waste materials into reusable objects to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, energy usage, air pollution (from incineration) and water pollution (from landfilling) by decreasing the need for "conventional" waste disposal and lowering greenhouse gas emissions compared to plastic production [20, 17]. Recycling helps us to convert our old products into new useful products. In other words, it is good for the environment. Since we are saving resources and are sending less trash to the landfills, it helps in reducing air and water pollution

Therefore, the justification for this research study is aimed at recycling of waste polyethylene water sachet water (PSW) made from Low-density polyethylene (LDPE) for the production of plastic ceiling tiles using sawdust as a reinforcement, to determine the effect of particle size and percentage weight of the reinforcement on the strength properties of the plastic ceiling tiles and compare the properties of the recycle plastic ceiling tiles to the existing tile.

II. EXPERIMENTAL PROCEDURE

Waste pure water sachet made from Low-density polyethylene (LDPE) was collected from the University of Calabar table water factory and sawdust gotten from the wood saw mill at Akim Timber Processing Company Calabar. The experiment was conducted at Civil engineering laboratory, University of Uyo, Akwa lbom State. The apparatus used for the research work are the electrical furnace, metal crucible, metal mould, sieve shaker, sieve, weighing balance and metal tongue from the University of Uyo Civil engineering laboratory.

2.1 Sample Preparation for recycling of pure water sachet

The pure water sachet was collected from the waste dump, wet and dirty, it was washed, shredded and then spread under the sun for a period of one month to get dried. The dried samples of pure water sachet polyethylene materials used for the research was pre melted using metal crucible in the furnace and allowed to solidified into lumps and weighed 800 grams. This lumps of pre melted pure water sachet were divided into equal 200 g by weight. The sawdust particles have five different particle sizes of 850µm, 1.18mm, 1.70mm, 2.36mm and 3.35mm, which was measured by six different percentage weight of 0, 10, 20, 30, 40, 50 grams for each particles sizes. The plastic ceiling tiles was produced at SAWDUST:LDPE resin ratios of 0:200,10:200,20:200,30:200,40:200:50:200% wt. 30 samples of the plastic ceiling tiles were produced,29 was reinforced with sawdust, one of the sample was without reinforcement and was also used as a control experiment for the research.

A

B

C

Fig 1:(a)pure water sachet sun drying process, **(b)**pure water sachet pre melting process in oven **(c)** lumps of pre melted pure water sachet .

2.2 Sample Preparation For Sawdust

The sawdust collected from the wood saw mill at Akim Timber Processing Company Calabar was air dried under the sun for one month before sieving. The sawdust particles were sieve into five different particle sieve sizes of 850µm, 1.18mm, 1.70mm, 2.36mm and 3.35mm, which was measured by six different percentage weight of 0, 10, 20, 30, 40,50grams for each particles size.

Fig 2: sample of sawdust preparation

III. MODE OF OPERATION OF THE ELECTRIC FURNACE

The electric furnace was connected to a power source. The furnace operates in the presence of oxygen so the furnace is not air tight. The source of the heat energy comes when the electrical switch is turned on. The furnace has an installed thermometer for measuring and indicating the temperature. It has a door which can be open and close during recycling..

Fig 3: crucible inserted into the electric furnace and the furnace turned on at a temperature of 150

IV. RECYCLING PROCEDURE

The pure water sachet made from Low-density polyethylene (LDPE), when collected from the waste dump was wet and dirty, it was washed, shredded and then spread under the sun for a period of one month to get dried. The dried samples of pure water sachet polyethylene materials used for the research was pre melted using metal crucible in the furnace and allowed to solidified into lumps and weighed 800grams.This lumps of pre melted pure water sachet were divided into equal 200g by weight Each 200g by weight sample lump of pre melted pure water sachet was put into a metal crucible and placed in the furnace; the furnace generates great heat which was regulated. The thermometer was carefully monitored to maintain required temperature which is around 150^{o} C until the polyethylene in the crucible is completely in molten form which normally takes 30 minutes, the crucible is now brought out from the furnace and then the weighed particles of sawdust added, it was discovered that immediately after adding the sawdust, the mixture produce bubbles which help in thorough recycling before casting into the mould. After casting, it was allowed to get cool for 24 hours. The physical properties of the plastic ceiling tiles that were examined include tensile strength, flexural and compressive strength test.

(a) **(b)**

Figure 4: (a) plastic tile immediately after casting, (b) plastic tiles arrange according to sizes of reinforcement.

V. PHYSICAL TEST CONDUCTED ON THE PLASTIC CEILING TILES

4.1 Flexural Test

Flexural is generally considered as the ability of a material to resist bending. A sample of recycled plastic tile was placed on two supporting pins set distance apart and a third loading pin lowered from above at a constant rate until the sample fails.

Fig 5: Sample undergoing flexural strength test

4.2 Compressive Strength Test

Compression is basically the capacity of a material to withstand loads tending to reduce size. Some materials fracture at their compressive strength limit, others deform irreversibly, so a given amount of deformation may be considered as the limit for the compressive load.

Fig 6: Sample undergoing compressive strength test

VI. RESULTS AND DISCUSSION

Table (1) flexural strength result for percentage of sawdust to pre melted plastic

Flexural strength)					Percentage of sawdust to pre-melted plastic (%)			
Sieve size 3.35mm	Sieve size 2.36mm	Sieve size 1.70mm	Sieve size 1.18mm	Sieve size 850µm		LDPE resin ratios	Aperture (mm)	Sieve number
0.0411	0.0411	0.0411	0.0411	0.0411	0	200	0	0
0.2757	0.6066	1.0368	1.3235	2.7574	10	200	3.35	6
0.2987	0.6397	1.0588	1.6544	2.9779	20	200	2.36	8
0.3529	0.6728	1.0698	1.7647	3.0882	30	200	1.70	10
0.3971	0.7941	1.0919	2.0945	3.5294	40	200	1.18	14
0.4301	0.8493	1.2132	2.3162	3.7500	50	200	850 µm	25

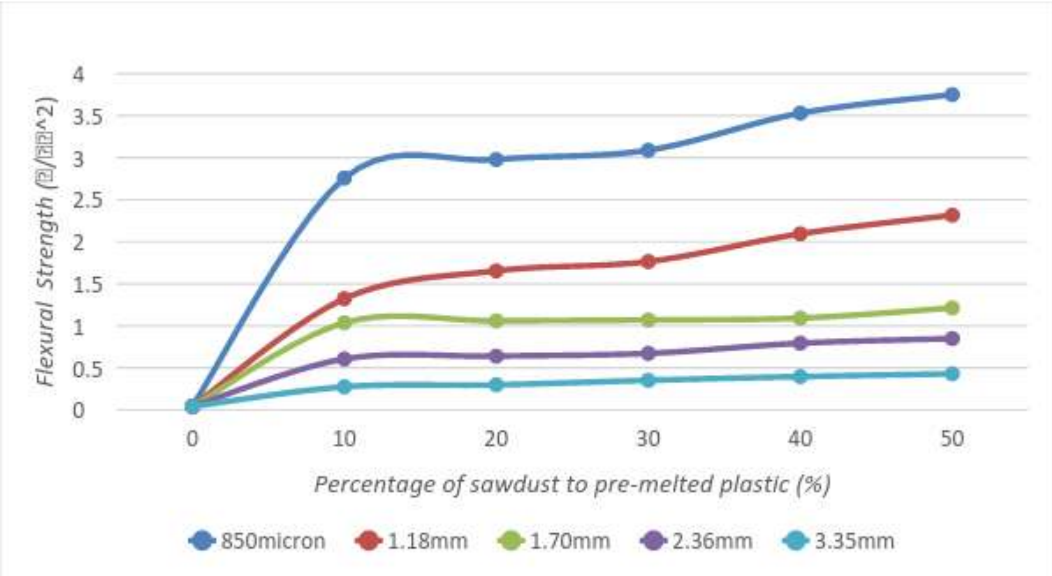

Figure 7:1 percentage of sawdust to pre melted plastic against flexural strength

‘’Fig.’’ 7.1 present the results of the percentage of sawdust to pre melted plastic against flexural strength. It was observed that, as the particle weight of sawdust increases, the strength properties of the plastic ceiling tile increases. From ‘’Table’’ 1. It was noticed that as the size of the sawdust decreases, the strength properties of the recycle plastic tiles increases.

Table (2) Compressive strength result for percentage of sawdust to pre melted plastic

Compressive strength)					Percentage of sawdust to pre-melted plastic (%)			
Sieve size 3.35mm	Sieve size 2.36mm	Sieve size 1.70mm	Sieve size 1.18mm	Sieve size 850µm		LDPE resin ratios	Aperture (mm)	Sieve number
0.8134	0.8134	0.8134	0.8134	0.8134	0	200	0	0
1.2059	2.2059	3.4412	5.2941	7.2941	10	200	3.35	6
1.4412	2.3235	3.5882	5.6176	7.3824	20	200	2.36	8
1.6471	2.4706	3.7941	6.1176	7.7647	30	200	1.70	10
1.7941	2.8235	3.9706	6.7941	8.6471	40	200	1.18	14
1.9706	3.5294	4.6176	7.4118	8.8255	50	200	850 µm	5

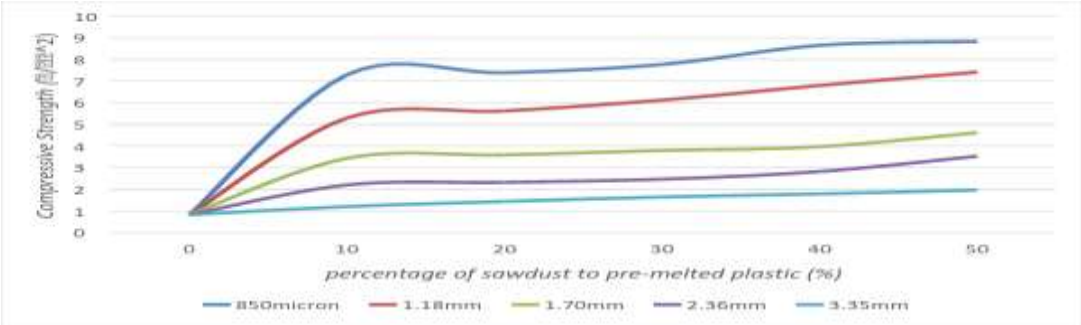

Figure7:2 percentage of sawdust to pre melted plastic against compressive strength

''Fig.'' 7.2 present the results of the percentage of sawdust to pre melted plastic against compressive strength. It was observed that the compressive strength test result conducted on the recycled plastic ceiling tiles are closely related to the result obtain in ''fig.'' 7.1.

Table (3) Tensile strength result for percentage of sawdust to pre melted plastic

Tensile strength)					Percentage of sawdust to pre-melted plastic (%)			
Sieve size 3.35mm	Sieve size 2.36mm	Sieve size 1.70mm	Sieve size 1.18mm	Sieve size 850µm		LDPE resin ratios	Aperture (mm)	Sieve number
0.0096	0.0096	0.0096	0.0096	0.0096	0	200	0	0
0.0135	0.018	0.0949	0.134	1.0027	10	200	3.35	6
0.0154	0.0311	0.1133	0.1453	1.1459	20	200	2.36	8
0.0242	0.0662	0.1307	0.1687	1.2573	30	200	1.70	10
0.0317	0.0883	0.1426	0.9424	1.321	40	200	1.18	14
0.0427	0.0955	0.1447	1.0366	1.4483	50	200	850 µm	25

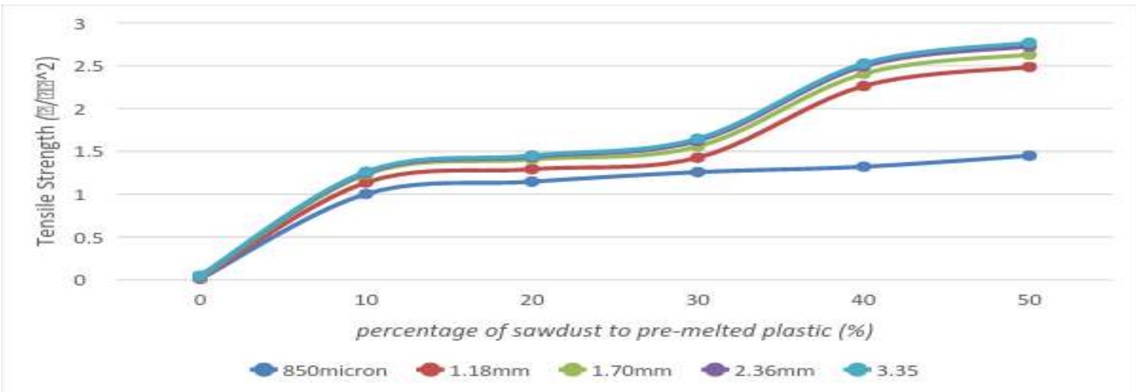

Figure 7:3 percentage of sawdust to pre melted plastic against tensile strength

‘’Fig.’’ 7.3 present the results of the percentage of sawdust to pre melted plastic against tensile strength. The result establishes that the strength properties of the recycle plastic ceiling tile was observed to be closely related as indicated between sieve size 3.35 and 2.36 also 1.70 and 1.18mm both at 10% weight of sawdust to pre melted plastic.

Table 4: maximum strength properties of recycled plastic ceiling tiles

Tensile strength test N/mm^2	Compressive strength test (N/mm^2)	Flexural strength test (N/mm^2)	Percentage of sawdust to pre-melted plastic (%)
1.4483	8.8255	3.7500	50
Maximum strength properties of existing tiles			
2.6350	9.3350	4.1830	50

In comparison, it was observed that the existing tiles have higher strength properties than the recycled plastic ceiling tile.

V. CONCLUSION

From the study conducted on the recycling of waste plastic materials (pure water sachet) made from Low-density polyethylene (LDPE) for the production of plastic ceiling tiles using sawdust as reinforcement, a number of conclusions were drawn from the research. The result showed that when the particle size of the sawdust decreases, the strength properties of the recycle plastic ceiling tiles increases. It was also observed that as the particle weight of sawdust increases, the strength properties of the plastic ceiling tile also increases. The maximum strength properties of recycled plastic ceiling tiles were compared with the Maximum strength properties of existing tiles. It was observed that the existing tiles have higher strength properties than the recycled plastic ceiling tile. Therefore, with improved recycling process, it is found necessary for everyone to seek for the best possible solution to reduce the emission, pollution, and constant environmental degradation as a result of waste pure water sachet and sawdust.

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