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Mechanical Analysis of Composite with Reinforcement Sawdust and Palm Kernel Shells

Chandra Shekher Giri and Utkarsh Singh***

ABSTRACT

In this study, the sawdust-palm kernel shellcrete composite was analysed. The sawdust-palm kernel shellcrete composite issue has been solved. Sawdust and palm kernel shells in weight varied from 100:0 to 90:10, 80:20 to 70:30, and 60:40 to 50:50 in composition. Urea formaldehyde (20% of the oven dry weight of agricultural waste) was used as a test binder. There were 300 m particles in the agricultural waste used in the process. A high water absorption capacity of aggregate materials and the need to build lightweight concrete with sufficient workability, strength, and durability led to the selection of these specific ratios of water to cement. In terms of yield strength (4.47 N/mm2), tensile strength (7.75 N/mm2), modulus of elasticity (2603 n/mm2), modulus of rupture (16.67 n/mm2), internal bond strength (0.54), thickness swelling (10.30 percent), water absorption (18.90 percent), and density (996.18 kg/m3), sawdust and palm kernel compositions performed best.

Keywords: *Mechanical properties; Sawdust; Composites; Palm kernel shell.*

1.0 Introduction

The development of materials science has been shown to be a factor of technological progress. To address the global need for lighter, cheaper, higher-quality, and more-durable products, scientists have shifted their focus from monolithic to composite materials in the past two decades [1]. The creation of the integral-composite concept, which integrates several components into a single unit, was spurred by the need for new materials with higher requirements. However, composite materials are possible to outperform their individual components. It's also possible to design using a broad variety of composites. The whole world's population faces a daunting challenge: decreasing pollution while simultaneously increasing industrial output. Environmentally friendly, biodegradable, and recyclable materials have seen a surge in popularity as a result. Agricultural waste is a perfect fit for this. As the global population and per capita income increase, so does the need for composite materials. It is becoming more difficult to keep up with the demand for items in certain regions of the globe. There has been a huge growth in demand for raw materials for both residential and industrial items as a result of the growing worldwide population. [3] Scientists all through the globe are studying the use of biomass residues as raw resources for the creation of both structural and nonstructural composites. Composites may currently be made using waste product as a raw source. Using recycled agricultural waste to make composite boards has the potential to be environmentally and economically beneficial [4].

**Corresponding author; M.tech Research Scholar, Department of Civil Engineering, KNIT Sultanpur, Uttar Pradesh, India (E-mail: giri.ucem@gmail.com)*
***Design Engineer, Maxbros Venture India Pvt Ltd (E-mail: utkarsh.vns1122@gmail.com)*

Due to an increase in forest fires, dwindling forestry supplies, and rising demand for woody goods, agricultural fibres and wood waste-based composite boards have become a viable alternative to solid wood. Composite panels made from non-wood and agroforestry waste are becoming more popular [5]. Agricultural and wood waste materials may be utilised to manufacture composite boards, which has been widely researched. It's been studied on a wide range of raw materials such as tea leaves (waste), almonds (shell), wheat straw (pith), durian peel (coir), groundnuts (husks) and rice husks (husks).

In Nigeria, the problem of disposing of agricultural waste is becoming more difficult. Using agricultural waste to make composite material would help reduce the country's waste disposal problems as a result. Society may choose a new material instead of the old ones that are already in use. Using agricultural waste to make composite materials would lower the cost of materials while also promoting environmentally friendly goods. New employment will be created and money saved as a result of cutting down on the importation of raw materials Burning waste will no longer contaminate the environment, and the area that was before used for its disposal might be better used. An agricultural waste-based composite material is being tested for its physico-mechanical characteristics as part of this investigation (fig 1: sawdust and palm kernel shell).

Figure 1: Sawdust and Palm Kernel Shell

2.0 Materials and Method

Mahogany sawdust and palm kernel shells from Benin City, Edo State, Nigeria, were employed in this experiment, while formaldehyde was used as a binding agent. A jaw crushing machine was used to smash the palm kernel shell into granules. The granules and sawdust were sun-dried and then oven-dried at 1050C to a moisture content of 4% to 2% before being employed in the final product. Particles less than 300 microns in diameter were obtained by sifting sawdust and palm kernel shells through two different types of vibrating sieve machines. A 20% urea formaldehyde binder concentration was used for the oven dry weight of agricultural waste. '10, 11' Previous studies have shown this to be true. Mixing sawdust with water in a 3.5:1 ratio before combining and blending with the binder yielded sawdust/palm kernel shell mixes as shown in Table 1.

Table 1: Compositions of the Composite Material

Composite material	Palm kernel shell (%)	Sawdust (%)
A	0.00	1
B	0.1	0.9
C	0.2	0.8
D	0.3	0.7
E	0.4	0.6
F	0.5	0.5

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To make the composite panels, the component mixtures were hot pressed for 15 minutes at a temperature of 2000C and 26.5 kg/cm2. For 96 hours, the finished composites were stored at 20 + 3°C and 65 + 1°C in a climate-controlled chamber to maintain a constant weight.

When it came to testing, it was established that samples should be checked for the following characteristics: thickness swelling, water absorption, rupture and elasticity moduli, and the internal bonding. It was also tested for its density, yield strength and ultimate tensile strength in the composite material. We repeated each test three times to get an average result. Avery-Denison Universal Testing Machine (0-600kN range) Model EN 77046 was used for the tensile test.

3.0 Results and Discussion

It's everything there in Tables 2, and 3: tensile (modulus of elasticity), rupture (inside bond strength), density (water absorption), and thickness swelling. Fig 2 yield and tensile strength of prepared specimen

Table 2: Test Results for Yield and Ultimate Tensile Strength

Composite Constituent composition		Mechanical properties	
Sawdust (%)	Palm kernel Shell granules(%)	Yield strength(N/mm^2)	Ultimate tensilestrength (N/mm^2)
1	0.00	1.32	2.48
0.9	0.1	1.55	3.15
0.8	0.2	2.65	4.49
0.7	0.3	3.35	5.48
0.6	0.4	3.95	6.67
0.5	0.5	4.65	7.87

Figure 2: Yield and Tensile Strength of Prepared Specimen

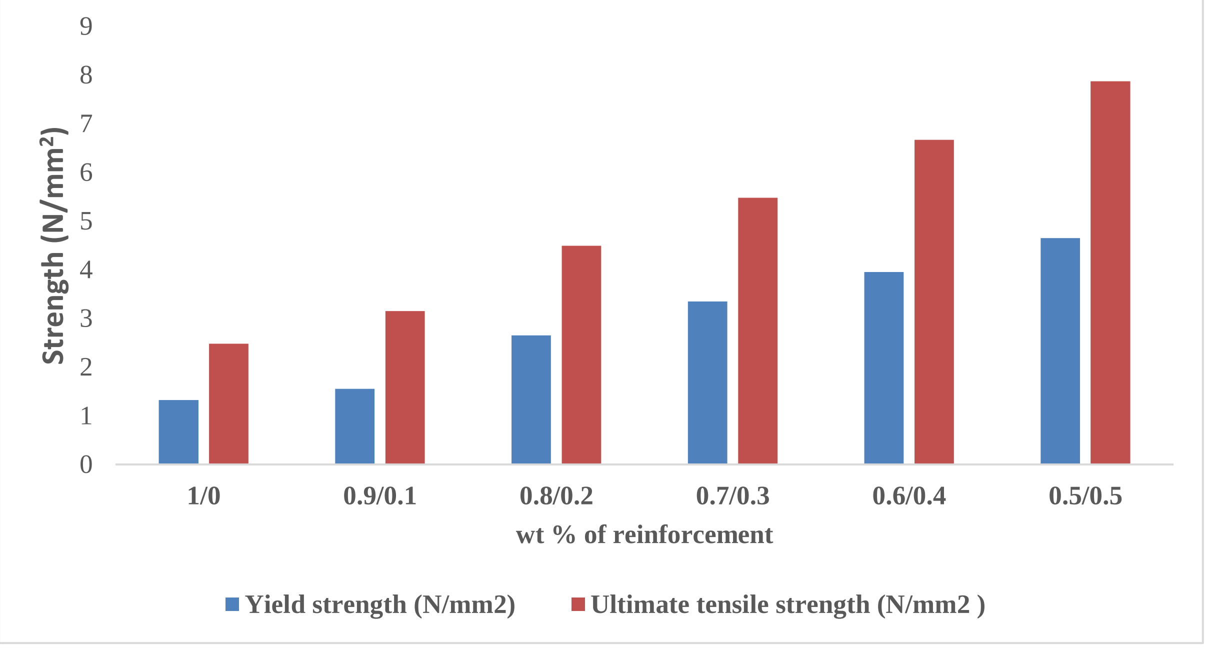


Table 3: Density, Water Absorption and Thickness Swelling Results

Composite Constituent composition		Physical properties		
Sawdust (%)	Palm kernel Shell granules(%)	Density (kg/m^3)	Water absorption (%)	Thickness swelling (%)
100.00	0.00	809.30	44.90	23.60
90.00	10.00	818.75	38.20	20.50
80.00	20.00	850.14	33.80	16.80
70.00	30.00	871.40	29.20	13.40
60.00	40.00	923.27	24.20	11.80
50.00	50.00	996.18	18.90	10.30

Figure 3: Density Measured of Specimen

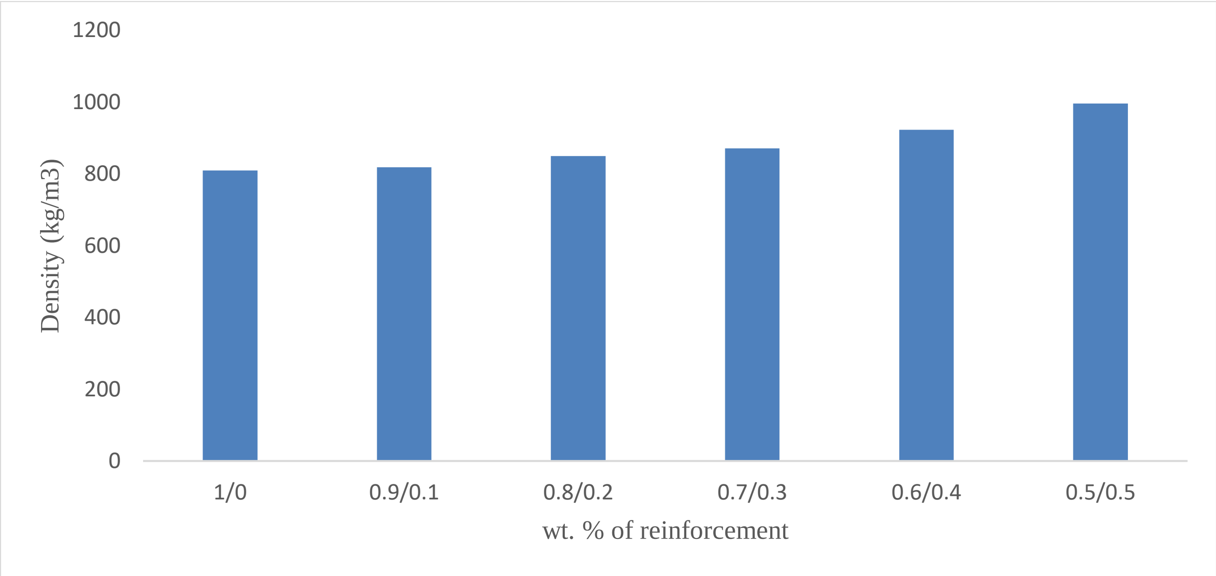
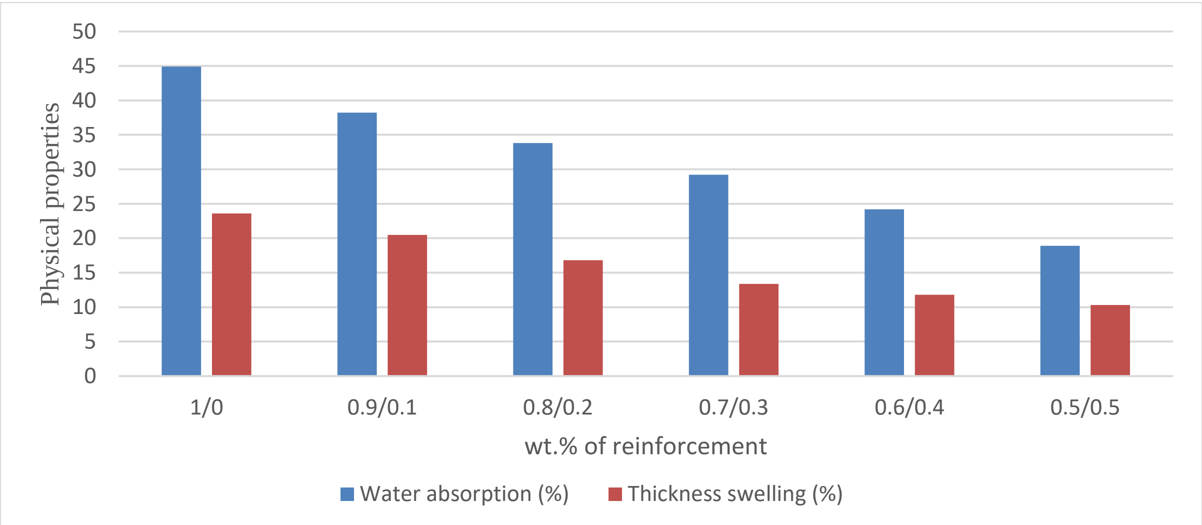


Figure 4: Physical Properties of Prepared Specimen



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4.0 Discussion of Results

The mechanical characteristics of composite materials are influenced by the material's composition. To enhance the overall mechanical qualities of the composite material, more palm kernel shell was discovered to be added. The yield strength was 1.5 N/mm2, the ultimate tensile strength was 3.11 N/mm2, the modulus of elasticity was 1807 N/mm2, the modulus of rupture was 10.79 N/mm2, and the internal bond strength was 0.40 N/mm2 when palm kernel shell grains represented 10% of the composite material (Tables 2 and 3). An elongation modulus of 22.880 N/mm2 and a rupture modulus of 13.08 Nim2 were found in a composite of palm kernel shell and sawdust with yield strength of 3.31 N/mm2 and ultimate tensile strength of 5.44 N/mm2. Fig 3 density measured of specimen and Fig 4 physical properties of prepared specimen

The composite had an internal bond strength of 0.47 Nim2 and a rupture modulus of 0.13 Nim2. Tensile strengths range from 2.44 to 7.75 N/mm2 for the composite material. For the composite material, the ultimate tensile strength was lower than that of sugarcane bagasse wastes with a binder polymer of HDPE.

For this high number, HDPE, which was utilised as a binder in the composite, might be to blame. From 1611 to 2603N/mm2, the modulus of elasticity of the new composite material was achieved.

The EN standard for furniture composite materials is 1600 N/mm2 [12]. All composite panels manufactured met or exceeded this criteria for elasticity modulus. A composite formed of agro waste (Eucalyptus camaldulensis Dehn.) and grass clippings (Lolium perenne L.) has an elastic modulus of 1918 N/mm2 [4]. Our and Olorunnisola and Adefisan rattan-cement composites have comparable modulus elasticity values. Coconut husk and cement composites, on the other hand, have a strength of around 900N/mm2 ([18]). Coconut husk particles have a low loose bulk density, which might account for this. Compared to the density of coconut husk particles (35–53 kg/m3), sawdust and shavings from common hard wood species have a bulk density of 100–250 kg/m3. The rupture modulus of composite materials ranged from 9.07N/mm2 to 16.67N/mm2, depending on the test.

In accordance with EN standards, composite materials must have a rupture modulus of 11.5 N/mm2. A and B, which had sawdust:palm kernel ratios of 100%: 0% and 90%:10%, were disqualified for this evaluation. Agriculture trash (Eucalyptus camaldulensis Dehn) and grass clippings (Lolium perenne L) had a modulus of rupture of 11.67 N/mm2 [4]. This value is greater than the composite made of coconut husk and cement, which had a value of 2.2N/mm2. Coconut husk particles have a lower loose bulk density than sawdust or palm kernel shells [19]. The internal bond strength of the composite material yielded a wide range of outcomes.

According to EN standard [12], general purpose composite materials have an internal bond strength of 0.24 N/mm2, whereas interior fittings have an internal bond strength of 0.35 N/mm2. Using this method, high-strength composite material panels may be manufactured. There was no significant difference in the internal bond strength between the composites prepared from agrowaste (Eucalyptus camaldulensis Dehn.) and grass clippings (Lolium perenne L.) for comparison [4].

It is evident from Tables 2 and 3 that mechanical characteristics improve with the addition of palm kernels. Sawdust is used to create this composite material. Yield Strength 4.47 N/mm2; Tensile Strength 7.75; Elastic Modulus 2603; and Rupture Modulus 16.67 N/mm2 are the mechanical parameters that make up this material's mechanical properties. 50% of palm kernels have mechanical qualities of the highest quality.

5.0 Conclusion

Agro-waste has been used to make composite materials (such as sawdust and palm kernel shell). Due to the addition of palm kernel shell, the composite material's overall qualities were enhanced. Composing 50 percent sawdust and 50 percent palm kernel, the composite material had the greatest yield strength of 4.47 N/mm2, the ultimate tensile strength of 7.75 N/mm2, modulus of elastic 2603 N/mm2; and modulus of rupture 16.67 N/mm2.

References

[1] J.U Ejiofor and R.G Reddy, Developments in the processing and properties of particulate Al-Si composites, Journal of Manufacturing 49(11) (1997) 31-37

[2] F.A Gasser, A three-phase constitutive model for macrobrittle fatigue damage of composites. A PhD Dissertation Submitted to College of Engineering and Mineral Resources at West Virginia University, Department of Mechanical and Aerospace Engineering Morgantown, West Virginia.(2000)

[3] J.L. Bowyer, R. Shmulsky and J.G . Haygreen, Forest products and wood science: An Introduction. Fourth Edition, Iowa State Press (2004)

[4] G. Nemli, S. Samet Demirel, E. Gümüşkaya, A . Aslan and C. Acar, Feasibility of incorporating waste grass clippings (Lolium perenne L.) in particleboard composites, Waste Management 29(3) (2009) 1129-1131

[5] M. Gürü, S. Tekeli and I . Bilici, Manufacturing of urea formaldehyde based composite particleboard from almond shell, Materials and Design 27(2006) 1148–1151

[6] M.K. Yalınkılıç, Y. Imamura , M. Tahashi , H. Kalaycıoğlu, G. Nemli, Z. Demirci and T. Ozdemir, Biological, physical and mechanical properties of particleboard manufactured from waste tea leaves, International Biodeterioration and Biodegradation 41(1998) 75–84

[7] D.Wang, and X. S Sun, Low density particleboard from wheat straw and corn pith, Industrial Crops and Products 15 (2002) 43–50

[8] J .Khedari, N. Nankongnab, J. Hirunlabh and S Teekasap, New low-cost insulation particleboards from mixture of durian peel and coconut coir, Building and Environment 39 (2004) 59–65A. Sampathrajan, N.C. Vijayaraghavan and K .R Swaminathan, Mechanical and thermal properties of particleboards made from farm residues, Bioresource Technology 40 (1992) 249 – 251

[9] J.O Osarenmwinda, Effect of resin concentration on the properties of groundnut husk particleboard, Global Journal of Mechanical Engineering 7(1) (2006) 60 – 64

[10] J.O Osarenmwinda and J.C Nwachukwu, Effect of particle size on some properties of rice husk particle board, Advanced Materials Research 18-19 (2007) 43-48

[11] EN 310, Wood based panels: Determination of modulus of elasticity in bending and bending strength, European Standardization Committee, Brussels (1993)

[12] EN 317, Particleboards and fiberboards: Determination of swelling in thickness after immersion, European Standardization Committee, Brussels (1993)

[13] EN 319, Particleboards and fiberboards: Determination of tensile strength perpendicular to plane of the board, European Standardization Committee, Brussels (1993)

[14] R.M Daniella, J.C Herman , Voorwald Maria Odila, H. Cioffi, Maria Lúcia, C.P. da Silva, Tessie Gouvêa da Cruz and Clodoaldo Saron, Sugarcane bagasse cellulose/HDPE composite obtained by extrusion, Carbohydrate Polymers 75(2) (2009) 317-321

[15] A.O Olorunnisola and O.O. Adefisan. Trial production and testing of cement-bonded particleboard from rattan furniture waste, Wood Fiber Sci 34 (1) (2002) 116–124

[16] A.O Olorunnisola, A. Pitman and H. Mansfield Williams, Strength properties and potential uses of rattan-cement composite, J. Bamboo Rattan 4 (4) (2005) 343–352

[17] N. Sharma, P. Sharma, and A. K. Parashar, "Incorporation of Silica Fume and Waste Corn Cob Ash in Cement and Concrete for Sustainable Environment," Mater Today Proc, Apr. 2022, doi: 10.1016/J.MATPR.2022.04.677.

[18] N. Sharma, P. Sharma, and A. K. Parashar, "Use of waste glass and demolished brick as coarse aggregate in production of sustainable concrete," Mater Today Proc, May 2022, doi: 10.1016/J.MATPR.2022.04.602.

[19] G. Nemli, and G. Colakoglu, Effects of Mimosa bark usage on some properties of particleboard, Turk. J. Agric. For. 29 (2005) 227-230