

Mechanical Behaviour of PLA and PHBV Based Lignocellulosic Composite Plates

M. Selwin, N. Rajini

Abstract: *The knowledge of 3D printing material used in 3D printing technique is so abundant. Even though there are many critical issues in practical applications. This paper reports the comparison study of the Tensile, Flexural and Impact properties of Environmental friendly composites. This composite material is intended to be used as a replacement for the current 3D printing material. The composite was prepared in compression molding/Injection molding technique under 150 kg/cm² pressure. This work consists of three specimens. One specimen is Poly Hydroxy Butyrate co Valerate (PHBV) and Sansevieria Roxburghiana. Second specimen is Poly Lactic Acid (PLA) and Sansevieria Roxburghiana and the last specimen is Pure PLA plate. The tensile, impact, flexural strength of pure PLA is comparatively better than the other two composite mixture plates. When comparing the fiber mixture of PLA and PHBV plates the PLA mixture possess greater mechanical properties. The research is further extended by changing the proportion of fiber and also improving the fiber lengths.*

Keywords : *Bio composites, Poly Hydroxy Butyrate co Valerate (PHBV), Sansevieria Roxburghiana, Poly lactic Acid (PLA).*

I. INTRODUCTION

[1] *Sansevieria Trifasciata* fiber which has a great impact in textile industries is a lignocellulosic fiber. Water retting is one of the notable technique that is used for the extraction of *Sansevieria Trifasciata* from its leaves. By improvising the various techniques the various geometrical and mechanical behavior have been measured in the lab. [2] This article surveys the procedure of provocative response that will be normal after implantation of PLA, and it features explicit cases in which the incendiary response can result in wellbeing concerns. The creators likewise survey chosen cases from various therapeutic fields to show conceivable clinical symptoms coming about because of its utilization. [3] PLA is delivered on huge scale and utilized for different applications, for example bundling for prescription, horticulture and material. Sadly, the weakness of PLA is significant disadvantage to limit its applications. So as to conquer these impediments, improvement the durability of PLA by copolymerization, plasticization, mixing or by the generation of filled

composites has been of intrigue. [4] The inexhaustible aliphatic polyesters of poly (hydroxyacid)-type homo polymers and copolymers comprising of poly lactic corrosive (PLA) PLA has pulled specifically consideration as a ultimate alternate for conventional plastics. [5] When comparing to other printing techniques such as Screen printing and inkjet technology 3D printing possess a remarkable impacts on engineering texture and material functionalization. The main objectives is to customize the usage of water, various bio components and to avoid various losses to improve the natural impacting and profit. [6] This work suggests the various parameters of *Sansevieria* natural fiber as fortification in the readiness of incompletely bio friendly green composites. The impact of fiber content on mechanical behavior of composite was investigated and found that rigidity and effect quality at greatest fiber content were 2.55 and 4.2 occasions to that of unadulterated tar, individually. [7] As per the formulated re-testing talked in this work, when suitable trial outputs can't be created, the weakness evaluation can be performed by utilizing a reference weariness bend with negative backwards incline equivalent to 5.5 and continuance limit. AM PLA is portrayed by a weakness act like the one of PLA produced utilizing customary and entrenched advancements. [8] The diffusive turning of PHBV filaments which were spun from arrangement utilizing a scope of polymer fixations, turn speed and spinneret to gatherer separates. [9] The effect of using a combination of substrates on the synthesis of PHBV which indicates that PHBV was synthesized only when fructose was used as the sole carbon source. [10] The study found that the relative porosity is managed to 80 percentage with maximum surface area while developing a PHBV specimen using SLS. [11] By comparing the compatibility with PHBV-g-MA this work suggests the techniques for fabricating PHBV/PBS blends. It incorporate the methods to manage the structural and heat conducting properties. [12] Biodegradable curcumin-stacked electro spun PHBV nanofibers were acquired with imperfection free morphology and their normal distances across extended from 207±56 to 519±15 nm. [13] PHBV films with dynamic fundamental oil mixes were exceptionally compelling against *L. innocua* and *E.coli* in vitro tests, yet they were significantly less viable in the genuine substances tried, except for the impact against *E. coli* in cheddar tests covered with PHBV-EU or PHBV-CLO films. [14] The impacts of g-illumination on PHBV/PLA: 50/50 w/w mixes brought about solid adjustments in the substance structure, particularly after 100 kg of assimilated portion. [15]

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Responsive expulsion convention for blending PHBV-g-GMA with a high GMA joining rate and few side responses.

Objectives of the work:

To check the variation in tensile property of PHBV and PLA with Sansevieria Fiber.

To compare the flexural behavior of PLA and PHBV with Sansevieria Fiber.

To analyze the impact behavior of PHBV and PLA

With the above mentioned studies the work is further extended and tested for making this as a replacement for conventional 3D printing material.

II. MATERIALS

A. Natural Fibers

Sansevieria Roxburghiana

The warm conductivity of the fiber diminishes with the expansion of fiber content. The expansion of Sansevieria decreases the Heat Release Rate. At the point when consumed it discharges more carbon dioxide than pitch composite. The rigidity of Sansevieria fiber is 2.55 occasions more prominent than gum and the effect quality is 4.2 occasions more prominent than the pitch. Elasticity of composite is expanded by 18.16%, 36.49%, 102.97%, and 155.24% over virgin polyester at 0.12, 0.21, 0.28, 0.36 volume division of filaments individually [6].



Fig.1. Extracted Sansevieria

B. Polylactic corrosive

Poly (lactic corrosive) or Polylactic corrosive or polylactide (PLA) is an environmental friendly biocompatible product prepared from corn starch, custard roots, chips or starch, or sugarcane. PLA had the second highest utilization volume of any natural plastic universally in 2010. [16]



Fig.2. PLA winding

C. Properties of Poly Hydroxy Butyrate Co Valerate

PHBV is obtained from bacteria which is biodegradable, non-toxic and bio-compatible. It is very brittle in nature. It possesses low elongation. The impact resistance of PHBV is also very low. When disposed it degrades into carbon dioxide and water. PHBV just like fats to humans it is the energy source to micro-organism. Enzymes produced by them degrade it and are consumed. The thermal stability of PHBV is very low with primitive mechanical properties. It has very high processing difficulties. [17]



Fig.3. PHBV Powder

III. PROBLEM DEFINITION

The PLA material which is utilized in the 3D printing strategy is a standout amongst the most boundless biomass-based, biodegradable (compostable) and biocompatible polymers. It is water-insoluble, can be either straightforward or semi-straightforward relying upon polymer crystallinity, and optically dynamic. The primary downsides of the material are high fragility, moderate crystallization rate, and high penetrability to gases. The ways for beating these issues are to utilize plasticizers, copolymerization with different segments, making composites, and mixing with different polymers [18]. So in order to find out an alternative to the pre-existing 3D printing material, a new composite has to be prepared which overcomes its defects. Therefore a composite consisting of both Sansevieria Roxburghiana and Poly Hydroxy Butyrate co Valerate (PHBV) is to be prepared as sample 1. The 2nd Sample is prepared from Sansevieria Roxburghiana and Polylactic Acid (PLA). PHBV also possesses the properties of brittleness and low impact resistance and the tensile strength of composite increased with the change in the volume fraction of fibers. Apart from this, to decrease the utilization of cost of the printing material and also to reduce the toxicity in the pre-existing material, this composite of PLA, PHBV and Sansevieria Roxburghiana will be more needful. Thus a biodegradable replacement can be made thereby reducing all the environmental impacts that the previous materials have incurred. Thus it can be opted as a better replacement in order to eliminate all the health hazards.

IV. METHODOLOGY

The fabrication and mechanical testing of PLA and Sansevieria based composite

specimen is done by the methodology given below.

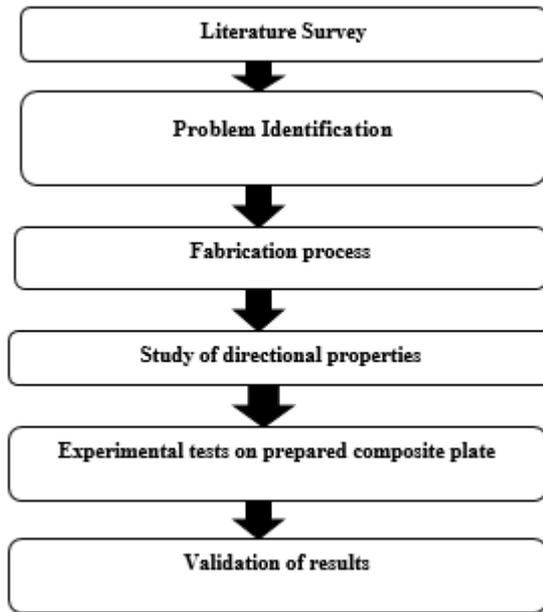


Fig.4. Methodology

V. PROCESS OF FABRICATION

A. Injection Molding

Infusion forming machine molds can be affixed in either an even or vertical position. Most of machines are evenly situated, yet vertical machines are utilized in some specialty applications, for example, embed forming, enabling the machine to exploit gravity. Some vertical machines likewise don't require the shape to be affixed. There are numerous approaches to attach the instruments to the platens, the most widely recognized being manual cinches (the two parts are dashed to the platens); be that as it may, water driven braces (chocks are utilized to hold the apparatus set up) and attractive clasps are additionally utilized. The attractive and water driven cinches are utilized where quick apparatus changes are required.

B. Specimen Preparation

Initially Sansevieria Roxburghiana fiber is prepared to be cut on different lengths such as 20mm. Pure fiber is separated which does not contain any green shades left over. Moreover, fine hair like structured fibers are separated in order to ensure that there are no thick pieces of fiber. This is done because such fibers can leads to improper plate preparation. The separated hair like fine fibers are eventually cut into different lengths. By injection molding the specimen is prepared for the following combinations.

VI. TESTING OF COMPOSITES

The test results are plotted on graph having X-axis as sample number and the Y-axis parameter is taken as strength obtained in each test results in N/mm². Three specimen for each testing gives twelve results in total. The average of the results is calculated and it is considered for the final conclusion. Thus the results are obtained and are plotted in the form of a graph which helps in providing a

clear knowledge on the outcome of the results. The following table consists of the list of results obtained from the appropriate test samples with pure PLA, PLA with fiber and PHBV with fiber

Table.1. Test Results

S.No	Test Parameters	Pure PLA	PLA with Fiber	PHBV with Fiber
1	Tensile Strength (N/mm ²)	41.56	19.38	18.65
2	Flexural Strength (N/mm ²)	118.24	89.38	33.42
3	Impact (Joules)	5.2	4.9	3.4

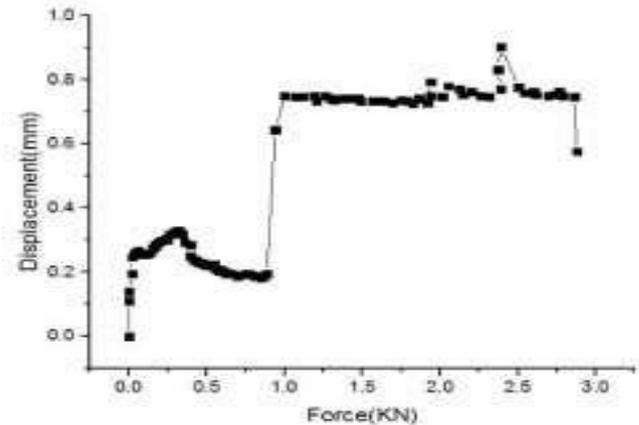


Fig.5. Load vs Displacement for PHBV and Fiber

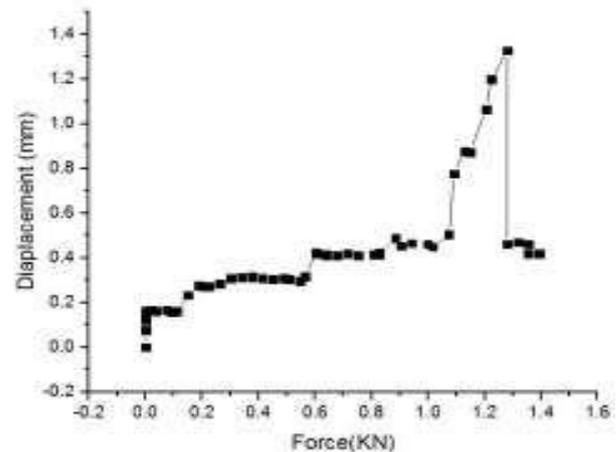


Fig.6. Load vs Displacement for PHBV and Fiber

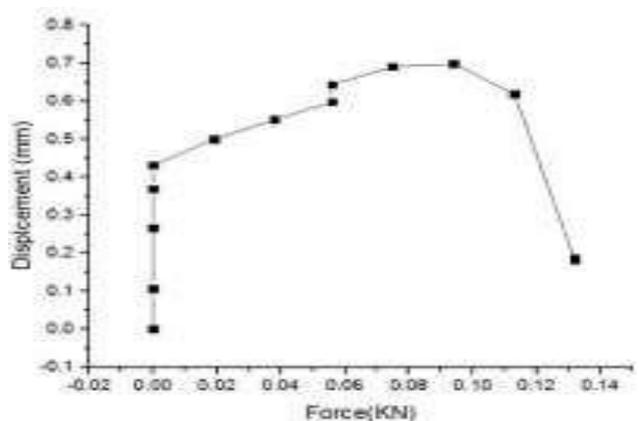


Fig.7. Load vs Displacement for PLA and Fiber

VII. CONCLUSION

This study focuses on utilizing *Sansevieria Roxburghiana* fiber with PLA and PHBV powder as reinforcement towards producing bio degradable composites, thus bringing economic values to the *Sansevieria Roxburghiana* fiber. The Specimen of PLA, PLA fiber mixture and PHBV fiber mixture is fabricated and the results shows that the sample with pure PLA 20mm fiber has the highest tensile strength when compared to PLA with fiber samples. Similarly, pure PLA contain high flexural strength and eventually PLA with fiber sample contain high impact strength. When comparing with the PHBV fiber mixture the PLA fiber mixture have higher Tensile, Flexural and Impact properties

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