

Rice Straw Reinforced Biocomposite: A Sustainable Development

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Abstract – Rice straw is agro-residue biomass that is abundantly available. Currently, it is nuisance for the farmer in absence of worth end-use consequently resulting in stubble burning. This creates environmental pollution. Therefore, rice straw can be used in reinforced polymer composites that would conserve existing wood and petroleum resources. Bio composites were prepared by using epoxy resin with different proportions of rice straw following the hand lay-up technique. The mechanical property (tensile strength) of the composite with rice straw content ranging from 5-25 wt% were investigated. The rice straw reinforced composite made from 15 wt% gm rice straw showed a remarkable improvement in the tensile strength, thermal insulation compared to all other bio-composites. It infers that the use of rice straw in making bio-composite would add economic benefit, help to minimize waste disposal's environmental effects, and, most significantly, offer a potentially low-cost alternative to currently available industrial artificial wood panels.

Keywords: Rice straw, Tensile strength, Biocomposite.

I- INTRODUCTION

One of the major issues facing the building business today is to enhance sustainability. Renewable resources are widely considered as an essential alternative for usage as building materials in order to increase the industry's sustainability. Renewable resources as fillers

or reinforcement materials in polymer composites have a number of advantages over synthetic fibres, including renewability, biodegradability, CO₂ neutrality, nontoxicity, wide availability, low cost, low density, low energy consumption during fabrication, and high specific strength. As a result, polymer composites reinforced with natural fibres are becoming more essential for the manufacturing of a wide range of composites due to their low cost, light weight, and environmental friendliness. Many research on the use of wood, sisal, hemp, coconut, and bamboo in cement-based products have been published in the literature (Xie *et al.*, 2015). The use of crop straws such as wheat and rice straw in composite materials, on the other hand, has not been well investigated in the literature. Crop straw is a significant renewable biomass resource in India, with an estimated 17.56 million tones per year in last ten years (Ranjan *et al.*, 2020). Crop straw, on the other hand, has received little attention and has been under-utilised for a long time. Most agricultural straws are now gathered as trash or burnt, resulting in the waste of biomass resources as well as pollution of the environment. As a result, making use of crop straw resources is difficult. Crop straw reinforced composites, as a result, are a good method to use crop straw while also adhering to the strategic goals for the long-term development of building materials. The focus of the research was on the effect of optimising the

proportion of rice straw percentage on the thermal insulation and mechanical characteristics of composites.

II -LITERATURE REVIEW

Rafiquzzaman et al., 2017 made an attempt to fabricate rice straw fiber based polymer composite and evaluate its mechanical performances. For preparation of composite, rice straw fibers were used as reinforcement and the epoxy resin (ADR 246 TX) as the matrix. The hand lay up technique was used to fabricate the composites. Different fiber weight percent (10, 20, 30 and 40 weight %) were used to prepare the composite. The mechanical properties in terms of tensile strength, flexural strength and impact strength of prepared composite were studied. The results affirmed that the tensile strength, flexural strength and impact strength of the rice straws composites increased with increasing fibers weight fraction.

III -METHODOLOGY

3.1 Material: Rice straw was collected from Sirsa KVK, Haryana. RS was washed with water and dried at room temperature for 24 h prior for the preparation of the composites. Epoxy resin was supplied by Ananya fabrication pvt. Ltd. Jaipur.

3.2 Fabrication of composite: Initially, the materials were cleaned and cut into small pieces manually. The composite fabrication is done by hand layup method. A thin plastic sheet was applied on the inner surface of the mold of dimension 20x20 cm which aided in easy removal of the sample from the mold. The composites were prepared with different fiber loadings (5, 10, 15, 20, 25 and 30). Resin was poured along with fibers of definite proportion in the mold. Entrapped air was removed manually with rollers to complete the laminates structure. Then the composite material was left for 24 hours at room temperature for curing.

3.3 Testing of composite

3.3.1 Tensile test: The tensile strength was measured on universal testing machine based on ASTM D638 standard.

3.3.2 Apparent Density: The bulk density of the composite samples was calculated on electronic weighing balance using the following formula:

$$\text{Bulk Density} = \frac{\text{Mass of composite sample}}{\text{Volume of composite sample}}$$

3.3.3 Thermal Insulation: The specimen thermal conductivity was measured by using guarded hot plate. Value of heat that absorbed by composite was calculated by formula:

$$\text{Clo value} = \frac{\text{Time (seconds)}}{2 \times 240}$$

IV- RESULT & DISCUSSION

To determine the optimum proportion of rice straw, composites were fabricated with five different proportions i.e. 5, 10, 15, 20 and 25 percent while matrix- reinforcement ratio and compressive force were kept constant. The results regarding optimization of proportion of rice straw fibres are given in Table 1.

Table 1- Optimization of proportion of rice straw fibres for fabrication of composites

Proportion of rice straw fibres (g)	Bulk density (g/cm ³)	Tensile strength (Mpa)	Thermal insulation (m ² K/W)
5	0.97	10.60	0.26
10	0.96	11.99	0.27
15	0.82	13.81	0.28
20	0.82	8.94	0.28
25	0.81	5.68	0.30

It can be inferred from the table when the proportion of rice straw fibres was increased 5 to 25 g the bulk density of fabricated composite was found to be decreased from 0.97 to 0.81g/ cm³ . On the other side with increase in proportion of rice straw fibres from 5 to 15 g the tensile strength and thermal insulation properties of fabricated composites enhanced from 10.60 to 13.81Mpa and 0.26 to 0.28 m²k/w respectively. With the progressive increment in proportion of rice straw fibre from 15 to 25 kg decrease in tensile strength (13.81 Mpa to 5.68 Mpa) and thermal insulation (0.28 m²k/w to 0.30 m²k/w) respectively.

Conclusively, it can be envisaged that a slight difference in bulk density was observed at 15 and 25 g of proportion of rice straw fibres. Since 15 g proportion of rice straw fibres imparted maximum tensile strength and thermal insulation to the fabricated composites, thus it was selected as optimum proportion to develop lighter weight composite a with enhanced tensile strength and thermal insulation properties.

The data relevant to the proportion of rice straw fibre at different weight% of rice straw are shown in table 1. It is apparent from table that proportion of rice straw fibre first increase tensile strength and thermal insulation properties and then decreased with increase in the weight

percent from 5 to 25%. The maximum tensile strength and thermal insulation obtained at 15%. This might be due to increase in fibre volume fraction but after a certain level strength starts decreased. The maximum stress of the composite depends on several factors, one such factor is the weight or volume fraction of the fiber. Thus the fibre loading factor essentially administered the resulted tensile strength. (Abhishek *et al.*, 2017). These results are in agreement with Rafiquzzaman *et al.*, 2017 and Zhao *et al.*, 2011 studied the mechanical and thermal properties of treated rice straw fibre and revealed that tensile strength and elongation increased significantly at all volume fraction (10, 20, 30 % v/v) by increasing fibre content (RSF) in the composite. But best results was found at 20% similarly the thermal stability of treated rice straw fibre was also improved with increased rice straw fibre content.

V- CONCLUSION

In the current study, the mechanical and thermal properties of five different proportion of RS were investigated. 15% RS containing composite has highest tensile strength and thermal insulation due to better dispersion and strong interfacial interactions between fiber surface and matrix. This sample has also the best mechanical property in rice straw reinforced composite. So it can be considered to be suitable for rice straw reinforced composite applications. Therefore, utilization of rice straw will potentially lead to reduction in environmental pollution and provide a higher profit margin for the rice farmers.

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