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Technical Report

Mechanical properties of natural fibre reinforced polyester composites: Jowar, sisal and bamboo

A.V. Ratna Prasad *, K. Mohana Rao

Department of Mechanical Engineering, V R Siddhartha Engineering College, Vijayawada 520 007, A P, India

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ABSTRACT

In this paper, the experiments of tensile and flexural tests were carried out on composites made by reinforcing jowar as a new natural fibre into polyester resin matrix. The samples were prepared up to a maximum volume fraction of approximately 0.40 from the fibres extracted by retting and manual process, and compared with established composites like sisal and bamboo developed under similar laboratory conditions. Jowar fibre has a tensile strength of 302 MPa, modulus of 6.99 GPa and an effective density of 922 kg/m^3. It was observed that the tensile strength of jowar fibre composite is almost equal to that of bamboo composite, 1.89 times to that of sisal composite and the tensile modulus is 11% and 45% greater than those of bamboo and sisal composites, respectively at 0.40 volume fraction of fibre. The flexural strength of jowar composite is 4%, 35% and the flexural modulus is 1.12 times, 2.16 times greater than those of bamboo and sisal composites, respectively. The results of this study indicate that using jowar fibres as reinforcement in polyester matrix could successfully develop a composite material in terms of high strength and rigidity for light weight applications compared to conventional sisal and bamboo composites.

1. Introduction

Since two decades natural fibre composites are emerging as realistic alternatives to replace the glass reinforced composites in many applications. Natural fibres such as banana, coir, sisal and jute have attracted the attention of scientists and technologists for application in consumer goods, low cost housing and other civil structures. Natural fibres have many advantages compared to synthetic fibres like low density, cheaper, acceptable specific properties and also they are renewable and biodegradable. These composites possess high strength and stiffness, good thermal and acoustic insulating properties and high resistance to fracture. However, the main disadvantage of these natural fibre/polymer composites seems to be the compatibility between the hydrophilic natural fibres and the hydrophobic matrix that makes necessary to use compatibilizers or coupling agents in order to improve the adhesion between fibre and matrix.

In the past, extensive studies on preparation and characterization of thermosetting and thermoplastic composites reinforced with most commonly used fibres such as sisal, banana, coir and hemp with and without treatment by different methods were carried out [1–5]. The effect of fibre surface wettability, alkali treatment and different ageing conditions on physical and mechanical properties of longitudinally oriented jute rovings reinforced polyester composites were evaluated [6]. The strength and modulus of longitudinal composites in tensile and flexural loading increased with fibre content as predicted in accordance with rule of mixtures. The mechanical properties of jute fibre-unsaturated polyester composites prepared by solution impregnation and hot curing methods were studied [7]. The major finding is the attainment of high mechanical properties of composites made of bleached jute fibres at 60 wt.% fibre loading compared to unbleached fibres. The mechanical properties of vinylester resin matrix composites reinforced with 5% NaOH treated fibres at room temperature for varying times were investigated [8]. As fibres, the improvements in properties were predominant around 6–8 h treatment where as composites, it was maximum when reinforced with 4 h treated fibres at 35% fibre loadings.

The properties such as tensile strength, tensile modulus, tear strength and elongation at break of bamboo-fibre-reinforced natural rubber composites with and without the presence of a bonding agent were studied [9]. The presence of bonding agent gave shorter curing time and enhanced mechanical properties. Some studies were also carried out on the flexural behavior of bamboo-fibre-reinforced mortar laminates [10]. It was reported that the flexural strength values of bamboo-fibre-reinforced mortar laminates have been improved more than 90 MPa.

The experiments of tensile and flexural tests were carried out using woven banana fibre reinforced epoxy composites [11]. It was found that the maximum value of stress in x and y direction is 14.14 MPa and 3.398 MPa, respectively and for Young's modulus

* Corresponding author. Tel.: +91 866 2582333; fax: +91 866 2582672.
E-mail address: ratnaprasad@vrsiddhartha.ac.in (A.V. Ratna Prasad).

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