Natural Weathering Behavior of Natural Fiber Reinforced Polyester Composites

B. Balasubramanian, K. Rajasekar, J. Dhiyaneswaran

Department of Mechanical Engineering Chettinad College of Engineering and Technology, Karur, Tamilnadu, India

Abstract – Natural fiber reinforced composites faces high risk of degradation when compared to synthetic fiber reinforced composites in outdoor applications. In this evaluation composites have been studied under natural weathering condition for 2 years at room temperature. The composites were inspected under scanning electron microscope (SEM). SEM evaluation reveals that the surface and the cut edges of the composites faces swelling and formation of fungus.

Keywords: Weathering, surface degradation, Chemical treatment, swelling, fungus, etc.

I. INTRODUCTION

Natural fibers are emerging as a replacement for glass fibers in reinforcing polymer due to their low cost, low density and eco-friendly nature. Coconut fruit husk and sugarcane waste are the most abundant agricultural waste materials of southern region of India which are rich in cellulose fibers which can be extracted from them. Presently, natural fibers applications are limited to interior and non-structural applications due to its low mechanical properties and poor moisture resistance [1]. Natural FRPs have the potential to eventually be lighter-weight and lower-cost than many synthetic composites. Natural fibers are easier to handle and have good thermal and acoustic insulation properties [4]. In light of this, there is a need to expand the research on natural fiber/polymer composites with regards of their degradability under different environmental condition [1]. Degradation of natural fiber/polymer composite in an outdoor environment is influenced by factors such as moisture, temperature, ultraviolet radiation, and microorganism activities [1]. Moisture absorption is one of the main disadvantages experienced with NFCs. It has been shown to increase with increased fiber treatment/coupling agent and fiber arrangement. It is commonly associated with swelling of NFCs and reduced mechanical performance with the exception of impact energy which is commonly seen to increase [2]. Resin transfer moulding is the process where a thermosetting resin is injected in to a cavity having the shape of the final component [10]. The typical fiber volume fractions are only 20-40% for NC [11].

II. EXPERIMENTAL

Materials

Commercial polyester in the form of resin, bought from the local market in Madurai, Tamilnadu was used as polymer matrix. Coir and bagasse fibers were bought from local processing units in Madurai, Tamilnadu.

TABLE 1. PROPERTIES OF POLYESTER RESIN, COIR FIBER AND BAGASSE FIBER [3]

Property	Polyester	Coir Fiber	Bagasse Fiber
Density (g/cm^3)	1.2-1.5	1.15-1.46	1.25
Modulus (Gpa)	2-4.5	2.8-6	17-27.1
Tensile strength (Mpa)	40-90	95-230	222-290
Elongation (%)	2	15-51.4	1.1

Fiber preparation

The fibers were immersed in 5% NaoH solution for 1h at atmospheric temperature. Chemical treatment on reinforcing fibers can reduce its hydrophilic tendency and thus improve compatibility with the matrix. The fibers were then cleaned with distilled water several times and dried in sunlight for 24hrs.

Fabrication of composites

Composites were fabricated by laying fibers and resin mixture was introduced in to the mould cavity and finally pressed in to sheets measuring 250×75×5 mm. Both coir and bagasse were used as reinforcement for polyester separately.

Natural weathering

Weathering evaluation of both coir and bagasse composites were carried out for two years naturally in room temperature.

Visual inspection

Both the coir and bagasse composites were visually inspected to detect any surface degradation. But the composites didn't show any sort of degradation behaviour.

SEM (Scanning Electron Microscope)

The surface deterioration of naturally exposed composites was examined under a scanning electron microscope. Fungal growth was noticed clearly at the cut edge as well as on the surface. The cross sectional view shows the clear view of poor interface.

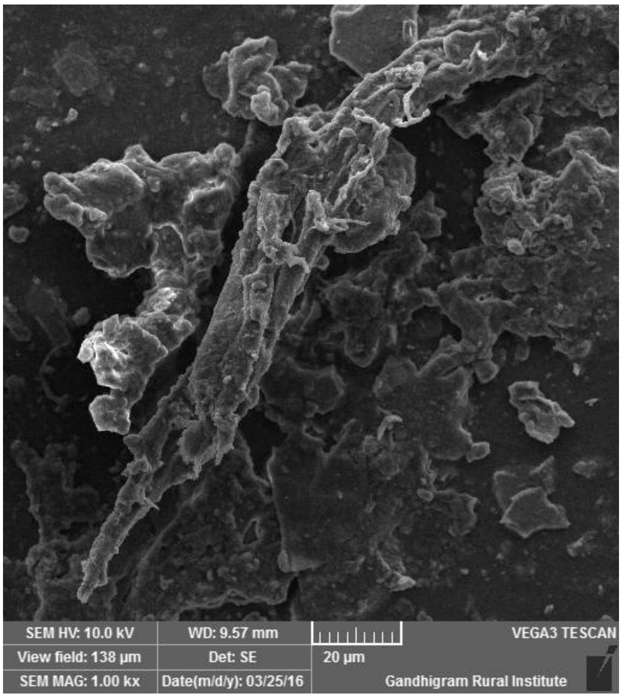

Fig. 2.1 SEM of weathered coir composite showing fragments of fiber

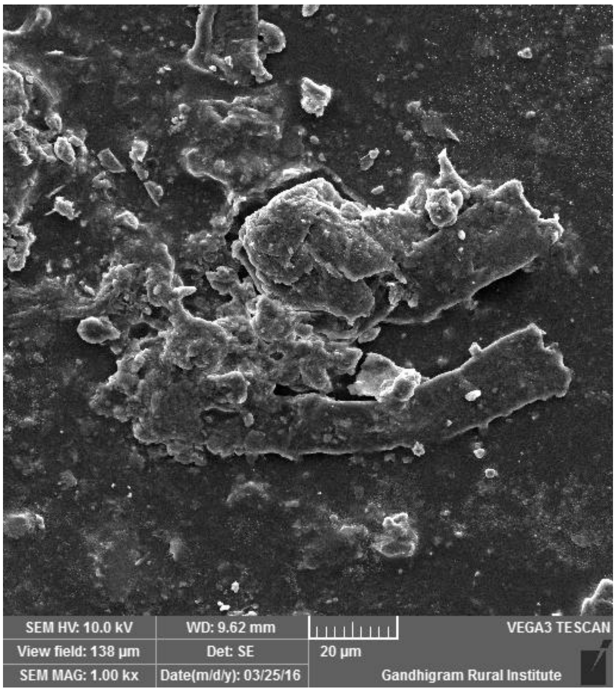

Fig.2.2 SEM of weathered coir composite showing cracks and poor interface

Debonding between fiber and matrix is initiated by the development of osmatic pressure pockets of the surface of fibers due to the leaching of water soluble from the fiber surface [1].

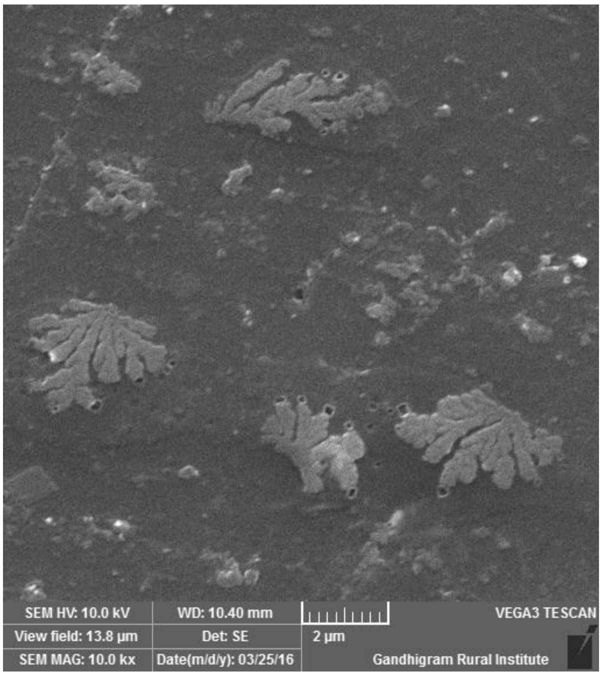

Fig. 2.3 SEM of weathered bagasse fiber composite showing pores and pits

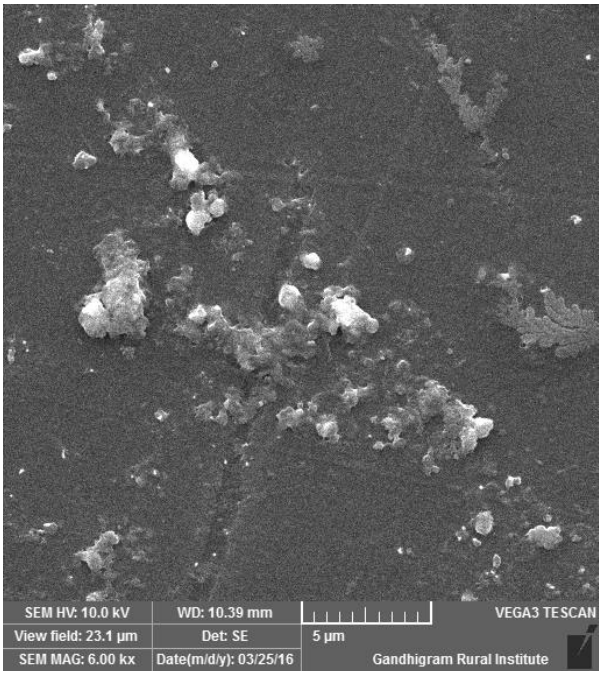

Fig. 2.4 SEM of weathered bagasse composite showing swelling of fibers

III. CONCLUSION

Overall, the global NFCs market was estimated at US$2.1 billion in 2010 and projected to rise 10% annually until 2016 reflecting further potential seen across a range of industries including automotive, aerospace, construction, civil and the sports and leisure industries [2]. This paper exposed the effects of natural weathering of composites clearly. Alkaline treatment was found to increase resistance to moisture to some extent. It should be noted that the effect varies with different environmental climatic condition. In order to reduce the effect of weathering degradation in composites, special coatings can be utilized on the external surfaces. Further research is still needed to extend their application range.

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