UNIVERSITI TEKNOLOGI MARA

# MECHANICAL PROPERTIES AND FRACTURE TOUGHNESS OF POLYPROPYLENE REINFORCED KENAF FIBRE AND NANOCLAY COMPOSITES

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# AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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# ABSTRACT

This research was carried out to study the effects of kenaf fiber (K) and nanoclay (NC) loadings on the mechanical properties and fracture toughness of polypropylene (PP) reinforced kenaf fiber and nanoclay composites. There were three composite system involve in this study, namely polypropylene/nanoclay (PP/NC), kenaf/polypropylene (KPP) and kenaf/polypropylene/nanoclay (KPP/NC) composites. Kenaf fibre (160 – 250 μm) loadings were varied at 20 wt%, 30 wt% and 40 wt%, meanwhile nanoclay loadings were varied at 0, 3 and 6 phr (part per hundred resin). Thermal mixer was used to mix kenaf, polypropelene and nanoclay to produce composite pellets and the pellets were injection molded to produce composite test specimens. The tensile test, impact test and fracture test were performed according to ASTM D638, ASTM D256 and ASTM D5045 respectively. Incorporation of 6 phr NC to the PP had resulted in a decreased about 8% in tensile strength and 44% in impact strength, however its fracture toughness had increased about 58%. The incorporation of kenaf fiber had lowered 19% of the tensile strength compared to pure PP. The impact strength decreased meanwhile the fracture toughness had indicated an increment about 14% as the kenaf loading increased. PP with 6 phr nanoclay was the highest tensile strength with 22.48 MPa. PP with 3 phr nanoclay composite showed the highest impact strength with the value of 12 $kJ/m^2$ whilst 40% of kenaf loading with 6 phr nanoclay was the highest fracture toughness of about 2.02 $MPa.m^{1/2}$.

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# CHAPTER ONE
# INTRODUCTION

## 1.1 BACKGROUND TO THE STUDY

The studies of natural fibres have attracted many researchers, academicians and engineers to find their way into commercial applications especially in the automotive trade, aerospace industries, marine hardware, argicultural sectors and household appliances. There are many kinds of natural fibres which are available in abundance , including kenaf, rice husk, sisal, banana, jute, coconut shell, flax, hemp, bamboo and oil palm. Fibres are most significant in the class of composites reinforcement. They are able to transfer their load to matrix materials, thus significantly affecting the properties of composite materials via load sharing between the matrix and fibres.

The use of natural fibres is appealing due to their renewable resources, low in weight, cost, and density; its accesibility, and chemical and mechanical modification ease. Natural fibres exhibit advantages in tensile, impact and fracture properties as reinforcement for composites and many studies were conducted on this material in order to determine their mechanical properties to suit the applications [1-5].

A study by Omar Faruk et al. [6] on the biocomposites reinforced with natural fibres had mentioned that kenaf-maleated polypropylene composites have a higher modulus and higher specific modulus than sisal, coir and even E-glass. Thus, these composites provide an option for replacing existing materials with a higher strength, lower cost and eco-friendly. According to Zini et al. [7] with the use of glass fibre at its end life disposal; approximately up to 50% of its volume would remain as unburned residues. Since 1990, the researchers for automotive companies had explored that natural fibre is more environmentally friendly compared to glass fibre due to the former being fundamentally biodegradable. The low density of natural fibres is very important in automotive industry. A study had been carried out which denoted that when 30% of glass fibres were substituted with 65% of hemp fibres, the net energy saving of 50,000MJ (3 tons of emission) was achieved [7].