

Evaluation of Mechanical and Manufacturing Parameters of Flaked Date Palm Fronds Reinforced Polypropylene Composites

Hani AL Rawahi

Abstract

In recent years, a remarkable progress has been accomplished to develop biodegradable, recyclable and environmentally friendly composites which reduce or eliminate the need for non-degradable materials like synthetic polymers and plastics. Due to many advantages of using natural resources, natural fibers have been used recently as a method of providing added strength and ductility to reinforced polymer composites. This is mainly due to their availability, renewability, low density, cost effectiveness as well as satisfactory mechanical properties, which makes them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites. In this study, a full factorial design of experiments technique has been utilized to study tensile strength and flexural strength of chopped date palm fronds reinforced polypropylene (CDPF/PP) composites. Both tensile and flexural strengths of fabricated composites were experimentally characterized according to ASTM standards. Then, nonlinear regression models were developed to predict the mechanical behavior over the target range of fabrication parameters. Chopped date palm fronds reinforced polypropylene composites with fiber contents (20, 40, and 60 v. %), alkali treatment (5, 10, and 15 wt.%) and treatment time (4, 6, and 8 h) have been considered. Subsequently, the response surface methodology approach was used for identifying the optimal combination of these parameters. Then, the machinability of developed bio-composite based on the optimal search in the mechanical properties analysis is utilized under conventional drilling. Specifically, machining of natural fiber reinforced composites causes delamination which is one of the major problems associated with the hole accuracy. Further investigation on optimal manufacturing input parameters is underway. The delamination of drilled chopped date palm fronds polypropylene composites are analyzed and characterized under controlled drilling parameters which includes drill bit diameter (d) spindle speed (s), feed rate (f). The results demonstrated that the drill size significantly influences the delamination among the cutting parameters. The optimal setting of the input variables shows that a combination of moderate values for drill diameter (6.6 mm), low feed rate (143 mm/min) and low spindle speed (1000 rpm) lead to minimum value of delamination. It was also observed that the induced delamination was minimal and so it can be concluded that chopped date palm reinforced polypropylene bio-composites are promising NFRC for industrial applications.