UNIVERSITI TEKNOLOGI MARA

QUANTIFYING AND PREDICTING THE TENSILE PROPERTIES OF MORINGA OLEIFERA BARK-SILICONE BIOCOMPOSITE

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ABSTRACT

Over decades, composite that made from the combination of synthetic fibres such as glass fibres, carbon fibres, and boron fibre have gained increased attention in composite fabrication industry due to its durability. However, high application based on synthetic fibre composite material has contributed towards environmental effects like pollution and global warming. To overcome this problem, replacing the synthetic fibre with natural fibre is one of the solutions. Besides, it could promote the fabrication of green materials and give alternative option to the researcher in green technology growth. Therefore, this study proposes a new material using Moringa oleifera bark (MOB), a plant-based fibre, as reinforcement filler since silicone rubber possesses weak intermolecular bonding and exhibits a highly nonlinear behaviour. Despite that, there is no reliable data in reinforcing MOB into silicone rubber. The specimens are made with 0wt%, 4wt%, 8wt%, 12wt%, and 16wt% of fibre composition according to proper standard of specimen fabrication. The physical and mechanical tests were conducted to define the properties of this newly material including its hydrophobic and hydrophilic properties and tensile behaviour under uniaxial tensile load. In order to access its properties, Density test (ASTM-D792), Moisture Absorption test and Uniaxial tensile test (ASTM-D412) were conducted. Due to the hyperelastic behaviour of the material, three hyperelastic materials models were adapted to quantify the material parameters using Neo Hookean, Mooney Rivlin, and Ogden models. The predicting approach was employed via MATLAB Neural Network Tool (nntool) using 80% of experimental data to train the network while the remaining 20% were used for data validation. The study constructed one artificial neural network (ANNs), where it had 3 inputs (weightage, load and elongation) and 2 output (material constants; α and μ) data. The network predicted the material constant of Ogden material parameter for uniaxial tensile. Results obtained from the testing showed that the density of specimen was seen to have a steady increment as the fibre content increased. In addition, the highest water uptake was possessed by 16wt% of fibre content specimen which was about 12.1%. From the tensile test, it showed that the material properties have been improved and the stiffness of the specimen has increased with further addition of fibre content. This was supported by the results obtained through numerical analysis. The study used the Coefficient of determination, R^2 to define the best curve fitting in hyperelastic modelling. Based on the result, the Ogden model showed the perfect agreement to the experimental data as it showed the highest value of R^2; 0.9988. It was observed that the Ogden model had good mimicking ability in capturing the curve of experimental data. From the prediction of ANN, the optimum trained network was obtained through several training trials. The coefficients of correlation, R for training, testing, validation and all proved to be satisfying which came out as 0.99699, 0.99917 0.99912 and 0.99748 respectively. The average percentage differences between prediction data by ANN and experimental data were about 2.40% and 12.06% for α and μ respectively. Therefore, it can be summarised that this thesis has successfully obtained the experimental-numerical analysis of this newly material; Moringa oleifera bark-silicone biocomposite (MOBSil). Besides, the prediction model would help other researcher in terms of time saving and minimum effort required in determining the material constant of MOBSil specimen in different composition rate. Finally, this research could contribute to a better comprehension of MOB-silicone biocomposite.

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