1. Adaptive Neuro-Fuzzy Inference SystemModel for Predicting the Mechanical Properties of Carbon Fiber-Epoxy Composite

BY AzharDhahirHabeeb

ABSTRACT

The aim of the present work is to experimentally investigate the effect of fiber prestress and curing temperature on the impact strength, fracture toughness, tensile strength and tensile modulus of carbon fiber-epoxy composite. Theoretically the present work uses ANFIS model to predict the effect of fiber prestress and curing temperature on the impact strength, fracture toughness, tensile strength, tensile modulus, flexural strength and flexural modulus ofcarbon fiber-epoxy composite. For that purpose a prestress methodology was developed to apply the desired prestress levels on the produced laminates, under certain curing temperatures. In this work the fiber volume fraction (*V*) isbeing 50% for impact and tensile tests. The prestress levels are 0, 10, 12.5, 20,25, 30, 40 and 45 MPa, and the epoxy curing temperatures are at ambient temperature, 40, 55, 67, 80, 97 and 115؛C. The laminates are cut according to ISO 179-1:2000 and ASTM D 3039 for Charpy impact and tensile tests respectively.Adaptive Neuro-Fuzzy Inference System models were used to predict the impact, tensile and flexural properties of the carbon fiber-epoxy composite. It was found that, the best membership functions for predicting the impact strength are trapezoidal membership functions with 3 number of membership functions, for predicting the flexural strength are generalized bell membership functions with 4 number of membership function, and for predicting the fracture toughness, tensile strength, tensile modulus and flexural modulus are Gaussian membership functions with 4 number of membership functions.The results showed a maximum percentage improvement in the impact strength and fracture toughness at

(30MPa) prestress level for ambient curing temperature as 28.571% and 29.914% respectively. Also, the results showed that the prestress machine can produce prestressed composite materials withbetter impact properties comparing to those impact properties of the nonprestressedcomposite materials. The best fiber prestress level for the carbon fiber-epoxy composite was influenced by the properties of the interfacial region, the extent of residual stress, and the epoxy curing temperature. From the comparison between the experimental and predicted results of carbon fiberepoxycomposite properties, it is found that the mean error is 0.456%, 0.541%, 0.444%, 0.891%, 0.412% and 1.071% for impact strength, fracture toughness, tensile strength, tensile modulus, flexural strength and flexural modulus

respectively. It was observed that the prediction results of this model show a good agreement with experimental results.