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ARTIFICIAL NEURAL NETWORK MODELING APPROACH FOR ELASTIC-PLASTIC STRESS AND STRAIN COMPUTATION FOR NOTCHED COMPONENTS

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ABSTRACT

Fatigue life assessment of notched components requires determination of accurate local stresses and strains at notch areas. Finite element (FE) methods using commercial software packages are more often employed to obtain actual notch stresses and strains induced by applied loadings, however FE based numerical methods for performing elastic-plastic stress and strain analysis are impractical due to long computation times and large data storage needs. In recent years, researchers adopt artificial neural networks (ANN) algorithms as predictive modeling approach(es) for solutions of complex engineering problems e.g., modeling of material deformation, and fatigue and fracture behavior. This study investigates the development of Artificial Neural Network (ANN) model for prediction of elasto-plastic stress and strain responses for notched components. Two separate FE models are employed to obtain linear elastic stress and nonlinear elasto-plastic stress-strain data for ANN model training and validation. A semicircular notched shaft made of representative steel alloys with varying mechanical properties is modeled under combined uniaxial tensile and torsion loading conditions for both linear and nonlinear FE models to generate the input and output numerical data, respectively to train and validate the ANN model. Different Ramberg-Osgood parameters are used to define various stress-strain curves of representative materials. Elastic stress-strain data and Ramberg-Osgood parameters are used as the input data and elasto-plastic stresses and strains as output data for the ANN model. Both input and output data sets are obtained under various loading and material hardening conditions so that the ANN model can learn the relationship between elastic and elasto-plastic behavior of different materials under various loading conditions. The ANN model is constructed to have two hidden layers with 2048 and 1024 neurons respectively. The predicted elasto-plastic stress and strain results show that the developed ANN model can efficiently and accurately predict the elasto-plastic stress, strain responses for notched shafts on the basis of linear elastic FE solution under different loading conditions. This study shows that ANN models can be employed for accurate and efficient estimation of elasto-plastic stress and strains for notch bodies with varying material properties.