# Artificial neural networks for nonlinear dynamic response analysis of damaged laminated composites

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**Résumé :** *The present investigation deals with an approach for predicting the dynamic behavior and the damage evolution of laminated composites structures, using stresses as indicative parameters and artificial neural networks (ANN) as a learning tool. Based on a phenomenological modeling of cracked structures, the dynamic behavior of the composite structure is expressed through elasticity coupled with damage. The incremental linear dynamic governing equations are obtained by using the classical linear Kirchhoff-Love theory of plates. Then, since the damage induces nonlinearity, the obtained nonlinear dynamic equations are solved in time domain using a Newmark unconditionally stable algorithm.*

*FEM simulations show that when the damage is taken into account, the eigenfrequencies decrease due to the loss of the structure stiffness. Thereby, this decrease significantly modifies the dynamic response by increasing the displacement response amplitude.*

*Several numerical simulations have been performed to generate a dataset consists of stress and damage states for various combinations of layer orientation and applied load. These data have been used to train a feedforward neural network till the network learns to an acceptable level of accuracy.*

*The trained ANN has been tested to predict the damage from the input stress state. The established ANN can learn effectively about the damage location and severity present in the composite structure and can predict reasonably well when tested with unknown data set. This approach provides a quick response for damage level prediction in online applications reducing significantly the computational costs.*

**Mots-clés : Artificial neural networks,composite structure, nonlinear dynamic, damage detection.**