The smart materials and their applications in new technologies: Application to failure analysis investigations in composite materials

Brahim NECIB[1] , Abdelaziz LEBIED[1] and Mohamed SAHLI[2]
[(1)]*Mechanical Engineering Department, University of Brothers Mentouri Constantine,*
[(2)] *Department of Applied Mechanics, Polytechnic School of Constantine, Algeria*

Abstract: The behavior of composite materials structures under impact forces makes their risk and damage mechanisms more and more complex and may causes crack propagations between their different elements or plies even at low impact velocities. In this context, the internal structural failure and crack propagation analysis of composite materials under the effect of external solicitations has been studied. As a result, several microscopic and macroscopic defects may appear within the composite structure that may produce their destruction or the disaster of the hall material. To prevent this phenomenon, adaptable or "smart" materials are incorporated between the fibers of the material in order to control their health state and to determine the weakness of their structure or the beginning of their failure. Consequently they will adapt adequate answers by announcing specific modification or by causing specific actions of correction which will appear in the environment and will protect the material or the structure from the hall disaster. In fact, the application fields of these types of smart and adaptable materials are of a great importance in the areas of new technologies such as in mechanics, aeronautics, tall buildings and bridges as well as in biomechanics and medical professions so as to control their internal stresses and strains and to prevent their disaster from external solicitations like: chocks, earthquakes and electrical solicitations.

In this work, smart materials with shape memory alloy and piezoelectric materials, their definitions, their principle works and their super thermo elasticity phenomenon will be considered. The crack propagation analysis of a laminate composite material of carbon/epoxy types under the effect of the external forces was studied. It was found that during the appearance of cracking in the matrix, a discontinuity of the curve stress/strain is observed. It was also noted that the appearance of the cracks increases in a more particular way when the loads are applied perpendicularly to fibers. The control of this crack propagation was reached using adaptable sensors of PZT types and the finite element models to get the displacement at every nodal point. It was noted that the presence of delaminating fibers is observed when the PZT static capacity induces a brutal increase in electrical tension which explain the apparition of the crack propagation.

Keyword: *Laminated Composites, smart materials, external solicitations, crack propagation and finite elements.*