

Abstract

Mohamed N. El-Shaib

Predicting acoustic emission attenuation in solids using ray-tracing within a 3D solid model

Acoustic Emission (AE), is a non-destructive testing and monitoring technique that can be applied to a wide range of situations for condition monitoring and fault diagnosis in mechanical systems and components. Acoustic emission technology involves the propagation of elastic (stress) waves generated by such events as particle impingement, cracking fluid flow. These waves are recorded at one more surface-mounted sensor placed at some distance from the generating site(s) and it is necessary to have a means of coping with the implications of the propagation path. It is generally not practicable to solve the wave equation for all possible modes of AE propagation in a solid and this project is based on simulating such propagation using ray tracing applied within a computer-generated solid model representing the structure being monitored. As the attenuation of AE waves is affected not only by the material properties but also by the geometry of the object and the type of surrounding media, knowledge of attenuation is essential to ensure that sensors can be placed appropriately on large complex structures. The aim of the current work was to establish the capability of predicting the attenuation of AE using a computer-graphical ray tracing technique incorporated in a 3D solid model. The investigative approach involved simulating AE propagation in a range of simple objects of various shapes and sizes and also measuring propagation in these objects using a point source. By comparing simulated and measured attenuation, it was possible to determine appropriate values for the parameters of the simulation, such as the reflection coefficients and the degree of internal friction as well as the proportion of energy carried in surface and bulk waves, respectively. It is concluded that the ray tracing technique has the capability to predict AE attenuation in different shapes and with different environments and materials using a simple division of wave modes into bulk and surface waves. Refinements are suggested in the further work for cases where a more precise representation of the propagation modes is needed.