World Academy of Science, Engineering and Technology
International Journal of Electrical and Information Engineering
Vol:16, No:06, 2022

Linear and Nonlinear Resonance of Flat Bottom Hole in an Aluminum Plate

Authors : Biaou Jean-Baptiste Kouchoro, Anissa Meziane, Philippe Micheau, Mathieu Renier, Nicolas Quaegebeur

Abstract : Numerous experimental and numerical studies have shown the interest of the local defects resonance (LDR) for the Non-Destructive Testing of metallic and composite plates. Indeed, guided ultrasonic waves such as Lamb waves, which are increasingly used for the inspection of these flat structures, enable the generation of local resonance phenomena by their interaction with a damaged area, allowing the detection of defects. When subjected to a large amplitude motion, a nonlinear behavior can predominate in the damaged area. This work presents a 2D Finite Element Model of the local resonance of a 12 mm long and 5 mm deep Flat Bottom Hole (FBH) in a 6 mm thick aluminum plate under the excitation induced by an incident A0 Lamb mode. The analysis of the transient response of the FBH enables the precise determination of its resonance frequencies and the associate modal deformations. Then, a linear parametric study varying the geometrical properties of the FBH highlights the sensitivity of the resonance frequency with respect to the plate thickness. It is demonstrated that the resonance effect disappears when the ratio of thicknesses between the FBH and the plate is below 0.1. Finally, the nonlinear behavior of the FBH is considered and studied introducing geometrical (taken into account the nonlinear component of the strain tensor) nonlinearities that occur at large vibration amplitudes. Experimental analysis allows observation of the resonance effects and nonlinear response of the FBH. The differences between these experimental results and the numerical results will be commented on. The results of this study are promising and allow to consider more realistic defects such as delamination in composite materials.

Keywords : guided waves, non-destructive testing, dynamic field testing, non-linear ultrasound/vibration
Conference Title : ICU 2022 : International Conference on Ultrasonics
Conference Location : Paris, France
Conference Dates : June 23-24, 2022