Numerical model of bolt stress measurement based on acoustoelastic theory

***Bo Yuan[1], †Qingchao Sun[1], Shuo Zhou[2], Wei Sun[1], and Xiaokai Mu[1]**

[1]School of Mechanical Engineering, Dalian University of Technology, China.
[2]AVIC Commercial Aircraft Engine Co. Ltd., China

*Presenting author: yuanbodut@mail.dlut.edu.cn
†Corresponding author: qingchao@dlut.edu.cn

Abstract

Bolt connection is widely used in aerospace and other important research fields. Particularly, bolts are subjected to either constant or temporal mechanical loads. An accurate and effective method of measuring the stress state is needed to ensure the safe operation of the whole equipment. Ultrasound technology can detect the stress of bolts by the acoustoelastic effect. According to the relationship between ultrasonic propagation velocity and stress, this paper establishes a multiphysics computational model to study the application of acoustoelastic effect in bolt stress measurement. Under the assumption of finite deformation, the acoustic-elastic equation of bolts under stress is derived. After theoretical derivation, the finite element simulation model is established. The simulation results were compared with experimental results and the same general trend was observed. The difference of results under different excitation frequencies and stress states is discussed. The calculation model proposed in this paper can guide the actual bolt state detection.

Keywords: Bolt; Acoustoelastic effect; Numerical simulation; Measurement