FEM Modeling of Ultrasonic Fatigue-Life Testing Machine

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Abstract

Usually fatigue-life tests of materials are long time consuming and expensive. The classic fatigue test equipment has some operational restrictions of frequency due to the technology used in the design of those machines. Due to this issue the number of testing cycles was generally limited to 10e6 or 10e7 called "endurance limit". With the development of high power piezoceramic actuators nowadays it is possible to provide fatigue tests at very high frequencies. The ultrasonic system consist of piezoceramic transducer, booster and horn (sonotrode) for vibration amplifying and specimen made of tested material. System works in resonant regime, so each of this element have to be designed with the same axial resonant eigenfrequency. The most used working frequency is 20 kHz due to some limitation of minimal specimen length. The response of ultrasonic system is modeled using Structural Mechanic and Piezoelectric interfaces in the following sequence. First eigenfrequencies of the system, second displacement amplitudes and stress distribution in frequency domain, and at the end heat generation of the specimen in time domain, were found. Results are compared with the existing ultrasonic test machine in our fatigue laboratory.