Asociación Argentina
de Mecánica Computacional

Mecánica Computacional Vol XXXVIII, págs. 1083-1083 (resumen)
H.G. Castro, J.L. Mroginski, R.R. Paz, M.A. Storti (Eds.)
Resistencia, 1-5 Noviembre 2021

DEVELOPMENT OF A FATIGUE CRACK GROWTH DETECTION CODE PARALLELIZED WITH PYCUDA

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Keywords: Fatigue, crack growth detection, PyCUDA, GPGPU.

Abstract. When a material is subjected to loads and strains that vary over time, it is susceptible to failure due to fatigue. In recent years, a non-destructive and non-contact technique has gained relevance in the characterization of materials under fatigue and in the study of crack growth mechanisms. It is the 'thermoelastic stress analysis' technique using infrared thermography (IRT). This technique is based on the so-called 'thermoelastic effect' that explains the existence of temperature changes (of the order of hundredths of a degree) induced by deformation. One of the possible applications of this technique would be the in situ detection of crack tips from amplitude and phase maps of the thermoelastic signal. For this, it is necessary to measure the surface temperature of the cracked specimen and analysing the characteristics and the evolution with time of the so-called thermograms, which are represented by fixed-size matrices according to the resolution of the camera used. In rapid fatigue tests, the acquisition frequency has to be also fast, e.g. 50 Hz, with the consequent increase in the number of operations that have to be performed on each pixel. This makes it inconvenient for its handling in CPU. Parallel programming using GPGPU is a solution to this problem, allowing a significant reduction in execution and analysis times. The calculation efficiency can be increased by stream synchronization, working with groups of data corresponding to different numbers of cycles. In this work, experimental data and a post-processing code in PyCUDA that allows the detection of cracks from thermographic measurements are presented. The obtention of amplitude and phase maps is accomplished through a non-linear fit with a simple model based on a gradient descent algorithm. From the maps obtained, it is possible to detect crack tips and study the evolution of their lengths over time by analyzing extraction lines close to the notch of standardized CT specimens. A new method of locating crack tips from phase curves is proposed in this work. The first experimental results in specimens constructed with Zircalloy-4 are promising. The advantages of parallel processing are evidenced with a speed-up factor of 800 when comparing the execution times in CPU versus GPU.