EXPERIMENTAL DETERMINATION OF CRACK PROPAGATION UNDER FATIGUE LOADING TYPE I+II IN THERMOPLASTIC COMPOSITE MATERIALS

ABSTRACT

In recent years, the application and development of composite materials have been growing steadily due to their exceptional properties and the ability to tailor materials to the specific requirements of each project. Thermoplastic materials can be reshaped, repaired, and even recycled as their intermolecular forces weaken with increasing temperature. They exhibit high resistance to fracture, impact, and good fatigue resistance.

The aim of this research work is the experimental determination of crack propagation under mixed-mode I+II fatigue loading with controlled force and displacement in thermoplastic composite specimens. A total of eight specimens were used, constructed from thermoplastic composite material reinforced with carbon fibers, specifically TC 1225 (LowMelt PAEK, TORAY CETEX). All specimens consisted of two similar plates joined together with a single-ply overlap, and they had the same layup, consisting of 12 layers [0/-45/45/90/45/-45]s. Two out of the eight specimens were used in static loading experiments according to ASTM D5868 standard. The next three specimens were subjected to fatigue loading experiments with controlled force, and the diagrams of crack length moved side versus load cycles and crack length fixed side versus load cycles were presented. Finally, the last three specimens were tested under fatigue loading with controlled displacement, and the diagrams of crack length moved side versus load cycles, crack length fixed side versus load cycles, and maximum force versus load cycles were presented to observe crack propagation under mixed-mode I+II fatigue loading.

In the controlled force and controlled displacement experiments the crack increases as fatigue progresses and loading cycles are added to the specimens. In the controlled force experiments the crack progression increases gradually at a similar rate. It is observed that on the fixed side in the first 500 cycles the crack evolves faster but from there onwards the rate of crack evolution on the moving side increases and at the end it has a longer length. On the other hand, in the controlled displacement experiments it is observed that the crack length on the fixed side grows at a higher rate and is much longer than on the moving side. Also, there is a decrease in the maximum load as the loading cycles increase since the crack propagation reduces the stiffness of the specimen.

Keywords: Composite materials, Thermoplastic composites, Mixed-mode I+II fatigue loading, Controlled force fatigue tests, Controlled displacement fatigue tests, Crack propagation