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A path iterative method for laser-controlled crack propagation and its convergence

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Summary

Laser controlled separation of brittle materials like glass is a promising non-conventional cutting method. It is an application of the crack propagation driven by thermal stresses induced by laser irradiation. In order to induce and control a crack propagating accurately along predetermined asymmetric trajectory in a brittle plate, an iterative method for effective laser scanning path was presented, and the effect of control parameters on the convergence was investigated. The iterative formulation for laser scanning path was based on PID control theory, which was composed of deviation of the crack from predetermined trajectory and its integral and differential. To avoid adaptive crack propagation analysis and the corresponding finite element remeshing, the deviation of the crack was evaluated by the crack propagation angle calculated from the simulation of enforced crack growth along the predetermined line. The path iterative analysis for typical examples was carried out by choosing various control parameters of proportion, integral and differential. Results show that the proportion parameter has obvious influence on convergence, and the relative greater value is advantageous to it. And the differential control parameter should be small enough. Furthermore, the adaptive crack propagation simulation shows that the crack propagation can be induced and controlled along predetermined trajectory as the laser scanning along the converged path, which demonstrated the validity of the present method.

keywords: laser-controlled separation; crack propagation; path iterative method; convergence; PID control

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