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Initial Trajectories of Propagation of Fatigue Cracks Under Biaxial Cyclic Loading with Phase Difference

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Abstract: This paper presents a method for predicting initial trajectories of propagation of two separate fatigue cracks, which are developed under two perpendicular cyclic loads with phase difference between them. Calculation of trajectories of these two initial cracks is the first step in prediction of trajectories and rate of propagation of long cracks. This problem is important for analysis of durability of structures subjected to biaxial loading, where it is necessary to know trajectories of cracks' propagation, stress intensity factors along the trajectories and dependence of cracks' growth rates on stress intensity factors. Existing methods, based on finite element analysis and automatic mesh generation [1,2], allow to perform such calculations only for uniaxial loading and for multi-axial proportional loading, without phase difference between applied external forces. Experiments, presented in this paper, show that under biaxial loading with phase difference between applied loads, two cracks are developed. Comparison of calculated and experimentally observed initial directions of cracks propagation shows that the calculations correctly reflect existence of two cracks and the fact that they are approximately symmetrical about the line that makes 45° with directions of applied loads. This method can become a theoretical basis for extending capabilities of existing methods, based on finite element analysis and automatic mesh generation, of predicting trajectories of fatigue cracks under complex loading conditions.

Keywords: *fatigue; biaxial loading; phase difference; trajectories of cracks propagation.*

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