有害な欠陥やき裂がある工業材料の疲労特性の評価と危険荷重の検出について

Form 3

Abstract

Title: Detection of Application of Hazardous Load and Evaluation of Fatigue Properties in Engineering Material Having Inconvenient Defects or Cracks.

Structural components experience different kinds of loads in their life cycle like axial, torsional etc. The existence of some unrecognized cracks results in poor mechanical properties which may bring terminal damage with higher load application. On this aspect, the detection of such kinds of overload and underload and crack initiation and propagation behavior due to the presence of inclusions in the machine structure were investigated. The main contents of the present dissertation are summarized as follows:

A detection technique of the application of unexpected or hazardous over and under load was investigated. S15C carbon steel has been used to conduct this experiment which is called JIS-S15C steel. The specimen was prepared with pre-crack and notch at the center of the specimen. An acceleration behavior of crack growth due to the application of overload and underload during fatigue crack growth test with constant stress amplitude was observed. In some cases, the acceleration of crack growth brings catastrophic failure in machine the structure. Therefore, it is useful for machine maintenance to determine whether an unexpected load was applied or not by doing a daily inspection. Fatigue limit and crack growth behavior of carbon fiber reinforced epoxy composites and hybrid composites has been studied with a slit specimen. Then the results were compared between epoxy carbon fiber reinforced composites and the hybrid composites. The fatigue limit was defined by the maximum stress amplitude that the specimen endured 10^6 times or more repeated stress when *S-N* curve was used. For both cases, the highest fatigue limit was obtained for parallel loading fiber direction. According to those results, it was expected that the fatigue limit of smoothed specimens of carbon composites and hybrid composites can be evaluated from the results of the slit specimens.

The fatigue life and fatigue limit of carbon steels having pre-cracks and inclusions, and prediction of fatigue limit by correction of crack initiation length were investigated. Presence of pre-cracks and inclusions may affect the crack initiation length and crack propagation behavior. Also, crack initiation behavior is related to the distribution of microstructure and inclusions present in the materials. Inclusion size higher than expected may decrease the fatigue strength of the material. This result is shown in the study of 0.25% carbon steel. For the material 0.45% carbon steel, there were some inclusions but fewer than 0.25% carbon steel. As initial crack length varied due to the presence of inclusions, a correction method has been proposed and fatigue life and limit have been predicted based on the correction.

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