 ICCES, vol.16, no.1, pp.7-7

Review on Fatigue Crack Initiation Mechanisms of Interior Inclusion-induced Fracture of Metallic Materials in Very High Cycle Regime

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Summary

Long term use of mechanical products provides us a lot of positive environmental effects such as saving resources, saving energy, reducing environmental load to globe and reducing the industrial wastes. Thus, fatigue property of metallic materials in very high cycle regime such as gigacycles has been a new important subject to ensure the long durability of actual mechanical structures during the latest decades. From this point of view, fatigue tests in the long life regime were performed for various kinds of metallic materials by many researchers and a series of experimental results were reported. One of most typical aspect in the fatigue property is that we have duplex S-N characteristics consisting of S-N curves for the surface-induced fracture and the interior inclusion-induced fracture. After this aspect was reported, the crack initiation mechanism has been focused as an important subject in the very high cycle fatigue of metallic materials. Thus, it was found that the characteristic area indicating fine granular morphology was usually formed in the vicinity around the interior inclusion during the long sequence of cyclic loadings. This area is so-called fine granular area (FGA), optically dark area(ODA), granular bright facet(GBF) and so on depending on the respective researchers. Recently, particular attention has been paid to the formation mechanism of this characteristic area and four different models have been proposed as follows; (1) micro scale polygonization around the interior inclusion and deponding of polygonized layer and matrix proposed by the authors, (2) hydrogen embrittlement assisted cracking around the interior inclusion proposed by Murakami et al., (3) dispersive decohesion of spherical carbides and matrix proposed by Shiozawa et al. and (4) traces of mutual beating of fracture surfaces during the crack propagation in vacuum proposed by Nakamura et al. In the present paper, a review on such crack initiation mechanisms was attempted for the sake of convenience to facilitate the research on very high cycle fatigue of structural metallic materials.