ADVANCES IN FATIGUE INVESTIGATIONS OF MATERIALS – STATE OF THE ART AND NEW CHALLENGES

POSTĘPY W BADANIACH ZMĘCZENIOWYCH MATERIAŁÓW – STAN BIEŻĄCY I NOWE WYZWANIA

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Summary

Many testing techniques commonly used for damage assessments have been developed up to now. Among them we can generally distinguish destructive and non-destructive methods. Having the parameters of destructive and non-destructive methods for damage development evaluation it is instructive to analyze their variation in order to find possible correlations. This is because of the fact that typical destructive investigations, like creep or fatigue tests, give the macroscopic parameters characterizing the lifetime, strain rate, yield point, ultimate tensile stress, ductility, etc. without any information concerning microstructural damage development and material microstructure variation. On the other hand, non-destructive methods provide information about damage at a particular time of the entire working period of an element, however, without sufficient information about the microstructure and how it varies with time. Therefore, it seems reasonable to plan damage development investigations in the form of interdisciplinary tests connecting results achieved using destructive and non-destructive methods with microscopic observations in order to find mutual correlations between their parameters. This is the main issue considered in this presentation.

Development of fatigue damage was investigated using destructive and non-destructive methods in materials commonly applied in power plants or automotive industry. In order to assess such kind of damage the tests for a range of different materials were interrupted for selected number of cycles. As destructive methods the standard tension tests were carried out after every kind of prestraining. Subsequently, an evolution of the selected tension parameters was taken into account for damage identification. The ultrasonic and magnetic techniques were used as the non-destructive methods for damage evaluation.

In most cases, fatigue damage has a local character and it is based on damage development leading to generation of cracks appearing around structural defects or geometrical notches. An identification of these areas and their subsequent monitoring requires a full-field displacement measurements performed on the objects surfaces. In this study an attempt to use the Electronic Speckle Pattern Interferometry (ESPI) method for fatigue damage evaluation and its monitoring on specimens made of the P91 steel and aluminide coated nickel super-alloys is presented.

In conclusion it is shown that good correlation of mechanical and selected non-destructive parameters identifying damage can be achieved for the materials tested. The hybrid technique proposed for fatigue damage evaluation looks also very promising in further investigations of many other types of materials.