FATIGUE DAMAGE ASSESSMENTS SUPPORTED BY NONDESTRUCTIVE TESTING TECHNIQUES

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In many 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 [1]. An identification of these areas and their subsequent monitoring requires a full-field displacement measurements carried out on the surfaces of objects tested. This paper presents an attempt to use the Electronic Speckle Pattern Interferometry (ESPI) and Digital Image Correlation (DIC) for damage evaluation [2] and its monitoring on specimens made of the P91 steel, Fig. 1, and aluminide coated nickel super-alloys subjected to monotonic or cyclic loading.

In this work, also a development of fatigue damage was investigated using destructive and non-destructive methods in materials commonly applied in power engineering or automotive industry. The fatigue tests for a range of different materials were interrupted for selected number of cycles in order to assess a damage degree. As destructive methods the standard tensile tests were carried out after prestraining due to fatigue. Subsequently, an evolution of the selected tensile parameters was taken into account for damage identification. The ultrasonic or magnetic techniques were used as the non-destructive methods for damage evaluation. In the final step of the experimental program some microscopic observations were performed. The results show that ultrasonic and magnetic parameters can be correlated with those coming from destructive tests. It is shown that a good correlation of mechanical and selected non-destructive parameters identifying damage can be achieved for the materials tested.

The work additionally presents simulation of fatigue crack initiation for cyclic loading within the nominal elastic regime. It is assumed that damage growth occurs due to action of mean stress and its fluctuations induced by crystalline grain inhomogeneity and free boundary effect. The macrocrack initiation corresponds to a critical value of accumulated damage [3].

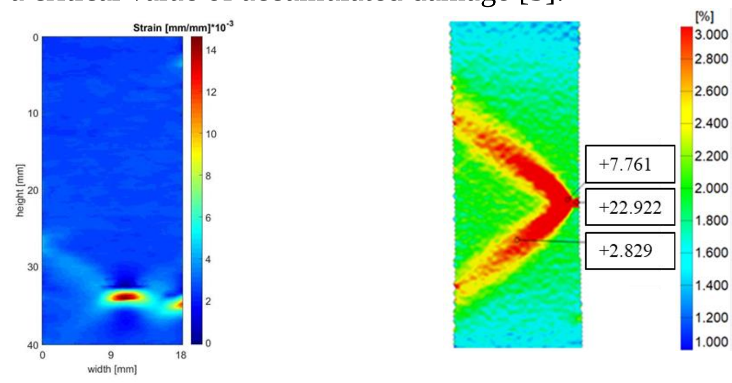

Fig. 1. Examples of optical methods application for fatigue damage identification for P91 steel:
(a) results captured by ESPI system after 245000 cycles, (b) results captured by DIC system after 144000 cycles

References:

1. M. Kopec et al. (2021), International Journal of Pressure Vessels 189, 104282-1-16.
2. M. Kopec et al. (2021), Archives of Civil and Mechanical Engineering 21, 167-1-13.
3. A. Ustrzycka et al. (2020), International Journal of Fatigue 131, 105342-1-15.