Investigation of stress relief holes geometry by means of machine learning and digital image correlation methods

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Fatigue of materials and structural elements has major influence on design and safety of machines and its components. One of the most important factor affecting the fatigue life is the stress concentration, which appears in the surroundings of notches and openings of various kinds. It is the common knowledge that such stress concentration can be reduced by different technological operations or structure modifications. On of these methods is the application of the stress relief holes (SRH), which reduce the stress concentration in a meaning way. The main problem of this approach is the determination of the optimal configuration of SRH (i.e. size and location). In this research the machine learning is applied for optimization of geometrical parameters of the applied stress relief holes.

Here, the input data required for machine learning analyses is prepared by means of numerical analyses, namely finite element (FE) calculations. The obtained optimal configurations are the starting point for preparation of samples for experimental studies. The experimental research is made with the use of the contactless method – digital image correlation (DIC), which is the well-established method for analysis of deformation and strains. The DIC method is used for evaluation of introduction of SRH effectiveness, which is illustrated by the reduction of the strains around the notches and by comparison of numerical FE results and experimental ones [1, 2].

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[2] P.J. Romanowicz, B. Szybiński, M. Wygoda, Assessment of Digital Image Correlation Effectiveness and Quality in Determination of Surface Strains of Hybrid Steel/Composite Structures, Materials 2024, 17(14), 3561; https://doi.org/10.3390/ma17143561.