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IDENTIFICATION OF ELASTIC MATERIAL PARAMETERS BASED ON DIGITAL IMAGECORRELATION RESULTS

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The goal of the work is to present the new methodology of determination of elastic constants in constitutive relations that can be applied to any elastic material. The approach is based on the Digital Image Correlation (DIC 2D) method in combination with stress field determination. It is worth emphasizing that there are no special requirements regarding the sample geometry, as well as the boundary conditions used to enforce the deformation process. Only the experimentally measured displacement field and the external force measured by the testing machine are needed for numerical calculations.

Parameters of the assumed linear constitutive law are found as an optimal set of values minimizing the measure of imbalance between external load and determined internal forces corresponding with assumed imaginary cut-surfaces. The imbalance function is assumed as a weighted sum of squares of residues of equilibrium equations, each written down for a finite-size part of a sample cut through with each particular surface. Optimization task is solved with the use of the Nelder-Mead downhill simplex algorithm.

The efficiency of the algorithm is verified with two types of materials: 310S steel and CFRP tape. Experimental studies are carried out on two types of samples with imperfections in the form of either eccentrically placed circular hole or undercut on one side. Each of the samples is stretched until the limit of elastic range is exceeded. The introduced imperfections cause that the deformation distribution is heterogeneous from the very beginning of the process. During deformation process the sequence of images is recorded using pco.edge 5.5 camera working in visible range. On the basis of the obtained image sequences, the displacement field is determined using ThermoCorr 2D digital image correlation program.

Additionally, the correctness of the proposed method is verified using numerically generated displacement field from FE simulations as experimental data. This approach allows to mimic the real experiment and estimate errors. Preliminary calculations show that the proposed method can be successfully used for identification of constitutive parameters for various types of materials.