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Short Communication

Research of the non-uniform strain and displacement fields in solids with concentrators with the use of the DIC technique

Elena M. Spaskova *

Center of Experimental Mechanics, Perm National Research Polytechnic University, 614990 Perm, Russia

ABSTRACT

This work focuses on analyzes the non-uniform strain fields in the area of stress concentration and study the limiting stress-strain state of the material in the test samples with different geometry concentrators with the use of the measuring system non-contact three-dimensional digital optical system Vic-3D. The research included tensile mechanical tests on flat samples with a hole research of the damage and failure processes of materials.

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1. Introduction

In the field of solid mechanics one of the important tasks is to study the effect of different types of stress concentrators on the behavior of structural elements. The aim of the work is an experimental study of the stress-strain states in the hubs using the method of digital image correlation. In this work we consider the use of three-dimensional digital optical system, Vic-3D, the mathematical apparatus which is based on the method of digital image correlation (Schreier et al., 2009).

2. Results

The video system is designed for the analysis of displacement fields and strain on the sample surface. The technique of the experiment using a digital optical system, described its structure and working principle. The mathematical foundations of computing device system tested on uniaxial compression "Brazilian test" in order to develop the methodology of the experiment using a digital optical system.

The results of the uniaxial tensile tests on plates made of plexiglass with concentrators of different geometries are also presented the results of tests on a uniaxial tensile carbon plate with a circular hole using a digital optical system. Mechanical uniaxial tensile test were performed on the test system Instron 5882 and Instron 5989, together with the use of digital optical system Vic-3D. In Fig. 1, a result of the tensile test plates are constructed field transverse, longitudinal, shear deformations (ε_{xx}, ε_{yy}, ε_{xy}), as well as the intensity deformation (Tretyakova and Spaskova, 2013).

In some cases destruction of plates happened in two stages, at first on the one hand the concentrator that about 50% were accompanied by sharp recession of level of loading, at further loading there was an insignificant increase in value of loading and final fracture of a plate (Fig. 2).

For the analysis of the sample damage mechanisms, the strain intensity fields for different values of load (points *g*, *e*) are shown in (Fig. 3). The *g*-point corresponds to the ultimate strain-stress state of the specimen. This point clearly shows the place of defect localization.

* *Corresponding author*. E-mail address: cem.spaskova@mail.ru (E. M. Spaskova)
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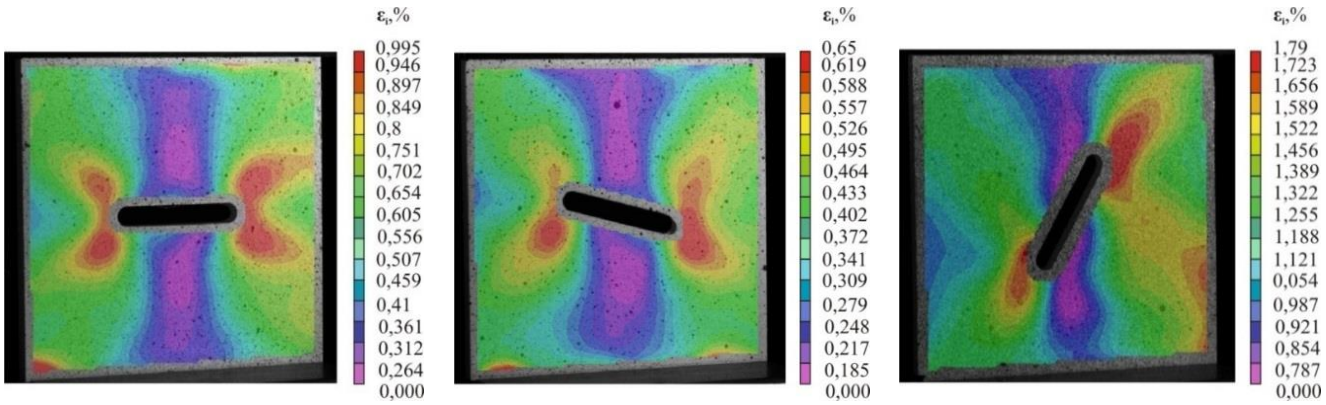

Fig. 1. Fields of strain intensity ε_i on a plate surface, an axis of cut with fields of plate.

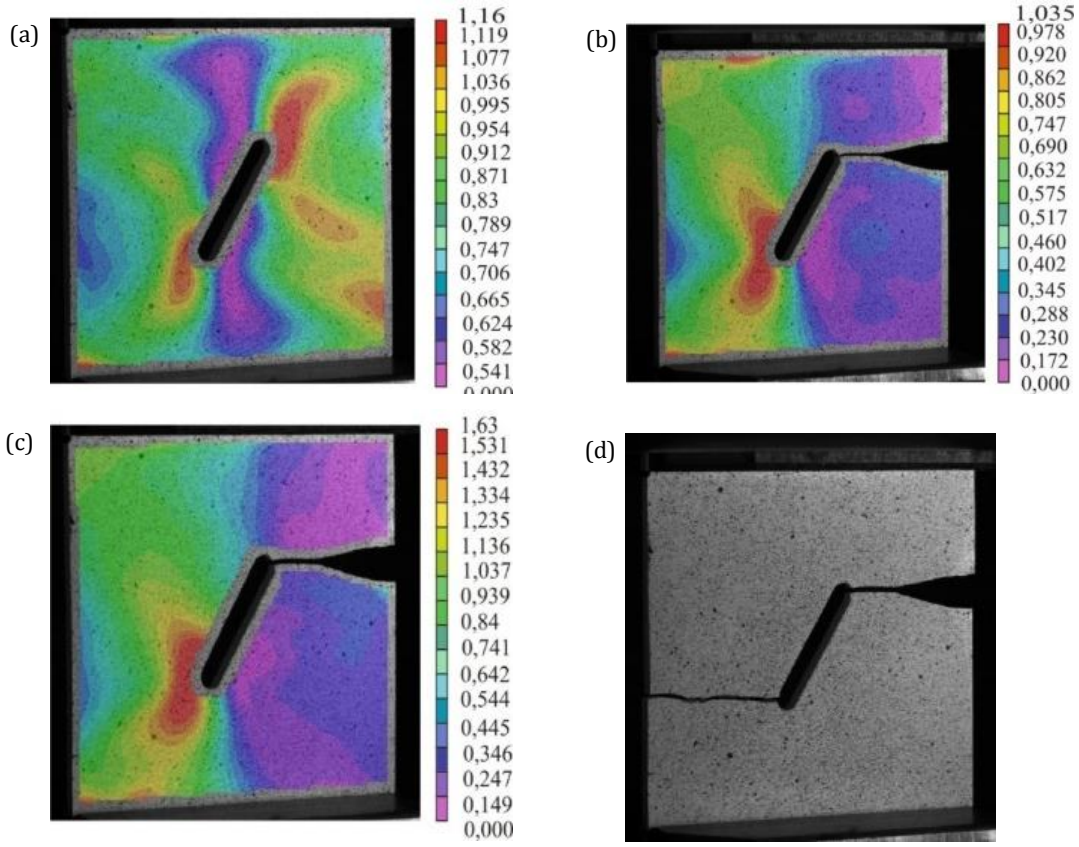

Fig. 2. Fields of strain intensity ε_i for a sample where the axis of cut made with the part of a plate is 60°, by load: (a) *P1*=2.837 kN; (b) *P2* = 1.243 kN; (c) *P3* = 1.713 kN; (d) photo of the destroyed sample.

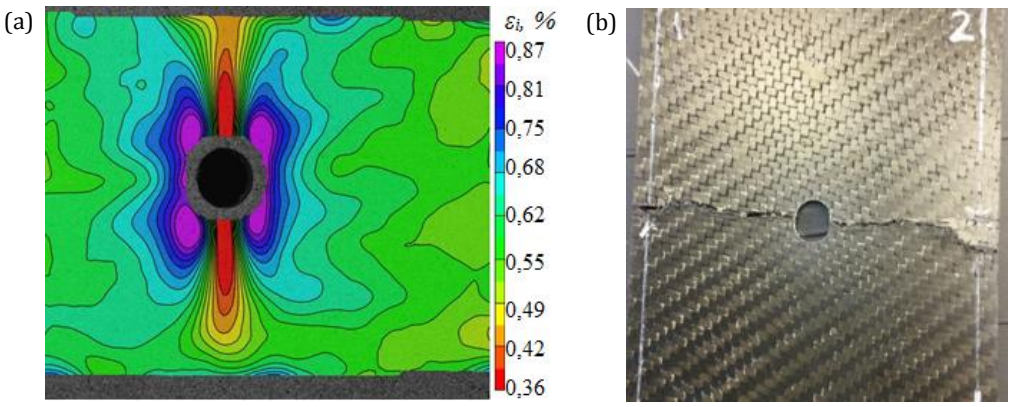

Fig. 3. Fields of strain intensity for different values of load: (a) isolines P_{max} = 104.74 kN; (b) broken specimen.

3. Conclusions

The system allowed to fix the evolution of the fields of displacements and strains to evaluate the nature of heterogeneity of fields to keep track of the material deformation processes occurring on the surface of the sample, and the add-on software video "virtual extensometer" was used in determining the mechanical properties of the material.

The high efficiency of the method of correlation of digital images to study the behavior of the material in the event of non-uniform strain fields (Tretyakova and Wildemann, 2014).

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