Applications of Physics
in Mechanical and Material Engineering
APMME 2021
Czestochowa, 19.02.2021

Dantec 3D image correlation system as a tool for determining strength properties

Tomasz Domański, Marcin Kubiak, Wiesława Piekarska, Zbigniew Saternus
Czestochowa University of Technology, Department of Mechanics and Machine Design Foundations

Experimental research

Fig 1. Measuring camera system.

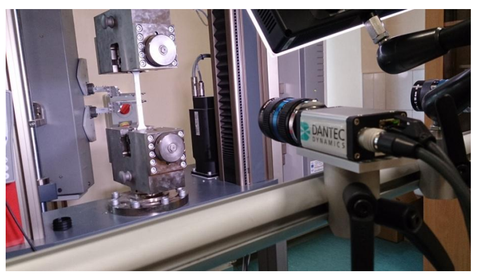
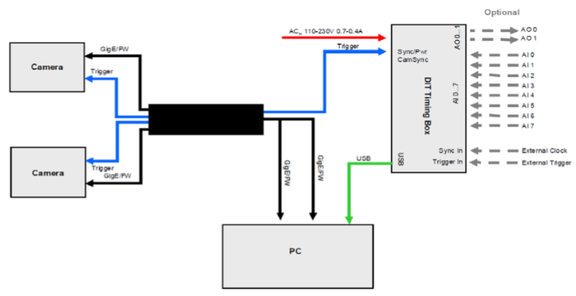


Fig 2. System of measuring.



The measuring system consists of:
1. Optical cameras
2. "Timing Box" signal synchronization module
3. PC with dedicated Dantec Istra4D software

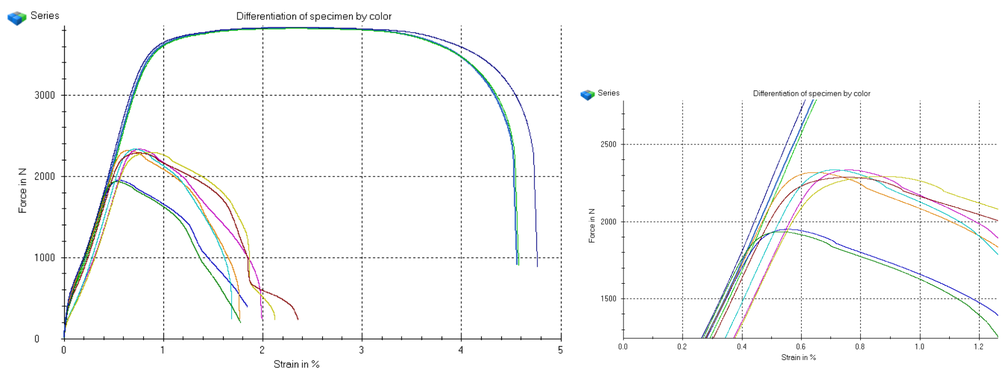


Fig 4. Stress-strain curves.

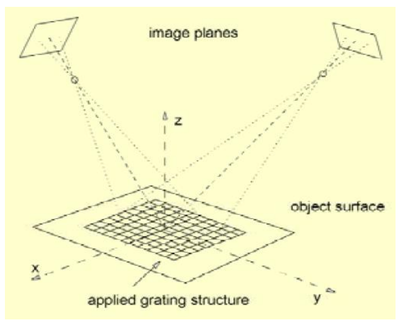


Fig 5. Measurement diagram.

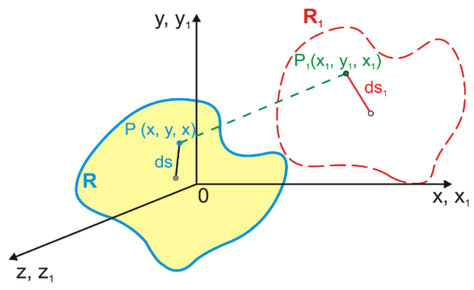


Fig 3. Characteristic values before (R) and after (R_1) deformation.

$$P_1 = (x_1, y_1, z_1) = [x + u(P), y + v(P), z + w(P)]$$

$$Q_1 = (x_1 + dx_1, y_1 + dy_1, z_1 + dz_1) =$$

$$\begin{bmatrix} x + u(P) + u(Q) - u(P) + dx, y + v(P) + x(Q) \\ -v(P) + dy, z + w(P) + w(Q) - w(P) + dz \end{bmatrix}$$

$$\varepsilon_{xx} \cong \frac{du}{dx} + \frac{1}{2}\left[\left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial v}{\partial x}\right)^2\right]$$

$$\varepsilon_{yy} \cong \frac{dv}{dy} + \frac{1}{2}\left[\left(\frac{\partial u}{\partial y}\right)^2 + \left(\frac{\partial v}{\partial y}\right)^2\right]$$

$$\varepsilon_{xy} \cong \frac{1}{2}\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right) + \frac{1}{2}\left[\frac{\partial u}{\partial x}\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\frac{\partial v}{\partial y}\right]$$

Experimental results

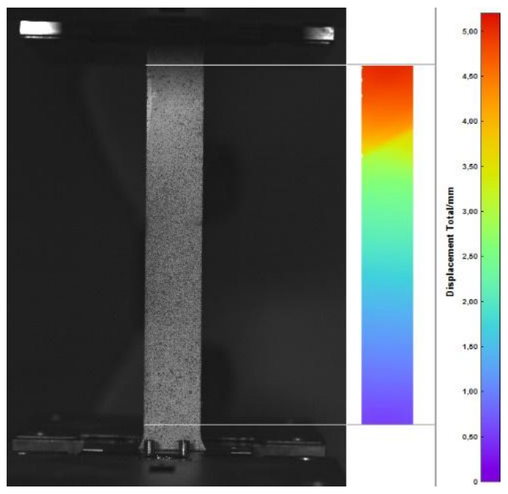


Fig 6. Flat specimen without hole.

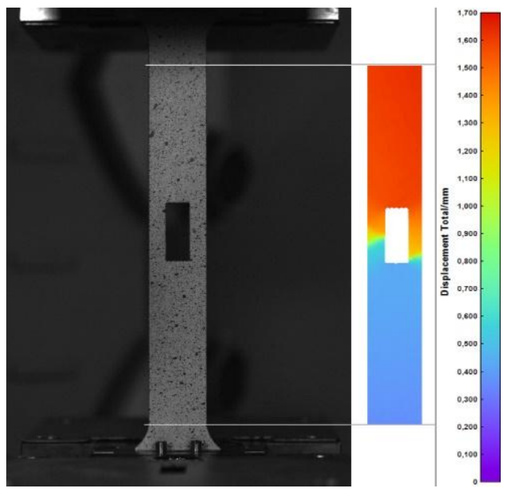


Fig 7. Flat specimen with a rectangular hole.

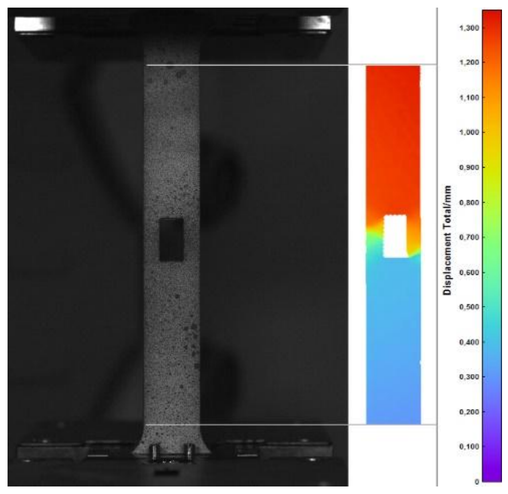


Fig 8. Flat specimen with a rectangular hole.

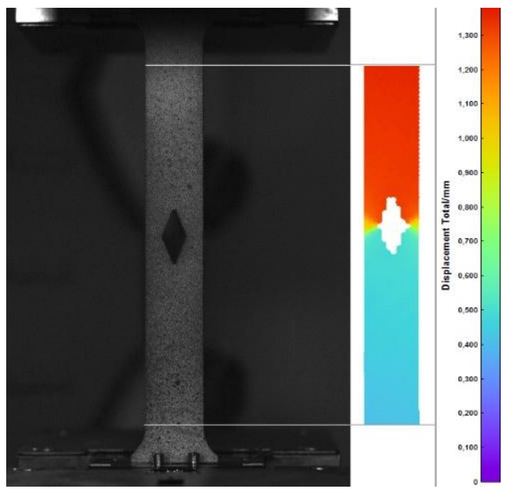


Fig 9. Flat specimen with a rhomboidal hole.

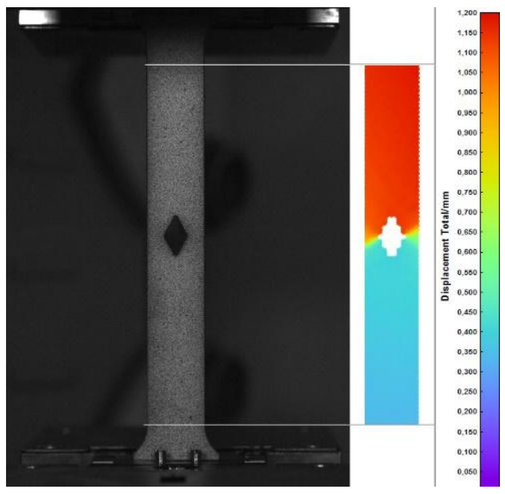


Fig 10. Flat specimen with a rhomboidal hole.

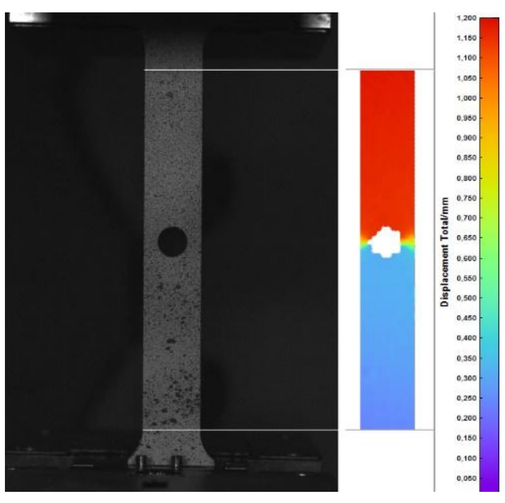


Fig 11. Flat specimen with a circular hole.

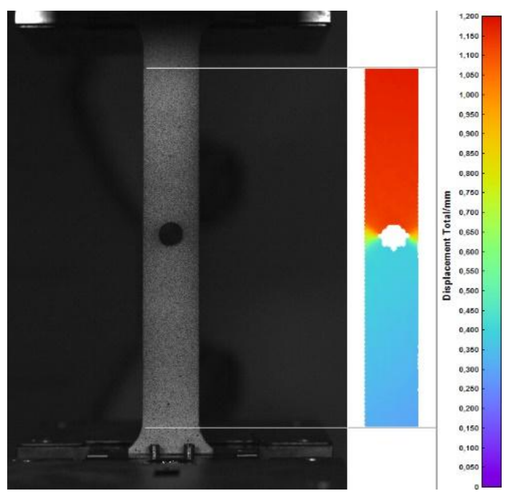


Fig 12. Flat specimen with a circular hole.

Summary

The presence of a notch has a decisive influence on the deterioration of the operational properties of each type of construction material. The shape of the notch and the stress distribution in the notch have an influence, in particular with high strains, on the properties of the material tested. To evaluate these properties, the static characteristics of the test material were determined for the various notches. The work presents the research possibilities offered by the multi-camera 3D image correlation system. The experiment is based on non-contact measurement of displacements and deformations of axially loaded samples. The samples are made of aluminum AW-1050A. The measurement was mainly used to estimate the value of deformations and displacements at various points of the loaded cross-section. The measurement was performed by following the displacements of the properly prepared outer surface of the sample.