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AN INEXPENSIVE ANALYSIS SYSTEM USING DIGITAL IMAGE CORRELATION

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Abstract: *In this work, we wanted to find if we can build a cheap system of analysis of mechanical systems behavior using the Digital Image Correlation method while obtaining satisfactory results. At the same time, we wanted to compare the results obtained by using different popular devices - a smartphone and a GoPro video camera. For the mentioned study we opted for the construction of a cheap analysis system.*
Keywords: *Digital Image Correlation, optical methods for materials*

1. INTRODUCTION

Digital Image Correlation, abbreviated D.I.C, is a method of analyzing materials using image correlation (hence the name of the method).
To analyze the materials, the method uses a large number of images (extracted from the test video of the studied material's behavior) in which a certain part of the image of the specified material to be studied is correlated with each consecutive image to determine the deformation, displacement, velocity of one or more points in the image section to be studied.
In experimental mechanics the digital image correlation method can be classified as a contactless optical metrology method, using digital image analysis to extract measurements of the full field deformation of objects subjected to external stresses. Digital Image Correlation is based on the interpretation of images, and its results have good accuracy given the fact that the study is discussed at the level of a pixel.

2. MEANS AND METHODS

In order to analyze the behavior of a system/part, we used the following:
- A 240 fps GoPro video camera and then, for comparison, a 30fps mobile phone camera
- An efficient light source
- Support for video camera stabilization
- Some form of data interpretation/analysis software – we used the "free", evaluation version of GOM Correlate, dedicated software for Digital Image Correlation - https://www.gom.com/3d-software/gom-correlate.html
- A laptop computer to run the software in which the images will be studied
- Paint (black and white colors) for painting the part of the piece to be studied

We aimed for a construction that can be done cheaply, using common tools. The materials and tools used for the construction of the stand were:
- 2 spruce wood boards with the dimensions 800mmx200mmx18mm, respectively 1200mmx400mmx18mm
- drilling machine
- pencil and ruler for drawing
- wood gluing adhesive
- universal screwdriver 5x40mm
- M8x50mm metric screw
- M8 butterfly nut
- 8.4mm flat washer
- cutting saw
- white paint
- blue paint
- abrasive sponge with a grain size of 80 for plate deburring

- metallic T ruler for drawing
- roller for painting and tray

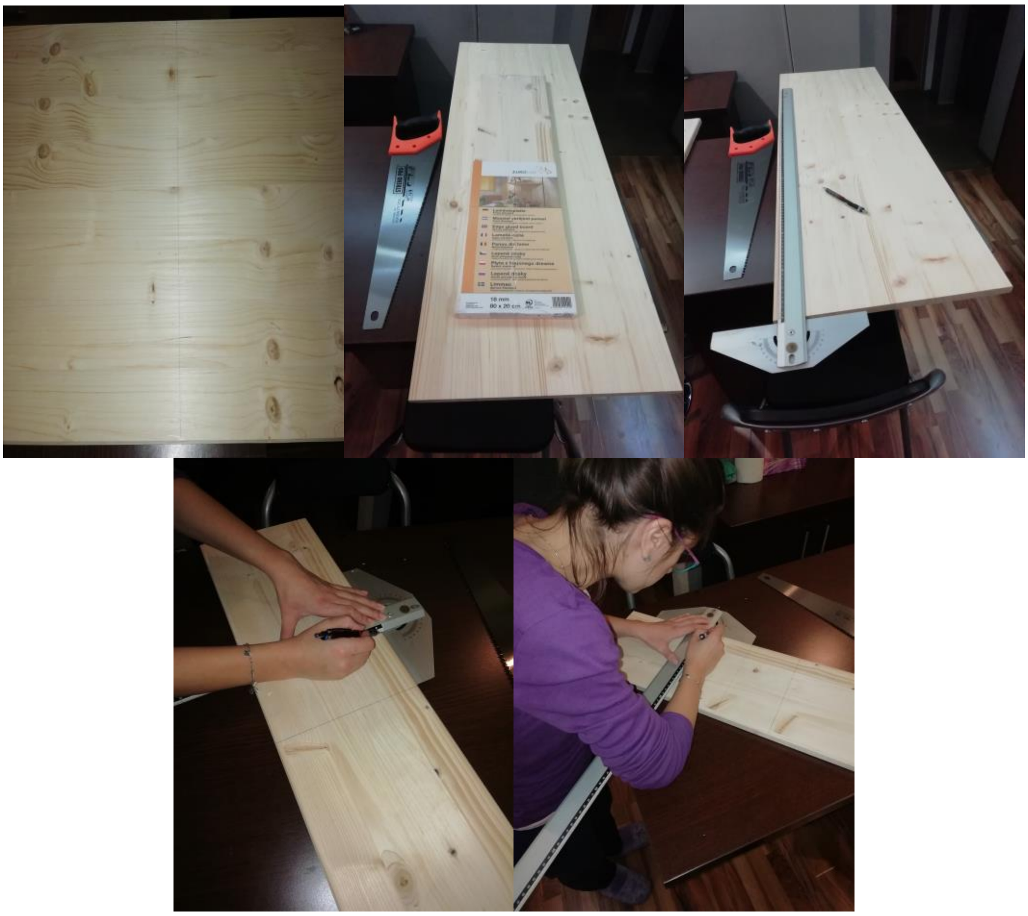

Figure 1: Building the experimental stand

We tested a 500x30x2 mm aluminum bar, embedded at one end, by hitting it at the open end with a force F = 0.07848 N.
We painted different zones of the bar using black paint, then we sprinkled those black zones using white paint. Simply put, the method tracks these white sprinkles frame by frame, being then able to estimate deformations, displacements, velocities.

Figure 2: A painted area on the aluminum bar

Figure 3: The final experimental stand

We filmed the experiment first by using a 30fps mobile phone camera and then by using a 240 fps GoPro video camera. We then modeled the system in ABAQUS and compared the results from the ABAQUS model with the two experimental results.
For the ABAQUS model we used, for aluminum:
- Young's modulus E=70000MPa
- Poisson's ratio ν=0.33
- as described above, we considered the force as being F=0.07848 N

3. RESULTS

The ABAQUS model is a simple one, and we obtained the von Mises (equivalent) stresses up to 0.1335 MPa

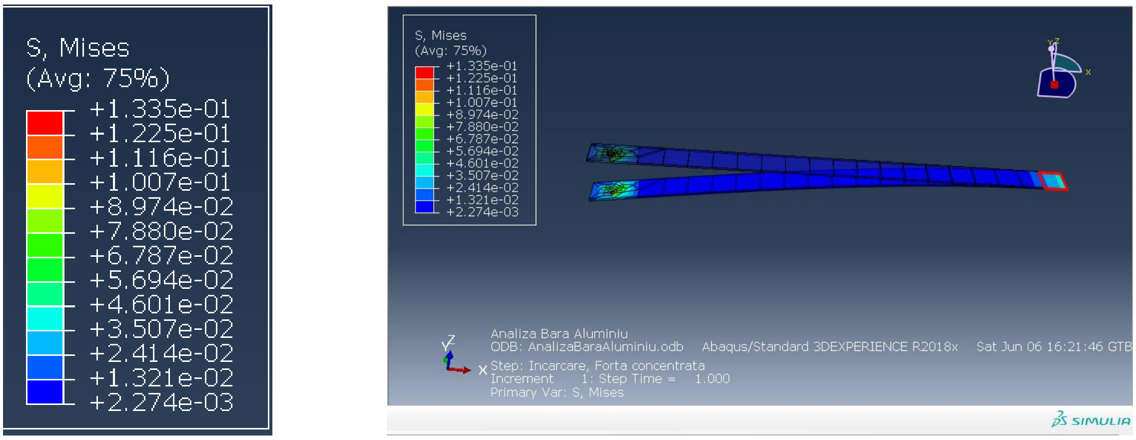

Figure 3: The ABAQUS results – equivalent stress

By analyzing the results provided by GOM Correlate, we could find the values for the equivalent stress "inside" the values provided by ABAQUS, when the video recording was done using the GoPro device. However, the values did not match perfectly.

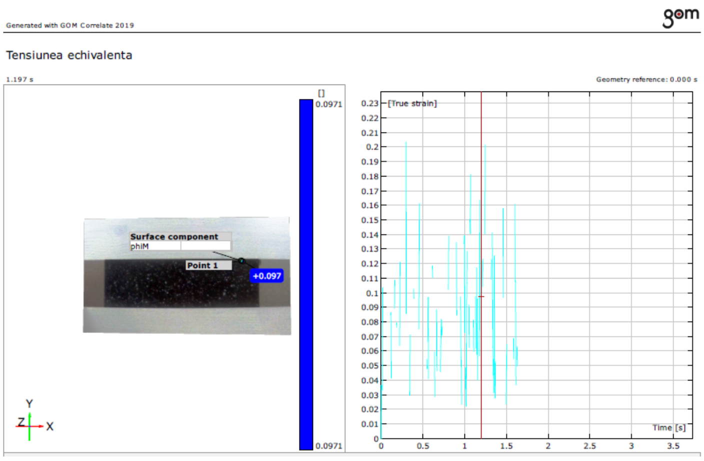

Figure 4: The GOM Correlate results – equivalent stress

Unfortunately, not the same could be said about the mobile phone results, the differences versus the ABAQUS model being very high.

3. CONCLUSION

In this paper, we wanted to check if satisfactory results can be obtained using a cheap analysis system, with the help of the Digital Image Correlation method, the videos being obtained with the help of a smartphone camera (30 frames per second) and a GoPro camera (240 frames per second).

The conclusions which we reached are presented below:
- a cheap system for Digital Image Correlation, like the one presented in this paper, is only good in creating an overview of the behavior of a system or part under external stresses; for exact numbers, a professional system is necessary – there is a reason why a professional DIC system has a considerable price
- frame rate matters – there is a huge difference between the results obtained with 240 fps and 30 fps, a very low frame rate gives improper results
- quality of image matters, as does a good light source

In the end, even if we cannot use such a system as the one described above for proper, design – usable results, we can still use those results as a guideline in different practical situations, especially considering how cheap such a system is to build.

REFERENCES

[1] Sutton, M.A., Yan, J.H.,Schreier, H.W.,& Orteu, J. J.The effect out-of-plane motion on 2D and 3D digital image correlation measurements. Optics and Lasers in Engineering, 2008

[2] Peters, W.H. , &Ranson, W.F (1982). Digital imaging techniques in experimental stress analysis. Optical engineering, 1982

[3] www.spectromas.ro

[4] www.gom.com