COMPARATIVE METHOD FOR DETERMINING THE MECHANICAL STRESSES

Ioan GHIMBASEANU

Transilvania University of Brasov, Romania

Abstract: *The electric tensometry is a method for measuring the deformations by using some transducers. These transducers turn the variation of a mechanical size into variations of an electric size.Compared with this method the aim of the paper is to develop interactive software for simulation the mechanical testing. The purpose of this paper is to compare the results of the two methods. The method can also be applied to measure the tension of aircrafts, rockets, ballistic missiles and gun barrels.*

Keywords: *sensor, transducer, sensitive element, software simulation, mechanical testing*

1. INTRODUCTION

The tensometric resistive sensors are those resistive sensors where the electrical resistance variation is produced caused by the variation of the conductor's length, as an effect of the elongation or of the contraction. Whether the tensometric sensor is mounted on a certain part of the piece subjected to deformation caused by a stress, then, it will suffer deformations in the same time with the piece supporting it.

Measuring the variation of the sensor's resistance through electrical methods, being proportionally with its elongation, the deformation of the part of the piece subjected to study can be determined on the basis of a previous measurement standard, establishing in the end the non-electric size inducing this deformation.

Tensometric transducers with paper support – In order to avoid the difficulties caused by the direct mounting of the resistive sensor on a piece, the transducer is previously stuck, by using a glue, on a paper support. As the electric resistance of the sensor must be higher enough as the transducer should have a corresponding sensitivity, the total length of the resistive wire is of about 10^2 mm. To reduce the surface on which the sensor is laid, the wire should be grid-shaped (fig. 1). [4]

Grid 1 is mounted on the paper support 2, at both ends two copper conducters 3 are glued to the larger surface, by means of which the transducer is connected in the circuit of measurement. The resistive sensor of the transducer is protected by a thin foil of paper 4 wich is glued above. This type of transducer, well-known, has a series of advantages, among which a relative easy mounting, a possibility of manufacturing transducers of various shapes and configurations, a uniformity of transducers produced simultanously and keeping the quality standard.

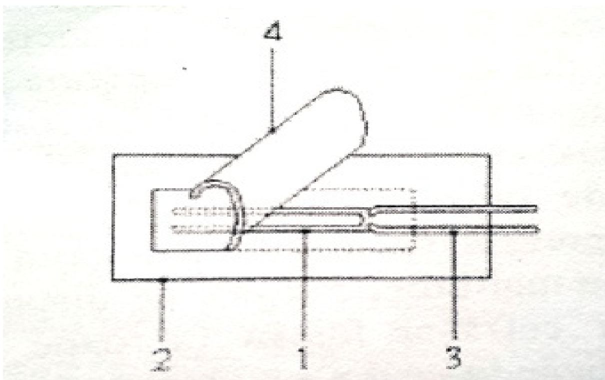

Fig. 1 Transducer with paper support

2. EXPERIMENTAL RESEARCH STUDY ON USING A TENSOMETRIC SENSOR ON PAPER SUPPORT

2.1.Description of the probe endowed with tensometric marks subjected to mechanical traction

The sketch of the probe is shown in figure 2. The material used is steel OLC45.

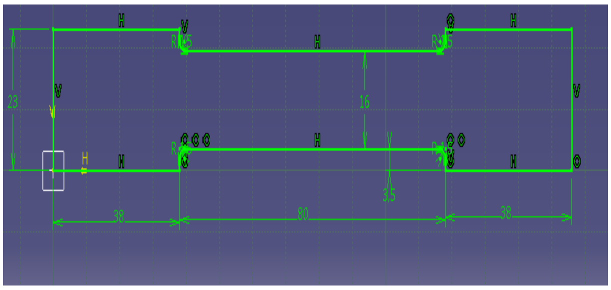

Fig.2 The sketch of the probe

2.2 The equipment used for the experimental research study

Tensometric marks is shown in figure 3. For testing the traction and determining the relative elongation, a traction device and a Wheanstone bridge are used and are shown in figure 4.[1,6]

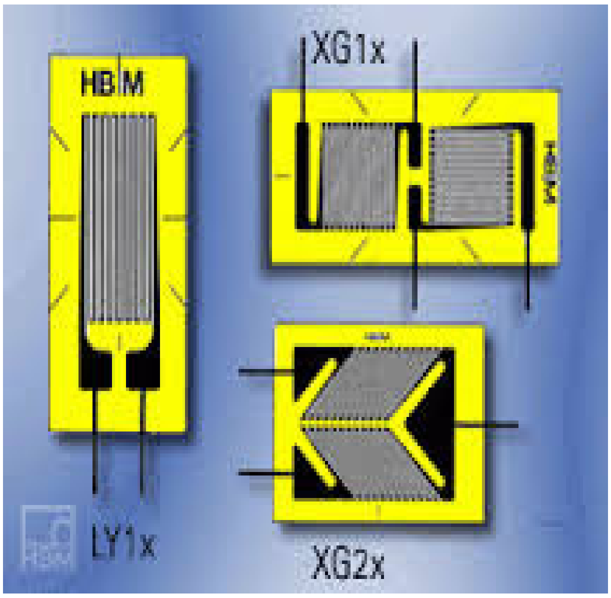

Fig.3 Tensometric marks

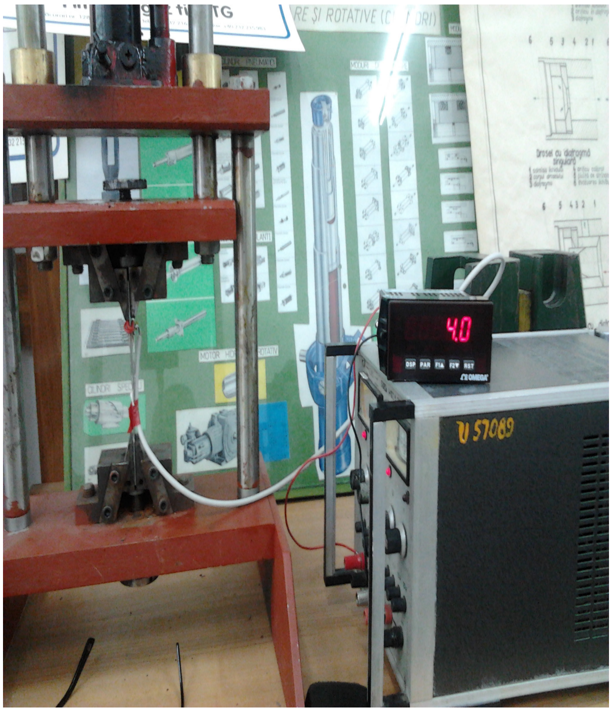

Fig. 4 Device for the traction test

2.3 Experimental test

On the basis of the calculation of the unbalanced tension of the bridge, the following equation results, as it can be shown below:

$$\varepsilon^2(k^2\Delta u + k^2 y^2 \Delta u + 2k^2\gamma \cdot \Delta u - k^2 u + k^2\gamma^2 u) + \varepsilon(4k\Delta u - 4k\gamma\Delta u - 2ku - 2k\gamma u) + 4\Delta u = 0 \quad (1)$$

The data for the tests one can obtain are recorded in table 1.

3. STATICAL ANALYSIS WITH FINITE ELEMENTS AT TRACTION TEST

The Generative Structural analysis programming module of CATIA environment allows the simulation of the test pieces mechanical behavior. [2, 3, 5]

The sketch of the probe is shown in figure 2.

The drawing of the test pieces model is shown in figure 5.

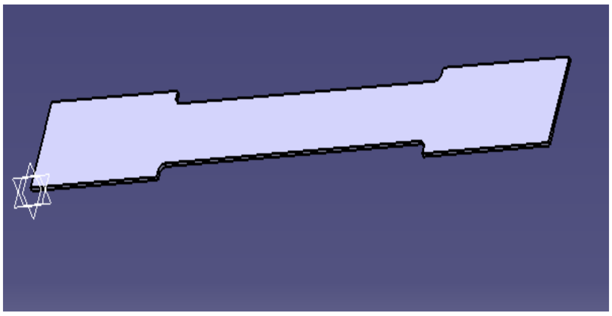

Fig. 5 Test pieces model

The displacement constraint and the distributed force of 7000 N is shown in figure 6 and 7.

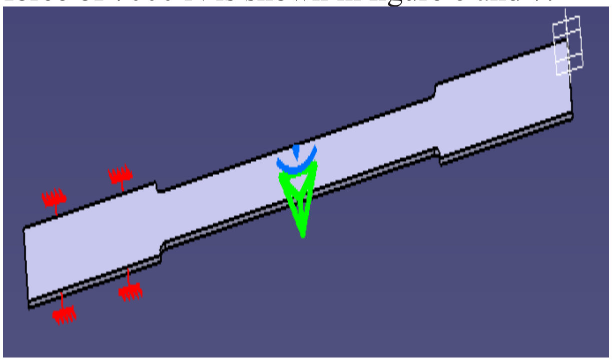

Fig.6 The displacement constraint

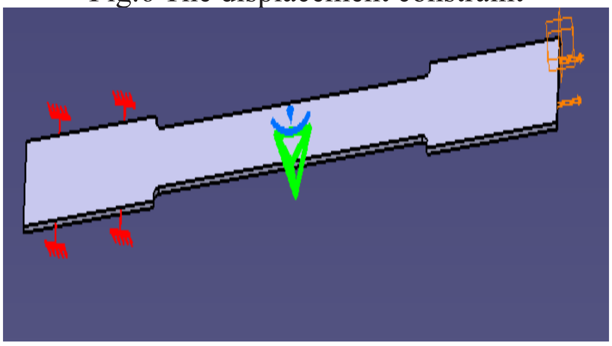

Fig.7 The distributed force

Solving the model and processing the results

The calculation model is launched. Figure 8 shows the deformation of piece.The stress von misses is shown in figure 9.The stress principal tensor is shown in figure 10.

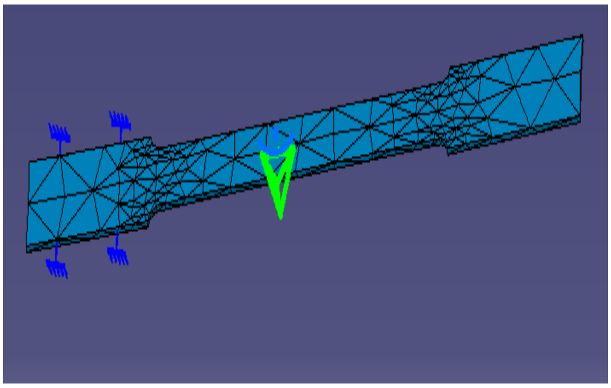

Fig. 8 The deformation of piece

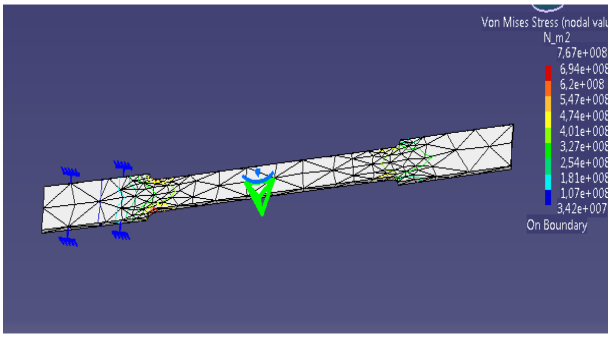

Fig. 9 Von Misses Stress

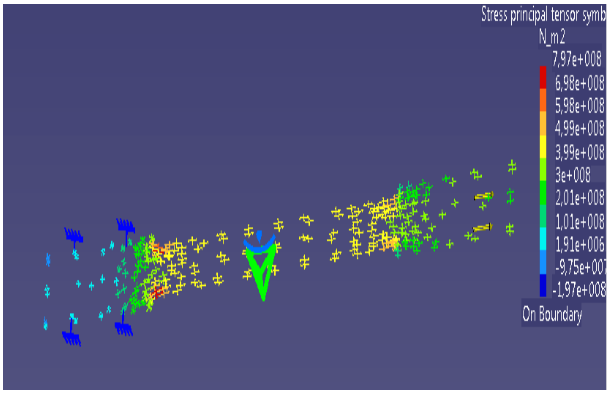

Fig. 10 The stress principal tensor

Table 1.Experimental data

Δu	b_0	h_0	R_0	K	γ	E	L	$[10^{-5}]$	Δl	$\sigma x10^6$	F
mv	mm	mm	Ω			N/mm²	mm		mm	[N/m²]	N
1	16	1	121,1		0,3	$2{,}1 \cdot 10^5$	143	1,4	0,002	2,94	47,04
4								2,2	0,00314	4,62	73,92
5								25,3	0,036	53,15	850,4
6								36,5	0,0522	76,65	1226,4
7								45,8	0,065	96,18	1538,8
8								54,9	0,078	115,29	1844,6
9								64,2	0,091	134,82	2157,2
10								121	0,173	254,1	4065,6
11								132	0,188	277,2	4435
12								146	0,20	306,6	4905
13								162	0,23	340,2	5443,2
14								188	0,26	394,8	6316,8
15								208	0,29	436,8	6988,2

Several values of mechanical stresses is shows in table 2.
For the node x=78 y=11.5 z= 1 and F=7000 N the resulting calculated stress by the experimental method is σ=4.368e+008 N/m^2 and simulate value is for the node x=78 y=11.5 z=1 σ=4,36895e+008 N/m^2 .

4. CONCLUSION

The method described previously allows the determination and the calculation von misses stress of material subjected to tensile stress. The measurement device of a high precision is used for determining the tension of unbalance occurring in the test piece following the tensile test. Then, the specific deformation of the test piece is calculated, the pulling force and the corresponding unitary stress.
Compared with this method the aim of the paper is to develop interactive software for simulation the mechanical testing.
The purpose of this paper is to compare the results of the two methods. For the node x=78 y=11.5 z=1 and F=7000 N the resulting calculated stress by the experimental method is σ=4.368e+008 N/m^2 and simulate value is for the node x=78 y=11.5 z=1 σ=4,36895e+008 N/m^2 . This shows that the static simulation of traction stresses by using Catia program is very good.
This shows that the static simulation traction stresses by using Catia program is of very good. The simulation by using Catia software can be used to determine the tensions inside the structure of helicopters (blades), of aircraft's (fuselage, wings), radar antennas and guns.

Table 2 Mechanical stress value

X[mm]	Y[mm]	Z[mm]	Von mises stress[N/m^2]
43,1937	8.267	1	4.094e+008
52.87	6.71	1	4.34 e+008
58.98	11.59	1	4.36 e+008
52.52	11.44	1	4.33 e+008
68.88	10.94	1	4.37 e+008
78	11.5	1	4.36 e+008
87.29	11.48	1	4.37 e+008
95.78	11.54	1	4.35 e+008
108.51	11.32	1	4.14 e+008
111.96	11.48	1	3.80 e+008

BIBLIOGRAPHY

1. Atanasiu C., *Material's testing*, Bucharest, Technical Publishing House, (1982);
2. Ghionea I., *Applications in mechanical engineering CATIA V5*, Bucharest, Bren Publishing, ISBN 978-974-648-843-6,(2009) ;
3. Ghionea I., *Aided design in CATIA V5*, Bucharest, Bren Publishing, ISBN 978-973-648-654-8, (2007);
4. Mogan G., Butnariu S., *Finite element analysis in engineering*, Brasov, Transilvania University of Brasov Publishing, ISBN 978-973=598-159-4, (2007).
5. Nicolau Th., *The electronics measurements in industry*, Bucharest, Technical Publishing House, (1964) ;