ELECTRICAL RESISTANCE TOMOGRAPHY IN A SMALL THIN SQUARE-SHAPED AREA

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1. Introduction

For conductive materials, such as carbon-epoxy composites, Electrical Resistivity Tomography (ERT) can be used to detect and localize damages of the structures [1, 2, 3]. Unfortunately, their relatively high conductivity makes it necessary to measure very small electrical currents, which is associated with large problems, especially the low signal-to-noise ratio. It may be a good solution to apply a graphite layer with a relatively high specific resistance to the non-conductive surface of the investigated element [4].

In the present study a resistance tomography method was used at square specimen. The influence of the damage in the conductive layer on resistance changes between electrodes in a square plate was investigated.

2. Materials and methodology

Used specimens had a form of a thin graphite layer applied at non-conductive base. Conductive area has shape of 50 mm x 50 mm square with 18 equal spaced silver electrodes on each edge (layer thickness about 10 µm). Electrical resistivity of electrodes was much lower than the graphite layer. Damage of surface was created by 4 mm diameter hole. Electrical resistance between pairs of opposites electrodes was measured at 4 directions: *x*,*y* prescribed by the edges of specimen and *u*,*v* parallel to diagonals. Measurements were taken for specimen without and with damage performed with a high accuracy digital multimeter Agilent 34401A.

Numerical analysis was performed in ANSYS code using electric analysis module. Constant current flow was simulated and the voltage change was measured.

3. Results

Figure 1 shows specimen and measurement results expressed by relative change in normalized resistance obtained by experiment and FEM analysis.

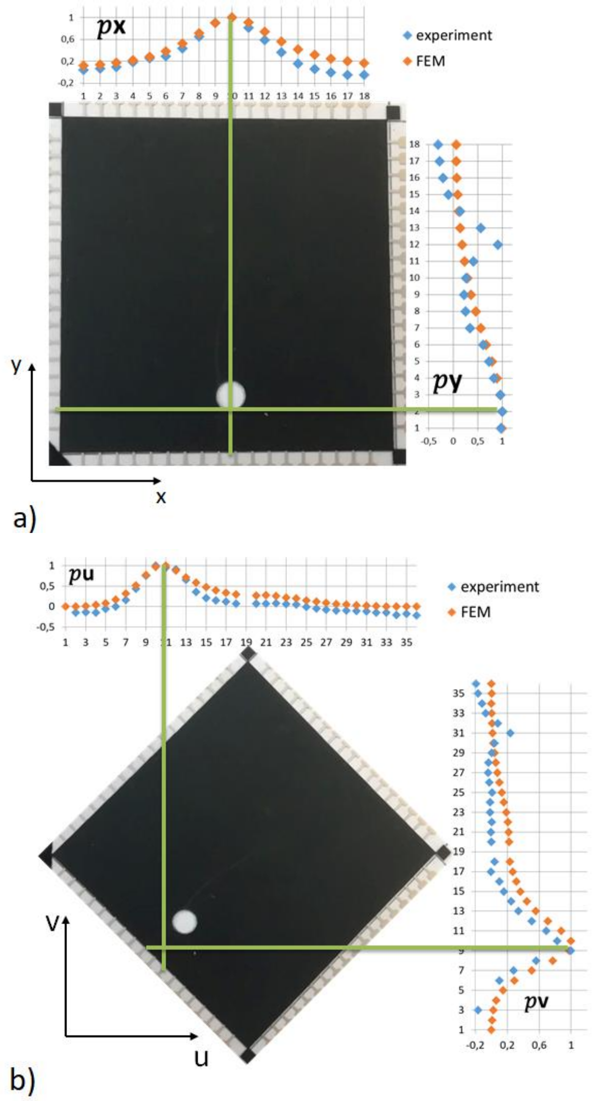

Fig. 1. Experimental and FEM results. Distribution of resistance between pairs of electrodes: a) direction x,y; b) direction u,v.

The resistance was measured at directions x,y (18 electrodes couples each) and u,v (36 electrodes couples each). There is visible increase in resistance caused by layer damage. The change in resistance was observed entire width of the specimen and is clearly greater on the pairs between which the damage exist. Thick green lines indicate the location of the center of the damage measured on the sample in perpendicular directions. Measurements were made for different damage locations. The largest increase in the resistance is visible on the electrodes that are closer to the edge of specimen than the damage. If damage is closer to the edge the effect is more visible. Basing on the FEM analyzes the correction functions were determined. Example of correction function shows at figure 2.

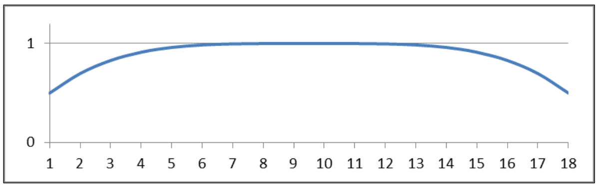

Fig. 2. Correction function – direction x.

The location of the damage can be determined by function *Z* in a similar way to that described in the work [4] (figure 3).

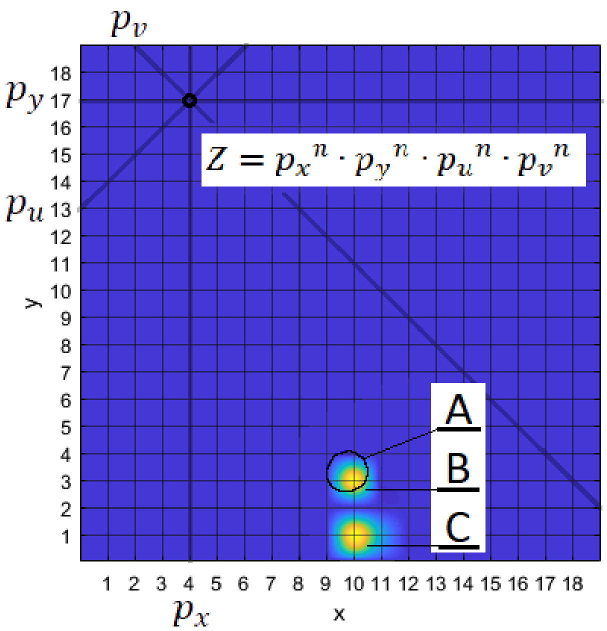

Fig. 3. Z-formula and Z-maps for experiment.
A: Real hole shape; B: hole detected by Z-formula which correcting function;
C: hole detected by simple Z-formula.

Figure 3 shows the real damage location (fig. 3, contour A), distribution of *Z* in the case with the use of corrective functions (fig. 3, shape B) and without the use of corrective functions (fig. 3, shape C)

4. Conclusions

In both the FEM analysis and experiment, a relationship between distribution of the resistance change and the location of the damage was observed. The influence of the edge is visible and can be corrected by the experimentally determined correction function.

The proposed method can be used for detection of damages on the surface of elements and for estimation of their location.

References

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