Title:

Thermal imaging and Thermal Stress Analysis of the impact damage of composite materials

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Abstract: (Your abstract must use **Normal style** and must fit in this box. Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text/diagrams into it.)

Composite structures, such as wind blade turbines, can be damaged due to the impact, or damaged during the transportation and montage. In the presented work the thermal imaging and the Thermal Stress Analysis (TSA) have been used to observe the impact on a composite material, and to evaluate the resulting damage. The 1st step included controlled impact and thermal imaging of the impact. The specimen was a four layered 490g/m^2 fibreglass roving for polyester resin impacted with a 19,61J impactor (1kg, 16mm diameter spherical tip, dropped from 2m). The 2nd step included the TSA of the damaged composite cyclically loaded (Fig.1). The TSA is based on the infrared camera (IR) and the Lockin [1,2].

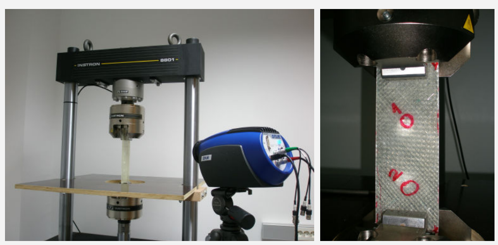

Figure 1. TSA and damaged specimen

Every material in elastic tension cools for a short instant, while heats for the case of elastic compression. For the plastic/damage case, thermal energy is generated and heat can be observed for a while. Fig. 2_{I} is the moment before impact. Fig. 2_{II} shows cooled (elastic tension) zone under the impactor. Fig. 2_{III} shows heated zone where the damage in material occurred and the cooled zone around. The last two figures show the generated heat in damaged area after the impact.

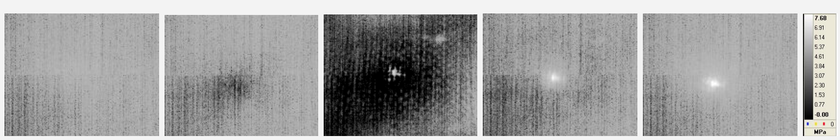

Figure 2. Thermal distribution during the impact (frame rate 360 Hz)

Fig. 3 shows the stress distribution for damaged and intact specimens. For the damaged specimens, the 0MPa stress at the point of impact, and in damaged glass fibres, is clearly visible.

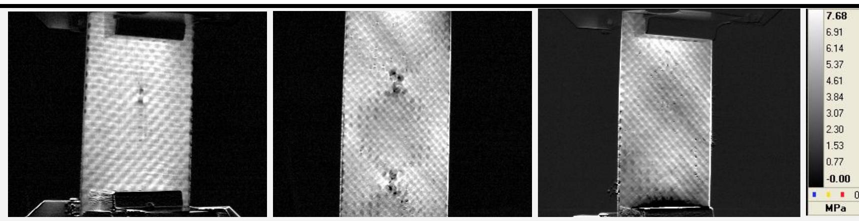

Figure 3. Stress distribution for damaged 0° fibres, damaged ±45° fibres and intact ±45° fibres specimen

The presented approach showed good correlation of damage during the impact (1st step) and damage observed by the TSA (2nd step). The TSA can be used as powerful, non destructive method for detecting the level of damage of composite structures.

References:

[1] L.M. Haldorsen. *Thermoelastic stress analysis system developed for industrial applications,* Ph.D. Thesis, University of Aalborg, Institute of mechanical engineering, 1998.

[2] L. Krstulovic-Opara, B. Klarin, Z. Domazet: A Non-Destructive Wind Turbine Blade Analysis Based on the Thermal Stress Analysis, *Proceedings of the International Symposium on Coupled Methods in Numerical Dynamics,* CMND 2009, eds.: Z. Terze, C. Lachor, 16-19 September 2009, Split, Croatia, 255-265, 2009.