CORRELATION BETWEEN SHEARING BEHAVIOUR AND SURFACE DEFORMATION

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Abstract

The safe-guarding of a wrinkle free drape of the reinforcing textiles into complex 3D geometries and the realization of the appropriate orientation of the reinforced structures are essential criteria for the design of FRP components. Therefore, the determination of the deformation behavior by reproducible experimental investigations is quite important for the realization of imperatively required material modellings and simulation processes. Significant parameters for the assessment of the deformation behavior of reinforcing textiles are the shearing behavior or the critical shearing angle, which indicates the beginning of the wrinkle formation.

The aim of the cooperation project is the upgrading of the equipment for shearing tests with an automatically detection and analysis of wrinkles.

Introduction

One of the most important requirements for the use of fiber composites at large scale production is the reproducible production of the FRP components in consistent good quality. Suitable methods for the simulation of the reinforcing textile material and the deformation process are necessary to reduce the number of prototypes and to be able to carry out the development of components in a virtual environment as long as possible. Application oriented test procedures for the determination of the simulation parameters are a fundamental requirement for a reliable prediction of the suitability of the reinforced materials and a systematic material choice.

Experimental

The automatically detection of wrinkles during the shearing test was the topic of numerous investigations. Some methods of the image processing are examined concerning its suitability and implemented in shearing test equipment.

The optical scanning technique consists of a line laser, which illuminates the test material perpendicular to the specimen surface (Fig. 1). Furthermore a Basler acA-14um industrial camera is positioned in an angle between the specimen plane and the line laser plane. A Basler SDK based software records the pictures of the lighted surface. An OpenCV aided picture processing method produces the lighted cross section pixels of the deformed material surface in every video frame.

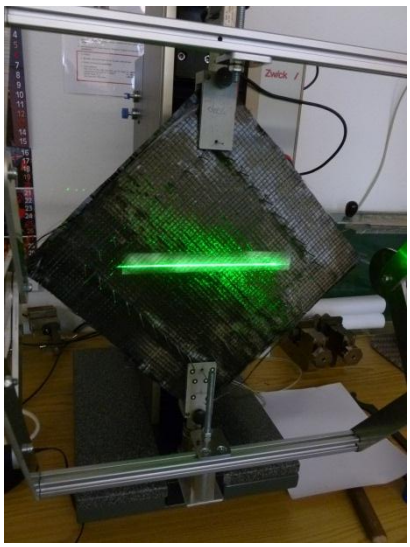

Figure 1: Shearing test equipment with the optical device for the acquisition of surface deformation

Results

After the calibration process and the interpolation of the changing of the real geometry, the lighted cross section curve is recorded as a time function. This information is synchronised with the shearing force/shearing angle measurement (Fig. 2).

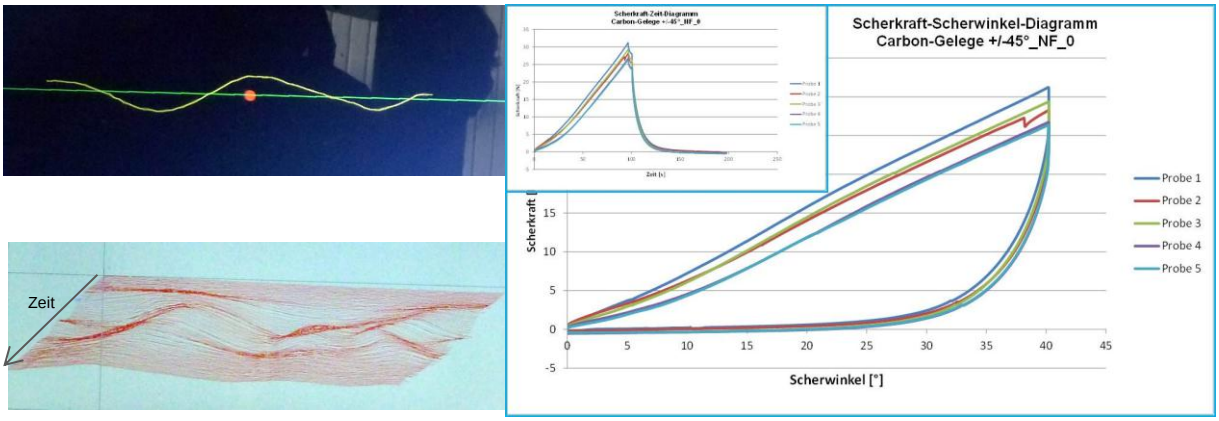

Figure 2: Graphical analysis of surface deformation and synchronisation with the shearing test

Summary

Through the development of hardware and software for acquisition and graphical analysis of surface deformation, it is possible to detect the distortions of the test sample and to assign automatically the shear angle/shear curves to determine the critical shear angle in an objective manner. It can be later used in solutions for kinematic simulations for the preforming of composite parts.

Acknowledgements

This work is part of a project carried out in the frame of the scientific and technological cooperation agreement between the Bundesministerium für Bildung und Forschung (BMBF, Germany, project executing organisation DLR) and the National Research, Development and Innovation Office (NKFIH Hungary, TÉT_12_DE-1-2013-0006, OTKA K100949 and PD116122), whom we thank for this opportunity and support.

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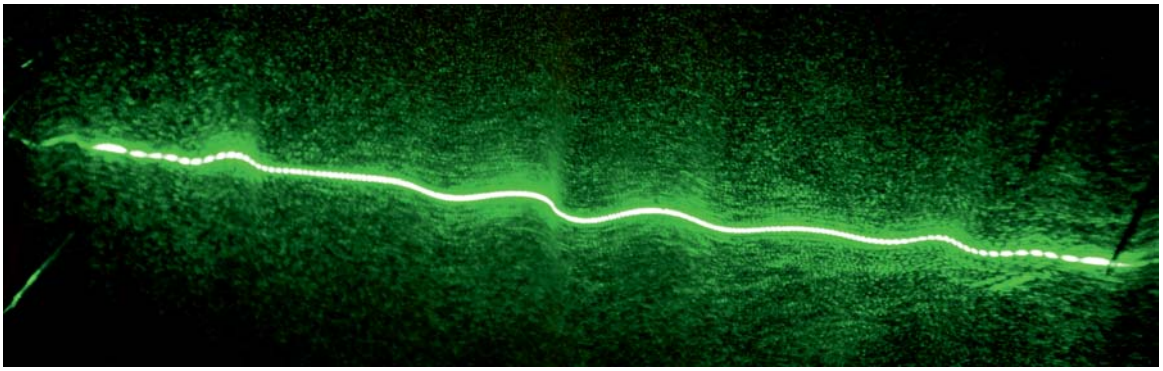
OPTICAL DETECTION OF SHEARING DEFORMATION

KORRELATION ZWISCHEN DEM SCHERVERHALTEN UND DER OBERFLÄCHENDEFORMATION



Laser line on the surface of carbon fabric

EN

OBJECTIVE

The safe-guarding of a wrinkle free drape of the reinforcing textiles into complex 3D geometries is an essential criteria for the design of FRP components. Significant parameters for the assessment of the deformation behavior of reinforcing textiles are the shearing behavior or the critical shearing angle, which indicates the beginning of the wrinkle formation.

The aim of the cooperation project is a upgrading of the equipment for shearing test with a automatically detection and analysis of wrinkles.

METHODS/RESULTS

The research project encloses the following key aspects:

- Examination of methods of the image processing concerning its suitability for carbon- or glasfiber reinforced fabrics,
- Development of the hardware implemented in shearing test equipment for determination of the surface deformation and
- Development of the software for the acquisition and graphical analysis of surface deformation.

To detect the distortions (critical shearing angle) of the test sample, the shear curve and the surface deformation are assigned.

The critical shear angle can be later used in solutions for kinematic simulations for the preforming of composite parts.

DE

ZIELSETZUNG

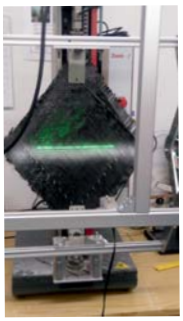
Die Sicherung einer faltenfreien Verformung textiler Verstärkungshalbzeuge zu stark gekrümmten räumlichen Konturen ist ein wesentliches Kriterium bei der Auslegung von FKV-Bauteilen. Eine signifikante Kenngröße zur Beurteilung des Verformungsvermögens ist das Scherverhalten bzw. der kritische Scherwinkel, mit dem der Beginn der Faltenbildung angezeigt wird.
Ziel des Kooperationsvorhabens ist die Erweiterung des Scherversuchsstandes um eine automatische Detektion und Auswertung der Oberflächen-deformation.

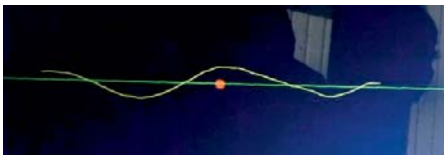
METHODEN/ERGEBNISSE

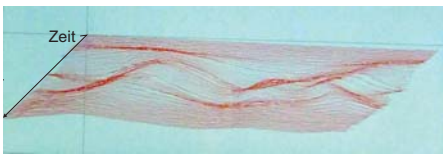
Die Forschungsarbeiten umfassen folgende Scherpunkte:

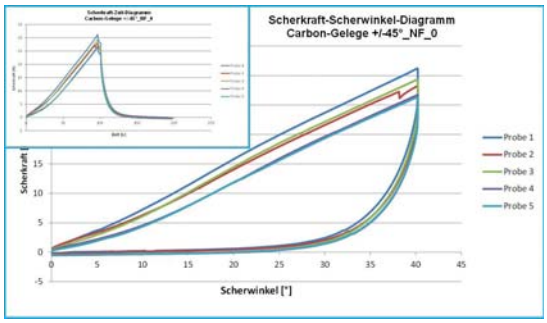
- Untersuchung von Methoden der Bildverarbeitung hinsichtlich ihrer Eignung für carbonfaser- bzw. glasfaserverstärkte Kunststoffe,
- Entwicklung der Hardware zur Adaption an die bestehende Prüfvorrichtung zur Ermittlung der Scherdeformation,
- Entwicklung der Software zur Erfassung und grafischen Auswertung der Oberflächendeformation und
- Kopplung der mechanischen und optischen Messergebnisse zur automatischen Bestimmung des kritischen Scherwinkels.

Der kritische Scherwinkel kann dann in kinematischen Simulationslösungen zur Zuschnittgenerierung verwendet werden.









Shearing test equipment with the optical device for the acquisition and graphical analysis of surface deformation

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