Kaunas University of Technology | Vilnius University | Klaipeda University

BALTIC POLYMER SYMPOSIUM 2016

Programme and Abstracts

Klaipeda, Lithuania
September 21–24, 2016

KAUNAS UNIVERSITY OF TECHNOLOGY

VILNIUS UNIVERSITY

KLAIPEDA UNIVERSITY

Baltic Polymer Symposium 2016

KLAIPEDA

September 21-24, 2016

PROGRAMME AND ABSTRACTS

MODELING FATIGUE OF CARBON FIBER COMPOSITES UNDER TENSILE LOADS

K. Lasn, N.P. Vedvik, A.T. Echtermeyer

Department of Engineering Design and Materials, Norwegian University of Science and Technology, Trondheim, Norway, kaspar.lasn@ntnu.no

Carbon fiber composites are utilized in various applications and in some cases, such as composite overwrapped pressure vessels (COPVs), the sustained and cyclic loading are predominantly tensile. The COPVs may be exposed to low-velocity impact damage reducing their short and long-term residual strength. Currently, no modeling approach for assessing the long-term performance of damaged COPVs under cyclic loads has become universally accepted by the community. In this work, a finite element (FE) based analysis is proposed for modeling the reduced fatigue life prognosis after impact. The fatigue modeling aspect is focused on, damage is simply represented by notches or holes.

The ply-level failure of composites in tension consists of fiber failure, delamination and matrix cracking as the main failure mechanisms. The implemented fatigue analysis considers two mechanisms: fiber tensile failure (FTF) and delamination (DL) between layers of different fiber orientation. A state of saturated matrix cracking is assumed to be initially present in the composite, a realistic assumption for highly loaded structures, such as COPVs after the factory testing.

The FE analysis and the general program logic is implemented by using Abaqus software and its Python-based Scripting Interface. When modeling fatigue, the stiffness degradation occurs in discrete steps for individual elements, as the remaining life becomes zero. The remaining fatigue life is calculated by a Miner sum and by relevant SN-curves for FTF and DL mechanisms. The damage growth and the final failure are simulated under force controlled tensile fatigue for a simple tensile specimen, a notched and a central-hole specimen. The current study looks into the behavior of tensile laminate specimens, preceding later investigations with a specific focus on the COPVs.

Acknowledgements
The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant agreement n° 621194, http://www.hypactor.eu/.