

Development of construction catalog for appropriate design of fiber reinforced Polymers

Viktoriia Butenko, Markus Spadinger, Albert Albers

Institute of Product Engineering

Karlsruhe Institute of Technology

Karlsruhe, 76133, Germany

viktoriia.butenko@kit.edu, markus.spadinger@kit.edu, albert.albers@kit.edu

Abstract

Fiber reinforced plastics have a wide application in automotive and aerospace industry due to their good mechanical properties, low density and high lightweight construction potential. Due to the complicated interdependencies between the reinforcing fibers, the matrix, the geometry, the manufacturing process control and the resulting mechanical properties, it is a challenge for product developer to find a suitable design. Guidelines described in the literature only provide general information and do not take account of the given complexity.

The aim of the presented work is to develop a construction catalog for the design of fiber reinforced composites to support the product developers.

For this investigation 10 geometrically different plate shaped finite element models with 12 bending load cases have been built in the CAE environment Abaqus. The models consists of two domains. A lower area, which represents the flat bending plate and is set as non-design space. The upper area is defined as the design space for the topology optimization. Each of the 120 analysis models have been topology optimized using an optimality criteria based approach, implemented in the commercial tool Tosca. Based on the optimization results, appropriate designs under consideration of the fiber orientations, manufacturing process control and matrix material were develop.

The results were discussed with experts and specific guidelines documented in the construction catalog.

Keywords

reinforced polymers, optimization, construction catalog, design guidelines

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Biography

Viktoriia Butenko is currently a research associate at the Institute of Product Engineering in Karlsruhe, Germany. Ms. Butenko holds a Bachelor and Master of Science degree in Mechanical Engineering from Charkiw Polytechnical University of Ukraine. And a second Master of Science degree in Product Development from Technical College in Pforzheim, Germany. Since 2013 she is working as research associate and does research on the subject “Design guidelines for fiber reinforced composite polymers”.

Dipl.-Ing. Markus Spadinger, born in 1987 in Villingen-Schwenningen, studied mechanical engineering at the Karlsruhe Institute of Technology (KIT) from 2007 to 2013. Since 2013 he is doctoral researcher at the IPEK – Institute of Product Engineering at the Karlsruhe Institute of Technology (KIT) and working at the research group CAE/Optimization. His research areas are optimization methods for long-fiber reinforced polymers, resource efficiency within the RTM-Process and Lightweight Design.

Prof. Dr.-Ing. Dr. h. c. Albert Albers, born in 1957 in Papenburg/Ems, has been head of the IPEK – Institute of Product Engineering since 1996.

After his studies of mechanical engineering at the University of Hannover from 1978 to 1983, Prof. Albers had a assistantship at the Institute of Machine Elements and Engineering Design under Professor Paland and obtained his doctorate in 1987 with honors (summa cum laude). From 1986 to 1988 Prof. Albers had a position as a senior engineer at the Institute of Machine Elements and Engineering Design at the University of Hannover until he changed his employer in 1987 and started his career in industry at LuK, a company of the Schaeffler-Group with focus on clutch- and gear-systems. Before returning to academia in 1996, Prof. Albers was product development manager, responsible for clutch-systems and member of the executive board.

Since 1996 Prof. Albers is head of the IPEK (the former Institute of mechanical design) at the Karlsruhe Institute of Technology (KIT) and established the research fields drive systems, design-methods and -management as well as mechatronics.