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Research area: Product aims

Paper, paperboard and board // Technical specialty papers

Key words:

Papery material, folded and honeycomb sandwich cores, buckling resistance, simulation

TITLE:

Analysis and simulation of mechanical properties for the development of adapted papery materials for folded and honeycomb sandwich cores

Background/Problem area

Sandwich designs are particularly suitable for structural applications requiring high bending stiffness in combination with low weight. Sandwich designs are used in the aerospace and automotive, machine construction and engineering or building sectors, among others.

Sandwich structures are usually comprised of two thin, very stiff and strong top or outer layers surrounding a thick, comparatively low-weight and soft middle layer, the so-called sandwich core. The latter may be made of quasi-homogeneous materials (e.g. wood, foam) or discrete supporting structures (e.g. honeycomb or fold cores). Compared to honeycomb cores, homogeneous cores provide lower mechanical weight-related strength levels. Owing to their structural potential, honeycomb and folded cores are thus at the forefront of attention. The most frequent defect when using folded cores under compressive or shear loads acting vertically to the core midplane is the buckling of individual core walls. Due to the materials used, the wall thickness of folded cores is small compared to their other dimensions. This results in a low buckling resistance of the core walls, which makes buckling the main failure type of folded cores. To be able to optimise the buckling resistance of folded cores made of papery materials, the corresponding systematic, theoretical and metrological knowledge needs to be improved.

Objectives/Research results

The aim of the project is to develop a suitable papery material and complement the systematic/theoretical and metrological fundamentals needed for characterising the mechanical properties of paper and papery materials for applications in the field of lightweight construction. This is intended to fill major gaps in the present knowledge about the design, manufacturing and converting processes involved and to provide the basis for the load- and application-specific selection, manufacture, simulation and adaptation of paper materials for lightweight sandwich cores.

One part of this project is devoted to developing adapted papery materials for core structures, the non-combustibility on the one hand and the mechanical properties on the other hand being the focus for improving the buckling resistance of the core structure as far as the requirements are concerned. Initial material options were produced on a laboratory scale in a pulp screening. In addition to the type of pulps, fillers were also used to influence the micro structure (expand the volume) and thus bending stiffness. Trials for producing a multi-layer material were successfully conducted.

In order to compare the material and potential core properties of these papery materials, novel and enhanced testing devices as well as enhanced constitutive law for numerical simulation have been suggested. It was possible to determine the mechanical parameters and forecast the mechanical behaviour of sandwich cores made of the new materials. By means of these methods, the best material was identified and optimized based on a three layer paper.

Application/Economic benefits

A papery core material with improved mechanical properties will enable many new applications, being suitable for a multitude of innovative products in the field of lightweight sandwich structures. The new or improved measurement methods developed in the project will be the basis for further application-oriented developments. The material model developed by means of the experimental results will significantly enhance the accuracy of numerical simulation models for the behaviour of sandwich structures comprising innovative cores. The simulation methods will enable their potential users to design new innovative structures and products much faster and, because of the reduced need for expensive experimental studies, at lower cost. The project results will help reduce the development and manufacturing times for products based on sandwich design and innovative core structures. The findings will be used to derive recommendations for improving the manufacture and economic efficiency of these products, thus increasing the competitiveness of SME in the specialty paper and paper converting sectors and of companies using the new core materials.

Project period: 01.06.2014 – 30.09.2016

Remarks

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