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MODELING THE CREASING PROCESS OF PAPERBOARD

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Laminated paperboard is widely used in packaging products. It usually consists of multiple layers bonded to each other by starch or adhesive materials, each of which is composed of a network of bonded fibers. To obtain the commercial cartons with high quality, the manufacture of fold lines (creasing) plays a crucial role during the whole converting processes. A good crease is to introduce damage in the paperboard to locally reduce its bending stiffness and to prevent the board from breaking during the following folding processes [1]. However, the breaking of the top layer is a frequent problem, especially for high grammage layer, and systematic studies of the phenomena underlying creasing are scare [2]. Therefore, the aim of this study is to introduce material models for layers and interfaces of paperboard respectively, which take into account the delamination and damage behavior of paperboard during the creasing process. For this, both experimental and numerical investigations are needed.

Each layer of the considered paperboard has three principal directions, namely, the machine direction (MD), the cross direction (CD) and the out-of-plane direction (ZD). Hence, in-plane tensile tests in MD, CD and at angle of 45°, as well as out-of-plane compression and shear tests were conducted to obtain its in-plane and out-of-plane deformation characteristics respectively. Based on the observed behavior, each layer of paperboard could, by combining the in-plane and out-of-plane models, be described as a three-dimensional anisotropic material. Thus, an orthotropic elastoplastic constitutive model was adopted to describe the mechanical behavior.

In addition, double cantilever beam (DCB) and shear tests were carried out to establish the interface properties. These were needed to adjust the cohesive zone model used in the computation. Based on that, a delamination modeling was employed to capture the opening behavior of interface in paperboard deformation process.

Finally, applying the mentioned models for each layer and interface, a 2D finite element model was employed to predict the paperboard's response in its creasing process. The model was validated by use of force-displacement curve during the performed creasing in laboratory setup.

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