

Abstract

In recent years, corrugated board production technologies and methods of its testing and modeling have been developing rapidly, with an increasing emphasis on ecological aspects. Corrugated board, as a biodegradable material derived from renewable sources, plays a key role in the efforts to reduce the use of plastic in the packaging industry. At the same time, the development of numerical methods allows for a more accurate analysis of the behavior of cardboard in various operating conditions, enabling more optimal design of packaging with increased durability and resistance to external factors. The recyclable structure of cardboard and its ability to be repeatedly processed without significant loss of mechanical properties make this material one of the most sustainable solutions in the packaging industry, responding to the needs of the ecological packaging market of the future. For this reason, the ability to analyze and predict the impact of various factors on the mechanical parameters of corrugated board has become crucial.

The aim of this doctoral dissertation was to develop a comprehensive characterization of the impact of technological and operational factors on the mechanical properties of corrugated board. The conducted research included an analysis of the effect of creasing on the key mechanical properties of cardboard, utilizing both experimental studies and numerical simulations. The consequences of creasing and perforation, which can significantly weaken the stiffness and strength of the material, were determined. Additionally, a methodology was developed to assess the effect of geometric imperfections on cardboard properties using numerical homogenization. The dissertation also provides a detailed analysis of the effect of humidity and temperature on the degradation of mechanical properties of corrugated cardboard in various thermal and humidity conditions.

The conducted research confirmed that technological and operational factors lead to significant changes in the strength parameters of corrugated cardboard. The obtained results can be the basis for optimizing production and operational processes, and also contribute to improving the durability and efficiency of using cardboard packaging in various environmental conditions.

Keywords: corrugated cardboard, numerical homogenization, finite element method, technological factors, environmental conditions

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