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Lightweight Structural Composites from Fibre-based Materials

Introduction

A grand challenge for the forest products industry is to create a new product platform that will enable the industry's true transformation. Our proposal is *light-weight structural composites*, particularly used for automobiles, trains, boats, wheel chairs, and bicycles, which require energy efficiency and environmental friendliness. Fibre is an ideal material for this purpose, and has been used for corrugated board for many years, and most recently for honeycomb sandwiches. However, product designers don't consider our fibres as "reliable" or "durable" for structural applications. These properties are most important in end-use, and the failure of properly evaluating them results in serious consequence (Fig. 1).

Objectives

Our project aims at developing lightweight, structural composites from fibre-based materials. For this purpose we develop scientific understandings of durability and reliability, and establish rational design criteria for these properties.

Fig. 1. A 30-tonne block of concrete suddenly fell out of the newly built bridge in Sundsvall in August 2015. http://www.svt.se/nyheter/regionalt/vasternorrland/bropelare-rasade-over-bil

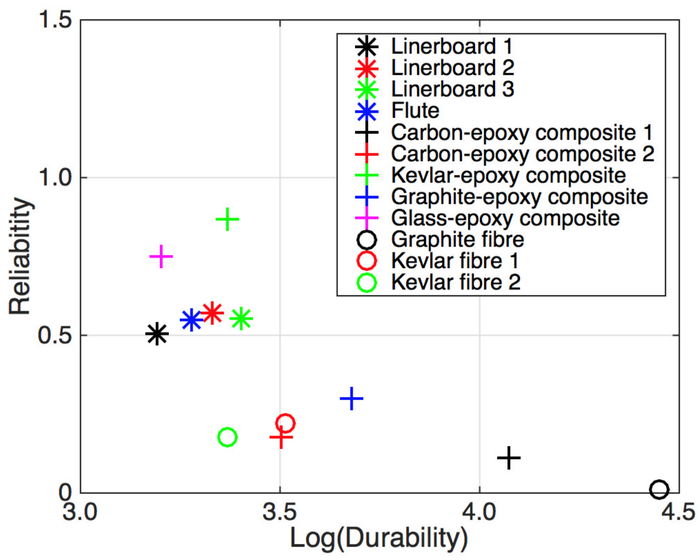

Fig. 2. Durability and reliability parameters for three linerboards and one flute compared with other fibre materials. Higher values for reliability, and durability means ”more reliable” and ”more durable” respectively.

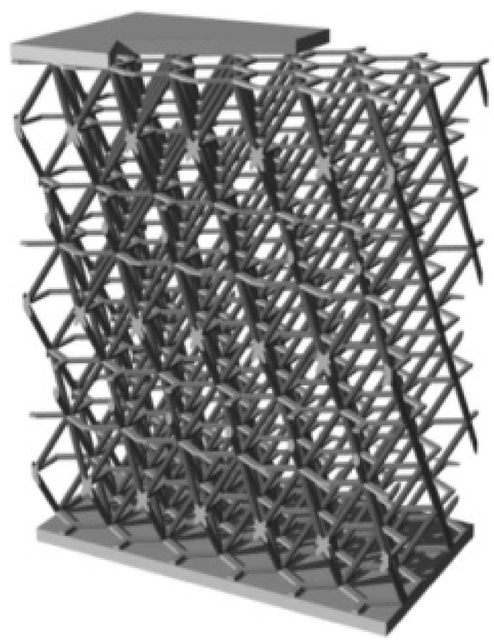

Fig. 3. Truss sandwich. http://www.google.com/patents/US7424967

Approach

We have developed systematic methods for evaluating the performance parameters (durability and reliability) by using time-dependent, stochastic failure theories. We performed Monte Carlo simulations of fibre network failures to understand how the fibre properties and network structures affect reliability and durability, experimentally determined these properties, and finally benchmarked with data for other fibre materials.

Results

In Fig. 2, the durability and reliability parameters for three linerboards and one flute are compared with more advanced fibre materials. The results indicate that our fibre networks are actually one of the most promising materials for lightweight composites. Our goal is to apply those fibre networks to even lighter structures, ”super-lightweight composites” (e.g., truss sandwich, Fig. 3).

References

A. Mattsson and T. Uesaka, *Time-dependent Statistical Failure of Fiber Network*, submitted to Physical Review E

A. Mattsson and T. Uesaka, *Time-dependent, statistical failure of paperboard in compression*, in Advances in pulp and paper research, Cambridge 2013

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