APPLICATION OF MOULDED WOODEN TUBES AS STRUCTURAL ELEMENTS

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ABSTRACT: Thermo-hygro-mechanical processes can be used to densify and to form wood [1]. This ability was applied to produce wooden tubes of structural size by shaping of plates, which were densified previously perpendicular to the grain [2]. The process steps are shown schematically in Fig. 1. The tubes have several advantages compared to structural elements with compact cross sections. Due to the larger moments of inertia, a higher load-bearing capacity for bending and buckling with a given amount of material can be reached. Furthermore, the low thickness of the tube walls allows employing small-sized tree sections, which are currently used only energetically or for fibre production. Thus, production of these tubes might increase the added value of the forests.

KEYWORDS: moulding, densification, technical profiles, textile structure, wind power plants

1 PRINCIPLES
Since the first ideas for producing moulded wooden tubes, about ten years ago [3], a considerable number of investigations was carried out to develop applicable processes, at first, and to determine the load-bearing behaviour and ecologic impact, afterwards.

These investigations are summarised in this contribution. The first presented aspect is the thermo-hygro-mechanical production process and its parameters in terms of applied temperatures, humidities and forces. The load-bearing behaviour was determined experimentally in a detailed manner for the case of axial compression. It is shown how the already substantial load-bearing capacity of plain tubes can be efficiently increased by application of confining fibre reinforcement on the outer surface. The reinforcement was based on epoxy resin and technical fibres where glass and carbon fibres were tested.

Moreover, first tests regarding the behaviour of fibre-reinforced tubes subjected to bending, torsion and inner pressure were performed. For construction purposes, also durability and connection techniques are important, which were investigated, as well. For structural design of the tubes, static verifications are necessary. First approaches are developed.

The ecologic impact of building materials becomes increasingly important. Although, wood is considered, in general, as an environmentally friendly material, the thermo-hygro-mechanical processes involved for the production of the tubes and the reinforcing layers require an additional amount of energy compared to plain wood. On the other hand, the tubes need for a given load-bearing capacity less material compared to compact structural elements. To estimate the ecologic impact, environmental performance analyses were carried out. The performance of the reinforced tubes was evaluated in terms of energy consumption, CO₂ and SO₂ release, and it was compared to other prominent building materials namely steel and reinforced concrete.

2 CONCLUSIONS
Moulded wooden tubes have various fields of application, for instance structural elements like columns and transport elements like industrial water lines. A first application, which was recently taken in service, is the shaft of a wind power plant with a height of 9 m.

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Figure 1: Processes for producing moulded wooden tubes [4]

REFERENCES


