Added-value for wood bark as a coating layer for flooring tiles

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Abstract

Worldwide more than 50% of the bark amount is used for energy generation. In this research, physico-mechanical and surface properties of flooring tiles coated with thin layers of larch bark were presented for the first time. Two types of adhesives were involved to bond the bark particles, namely polyurethane and a formaldehyde-free tannin-hexamine resin.

Larch (Larix decidua Mill.) bark was used to produce layers with 3 mm thickness at three levels of density, from 0.6 to 0.8 g/cm³, to coat standard high density fiberboard (HDF) as core material. Mechanical and physical properties of the specimens including surface soundness, Brinell hardness, dimensional stability, abrasion resistance, cross-cut test, resistance to chemicals and fire resistance of the bark coated panels were determined and compared with the properties of industrial multilayered boards with granulated cork as wear layer. Overall, excepting the Brinell hardness, all the properties of the boards produced with wear layer made of larch bark were lower compared to cork-based coated control. Surface soundness of panels with larch wear layer was 30% or 60% lower compared to control. Both thickness swelling and water absorption after 24 h of the panels were too high. Neither polyurethane nor formaldehyde-free tannin adhesive influenced better the panel’s properties. Surface properties were similar to control. Although mechanical properties of the samples considered in this work were inferior to those of typical flooring material coated with cork layer, it can be stated that such a little used material like bark may have a useful potential as a value-added product for such application.

1. Introduction

Worldwide more than 50% of the bark amount is used for energy generation (Barbu, 2011). Tree bark is a by-product of the wood processing industry. The percentage of bark from a harvested tree ranges between 10 and 20%, based on species, age and diameter (Pasztory and Ronyecz, 2013).

High Density Fiberboard (HDF) based laminated flooring panels have been used for the last several decades and they are getting more popular as a substitute of solid wood flooring due to their higher performances, decorative variety and environmentally friendly attributes. Surface of laminated flooring is usually coated with impregnated decorative paper (e.g. melamine formaldehyde), with cork and other products (Paulitsch and Barbu, 2015). Bark as an alternative and little used resource can be also considered as coating material in laminated flooring manufacture (Tudor, 2014). Burning the bark to produce heat and using the mulch for land filling still does not ensure effective utilization of this natural resource (Barbu, 2011). There are some studies where bark was used as a filler in wood composites manufacture (Einspahr and Harder, 1975; Trittov et al., 2006; Dix and Marutzky, 1984; Link et al., 2013), insulation panels (Kain, 2013; Kain et al., 2014), and for pallets manufacture and an energy source (Heinzmann and Barbu, 2013; Wollenberg and Warnecke, 2004).

It is a fact that bark is considered as an underutilized material (Kain, 2013). Therefore, this study purpose was to use the bark as a coating layer in the manufacture of flooring panels, as an added-value product also in terms of sustainability and cascading use of wood (Mantau et al., 2010; Krauhausen, 2013).
Larch (Larix decidua Mill.) is one of the common species in Austria having 6.6% share of all forest resources. Approximately 1 million m³ larch wood is used per year in this country (Schadauer and Lackner, 2011). The larch bark has a share up to 25% on stem volume, which is a much higher amount than those of other species (Sachsse, 1979). Considering that in the Salzburg area there is a large bark production, such resource was used in this work to produce flooring material so that specific under-utilized waste material can be converted into panel products (Tudor, 2014; Wolpers, 2015).

The larch bark contains many different types of extractives among 12% are tannin, 4% methoxyl, 3% resin, 13% arabinogalactan and 35% sugar (Sachsse, 1979; Pelz, 2002). Although most of the properties of larch bark have been studied, there is a very little or no information about using it in flooring panels production as substitute of cork (Tudor, 2014). Therefore, this study attempts to use larch bark as coating layer in flooring HDF based panel products so that such under-utilized resource can be converted into a value-added product.

2. Materials and methods

Larch (Larix decidua Mill.) was supplied from the Graggaber Company, which is a local sawmill in Salzburg County, Austria. Bark was reduced into particles in a four-spindle shredder (RS40) at Untha Company in Kuchl (Austria) and successively screened with different sieves in order to obtain 3–6 mm particles. The coarse particles (>6 mm) were used for insulation panel manufacture (Kain et al., 2014). The raw material was dried in a Bruner-Hildebrand High VAC-S, HV-S1 oven to reduce its moisture content to 9%. Samples of 100 g dried material were used to analyze particle size distribution on shaker-type sieve (Fig. 1).

The particles were blended manually with 10% polyurethane based adhesive Epotal P100 Eco, supplied by BASF Co. (compostable according to EN 13432, 2000), for 3 min to ensure a homogenous mixture. Adhesive solid content, pH level and viscosity are 40%, 8 and 40 mPas, respectively.

Tannin extract powder - Mimosa tannin (Mimosa - Acacia mearnsii) from Silva Chimica (Italy, www.silvateam.com), hexamethyleneetetramine (hexamine) from Merck Schuchardt OHG (C99%) and sodium hydroxide solution (C32%) from Carl Roth GmbH & Co were used to prepare the tannin based adhesive. 50% tannin extract powder and 50% water were mixed with a mechanical mixer at variable speed between 700 and 1500 rpm. 10% of hexamine was added to adjust the pH of the mixed solution to 9 with sodium hydroxide solution. The larch particles were also blended with 10% of this formaldehyde-free tannin based adhesive in order to obtain the 3 mm wear layer.

The mixtures (particles and adhesive) were manually laid on a frame having 500 mm by 500 mm cross section before the mats were preprocessed. Each mat was compressed in a computer controlled press, Hofer HLOP 280, at a temperature of 80 °C for 5 min to obtain a thickness of 3 mm. A total of 18 panels, three for each density levels (0.5, 0.6 and 0.7 g/cm³) were manufactured for the experiments (Table 1).

Fig. 1. Screen analysis of the larch bark particles.
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