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ARAŞTIRMA MAKALESİ RESEARCH PAPER

Effects of Pressing Time on Some Technological Properties of Laminated Veneer Lumber (LVL) Produced Using Polythene Waste as Adhesive

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Abstract: It is desired the wood composite materials which have broaden using areas in human residence have no negative effects on human health and environment. But because of formaldehyde content of most of resins used in wood based composite production, wood composite materials have been seen a threat on human health and environment. Therefore, numerous studies have been made to develop an effective method to decrease formaldehyde emission from the wood based panels and various methods have been tried.

The aim of the study was to investigate those effects of pressing time on some technological properties of polythene composite LVL. Poplar (*Populus deltoides*) veneers were used to produce polythene composite LVL. Three different pressing time (8, 10, 12 minutes) and pressing temperature 140 °C were chosen as press parameters in the manufacturing of polythene composite LVL. Bonding strength, bending strength, modulus of elasticity, density and equilibrium moisture content of polythene composite LVL panels were determined according to TS EN 314-1, TS EN 310, TS EN 323 and TS EN 322, respectively. The experimental results showed that technological properties of panels generally increased with decreasing pressing time.

Keywords: Polythene composite LVL, pressing time, technological properties.

Presleme Süresinin Yapıştırıcı Olarak Polietilen Atık Kullanılarak Üretilen Lamine Kaplama Kerestenin (LVL) Bazı Teknolojik Özellikleri Üzerine Etkisi

Öz: Yaşam alanlarındaki kullanımı genişleyen ahşap kompozit malzemelerin, insan sağlığı ve çevre üzerinde olumsuz bir etkisinin olmaması istenmektedir. Ancak odun esaslı kompozit üretiminde kullanılan tutkalların çoğunun formaldehit içeriği nedeniyle, odun kompozit malzemelerinin insan sağlığı ve çevre üzerinde bir tehdit oluşturduğu görülmüştür. Bu nedenle, ahşap esaslı panellerden formaldehit emisyonunu azaltmak için, etkili bir yöntem geliştirme amacıyla çok sayıda çalışma yapılmış ve çeşitli yöntemler denenmiştir.

Bu çalışmanın amacı, presleme süresinin polietilen kompozit LVL'nin bazı teknolojik özellikleri üzerindeki etkilerini araştırmaktır. Polietilen kompozit LVL üretmek için Kavak (*Populus deltoides*) kaplamaları kullanılmıştır. Polietilen kompozit LVL imalatında pres parametreleri olarak üç farklı presleme süresi (8, 10, 12 dakika) ve presleme sıcaklığı 140 °C seçilmiştir. Polietilen kompozit LVL panellerin yapışma dayanımı, eğilme dayanımı, elastikiyet modülü, yoğunluk ve denge rutubet miktarı sırasıyla TS EN 314-1, TS EN 310, TS EN 323 ve TS EN 322'ye göre belirlenmiştir. Deneysel sonuçlar panellerin teknolojik özelliklerinin genellikle presleme süresinin azalmasıyla arttığını göstermiştir.

Anahtar sözcükler: Polietilen kompozit LVL, presleme zamanı, teknolojik özellikler.

INTRODUCTION

Wood has characteristics that make it suitable for many uses. Laminated veneer lumber (LVL) is manufactured from veneers with equal or different thicknesses or wood species glued together, ensuring that grains are glued parallel (Gaff and Gašparík, 2015;Shukla and Kamdem, 2009). LVL panels are of great structural use due to their high mechanical strength, great dimensional stability and ability to receive preservative treatment (Kamala et al., 1999). It has potential for use in structural and nonstructural applications such as in the construction and furniture industries, as a material for flooring, as structural beams, headers, columns and in both residential and commercial applications and numerous interior and exterior application areas (Burdurlu et al., 2007; Souza et al., 2011; Melo and Menezzi, 2014).

LVL may be one of the most important solutions concerning raw material economy. It is also one of the well-known and commercially produced engineered wood products (EWPs) in the forest products market in North America and Europe. LVLs can be used for structural and non-structural purposes due to their high strength, dimensional stability, consistency, and treatability (Nelson, 1997).

Importance of wood based materials gradually increases due to growing demand to wood materials and existence and decreasing quality of raw materials. Therefore, use of adhesive extensively increases and use of raw material source develops in forest product industry. It is stated that adhesives used in about 70% of application in woodworking industry (Aydin et al., 2010). At present, urea formaldehyde and phenolic resins are the adhesives used mainly in plywood production and account for 87.1% and 9.6% of all adhesives used in plywood manufacture, respectively, in 2004 (Qian, 2006). Urea formaldehyde resin is non-flammable and resistant to changes in high temperature, light and corrosion. It has good adhesive strength is, a short curing time, simple production technology and low production costs. But it also has a number of disadvantages, such as a high curing shrinkage ratio, a brittle colloidal property, weak water resistance and formaldehyde emission. Phenolic resins are able to enhance bonding strength and water resistance, but they require a long curing time, high curing temperatures, and have high production costs and emit formaldehyde and phenol (Cui et al., 2010). Formaldehyde release depended on content of release causes adverse health effects such as eye and respiratory irritation, irritability, inability to concentrate and sleepiness (Colak and Colakoglu, 2004). Also, The International Agency for Research on Cancer (IARC) in 1995 attached to formaldehyde in terms of human health "Possible Carcinogenic Substances" class and the ratio of formaldehyde can release from wood based materials was limited in most of country (IARC, 2004; Colakoglu, 1993). After this area investigated comprehensively, IARC in June 2004 removed formaldehyde from "Possible Carcinogenic Substances" class and identified as an agent caused directly carcinogen for human (Jianying et al., 2010). It is started to prefer alternative adhesives or using formaldehyde scavenger prevented formaldehyde release in industry due to this disadvantage of formaldehyde based resins. Although some of these new adhesives have already been used in industrial applications, their supply is limited which may be due to the high modification costs or some their poor properties, for example, low wood resistance (Fang et al., 2013). Therefore, the chemicals and adhesives used are both cheap and easily accessible and its technological properties qualify according to usage of wood based panels (Colak et al., 2016).

Solid waste composition varies with changing consumption habits in Turkey, population growth, rising living standards, the increase in packaged product sales. Overall, 20% by weight and 50% by volume of the waste consists of packaging waste is formed (Official Gazette, 2014). Recycle of polythene constitutes an important part of packaging waste is gained importance due to both dissolution of nature for a long time and harmful gases are released by burning into the atmosphere (Colak et al., 2016). In literature, it was shown that the wood based panels obtain from using plastic and textile fiber waste are petrochemical materials as an adhesive gave successful results (Cui et al., 2010; Kajaks et al., 2012; Kofi, 2014). From there, it is thought that the polythene constitutes a serious waste of potential for our country and is a petrochemical is evaluated in LVL industry.

MATERIAL and METHODS

Poplar logs were selected in the study. The LVLs used in this study were manufactured using rotary peeled veneers. Logs were not steamed or boiled prior to peeling. Rotary peeled veneers clipped into 500 mm long by 500 mm wide by 2 mm thickness and shipped to a manufacturing site. The veneers were pre-selected for strength and appearance. They were conditioned in an environmentally controlled room in relative humidity of 65 ± 5% and a temperature of 20 ± 2 °C until they reached the equilibrium moisture content of 12%.

The veneers were then dried to 6-8% moisture content with a veneer dryer. After drying, it was formed polythene composite LVL panel drafts. The draft of polythene composite LVL is shown in Figure 1.

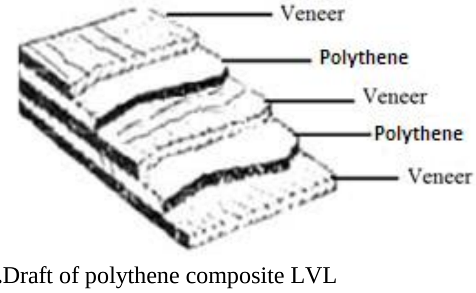

Figure 1. Draft of polythene composite LVL

Three-ply-LVL panels with 6 mm thick were manufactured by polythene wastes. The polythene wastes were lay outed at rates of 160 g/m^2 to the single surface of veneer. Hot press pressure was 8 kg/cm^2 for poplar while hot pressing time and temperature were 8, 10, 12 minute and 140°C, respectively. Two replicate panels were manufactured for each test groups.

Table 1. Press parameters.

GROUP	Bonding Types	Pressing Time (m)	Press Pressure (kg/cm^2)	Press Temperature (°C)
Control	UF	6	8	110
A	Polythene	8	8	140
B	Polythene	10	8	140
C	Polythene	12	8	140

The specific gravity, shear strength, bending strength and modulus of elasticity of polythene composite LVL panels were determined according to TS EN 323-1 (1999), TS EN 314-1 (1998), and TS EN 310 (1999) standards, respectively.

RESULTS and DISCUSSION

Technological properties test results of polythene composite LVL panels according to press parameters were presented in Table 2 and Figure 2-3.

Table 2. Technological properties of polythene composite LVL panels.

Test Methods	Control (UF)	8 minutes	10 minutes	12 minutes
Bonding strength (N/mm²)	3,99 (0,42)	2.647 (0,61)	3.107 (0,25)	2.787 (0,39)
Bending Strength (N/mm²)	100,44 (17,20)	95,43 (7,05)	85,76 (8,54)	54,79 (17,76)
Modulus of Elasticity (N/mm²)	7338,01 (695,88)	6719,31 (302,49)	6095,12 (233,95)	4687,38) (772,39)
Density (gr/cm³)	0,497 (0,03)	0,495 (0,05)	0,493 (0,02)	0,499 (0,06)
Equilibrium Moisture Content (%)	6,034 (1,38)	4,825 (0,31)	4,469 (0,32)	4,966 (0,65)

*Values in parenthesis are standard deviations.

Figure 2. Effects of wood pressing time on the technological properties of panels.

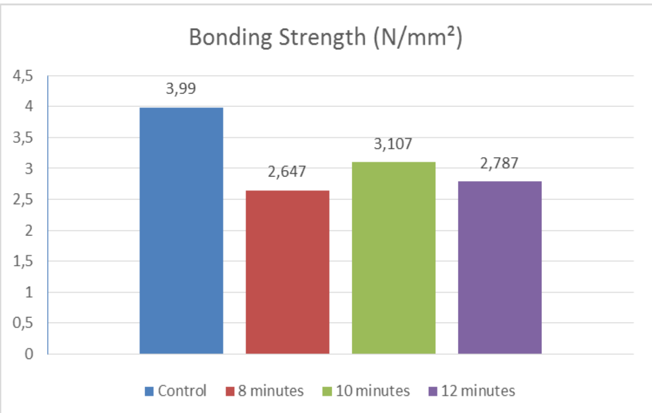

Figure 3. Effects of wood pressing time on the bonding strength of panels

The all of bonding strength values of polythene composite LVL panels were higher than 1 N/mm^2 determined according to DIN 68705-3 (2003). The bending strength and modulus of elasticity values of polythene composite LVL panels were higher than 40 and 4000 N/mm^2 determined according to DIN 68705-3 (2003), respectively. Generally, the lowest result is the C group. Colak et al. (2016) stated that molten state polythene, depend on both wood processing and wood anatomical structure, penetrates into porous structure of wood and filled cracks and cavities on surfaces, and this helps to have smoother veneer surfaces. In literature, it was stated that smooth surface veneer bonded better than rough surface veneer and so it shows better performance on mechanical properties (Frihart, 2005).

As a result; formaldehyde-free polythene composite LVL has been successfully produced using polythene waste as wood adhesive. This novel product shows considerable mechanical properties. The panels produced using 160 gr/m^2 polythene amount and 8 minute gave the best mechanical strength values. When this study applies in the LVL industry, can provide to both recycle polythene waste and prevent formaldehyde release. In addition, Polythene composite LVL waste can be used production of wood plastic composite panels.

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