SERİ / SERIES / SERIE / SÉRIE	A	CİLT / VOLUME / BAND / TOME	55	SAYI / NUMBER / HEFT / FASCICULE	2	2005

İSTANBUL ÜNİVERSİTESİ

ORMAN FAKÜLTESİ

DERGİSİ

REVIEW OF THE FACULTY OF FORESTRY, UNIVERSITY OF ISTANBUL

ZEITSCHRIFT DER FORSTLICHEN FAKULTÄT DER UNIVERSITÄT ISTANBUL

REVUE DE LA FACULTÉ FORESTIÈRE DE L'UNIVERSITÉ D'ISTANBUL

INFLUENCE OF COATING MATERIAL TYPES ON THE SOME QUALITY PROPERTIES OF PARTICLEBOARD

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Abstract

In this study, effects of surface coating materials on the resistance to the scratch (SR), abrasion (AR), cigarette burns and staining were investigated. Melamine impregnated papers (MIP), polyurethane based varnish (PV), polyurethane based lacquer paint (LP), continuous press laminates (CPL), high pressure laminates (HPL) and polyvinylchloride sheets (PVC) were used as surface coating materials for particleboard. The results showed that scratch and abrasion resistances were affected significantly overlay types. High pressure and continuous press laminates had resistant to the staining and burning and had the highest abrasion and scratch resistance values.

Keywords: Melamine paper, Laminate, Scratch resistance, Abrasion resistance

1. INTRODUCTION

Over the past several years, industrial grade particleboard and fiberboard have been recognized through the wood industry as a substrate for laminated panel constructions, utilizing various types of overlay surfacing materials. Laminates, melamine or polyester impregnated papers, wood veneers, vinyl films and heat transfer films comprise the types of overlay materials (ANONYMOUSa 1996; VANSTEENKISTE 1981). The purpose of the overlays is to suppress the absorption of water and humidity, and to eliminate the release of nocuous gas, like formaldehyde, pesticides, etc (ÖZDEMİR 1996; NEMLİ 2000). Laminated wood-based composite panels are used in office furniture, kitchen worktops, refrigerator cabinets, computer tables, shower cabinets, and external cladding .

Decorative surface papers generally weighing between 60 and 130 g/m^2. These papers are saturated with reactive resins and partially cured at the point of manufacture. Final curing is done at the time of hot press lamination when the resins form a hard crosslinked thermoset material. The paper formations similar to the sheet used for high-pressure laminates. These products are self-bonding: that is, the resin in the paper flows into the surface of the board during lamination, creating a permanent bond. For this reason, no adhesives are required (ANONYMOUS b 2001). The production of the overlays based on melamine resin-impregnated alpha cellulose paper is

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Yayın Komisyonuna Sunulduğu Tarih:25.06.2004

rapidly growing, in importance. The melamine formaldehyde resin used has modifiers added to it to enhance the elasticity of the hardened melamine resins. Other materials are added to the resin solutions, which later on improve the impregnation of the paper and helps prevent films from sticking to the platens. The melamine-impregnated papers usually contain %50-60 resin (SELLERS 1996; OH 1999).

The typical construction of a continuous laminate is melamine-impregnated, alpha cellulose overlay plus a decorative surface paper, superimposed over one or more phenolic or melamine resin impregnated papers. The laminate is formed on a continuous, double belt press at pressures of 25-50 kg/cm^2 and at temperatures between 135-150 ^{0}C. The thickness, which is determined by number of layers of kraft papers and the resulting amount of resin absorbed, is normally in the 0.79 mm range. When the sheet is pressed, a steel caul plate or a paper release sheet is used to create a surface finish ranging from high gloss smooth, to fully textured. Continuous laminates can be rolled, but only into large diameter rolls (ANONYMOUS b 2001).

Decorative laminated plastic sheets which consist of papers, fabrics or other core materials that have been laminated at pressures normally between 100-150 kg/cm^2, using thermosetting condensation resins as binders. A typical sheet of general purpose high pressure laminates (HPL) is made from a sandwich of melamine-impregnated, alpha cellulose overlay and decorative surface papers, superimposed over phenolic resin-impregnated kraft papers. The sandwich is pressed at temperatures exceeding 130 ^{0}C, at pressures as high as 125 kg/cm^2. The thickness, which is determined by number of layers of kraft papers and the resulting amount of resin absorbed, can range up to 9.50 mm. When the sheet is pressed, a steel caul plate or a paper release sheet is used to create a surface finish ranging from high gloss smooth to fully textured or embossed. HPL is made in a multitude of solid colors and printed patterns (ANONYMOUS b 2001).

An extruded or calendared thermoplastic materials, made of polyvinyl chloride (PVC), is used for decorative surfacing. Calendared PVC is manufactured in wide logs slit to size, while extruded is manufactured to exact size. PVC offers unlimited color and pattern availability, a wide range of widths, thicknesses, surface textures, and gloss level. The oriented surfaces as well as the solid colors are generally top coated with a UV cured resin for protection. PVC is mainly used for straight line and contour automatic edge banding applications. PVC is not recommended for soft form applications.

Wood veneers are flat cut, rift cut, quarter cut, etc. The veneers are sliced from 0.3-0.5 mm thin and are available plain, paper, or fleece backed in varying degrees of flexibility. The backers provide stability and strength to the veneer, and minimize splintering, cracking, and checking. The veneers may be finger or butt jointed to produce continuous coil edge banding (VANSTEENKISTE 1981; ÖZDEMİR 1996; NEMLİ 2000).

The objective of this study was to determine the changes on the surface quality properties related to the overlay types. Evaluated properties were resistances to the scratch (SR), abrasion (AR), cigarette burns and staining.

2. MATERIALS AND METHODS

Wood particles consist of approximately 50 % beech, 30 % pine and 20 % poplar were obtained from a commercial particleboard plant in Turkey and dried to 3% moisture content prior to use. For the blending; as adhesive urea formaldehyde (UF), as a hydrophobic substance 32 % paraffin solution and as a hardener 20 % of ammonium chloride solutions were used. Three-layered boards were pressed under 225 ^{0}C press temperature, 110 sec. press time and 3.5 N/mm^2

pressure and produced 280x210x1.8 cm dimensions. After pressing, particleboards were conditioned at a temperature of 20 ^{0}C and 65 % relative humidity.

Surface coating materials used in this study and their properties are given below:

1. Melamine Impregnated Papers (MIP) (Raw paperweight is 70 g/m^2)

   In the production of melamine impregnated papers, alpha cellulose based decorative papers were impregnated with melamine and urea formaldehyde adhesives with 55 % solid content. Melamine impregnated papers were pressed to the particleboard surfaces under 190 ^{0}C press temperature; 25 sec. press time and 2.6 N/mm^2 pressure.

2. Polyurethane Based Varnish (PV) (Beech Wood Veneer, 0.55 mm thickness)

   After overlaying of particleboard with wood veneers, surfaces were coated with filler (solid content: 45 %) and topcoat polish (solid content: 45 %), respectively.

3. Polyurethane Based Lacquer Paint (LP)

   After sanding (120 grit size) particleboard, surfaces were coated with the polyurethane based paste (solid content: 75 %) and topcoat polish (solid content: 45 %), respectively.

4. Continuous Press Laminates (CPL) (0.55 mm thickness)

   CPL was manufactured, using a combination of alpha cellulose base decorative paper, barrier and kraft papers. The raw weights of cellulose, barrier and kraft papers were 100 g/m^2. Melamine formaldehyde resin with 55 % solid content was used to impregnate decorative paper while kraft papers were impregnated by phenol formaldehyde with 45%. Papers were soaked in a resin tank before impregnated paper sheets pressed in a continuous press. The layers were pressed at the temperature of 190 ^{0}C and press time of 30 second with a pressure of 2.5 N/mm^2.

5. High Pressure Laminates (HPL) (0.55 mm thickness)

   HPL was manufactured using a conbination of alpha cellulose base decorative paper, barrier and kraft papers. The raw weights of cellulose, barrier and kraft papers were 120 g/m^2. Melamine formaldehyde resin with 55 % solid content was used to impregnate decorative paper, while kraft papers were impregnated with phenol formaldehyde with 45%. Papers were soaked in a resin tank before impregnated paper sheets pressed in a multi layer press. The layers were pressed at the temperature of 190 ^{0}C and press time of 60 minutes with a pressure of 3.5 N/mm^2.

6. Polyvinyl chloride sheets (PVC) (0.55 mm thickness)

   Wood veneers, continuous laminates and high pressure laminates were pressed to the particleboard surfaces under 100 °C press temperature for 5 min. press time with 0.2 N/mm^2 pressure by using urea formaldehyde adhesive. Polyvinylchloride sheets were pressed to the particleboard surface under 90 °C press temperature for 15-second press time with 0.2 N/mm^2 pressure by using polyvinyl acetate adhesive at the membrane press.

Two panels were produced for each group and five specimens were cut from particleboard for each test. Resistances to the scratch (SR), abrasion (AR), cigarette burns and staining were determined in accordance with appropriate standards, TS 10607 (1993), TS 10610 (1993), TS 10604 (1993), TS 10606 (1993), respectively. All specimens were conditioned to equilibrium at a temperature of 20 °C with 65 % relative humidity.

Data for each test were statistically analyzed. One-way analysis of variance (ANOVA) was performed (alpha= 0.05) to test differences between factors and levels. The experimental design of this study is summarized in Table 1.

Table 1: The Experimental Design of the Study
Tablo 1: Araştırmanın Deneysel Düzeni

Board Type Levha Tipi	**Surface Coating Material Type** Yüzey Kaplama Malzemesi Tipi
1	MIP
2	PV
3	LP
4	CPL
5	HPL
6	PVC

3. RESULT AND DISCUSSION

Values for average scratch and abrasion resistances and resistance to the cigarette burns and staining of the overlay types are presented in Table 2.

Table 2: The Quality Properties of Overlay Types and Results of Statistical Analysis
Tablo 2: Yüzey Kaplamalarının Kalite Özellikleri ve İstatistik Analiz Sonuçları

Type Tipi	**SR (N)**	**AR (Rpm)**	**Resistance to Cigarette Burns** Sigara ateşine dayanıklılık	**Resistance to Staining** Lekelenmeye dayanıklılık
1	3,48 D	428 D	-	+
2	2,40 E	396 E	-	+
3	0,16 F	423 D	-	+
4	6,06 B	696 B	+	+
5	7,08 A	750 A	+	+
6	4,46 C	452 C	-	+

Note: Different letters represent statistical difference ($p < 0.05$). + = Resistant, - = No resistant

The scratch and abrasion resistances ranged from 0.16 to 7.08 (N), and 396 to 750 (Rpm), respectively. The ANOVA showed that the overlay types significantly affected these properties.

While the highest abrasion resistances were found in the order of HPL, CPL, PVC, LP and MIP, the PV had the lowest value. This may be due to differences on the resin type, amount used, and manufacturing conditions of the overlays. The effect of the overlay type on the abrasion resistance is showed in Figure 1.

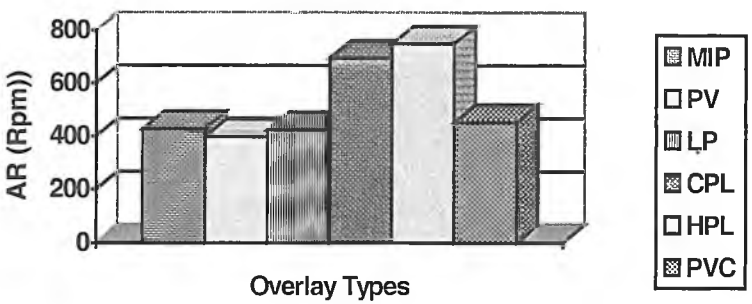

Figure 1: Effect of overlay type on the abrasion resistance
Şekil 1: Aşınma direnci üzerine yüzey malzeme tipinin etkisi

While the highest scratch resistances were found in the order of HPL, CPL, PVC, MIP, PV, the LP had the lowest value. This is because of the difference in resin used for the overlay manufacturing. The effect of the overlay type on the scratch resistance is showed in Figure 2.

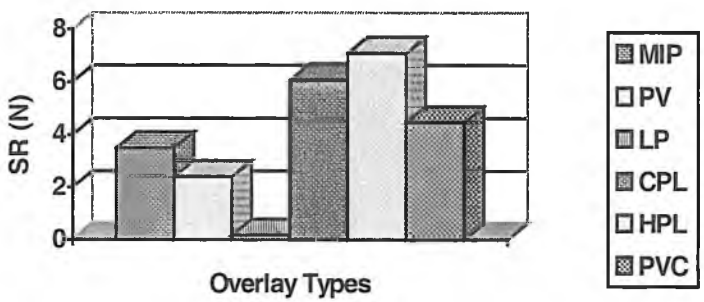

Figure 2: Effect of overlay type on the scratch resistance
Şekil 2: Çizilme direnci üzerine yüzey malzeme tipinin etkisi

The results showed that all of the overlay types were resistant to the staining. However, except for CPL and HPL, the other overlays were not found the resistant to the cigarette burns. This is due to differences in the application of resin formulation on the overlays. In the production of CPL and HPL, only melamine formaldehyde resin was used on the surface layer. However, for the melamine paper production, melamine and urea formaldehyde adhesive formulation was applied the layer.

3. CONCLUSION

Particleboard and MDF are the substrate of choice when it comes to most wood-based panel laminating applications. Both of these materials are manufactured as uniform, flat panels that provide excellent surfaces for the application of laminating materials such as high pressure laminates, veneers, melamine papers, poly vinyl chloride and more. These laminated panels are

then used in the construction of cabinets, furniture, paneling and other industrial product applications (NEMLİ /USTA 2003; PIZZI 1983)

This study showed that the performance of the laminated product was dependent on the surface overlay types. According to the results, overlay types affected surface properties. In the light of this study, it was found that HPL and CPL could be used for horizontal and vertical applications.

Additional work is needed to determine the effects of other overlay types, resin formulations used, resin absorption percentages and overlay thickness on the surface properties.

YONGALEVHANIN BAZI KALİTE ÖZELLİKLERİ ÜZERİNE YÜZEY KAPLAMA ÇEŞİDİNİN ETKİSİ

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Kısa Özet

Bu çalışmada, yongalevhalarda çizilme direnci, aşınma direnci, sigara ateşine ve lekelenmeye karşı dayanıklılığa yüzey kaplama malzemelerinin etkisi araştırılmıştır. Yongalevha yüzey kaplaması olarak melamin emprenyeli kağıt (MIP), poliüretan bazlı vernik (PV), poliüretan bazlı lake boya (LP), sürekli pres laminatı (CPL), yüksek basınç laminatı (HPL) ve polivinilklorür kaplama (PVC) kullanılmıştır. Sürekli pres laminatı ve yüksek basınç laminatları hem sigara ateşine ve lekelenmeye karşı dayanıklı hem de en yüksek çizilme ve aşınma direncine sahiptir.

Anahtar Kelimeler: Melamin kağıt, Laminat, Çizilme direnci, Aşınma direnci

ÖZET

Son yıllarda, yongalevha ve liflevhaların yüzeyi çok fazla miktarda çeşitli yüzey kaplama malzemeleriyle kaplanmak suretiyle kullanılmaktadır. Bu kaplama malzemeleri; boya ve vernikten başka, laminatlar, melamin ya da polyester emprenye edilmiş kağıtlar, ahşap kaplamalar, vinil filmleri ve ısı transfer folyelerinden oluşmaktadır.

Yüzey kaplama malzemelerinin kullanım amacı, levhanın su ve rutubet almasını azaltmak; levhaya dekoratif bir görünüş kazandırmak; levhadan formaldehit vb. gazların çıkışını azaltmak, lekelenmelere karşı direnç sağlamak ve levhaların çizilme ve aşınma gibi fiziksel etkilere karşı dayanıklılığını artırmaktır.

Yüzey kaplama malzeme tiplerinin yongalevha ve liflevhaya yukarıda belirtilen özellikleri ne derece kazandırdığı ve aralarındaki farklılıklar önem arzetmektedir. Bu nedenle, araştırmanın amacı, çeşitli yüzey kaplama malzemelerinin levha özellikleri üzerine etkisinin ortaya konulması olarak belirlenmiştir.

Araştırmada yüzey kaplama malzemelerinin taşıyıcısı olarak, %50 Kayın, %30 Çam % 20 Kavak yongalarından Üre-formaldehit tutkalı ile laboratuar şartlarında üç katlı ve 280x210x1.8 cm boyutlarında üretilen yongalevhalar kullanılmıştır. Levhaların üretiminde, 225 ^{0}C pres sıcaklığı, 110 san. presleme süresi ve 3.5 N/mm^2 pres basıncı uygulanmıştır. Üretilen levhalar 20 ^{0}C sıcaklık ve % 65 bağıl nem şartlarında kaplama malzemeleri üzerlerine yapıştırılana kadar bekletilmişlerdir.

Üretilen levhalar üzerine yapıştırılan yüzey kaplama malzeme tipleri aşağıda verilmiştir:

1. Melamin emprenyeli kağıt (MIP) (Ham gramaj 70 g/m^2)
2. Poliüretan bazlı vernik (PV) (0.55 mm kalınlıkta Kayın kaplama üzerine)
3. Poliüretan bazlı lake boya (LP)
4. Sürekli basınç Laminatı (CPL) (0.55 mm kalınlıkta)
5. Yüksek basınç laminatı (HPL) (0.55 mm kalınlıkta)
6. Polivinilklorür (PVC) (0.55 mm kalınlıkta)

Her bir yüzey kaplama malzemesi için iki levha üretilmiş ve her bir deney için beşer örnek hazırlanmıştır. Hazırlanan örnekler üzerinde çizilme direnci (SR), aşınma direnci (AR), sigara ateşine dayanıklılık ve lekelenmeye karşı dayanıklılık testleri sırasıyla TS 10607 (1993), TS 10610 (1993), TS 10604 (1993) ve TS 10606 (1993) standartlarına göre yapılmıştır. Deneyler yapılmadan önce bütün örnekler 20 °C sıcaklık ve % 65 bağıl nem şartlarında klimatize edilmiştir.

Sonuçlar basit varyans analizi (ANOVA) ile karşılaştırılmıştır (α= 0.05). Araştırmanın deneysel düzeni aşağıdaki tabloda verilmiş bulunmaktadır:

Tablo 1: Araştırmanın Deneysel Düzeni

Levha Tipi	Yüzey Kaplama Malzemesi Tipi
1	MIP
2	PV
3	LP
4	CPL
5	HPL
6	PVC

Araştırma sonucu bulunan aşınma direnci, çizilme direnci, sigara ateşine dayanıklılık ve lekelenmeye karşı dayanıklılık değerleri Tablo.2'de verilmiştir.

Tablo 2: Yüzey Kaplamalarının Kalite Özellikleri ve İstatistik Analiz Sonuçları

Levha Tipi	SR (N)	AR (Rpm)	Sigara ateşine dayanıklılık	Lekelenmeye karşı dayanıklılık
1	3,48 D	428 D	-	+
2	2,40 E	396 E	-	+
3	0,16 F	423 D	-	+
4	6,06 B	696 B	+	+
5	7,08 A	750 A	+	+
6	4,46 C	452 C	-	+

Not: Farklı harfler istatistiki farklılığı temsil etmektedir ($p < 0.05$), + dayanıklı, - dayanıksız

En yüksek aşınma direnci sıasıyla HPL, CPL, PVC, LP, MIP ve PV'de elde edilmiştir. Çizilme direncinde de en yüksek değer HPL kaplamalarda bulunmuştur. HPL ve CPL laminatlar

sigara ateşine karşı yeterli dayanıklılığa sahipken, diğer kaplama malzemeleri dayanıksız bulunmuştur. Ayrıca bütün kaplama tipleri lekelenmeye karşı dayanıklı bulunmuştur.

Bu sonuçlara göre, yongalevha ve liflevha üzerine uygulanan yüzey kaplama malzemelerinin çeşitli fiziksel ve kimyasal etkilere karşı dayanıklıkları arasında önemli farklar bulunmaktadır. Bu bakımdan kullanım yeri istekleri dikkate alınarak yüzey kaplama malzemesi tipi seçilmelidir.

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