ТЕХНОЛОГИЯ ХИМИЧЕСКОЙ ПЕРЕРАБОТКИ ДРЕВЕСИНЫ И ПРОИЗВОДСТВО ДРЕВЕСНО-ПОЛИМЕРНЫХ КОМПОЗИТОВ

Original article
УДК 630*23(470.45)
DOI: 10.37482/0536-1036-2025-2-172-182

Influence of Décor and Overlay Paper Mass on Laminate Floor Product Properties

Murat Aydin[1]✉ ***, Doctor of Science, Assoc. Prof.;*** *ResearcherID: ADK-7476-2022, ORCID: https://orcid.org/0000-0002-3015-1868*
Mehmet Erdal Kara[2]***, Doctor of Science;*** *ORCID: https://orcid.org/0000-0003-1741-8211*
Osman Çamlıbel[3]***, Doctor of Science, Assoc. Prof.;*** *ResearcherID: S-3506-2017, ORCID: https://orcid.org/0000-0002-8766-1316*
[1]Isparta University of Applied Sciences, Bahçelievler Mh,143, Cd no. 2, Isparta, 32200, Türkiye; murataydin@isparta.edu.tr✉
[2]Kastamonu Entegre Ağaç Sanayi ve Ticaret A.Ş., Kastamonu Organize Sanayi Bölgesi, 7, Cd. no 2/8, Halife Köyü, Kastamonu, 37200, Türkiye; erdal.kara@keas.com.tr
[3]Kırıkkale University, Ankara Yolu, 7 km, Yahşihan / Kırıkkale, 71450, Türkiye; osmancamlibel@kku.edu.tr

Received on May 20, 2024 / Approved after reviewing on August 14, 2024 / Accepted on August 18, 2024

Abstract. Laminate flooring products are among the essential construction and building materials not only because of their aesthetics, but also their ability to provide energy saving, sound insulation, prevent surface scratches, and minimize maintenance such as periodic varnishing in the case of solid wood flooring, etc. Even though the laminate flooring products are scratch-resistant and easy to install, they must meet the standard requirements. Therefore, optimizing the production parameters of laminate flooring products is of interest in research and development to obtain cost-effective products that not only compete in the market but also represent scientific communities' studies. In this sense, production parameters such as paper properties, core material type and properties, resin utilization, pressing conditions (pressure, duration, and temperature), etc. come to the forefront. From this point of view, the effect of décor (105, 115, and 125 g/m²) and overlay (90 and 95 g/m²) paper mass on the surface abrasion (SA), abrasion resistance (AR), impact resistance (IR) and cure properties of laminate floor products which have been industrially produced has been figured out. According to the results, SA, AR, IR, and cure values ranged from 3,600–4,800 revolutions, 4.5–5.0, 110–130 N, and class 5, respectively. According to BS-EN 13329 and BS-EN 14323, products meet the requirements. However, the effect of paper masses on properties has been found to be unstable due to oscillations and no changes observed. In the literature, there are scarcely any studies that figure out these parameters and the authors think that the results of this study may provide valuable data for the comparison.

Keywords: laminate floor, overlay paper, décor paper, high-density fiberboard

Acknowledgements: The authors would like to thank Kastamonu Entegre Ağaç Co. for providing all opportunities for performing this study.

For citation: Aydın M., Kara M.E., Çamlıbel O. Influence of Décor and Overlay Paper Mass on Laminate Floor Product Properties. *Lesnoy Zhurnal* = Russian Forestry Journal, 2025, no. 2, pp. 172–182. https://doi.org/10.37482/0536-1036-2025-2-172-182

Научная статья

Влияние свойств накладной и декоративной бумаги на характеристики ламинированного напольного покрытия

М. Айдын[1]✉***,*** *д-р наук, доц.; ResearcherID: ADK-7476-2022, ORCID: https://orcid.org/0000-0002-3015-1868*
М.Е. Кара[2]***,*** *д-р наук; ORCID: https://orcid.org/0000-0003-1741-8211*
О. Чамлыбель[3]***,*** *д-р наук, доц.; ResearcherID: S-3506-2017, ORCID: https://orcid.org/0000-0002-8766-1316*
[1]Университет прикладных наук Испарты, Бахчелиэвлер, ул. 2, д. 143, Испарта, Турция, 32200; murataydin@isparta.edu.tr✉
[2]Кастамону Интегрейтед Вуд Индастри энд Трэйд Инк., орг. пром. зона Кастамону, ул. 2/8, д. 7, дер. Халифа, Кастамону, Турция, 37200; erdal.kara@keas.com.tr
[3]Университет Кырыккале, дор. Анкара–Кырыккале, 7-й км, Яхшихан/Кырыкалле, Турция, 71450; osmancamlibel@kku.edu.tr

Поступила в редакцию 20.05.24 / Одобрена после рецензирования 14.08.24 / Принята к печати 18.08.24

Аннотация. Ламинированные напольные покрытия входят в число базовых строительных материалов не только из-за своей эстетичности, но и благодаря возможности с их помощью обеспечить энергосбережение, звукоизоляцию, предотвратить царапины на поверхности и минимизировать уход, такой как периодическая лакировка в случае с напольными покрытиями из массива дерева и др. Несмотря на то, что ламинированные напольные покрытия устойчивы к царапинам и просты в укладке, они должны соответствовать стандартным требованиям. Поэтому оптимизация параметров производства ламинированных напольных покрытий представляет интерес для научных исследований и разработок, нацеленных на получение экономически эффективной продукции, которая не только конкурентноспособна на рынке, но и репрезентует результаты деятельности научных сообществ. В этом смысле на первый план выходят следующие параметры: свойства бумаги, тип и характеристики материала сердцевины, использование смолы, условия прессования (давление, продолжительность, температура) и т. д. Определено влияние массы декоративной (105, 115 и 125 г/м^2) и покровной (90 и 95 г/м^2) бумаг на истираемость поверхности, устойчивость к истиранию, ударопрочность и износостойкость ламинатных напольных покрытий, произведенных промышленным способом. Результаты исследования продемонстрировали, что показатели варьировали в пределах 3600–4800 об., 4,5–5,0, 110–130 Н и класса 5 соответственно. Продукция отвечает требованиям стандартов BS-EN 13329 и BS-EN 14323. Однако было обнаружено, что влияние массы бумаги на свойства нестабильно: наблюдались колебания показателей или отсутствие изменений. В литературе почти нет сведений об указанных параметрах, поэтому результаты этой работы могут представлять ценные данные для сравнения.

Ключевые слова: ламинированный пол, покровная бумага, декоративная бумага, древесноволокнистая плита высокой плотности

Благодарности: Авторы хотели бы поблагодарить компанию Кастамону Интегрейтед Вуд Индастри энд Трэйд Инк за предоставление возможностей для проведения данного исследования.

Для цитирования: Aydın M., Kara M.E., Çamlıbel O. Influence of Décor and Overlay Paper Mass on Laminate Floor Product Properties // Изв. вузов. Лесн. журн. 2025. № 2. С. 172–182. https://doi.org/10.37482/0536-1036-2025-2-172-182

Introduction

Laminate floor products, composed of balance paper, core, décor paper, and overlay, are generally manufactured with wood and wood-based materials. The purpose of each layer is different such as providing aesthetic appearance (décor paper), surface wearing protection (overlay), a stable main structure (high-density fiberboar (HDF), core), and balancing the opposing layers against wrapping (balance paper).

The market share of laminate products in flooring applications increases day by day due to their advantages against traditional flooring products such as solid wood parquets. This increase also brings some challenges in wood-based engineered product manufacturing sector. Furthermore, up-to-date standards may require some advancements for these products. On the other hand, cracking, brightness, staining, tone, and level difference are some of the major problems encountered in laminate flooring applications [8]. As a result, manufacturers invest in research and development activities, and researchers report on their studies. However, when the literature has been reviewed, the limited number of studies that evaluate the influence of these layers' properties on laminate flooring products has been discovered, and the following are some of the recent studies [1, 3, 9, 10, 12, 14, 17, 19, 21, 22]. The surface roughness of laminate flooring product (melamine resin-saturated paper overlay) has been determined by Kalaycıoğlu and Hızıroğlu [11]. Nemli [15] has evaluated the influence of surface coating types (varnish and overlaying materials) on the abrasion resistance of particleboards. However, the influence of overlay paper on the laminate floor product properties has scarcely been evaluated. Kara et al. [12, 13] have figured out the effect of overlay paper on laminate floor properties. Apart from overlay paper, the fact is that the influence of décor paper on laminate floor products is uncertain, but Istek et al. [7] have evaluated this issue using particleboard. Therefore, this study is aimed to figure out the influence of overlay and décor paper properties on laminate floor properties.

Research Objects and Methods

The core of the laminate flooring, HDF, has been produced using 75 and 25 % fiber mixture of Oriental spruce (*Picea orientalis* L.) and Oriental beech (*Fagus orientalis* L.), respectively. The refining process has been performed using Andritz AG 2008 (Graz, Austria). The fiber mixture has been sequentially blended with 11.8 % wt. kg/m³ urea formaldehyde (UF) resin, 0.9 % wt. kg/m³ hardener ($Al_2(SO_4)_3$), and 1.19 % wt. kg/m³ liquid paraffin. The moisture level of fiber has been set to 12.8 %. The mat has been pre-pressed and hot-pressed by Siempelkamp (Krefeld, Germany) press at a speed of 820 mm/s and temperature of 220 °C for 70 s. The boards with the density of 885 kg/m³ and the dimensions of 7.4×2,097×7,365 mm have been produced. Following the cooling stage, the boards have been stored for 5 days at a temperature of 20 °C and relative humidity of 65 %. Then, the boards have been sequentially sanded using 60-, 80-, 100-, and 140-grit sandpapers to obtain 7.4±0.1 mm thickness.

Table 1

The resin properties during the impregnation process

Properties	UF resin	MF resin
Solid Matter (%)	50	54
Density (g/cm³)	1.22	1.25
Mol ratio (g/mol)	1.65	1.55
Viscosity (cP)	20–50	25–50
pH	7–9	8.8– 9.8
Jelling time (s)	20–35	–
Discharging time (s)	10–20	10–20
Water tolerance	–	1/1–1/2.5

The UF and melamine formaldehyde (MF) resin properties are presented in Table 1. The impregnation details of decor, overlay, and balance papers are presented in Table 2. Chemicals (hardener, antibacterial agents, etc.) have been applied to overlay and décor paper resins. The total jelling time of the overlay, décor paper, gravure unit, and balance paper resins (300 kg for each) have been 4.35, 4.50, 4.20, and 3.30 min, respectively.

Table 2

The impregnation process

<table>
<tr><th colspan="2" rowspan="2">Paper type (g/m²)
UF (%)</th><th>1. Wash</th><th>1. Oven temp</th><th>1. Oven fan speed</th><th>2. Wash</th><th>2. Oven temp</th><th>2. Oven fan speed</th><th>Paper final mass</th><th>Paper moisture</th><th rowspan="2">Corun-dum</th></tr>
<tr><th>°C</th><th>RPM</th><th>MF (%)</th><th>°C</th><th>RPM</th><th>g/m²</th><th>%</th><th>Al2O3 (g/m²)</th></tr>
<tr><td rowspan="4">Decor</td><td rowspan="2">40 (A1–A2–A3–A4)*</td><td rowspan="4">100</td><td rowspan="4">110</td><td rowspan="4">850</td><td rowspan="4">100</td><td rowspan="4">135</td><td rowspan="4">850</td><td>105</td><td rowspan="4">6.0±0.2</td><td rowspan="4">–</td></tr>
<tr><td>115</td></tr>
<tr><td rowspan="2">50 (B1–B2–B3–B4)*</td><td>115</td></tr>
<tr><td>125</td></tr>
<tr><td rowspan="2">Overlay</td><td>18</td><td>–</td><td>–</td><td>–</td><td>100</td><td>130</td><td>850</td><td>90</td><td>6.9–7.2</td><td>12</td></tr>
<tr><td>22 (Control)</td><td>–</td><td>–</td><td>–</td><td>100</td><td>130</td><td>850</td><td>95</td><td>6.9–7.1</td><td>12</td></tr>
<tr><td>Balance</td><td>50</td><td>–</td><td>–</td><td>–</td><td>100</td><td>145</td><td>800</td><td>115</td><td>6.8–7.1</td><td>–</td></tr>
</table>

*Product types. RPM – revolutions per minute.

Wemhöner Press (Herford, Germany) has been used for hot-pressing at the temperatures of 202 °C (top plate) and 204 °C (bottom plate). The pressure and duration of pressing have been 38 kg/cm² and 14.8 s, respectively. Following manufacturing, the products have been acclimatized for 5 days at a temperature of 20 °C and relative humidity of 65 %. After conditioning, surface abrasion (AC3 ≥2000 revolutions, BS-EN 13329:2023 [4]), scratch resistance (AC3 ≥ 3.5 N, BS-EN 14323:2021[5]), small ball (AC3 ≥ 10 mm, BS-EN 13329:2023[4]), and cure properties of the A and B product types (Table 3) have been determined.

Table 3

The experimental design of products

Product type	Decor paper		Overlay paper	
	Raw mass (g/m²)	Final mass (g/m²)	Mass (g/m²)	Final mass (g/m²)
A1	40	105	18	90
A2		115		
A3		105	22 (control)	95
A4		115		
B1	50	115	18	90
B2		125		
B3		115	22 (control)	95
B4		125		

Abrasion Resistance. The 10×10cm-sized samples have been prepared for the abrasion test. The centre has been drilled in each of them. As seen in Fig. 1, Taber 5155 abraser (Taber Industries, North Tonawanda, NY, USA) has been used for accelerated wear testing to determine abrasion resistance. Taber abrasive wheels covered with 100-grit sandpaper have been applied to each sample surface. The sample surface has been controlled every 100 turns. At the end of 200 tours, the sandpapers have been replaced with the new ones. Abrasion resistance (AR) has been determined using Eq. 1.

$$AR = \frac{(IRP + FRP)}{2}, \quad (1)$$

where AR is the abrasion resistance (revolutions); IRP and FRP are the initial and full removal of the pattern, respectively.

Fig. 1. The abrasion test

Scratch Resistance. Erichsen Scratch Hardness Tester 413 (Erichsen GmbH& Co.Kg. Hemer, Germany) has been used to determine scratch resistance. As can be seen in Fig. 2, the 10×10cm samples with a hole in the centre have been mounted on a rotating table, and load (from 3 to 6 by 0.5 N increments) has been applied to the surface by a diamond tip attached to the load arm till scratch has become continuous. The test has been finished and the load determined when continuous scratches (1 mm gaps between the scratch lines) have been observed.

Fig. 2. The scratch resistance test

Small Ball Test. As can be seen in Fig. 3, a small ball impact tester mounted on the sample surface has been used to determine the impact resistance of laminate floor products. The thimble has been increased by 0.5 N increments to determine the maximum force at which no damage has occurred on the surface while the ball has been released. Following each drop, the surface has been checked and marked to ensure the presence of the damage.

Fig. 3. The small ball test (AC3 ≥ 10 mm, BS-EN 13329+A1 [4])

Cure Test. The curing performance of the samples has been evaluated using 37 % hydrochloric acid (HCl) and Rhodamine B. A drop of the solution has been distilled to the surface, left for five minutes, and then cleaned. The coloration (pink tones) of the surface has been observed. It has been desired that the surface had no visible pink color (Fig. 4) on the surface which corresponds to the 5th degree. An increase in pink color tones on the surface leads to the 1st degree which is not acceptable.

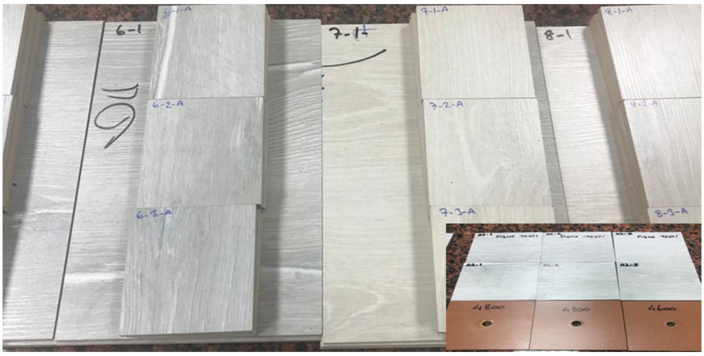

Fig. 4. The cure test samples

Results and Discussion

The surface abrasion range of the products has varied from 3400 to 4800 revolutions, and the means ranged from 3600 to 4733 revolutions, as can be seen in Table 4 and Fig. 5, respectively. According to BS-EN 13329 [4], all product types meet the abrasion class (AC) 3 and values are in harmony with Kara et al. [12, 13].

Table 4

The test results

Products	SA (AC3 ≥ 2000 rev.) (BS-EN 13329 [4])			AR (AC3 ≥ 3.5 N) (BS-EN 14323 [5])			IR, Small Ball (AC3 ≥ 10 mm) (BS-EN 13329 [4])	Cure (1–2–3–4–5)		
	Left	Center	Right	Left	Center	Right	Center	Left	Center	Right
A1	3,400	4,800	4,400	5	5	4.5	110	5	5	5
A2	4,800	4,800	4,600	4.5	4.5	5	130	5	5	5
A3	4,300	4,600	3,600	4.5	4.5	4.5	120	5	5	5
A4	4,000	4,200	4,400	5	5	4.5	120	5	5	5
B1	4,200	4,200	3,600	5	5	5	110	5	5	5
B2	4,400	4,800	4,400	5	5	5	120	5	5	5
B3	4,000	4,400	4,000	5	4.5	4.5	120	5	5	5
B4	3,600	3,600	3,600	4.5	4.5	4.5	110	5	5	5

The averages and changes in surface abrasion are illustrated in Fig. 5. For A type products, when the final mass of the décor paper has increased from 105 to 115 g/m², 12.7 % (A1vs A2) and 0.8 % (A3 vs. A4) increases in surface abrasion have been observed for 90 and 95 g/m² overlay final mass groups, respectively. Therefore, the advance in surface abrasion has almost been zeroized when the overlay final mass has increased from 90 to 95 g/m². For B type products, a 13.3 % increase (B1 vs B2) and 12.9 % decrease (B3 vs. B4) have been observed within the 90 and 95 g/m² overlay paper groups, respectively, when the décor paper final mass has increased from 115 to 125 g/m². Within the same décor paper final mass, an increase in the overlay paper final mass (90 to 95 g/m²) has caused –0.8 % (A1 vs. A3), –11.3 % (A2 vs. A4), 3.3 % (B1 vs. B3), and –20.6 % (B2 vs. B4) alterations in surface abrasion. When comparing the product types in the same décor and overlay paper masses, surface abrasion of the B1 and B3 have been 15.5 and 1.6 % lower than A2 and A4, respectively. As can be seen in Table 2, the impregnation process parameters have been the same. However, even if the 1.6 % difference can be neglected, the reason for the 15.5 % difference has not been normal and is associated with 2 essential differences between the A and B types of products such as 10 g/m² excess of the décor paper raw mass and the fiber types.

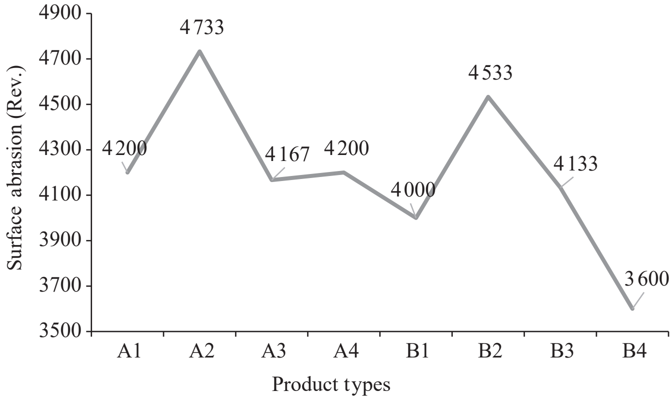

Fig. 5. The surface abrasion alterations

The averages and changes in abrasion resistance are illustrated in Fig. 6. For A type products, AR 3.4 % has decreased (A1 vs. A2) and 7.4 % has increased (A3 vs. A4) when the décor paper final mass has increased from 105 to 115 g/m² while the overlay paper final mass has been 90 and 95 g/m², respectively. Also, a 6.9% decrease (A1 vs. A3) and a 3.6 % increase have been observed when the overlay paper final mass has increased from 90 to 95 g/m² while the décor paper final mass has been 105 and 115 g/m², respectively. However, as can be seen in Table 4, AR of A1 and A4 are equal, and improving the décor and overlay papers' final masses has not provided any improvement. For B type products, an increase in the overlay paper final mass has caused adverse effects (–6.7 % for B1 vs. B3 at 115 g/m² and –10 % for B2 vs. B4 at 125 g/m²). AR has not changed and has decreased by 3.6% when the décor paper final mass has increased from 115 to 125 g/m² for the 90 and 95 g/m² overlay paper final mass, respectively. When A and B type products are compared considering the same décor and overlay paper masses (115 and 90 g/m² for décor and overlay, respectively), a 7.1 % increase (A2 vs. B1) and a 3.4 % decrease (A4 vs. B3) have been observed in AR. Therefore, a stable improvement in terms of paper mass has not been generally achieved.

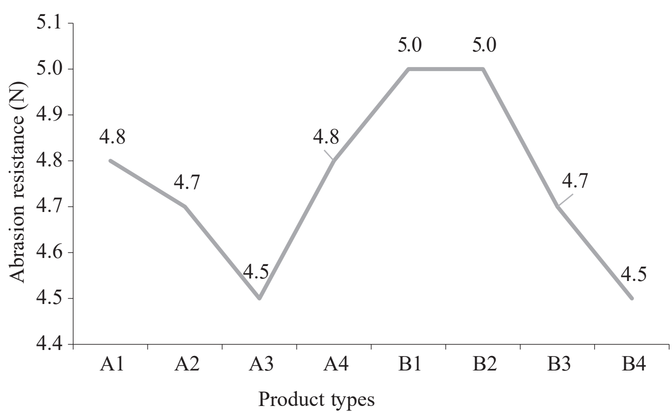

Fig. 6. The abrasion resistance alterations

Bardak et al. [2] have evaluated the influence of décor paper grammage (80.15 to 130.03 g/m²) on AR of particleboards and have stated that an increase in mass provides advancement in AR. An increase in density with an increase in mass which decreases the pore amount of the décor paper by impregnation to holes is attributed to the AR improvements as Bardak et al. [2] have expressed.

Nemli et al. [16] have stated that when the grammage of the melamine paper, used to cover particleboards, increases from 70 to 100 g/m², significant improvements are observed on modulus of rupture (MOR), modulus of elasticity (MOE), and thickness swell (TS) (24h). Remarkable increases in density as seen in Bardak et al. [2] are assumed as one of the main factors that cause improvements in the properties.

It has also been reported that abrasion has decreased with an increase in the overlay paper final mass at 23 g/m² corundum amount. But when the corundum amount has increased to 28 g/m², a more than 4 % decrease has been reported by Kara et al. [12]. In this study, oscillations are the fact instead of general increase or decrease behaviors.

The averages and changes in impact resistance (IR) are presented in Table 4. For A type products, IR has increased by 18.2 % (A1 vs. A2) and has not changed (A3 vs. A4) when the décor paper final mass has increased from 105 to 115 g/m² while the overlay paper final mass has been 90 and 95 g/m², respectively. Furthermore, IR has increased by 9.1 % (A1 vs. A3) and has decreased by 7.7 % (A2 vs. A4) when the overlay paper final mass has increased from 90 to 95 g/m² while the décor paper final mass has been 105 and 115 g/m², respectively. For B type products, an increase in the overlay paper final mass has provided a 9.1 % improvement for B1 vs B3 at 115 g/m² and a –8.3 % worsening for B2 vs B4 at 125 g/m²). The same improvement and worsening are valid when the décor paper final mass has increased from 115 to 125 g/m² for the 90 and 95 g/m² overlay paper final mass groups (B1 vs B2 and B3 vs B4), respectively. When A and B type products have been compared considering the same décor and overlay paper masses (115 g/m² and 90 g/m² for the décor and overlay ones, respectively), A4 and B3 have not presented numerical difference while a –15.4 % decrease has been observed for A2 vs. B1.

Kara et al. [13] have noted 20 to 25.25 N IR of the laminate flooring which has been determined by a large diameter ball test. In the literature, there are scarcely any studies for the comparison. However, the results of this study fit the standard requirements.

As can be seen in Table 4, no numerical differences have been observed in cure properties within and between the groups. As for IR, the results of this study have not been sufficient compared to the literature due to the lack of reported values. It may be thought that the discussion of the results is insufficient. However, when the literature is reviewed, laminate floor properties evaluated in this study are limited to a few studies that have already been mentioned. Therefore, industrially produced laminate floor products should be further studied for detailed evaluation.

Sıradağ [20] has stated that extending the storage duration can reduce (up to 15 % after 2 years of conditioning) the free formaldehyde amount of laminate floorings. However, the influence of such a storing time on the physical and mechanical properties of laminate flooring with HDF core has not been reported. However, Çamlıbel and Aydın [6] have reported that 3 days of conditioning before the tests has provided around 1 and 1.4 % increases in MOE and surface soundness of the particleboards while a 3.5 % decrease in water absorption (WA). However, neither short nor long periods of storage influence on the properties have been the aim of this study.

It has been expressed that laminate flooring is sometimes considered as inferior to natural flooring materials, even though many of its qualities are objectively superior [18]. Besides the outstanding physical and mechanical performance, perceptual salience is one of the prominent features of the laminate floorings as an aesthetic product.

In this study, production variables have been limited, and consistent changes in the features have not been observed. Therefore, further experimental designs (3–5 grammage groups for each layer) should be evaluated to better understand the influence of the final grammage of the décor and overlay paper on the product features.

Conclusion

The influence of the décor and overlay paper final mass on abrasion, impact, and cure properties of laminate floor products produced in industrial conditions has been figured out. Considering the standards, products meet the requirements of the commercial market. However, at this stage, behavioral stability of the influence of paper mass on the properties is not the fact when overall results are taken into consideration.

REFERENCES

1. Arenas J.P., Sepulveda L.F. Impact Sound Insulation of a Lightweight Laminate Floor Resting on a Thin Underlayment Material Above a Concrete Slab. *Journal of Building Engineering*, 2022, vol. 45, art. no. 103537. https://doi.org/10.1016/j.jobe.2021.103537

2. Bardak S., Sarı B., Nemli G., Kırcı H., Baharoğlu, M. The Effect of Decor Paper Properties and Adhesive Type on Some Properties of Particleboard. *International Journal of Adhesion and Adhesives*, 2011, vol. 31, iss. 6, pp. 412–415. https://doi.org/10.1016/j.ijadhadh.2011.02.008

3. Borrell J.M.G., Alcaraz J.G.S., Sanchis E.J. Experimental and Numerical Acoustic Characterization of Laminated Floors. *Experimental Techniques*, 2016, vol. 40, pp. 857–863. https://doi.org/10.1007/s40799-016-0086-9

4. *BS-EN 13329:2023. Laminate Floor Coverings. Specifications, Requirements and Test Methods*. London, BSI, 2023. 24 p.

5. BS-EN 14323:2021. Wood-Based Panels. Melamine Faced Boards for Interior Uses. Test Methods. London, BSI, 2021. 26 p.

6. Çamlıbel O., Aydın M. The Effects of Continuous Press Speed and Conditioning Time on the Particleboard Properties at Industrial Scale. *BioResources*, 2022, vol. 17, iss. 1, pp. 159–176. https://doi.org/10.15376/biores.17.1.159-176

7. Istek A., Aydemir D., Aksu S. The Effect of Décor Paper and Resin Type on the Physical, Mechanical, and Surface Quality Properties of Particleboards Coated with Impregnated Décor Papers. *BioResources*, 2010, vol. 5, iss. 2, pp. 1074–1083. https://doi.org/10.15376/biores.5.2.1074-1083

8. İstek A., Özlüsoylu İ., Özel F., Yazıcı H. Problems in Laminate Parquet Applications. *Proceedings of the III International Mediterranean Forest and Environment Symposium.* Kahramanmaraş Sütçü İmam University, 2019, pp. 633–636.

9. Jiménez P., Dunkl A., Eibel K., Denk E., Grote V., Kelz C., Moser M. Evaluating Psychological Aspects of Wood and Laminate Products in Indoor Settings with Pictures. *Forest Products Journal*, 2015, vol. 65, iss. 5–6, pp. 263–271. https://doi.org/10.13073/FPJ-D-14-00003

10. Jiménez P., Dunkl A., Eibel K., Denk E., Grote V., Kelz C., Moser M. Wood or Laminate?—Psychological Research of Customer Expectations. *Forests*, 2016, vol. 7, no. 11, art. no. 275. https://doi.org/10.3390/f7110275

11. Kalaycioglu H., Hiziroglu S. Evaluation of Surface Characteristics of Laminated Flooring. *Building and Environment*, 2006, vol. 41, iss. 6, pp. 756–762. https://doi.org/10.1016/j.buildenv.2005.03.012

12. Kara M.E., Ayrilmis N., Uncu A. Effect of Overlay Paper Properties on the Surface Quality of Laminate Flooring. *Machines. Technologies. Materials*, 2022, vol. 16, iss. 6, pp. 199–201.

13. Kara M.E., Yerlikaya Z., Ateş S., Olgun, Ç. Effect of Pressing Conditions on Some Surface Properties of HDF Laminate Parquets. *Indian Journal of Engineering & Materials Sciences*, 2016, vol. 23, pp. 274–278.

14. Nandipati M.R., Suman K.N.S. Improving Abrasion Resistance of Laminate Floor with Additional Curing Prior to Final Coating – An Experiment and SAS Program. *International Journal of Innovative Science and Research Technology*, 2021, vol. 6, iss. 12, pp. 780–784.

15. Nemli G. Factors Affecting Some Quality Properties of the Decorative Surface Overlays. *Journal of Materials Processing Technology*, 2008, vol. 195, iss. 1–3, pp. 218–223. https://doi.org/10.1016/j.jmatprotec.2007.05.001

16. Nemli G., Yıldız S., Gezer E.D. Effects of Melamine Raw Paper Weight, Varnish Type and the Structure of Continuous Pressed Laminate (CPL) on the Physical, Mechanical Properties and Decay Resistance of Particleboard. *International Biodeterioration & Biodegradation*, 2005, vol. 56, iss. 3, pp. 166–172. https://doi.org/10.1016/j.ibiod.2005.07.002

17. Roos A., Hugosson M. Consumer Preferences for Wooden and Laminate Flooring. *Wood Material Science and Engineering*, 2008, vol. 3, iss. 1–2, pp. 29–37. https://doi.org/10.1080/17480270802573586

18. Schütte S., Lindberg A., Eklund J. Subjective Assessment of Laminate Flooring. *Contemporary Ergonomics*. London, Taylor & Francis, 2006, pp. 194–198. https://doi.org/10.1201/9781003072072-45

19. Seo J., Jeong S.-G., Kim S., Huh W. Improvement of Thermal Conductivity of Underlay Foam for Laminate Flooring to Reduce Heating Energy. *BioResources*, 2016, vol. 11, iss. 4, pp. 9059–9067. https://doi.org/10.15376/biores.11.4.9059-9067

20. Sıradağ H. *Free Formaldehyde Change in Laminate Parquet Depending on the Waiting Time*: Master's Thesis. Turkey, Bartın, Bartın University, 2019. 273 p. (In Turk.).

21. Wilson J., Cunefare K. Sound Quality of Laminate Flooring Systems. *The Journal of the Acoustical Society of America*, 2008, vol. 24, iss. 4_Supplement, art. no. 2441. https://doi.org/10.1121/1.4782562

22. Yetiş C., Tuna Kayili M. Determination of the Effect of Laminate Flooring on Indoor Air Quality during the Installation Phase of the Building. *Journal of International Environmental Application and Science*, 2021, vol. 16, iss. 4, pp. 140–148.

Конфликт интересов: Авторы заявляют об отсутствии конфликта интересов
Conflict of interest: The authors declare that there is no conflict of interest

Вклад авторов: Все авторы в равной доле участвовали в написании статьи
Authors' Contribution: All authors contributed equally to the writing of the article