INTERNATIONAL CONFERENCE 30TH
RESEARCH FOR FURNITURE INDUSTRY

Poznań University of Life Sciences

Determination of Abrasion and Scratch Resistance of Some Varnishes Applied to Naturally Aged Wood

Kenan KILIÇ*, Uğur ÖZCAN*, Cevdet SÖĞÜTLÜ*

*Gazi University, Technology Faculty, Wood Products Industrial Engineering, Ankara, Turkey

ABSTRACT

In this study, it was aimed to determine the abrasion resistance and scratch resistance of water-based, polyurethane and acrylic varnish applied to naturally aged and fresh scotch pine (*Pinus sylvestris* L.), sessile oak (*Quercus petrea* L.) and chestnut (*Castanea sativa* M.) wood surfaces. The test samples prepared for the experimental study were sanded with 150 grit sandpaper after they were kept in condition of 20±2 ºC and 65±5% relative humidity until the equilibrium humidity was reached. The varnish was applied to the surface of the test samples with a paint sprey gun perpendicular to the grains and then parallel to the grains. Abrasion resistance was determined in accordance with TS EN 15185 and scratch resistance was determined in accordance with TS EN 15185 principles. As a result, it was determined that wood type, age period (naturally aged and fresh) and section direction were not effective on abrasion and scratch resistance, whereas varnish type was effective.

Keywords: Wood, Varnish, Abrasion resistance, Scratch resistance

INTRODUCTION

As an engineering material, wood is one of the materials widely used in interior and exterior decoration applications due to its ease of processing, low energy consumption requirement during processing, availability in various colors and patterns, sound and heat permeability, and sound and heat permeability [Kopac and Sali, 2003; Söğütlü et all, 2016].

Fading occurs in the color of the wood material exposed to the effect of open weather conditions and decomposition occurs in the preservatives used in the surface treatment [Wiiliams et all 1990; Wiiliams 2005].

Degradations vary according to the nature of the effects it is exposed to. For example, while kitchen furniture is primarily affected by water and humidity, detergent, citric acid, oil and some chemicals found in cooking steam, elements such as joinery, pergola and garden furniture such as sun rays, rain, dew, snow, frost, temperature differences between night and day. are exposed to effects [Ross, 1972].

The main factor responsible for the weathering of wood is ultraviolet. As a result, the most obvious initial effect is degradation, photo degradation disruption, and depolymerization of lignin. It is followed by leaching of lignin fragments from the rain from the wooden surfaces [Hon, 2001].

Unprotected wood is sensitive to weathering. Color change, roughness, mechanical and physical properties etc. in wood. Many environmental factors cause wood abrasion [Suduyani et all, 1999].

The aim of this study is to examine the scratch and abrasion resistance of water-based, polyurethane and acrylic varnishes applied to the surface of test samples prepared with naturally aged and fresh Scots pine (*Pinus sylvestris* L.), sessile oak (*Quercus petrea* L.), and chestnut (*Castanea sativa* M.) wood.

EXPERIMENTAL

Material

In the preparation of test samples; Naturally aged and fresh Scotch pine, sessile oak, and chestnut woods were used. Water-based, polyurethane and acrylic varnishes were preferred for finishing of test samples.

Determination of Abrasion and Scratch Resistance

Abrasion resistance of varnished wooden surfaces has been determined according to TS EN 15185 principles. Accordingly, 10 specimens of 100×100×10 mm in size, 360 specimens were prepared for each parameter and the surfaces were abraded with the aid of an abrasion tester. After every 25 rotation of test sample, the surface was checked and this process was continued until the varnish layer was worn. When the varnish layer was worn and the wood surface became clear, the experiment was terminated and the number of revolutions of the device was recorded.

Scratch resistance was determined in the scratch test device according to TS EN 15186 principles. According to this; Prepared samples were kept at 23±2 ºC temperature and 50±5% relative humidity conditions for 4 days. After the test device was positioned in a balanced position parallel to the ground, the experiments were carried out (Figure 1).

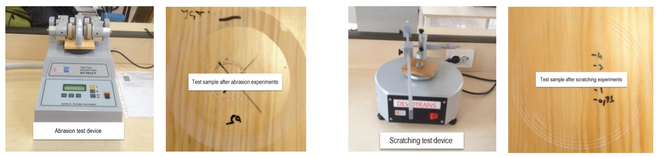


Figure 1. Abrasion and scratching devices-test samples after experiments

Evaluation of Data

In the experiments, a total of 720 for each age period (2), wood species (3), section direction (2), varnish type (3), test method (2), and replication (2×3×3×2×10) experimental samples were used. The data obtained from the experiments were statistically analyzed using Python Pandas and Python Dtale. As a result of the analysis, the success order of the variables was made.

RESULTS AND DISCUSSION

The abrasion and scratching arithmetic mean values obtained as a result of the experiments are given in Table 1.

Table 1. The abrasion and scratching arithmetic mean values

Wood Type	Abrasion Resistance						Scratching Resistance					
	Age Period / Varnish Type						Age Period / Varnish Type					
	Naturally Aged Wood			Fresh Wood			Naturally Aged Wood			Fresh Wood		
	WB	PU	AC	WB	PU	AC	WB	PU	AC	WB	PU	AC
Scotch pine	25	50	50	25	50	50	0.25	0.75	0.75	0.25	0.75	0.75
Sessile oak	25	50	50	25	50	50	0.25	0.75	0.75	0.25	0.75	0.75
Chestnut	25	50	50	25	50	50	0.25	0.75	0.75	0.25	0.75	0.75

WB: Water-based varnish PU: Polyurethane varnish AC: Acrylic varnish

According to the results of the experiments, there is no difference between the wood type and age period, but there are differences between the abrasion and scratch resistance of the varnishes. Statistical analysis results using Python Pandas and Python Dtale are given in Table 2.

Table 2. Statistical analysis results

Variant	Abrasion Resistance						Scratching Resistance					
	Water-based		Polyurethane		Acrylic		Water-based		Polyurethane		Acrylic	
	Radial	Tangential	Radial	Tangential	Radial	Tangential	Radial	Tangential	Radial	Tangential	Radial	Tangential
Recurrence	6.0	6.0	6.0	6.0	6.0	6.0	6.00	6.00	6.00	6.00	6.00	6.00
Average	25.0	25.0	50.0	50.0	50.0	50.0	0.25	0.25	0.75	0.75	0.75	0.75
Ss.	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Min.	25.0	25.0	50.0	50.0	50.0	50.0	0.25	0.25	0.75	0.75	0.75	0.75
%25	25.0	25.0	50.0	50.0	50.0	50.0	0.25	0.25	0.75	0.75	0.75	0.75
%50	25.0	25.0	50.0	50.0	50.0	50.0	0.25	0.25	0.75	0.75	0.75	0.75
%75	25.0	25.0	50.0	50.0	50.0	50.0	0.25	0.25	0.75	0.75	0.75	0.75
Max.	25.0	25.0	50.0	50.0	50.0	50.0	0.25	0.25	0.75	0.75	0.75	0.75

Polyurethane and acrylic varnish started to be drawn with a force of 0.75 N regardless of wood type, age period and section direction.

Abrasion and scratch resistances were made statistically with explanation. Since the resistors have the same strength, the standard deviation value is seen as 0.

Apart from the standard deviation value, the Pandas library also provided the minimum, maximum, 25%, 50% and 75% data distribution. As it can be seen in the table, there is no statistical change since there is no difference in strength.

Since the forces are the same, the probability distribution success in the data is 100% and this is the same for all resistance values.

CONCLUSIONS

It has been determined that polyurethane and acrylic varnish have the same abrasion resistance (50 rotations). Water-based varnish is half as much as polyurethane and acrylic varnishes. Regardless of the wood type, age period and section direction, polyurethane and acrylic varnish started to be scratched with 0.75 N. The water-based varnish showed a scratch resistance of 0.25 N, independent of the varnish wood type, age period and cross-section direction. It has been determined that polyurethane and acrylic varnish have the same scratch resistance. It showed 1/3 scratch performance of water-based varnish, polyurethane and acrylic varnishes. Polyurethane and acrylic varnish application can be recommended in terms of abrasion and scratch resistance.

REFERENCES

Hon, D. N. S. (2001). Weathering and photochemistry of wood. *Wood and cellulosic chemistry,* 2, 512-546.

Kopac, J., Sali, S. (2003). Wood: an important material in manufacturing technology. *Journal of materials processing technology, 133(1-2), 134-142.*

Ross, R.T. (1972). Painting Testing Manual Biological Deteration of Paints and Paints Films, *ASTM Special Technical Publication*, 13. Edition of the Gardner-Sward Handbook, Philadelphia, 366.

Söğütlü, C., Nzokou, P., Koc, I., Tutgun, R., Döngel, N. (2016). The effects of surface roughness on varnish adhesion strength of wood materials. *Journal of Coatings Technology and Research*, 13(5), 863-870.

Sudiyani,Y., Takahashi, M., Imamura, Y., and Minato, K. (1999). Physical and Biological Properties of Chemically Modified-Wood Before and After Weathering, *Wood Research* 86,1-6.

TS EN 15185. (2013). Mobilya – Furniture - Assessment of the surface resistance to abrasion, *Turkish Standards Institution*, Ankara.

TS EN 15186. (2013). Furniture - Assessment of the surface resistance to scratching, *Turkish Standards Institution*, Ankara.

Williams, R. S. (2005). *Handbook of wood chemistry and wood composites*. *Weathering of wood*, 139-85.

Williams, R. S., Plantinga, P. L., Feist, W. C. (1990). Photodegradatin of Wood Effects Paint Adhesion, *Forest Products Journal*, 40 (1), 45–49.

Acknowledgment
This study was produced from Kenan KILIÇ's M. Sc. Thesis.