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# SOME PHYSICAL AND MECHANICAL PROPERTIES OF ANTIQUE AND FRESH CUT PİNUS SYLVESTRİS AND ABİES NORDMANNİANA SUBSP. BORNMULLERİANA WOODS

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***Abstract:***

*Historically, the older houses and barns of various ages have been widely built from wood in the rural and highland areas across the country of Turkey. These wooden houses and barns are in dilapidated, abandoned or deteriorated conditions and they are left to a slower destruction or these buildings are demolished for use as firewood.*

*The recycled sound wood from old buildings may be called 'Antique Wood' and has been found new life at the furniture industry in Kastamonu, Turkey. In addition, there is a growing demand for the high priced antique wood furniture by the customers.*

*The objective of this study is to determine and to compare some physical and mechanical properties, including shock resistance, of an antique wood which has been in service for more than 100 years, and fresh cut Pinus sylvestris L. and Abies nordmanniana subsp. bornmulleriana Mattf. woods. The findings may help furniture makers to use more antique wood for high priced furniture and to reduce the waste of using it as firewood.*

***Key words:*** *Pinus sylvestris L.; Abies nordmanniana subsp. bornmulleriana Mattf.; Antique Wood; shock resistance.*

## INTRODUCTION

In earlier times across Turkey, the most prevalent forms of shelter and barns have been built from wood or logs. Even stone or brick built houses had wooden ceilings and roofing. Especially in rural areas and highland country, houses had been built entirely from wood.

Most of these old wooden houses and barns of various ages are in dilapidated, abandoned or deteriorated conditions. The demolished and outmoded houses are generally being left to a slower destruction by decay, insects and rodents. Some of these houses are torn down for use as firewood, even though there is a possibility to find sound wood among these which can be recycled. Wood does not deteriorate (except shock resistance) in strength or stiffness from age alone for periods of 100 years or more under appropriate condition (Sherwood 1975). The mechanical properties of *Castanea sativa* Mill. wood samples taken from 100, 110, 120 year old houses in Artvin and Ordu provinces located in the northern part of Turkey were examined (Palasoglu 2012).

Recycled beams and boards from 100 years or more old buildings and barns may be called 'Antique Wood' and has been found new life in the furniture industry in Kastamonu. Kastamonu province located in the north western Black Sea Region of Turkey. Further information about Kastamonu may be seen from Kastamonu governorship web page (2013). Because of superior wood properties, a growing demand but limited sources, antique wood is a premium and high priced material for furniture making, such as tables, coffee tables, dresser cabinets, dining tables, jewellery boxes etc. In addition, some people especially prefer to buy furniture made from antique wood.

The aim of this study is to determine and to compare some physical and mechanical properties, including shock resistance, of antique wood and the fresh cut wood of Scots pine ( *Pinus sylvestris* L.) and Turkish fir ( *Abies nordmanniana subsp. bornmulleriana* Mattf.). The reason for selecting Scots pine and Turkish fir is that, these species are the naturally growing major tree species in Kastamonu region (Sarıbaş 2008). Thus, these species were used predominantly for building and barn construction for local forest villagers in earlier times in order to eliminate long distance transportation difficulties. Actually, they had used wood species that they found around. Solid beams, squared with an axe during that time or debarked logs were mostly used for these old houses because of the unavailability of sawmills close to the villages. The findings may help antique wood furniture makers and the customers. It also helps to reduce wasting this antique wood resource as firewood.

### *Material*

Scots pine (*Pinus sylvestris* L.) and Turkish fir (*Abies nordmanniana* subsp. *bornmulleriana* Mattf.) were selected for the determination of some physical and mechanical properties of antique wood which had been in service for approximately 100 years and fresh-cut wood as the control samples of these species which had not been used before.

To get the antique wood, the firewood dealer was firstly visited. A 15x20x210 cm Scots pine beam was selected which had been squared with an axe when it was used in building and appeared to be sound. After cross-cutting, the centre of the selected beam was observed and any severe internal decay was eliminated. Secondly, samples of antique woods were obtained from antique furniture makers in Kastamonu. The fresh-cut control samples of these species were obtained from one of the local sawmills.

### *Methods*

The determination of selected physical and mechanical properties of antique wood and fresh- cut control wood samples were measured by using related Turkish Standards (TS) for both species. Accordingly, the test samples were prepared for each test.

For density measurement, 20x20x30mm pieces were cut and oven-dried for 24 hours at 102±3°C (TS 2472, 1976). The radial and tangential swelling and shrinkage were determined according to TS 4084, 1983 and TS 4083, 1983 respectively by using 20x20x30mm pieces.

The shock and bending strengths were determined by using TS 2477, 1976 and TS 2474, 1976 standards respectively. The sample dimension 20x20x300mm for shock and bending strengths were prepared and conditioned at 65% relative humidity and 20°C for 10 days before testing in a humidity controlled room. The mean values analysed with t-test at 95% probability level by using SPSS-17 packet program for each of the test results.

## RESULTS

### *Test Samples*

Being a biological material, the wood properties show significant variations between trees and within the tree with height and radial positions outward from the pith. Therefore, taken test samples from the tree trunk should be specified for the experiment. On the other hand, it is almost impossible to specify test

samples other than naming the antique wood and the fresh-cut control species in this study. Only, the average number of rings per centimetre is given in Table 1 for the test sample specification. Thus, the fresh-cut control test pieces may not be representative as is generally required in the preparation of control species.

***Density***

The average wood density of Scots pine and Turkish fir is given in Table 1 for their both antique and control wood samples. According to t-test between means, there was no significance in Scots pines. However, there was a significant difference at 95 % probability level in Turkish fir. The number of annual rings per centimetre may cause these differences.

*Table 1*

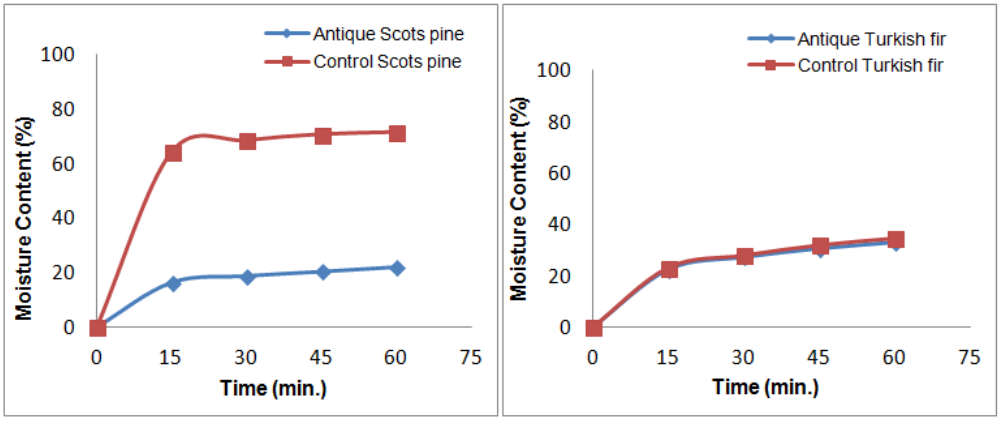
***Wood Density of Scots pine and Turkish fir***

| Species | | Number of annual rings per cm | Number of Samples | Density (gr/cm$^3$) | Probability (P) |
|---|---|---|---|---|---|
| Scots pine | -Antique wood | 8.75 | 10 | 0.444 (±0.024) | 0.123$^{ns}$ |
| | -Control sample | 3.58 | 12 | 0.424 (±0.033) | |
| Turkish fir | -Antique wood | 2.17 | 12 | 0.373 (±0.015) | 0.000$^{*}$ |
| | -Control sample | 9.14 | 7 | 0.438 (±0.027) | |

ns: not significant, P>0.05; *:significant, P≤0.05

***Swelling and shrinkage***

The test samples were soaked in water for 72 hours for the determination of tangential and radial dimensional changes. During this period, the increase in moisture content (Fig. 1) and the tangential dimensional changes in per cent (Fig. 2) is plotted against time at 15, 30, 45, 60 minutes. As shown in Fig. 1, the moisture content percentage increased and reached almost maximum level in 15 minutes. The tangential swelling almost reached maximum level at 15 minutes, parallel to moisture content increases with the exception of Turkish fir dimensional change which there were increasing fluctuations in 45 and 60 minutes (Fig. 2b). Radial dimensional changes showed the same pattern as in the tangential direction. This situation may be explained by the anatomical and the impregnation characteristics of the species. The lower moisture content and dimensional changes of antique wood are expected (Table 2 and Table 3). Because, wood in buildings is exposed to diurnal annual climatic cycles for years that may cause the hygroscopic characteristic and dimensional changes of wood to diminish with time as expected.




a b

***Fig. 1***

***Moisture content changes in antique wood and control samples of Scots pine and Turkish fir in one hour: a - Scots pine; b - Turkish fir.***

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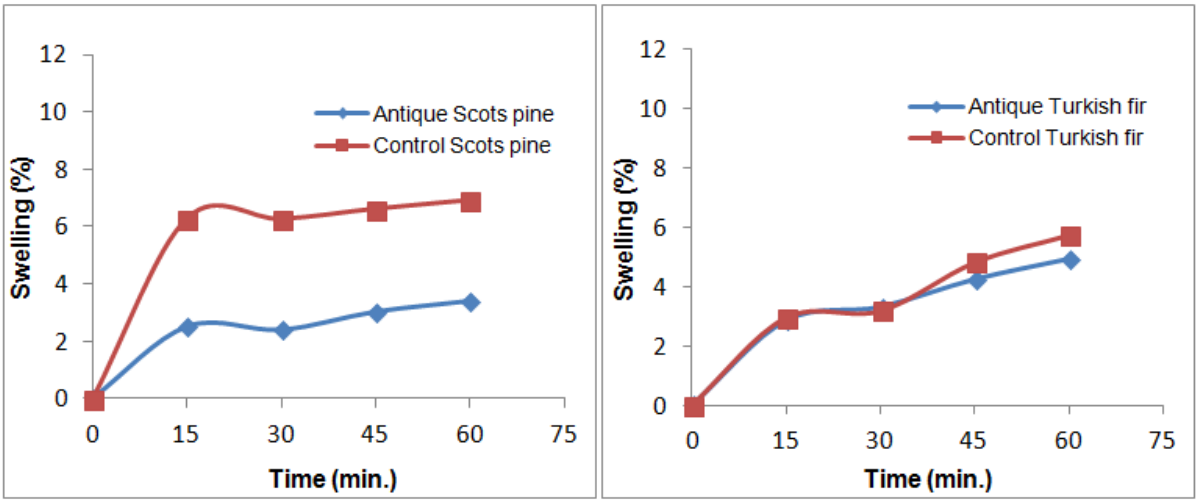


a b

***Fig. 2***
***Swelling percentage in antique wood and control samples of Scots pine and Turkish fir in one hour: a -Scots pine; b - Turkish fir.***

*Table 2*

***Swelling and water absorption of Scots pine and Turkish fir***

| Species | Number of Samples | Tangential Swelling (%) | Probability (P) | Radial Swelling (%) | Probability (P) | Total Water Held at 72 hours (%) | Probability (P) |
|---|---|---|---|---|---|---|---|
| Scots pine -Antique wood | 10 | 7.164 (±0,672) | 0,003* | 4.712 (±0,736) | 0.504$^{ns}$ | 102.004 (±6.334) | 0.002* |
| -Control sample | 10 | 8.167 (±0.642) | | 4.480 (±0.783) | | 137.046 (±29.436) | |
| Turkish fir -Antique wood | 10 | 8.849 (±1.043) | 0.04* | 3.730 (±0.500) | 0.000* | 138.850 (±5.528) | 0.008* |
| -Control sample | 7 | 9.832 (±0.577) | | 6.008 (±0.385) | | 122.370 (±15.744) | |

ns: not significant, P>0.05; *:significant, P≤0.05

*Table 3*

***Shrinkage of Scots pine and Turkish fir***

| Species | Number of Samples | Tangential Shrinkage (%) | Probability (P) | Radial Shrinkage (%) | Probability (P) |
|---|---|---|---|---|---|
| Scots pine -Antique wood | 10 | 6.816 (±0.614) | 0.02* | 4.402 (±0.429) | 0.192$^{ns}$ |
| -Control sample | 10 | 7.411 (±0.410) | | 3.993 ±(0.854) | |
| Turkish fir -Antique wood | 10 | 8.179 (±0.664) | 0.002* | 3.381 (±0.465) | 0.000* |
| -Control sample | 7 | 9.205 (±0.354) | | 5.186 (0.384) | |

ns: not significant, P>0.05; *:significant, P≤0.05

***Strength Properties***

The modulus of elasticity in bending, bending strength and dynamic bending strength are given in Table 4 and Table 5 for both species; Scots pine and Turkish fir. The strength values are parallel to the density in Table 1. A slight increase in density increased the strength values (Table 4 and Table 5). The modulus of elasticity means for the antique wood and control samples showed significant differences according to t-test results at 95% probability level for both species. The impossibility of ensuring control test pieces as in this type of experiment makes it difficult to make conclusions what strength tests are the best testing method for further evaluation of antique wood. However, the modulus of elasticity in bending seems to be the appropriate test method for the evaluation of prehistory of the material because of the significant differences between mean values for both species.

*Table 4*

***Bending Strength and modulus of elasticity of Scots pine and Turkish fir***

| Species | Number of Samples | Bending Strength ($N/mm^2$) | Probability (P) | Number of Samples | Modulus of Elasticity ($N/mm^2$) | Probability (P) |
|---|---|---|---|---|---|---|
| Scots pine -Antique wood | 10 | 73.556 (±7.228) | $0.401^{ns}$ | 7 | 7941 (±293) | 0.000* |
| -Control sample | 9 | 70.251 (±9.444) | | 7 | 6681 (±589) | |
| Turkish fir -Antique wood | 10 | 62.433 (±4.940) | $0.377^{ns}$ | 8 | 6419 (±487) | 0.026* |
| -Control sample | 10 | 64.582 (±5.655) | | 7 | 7223 (±738) | |

ns: not significant, P>0.05; *=significant, P≤0.05

*Table 5*

***Dynamic bending strength of Scots pine and Turkish fir***

| Species | Number of Samples | Dynamic Bending Strength ($kpm/cm^2$) | Probability (P) |
|---|---|---|---|
| Scots pine -Antique wood | 10 | 0.296 (±0.040) | $0.284^{ns}$ |
| -Control sample | 9 | 0.343 (±0.127) | |
| Turkish fir -Antique wood | 10 | 0.261 (±0.066) | $0.000^{*}$ |
| -Control sample | 8 | 0.404 (±0.050) | |

ns: not significant, P>0.05; *:significant, P≤0.05

**CONCLUSION**

1) As generally known, it cannot be expected that one piece of wood will behave exactly the same as any other piece. However, ensuring representative control test samples is very difficult or almost impossible when dealing with historical or antique wood.

2) Antique wood has lower dimensional changes as compare to fresh-cut wood. This is an expected result. Because, antique wood constantly subjected to cyclic humidity changes for years may diminish the hygroscopic characteristics of wood.

3) The strength and stiffness evaluation types of experimental studies for antique or historical wood, the modulus of elasticity in bending test may be the best indicator for the evaluation. It should be included

among other selected testing methods. Even though, Sherwood (1975) states that, except for shock resistance, wood does not deteriorate in strength or stiffness from the age alone for a period of 100 years or more.

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