THE EFFECT OF CUTTING DIRECTION AND TYPE OF WATER-BASED VARNISH ON SOUND TRANSMISSION LOSS IN ORIENTAL BEECH (FAGUS ORIENTALIS L.) AND SCOTS PINE (PINUS SYLVESTRIS L.)

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<table>
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<th>Key words</th>
<th>Abstract</th>
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<td>Transmission loss,</td>
<td>Oriental Beech and Scots Pine are widely used in interior decoration and</td>
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<td>Water-based varnishes,</td>
<td>the furniture industry. In this study, the effects of tree species,</td>
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<td>Cutting direction</td>
<td>cutting direction and water-based varnishes (single and double component)</td>
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<td>on sound transmission losses were analyzed. 18 mm thick wooden material</td>
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<td>was cut in tangent or radial direction and varnished with single or double</td>
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<td>component water-based varnish. The sound transmission losses of the</td>
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<td>wooden material were determined by an impedance tube method.</td>
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<td>According to the results of the research, double component water-based</td>
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<td>varnish and the tangent cut positively affected the sound transmission</td>
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1. INTRODUCTION

It called a voice to be heard on the audio material ambient vibrations which evoke the human ear [Karabiber, 1992]. The noise is considered as unwanted sound. Better methods are needed in order to come to sound the human ear is the subject of acoustic science development operations. Acoustical science, the formation of sound insulation, is the science dealing with the principle of unlimited strength and characteristics [Demirkale, 2007]. Today, community life and particularly technological development, depending on the importance of sound and sound, a dimension of sound, a little more with each passing day increases [Özkan, 2001]. As a result, noise control in places, has emerged as an important issue and has gained importance due to rapid urbanization [Kayılı, 1981].

Uyanık (1995), impedance tube method normal angle of sound absorption coefficient at the typical building materials 250, 500, 1000, 2000 and 4000 Hz frequency range have been measured. B400 impedance tube model used in the experiment, samples were cut to 69 mm in diameter was used. Mineral fibers in comparison, PVC coated glass fiber, fiberglass supplemented rock wool, aluminum, gypsum, cement board, glass wool, rock wool, vinyl covered gypsum, plywood, velvet-covered plywood, perlite plaster, normal plaster, hardboard, artificial foam, polystyrene, felt, straw, foam rubber, velvet, leather and carpets used. Measurements were made comparisons of sound absorption performance of the base material.

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Wang ve Torng (2001) The tests performed with rock wool as a natural resource and swallow sound close to the results of tests it was determined that the feature fiberglass. Koizumi et al (2002) have worked with composite materials made from natural bamboo fiber and glass wool to close the show that has established sound absorption properties. Also reported as a result of the surface of the bamboo fiber coated with a material that provides much better sound scavenging by plywood.

The aim of the use of timber in the interior design of the space to pass to the other side of the sound spaces is to provide aesthetic value as well as preventing sound insulation. However, the sound insulation properties of the material used is not known sufficiently. Regarding this issue, the range of applications and cannot be achieved with adequate information in scientific studies. More concerts in the application, theater, radio and television studios have been built in places such as the audio and acoustic measurement seems to be carried out in these venues.

However, this work, in places such as homes or work places; developing technology and noise brought along the vital habits accordingly livable is required to maintain that level of respect. The materials used in the interior design, the scope of sound transmission and switching of voice; positive results of the properties defined by numerical data can be drawn by designers and practitioners is an important fact can be taken. For this purpose, studies of deciduous trees oak trees in areas that have a significant interior decoration aimed to determine the sound transmission loss.

2. GENERAL INFORMATION

**In the Acoustic Properties of Wood Materials Structures**

Structures in, lounge in the trees organizer of sound waves made surface coating material, sound absorbing, preventive effect of bad sound echo caused by sound reflections on the walls is important. Due to the reflection of sound waves in the room with bare walls and smooth surface sound echoes occur. With the opening of a window or a few sound echo can be avoided. However, this drawback is continuous and the surest way to avoid absorbing the sound of wall fabric, felt, wood chips or fiber sheets, it is possible to be covered with plywood and solid wood. Theater, concerts, edits sound waves in the air in places such as cinemas and lecture halls, on the walls to absorb, covering the ceilings and floors made of wood are used. So a portion is absorbed by absorbing sound waves [Berkel, 1970].

**Sound**

Of hearing can detect the small pressure fluctuations in the environment or is called an elastic sound sensation created by the change. For the detection of these pressure fluctuations in sound pressure balance in the environment to form around certain features (in terms of size and speed fluctuations) should not have. Mass will spread within the sound source and the sound pressure fluctuations which are needed for the formation of the elastic medium [Çalışkan, 2004].

That does not mean anything until unwanted sounds or noise is considered to be affected. Music sounds as it detects a noise defined as a person by another person. Therefore, the subjective noise (subjective) it is possible to say that one side [Çalışkan, 2004].

Sound transmission loss
A barrier of sound passing through the sound transmission loss is called the loss suffered. These losses as a logarithmical size are given in dB and shows directly toward a reduction in terms of dB [Sirel, 2000]. Sound transmission coefficient of the fact that a proportion of the acoustic energy sound transmission loss of movement or sound loss (TL)
\[
\text{TL}=10 \log \left( \frac{1}{\tau} \right)
\]

It is recognized. Sound transmission loss of a wall element can be roughly estimated at about analytical methods but although the real value of sound transmission in the container as a suite called special laboratory conditions (ISO 140) determined by the measurement being made. Analytical approaches to multi-layered wall should be used with caution. Sound Transmission Coefficient sound transmission loss denominated \( \tau = 10 - \text{TL}/10 \) It can be written as.

Wood in the sound transmission loss of the tree structure, specific gravity, surface consisting of regular or irregular and uneven, the moisture content, thickness varies depending on temperature and frequency. Wood structure, the higher the specific gravity, surface roughness, moisture and heat increases sound transmission loss increases [Berkel, 1970].

Octave Bands
The human ear is sensitive to sounds from 16-20000 Hz. This frequency range of different sources in 16 Hz - 16 kHz or 20 Hz - 20 kHz are given. If the ear is most sensitive frequency it is 3000 Hz. It covers the normal speech frequency range from 200 to 10,000 Hz. Frequencies in the 1000-2500 Hz range to be intelligible speech is important. Phones transmit sound across the range of 500-3000 Hz. Music has a wider frequency range of speech in general. In examining the entire frequency range to be sensitive ear for noise control provisions may not be required. 50-100 Hz vicinity of the lower limit, the upper limit if the case may be 6 or 12 kHz [Özburgüven, 2008].

The frequency range is too wide to be examined and analyzed, thus prolonging the use of fixed-width tape. Therefore, the analysis will be examined in the audio frequency range is divided into sections given octave band name.

Sound and noise analysis in octave bands and \( \frac{1}{n} \) octave band \( (n = 2, 3, 10, 12, \text{etc.}) \) Have been used to standardize. Although generally used octave analysis, 1/3 octave band analysis is widely used in measurement standards [Özburgüven, 2008].

3. MATERIALS AND METHODS

Scotch Pine (Pinus silvestris L.):
Sapwood wide annual rings are distinctive and slightly wavy. The color is red, are easily handled, is more domestic wood ratio. It is very resinous. A specific gravity of 0.49 g / cm3 [Gürtetekin and Alex, 2002]. Radial and tangential sections are bright, which frequently is a softwood tree species and large resin canals. Especially building materials (doors, windows, paneling, floor and ceiling coverings) to be used for furniture and turning [Örs and Keskin, 2001].

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**Oriental Beech (Fagus orientalis L.):**
Mature trees is from woody group. Although natural wood reddish white, then baked brick red color. Annual rings are distinct. Pink is a color close to [Gürtekin and Oguz, 2002]. Medium is a type of tree processed easily hardness. Bend is convenient. In a humid environment it is not stable. Therefore it used in more confined spaces. A specific gravity of 0.63 g / cm3. Furniture, flooring, veneer, plywood and turning. Also, packaging, toys, farming tools, railway sleepers, are used in production of barrels and utensils [Örs and Keskin, 2001].

**Water-Based Varnishes**
Water-solvent paints; alkyd, polyester, produced from many types of varnish and polyurethane acrylic resin next. While there is no pigment in bright varnish, a matting elements in matt varnish. This system dispersion starts to hold an important place in the industry, and emulsion polymerization prepared on the basis of [Johnson,1997].

The thermoset structure is not converted molecules in the layer. In this structure the first degree transverse forces molecules form large molecule by establishing cross-links. The arrangement of the molecules are thermoplastic structure is linear (linear) and II. degree are held together by forces. Thermoset embodiment, the polymerization is completed by a reaction initiator or high-temperature impact and unaffected by temperature after hardening layer. The thermoplastic structure is softened with heat-hardened layer effect; it reaches back to the old rigidity effect of heat removed from the environment. Both thermoplastic as well as thermoset shape of the molecular structure, organization and degree of polarity of the polymer will affect its physical properties. Thermoses structure established with first degree crosslinks forces, chemical bonds are direct, heat, water, solvent and rugged mechanical stresses. As the number of cross-links increases rigidity and stiffness. Few are more flexible layer established in the vineyards [Sönmez, 2006].

Varnishes used in experiments one-component water-solvent from the resin primer Johnson Company, while the two-component acrylic modified polyurethane copolymer resin was obtained from Kimetsan company.

Varnish types used in experiments and is coded as abbreviated in Table 1.

| Table 1. Abbreviations for the kinds of water-solvent varnish used in the experiments |
|---------------------------------------|---|
| Modified acrylic polymer resin (Fill) | T |
| Two-component acrylic modified polyurethane copolymer resin (last layer) | Ç |

**Method**

**Preparation of test samples**
Test samples from first-class wood, straight grained, knot, crack, tulle formation and growth defects without color and intensity are not noticeable, reaction without wood, have undergone fungal and insect damage, the annual rings of the surfaces perpendicular to the sapwood part of ASTM D 358 and TSA has been prepared on the basis set in 2470. Air dry the samples were cut in humidity as a draft measure 110x110x22 mm. Examples ASTM D 3924 and TS

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20 °C, relative humidity and 2471 is based on the literal weight until they reached 60 ± 5% in the conditioning cabinet. Later, the 18 mm thickness is measured and will be ø100 ø29 mm.

**Varnishing of test samples**
In the varnishing process varnishes ASTM D 3023 test material has been carried out according to specified principles and industrial applications. In terms of ready application layer lacquer hardener and water rates so as to not adversely affect the performance and the company is in accordance with manufacturer recommendations. 2 times 2 times filling and topcoat is applied. Gun tip clearance during the varnishing of samples with two component varnish and air pressure is adjusted in accordance with the recommendations of the manufacturer. 20 cm from the sample surface and the varnish gun was moved horizontally.

Fill layers of fiber swelling in the treated sample surface was removed by sanding No. 300. Considering the amount of water solvent varnish amount of solids in the implementation of each floor of 70 g / m2 and it was performed by applying two coats. The two-component water-solvent varnish solution equipped varnish laboratory water using specially produced 0.7 mm tip clearance with varnish gun for solvent varnishes and paints, single component water-solvent primary resin it is because faced with adversities practice with the gun with a soft bristle varnish brush filling + topcoat It was administered.

**Sound transmission loss measurement**
Ingestion to calculate the volume takes place in rather difficult conditions. Sound absorption coefficient measurements can be performed in an anechoic room. This room for standards ISO 140 or ISO determines the measurement conditions in the traditional tube / DIS 10 354 standard are applicable [ISO / DIS 10534 standard]. Both methods were not conducted under natural conditions. The first method is just the place for frequency measurements and measurements take a long time. Other methods in the form of small samples are measured after the material to be measured is done in a tube [Farina ve Torelli, 1997].

This study was conducted by the impedance tube measurements of sound transmission loss method. Measurements can be made in the frequency range of 50-6400 Hz. during measurements, the ambient temperature and humidity 50'01 23%. The experimental setup where the measurements “ISO 10534-2 Acoustics-Determination of sound absorption coefficient and impedance in impedance tubes- Part-2: Transfer-function method” It complies with international standards. For the determination of the sound transmission loss due to frequency wood in test 5, measurements were made on 3 specimens for composite sheet material. The measurement system used to determine the sound transmission loss depending on the frequency is schematically shown in Figure 1.

![Impedance Tube Measurements](image)

Figure 1. Depending on the frequency of the sound transmission loss measurement [Brüel&Kjaer, 2006]

Evaluation of Data
After the sound transmission loss in impedance tube assembly of sample used in the experiments carried out by measuring the statistical analysis of data obtained using SPSS 15.0 software package was used. Sound transmission loss of material in the tree; material cutting direction, varnish type, with double and triple in their comparisons and composite materials; composite material type, surface type varnish coating types and comparisons made with their double and triple, single, in order to determine whether effective dual and triple factor "One Level Analysis of Variance "(ANOVA) and" Multilevel Analysis of Variance ",(MANOVA) was conducted. Determined differences p <0.05 according the event of a significant in statistical terms to determine the significance between groups of these differences "Least Significant Difference" (LSD: Least Significant Difference) test and pair wise comparison test (Duncan) and the data on each frequency level. Analysis of the factors taken to try to leave their rankings is determined by success in homogeneity group between them.

4. RESULTS

Intensity
Air drying of the wood species used in the experiment some statistical data on the concentrations is given in Table 2.

Table 2. Air dry densities (g / cm³)

<table>
<thead>
<tr>
<th>Kind of tree</th>
<th>N</th>
<th>Air dry density</th>
<th>Standard deviation</th>
<th>variance</th>
<th>Xmin.</th>
<th>Xmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oriental Beech</td>
<td>10</td>
<td>0.62 gr/cm³</td>
<td>0.01</td>
<td>0.000313</td>
<td>0.61</td>
<td>0.62</td>
</tr>
<tr>
<td>Scotch Pine</td>
<td>10</td>
<td>0.51</td>
<td>0.03</td>
<td>0.010701</td>
<td>0.48</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Sound transmission loss at different frequencies of wood species
According to the sound transmission loss value, statistically significant differences between the values of the frequencies are different levels of tree species has been found in the sound transmission loss. When tree species of whether there is effective at different frequencies depending on the type of tree p<0.05 value is smaller than 0.05 coefficient of variation it has been found to be effective over the entire frequency range of sound transmission loss.
According to the test results, tree comparison in sound transmission loss at different frequencies types of materials at high sound transmission losses of 50-800 Hz frequency range was obtained in Beech material, 1000-5000 range Hz frequency values were obtained in my Scotch pine.

Sound transmission loss at different frequencies according to cutting direction
Statistically significant differences between the values of the different frequencies of sound transmission loss in the intersection direction were level. Intersect whether the direction is effective at different frequencies (p<0.05) When the variance analysis for determining the 50-1250 Hz frequency range of variation coefficient 0.05 'greater than (p<0.05) intersect direction because it has been found to be ineffective in sound transmission loss. However, the coefficient of variation of frequencies of 1600-5000 Hz frequency range of less than 0.05

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(p≤0,05) direction because the intersection has been found effective in sound transmission loss.

The highest sound transmission loss value According to the statistical results in the 2000-2500 Hz and 4000-5000 Hz frequency tangent sections of the tangent in the 1600 and 3150 Hz frequencies were equivalent in value and radial section. From 2000-2500 Hz and 4000-5000 Hz frequency values obtained in a radial section.

**Sound transmission loss at different frequencies according to varnish types**

Statistically significant differences between the values of the sound transmission loss in sound transmission loss values for different frequency levels according to the data type of varnish was found. That is effective in sound transmission loss at different frequencies of the varnish type (p≤0,05) When the variance analysis for determining the coefficient of variation in all frequencies less than 0.05 (p≤0,05) effect was found varnish type in the loss of sound transition for that. Accordingly, the audio frequency sound transmission loss and cutting direction differentiation was statistically significant (P≤0,05).

Accordingly, the highest sound transmission loss value of 50-400 Hz frequency range and 4000 Hz, double component is obtained from water-based varnish type and control samples, 500-2500 Hz frequency range were obtained in dual-component varnish type. In addition, 3150 and 5000 Hz frequency direction worth the sound transmission loss values for all samples were at levels equal to each other and close. The lowest value of 50-2500 Hz sound transmission loss in the frequency direction and the value of 4000 Hz frequency range were obtained in a single-component varnish type.

**Material type tree-cutting direction different frequency sound transmission loss in value of bilateral interaction**

Wood-cutting direction according to the type of sound transmission loss data were statistically significant differences between the values of the different frequency sound transmission loss in value of bilateral interaction. Material type tree-cutting direction that is effective in different frequency of bilateral interaction (p≤0,05) When the variance analysis for determining the coefficient of variation in all frequencies less than 0.05 (p≤0,05) when the wood type-intersection direction of the bilateral interaction has been found effective sound transmission loss.

The highest value in the 50-500 Hz range sound transmission loss of the wood cutting direction türü- interaction based on statistical results in Beech radial material, in the 630-Hz range scotch samples were obtained from the tangent

**Sound transmission loss of material type lacquer tree species different frequency values of binary interaction**

According to the type of wood lacquer sound transmission loss data type it was found statistically significant differences between the values of the different frequency sound transmission loss in value of bilateral interaction. Wood type lacquer type of interaction that no is effective at different frequencies (p≤0,05) When the variance analysis for the determination, coefficient of variation in all frequencies less than 0.05 (p≤0,05) is, wood türü-

type of varnish was effective bilateral interaction in sound transmission loss. The highest sound transmission loss value of wood varnish type of binary interaction type-pine-double component according to the statistical results was obtained in samples from the entire frequency range. The lowest value is close to the entire frequency range of 50-5000 Hz was obtained in beech-single-component material.

**Sound transmission loss in the intersection direction lacquer types of binary interaction of different frequencies**

According to the cutting direction of the lacquer type sound transmission loss data were statistically significant differences between the values of the different frequency sound transmission loss in value of bilateral interaction. Cutting direction-varnish species that is effective in different frequency values of binary interaction (p≤0,05) When the variance analysis to determine the coefficient of variation in all frequencies less than 0.05 (p≤0,05) from the intersection because the varnish type the bilateral interaction has been found effective in sound transmission loss.

Accordingly, cutting direction-varnish type of bilateral interaction at the highest sound transmission loss value of 50-400 Hz frequency range of radial-control, radial-double component and tangent-double component was obtained in the sample, the maximum volume transition in the 500-5000 Hz frequency range loss tangent-double component was obtained in the sample. Besides the low sound transmission loss value of 50-400 Hz frequency range tangent-single-component, tangent-control and radial single-component was obtained in the sample, 500-5000 Hz frequency value of the lowest sound loss radial single-component range and tangential. It was obtained in a single-component sample.

**Type of wood-cutting direction-varnish type of sound transmission loss in different frequency value of trilateral interaction**

Sound transmission loss data according to the type of wood-cutting direction lacquer species were found statistically significant differences between the values of the different frequencies of sound transmission losses in the triple interaction. When the material type of tree-cutting direction-varnish type in different frequency value of trilateral interaction we look at the ANOVA analysis of whether effective coefficient of variation in all frequencies less than 0.05 (p≤0,05) that for wood species-cutting direction-varnish species has been found effective in the triple interaction of sound transmission loss.

According to the homogeneity of the group as a result of tree species-cutting direction-varnish type triple interaction at the highest sound transmission loss value of 50-400 Hz frequency range in beech-radial-control samples, 500-5000 Hz frequency range I-tangent-double components were obtained in samples.

**5. CONCLUSIONS AND RECOMMENDATIONS**

Wood in the sound transmission loss of the tree structure, specific gravity, and surface consists of the rough, the moisture content; thickness varies depending on temperature and frequency. Wood structure, the specific gravity increases, the roughness of the surface, moisture and heat increases sound transmission loss is increasing also intercellular passage in

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one of the ash and trees in the material structure (especially pine) differences in extractives amount is thought to be effective in sound transmission loss [Berkel, 1970]. In the literature, as noted in the specific gravity of wood, surface roughness and the frequency is increasing in line with sound loss. According to another example of the specific gravity of sessile oak more, have higher surface roughness and structure of the porous than other tree species, the sound of the intracellular gate in located in pure ash content of other wood species from the more composed and pine trees located in the, excessive amount of extractives It is thought to be effective in the transition loss.

Smaller molecules and linear constellation of sound transmission loss in a single-component varnish layer in thermoplastic structures low, larger molecules thermoses featured two components in built branched polymeric structure water-based varnish layers of sound transmission loss is high. b result in water-based varnish system in single-component varnish of thermoplastic structure no sound loss in a negative way, the sound transmission loss of the thermoses structure consisting of two component lacquer is thought to affect positively.

Tangential section and Variations in summer wood participation rate in the radial section, the sessile oak as the maker tangential section of ÖZİŞ radial section is oriented toward self transmission tubes are thought to influence the sound transmission loss of not if. In the literature section tangential sequence differences as specified in the cell, the tree said to be effective in sound transmission loss materials.

Dual-component water-based varnish application of sound transmission loss has affected in a positive way. Double component with high consist of specific weight of the wood lacquer large molecule and homogeneous samples of the found sound transition loss at enhancing effect, single-component varnish the low level of sound transmission loss of wood specific gravity with thermoplastic structure is adversely affected.

Hollow sections of building material difference in the tangential transition are effective in loss of audio. Besides, two component lacquer thermoses structure of sound transmission loss is considered to affect positively. The effect of arrangement of the cells in tangential section in the bilateral interaction and double-component varnish can be said that the large molecule and consists of a homogeneous structure of the material found in the effect of increasing the sound transmission loss.

Tripartite interaction in wood as well as the specific weight gain double component is likely to water-based lacquer thermoses structure of sound transmission loss increase, as will be found in the impact and the vacancy rate in the tangent section of the sound transmission loss of less formed by the radial cross-section increasing in influence.

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