University of West Hungary
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Theses of Ph.D. Dissertation

NEW METHODS and ASPECTS of WOOD SCIENCE in UTILIZATION of POPLAR SPECIES IN PARQUET PRODUCTION

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1. TIMELINESS, REASONS and OBJECTIVES of the RESEARCH

Timeliness

Production of traditional hardwood parquet has shrunk and the market share of multi-layer parquet has increased, of which nowadays the most popular and well-known is the three-layer parquet.
In Europe, the back layer and middle core of the three-layer parquet are usually made from pine wood. In Hungary we need to import it, though. At the same time, enough quantity of poplar species is available. The latest tests show that knots have weaker effects on strength in case of poplar than that of pine species, and its mechanical properties can be significantly improved by densification.
To chose the raw material for testing we considered the following:

- Hydrothermal treatment is widely used in case of the top layer made from durilignosa, which improves shrinkage and swelling properties of the wood, however, it gives it a darker colour and more homogeneous tone.

- Pannonia poplar has similar physical and mechanical properties to spruce; and its plantation-growing system makes it important for industrial utilization.

Reasons

There has been no scientific reference to applicability of Pannonia poplar in parquet production and improving its durability by steaming in foreign or Hungarian technical literature.
In 2006 some tests were carried out in Kecskemét branch of Graboplast Zrt. as the company wanted to find a substitute for spruce, purchasing of which had become rafter unreliable. In 1970s, Zalahaláp site of Bakonyerdő Erdészeti és Faipari Zrt. produced oak parquet with poplar back layer, but only occasionally. There was no documentation of reasons for cancelling it after a short period.
With the support of NKTH-4/011/2005 „Wood Resource" Jedlik Ányos National Wood Research and Development Project laboratory tests on parquet samples (produced by Graboplast) were carried out in the Institute of Wood Science at the University of West Hungary .
Graboplast is going to utilize the results of this complex research in its manufacturing. I hope domestic wood industry and economy will benefit from my thesis.

Objectives

The main objectives of the thesis were to summarize the results of necessary research on how to use poplar hybrid as a substitute for spruce in parquet production as well as to contribute to industrial utilization of it. The phases of the research were the following:

- Choosing the most suitable poplar hybrid species after surveying technical literature.
- Analyzing changes in physical and mechanical properties of poplar hybrid raw material caused by its hydrotermic modification.
- Discovering changes in physical and mechanical properties of parquet caused by presently used pressing technology while gluing parquet layers.
- Comparing relevant properties of the three-layer parquet from poplar hybrid and that of spruce.

2. TEST MATERIALS and METHODS

Wood material used for testing

Pannonia poplar (Populus x euramericana cv. Pannonia) was steamed for six days at the temperature of 95 °C and the pressure load of the applied technology was 1.2 kN/mm^2.

Test samples

Test samples were prepared according to related standards for physical and mechanical testing. 20x20x30 mm (radial x tangential x filamental) test samples were made out of unsteamed, steamed and steamed – pressured sawn wood (32 pieces of each type) to measure their bending strength and modulus of elasticity. To measure density, shrinkage and hardness we also used 20 x 20 x 30 mm size samples, 25 of each type.

To test physical and mechanical proper ties of finished parquet we used seven different layer structures:

1. oak top, spruce middle core - spruce back layer (O-S-S)
2. oak top, spruce middle core - poplar back layer (O-S-P)
3. oak top, poplar middle core - spruce back layer (O-P-S)
4. oak top, poplar middle core - poplar back layer (O-P-P)
5. poplar top, poplar middle core - spruce back layer (P-P-S)
6. poplar top, spruce middle core - back layer (P-S-S)
7. poplar top, spruce middle core - poplar back layer (P-S-P)

24 samples (sized 14 x 42 x 330 mm) of each type were produced to measure their bending strength and 27 samples (sized 14 x 25 x 50 mm) to test tensile strength of click lock in O-S-S and O-P-S layer structures.
Parquet samples with oak (O-S-S) and steamed poplar (P-S-S) top layer were produced according to relevant standards to test their strength, adhesion, resistance to shock, scratch, wear, water and chemicals.

Methods

To test physical and mechanical properties of wood we applied related standards as follows:

Physical

1. Density (MSZ 6785 – 3:1988) of raw material
2. Shrinkage and swelling (MSZ 6786 – 18:1989 and MSZ 6786 – 9:1989) of raw material
3. Impermeability and chemical resistance (MSZ EN 13442:2003) of end product

Mechanical

1. Bending strength (MSZ 6786 – 5:1976)
   – of raw material and end product
2. Modulus of elasticity (MSZ 6786-15:1984) of raw material and end product
3. Brinell – Mörath hardness (MSZ EN 1534:2000) of raw material and end product

4. Resistance to shock (MSZ EN 438-2-2000) of end product
5. Scratch resistance (MSZ EN 438-2-2000) of finished product
6. Wear resistance (MSZ ENV 13696:2000) of end product
7. There is no standard for tension tests of click lock in end products

Centesimal digital scales and callipers were used to measure volumetric and dimensional changes in air-dried, wet and absolute raw material. INSTRON 4208 universal material tester was used to measure bending strength, modulus of elasticity and Brinell-Mörath hardness of the material. Resistance to shock was tested with a device suitable for “ball dropping” measurement, scratch resistance was tested with a spin disc device. A Tabler tester for wear resistance and Tinius Olsen H 10KTA material tester for tension tests of click lock were applied.

3. SUMMARY of NEW SCIENTIFIC RESULTS; THESES

3.1. Effect of steaming on anisotropy of poplar hybrid.

I have been the first to analyse the effects of atmospheric steaming on poplar raw material. I stated that **values of shrinkage anisotropy of steamed material show a significant improvement, more than 20%, besides a more advantageous aesthetically more homogeneous appearance.** It means that parquet produced from steamed raw material has less propensity for warping than that of unsteamed. Test data show that bending, elasticity and hardness properties of raw material do not change significantly during steaming.

3.2. Density changes during pressing

Tests prove that **density of wood significantly increases during parquet production due to the applied technology in pressing, however steaming in production process decreases this level.** Presumably, density of wood could be more significantly improved by stronger pressing, the effect of which could be seen after steaming as well.

3.3. Shrinkage and swelling properties of the pressed material

I assumed that **shrinkage and swelling properties of poplar raw material show less improvement as a result of pressing than that of atmospheric steaming, but they do improve, and consequently values of shrinkage and swelling anisotropy are higher.** Anisotropy of pressed poplar raw material increased by 16.5% contrary to that of unsteamed. It can be assumed that parquet produced from pressed poplar hybrid has less propensity for warping and keeps better shape than that of unmodified.

3.4. Comparison of click lock in Pannonia poplar and spruce

The samples with poplar middle core seemed to be stronger than that of spruce during testing tensile strength. Analysing the data of glue-free click lock in parquets, it is clear that the value in the test sample with poplar middle core is appr. 13% higher than that of spruce.

It is **proved that the stability of click lock in parquet with poplar middle core can be significantly increased contrary to that of spruce.**

3.5. Using poplar for back layer

Analyzing the average values of three-layer parquets with different structure, it is clear that the three test samples with the lowest static bending strength have their back layer from poplar. Modulus of elasticity in parquets with spruce back layer is more advantageous. Consequently, **using of poplar back layer in parquet production is not favourable.** However, its use as middle core does not make the technical properties of the parquet worse.

OPTIONS for INDUSTRIAL UTILIZATION

On the base of test results I proved that both the natural and modified poplar raw material can be utilized for manufacturing more valuable wood products.

The wood material gains a darker tone after steaming, and its shrinkage anisotropy decreases significantly. Due to that, steamed poplar can be used for production of parquet, furniture or other quality-goods.

Test data of pressing procedure while gluing of three layer parquets show that further improvement is required in hardness and strength of poplar by appropriate level of pressing.

According to test results, poplar hybrid is suitable for using it as middle core of the parquet, for click lock in it is much stronger than that of spruce.

However, using poplar raw material as a top or back layer is not favourable, for they suffer more bearing.

4. NOTES

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