FOREST AND WOOD PRODUCTS RESEARCH AND DEVELOPMENT INSTITUTE

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„Comparison of two-layer and multi-layer flooring parquet boards for use in under heated floors under the variable environment humidity”

Research Report

Customer: SIA „Amber Wood”

Contractor: SIA „Meža un koksnes produktu pētniecības un attīstības institūts”

Research carried out according to the Contract No. 172-12/22 PT, 29/12/2022.

Jelgava 2023

Content of research:

The research was carried out in accordance with the Contract concluded on December 29, 2022 no. 172-12/22 PT between the customer SIA "Amber Wood" and the contractor SIA "Forest and Wood Products Research and Development Institute". The aim of the study is to compare two-layer and multi-layer flooring parquet boards for use in under heated floors in conditions of changing air humidity, to prepare a methodology and to carry out the necessary research.

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This study is for information purposes only and cannot be used to support legal decisions

1. Situation analysis and methodology

Wooden floorboards on heated floors dry out more during the heating period under the influence of increased temperature, as a result of which internal stresses are formed in them, changes in their geometric dimensions occur. Today, different combinations of wood materials are used for wooden floors load-bearing layers - plywood, HDF, OSB, softwood and hardwood lumber and various other materials. Each of these materials has its own properties, and when they change, the properties of the product also change.

The aim of the research is to compare the suitability of two parquet constructions - with a supporting layer of birch plywood (multi-layer parquet) and with a supporting (bottom) layer of OSB (oriented strand board) for use on heated floors (two-layer parquet). In both cases, the toplayer uses oak with a thickness of 3.2 mm. In both cases, Stalgen® Super White hard wax with a two-layer finish is used for surface finishing.

Table 1 Materials used in research

Total thickness, mm	Multi-layer	Two-layer
Oak top layer thickness, mm	12	12
Width of the covering surface of the parquet, mm	185	185
Top layer material thickness, mm	3.2	3.2
Bottom layer material	Birch plywood	OSB
Bottom layer mat. density, kg/m3	720 ±50	610 ±30
Bottom layer mat. thermal conductivity, W/(mK)	0.17*	0.13*
Thickness of the supporting material, mm	8.7	8.7
Glue type for gluing top layer	PU HOT-MELT	PU HOT-MELT
Adhesive layer thickness, mm	0.1	0.1
Surface finish with Stalgen® SuperWhite hardwax	X	X

**According to EN13986*

Research methodology

An electric warm floor layer is created on a 100 mm concrete base, parquet boards with a width of 185 mm and a length of 1 meter are glued with polyurethane one-component parquet glue. Floor heated for 240 hours at 30 °C (maximum permissible temperature for heated wooden floors usually 27 °C to 29 °C). Room temperature between 16 °C and 20 °C, room humidity from 50 % up to 60 %. Next, the surface temperature of the parquet top layer was determined, the deformations of the boards in the width (shrinkage) and cross-section (convex and concave cup), the relative humidity of the wood for the top layer (wood surface humidity) were measured.

Compact report

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Logger	EBI 20-TH
Serial	62301070
Logger description	Paraugs
Measurement remark	
Location	
User	

Measurement

Start time	20.09.2022 14:48:29
Interval	1 Hour
Measurements	311

User information

Curve	Unit	Name			Min. limit	Max. limit
1	%rH				40,00	60,00
	Statistic	Min	Max	Duration		
		29,5	100,0	12:22:00:00		
2	°C				16,00	22,00
	Statistic	Min	Max	Duration		
		15,1	28,8	12:22:00:00		

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Subsequently, in the second stage of the study, the stability of the floor structure was tested in extremely high and low air humidity conditions. Initially, 100 % air humidity was maintained for a one week with the underfloor heating turned off. After that, the floor was heated and kept at an elevated heating temperature. The following diagram shows the curve of relative air humidity and air temperature at the top of the floor during the course of the study.

2. Results of Research

1. Surface temperature

After passing 240 hours, the following values are determined:

- concrete surface temperature in the range of 30 °C;
- surface temperature for multi-layer parquet 29.6 °C, S = 0.8;
- surface temperature for two-layer parquet 29.08 °C, S = 1.08.

2. Deformation of boards in width

Using gap gauges, the following values are determined:

- size reduction in width for the top layer of multi-layer parquet 0.129 ± 0.084 mm;
- size reduction in the width of the upper layer for two-layer parquet 0.134 ± 0.076 mm

Absolute size reduction in width expressed as a percentage of the original size width of 185 mm:

- for multi-layer parquet 0.07 ± 0.045 %;
- for two-layer parquet 0.072 ± 0.04 %.

3. Longitudinal deformations of boards

No significant changes in board length were observed for any of the materials.

4. Cup of boards

The cup of the boards (convex cup) depends significantly on the direction of the fibres of the oak top layer. In the course of the research, the cup was determined using gap gauges. The observed convex cup is higher for multi-layer parquet, maximum values up to 0.3 mm.

5. Wood moisture content

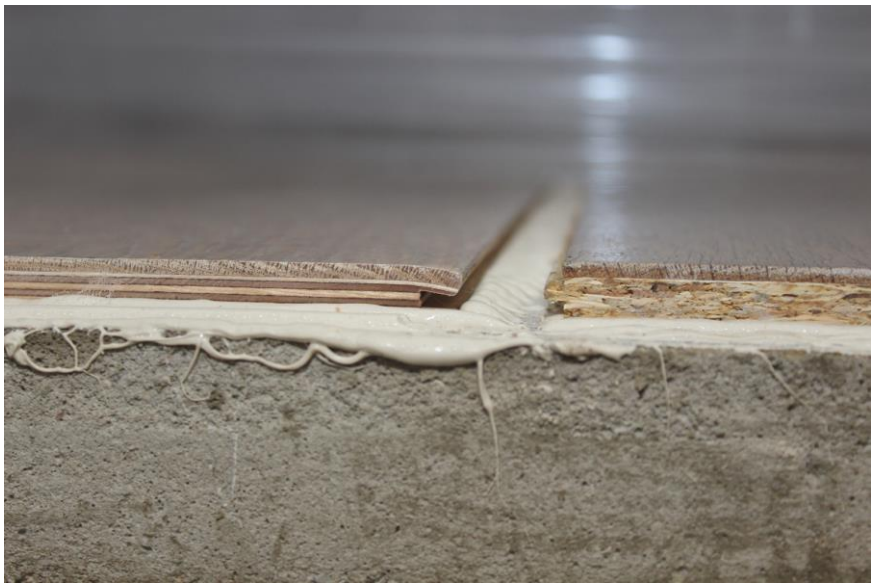
Observed relative wood moisture content after 240 hours of heating in the oak top layer:

- for multi-layer parquet W = 5.4 %, S = 0.3 %;
- for two-layer parquet W = 5.5 %, S = 0.3 %.

6. Influence of increased air humidity and condensate water

Condensation formed on the surface of the floor due to increased air humidity when the warm floor was turned off.

High compressive stresses were formed in the upper layer



After the end of the experiment, when the air humidity had decreased to 30 %, gaps were observed between individual floor boards.

Using gap gauges, the following values are determined:

- size reduction in width for the top layer of multi-layer parquet 0.313 ± 0.24 mm;
- size reduction in width for the top layer for two-layer parquet 0.374 ± 0.21 mm..

3. Conclusions

1. Two-layer parquet conducts heat a little worse if the product layers are of the same thickness. The surface temperature of multi-layer parquet is 0.52 °C higher than the surface temperature of two-layer parquet. This is due to the slightly lower density of OSB compared to birch plywood. However, it can be seen that the difference is small, it could not significantly limit the practical application of the heated floor in operating conditions. At the time of measurement, the room temperature was 16 °C, the surface temperatures 29.6 ºC and 29.08 °C. It can be concluded that the two-layer parquet heated floor is 4 % less efficient compared to the multi-layer heated floor.
2. The deformations of the boards in width (cup) are practically the same for both types of parquet. It should be taken into account here that OSB material is used in the product with fibres placed in the transverse direction. This ensures high dimensional stability of the product in width. In practice, after 10 days in extreme heating conditions, where the temperature of the floor was constantly around 30 °C, the total width change for 185 mm wide material does not exceed maximum of 0.2 mm. It can be concluded that both materials are suitable for use on heated floors from the point of view of possible width deformations, that is, the formation of gaps between the boards.
3. Visually no deformations have been observed in the longitudinal direction of the boards. It should be noted that in the case of the study, the boards are glued to the base technologically correctly according to the instructions of the glue manufacturer. The study does not provide data on possible deformations that could occur if the boards are not glued down to the subfloor or are glued with other types of adhesives.
4. Convex cup of planks has been observed up to 0.3 mm. Multi-layer parquet has a higher convex cup than two-layer parquet. In all cases, the middle of the board has tried to rise from the concrete base by high air moisture content conditions. When birch plywood changes in humidity, there is not only a greater amount of deformations, but also greater stress forces in the product, because the layers of wood work individually perpendicular to adjacent layers. The largest tension forces in birch plywood explain the largest convex cup. In the case of low-quality plywood, such stresses can cause delamination, in which case the parquet will be irreversibly damaged.
5. No delamination or significant transverse deformations were observed after one week of the samples with the floor heating turned off in air humidity from 90 % to 100 %, when the dew point was reached on the floor surface and condensation formed. When the floor heating was turned on again and the air humidity was reduced, an increased formation of gaps between individual floor boards was observed. It can be seen that shortening deformations have formed in the material, which are irreversible. This is due to increased compression stresses in top layer. The deformations caused by these stresses have exceeded the elastic deformation limit of the material. Gaps of up to 0.5 mm have been observed between individual boards, which is 0.3 % of the width of the material before testing.

4. Summary

The products have passed the test equally well, the differences between them are small, they are interchangeable products. The following conclusions can be mentioned:

- multi-layer parquet conducts heat a little better, the difference in heat capacity is about 4 %. Since the top layer in both cases is oak with a density of 750 kg/m2, the heat transfer from the parquet to the room by equal temperature difference between top layer and air is not affected by the bottom layer (solid wood, OSB, plywood, etc.);
- two-layer material with the bottom layer of OSB has smaller internal stress. The two-layer floor remains evener under high stress conditions than multi-layer floor.
- both materials withstand the effects of increased humidity equally well. No delamination or significant deformations were observed. However, it should be taken into account that if the top layer of the floor is in contact with water in a liquid state for a long time, as a result of the high moisture content of the material, large compression stresses are formed in the wood and they cause permanent transverse shortening deformations. After re-drying the wood, the remaining transverse shortening deformations result in visually observable gaps between individual floor elements. The processes affect the materials of both structures equally intensively. The gaps observed during the experiment reached 0.5 mm after drying.