



Construction and Material Issues and Usage Prospects of Antique Wooden Beam Floors

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Aim of the study

- **Identification of the floor structure and analysis of the stresses created by static and dynamic loads**
- **Test of the strains of the panels and of other layers of the structure**
- **Analysis of the designs of individual panels and of the selection of wood species with particular characteristics and their impact on the stability of panel dimensions**
- **Evaluation of the safety of a given structure**
- **To chose the appropriate and optimum means of its preservation**

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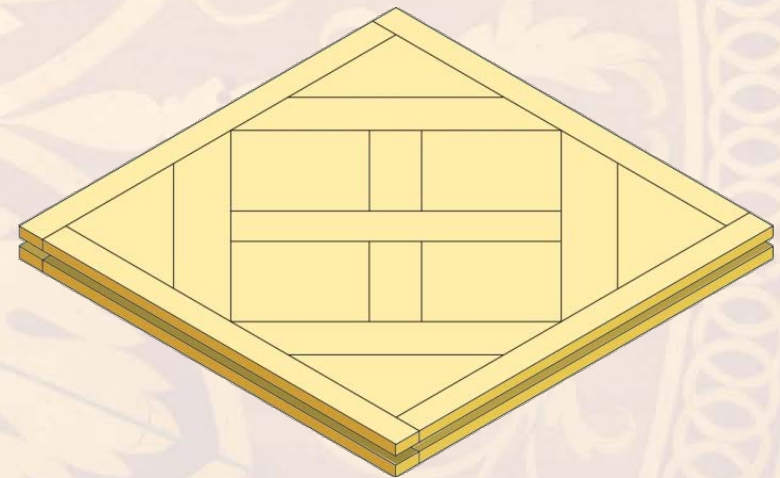
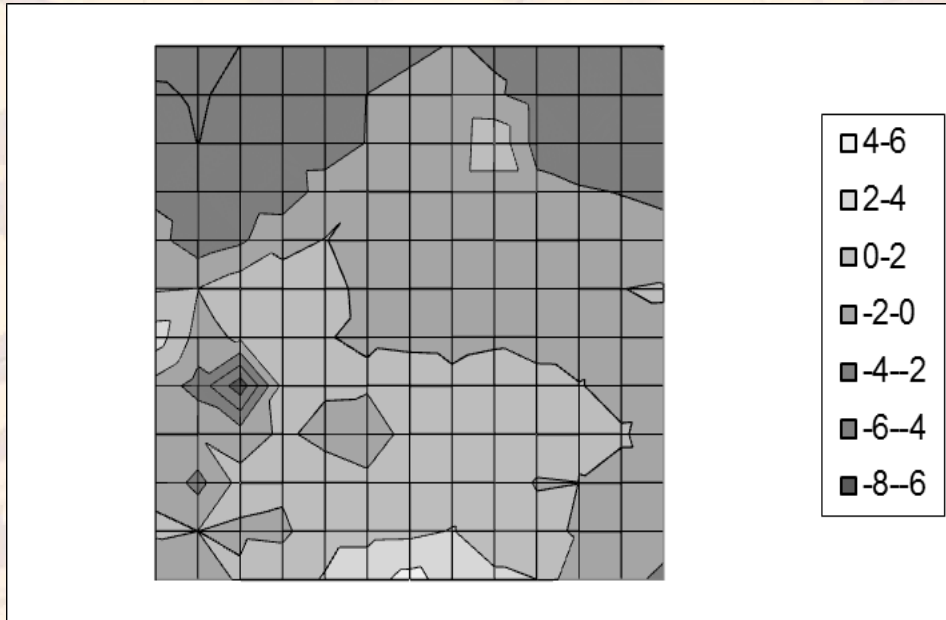
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Proposed assessment criteria

- **Antique wooden floors with beam structure had to support static and dynamic loads during usage (e.g. related with traffic or dance taking place on them). Even the static and dynamic loads that remain below the endurance limit cause elastic and plastic strains of wood that can disappear together with the force or can become fixed.**
- **They influence the force distribution inside the wood and can be combined with desorption stresses, intensifying deformations and cracks.**
- **Repetitive stress cycles result in material fatigue, which can damage its structure (Rozanska et al. 2011).**

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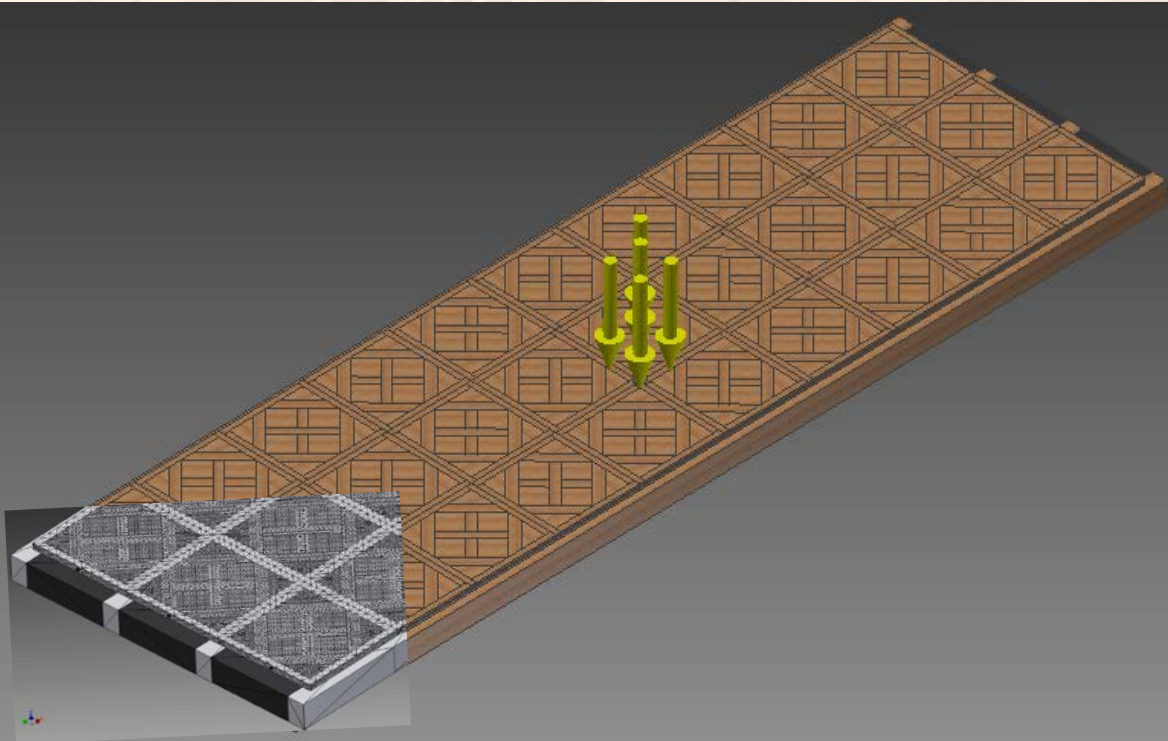
- We analysed the strains caused by static and dynamic loads and tested dimension stability and deformations of panel elements and other structural layers of the floor.



Surface elevation map – numerical values of deformations in mm

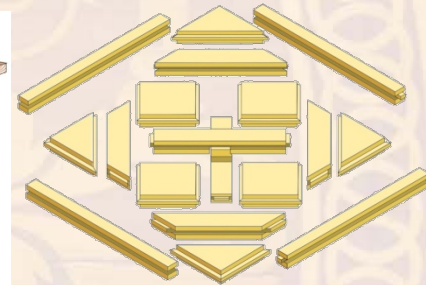
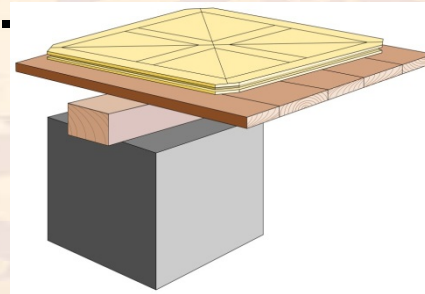
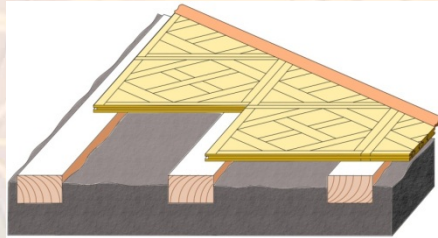
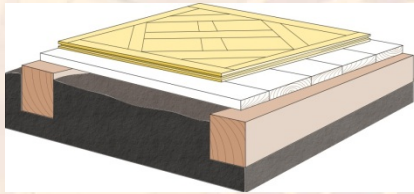
Proposed assessment criteria

- The capacity to transfer own and usage-related (live) loads was assessed through numerical calculations determining the stresses in floor elements, with the use of the finite element method (Rozanska et al. 2012b), while the capacity to transfer dynamic loads was checked through shock absorption tests in accordance with PN-EN 14808:2006 (Rozanska et al. 2013).



Proposed assessment criteria

- The importance of given structural layers was compared by analysing the resistance of floors with continuous support (joists laying on a mineral base and joists placed in a layer of sand) and parquets with punctual support. We also compared the resistance of floors that had various variants of subfloor structure.



- The analysis of the influence of profiled woodwork joints used between panel elements on the character of their work and the loading degree were carried out with the use of a series of numerical analyses (Rozanska et al. 2012a). The input data for the analysis were determined on the basis of preliminary tests. We determined, among others, the density and static bending strength of individual parquet elements, which allowed us to determine the actual, current wood grade.

Proposed assessment criteria

- In order to assess the usage prospects of antique wooden floors, we characterised the relations between mechanical, physical and chemical properties of wood and the changes of the structural and material properties of the floors made of it.
- We tested the resistance parameters of antique floors (especially their hardness (PN-EN 1534:2011), elasticity (PN-EN 408:2012), as well as surface properties: resistance to abrasion (PN-EN ISO 5470-1:2001) and resistance to scratches (PN-EN 438-2:2005) (Swaczyna et al. 2011).

Conclusions

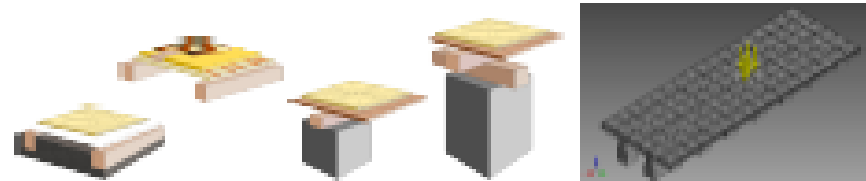
- **Some antique decorative wooden floors fulfil contemporary usage requirements, in spite of wood degradation caused by the passage of time and by the usage conditions.**
- **Their state of preservation permit the transfer of their own load (of the parquet layers) and of usage loads.**
- **In accordance to contemporary standards, concentrated usage loads in residential buildings amount to, as a minimum $Q_k = 2 \text{ kN}$ (for instance for a leg of a piece of furniture) or even 3 kN for a grand piano leg (PN-EN 1991-1-1).**
- **However, in case of antique parquets we are not able to obtain a “perfectly flat” surface that is preferred in contemporary parquets.**



Usage requirements

Wooden floors are assessed in two aspects: visual - just after they are made, and quality - in a longer usage perspective. The main purpose of a floor is to transfer dynamic loads caused by the traffic taking place on its surface, and static loads of the objects placed on it through the joists, the subfloor and the insulation layer. The purpose (floor covering) is to be top, wear layer and the external finishing element of the floor (PN-EN 12023-1:2015). The purpose, and especially its wear layer, should be resistant to abrasion and humidity, warm to the touch, sound, noise absorbing, resistant to light, resistant to deformation, chemical resistance or antiseptic, easy to keep clean, durable and aesthetic. The subfloor is an element of floor structure used to fix the purpose, which transfers static and dynamic loads including vibrations. Additionally, it also levels the support structure, provides thermal and acoustic insulation, and helps to maintain good microclimate conditions in the interior (improving the accumulative properties of the partition). The subfloor connected with the support structure must also have similar mechanical properties, should be placed directly on the support structure, avoiding a settling sagging in and causing an uneven distribution of the position of joints supported only by expansion in the voids in accordance with PN-EN 12023-2:2015. The requirements for the subfloor depend largely on the type of purpose. Purpose made of hard materials resistant to compression and bending, such as laminates, can be placed on a subfloor with multi-layer resistance properties. The insulation layer should consist of an anti-humidity layer placed below the structure on the ground and in the structure below the floor covering, a layer of thermal insulation and a layer of sound insulation.

In Antiquated Material



The research covers antique parquet from 18 rooms in 21 sites dating from the 18th century and located in South-Eastern Poland. The parquet are located in the Lubuskie Voivodeship, in the Palaces in Gorzków, Szamotuły and Proszowice, in the Palaces of the Bishops of Poznań in Gostów, Pleszew and Łódź in Łódź, as well as in manor houses in Skarżysko, Szepietów, Szydłowa, Polkowice, Inowrocław, Krasowice, Goposzew, Tarnobrzeg, Wrocław, Proszowice, Łódź, Warszawa, Warszawa, Wągrowiec and Tarnobrzeg, as well as buildings in Katowice and Wrocław in Germany, Yugoslavia.

Assessment criteria

Antique wooden floors with beam structures had to support static and dynamic loads taking shape (e.g. related with traffic or items taking place on them), from the static and dynamic loads that results below the surfaces limit cause static and plastic strains of wood that can change together with the form of the beams floor. They influence the stress distribution inside the wood and not its connection with insulation structure, identifying deformations and cracks. As a result stress cycles result in material fatigue, which can change its structure (Rozczińska et al. 2011) in order to assess the usage prospects of antique wooden floors, we investigated the relations between mechanical, physical and chemical properties of wood and the changes of the structural and material properties of the floor made of it. We tested the resistance parameters of antique floors (especially their hardness (PN-EN 1509:2011), stability (PN-EN 408:2002), as well as surface properties: resistance to abrasion (PN-EN 404:2010) and resistance to corrosion (PN-EN 408:2002) (Rozczińska et al. 2011). We analyzed the stresses caused by static and dynamic loads and lateral dimension stability and deformations of panel elements and other structural layers of the floor. The capacity to transfer static and dynamic loads was assessed through numerical calculations determining the stresses in floor elements, with the use of the finite element method (Rozczińska et al. 2012a), with the capacity to transfer dynamic loads was checked through shock absorption tests in accordance with PN-EN 12667:2004 (Rozczińska et al. 2012b). The importance of grain structure layers was compared by analyzing the resistance of floors with continuous support (jointed layers) on a virtual base and joint placed in a layer of sand) and parquet with partial support. We also compared the resistance of floors that had various variants of subfloor structure. The analysis of the influence of profile elements joint and between panel elements on the structural effect and the loading degree were carried out with the use of a series of numerical analyses (Rozczińska et al. 2012c). The input data for the analysis were determined on the basis of preliminary tests. We determined, among others, the density and static loading average of individual parquet elements, which allowed us to determine the actual, normal weight grade.

Concluded form

Some antique decorative wooden floors fulfil contemporary usage requirements, in spite of wood degradation, caused by the passage of time and by the usage conditions. Their state of preservation proved the benefit of their use, both (of the purpose layers) and of usage loads, in accordance to contemporary standards, conventional usage loads in residential buildings amount to, as a minimum, 20-25 kN (for instance for a bag of a plate of furniture) or even less (for a panel game leg (PN-EN 12023-1:2015)). However, in case of antique parquet use we are not able to obtain a "perfect floor" surface but it is preferred in contemporary parquet.

