OVERVIEW OF HANGING FURNITURE AND ITS CONSTRUCTION

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Abstract

The topic of this paper is hanging furniture. Nowadays, the principle of hanging furniture is applied in many furniture groups: these are mainly kitchens, bathrooms but also living and office spaces. In general, hanging furniture can be found in almost all definable furniture groups that interact with the building structure. Furniture is suspended from vertical walls or structures but also from ceilings or other auxiliary horizontal structures. The article defines the basic subdivision of suspended furniture into shelving systems, upper cabinets, lower cabinets and ceiling cabinets. In addition to basic aspects such as functionality of the furniture, principles of assembly and disassembly, manufacturability and transportability, safety is an important aspect of hanging furniture. A comprehensive assessment of the overall safety of the application of hanging furniture is required, which does not focus rigidly on the furniture part of the issue, but also perceives the interaction with the building or structure on which the furniture is hung. The paper describes the research started in this area, which is divided into sub-areas: the construction material of the hanging furniture, the connecting fittings of the hanging furniture structure, special connecting fittings, hanging fittings including anchoring technology, and finally the material design of the supporting structure (wall, ceiling).

Keywords: hanging furniture, dowels, construction material, connecting fittings, construction material, hanging fittings

INTRODUCTION

Nowadays, when we have the possibilities to furnish our homes with various furniture items according to our liking and at the same time we try to make the most of our small spaces for storing furniture items [1]. One of the options is hanging furniture, whose history is linked to the invention and patenting of the dowel in 1911 in England by John Joseph Rawlings, when it was an impregnated hemp cord, with bovine blood [2]. Until then, dowels were made using wooden blocks placed in drilled holes with a hand drill. The invention of the plastic dowel in 1957, made of nylon by Fischer S. It allowed us to hang even heavier objects, as the function of plastic dowels was higher than that of wooden dowels, including the development of screw and bolt fasteners from the original conventional nails [2]. Thanks to these advances, we can now hang various objects on walls without much difficulty. Another pioneer is chemical anchors. It is a chemical reaction between two components that starts its reaction after mixing the two components [2]. Thanks to this technology, we can hang much heavier objects than was previously possible.

The History of Hanging Furniture

Hanging furniture is an integral part of our private and public interiors. One important pioneer of hanging furniture is the required String Wall Storage System, when in 1949 its authors, Nisse and Karin Strinning, won first place in a competition for simple interior library furnishings [3]. It is a modular wall storage system that allows its owner to configure it according to his requirements by purchasing individual modules, which he uses to build the wall storage system in his home (Fig. 1). An undeniable advantage is their further possible variation in the sense of browsing the storage of individual modules. The basic load-bearing element is the metal „grid“ with which the individual modules are fixed. This construction solution is fixed to the wall using classic dowels and screws. This modular system is manufactured today under the brand name String.

Another important designer of hanging furniture was Dieter Rams, who in 1960 designed the Vitsoe wall system, which is to some extent directly based on the String hanging system of 1949 [3]. Rams

1: *Example of the String 1949 wall storage systém [3]*

simplified his design to aluminium profiles, on which the individual bodies are placed according to the height and proportion requirements of their owner, made of bent metal flat profiles (Fig. 2). The undeniable advantage of this furniture object is its variability and the possibility of replacing the individual bodies with others. This system is also produced to this day.

2: *Example of the Vitsoe wall system 1960 - Dieter Rams and its design [3]*

A later important hanging furniture element is the Bookworm variable „bookshelf“ designed by Ron Arad in 1993 [4]. It is a system of dividing partitions that are also the supporting element of the whole structure and are connected by a common moulded element. The original design was in metal, but in agreement with Kartell, this design was adapted to be manufactured in extruded PVC and then subsequently in ABS [4]. This adaptation subsequently allowed for greater bends in the connecting element and therefore the subsequent final shape. This system is still in production to this day (Fig. 3).

3: *Example of the 1993 Bookworm by Ron Arad and its design [4]*

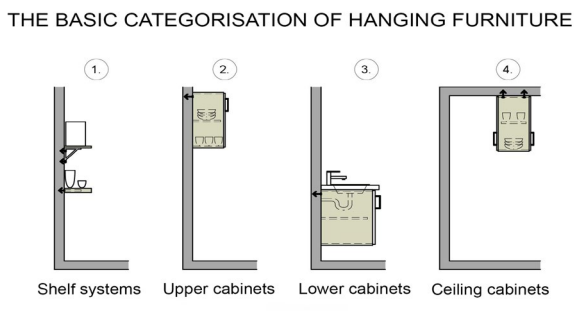
An important suspension system of the first decade of the 21st century is the ceiling suspension system. This system had been used before, but in 2004 Jean Nouvel came up with an innovative solution for a suspension system from the ceiling. His creation is the Graduate ceiling hanging shelving system from Molteni [5]. It is a shelving system whose supporting structural element is metal rods suspended from the ceiling, on which shelves made of overhanging material are arranged using adjustable stops. This system allows the bookcase to be placed in a space without being tied to the floor (Fig. 4).

4: *Example of Graduate 2004 - Jean Nouvel and its structural design [4]*

Basic Classification of Hanging Furniture

Hanging furniture can be classified according to several criteria: where it will be placed; what function it will have in the interior; the size of the hanging furniture; how it will be hung on the wall (hanging hardware and dowels); what material the construction will be made of; etc.

The most important factor is the location of the hanging furniture in the interior. Hanging furniture can be divided into four categories according to the technical difficulty of hanging: shelves including shelving systems, upper cabinets, lower cabinets and ceiling cabinets (Fig. 5).



5: *Example of the basic categorisation of hanging furniture*

Shelving Systems

Shelving systems, or individual shelves, are the most basic hanging furniture. This category has been in use since ancient times, when massive wooden planks were inserted into the resulting holes in the walls (a niche, or also called a niche, is usually a decorative depression in the thickness of the masonry of a building.), which were stuck and then walled both ends into the wall [6]. This solution gave us a storage system for putting small items on the walls, in this case just into the walls. The development of separate shelves without the need to be stuck into the wall, came with the development of anchoring technology (dowels themselves). This technical solution made it easier to create storage or storage spaces on the walls. Today, shelves and shelving systems are primarily used to store small furniture items such as books, crockery, jewellery, plants etc. We must not forget the decorative items that are an integral part of our interiors, e.g. various souvenirs from our travels, statuettes, art objects, framed photographs, etc.

The methods of hanging shelves and shelving systems can be divided into three different ways of attaching them to the wall. The first way is that the shelf itself has a hole drilled in it, using which and a screw to attach the shelf to the wall. The second way is that the shelf itself contains a hanging fitting which allows it to be fixed to the wall. The third and final way is by means of auxiliary support elements which transfer the load-bearing capacity of the shelves to themselves. These can be divided into hanging spikes on which the shelf or shelving system slides, and metal angles. The use of these methods of attachment to the wall allows me to make greater use of shelves and shelving systems in our interiors (Fig. 6).

Upper Cabinets

Upper hanging cabinets are the category of hanging cabinets that are most visible in kitchens, especially for storing kitchen equipment (plates, bowls, glasses, mugs, etc.) The depth of these cabinets is generally half that of the lower hanging cabinet category and therefore they are also subject to fewer requirements, including variability in terms of furniture hanging hardware, where they can be divided into three groups according to their location: in the cabinet, in the back of the cabinet and, last but not least, part of the cabinet. When the furniture hanging hardware in question is applied to the construction material. In short, it becomes part of the construction material, usually DTD and MDF. The category of hanging upper cabinets is already a standard part of every kitchen cabinet, especially in terms of the need to store kitchen items, and mainly thanks to this category we use the maximum space under storage.

Top cabinets are not only found in kitchen cabinets, in some cases they are also used in other rooms of a given interior. The main function is still to store items. A possible typical example, specifically in my home. When we were limited by the size of the bathroom space including other spaces to find a solution to store towels and hygiene products without having to place them in another room. The resulting solution was hanging overhead cabinets that were placed over the entry door to the room and positioned above the built-in toilet bowl. Where hygiene products and towels were stored separately, of course. Another use is living room walls, which are not as massive as in the last century. In some cases these living walls took up one entire wall in a room [6]. Nowadays these living walls have been replaced by smaller storage units either placed on the floor or, for maximum use, hung on the wall of the room. A separate group is specifically the hanging overhead cabinets in office spaces, which mainly store massive binders of important documents. This group should be particularly taken into account when selecting the hanging hardware and its connection (Fig. 7).

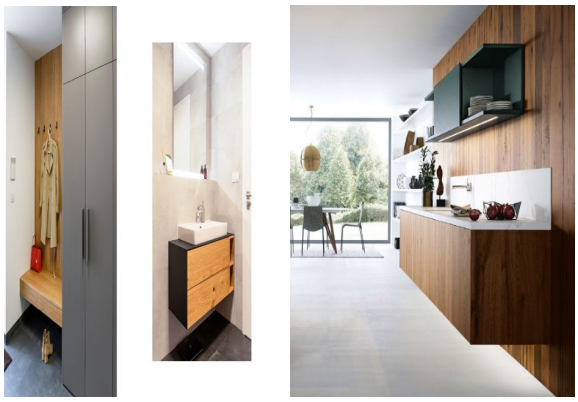
6: *Example of shelving systems and shelves including design solutions in interiors [4]*

7: *Example of another use of upper hanging cabinets in interiors [4]*

Lower Cabinets

Bottom hanging cabinets are the category of hanging furniture that shows up most in bathroom design from a practical standpoint, as previous locations of bathroom cabinets reached the floor. But the effect of moisture and water in the bathroom resulted in surface degradation in the lower part of the cabinetry that was in direct contact with the floor. One way to prevent the degradation of the cabinet is to hang it on the wall. This solution prevents unwanted degradation of the enclosure and allows cleaning underneath the enclosure, as environmental hygiene is an integral part of any sanitary facility. This category and its hanging is solved by means of special hanging fittings for lower hanging bodies from Haffele [7]. Another possible solution is the classic hanging fitting for hanging upper cabinets. Alternatively, a solution by inserting a profile between the sides of the cabinet, in which holes are drilled and fixed to the wall using anchors.

Lower hanging cabinets are also appearing more in interiors instead of bathrooms. Their variety and design solutions allow for application in kitchens, living rooms, bedrooms and other interior rooms. The reason for this use is primarily due to environmental hygiene. Built-in kitchen units are a typical example. Who among us has ever cleaned up the accumulated dust underneath the base units of a kitchen cabinet? Perhaps someone who has never cleaned it has come to the conclusion that they cannot clean the area so thoroughly. The frequent removal of the skirting board results in fatigue of the plastic grip material of the rectifier leg with the skirting board. An innovative solution to limiting the access of dirt under the kitchen base units is the isolation strips, which prevent dirt and liquids from entering under the kitchen unit. The use of hanging the lower cabinets on the walls achieves the result of easy access to a more hygienic environment. This solution can be more visible in other rooms of our interiors (Fig. 8). The disadvantage of this category of hanging furniture is their depth for hanging and the load of these furniture items. The solution to this problem is the new design solutions for the hanging itself, which the manufacturers are guarding and patenting.



8: *Example of the use of hanging lower cabinets in interiors*

Ceiling Cabinets

A special separate category is the hanging of ceiling cabinets, the method of hanging which, for some of us, may seem an unconventional solution, but in some cases there is no other option than just anchoring them to the ceiling, since the partition in question does not have the appropriate parameters for the classic hanging of upper cabinets. An example of this solution was implemented in the last half of the 20th century in the Brno-Lesná district, where the parameters of the partition were not suitable enough for classic anchoring of upper cabinets. The subsequent solution was to suspend the upper cabinets from the ceiling. This solution solved the problem of the unsuitable partition parameters without the kitchen being without upper storage spaces.

Currently, hanging cabinets from the ceiling is a very unusual solution for kitchen units. This category is mostly used just above the kitchen islands that are placed into the kitchen cabinet space, these islands are incorporated into the kitchen cabinet space (Fig. 9). The important parameter for hanging these cabinets is just the ceiling structure and its composition.

9: *Example of the current use of ceiling cabinet suspension in interiors*

A separate category of overhead suspension of furniture items in interiors and exteriors from the ceiling structure are various chairs or „sofas“. An important parameter is their anchoring to the ceiling structure. Thus, we must not overlook the fact that this type of furniture item will be subjected to a lot of load, as its users can weigh up to around 120 kg. For these purposes, we must choose a suitable anchoring system with a combination of suspension elements that will support the structure.

Special Suspension Furniture

A separate category is special hanging furniture, which is in the development stages of the various manufacturers and developers of furniture items.

10: *Example of specialty hanging furniture*

Typical indicators are unusual dimensions and special technical and structural solutions for hanging on the wall (Fig. 10). This category can be found at furniture fairs and in private interiors or public spaces. This type of hanging furniture is still very expensive to produce, including the technology and design solutions used. For these purposes, specialised suspension fittings are designed and guarded by the manufacturers. With the development of technology and design solutions this category will reach all interior spaces in the future.

Materials and Methods

Hanging furniture is an integral part of our homes, public interiors and exteriors. In earlier times, hanging furniture was not very common with the development of furniture fittings and anchoring fixtures (dowels), hanging furniture has become a common part of our homes. Nowadays we have many ways of attaching hanging furniture to building materials (concrete, brick, aerated concrete, board materials, plasterboard, etc.) using various furniture fittings, systems, and most importantly, wall anchors.

Construction Material for Hanging Furniture

Today we have many board materials with different finishes for the production of hanging furniture. The most widely used board materials are particleboard (DTD) and medium-density fibreboard (MDF). Solid wood boards are another widely used material [8].

Classification of Construction Materials by Manufacture

Agglomerated materials can be divided according to production into solid wood boards (spars, biodesks), plywood boards (PD, slats), particleboard (DTD), fibreboard (MDF, HDF), flat chipboard (OSB) and lightweight board materials (honeycomb board) [8].

Fasteners for Hanging Furniture Construction

Each piece of furniture includes connecting hardware that allows us to join the individual furniture pieces into a body. The most important connecting hardware for hanging furniture is the corner connection between the top piece (the floor) and the side pieces (the sides). It also depends on the position of the top piece, whether it is loaded or inserted these parameters can affect the strength and rigidity of the cabinet [9].

Basic Categorization of Fasteners

The most common fasteners for corner joints are wooden pins, screws, industrial fasteners, confirmers, fastener slats, eccentric fasteners, trapezoidal fasteners, spherical eccentric fasteners, and other specific fasteners from various manufacturers [10].

Special Fasteners

Each fastener manufacturer have their special fasteners which they have patented for their own purposes. The undeniable advantage of these special fasteners is their variability and their special solutions for placement in the parts themselves. The disadvantage of these connecting fittings is their financial aspect and also their more complicated installation in the parts and subsequent connection to the bodies.

Hinged Fittings

Hanging hardware is an integral part of hanging furniture. They can be classified according to their load-bearing capacity and their design in the furniture body [11]. There are three major manufacturers of furniture fittings in the furniture industry: Hafele, Hettich, Blum and other smaller manufacturers of furniture fittings.

Dowels

A dowel is an insert for fastening screws, bolts, threaded rods in rigid, inflexible materials, most commonly masonry buildings or building board materials. Dowels are usually made of plastic, the better quality dowels of nylon and there are also metal variants (steel, stainless steel, brass) for which the term anchor is used [11]. There are many types of construction materials and mounting options, and many types of special dowels are produced.

Types of Dowels

Dowels can be classified according to the material produced, as well as their use in different building materials. For different types of building materials we select dowels designed for them. For example, we have: steel, frame, universal, expansion, special dowels for the building material [2]. Next, we should focus on which dowel will carry what. After selecting the dowel, drill a hole in the wall where the dowel will be placed. The hole for the dowel should be deep enough, and wide enough for easy placement of the dowel. Before placing the dowel, the drilled hole must be cleaned of any remaining drilling material. Then we can install the dowel, and the remaining parts that the dowel will carry.

The Building Material Used

Nowadays, we have many options for building masonry materials to build walls, from load-bearing walls to partition walls in interiors. Walls can be made of the following materials: stone, burnt brick, concrete, plasterboard, aerated concrete, hollow bricks (blocks), polystyrene and wood panelling [2].

Concrete

Concrete is a mixture of cement, aggregate, water and additives with reinforcing bars. The main properties of concrete include: High compressive strength but low tensile strength (about 10% of the compressive strength). An important component of concrete is the reinforcing bars or rebar, which compensates for the low tensile strength (steel + concrete = reinforced concrete) [2].

Masonry

Compared to concrete, masonry is a considerably more diverse anchorage substrate with varying texture and strength. The main components include burnt clay or concrete or other material. Masonry can be classified according to: The type of lump masonry (e.g., burnt brick, natural stone, or aerated concrete). Further, by type of wall (e.g., single-layer, double-layer). And according to the strength and density of the piece masonry [2].

Slab material

Slab building materials are thin-walled and generally have low strength e.g. gypsum plasterboard, gypsum fibreboard or particleboard, fibreboard, plywood etc. They are used to construct non-load bearing walls or partitions, and are also used as cladding material [12].

Mechanical and Physical Properties of Hanging Furniture

For hanging furniture and its interrelationship with the supporting element (wall). They are an integral part of the physical and mechanical properties that will determine the final values of this study and subsequent experimental measurements. Of the mechanical properties of the materials, the values of Strength = failure and Stiffness = deformation, or Toughness are particularly important, but these are not indicative for this work [9]. Furthermore, from the physical properties, the values of the densities of the materials will be particularly important for this work. To obtain these physical and mechanical properties, at least the basic dimensions and data will be necessary, which will influence the results of the actual experimental measurements. An integral mechanical part in testing, and especially in normal use in our homes, will be the application of forces or also the application of loads to the hanging furniture (body). Where the load will not only be applied to the body, but will mainly be transferred to the hanging hardware and from it to the supporting anchor (hook, screw, etc.) and then to the anchor (dowel) itself placed in the drilled hole of the wall (supporting material). In particular, pressure will be applied to the anchor and also to the anchoring element, and bending will be applied to the anchor itself. These main mechanical properties will influence the resulting measurement values and, more importantly, the hanging furniture itself [13]. Part of this work is just the appropriate selection of both the structural material (the body) and the supporting material (the wall) to obtain the best experimental testing results. When maximum loads are applied to hanging furniture, three types of failure and deformation of the integrity of the body and its connection to the wall can generally occur.

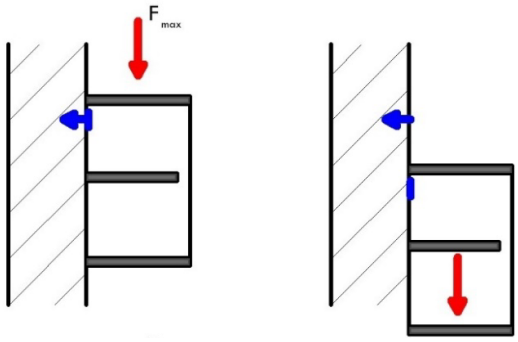
1. The failure can be caused by overloading the load capacity of the hanging body and the so-called shearing of the anchoring technique or the hanging material occurs, or the material fatigues under a greater load than planned (Fig. 11).
2. The breach may be caused by improper use of the anchor or anchors, or by the type of masonry of the wall on which the body has just been hung (Fig. 12).
3. Breach may be caused to some extent by the incorrect use of the connecting fittings, where the subsequent use or load.
4. Has not been taken into account. Or it may be caused by the improper use of the construction material of the body, where again the load applied in normal use may not have been taken into account (Fig. 13).

RESULTS

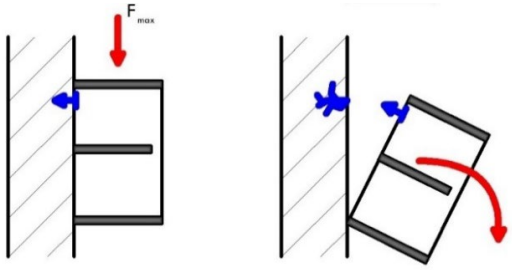
Suspension furniture is still an unexplored and untested scientific discipline worthy of investigation.

Hanging furniture and its issues are divided into four research sections: When the first research section has already been completed. And its results will soon be published. The section itself dealt with research on the connecting hardware used in hanging furniture. The fasteners were divided into 2 categories of three types of fasteners each. The first category is called glued = fixed connection, which includes wooden pins, connecting slats, and embedded pens. The second category is called mechanical = disassembled connection, which includes screws, fasteners and eccentrics. It has been tested using two methods in compression and tension. The disassembled connections using confirmatives were the best. Of the bonded joints, fastener slats performed best. However, connections using eccentrics performed the worst.

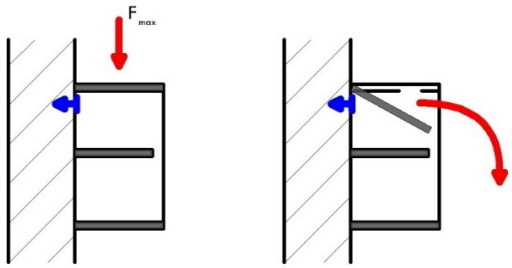
The next research section will test the hinge fittings used in hanging furniture. The attachment of the back to the hanging body will need to be considered in this research section. Since according to the fit of the back, a certain type of hanging hardware is used. The hanging hardware can be



11: *Graphical treatment of the problem 1. failure of hanging furniture*



12: *Graphical treatment of the problem 2. breach of hanging furniture*



13: *Graphical treatment of the problem 3. failure of hanging furniture*

divided into embedded in the body, loaded on the back of the body and laterally attached to the body and the category itself is the hanging hardware that is part of the body. In this research section, it will be necessary to predefine the most used hinge fittings for a given categorization. Subsequently, the manufacturers of the fittings themselves will have to be taken into account. Furthermore, the dimensions of the test bodies and the number of test bodies will have to be defined in order to obtain objective results.

Another subsequent research section will be research into the construction materials used in hanging furniture. It will be necessary to analyse the overall physical-mechanical properties of the structural materials in question, followed by their statistical evaluation. The course will be similar to the previous research sections.

The last research section will be the use of anchoring material in the walls on which we hang the hanging furniture. This section is not yet predefined it will have to be defined.

DISCUSSION

Overall, hanging furniture is still a potential hazardous furniture item in the home. In terms of its hanging. Inappropriate way of hanging corpora on walls and ceilings can cause unwanted events e.g. personal injury at worst, at best it can damage other things underneath. The hanging of furniture cabinets is not so much a matter of getting it right, it always depends on the installation and who is doing the installation. The assembler chooses the right anchor according to their discretion and experience. Others have the hanging furniture mounted by a shared service called *an hourly man* or by a company whose hanging furniture users buy and then have anchored to the wall or ceiling. Part of this research on hanging furniture will take into account the selection and definition, based on scientific knowledge, of the correct use of anchoring techniques for hanging corpuses. A separate category is the occasional painting of walls and ceilings in the home. In this case, we can take the hanging furniture down from its placement on the

wall or ceiling. After the painting activity is completed, we put the hanging furniture back in its proper place. Frequent handling of the hanging furniture in terms of taking it down and putting it back can cause wear and tear on the anchoring technology. Possibly to the hanging hardware and the corner ties of the cabinetry itself. At the same time, the correct recommended loads set by the manufacturer of the hanging furniture should be observed. If we choose the wrong anchoring technique and its suspension, we may unintentionally reduce the maximum and recommended load without meaning to. When hanging furniture, we have to take into account more factors that affect it than we might expect.

CONCLUSION

Hanging furniture is a hot topic in modern interior design. In addition to aspects such as the functionality of the furniture, the principles of assembly and disassembly, manufacturability and transportability, safety aspects are essential. A comprehensive assessment of the topic of suspended furniture, including the interaction with the building or structure on which it is suspended, is necessary for an overall safety assessment of the application of suspended furniture. Such research has not yet been carried out. The article describes the division of the research in this area into individual sub-areas: the construction material of hanging furniture, the connecting fittings of the hanging furniture structure, special connecting fittings, suspension fittings and, of course, anchoring technology, as well as the material design of the supporting structure (wall, ceiling). The text presents the results of the first part of this research, concentrating on the mechanical and physical properties of hanging furniture. The principles of the physical interaction between the suspended furniture and the supporting material are described. The basic types of failure are defined: overloading of the load capacity of the hanging body causing so-called shear of the anchoring technique, inappropriate use of an anchoring element with insufficient load capacity, improper use of the connecting hardware of the hanging element. Research will continue in other formulated areas. The section developed so far holds promise for a comprehensive picture of the topic with the aim of defining critical moments and recommendations for the safe use of suspended furniture in interiors.

REFERENCES

[1] HALABALA, Jindřich. 1982. *Furniture design and construction* [in Czech: *Výroba nábytku*]. Third Edition. Prague: SNTL – publishing house of technical literature.

[2] HORSKÝ, Antonín; PETRÁŠEK, Ivo. 2020. *Design basis* [in Czech: *Podklad pro navrhování*]. 16th Edition. Wienerberger s.r.o.

[3] KARASOVÁ, Daniela. 2001. *History of Furniture Art in 19. and 20. century (Volume 4)* [in Czech: *Dějiny nábytkového umění 19. a 20. století (4. díl)*]. Prague: Argo. ISBN 80-7203-339-5

[4] FIELL, Charlotte; FIELL, Peter. 2022. *Design of the 20th Century*. Cologne: Taschen. ISBN 978-3-8365-4106-0

[5] SVOJTKA & CO. 2008. *An encyclopedia of furniture* [in Czech: *Encyklopedie Nábytek*]. Translated from english original by Veronika Matysová. Praha: Svojtka & Co. ISBN 978-80-256-0104-4

[6] DLABAL, Stanislav. 2000. *Furniture art: selected chapters from history* [in Czech: *Nábytkové umění vybrané kapitoly z historie*]. Brno: Grada Publishing, spol. ISBN 80-7169-655-2

[7] HAFELE. 2024. *Hafele*. [Accessed: 2024-11-18] https://www.hafele.cz/cs/

[8] HRÁZSKÝ, Jaroslav; KRÁL, Pavel. 2007. *Wood-based composite materials – Part I* [in Czech: *Kniha Kompozitní materiály na bázi dřeva. - Část I.*]. Brno: Mendel University of Agriculture and Forestry in Brno. ISBN 978-80-7375-034-3

[9] JOŠČÁK, Pavol; LANGOVÁ, Naděžda. 2018. *Strength design of furniture* [in Slovak: *Pevnostné navrhovanie nábytku*]. Zvolen: Technical University of Zvolen. ISBN 978-80-228-3146-8

[10] JOŠČÁK, Pavol; GAFF, Milan; LANGOVÁ, Naděžda. 2011. *Furniture structural joints* [in Slovak: *Nábytové konštrukčné spoje*]. Zvolen: Technical University of Zvolen. ISBN 978-80-228-2255-8

[11] JOŠČÁK, Pavol, LANGOVÁ, Naděžda. 2019. *Technical equipment of furniture* [in Slovak: *Technické vybavenie nábytku*]. Zvolen: Technical University of Zvolen. ISBN 978-80-228-3215-1

[12] BOHM, Martin; REISNER, Jan; BOMBA, Jan. 2012. *Wood-based materials* [in Czech: *Materiály na bázi dřeva*]. Praha: Czech University of Agriculture in Prague. ISBN 978-80-213-2251-6

[13] JOŠČÁK, Pavol; LANGOVÁ, Naděžda; KRASULA, Patrik. 2014. *Mechanical tests of furniture* [in Slovak: *Mechanické skúšky nábytku*]. Zvolen: Technical University of Zvolen. ISBN 978-80-228-2788-1

[14] ASHBY, Michael; SHERCLIFF, Hugh; CEBON, David. 2007. *Materials: engineering processing and design*. Oxford: Elsevier. ISBN 978-0-7506-8391-3

[15] ASHBY, Michael, F. 2005. *Materials Selection in Mechanical Design*. Third Edition. Oxford: Elsevier. ISBN 0-7506-6168-2

[16] ASHBY, Mike; JOHNSON, Kara. 2002. *Materials and design: the art and science of materials, Selection in product design*. Oxford: Elsevier. ISBN 0-7506-5554-2
[17] ASHBY, Michael, F. 2009. *Materials and the Environment: Eco-Informed Material Choice.* Burlington: Elsevier. ISBN 978-1-85617-608-8
[18] ASHBY, Michael, F.; JONES, David, R. H. 2006. *Engineering Materials 2: An Introduction ti Microstructures, Processing and Design.* Third Edition. Oxford: Elsevier. ISBN 978-0-7506-6381-6
[19] DRÁPELA, Jindřich ***et al.*** 1980. *Furniture manufacturing technology* [in Czech: *Výroba nábytku: technologie*]. Prague: SNTL - publishing house of technical literature.
[20] DRÁPELA, Karel. 2000. *Statistical methods II* [in Czech: *Statistické metody*]. Brno: Mendel University of Agriculture and Forestry in Brno. ISBN 80-7157-474-0
[21] GANDELOVÁ, Libuše; ŠLEZINGEROVÁ, Jarmila. 2014. *Wood construction* [in Czech: *Stavba dřeva*]. Second Edition. Brno: Mendel University in Brno. ISBN 978-80-7375-966
[22] GAFF, Milan; GÁBORÍK, Jozef. 2009. *Surface properties of wood modified by embossing* [in Slovak: *Vlastnosti povrchu dreva modifikovaného reliéfovaním*]. Zvolen: Technical University of Zvolen. ISBN 978-80-228-2035-6
[23] HOLOUŠ, Zdeněk; MÁCHOVÁ, Eliška. 2013. *Furniture construction I.: Processes, instructions, examples* [in Czech: *Konstrukce nábytku I.: procesy, návody, příklady*]. Brno: Mendel University in Brno. ISBN 978-80-7375-844-8
[24] HOLOUŠ, Zdeněk; MÁCHOVÁ, Eliška. 2014. *Furniture construction II.: Construction, construction of supporting frames of upholstered furniture and furniture tests* [in Czech: *Konstrukce nábytku II.: konstrukce nosných koster čalouněného nábytku a zkoušky nábytku*]. Brno: Mendel University in Brno. ISBN 978-80-7509-010-2
[25] HOLOUŠ, Zdeněk; MÁCHOVÁ, Eliška. 2015. *Furniture construction* [in Czech: *Konstrukce nábytku*]. Modification 2016. Brno: Mendel University in Brno. http://user.mendelu.cz/holous/konstrukce_nabytku.pdf
[26] HORÁČEK, Petr. 2008. *Physical and mechanical properties of wood I* [in Czech: *Fyzikální a mechanické vlastnosti dřeva I*]. Brno: Mendel University of Agriculture and Forestry in Brno. ISBN 978-80-7375-169-2
[27] KASAL, Ali; SMADRZEWSKI, Jerzy; KUSKUN, Tolga; GURAY, Ersan. 2011. Analyses of L-type Corner Joints Connected with Auxetic Dowels for Case Furniture. *Materials*. 16(13), 4547.
[28] KRÁL, Pavel. *Veneers, plywood and glued materials* [in Czech: *Dýhy, překližky a lepené materiály*]. Brno: Mendel University in Brno. ISBN 978-80-7375-552-2
[29] KŘUPALOVÁ, Zdeňka. 2000. *Technology for the first year of SOU in wood processing* [in Czech: *Technologie pro 1. ročník SOU oborů zpracování dřeva*]. Prague: Sobotáles. ISBN 80-85920-74-3
[30] KŘUPALOVÁ, Zdeňka. 2023. *Science of materials for the 1st and 2nd year of the SOU carpenter's apprenticeship.* Fourth, revised. Prague: Sobotáles. ISBN 978-80-86817-52-1
[31] LANGOVÁ, Naděžda; JOŠČÁK, Pavol. 2018. *Mechanical properties of bolted joints of furniture structures* [in Slovak: *Mechanické vlastnosti skrutkových spojov nábytkových konštrukcií*]. Zvolen: Technical University of Zvolen. ISBN 978-80-228-3153-6
[32] MÁCHOVÁ, Eliška. 2017. *Structural furniture joints of wood-plastic composite materials applied for furniture production*. Dissertation. Brno: Mendel University in Brno.
[33] MUZIKÁŘ, Zdeněk; TESAŘOVÁ, Daniela; HOLOUŠ, Zdeněk; JERGL, Zdeněk; MELOUN, Milan. 2008. *Materials II. for the carpenter's apprenticeship* [in Czech: *Materiály II – Pro učební obor Truhlář*]. Prague: Informatorium, spol. ISBN 978-80-7333-061-3
[34] ŠLEZINGEROVÁ, Jarmila; GANDELOVÁ, Libuše. 2019. *Wood construction – exercises* [in Czech: *Stavba dřeva*]. Second Edition. Brno: Mendel University in Brno. ISBN 978-80-7375-168-5
[35] WOHRLING, Traugott. 2008. *Furniture styles from antiquity to the present* [in Czech: *Nábytkové slohy: Od antiky po současnost*]. Brno: Grada Publishing, spol. ISBN 978-80-247-2034-0
[36] ZEMIAR, Jan; GÁBORÍK, Jozef; MUZIKÁŘ, Zdeněk; NAVRÁTIL, Vojtěch; RUŽINSKÁ, Eva; ŠEBO, Norbert. 2016. *Technology of furniture production* [in Slovak: *Technológia výroby nábytku*]. Zvolen: Technical University of Zvolen. ISBN 978-80-228-2064-6
[37] BLUM. 2024. *Blum*. https://www.blum.com/cz/cs/
[38] HETTICH. 2024. *Hettich*. [Accessed: 2024-11-18] https://web.hettich.com/cs-cz/domu

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