WOODEN BUILDINGS IN BULGARIA

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Abstract. Historically, the use of wooden structures in residential, public or industrial buildings in Bulgaria is most often associated with low stores - up to two or three floors, as well as the construction of the entire supporting structure of the building or partial application in certain narrowly specialized parts such as floors, walls, roofs.

Many historic residential buildings, built from the end of the 18th to the end of the 19th century, have been preserved with all-wooden or mixed - wood-massive constructions, stone in the ground floors (partially in the upper ones as well) in combination with wooden elements in the upper one's floors when the height of the buildings is two or three floors, even four, with a large unevenness of the terrain in mountainous areas.

In public buildings, wooden structures are mainly used for the intermediate supporting elements – the floors and ceilings of the buildings to lighten the structure and overcome larger support distances and achieve the monumentality of the different types of spaces. In rarer cases, there are examples of three-story, all-wood constructions or those combined with stone and wooden supporting elements.

In industrial buildings, the use of different types of wooden structures is also widespread in cases of low total load on the structure, for example, in tobacco warehouses in Plovdiv, but most often for roofs and intermediate floor elements.

Historically, the use of wooden bearing structures in our country has been limited, due to the large annual temperature amplitude and the not very high density of local wood species, which would hardly provide the required longevity and general durability of the buildings.

Today, many of these challenges are more easily solved with the use of high technologies in the preparation of wooden structures, for example in glued timber or with additional treatment for preservation against pests and moisture.

Research background: Reconstruction of buildings and public spaces. *Purpose:* Historical review of wooden structures and buildings after the beginning of the 19th century in Bulgaria and the possibilities for reconstruction and construction of new buildings. *Methods:* Historical overview and modern construction models. *Findings and novelty:* The construction of completely wooden buildings with a height of more than three stories is connected with the introduction of new technologies for wood processing in Bulgaria.

Evacuation regulations and fire protection requirements in Bulgaria are also a challenge.

Law and regulations of the European Union provide new opportunities and sharing of proven experience about the possibilities given by wooden load-bearing structure for multi-storey buildings.

Keywords: wooden buildings; wooden residential buildings; wooden industrial buildings; wooden public buildings

Traditional and urban housing architecture of the 19th century, already influenced by European styles in Bulgaria and on the Balkans (end of the 17th to the end of the 19th century), were built with wooden structures - entirely wooden or houses with partial use of wooden construction in the upper floors, while the ground floors are built of stone. With a large unevenness of the terrain in the mountainous regions and especially in the Rhodopes, there are a number of examples of three-story and four-story houses with mixed constructions of wood and stone.



Figure 8. Plovdiv, house "Lamartin" 1829 – 1830 г. (visitplovdiv.com 2023)



Figure 9 Plovdiv, "Hisar gate" (visitplovdiv.com 2023)



Figure 10 Koprivshtitsa, House Museum "Georgi Benkovski" 1831. (wikipedia.org 2023)

Wood is a traditional material, as on the Balkans it is an accessible, cheap, durable and easy-to-work material. It is used for the skeleton construction in its two varieties - batten (a combination of a wooden skeleton construction with massive filling, in which the wall elements are plastered on both sides) or a completely wooden construction - skeleton and forming elements - boards, in the exterior and interior Yordanova 2018).

A widespread variant of the wooden structure is the mixed form - a wooden skeleton and wooden sheathing with a filling of wooden woven panels plasterboards, plastered with clay / mud and other binding compounds. The houses in Melnik, shown in the illustration, were also built with this construction system.



Figure 11 Melnik, photo from 1924. (mni.bg 2018)

In the case of public buildings in the 18th-19th centuries, mainly monasteries, mixed structural systems were traditionally used - wooden structures in the upper floors and massive, stone-built ground levels. Mostly wooden structures are used to build the framework of the light upper floors, for the intermediate structures of the individual levels, for the floors, for the decorative ceilings of the rooms. The wooden constructions in this type of building create extremely beautiful light structures that contrast with the characteristic monumentality of the stone-built parts. In rare cases, examples with three-story all-wood constructions can be seen. Such unique examples are preserved in Dryanovo.



Figure 12 Rila Monastery "Saint John (Ivan) of Rila" 1335 - 1833. (wikipedia.org 2023)



Figure 13 Rozhensky Monastery 18 c. (wikipedia.org 2023)

The wide application of wooden structures continued during the industrial age, when buildings suitable for production and warehouses were constructed. In the case of production buildings and those with a storage purpose from the time of the Third Bulgarian State - the end of the 19th century. in the 20th century, the use of wooden structures as a load-bearing element was widespread. Wooden constructions with a small total load on the floors provide a height of up to 4-5 floors. Such an example is the tobacco warehouses in Plovdiv. The roof structures are also entirely made of wood - wooden trusses.



Figure 14 Roof construction of a building next to Montana Airport, Personal archive. (Петров 2016)



Figure 15 A tobacco warehouse that was deliberately set on fire in order to build new residential buildings on its site in Plovdiv (plovdivtime.bg 2022)

In the years following World War II, mass construction was monolithic. Ceramics and concrete are mainly used. Wooden structures are used only in roof structures. It is known that the massive large-panel construction was carried out from typical concrete structures without the use of wood even in the roof structures. In connection with the structural stability of the buildings, norms for resistance not only to loads but also to earthquakes are gradually being introduced.

The historic timber-framed building stock faces a number of challenges. And even more are the challenges to the more widespread use of wood in modern conditions against the background of the increasingly widespread research findings on the benefits of using wood for human health and environmental protection:

- Change in people's habits for using this type of building;
- Poor maintenance or even neglect over the years;
- Lack of state policies in their protection;
- Changed requirements for the energy efficiency of buildings;
- Increased fire risk;

• Existing problems before the construction of new buildings with wooden structures;

• Difficult and expensive to completely solve engineering problems related to installations and non-standard architectural solutions due to earthquake requirements;

• The feeling of the majority of investors about the insufficient durability of the future buildings;

• Insufficient well-trained personnel for the construction of all-wood supporting structures;

Today, in our country, the interest in wooden structures in single-family residential buildings is growing. This type of construction is mainly associated with the problems of low-tech production. From a constructive point of view, wooden houses are considered only as a supporting structure, and the partition elements - the walls can be made of many different materials, even plant-based.

There is another extremely limited category of buildings where renewable building materials are used for partition walls and ceilings, and the structure is made of another type of material – metal, concrete or a combination of the two. This is a case where a particular individual architectural detail or structural/fire requirement is achieved that cannot be achieved using an all-timber support structure.

The most often built wooden houses in Bulgaria are in detail like the image shown, which is a wooden structure, between the ribs of which stone wool is placed and the walls are built according to dry construction systems.



Figure 16 Knauf systems with gypsum fiber and wooden construction (KNAUF 2023)

Another type of wooden houses are prefabricated structures. Ready-made wall and floor elements are executed in factory conditions, which are joined according to the project on the construction site. The filling of the walls can be of different growth materials or stone wool in some cases. This technology significantly shortens the time to build the house and gives significant opportunities for customization and freedom when preparing the architectural project of the building.

The filling can be of plant or wood type. Preferred wallfilling materials are materials that are not preferred for building small animal and bug habitats in nature. There are many engineering solutions to control moisture and keep out pests inside the walls, this can be done by using metal mesh or other plant species, even by secondary treatment so as to achieve the necessary and sufficient barrier to biological compromise of the construction.



Figure 17 Pressed rye straw panels (homenest.eu 2023)



Figure 18 Cane and wood wool panel (homenest.eu 2023)

Naturally, there are examples where lower-tech solutions are used, such as building the walls directly from agricultural bales obtained during the harvesting of grain crops. The problems encountered in this type of construction are mainly related to the different size of each hay bale and their strength and possibilities to change its volume when several rows are loaded on top of each other. Due to the lower density, compared to the examples above, in practice it is recommended to pay special attention to the gaps between the individual elements and to use rye straw, which is not preferred by rodents.



Figure 19 Straw bale house (freeoldmen 2023)

Possible solutions for the preservation and maintenance of historic timberframed buildings, as well as for increasing the number of timber-framed buildings as a way to reduce carbon emissions during construction or replacement of the building stock, can be systematized as follows:

- Increasing the qualification of builders;
- Restoration of construction techniques to maintain the existing building stock;

• Development and implementation of new technological productions for wooden houses, ensuring even shorter terms for construction and maintenance of buildings with a partially or completely wooden supporting structure or a wooden structure with plant materials for partition walls;

• The introduction of new technologies of the type of engineered wood CLT (CLT has been used for low-rise buildings in European countries such as Germany and Austria since 1990), which are already quite advanced in the world, and the use of recyclable materials for the construction of combined load-bearing structures from wood, metal, polymer materials.

Good practices in construction are the production of blocks of plant species with the addition of lime, which adds many and different types of qualities: the possibility of molding and subsequent free processing without disturbing the rest of the block or wall.

A perspective material for use in construction is also industrial hemp, which has a significantly high resistance to decay, grows quickly and is not suitable for feeding animals. This makes it very suitable as a sustainable material in its use in construction, as a substitute for rye straw, which is an important ingredient in the quality feed needed in animal husbandry.



Figure 20 Industrial hemp and lime bricks (БАИС 2023)

In order to achieve the sustainability of the various types of composite industries, it is necessary to look for sustainable models for the development of each one of them. This principle can be illustrated in the production of wood in general. In addition to the large volume of production of construction wood, wood is also produced for boards for furniture production, as well as for heating - directly or through the production of pellets (they were originally produced from the waste product of these two types of industry). Due to the significantly increased volume of demand, there is a shortage of wood and a corresponding increase in its price.

The use of wooden structures has many definite advantages and at the same time poses many questions that remain open, namely:

• The wooden structure can be easily disassembled, which allows it to be used for new purposes;

• The wooden structure meets the so-called climate economy – reduces carbon emissions of the urban environment;

• But the wooden structure, despite the increase in its mass, remains an expensive technology;

• Changes in building regulations and changes in the attitude to the material are still to come;

• When harvesting wood, uncontrolled growth of monoculture areas is possible, which is harmful to the environment and the sustainable development of the planet.

ЛИТЕРАТУРА

freeoldmen. 2023. Закъсняло осмомартенско: приз Златен Кър! 05 24. ж. homenest.eu. 2023. Строителни техники с естествени материали. 05 25. https://homenest.eu/bg/slider/stroitelni-tehniki-s-estestveni-materiali.

KNAUF. 2023. *Кнауф системи с гипсфазер и дървена конструкция*. 05 25. https://knauf-gipsfaser.com/sgradi-s-darvena-konstruktsiya-1-121.

mni.bg. 2018. Края на цветущия Мелник. 04 10. Accessed 05 01, 2023. http://www.mni.bg/2018/04/melnik-putni-belezhki.html.

plovdivtime.bg. 2022. Пловдивчани към президента и главния прокурор: Спрете разрухата в Тютюневия град. 09 29. Accessed 05 01, 2023. https://plovdivtime.bg/gradat/plovdivchani-kam-prezidenta-i-glavniia-prokurorsprete-17221/.

visitplovdiv.com. 2023. *Къща "Ламартин"*. 05 01. http://www.visitplovdiv.com/bg/node/678.

—. 2023. Xucap кanuя. 05 01. http://www.visitplovdiv.com/bg/node/518.

wikipedia.org. 2023. Къща музей "Георги Бенковски". 05 01. https://bg.wikipedia.org/wiki/%D0%9A%D1%8A%D1%89%D0%B0_%D0%BC% D1%83%D0%B7%D0%B5%D0%B9_%E2%80%9E%D0%93%D0%B5%D0%BE %D1%80%D0%B3%D0%B8_%D0%91%D0%B5%D0%BD%D0%BA%D0%BE %D0%B2%D1%81%D0%BA%D0%B8%E2%80%9C.

 —.
 2023.
 Рилски
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 05
 01.

 https://bg.wikipedia.org/wiki/%D0%A0%D0%B8%D0%BB%D1%81%D0%BA%
 00%B8_%D0%BC%D0%B0%D0%B0%D1%81%D1%82%D0%B8%D
 1%80.

 —.
 2023.
 Роженски
 манастир.
 05
 01.

 https://bg.wikipedia.org/wiki/%D0%A0%D0%BE%D0%B6%D0%B5%D0%BD%
 D1%81%D0%BA%D0%B8_%D0%BC%D0%B0%D0%BD%D0%B0%D1%81%
 D1%82%D0%B8%D1%80#.

БАИС. 2023. *Къща от коноп.* 05 24. https://bais.bg/%D0%BA%D1%8A%D1%89%D0%B0-%D0%BE%D1%82-%D0%BA%D0%BE%D0%BD%D0%BE%D0%BF/.

Петров, арх. Петър. 2016. Покривна конструкция на летищен хангар до гр. Монтана. 9 8. www.arch.bg.

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