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PRESERVATION OF VERNACULAR ARCHITECTURE IN SERBIA – AUTHENTICITY VERSUS THERMAL COMFORT ISSUES

Ana Radivojević[1], *Mirjana Roter-Blagojević*[2], *Aleksandar Rajčić*[3]

ABSTRACT

Traditional rural houses are one of the most endangered forms of cultural and built heritage in Serbia today. A special quality of traditional architecture of this region could be recognized in its manifold typological diversity that is present not only in its spatial and formative characteristics but also in various structures and materials that were used in their construction. In the past, materialization of this vernacular architecture was in interaction with nature and the conditions of the immediate environment, especially in terms of its climatic and geographic properties.
Although old rural houses represent the keepers of the tradition, they are often abandoned and left to the effects of the march of time, or replaced with new buildings that do not manifest any authentic regional or local features. Problems related to their protection, preservation and regeneration to a great extent could be connected either with properties of materials used for their construction, since they are usually not very durable, or with level of how comfortable they are altogether, which is less than it is necessary for a comfortable life of a contemporary man.
Through a review of types and methods of materialization of traditional rural houses in Serbia, as well as an analysis of their achieved thermal performances, this paper strives to point out the real need and optimal possibilities for their improvement, with respect to the need for protection of their integrity and authenticity during the renovation process, which are basic postulates of the contemporary conservation theory and practice.

Keywords: *Traditional architecture, Regeneration, Renovation, Thermal comfort*

1. INTRODUCTION – TRADITIONAL ARCHITECTURE AND MODERN CONCEPTS OF BUILT HERITAGE PRESERVATION

Throughout history the folk builders followed the basic building principle from a distant past, that Vitruvius, an ancient architect said that "…*it is obvious that designs for houses ought similarly to conform to the nature of the country and to diversities of climate*" [1], which is clearly expressed in vernacular architecture all over the world. In traditional rural architecture, the basic factors influencing on the spatial, structural and shaping characteristics were the natural conditions, the characteristics of the land, the vegetation and climate, whereas the historic ones, the social, cultural and economic conditions of certain epochs were much less taken into consideration. In forested areas all over the world, the most frequently used building materials were stone and wood, while in the flatlands it was straw and reed. The climate conditions predisposed the house spatial characteristics and the roof pitch. Thus, in the warmer climate regions, roofs were mildly slanted with deep eaves and houses were more open towards the countryside, having large porches. On the other hand, in regions with long, snowy winters, the roof were sharply pitched, the houses closed, with small openings. So it tells us that it was that organic relationship with the natural environment that produced those basic traditional rural architectural values – conformity to the natural environment and preservation of the ecological balance, as well as possessing certain

[1] Dr Ana Radivojević, associate professor, Faculty of Architecture, University of Belgrade, ana@arh.bg.ac.rs
[2] Dr Mirjana Roter Blagojević, associate professor, Faculty of Architecture, University of Belgrade, mirjana.roter@gmail.com
[3] Dr Aleksandar Rajčić, assistant professor, Faculty of Architecture, University of Belgrade, rajcic@arh.bg.ac.rs

universal characteristics that connect different architectures of a wider region with similar natural conditions [2].
Traditional vernacular houses were built by their users, through specialized master builders and other members of the community, so that building a house was a collective activity, expressing collective needs and values. The changes were never abrupt, but gradual, so that until the modern times, the rural houses have preserved the ancient building mastery and the traditional cultural values. The modern era, however, followed by a trend of depopulation of the rural areas, along with an overall application of universal building and materialization techniques leads to a gradual disappearance of the traditional lifestyle and the ever decreasing rural population loses interest in preserving the old rural houses. Contemporary standards, the use of modern materials and types of houses, as well as a constant desire for achieving a better living comfort in residential houses, have resulted in a loss of traditional forms of the vernacular architecture, leading to a disappearance of their authenticity and the connections with the tradition and the natural environment they once originated in. Consequently, we see the negative results in the cultural and built heritage preservation within the framework of the rural settlements' and regions' sustainable development. As an important cultural resource, the traditional rural houses are either disappearing or are being submitted to so much reshaping by the use of the new materials that they are losing their original characteristics and authenticity. And the pretext for such changes and the overall treatment of the heritage lies in a desire to make the houses more durable and to adjust the comfort of living and dwelling in them to the modern standards.
Therefore, it is very important to consider all the possible modern approaches which would allow, on the one hand, to preserve the authenticity and integrity of the traditional rural houses, as basic premises of conservation, and on the other hand, to improve their standards for better living. In the context of the 1972 UNESCO World Heritage Convention, authenticity is viewed through the following parameters: design, materials, workmanship and setting. Later on, the issue of authenticity was broadened to include form, substance, tradition, function, context, spirit, etc. In vernacular architectural it is important to emphasise cultural pluralism and the respect of different values, thus enriching the totality of the humankind heritage. Today, the concept of authenticity is viewed in relation to the originality of a piece of work as a result of mental and creative processes, as both the historic document of the past and the work of the live cultural tradition. Authenticity also has its creative dimension and the builders can create authentic structures, following tradition and at the same time introducing their own views and knowledge that are in accordance with the time they live in. It is important to discover the truth of a piece of work, which lies in its design and material realisation, as well as in its identification as an historic document [3].

2. BASIC SPATIAL, CONSTRUCTIVE AND SHAPING CHARACTERISTICS OF THE TRADITIONAL RURAL HOUSES IN SERBIA

The natural and climatic conditions in Serbia had a primary impact on the general characteristics of the rural houses, so the basic building materials – wood, earth and stone – found in the immediate environment, have always been predominant in vernacular architecture. The presence of these materials, ways of their use and combinations depended on a particular geographical area, i.e. of local characteristics of the climate, soil and a place the houses were built. There are three characteristic regions, belonging to wider geographical areas that go beyond the present borders of the country, where recognisable clear-cut types have been formed:

1. In hilly areas of Šumadija and west Serbia (linked to the regions of the West Balkans and Dinara mountain), with houses built of quality lumber – log cabins;
2. In flatland areas along the Morava river and east Serbia (linked to the southern parts of the Balkans and the Vardar River area), with houses made of light lumber posts and wattle and daub structure (the so-called *bondruk*);
3. In Vojvodina (as part of the Pannonia plains and the Danube area), where houses were built of rammed earth, earth being the basic material [4].

Historical development special features of these regions also made an impact on the rural houses in Serbia secondary characteristics, as regions to the south from the Sava and the Danube were developing under the Ottoman culture influence, while the northern regions were under the cultural influence of Central Europe. The outside factors mixed with the autochthon building tradition, dating from the earliest times when the Slavs were migrating to the Balkans. Consequently, such intermixing

gave those individual values of the traditional rural architecture in Serbia, connecting it with other European and Balkan nations, but also making it quite particular at the same time [5].

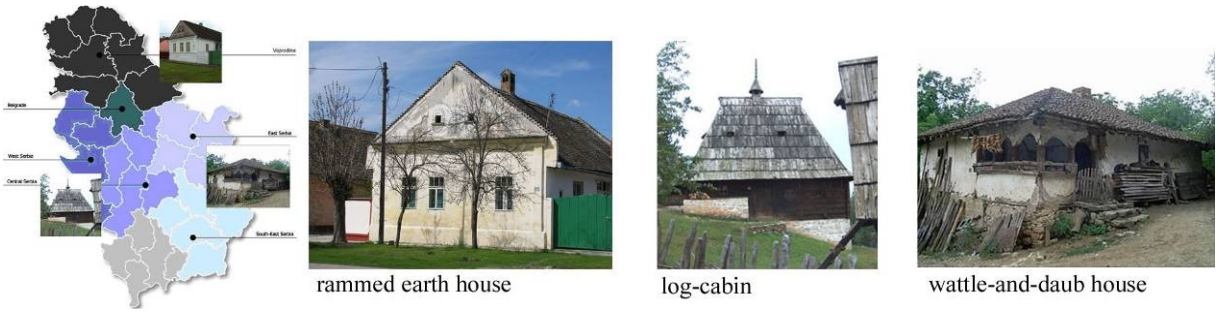


Fig. 1 Distribution of specific types of vernacular houses along Serbia

2.1. Log-cabins basic characteristics

The rural timber houses, log-cabins, used to be built in the livestock breeding communities in the mountain areas covered with high quality pine and oak forests. The basic material used for walls and roofing was massive logs of circular cross-section or more often rectangular beams. They were notched at their ends to form corner joints, usually the saddle notched ones. Such houses had shallow foundations of broken stone and if they were built on a sloping terrain, they usually had a stone walled cellar under one part of the house, where they kept livestock or other necessities. Due to the climate conditions, the roof was pitched under a sharp angle, covered with wooden shake shingles, placed down the rafters. In regions abundant in shale material, the roofing was of shale tiles. There are examples of log-cabins that were covered with straw.

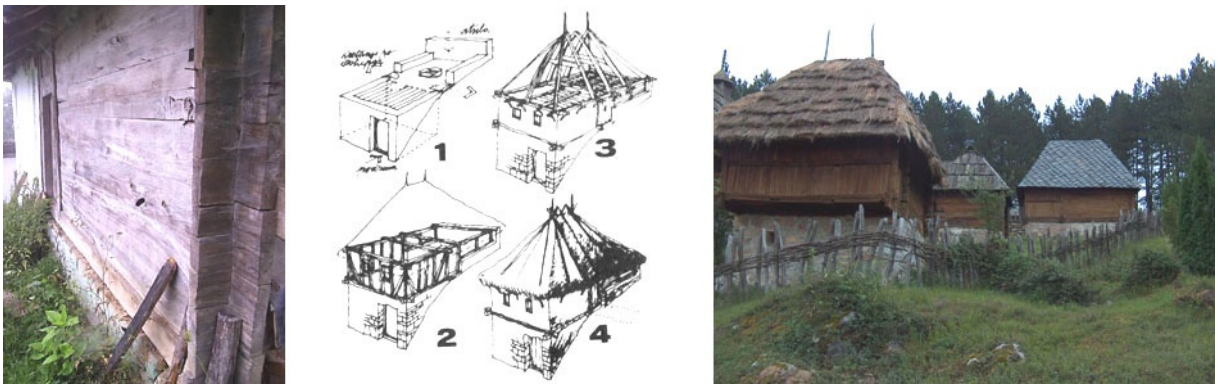


Fig. 2 Examples of various subtypes and some building details of log-cabin houses in Serbia

The houses were of rectangular ground plan and quite simple spatial arrangement – a one-room structure (called *kuća*, meaning a "home") or a two-room structure with an additional room. The area under the roof was conjoint with the *home* and having an open hearth. The ground floor had an earthen floor and the room had both the floor and the ceiling made of wood. In some cases a space of the "*home*" could have been built with stone. Rarely, a porch was consistent part of a log-cabin, but this can not be considered as typical. Some houses were built as a combination of logs and wattle and daub, with the room walls of light wooden structure covered with lath and clay and mud plaster.

2.2. Post, wattle and daub houses basic characteristics

Rural houses of light wooden structure, the so-called *bondruk* style, were built in the Morava river valley and in east Serbia, in the flatland farming regions along the waterways. As they were built mostly in the Morava river basin, they are also called the *Morava houses*.

The basic timber frame consisted of the post and beam structure with trusses or braces supporting at corner points. This type of timber frames was widely applied, as it allowed the houses to be built quite quickly and the timber material did not have to be of top quality. This type of timber frame construction also had an advantage of being quite safe in terms of good seismic stability.

The horizontal, sill timbers are placed on top of the low stone foundation, built just by dry stacking the stones or with a use of mud plaster and then, at about 1m distance, vertical posts are placed and

connected with the roof structure with horizontal tie beams. The walls are filled with different types of material, but the simplest way was wattle – stakes woven with branches and daubed with a combination of mud and straw. Somewhat more elaborate wall structure could be found in houses with other sorts of daub covering or filling, with horizontal wattle anchored to the supporting vertical posts, filled with clay, crushed stone and straw, and covered with mud plaster. Adobes could also be used with mud plaster.

Fig. 3 Example of *bondruk style* houses from South East Serbia (left) and East Serbia (right) and detail of the building technique (center)

Those houses usually had mild hip roofs, with a structure of rafters and battens. Spatial arrangement was primary similar to that of a log-cabin. Due to a mild climate, the Morava house usually had an open porch at its entrance. It was used for various farming chores, but it had a separate sitting and resting section. Later on, a part of the porch got closed, forming a larder, then rooms were added to the house, thus getting a more complex structure with the porch at the corner [6].
A house could be built on a flat terrain or on a slope and then it had a stone cellar for storing farming produce and tools or for keeping livestock.

2.3. Rammed earth houses basic characteristics

In the Pannonia flatlands, the rural houses were built of earth, mostly rammed earth, but also with adobes and later fired brick. The low thick walls were built by compressing semidry mixture of earth into wooden moulds, packing layer upon layer. Corners and joints were reinforced with tree or bush branches inserted at every 20-30 cm of height; reinforcing could also be done with bricks. There was a frequent practice to apply reed, branches or vines at every 20-30 cm, providing a certain seismic reinforcement to the walls. Unlike in other climatic regions where the foundations were built of stone, in the Vojvodina rammed earth houses, the foundations were also built of rammed earth, thus creating a serious problem of capillary suction – the capillary moisture. The houses usually had timber structure gable roofs, covered with straw or reed, but later on, from the mid-20th century, with roof tiles. Inside the house, above all the rooms there was a ceiling, made of either of hewn wood or round logs, then wrapped in straw and covered with mud.
The houses were built along a street, facing it with their narrow sides. There was a small entrance hall that led to a semi-open area of the kitchen with a hearth that was built with brick and vaulted. Only one room looked to the street, while the others went in a row along the yard porch, which actually connected all the rooms and was used for various farming jobs.
Quite characteristic for those houses were nicely shaped decorations on the street side façade and on the yard porch – under the influence of Central European urban architecture.

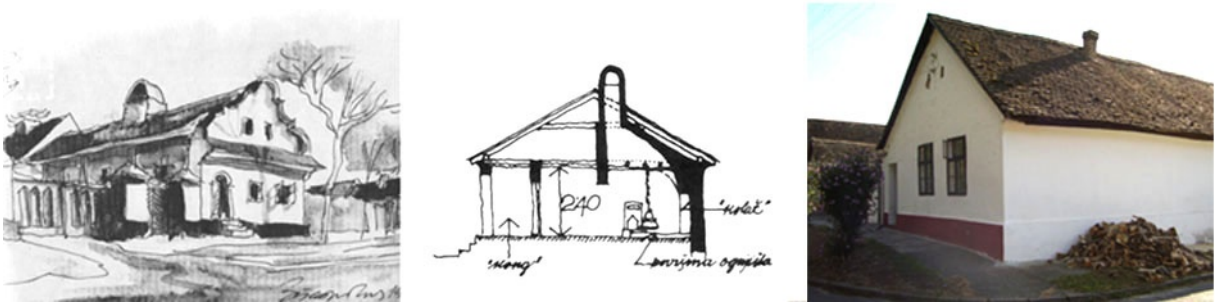


Fig. 4 Examples of rammed earth houses from Vojvodina and a cross section through a kitchen

3. THERMAL COMFORT OF TRADITIONAL RURAL HOUSES IN SERBIA

Living comfort, as understood nowadays, considers that a house has an adequate equipment, providing appropriate living conditions regarding a thermal, sound and visual comfort, as well as adequate indoor air-quality. Although the sensation of the total comfort is an individual and subjective matter, it could be said that it refers the most to sensation of a thermal comfort as a consequence of thermal characteristics of a house and. Therefore, this aspect will be investigated further on.
Recently conducted research regarding characteristics of a residential building stock in Serbia, based on a statistic sample of about 6000 houses [7], showed that traditional rural houses that are still in use could be found all along the country. In the most of the cases they date from the time before the World War Two, since extinction of traditional building techniques gradually started by the mid of the 20th century. This trend was followed with a praxis of replacement of traditional rural houses with new ones that did not express its regional characteristics anymore, and became uniform for their spatial organization and visual appearance all along Serbia. The living comfort of traditional rural houses is certainly not in accordance with the modern understanding of a comfortable housing, which could be an explanation for a frequent phenomenon of being abandoned by their users and/or replaced with new buildings. However, it is a valuable building heritage that deserves to be preserved, but also modernized in a way that will not endanger its authenticity, but will simultaneously improve the living standard to an adequate level.
When analyzing different aspects of thermal comfort and possibilities of its improvement in a case of different types of traditional rural houses in Serbia, it is important to distinguish certain characteristics that could be understood as „predispositions“ of these houses regarding the thermal comfort. With respect to this, aspects of importance are related to:

1. Respect for climate conditions in a sense of an adequate building orientation and adjustment to the configuration of the terrain;
2. Spatial organization of a house in a sense of respect for the rules of thermal zoning, both in a horizontal and a vertical level;
3. Characteristics of the building envelope itself.

3.1 Relation between traditional rural houses in Serbia and their environment

Harmonization with environmental conditions, which is considered as one of the basic bioclimatic principles, was very important for vernacular architecture in Serbia. This especially refers to the traditional log-cabins which, due to the harsh climatic conditions of mountainous areas where they were built, had a true need to harmonize with the environment, starting with the choice of a place for its erection. As a rule, they are placed on sunny slopes that are well protected from dominant winds, having openings (windows and doors) on their sunny sides, while on the north they had very small or no windows, covered with wooden shutters.
Unlike the log-cabins, *bondruk style* houses were mainly built in the regions with a more temperate climate, offering more freedom when choosing the construction place. Depending on the configuration, when raised on a flat terrain, houses had only one-storey, while in the case of inclined slopes, they could partly have a cellar on the lower side. Size and position of façade openings were not as strictly dictated by the orientation of the house. The entrance to the house was on one of its sunny sides, and, a as rule, there was an open porch as well.

Fig. 5 Examples of rural settlements from: central Serbia (left) and a village from Vojvodina (right)

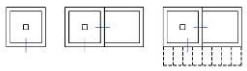
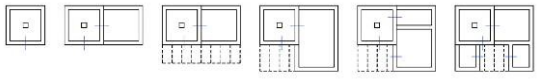
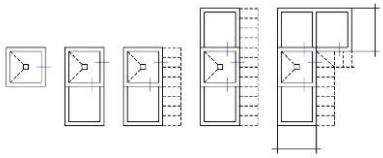
In the case of traditional rural houses from Vojvodina, unlike the mentioned types of traditional rural houses that were able to follow bioclimatic principle due to the possibility for the spontaneous choice of the building location, the position or these rammed earth houses was a result of a planned street matrix of rural settlements. This was typical for the Austro-Hungarian monarchy to which Vojvodina belonged in the past. Having this in mind, the optimal orientation of the house and their position on the lot could not always be synchronized and optimized.

3.2 Usage and thermal zones of traditional rural houses

Contemporary attitude regarding thermal performances of buildings takes into account the position and the way that different parts of a building were grouped with respect to the need for preservation of certain thermal conditions, which is considered as a thermal zoning. In this sense, traditional rural houses in Serbia do have certain rules of disposition the rooms that could be considered as a simplified way of thermal zoning. No matter of their origin, their spatial organization was a result of organization around the room that placed a hearth, called "home". Further spatial development of the house meant that additional rooms to the initial one were predominately used as sleeping rooms, while basic daily life of a family took place in the "home". In the region with less harsh climatic conditions, or, in case of a log-cabin, when there was an extremely favourable orientation, rural house could have a porch in front of the entrance to the house. In the case of *bondruk* style houses it could be placed on different positions: at the corner, in the middle of a façade, along a side of a house, while houses from Vojvodina, as a rule, had porches along the longer side of a house. The entrance to the house obligatory led to the "home", which usually had a rammed earth floor which was suitable for all the activities that happened in it.

Although there are certain similarities in spatial organization of rural houses from all three typical regions in Serbia, differences exist regarding the treatment of the under roof space of the main room or a "home". Log-cabin house has in this particular part, either above the whole area, or partially, an open under-roof space. They rarely have a chimney since the extraction of the smoke from the hearth was happening directly through the gaps between elements of roof covering, or through the specially designed openings in a roof since there was no ceiling to prevent the movement of a smoke. Unlike them, two other types of traditional houses did have a chimney above a hearth, and a ceiling above the rest of the room. In the case of *bondruk* style houses, the ceiling was made of wooden beams and a layer of planks, or there was an additional straw and plaster ceiling, while rammed earth houses had a vaulted structure, either built with adobes or made as a false wooden structure covered with thick layer of mud mortar. Special attention was paid to the building and modelling process of a chimney, which was a compulsory element of these houses.

Table 1 Typical organizations and usage of traditional rural houses in Serbia

Type of a house		Typical spatial organization schemes	Typical cross section schemes with heated areas marked
A			
B			
C			

Traditionally, heating system of rural houses was based on the use of hearth. Other rooms, meant for sleeping could be heated either indirectly, which was the principle used in older examples, or there were individual furnaces, often with fireboxes placed in the "home". When there was a cellar in a house, it was used as a storage place and therefore it was not heated. However, this disposition

provided better thermal conditions to the sleeping rooms that were above, as well as more suitable flooring surface, since walking surface was a wooden flooring. As a rule, sleeping room had a ceiling structure that separated the loft from the room itself.
When there was a porch in the house, it protected the entrance door from a direct impact of a wind, creating in this way in a sense of thermal conditions, a tampon zone and acting as a windshield.

3.3 Characteristics of thermal envelope of traditional rural houses

In a thermal sense, living comfort of a house depends to the great extent on exact characteristics of structures that create its thermal envelope. Matters of interest are thermo-insulating characteristics of materials and structures, their ability to store the heat, as well as behaviour regarding the water vapour movement through the structure. Besides, air movement in a room could contribute to the sensation of (dis)comfort. Therefore, the way different structures of a house are connected, or how their joins are sealed is of great importance for the total thermal comfort.

Fig. 6 Examples of windows from traditional rural houses in Serbia

Descriptions of basic characteristics of typical rural houses and their usage indicated types of structures that should be taken into account when analysing the level of the thermal comfort that traditional houses offer. These structures are floors, either on the ground or above the unheated cellar, roof and ceiling structures and walls, including windows. Having in mind regional building types that are present in Serbia, it could be said that among different elements of a thermal envelope, the most varieties are found in case of wall structures and their characteristics. It is interesting that, no matter of the region, windows of traditional rural houses in Serbia are wooden, single framed and glazed with a single glass. They were placed on the external side of the window openings, and in the most of the cases they were opened outward.

4. MEASURES FOR IMPROVEMENT OF THERMAL COMFORT OF TRADITIONAL RURAL HOUSES IN SERBIA

Although traditional rural houses are still present in the housing building stock of Serbia, they could be rarely found in their original form. Endeavouring to improve the living quality in such houses and following their own initiative, their owners, used to apply different measures of adaptation that were often not appropriate for genuine properties and values of the houses. Due to the frequent application of contemporary building materials and products that were not compatible with original – traditional ones, these laic improvement measures could not only change basic characteristics of the houses regarding their form and appearance, but could bring new problems, especially those that concern the building physics, which were not present before.

Fig. 7 Different treatment and usage of traditional *bondruk style* houses in Serbia: abandoned (left); in use with minimal interventions (central), improved with contemporary thermo-insulating materials (right)

Having this in mind, it is important to review and perceive possible measures of thermal improvement that will contribute to the original quality of the house, but will not endanger its authenticity. This could be understood as a „passive way of improvement“ of traditional houses.

Table 2 Characteristics of different elements of thermal envelope of traditional rural houses in Serbia

Thermal envelope – type of structure	Description	U value [W/mK]
 Ground Floor	rammed earth	> 3.0
	wood decking, send and batten layer rammed earth	1.9
	brick sand or gravel rammed earth	2.5
 Floor above the unheated space	rammed earth plank timber beams	1.0-1.2
	wood decking, timber beams	1.0-1.4
 Ceiling under the unheated loft	wood decking, timber beams	> 2.4
	wood decking, timber beams straw-mortar ceiling	0.8-1.5
 Roof Structure	straw timber beam	0.6-1.0
	hale tile plank timber beam	> 2.5
	shingle batten layer timber beam	> 2.2
 External Wall	timber post with adobe infill, plastered both sides	1.7
	timber post with wattle-and daub infill, plastered both sides	1.1-1.5
	wood (logs or squared-off logs)	1.2-1.5
	rammed earth wall plastered both sides	2.1
 Window	wooden, single framed with single glass	> 4

„Passive measures“ were recognized in the following procedures:

- addition of layer of, preferably natural, thermo insulation, in the zone of a ceiling structure, above those spaces where such structure existed,
- addition of preferably natural, thermo insulation, in the zone of wooden floor structure towards the unheated cellar,
- insertion of additional, inner casement window, which basically did not exist in traditional rural houses; it should be made of wood, with thermo-insulating glazing;

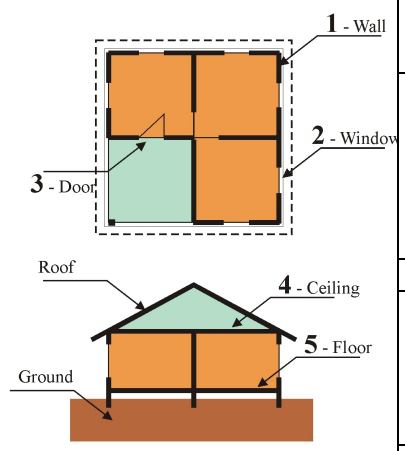
Further improvement could be achieved by adequate interventions on walls. However, this opens the problem of authenticity. These, measures should be applied on the inner side of a wall and with caution when choosing the exact thermo insulating material.

4.1 Evaluation of passive improvement measures on a model building

Previous analyses pointed out that *bondruk style* traditional houses have the highest potential for the described passive measures. Therefore an experimental model-building was created, based on building principles of this one-storey house that has three rooms („home“ and two rooms) and a porch, and typical wattle-and-daub walls. It was assumed that floor of this house did not lie directly on the

ground, but was slightly raised above it and placed over a wooden floor structure. Wall improvement for this particular type of a building, could be made with thermo-insulating reed layer, offering better thermal characteristics, but keeping the tactile and visual characteristics of the improved wall very much alike to the original one. Applied measures on chosen structures of thermal envelope and achieved U-values are shown below (Table 3).

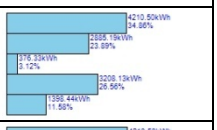
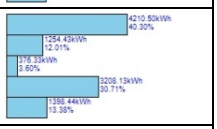
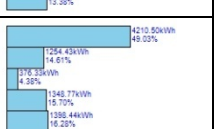
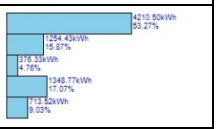
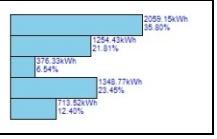
Table 3 Characteristics of a model-building and structures of its thermal envelope



No	OLD Original structure	U value [W/mK]	NEW Improved structure	U value [W/mK]
1	timber post with wattle-and-daub infill, plastered both sides	1.0	plaster, timber post with wattle-and-daub infill, + insulation + plaster	0.5
2	wooden, single framed with single glass	> 4	wooden, single framed with single glass + inner casement with thermo insulating glazing	2.0
3	not changed			3
4	wood decking, timber beams straw-mortar ceiling	1.3	wood decking, timber beams insulation straw-mortar ceiling	0.6
5	wood decking, timber beams	1.0	wood decking, timber beams insulation batten	0.5

Efficiency of applied improvement measures could be evaluated through comparison of energy consumption for heating of the model-house, before and after interventions. It is expressed through quantity of energy (Q) per hour (h) per square meter of the heated area (A) of the house. The order of intervention types was made having in mind accessibility of the structure and results are shown in the table below (Table 4).

Table 4 Efficiency of applied intervention measures

Intervention type	1. Walls		2. Windows		3 Door		4. Ceiling		5. Floor		Qh/A [kWh/m^2]	Distribution of transmition heat losses
	old	new	old	new	old	new	old	new	old	new		
No intervention	■		■		■		■		■		357.6 (100%)	
Type 1 window improvement	■			■	■		■		■		273.8 (76.6%)	
Type 2 Type 1 + ceiling improvement	■			■	■			■	■		231.5 (64.7%)	
Type 3 Type 2 + floor improvement	■			■	■			■		■	216.0 (60.4)	
Type 4 Type 3 + wall improvement		■		■	■			■		■	167.0 (46.7%)	

5. CONCLUSION

The conducted analyses showed that by identification of structures, elements and details of traditional rural houses, different types of interventions could be applied, improving the living quality, but not endangering the authenticity of these buildings. Each of the chosen measures that were targeted to the improvement of thermal comfort of a building brought certain improvement regarding its thermal conditions and characteristics that had direct implication to the reduction of energy consumption, from 23.4 to 53.3% in comparison with the state before the intervention.

This could be a signal and proof to owners of such houses that with small but carefully chosen interventions they could feel significant benefits of their home budget. These are also good arguments that support the idea and the need for protection of sensitive building heritage as vernacular architecture is, offering acceptable solutions that could prevent its further disappearance.

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