Department of Building Equipment and Technology Safety
Faculty of Engineering SUA in Nitra

Katedra zariadení stavieb a bezpečnosti techniky
Technická fakulta SPU v Nitre

RURAL BUILDINGS IN EUROPEAN REGIONS

RUBER 2019

Architectural - Construction - Technology - Safety - Logistics

VIDIECKE STAVBY V EURÓPSKYCH REGIÓNOCH

RUBER 2019

Architektúra - konštrukcie - technológie - bezpečnosť - logistika

Reviewers/ Recenzenti:

doc. Ing. Marek Angelovič PhD.
doc. Ing. arch. Silvia Bašová, PhD.
doc. Ing. Miroslav Brodňan, PhD.
Ing. Marián Bujna, PhD.
Ing. Michal Franek, PhD.
doc. Ing. Jiří Fryč, CSc.
Ing. Katarína Gécová, PhD.
doc. Dr. Ing. Zdeněk Havlíček
doc. Ing. Oľga Hubová, PhD.
Dr.h.c. prof. Ing. Dušan Húska, PhD.
doc. Ing. Juraj Jablonický, PhD.
doc. Ing. Ingrid Karandušovská, PhD.
Ing. Filip Khestl
doc. Ing. Maroš Korenko, PhD.
Ing. arch. Katarína Kristiánová, PhD.
doc. Ing. Gabriel Kuczman, PhD.
Ing. arch. Ján Legény, PhD.
doc. Ing. Radoslav Majdan, PhD.
Ing. Pavel Mec
doc. Ing. Dana Országhová, PhD.
Ing. arch. Pavol Pauliny, PhD.
Ing. Stanislav Paulovič PhD.
Ing. Ana Petrovič. PhD.
doc. Ing. Štefan Pogran, CSc.
prof. Ing. arch. Hana Urbášková, Ph.D.
prof. Ing. arch. Vladimír Šimkovič, PhD.
doc. Ing. Petr Vaculík,Ph.D.
doc. Ing. Ivan Vitázek, PhD.
doc. Ing. arch. Ľubica Vitková, PhD.
doc. Ing. Vlasta Vozárová, PhD.

Publication title: Rural Buildings in European Regions RUBER 2019
Architectural - Construction - Technology - Safety - Logistics

Názov publikácie: Vidiecke stavby v európskych regiónoch RUBER 2019
Architektúra - konštrukcie - technológie - bezpečnosť - logistika

Approved by the Rector of the Slovak University of Agriculture in Nitra on 14. 10. 2019 as an Anthology of Scientific Papers online

Schválila rektorka Slovenskej poľnohospodárskej univerzity v Nitre dňa 14. 10. 2019 ako zborník vedeckých prác online.

ISBN 978-80-552-2068-0

Type of publication / Druh publikácie: Zborník recenzovaných vedeckých prác / Anthology of Reviewed Scientific Papers

Publication title / Názov publikácie: Vidiecke stavby v európskych regiónoch RUBER 2019 / Rural Buildings in European Regions RUBER 2019
Architektúra - konštrukcie - technológie - bezpečnosť – logistika / Architectural - Construction - Technology - Safety - Logistics

Authors / Autori: team / kolektív

The anthology compiled / Zborník zostavili:
Ing. Milada Balková, PhD
Ing. Tímea Szabóová, PhD.

Number of pages / Počet strán: 108

Publisher / Vydavateľ: Slovenská poľnohospodárska univerzita v Nitre / Slovak University of Agriculture in Nitra

Year of issue / Rok vydania: 2019

Issue / Vydanie: first / prvé

The texts did not undergo linguistic and editorial editing in the publishing house, the authors are responsible for the content and formal aspects. / Texty neprešli jazykovou a redakčnou úpravou vo vydavateľstve, za obsahovú a formálnu stránku zodpovedajú autori.

ISBN 978-80-552-2068-0

CONTENTS / OBSAH

CONTRIBUTION TO BALANCED TERRITORIAL DEVELOPMENT OF VILLAGES IN SLOVAK REPUBLIC

Filip BRÁNICKÝ[1], Jarmila HÚSENICOVÁ[1]

[1]*Katedra Architektúry, SvF, STU Bratislava*

Abstract
The Orava region, as one of many, has undergone different transformations due to different cultures (mainly due to the three main colonization waves). However, the building culture evolved continuously and a unique form of the Orava vernacular was created. In the middle of the 20th century, this natural process was interrupted and modernist typified houses were introduced into the existing settlement structures, which forever changed the appearance of the Orava villages. Later, at the turn of the millennium, the new foreign architecture coming from all over the world reflected the impact of globalization and the neoliberal economy. At present, many inappropriate houses are still being produced in Orava. They are based on vague and illegitimate concepts in an effort to shine as much as possible. The question remains: How much has been pushed into the silhouette of settlements over the past 70 years? Analysing the selected Orava village on the basis of ground plan silhouettes of vernacular dwellings from the Horná (Upper) Orava micro-region shows the overwhelming number of objects unrelated to natural development. To reverse the current situation, proper adjustment of quality control mechanisms is required.

Key words: building culture, vernacular architecture, traditional architecture, regulations

INTRODUCTION
Archetype (from gr. Arché = origin + typos = form, pattern) is original form of building substance serving the same purpose. If it exists, it can generate analogues and serve in the design of a new building substance. The building culture has been undergoing different levels of maturity over the ages and always reflects the current economic and cultural state of society. A number of terms and definitions are hidden under this generic term. Most often, however, it is understood as a culture to design, build, construct, but mainly to think. A house as a building substance is not just an uncharacteristic matter. It carries ideas and values within itself. These may be true, deceptive, temporary or persistent. On the basis of the intellectual performance behind the development of the urban and architectural concept, through the right planning and design, to the honest craftsmanship, a work is created, a work that forms and educates the next generations. The way urban planners, architects, landscape planners, civil engineers, site managers, craftsmen and investors approach to delivering such performances forms the already mentioned building culture along with the message, whatever it is, which tends to be generated in the countryside. This is especially true in the case of ordinary constructions, the largest number of which form an integral part of the building culture.

METHODOLOGY
Empirical exploration of the territory of Orava and analysis of its building culture is part of my dissertation. The main part of the methodology needed for the paper was work with specialized literature and analysis of ground plan silhouettes in the Orava village which was created on the basis of field research and study of maps.

HISTORICAL EXCURSION
The building culture of the Orava region can be analysed from various points of view. One of the most important is historical analysis. Who was involved in visual appearance of an architecture and landscape shaping at what time? The first important wave of colonizers flowed here in the first quarter of the 14th century, mainly due to the road that led from Nitra, the Turiec valley, the northern foothills of the Choč Mountains across Orava to Nowy Targ and Krakow, and then from Liptov side, Malatiná or Valaská

Dubová. Until then, there were about 10 peasant villages, mostly in the lower part of Orava. The second strong wave of settlements, organized Wallachian colonization, came at the end of the 14th century. A line was created along the perimeter of the territory on the border with Poland and also a wreath of villages along the perimeter of the agricultural urban core. In Orava, this wave was more intense than in the neighbouring regions and therefore absorbed the communities with the indigenous population. At the beginning of the 18th century, Orava began to revitalize by the third important wave of settlement after the Kuruc wars, which looted and depopulated a substantial part of the region. The colonizers came from the agricultural regions of central Slovakia, especially from the surroundings of Trenčín. There were Polish, Ruthenian and German inhabitants, but mainly Slovak. At the beginning of the 19th century, the process of colonization in Orava was completed.

ORAVA VERNACULAR ARCHITECTURE

Due to the different cultural influences, Orava is one of the most difficult and hard to analyse regions in Slovakia in terms of architectural structures. Gothic culture gave Orava villages their ground plan. It is manifested by rhythmic rows of gable log houses oriented perpendicular to one or two sides of the road, and narrow fields behind the houses running up the hill. The courtyard premises were closed with wooden gates. The granaries were made of logs with a wooden vault and a light roof above it. These were usually long rows or clusters of small buildings along streams and roads opposite dwellings, or small groups on the hillsides or outskirts of villages. Later, after the arrival of the Wallachian population, the Orava House acquired its internal layout, proportionality and morphology. This began to differ from the Polish and Goral house. The layout of the rooms makes Orava house similar to the house from the southern parts of Slovakia. The base always consists of the front room and entrance - the pit behind it. Gradually, the chamber began to be added to the rear, later the entire room. The entrance room began to be divided and a side chamber was created, which evolved into a black kitchen. Such branched dispositions of narrow and long houses formed the basic concept of the Orava archetype. The courtyards were narrow and long, so it was not strange to shift the second dwelling back to the courtyard behind the first dwelling. Thus, two, even sometimes three families could live under a compact roof. In the 18th century, a typical Trenčín type of building was connected to the Goral parts of Orava, connecting the dwelling with the granary under one roof - a house with a height. It was further developed according to the same laws as in the Trenčín region with a different log construction. In this way, complicated multi-storey houses were formed in the Polish part of Orava. The predominant material was wood, first logs, later fluted prisms, but at the end of the 19th century new building materials began to be used: stone, clay, rarely brick. After World War I, masonry began to be used more and more often. However, an important fact remains: even these brick houses still retained the character of their predecessor. They did not differ significantly in ground plan or frontal strength. They were able to blend harmoniously into an existing wooden village by using the same morphology. There were changes, mainly due to the increasingly required hygiene standard. The black kitchen gradually became sanitary facility, the front room served as a bedroom and the back one served as an intermediate kitchen behind which another room was added. The house grew naturally towards the courtyard with the addition of other rooms or economic facilities. In the period after World War II, however, the continuity of this building culture began to break. Modern type houses were forcibly incorporated into the existing buildings without scale or any contextual idea. The monotony of type villas was transferred from town to countryside. In the second half of the 20th century, much of the Orava vernacular was destroyed. Values and ideas were suppressed. Perhaps that is why people were looking for inspiration in other cultures from different parts of the world. It results in an existing tangle of building substance in different pseudo-styles and structures, not harmonizing with the environment or with itself. Although the present time is in favour of going back to traditions, there are still many unsuitable homes designed that are based on unclear and illegitimate concepts in an effort to shine as much as possible.

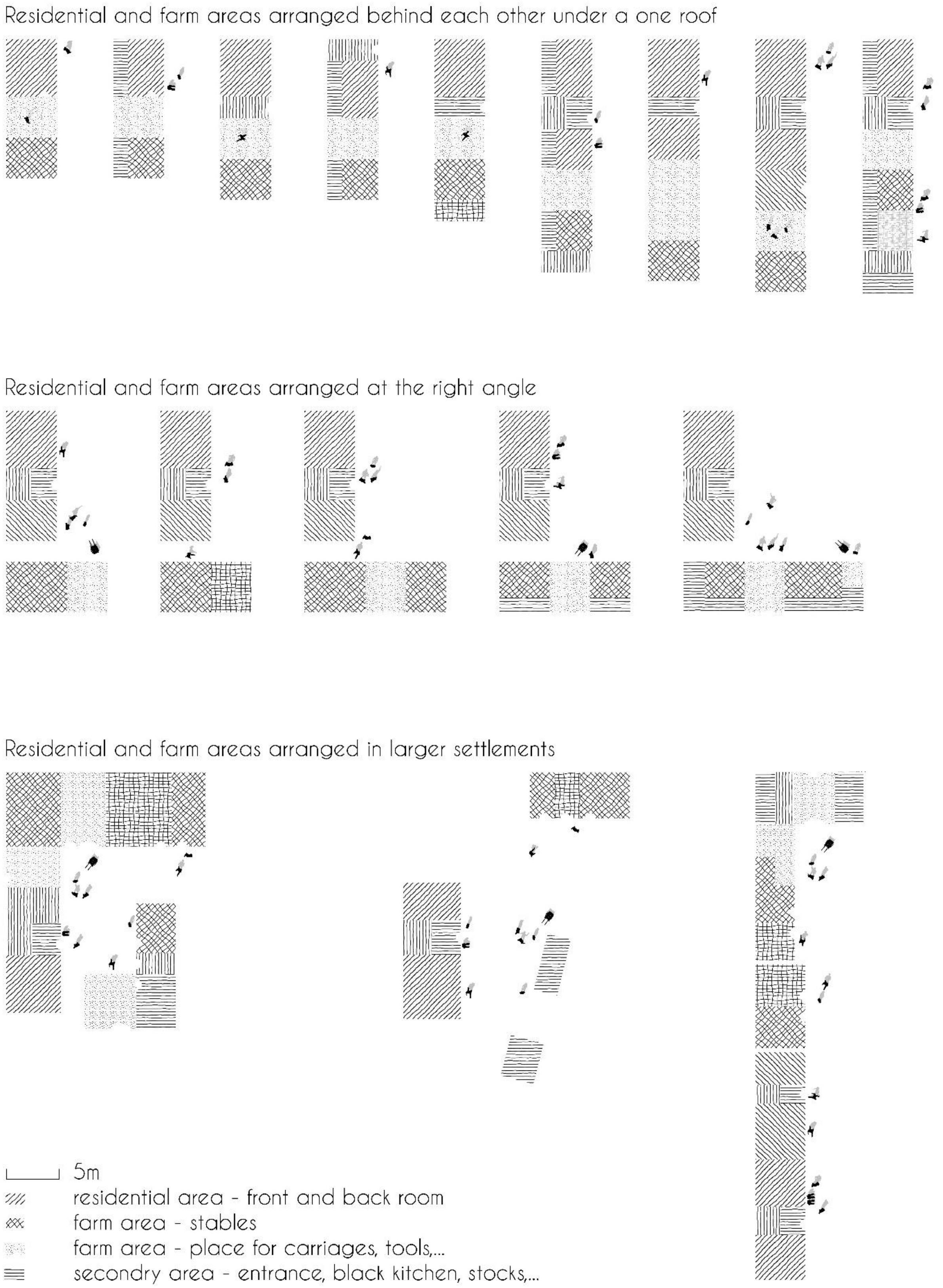


Fig. 1 Possible variants arrangement of residential and farm areas. (graphics: Bránický, Filip)

FRAGMENTS

The influence of socialist ideology was pushed into the ground structures of the villages so strongly that often only crumbs remained from the original stream structure of perpendicularly oriented masses. But when can we say with certainty that the Orava countryside is so overwhelmed by objects that are not related to natural development that such a situation cannot be reversed? How big must be the percentage of such fragments? As an example, I present the current situation in one of the Orava municipalities. Štefanov nad Oravou is one of many ordinary villages still unmarked by tourism in the upper Orava. It was created by joining Dolný (Lower) and Horný (Upper) Štefanov. Dolný (Lower) Štefanov was established on domestic customary law already in 1355, while Horný (Upper) Štefanov at Wallachian one in 1592.

Fig.2 Fragments of buildings carrying vernacular values in Dolný Štefanov are marked with white and grey. Residential buildings with vernacular ground plan values are white – 20 pcs, farm houses and small buildings with vernacular ground plan values are grey – 75 pcs. Others buildings are marked green – 102 pcs. (graphics: Bránický, Filip)

Fig.3 Fragments of buildings carrying vernacular values in Dolný Štefanov are marked with white and grey. Residential buildings with vernacular ground plan values are white – 44 pcs, farm houses and small buildings with vernacular ground plan values are grey – 69 pcs. Others buildings are marked green – 69 pcs. (graphics: Bránický, Filip)

In the village there are a few national cultural monuments, one church with a mourning house, an abandoned school building, one apartment building and two cultural houses. The rest of the building

substance consists of houses, farm buildings and small village architecture. With the help of archetypal ground-plan silhouettes I have analysed and marked fragments of vernacular architecture along with the newer buildings still bearing the ground-plan values of folk buildings. It is not uncommon that people built self-helped economic objects according to traditional principles behind the modernist type house and lived as their parents had taught them, even if the family house corresponded to another ideology.
After counting the individual detached buildings, there are 208 such buildings out of a total of 379. On the other hand, there is architecture from the socialist period and houses built after 1989. There are 171 such buildings in the whole village. Therefore, we can find much more of the type houses there. 54,88 % of the buildings retain their vernacular ground plan values which is a little bit more than a half in an ordinary village.

TERRITORIAL PLANNING
The task of spatial planning is the economic use of the built-up area of the municipality. According to the experience of the developed capitalist states with the participation of the communal sphere and the citizens of urban and rural settlements, the system of processing the vision of regional development with a lower degree of bindingness but with outlining the possibilities of development is beginning. A functioning rural settlement (village) generally meets the needs of a person better than a city (a clear size of approximately less than 5,000 inhabitants, immediate personal relationships, proximity to nature). To stay alive, it must be inhabited and developed by the people. Leaving mostly young people to work weekly in towns or long-term economically forced labour journeys abroad is impoverishing the countryside and, on the other hand, is a natural consequence of the neoliberal world economy. The transformation of spatial planning depends, whether we want it or not, from the transformation and restructuring of the economy. At present, the basis for previous ways of shaping regional policy has changed radically based on the former ways of generating resources. Increased flow of territorial streams (goods, people, capital and information), specific demographic developments (aging of population, migration), a new way of massive investment of lifetime savings (instead of using risky financial institutions), lucrative real estate (buildings and land), the scarcity and exhaustibility of fossil fuels and macro-climatic changes and the protection of land and land as an exhaustible non-renewable resource will be reflected in the transformation of settlements, roads, as well as the basic and public facilities of the territory. A specific problem in terms of realization of investments in the area of spatial development is the very fragmented land ownership in the Slovak Republic. The size and shape of the land of the Theresian cadastre (unlike the Josephine cadastre in the Czech Republic), which were established under Hungarian law, are very small for construction and their compassing and reparcelling is a time, cost and management consuming process. Another problem is the absence of systematic applied research at the level of municipalities, towns and the whole Slovak Republic, and there is also a lack of a uniform model for the creation, administration and presentation of land use plans that would contribute to their easy readability for citizens and public administration and guaranteed territory information. There is a need for a new model of urban and municipal development that includes the problems of growth, density and intensity, space, mixing urban functions, transport, modernization and renewal, and creating new or refurbishing existing spaces within the settlement. In this context, in some countries it is called for the creation of new independent institutions (non-profit organizations) to carry out analyses and syntheses on a permanent basis to set development strategies at different organizational levels without the influence of national governance systems. Institutionalization of this process is called "Action Planning".

QUALITY CONTROL INSTRUMENTS
The tendencies of the territorial development process with a view to optimizing the layout of the territory are favoured by all economically developed Western states, in particular: Germany, France, Belgium, the Netherlands, Austria and other Western European countries. In these advanced foreign cultures, building regulations are seen as a guarantee of a quality environment. Their society does not need to win over legislation and break the regulation. In a society such as ours, architectural concepts often come to individualism which is more shown within the rural area. There are hard and soft mechanisms that influence qualities. Hard instruments include, but are not limited to, regulations, legislation and

government performance. Building authorities do not assess or require the quality of architectural design or urban integration. It is often due to the lack of qualifications of officials and in the result the low authority of the institution. On the territory of Orava, we encounter designs of ordinary family houses with the absence of quality urban planners or architects. Catalogue houses are generated here even though they do not belong to the given type of land and are modified often not in the happiest way. The design of a family house requires a large number of professions, but if it is in the hands of a designer without architectural ambitions and no interdisciplinarity in the form of urban or architectural external cooperation is required, the house does not possess any or low aesthetic qualities. Soft examples include good examples and role models, support for education and enlightenment. In the countryside, they are important because investors tend to lean towards a solution they have already seen with their own eyes. Also, influencing mechanisms can be divided into external and internal. External regulations and legislations were already mentioned. Internal tools or self-regulation are individual values that set the mirror of the company in which it is located. By correctly setting the rate of external instruments according to the state in which the company is located, it is possible to achieve proper regulation of the territory.

CONCLUSION

The impact of globalization and the neoliberal economy is reflected in the new foreign architecture of houses and streets as well as in the appearance of public spaces. The authentic context is disappearing from the village and the consequence has a negative impact on the village's silhouette. The scenery of the landscape changes throughout the cadastral territory. The issue of rural renewal is a complex problem. By its very nature, however, the rural landscape needs a clear concept. The search for the archetypes of a place is one of many forms of sustainability. Such an archetype can be viewed to varying degrees. Whether through the ground plan silhouette, shape, mass concept, choice of construction and material, architecture will consciously become the bearer of the values and ideas of our ancestors. Analysis of the current state of degraded building substance of the municipality and the fact that Upper Orava, like every territory, has its archetype, could be sufficient reasons for the emergence of properly configured tools to influence urban and architectural qualities. If the examples of new construction abound in good architecture and the population of the Orava region wants to imitate it, the unhealthy state of the building culture of today can be reversed. According to the experience of the developed capitalist states with the participation of the communal sphere and the citizens of urban and rural settlements, it is undergoing to the system of processing the vision of regional development with a lower degree of bindingness but with outlining the possibilities of development.

REFERENCES

Čaplovič, P. (1977). Čaro kresaného dreva. Ľudová architektúra Oravy. Martin: Osveta, 1977.

Kusý, M. (2016). Stavebná kultúra v sídelnom prostredí. In: Urbanita. 3-4/2016, ročník 28, november 2016. Vyd. MDVRR SR, Bratislava, p. 22-29

Krpelán, I. (2017). Zachovanie a pokračovanie rodu. Bratislava: Vydavateľstvo Eurostav, 2017. ISBN 978-80-89228-54-6, p. 47

Mencl, V. (1980). Lidová architektura v Československu. Praha: Vydavateľstvo Academia, 1980. 403-22-858, p. 412 - 422

Kol. autorov. (2015) In: Politika architektury a stavební kultury české republiky. Ministerstvo pro místní rozvoj, Ústav územního rozvoje, Praha a Brno, 2015

Húsenicová, J. (2000). Regionálna veda, Tempus-Phare, Žilinská univerzita, Vyd. EDIS, Žilina 2000.

Zibrin, P. (1981) Priestorové štruktúry sídelných systémov – Spatial structures of settlement systems, Alfa, Bratislava 1981

Hrůza, J. (2014) Svět měst. Academia Praha, 2014

Corresponding author:

Ing. Filip Bránický, Katedra architektúry, SvF STU Bratislava, Radlinského 2766/11, 810 05 Bratislava-Staré Mesto, Slovensko, e-mail: branicky.filip@gmail.com

PRESSURE DISTRIBUTION ON DUOPITCH ROOFS FOR AGRICULTURAL STRUCTURES

ROZLOŽENIE TLAKOV NA DVOJSTUPŇOVÝCH STRECHÁCH POĽNOHOSPODÁRSKYCH STAVIEB

Michal FRANEK[1], Jana LENDELOVÁ[2], Marek MACÁK[3], Oľga HUBOVÁ[4]

[1]*Faculty of Civil Engineering STU in Bratislava, Department of Building Structures*
[2]*Slovak University of Agriculture in Nitra, Department of Building Equipment and Technology Safety*
[3]*Faculty of Civil Engineering STU in Bratislava, Department of Mathematics and Constructive Geometry*
[4]*Faculty of Civil Engineering STU in Bratislava, Department of Structural Mechanics*

Abstract
Shape of building and roof has strong impact on distribution of the pressure. For that purpose, a wind tunnel test is mentioned at the scaled rigid models. Experiments are carried out in the Boundary Layer Wind Tunnel (BLWT) in Bratislava. The intensity of turbulence, wind speed and direction of wind is crucial for overall wind loads. The aim of our article is a wind analysis of various shapes of duopitch roofs. The purpose of this work is to quantify the external pressure coefficient for various wind directions and shapes. The results of wind tunnel measurements are analyzed in external pressure coefficient maps.

Key words: wind tunnel testing, external pressure coefficient, boundary layer wind tunnel

INTRODUCTION

The Eurocode with National Annex (STN EN 1991-1-4, 2007) gives recommended values for external pressure coefficient c_{pe} on duopitch roofs. It allows to classify the roof according to pitch angle and wind directions. Roof is divided into the zones with recommended value of c_{pe}. Eurocode is very conservative and it is based on wind tunnel tests, which are performed on an isolated rigid model in open exposure. Recommendation of Eurocode is useable for simple shape of structure. Details of the roof are not taken into account. Furthermore, the overall pressure on the surface is seriously affected by internal space and a type of ventilation. Structure with animal production have to ensure the thermal comfort for efficient production and high product quality. For that reason it is recommended to include the ventilation into the modeling. Shape of the building and roof can ensure the efficient natural ventilation of interior space. Several studies have shown that appropriate climate control is crucial for the productivity and animal comfort (Boulard et al., 2002; Gebremedhin and Wu, 2005).

CHARACTERIZATION OF MODEL OF AGRICULTURAL TENSION STRUCTURE

The four type of tension membrane structure considered in this study with duopitch roof. Shape and dimension correspond to custom dairy barn. Plan view of dairy barn is 63 m . 36 m. In Fig. 1 it is illustrated the cross section dimension of barns in full scale. Pitch angle of roofs was proposed from point of view of thermal comfort. There was considered the natural and mechanical ventilation of dairy barns. Variant 1 is designed as housing with mechanical ventilation, variant 2 and 3 as variant with natural ventilated and variant 4 is combination of the variant 2 and 3 and there can be used hybrid ventilation system.

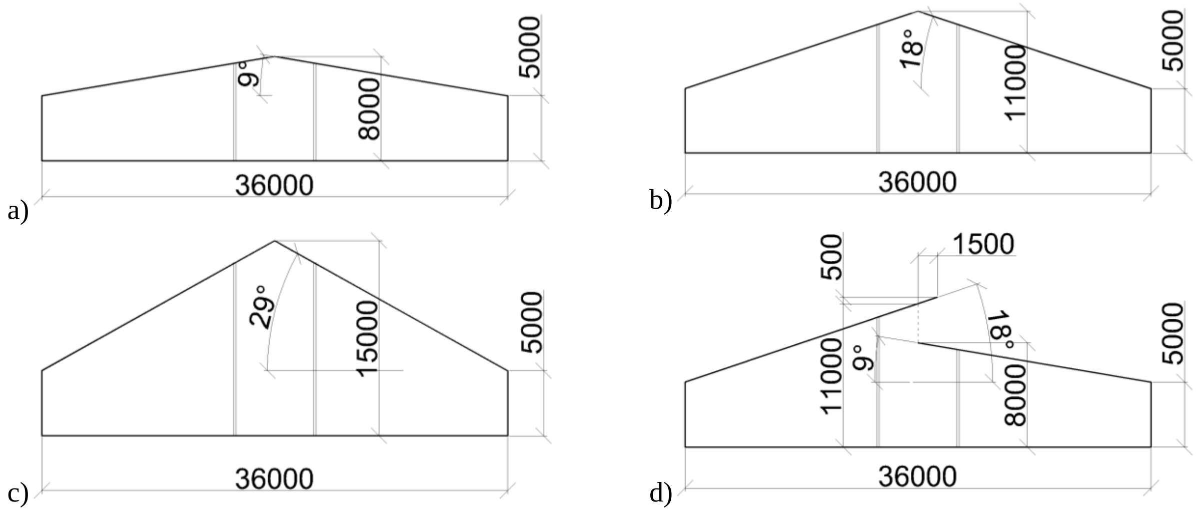


Fig. 1 Cross section of duopitch roofs a) variant 1, b) variant 2, c) variant 3, d) variant 4

WIND TUNNEL EXPERIMENT

Measurements were characterized as a series of pressure measurements with pressure transducers, which works on piezoresistive principle. It was used 42 pressure sensors on the roof area.
External pressure coefficients in BLWT in Bratislava were evaluated on rigid body model. It means that it could be not adequate to describe the aerodynamic behavior of tension structures which are flexible. According to Rizzo et al. (2011), the flexibility of the tension structure is not so relevant as to affect negatively the coefficients obtained on a rigid body. If the structure has an optimal preliminary design, the fluctuations of shape are not so important as to change its aerodynamic response.

METHODOLOGY OF AN EXPERIMENT

Before pressure measurement it was evaluated the properties of ABL. The wind velocity profile, turbulence intensity profile and non-dimensional power spectral density were measured. Mean longitudinal wind speed follows the logarithmic law. It is defined by Davenport (1965) as expressed Eq. 1. The longitudinal turbulence intensity is found to fit well with Eq. 2.

$$U_{(z)} = \frac{u_*}{\kappa} \ln \frac{z}{z_0}, \ (\mathrm{m.s^{-1}}) \tag{1}$$

$$I_u = \frac{\sqrt{\overline{u'^2}}}{U_{(z)}}, \ (–,\%) \tag{2}$$

where $U_{(z)}$ is the longitudinal mean velocity of wind at height z (m.s^{-1}), u_* is the shear velocity (m.s^{-1}), κ is von Kármán constant (–), z is the height of measuring point (m), z_0 is roughness length (m), I_u is longitudinal turbulence intensity (–), $\sqrt{\overline{u'^2}}$ is the RMS of the turbulent velocity fluctuations (m.s^{-1}).

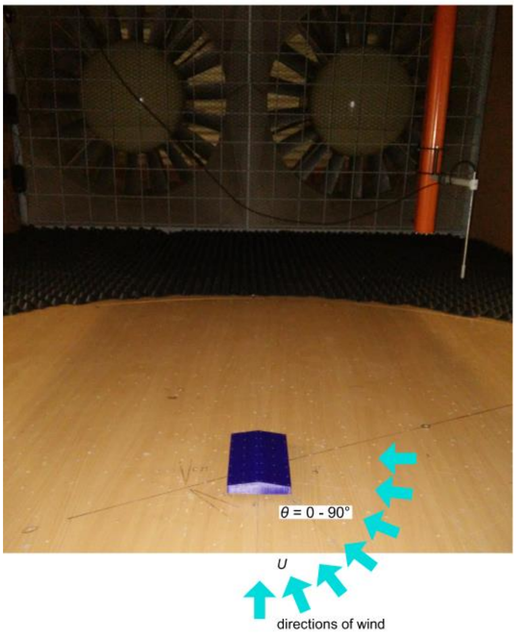
Non-dimensional power spectral density agreed well with von Kármán spectrum.
Geometric scale according to properties and scaling of ABL was 1/350 which is same with model scaling. Velocity scale was selected 1/2.8. It means that velocity during measurement was 2.5 lower than fundamental value of the basic wind velocity according to Eurocode (2007). Frequency scaling was determined with Strouhal similitude (ASCE, 1999), it is 125/1. The maximum blockage ratio of models was 0.2 % which is regard as acceptable (Stafford, 1981).

Conditions during pressure experiment were as follows: recording time for each test was 30 s, which means 500 frames per scan for all taps. It means that for each tap the sampling frequency was 31.25 Hz. Reference velocity was measured with miniCTA before the model at the top of the roof.
From pressure measurement it was calculated in this case only mean external pressure $c_{pe,\ mean}$ for purpose of the evaluation of optimal shape of roof. cpe, mean is defined by Eq. 3.

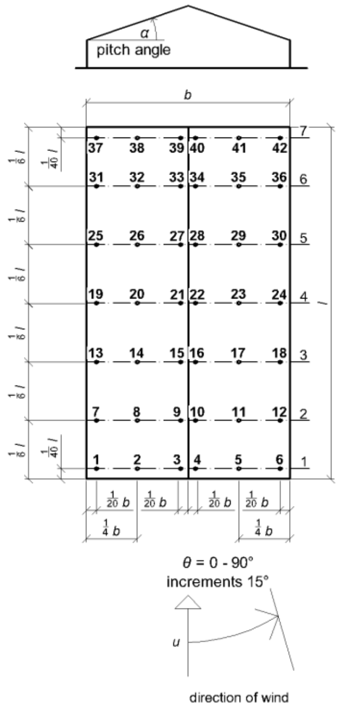
$$c_{pe,mean} = \frac{p - p_S}{\frac{1}{2}\rho\ U_{ref}^2},\ (-) \qquad (3)$$

where $c_{pe,\ mean}$ is mean external pressure coefficient (–), p is local mean surface pressure in tap (Pa), p_s is free stream static pressure (Pa), ρ is the physical density of air in kg.m^{-3}, U^2_{ref} is the free stream reference velocity at the top of the model in m.s^{-1}.

Four variants of models were modeled from polylactic acid (PLA). For accuracy of dimension of dairy barn it was used 3D printer. For each testing model, there were 42 pressure taps on the roof. Pressure measurement were taken for 7 wind directions (from 0 ° to 90 ° with a step of 15 °) as it is illustrated in Fig. 2.



a)

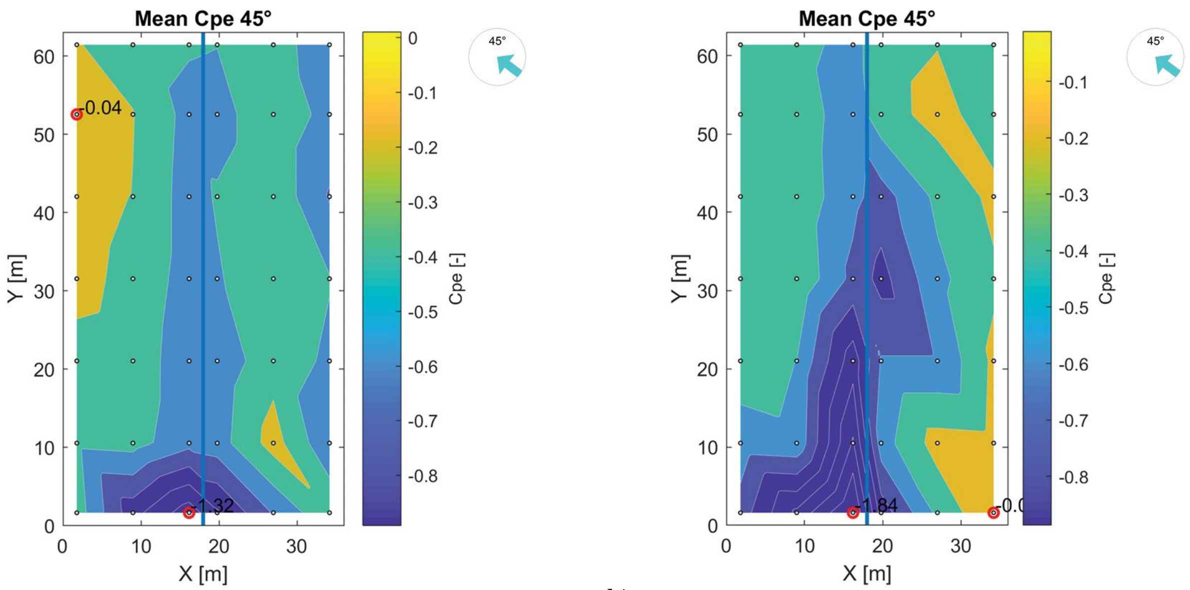


b)

Fig. 2 Model of dairy barn a) in wind tunnel with wind directions and layout of pressure taps on roof, b) 2D sketch of model with position of pressure taps

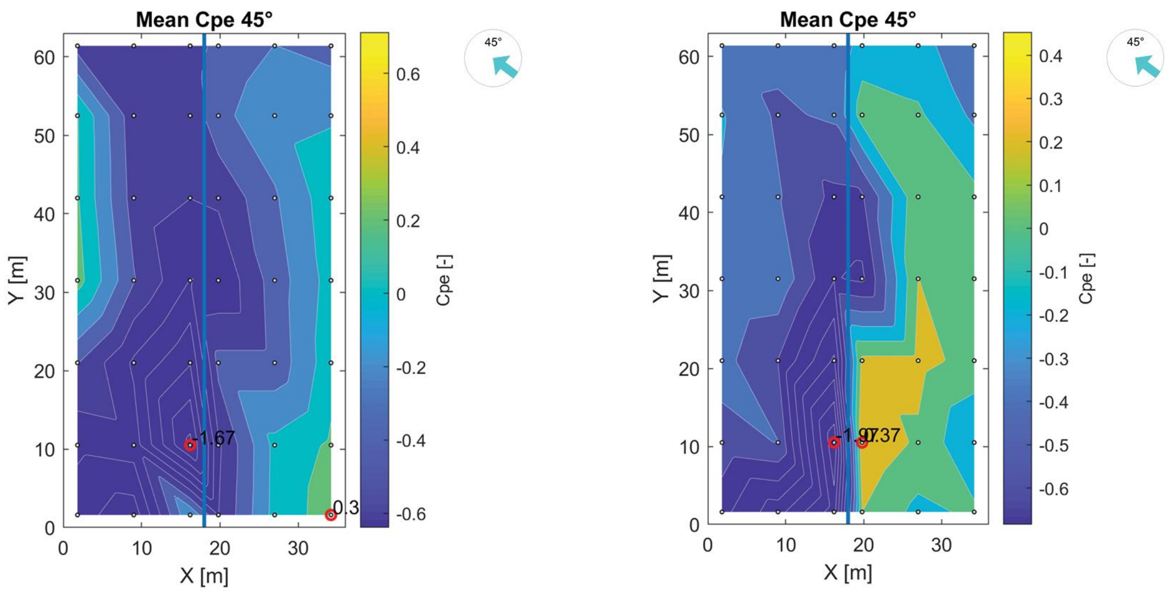
RESULTS AND DISCUSSION

From data series it was calculated $c_{pe,\ mean}$ according to Eq. 3 with reference to a mean dynamic pressure at a height of the top of the roof. Wind force that acts to the surface is defined in results as pressure, force from surface as suction. Because of a limitation of pages, it was plotted only case with maximal negative values of $c_{pe,\ mean}$, hereinafter called the maximal suction, which is in terms of wind loads the worst case. Figures 3 and 4 show the distribution of $c_{pe,\ mean}$ on the roof for each variant of the model.



a) b)

Fig. 3 Maximal suction $c_{pe,\ mean}$ a) for variant 1, b) for variant 2



a) b)

Fig. 4 Maximal suction $c_{pe,\ mean}$ a) for variant 3, b) for variant 4

CONCLUSIONS

The purpose of this article was the study of external pressure distribution of agricultural duopitch roofs. Wind tunnel tests in BLWT in Bratislava have been done. Four different pitch angles of duopitch roofs have been chosen. The results show that the optimal pitch angle of roof from the point of view of wind loads depends on the wind direction. The great impact has the negative $c_{pe,\ mean}$. In

general, to take into account variation of wind from angle of 0 ° to 90 ° the best variant is the variant 1 with maximal suction value of $c_{pe,\ mean}$ equal to -1.32. According to mentioned the wind loads and various wind directions, the worst case is the variant 4 with maximal suction value of $c_{pe,\ mean}$ equal to -1.97.
Optimal wind direction for these type of roofs was obtained in angle around 60 ° and 75 °. Critical direction was obtained around 45 °.
Our article was focused only on the distribution of external pressure on rigid model. In future works we will analyze issue of ventilation of dairy barns on models with openings and use experimental measurement with a combination of Computational Fluid Dynamics (CFD) for better understand of this phenomenon.

ACKNOWLEDGEMENTS

This work was supported by the Slovak Research and Development Agency under the contract No. APVV-16-0126 and by the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences in the project VEGA 1/0113/19.

REFERENCES

Boulard T., Kittas C., Roy J. C., and Wang, S. (2002), Convective andventilation transfers in greenhouses, part 2: determination of the distributed greenhouse climate. In: *Biosystems Engineering*, vol. 83, pp. 129–147, available on: https://doi.org/10.1006/bioe.2002.0114.

Gebremedhin K. G., and Wu B. (2005), Simulation of flow field of a ventilated and occupied animal space with different inlet and outlet conditions. In: *Journal of Thermal Biology*, vol. 30, pp. 343–353, available on: https://doi.org/10.1016/j.jtherbio.2004.10.001.

Rizzo F., D'Asdia P., Lazzari M., and Procino L. (2011), Wind action evaluation on tension roofs of hyperbolic paraboloid shape. In: *Engineering Structures*, vol. 33, pp. 445–461, available on: https://doi.org/10.1016/j.engstruct.2010.11.001.

STN EN 1991-1-4 (2007): Eurocode 1: Actions on structures. Part 1-4: General actions. Wind actions.

Stafford L. G. (1981), A streamline wind-tunnel working section for testing at high blockage ratios. In: *J. Wind Eng. Ind. Aerod.* vol. 9, pp. 23–31, available on: https://doi.org/10.1016/0167-6105(81)90075-1.

ASCE, Wind Tunnel Studies of Buildings and Structures (1999). *ASCE Manuals and Reports on Engineering Practice No. 67*. American Society of Civil Engineers, Virginia.

Korešpondujúci autor:
Ing. Michal Franek, PhD., Katedra konštrukcií pozemných stavieb, Stavebná fakulta STU v Bratislave, Radlinského 11, 810 05 Bratislava, e-mail: michal.franek@stuba.sk

THE EFFECT OF TEMPERATURE-HUMIDITY INDEX ON SELECTED PARAMETERS IN ROBOTIC MILKING

VLIV TEPLOTNĚ-VLHKOSTNÍHO INDEXU NA VYBRANÉ UKAZATELE DOJENÍ V ROBOTICKÉM DOJENÍ

Jana HANUSOVÁ[1], Ivana KNÍŽKOVÁ[2], Petr KUNC[2]

[1]Department of Building Equipment and Technology Safety, Faculty of Engineering, Slovak University of Agriculture in Nitra, Slovak Republic
[2] Livestock Technology and Management, Institute of Animal Science, Prague Uhříněves, Czech Republic

Abstract
The aim of this study was to determine the effect of the temperature-humidity index (THI) on selected milking parameters in AMS. Three dairy farms with AMS were included in the monitoring. The monitoring period was three years. The selected parameters were as follows: milk production.cow^{-1}.day^{-1}, milking frequency.cow^{-1}.day^{-1}, milking time.cow^{-1}.day^{-1}, THI. The results showed that heat stress (THI above 72) negatively influenced average daily milk yield and milking time. These parameters showed significantly ($p< 0.05$) lower values in mild-moderate zone (MMS) zone than in no heat stress zone (NS) and heat stress threshold zone (ST). The difference in milking frequency per day was not found to be significant, although in the MMS zone dairy cows were milked less often.

Key words: automatic milking system, dairy cows, THI, milk yield, milking frequency, milking time

INTRODUCTION
A large number of farmers have installed a milking robot (automatic milking system - AMS). They have two main reasons: to improve their quality of life and to increase the economic efficiency of their farm (Speroni et al., 2006). Since the introduction of an AMS into practice, the AMS has been researched. So far, scientific and technical works have focused primarily on the number of milking, ejection effect, milk quality (mainly somatic cell counts, fat content in milk), udder hygiene or mastitis in AMS, and welfare of dairy cows housed with the AMS (Gustafsson, 2017).
The rearing environment plays an important role in the success of dairy cattle breeding and hence in milk production. The thermal environment is a major factor that can negatively affect milk production of dairy cows (Kadzere et al., 2002). Especially hot weather are associated with reductions in dairy cow feed intake and milk yield (Gantner et al., 2017; Peng et al., 2019). The temperature-humidity index (THI) is usually the main determinant for heat stress (Herbut et al., 2018). The THI incorporates the effects of both temperature and relative humidity and is commonly used to quantify the degree of heat stress in dairy cows. So the THI is a simple combination of temperature and humidity and has been design as a measure of animal comfort (Habeeb et al., 2018).
The aim of this study was to determine the effect of the temperature-humidity index (THI) on selected milking parameters in the AMS.

MATERIAL AND METHODS
Three dairy farms with the AMS were included in the monitoring. Their characterization is given in table 1 (Tab. 1). Selected indicators were obtained from reports of individual dairy farms with the AMS for the period 2014 – 2017. Temperature data (air temperature, relative air humidity) were obtained from meteorological data recorded at farm sites in the monitored period.

Tab. 1 Characterization of selected dairy farms

Farm	model AMS	Number of milking robots	Number of dairy cows	Average milk yield per cow [l]
A	Lely Astronaut A4	4	288	8717.56
B	Lely Astronaut A4	4	295	7500.00
C	Lely Astronaut A4	4	303	8710.25

The selected parameters were as follows:

- milk yield.cow^{-1}.day^{-1} [l]
- milking frequency.cow^{-1}.day^{-1}
- milking time.cow^{-1}.day^{-1} [min]
- THI

The THI was calculated based on the formula determined by LPHSI (1990). The division of the zone according to the calculated THI is as follows:

- 64 – 67: no heat stress (NS)
- 68 – 71: heat stress threshold (ST)
- 72 – 79: mild-moderate heat stress (MMS)
- 80 – 89: moderate-severe heat stress (MSS)
- 90 – 98: seveer heat stress (SS)
- 99 – 104: deadly zone (DZ) (Zimbelman and Collier, 2011)

The program Statistica CZ v. 9 (StatSoft, USA) was used for statistical evaluation of the results. Data were expressed as means ± SD (standard deviation). One-way analysis of variance by ANOVA and by following select POST-HOC test (Tukey HSD test) were utilized 95% confidence interval was selected. The graphs were created by the statistical program Statistica.cz (v.9) as well.

RESULTS AND DISCCUSION

Fig. 1 shows the average daily milk yield per cow depending on THI.

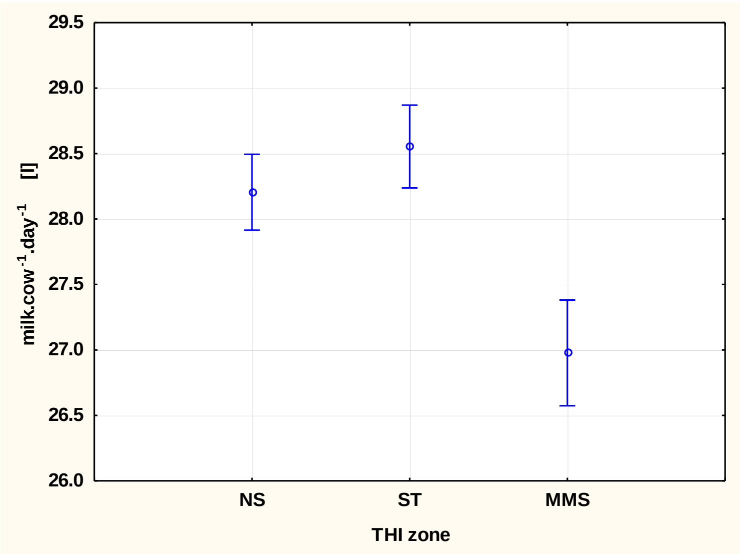


Fig. 1 Daily milk yield per cow depending on THI

An average daily milk yield of 28.20 ± 4.70 l was found in the NS zone. The value of average daily milk yield 28.55 ± 4.43 l was recorded in the ST zone and 26.98 ± 3.95 l in the MMS zone. No statistically significant difference in milk yield was found between NS and ST zones. However, the MMS zone was already statistically significantly ($p < 0.05$) different from the NS and ST zones. In both cases there was a significant decrease in average daily milk yield per cow.

Fig. 2 illustrates the average milking frequency per cow depending on THI.

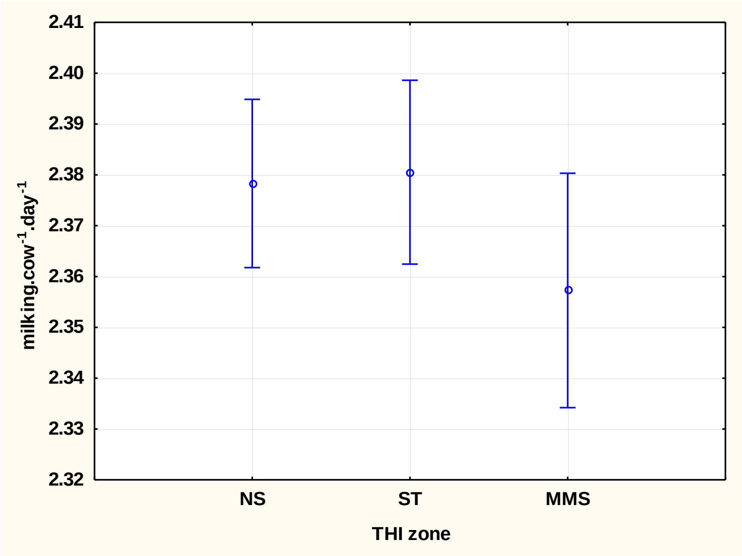


Fig. 2 Milking frequency per cow and day depending on THI

The highest values of the average milking frequency per dairy cow were reached in the zone ST, namely 2.38 ± 0.27. The average milking frequency per dairy cow was lower in the NS and MMS zones with the lowest average milking frequency per dairy cow recorded at 2.36 ± 0.23 in the MMS zone. There was no statistically significant difference between the values.

Fig. 3 documents the effect of THI on milking time per cow.

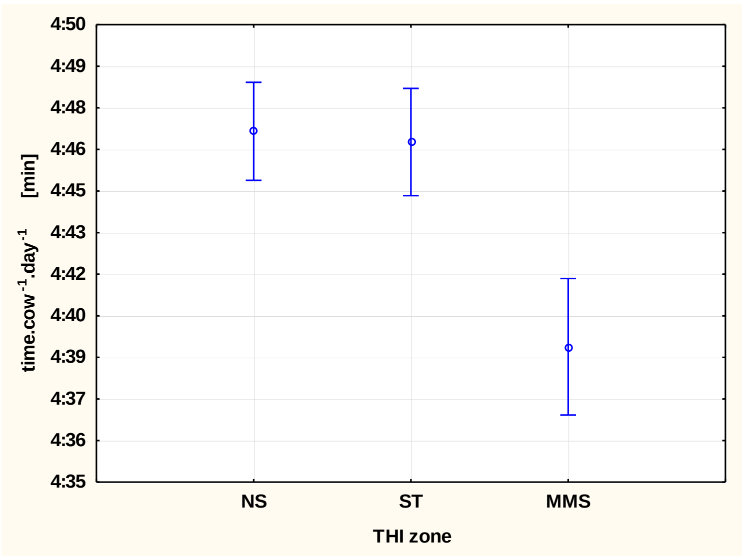


Fig. 3 Milking time per cow and day depending on THI

The graph shows that the average milking time per dairy cow (4:47 ± 0:26 min and 4:46 ± 0:26 min, respectively) was found in the NS and ST zones virtually identical. In contrast, the mean milking time (4:39 ± 0:25 min) was significantly lower ($p < 0.05$) in the MMS zone.

Generally, elevated temperature and humidity as presented in the THI negatively affects the production of dairy cows (Gantner et al., 2017; Habeeb et al., 2018). Speroni et al. (2006) state that the hot season causes milk yield reduction and the decrease of milking frequency in the AMS. Similar results were received by Bava et al. (2012). These results were also found in our study. These negative consequences are caused by cattle's responses to thermal stress (Silanikove, 2000; Kadzere et al., 2002). Results of Collier et al. (2005) show that THI beginning at 68 affect dairy cows adversely during heat stress. This result was not confirmed in our studies, but agrees with the results of Bava et al. (2012). The authors noted negative effects from THI 72. Changes in the monitored parameters were found from THI value 72 in our study too. This difference in result may be due to different rearing conditions, breed and management in experimental monitoring. However, climate change can bring about an increased incidence of zones with higher THI values (Rojas-Downing et al., 2017). Therefore, cooling methods on commercial dairy farms should be implemented earlier to prevent these effects. In the case of discomfort, the positive effect of automatic milking will be lost (Speroni et al., 2006; Collier et al., 2005).

CONCLUSION

The results showed that heat stress (THI above 72) negatively influenced average daily milk yield and milking time. These parameters showed significantly lower values in the MMS zone than in the NS zone and the ST zone. The difference in milking frequency was not found to be significant, although in the MMS zone milking frequency was observed lower.

Abstrakt

Cílem práce bylo zjistit vliv teplotně-vlhkostního indexu (THI) na vybrané ukazatele dojení v AMS (denní nádoj na jednu dojnici, počet dojení na dojnici a den, čas dojení na dojnici). Do sledování byly zařazeny tři farmy s AMS, doba sledování byla 3 roky. Výsledky ukázaly, že teplotní stres (THI nad 72) negativně ovlivnilo průměrný denní nádoj na dojnici a čas dojení. Tyto parametry vykázaly signifikantně nižší hodnoty v zóně mírného stresu (MMS) v porovnání s bezstresovou zónou (NS) a zónou velmi mírného stresu (ST). Rozdíl v počtu dojení mezi jednotlivými zónami nebyl statisticky průkazný, i když v zóně MMS byly dojnice dojeny méně často.

Klíčová slova: automatický dojicí systém, dojnice, THI, mléčná užitkovost, počet dojení, čas dojení

ACKNOWLEDGEMENT

Supported by Ministry of Agriculture of the Czech Republic, institutional support MZE-RO0718.

REFERENCES

Bava, L., Tamburini, A., Penati, Ch., Riva, E., Mattachini, G., Provalo, G., Sandrucci, A. (2012). Effects of feeding frequency and environmental conditions on dry matter intake, milk yield and behaviour of dairy cows milked in conventional or automatic milking system. *Italian Journal of Animal Science*, 11, 230 – 235.

Collier, R.J., Zimbelman, R.B., R.P. Rhoads,R.P., M.L. Rhoads, M.L., L. H. Baumgard, L.H. (2005). A re-evaluation of the impact of temperature humidity index (THI) and black globe humidity index (BGHI) on milk production in high producing dairy cows. In. Western Dairy Management Conference, 2005, Reno, Nevada, USA, 113 – 125.

Gantner, V., Bobic, T. Gantner, R.,Gregie, M., Kuterovac, K., Novakovic, J., Potocnik, K. (2017). Differences in response to heat stress due to production level and breed of dairy cows. *International Journal of Biometeorology*, 61, 1675 – 1685.

Gustafsson, L. (2017). Production and management in automatic milking systems. Faculty of Veterinary Medicine and Animal Science, Upsala University, Sweden.

Habeeb, A.A., Gad, A.E., Atta, M.A. (2018). Temperature-humidity indices as indicators to heat stress of climatic conditions with relation to production and reproduction of farm animals. *International Journal of Biotechnology and Recent Advances*, 1, 35 – 50.

Herbut, P., Angrecka, S., Walczak, J. (2018). Environmental parameters to assessing of heat stress in dairy cattle – a review. *International Journal of Biometeorology*, 62, 2089 – 2097.

Kadzere, C.T., Murphy, M.R., Silanikove, N., Maltz, E. (2002). Heat stress in lactating dairy cows: a review. *Livestock Production Science*, 77, 59 – 91.

Livestock and Poultry Heat Stress Indices (LPHSI) (1990).The Agricultural Engineering Technology Guide, Clemson University, Clemson, Sc, USA.

Peng, D., Chen, S., Li, G., Chen, J., Wang, J., Gu, X. (2019). Infrared thermography measured body surface temperature and its relationship with rectal temperature in dairy cows under different temperature-humidity indexes. *International Journal of Biometeorology*, 61, 1675 – 1685.

Rojas-Downing, M.M., Nejadhashemi, A.P., Harrigan, T., Woznicki, S.A. (2017). Climate change and livestock: impacts, adaptation, and mitigation. *Climate Risk Management*, 16, 145 – 163.

Silanikove, N. (2000). Effects of heat stress on the welfare of extensively managed domestic ruminats. *Livestock Production Science*, 67, 1 – 18.

Speroni, M., Pirio, G., Lolli, S. (2006). Effect of automatic milking system on milk yield in a hot environment. *Journal of Dairy Science*, 89, 4687 – 469.

Zimbelman, R.B., Collier, R.J. (2011). Feeding strategies for high-producing dairy Cows during periods of elevated heat and humidity. In. Tri-State Dairy Nutrition Conference, 2011, Ft. Wayne, Indiana, USA, 11 – 121. Dostupné z: https://www.cabdirect.org/ cabdirect/ abstract/20113168402.

Corresponding author:
Assoc. Prof. Ivana Knížková, PhD., Livestock Technology and Management, Institute of Animal Science, Přátelství 815, 104 00 Prague Uhříněves, Czech Republic, e-mail: knizova.ivana@vuzv.cz

Rural Buildings in European Regions :: RUBER 2019
September 10, 2019 :: Nitra, Slovakia

DIVERSIFICATION OF ACTIVITIES – SUPPOSITION OF RURAL SETTLEMENTS SPACE DEVELOPMENT

DIVERZIFIKÁCIA AKTIVÍT - PREDPOKLAD PRIESTOROVÉHO ROZVOJA RURÁLNYCH SÍDIEL

Ľubica ILKOVIČOVÁ[1], Ján ILKOVIČ[1]

[1]*Ústav konštrukcií v architektúre a inžinierskych stavieb,*
Fakulta architektúry, Slovenská technická univerzita v Bratislave

Abstract
At transformation of rural settlements since the 90s we have found different forms of their development influenced by change of living and at providing needs for inhabitants.
The aim of the article is to introduce exploratory theoretical view at problems of general development of rural settlements in Slovakia with focus on the part of diversification of production and non-production forms of activities with practical verification in chosen locations.
The authors deal in the article with the rhythm of life of families and its impact on settlement formation and reversely how a functional trend influences life of a family and existence of a settlement. Levels of imaginary intersections of rhythm of life and needs of a family and activities in a rural settlement are a condition for sustainability and overal stability. The article presents functional models of settlements which reflect their categorisation and different levels of requirements for sustainability.

Key words: agriculture, sustainability, models, production, architecture, tradition, identity

INTRODUCTION

Solution of rural surrounding should reflect development and historical connections. Connected with the solved issues we should present basic facts and contexts which have a direct connection with the article and they were the object of different researches. For the start it is necessary to determine time periods that marked development of Slovak countryside. The authors of the article have in mind three basic development periods of settlements: 1. Integrations of villages (1950 -1989), 2. disintegration of villages (1990-2004) and 3. stabilisation (2005 - present).
As the authors say (Buček and Ondoš 2014), from the 60s to the 80s the concentration of towns culminated for providing the tasks which are overtaken by public sector in the cities – from education, health system to technical infrastructure. This fact was shown also in settlements of central meaning. Since the 80s the situation has been changed and in the centre of interest there are questions of economical development, intensification of industrial activities and quality of environment.
In this context in a relatively short period of time the social structure of a village was changed. That is why it is necessary to provide an inevitable level of stableness at present. Excessive intensive development in the 80s and growth of industrialisation of agriculture regardless the culture-historical values disturbed the balance what influenced the deterioration of environment and it had impact on architectonic works and suppression or even loss of identity (Bóna et al., 1987).
Also other authors point at negative impact in the form of loss of identity of rural surroundings. The vital break in development of Slovak countryside in the whole width was collectivisation of agricultural farming. On one hand it brought a certain development of living standards in the following period in the countryside connected with loosening the workforce for city industry which was connected with a daily migration for the work into the cities. On the other hand and mainly from the present view, this caused permanent scarves on natural development of the countryside. A natural connection of a country man to the land and responsibility for his own farming was broken. A tradition of Slovak countryside was permanently broken and a follow-up can be done only in a minimal way (Ilkovič, 1998).

Extensive (non-economical taking of the land) and at the same time intensively growing production surrounds the settlements which ends up in literally cutting away the direct connection of a person with a natural surroundings. The presented problem of unwelcome growth was joined by an issue of cities (Dorotjak, 1970). This issue brings a lot of negatives in social-sociable, cultural area and in territorial and construction development.
After 1989 we started to perceive the broken form of residences more. The presented problem and inevitability of its solution is stressed (although not always with a good effect) by the European Union. The aim of the European Union is to grow cultural diversification and identity of regions and to deepen culture of the village. Keeping the identity of the countryside becomes an urgent challenge for architecture and urbanisation of our times (Šarafín and Rudinský, 2010).

MATERIAL AND METHODS

In the research were used classical methods of observation, analysis and comparison which helped to generalize facts and then to apply them in forming a functional theoretical model of sustainable rural residence depending on its location, character, category and regional connections.
Sustainability of the countryside is generally defined as fulfilling of these principles: ecological principle and efficiency of economy, fulfilling cultural and social integrity of rural surroundings, respecting the needs of future generations and keeping the level and principles of acceptable mistakes (Huba, 2002). A wide scale of diversity of activities is defined by this. They can be set in the limits of the issues searched, which are as follows:

- activities in the country, settlement (production, non-production),
- using of renewable sources,
- mostly a closed cycle of production and minimalisation of losses, limiting the negatives,
- keeping the values of the country, culture, folk culture and traditions.

Observation and analysis showed a direct rate of the size of the settlement and range of activities and exercised factors. Unfriendly phenomena can be seen in smaller marginal villages where any economical activities almost vanished, traditional possibilities for employment in a primary sector are only in minimal range. A dominant function of these villages is a residential or recreational one and they are gradually becoming dying out places (Sloboda, 2004).
An antipole is city settlements which have mostly living function and mainly in new satelites of these settlements we called them „laying block of flats“ where other functions are often in deficit. The countryside always presented a high level of polyfunction, it means it had historically a relatively balanced structure of functions, needs and production based mainly on agriculture and land basic. The aim is based on suitable methods of searching the settlement (e.g. a SWOT analyses) set the structure, grid of different functions. Then based on evaluation and graphic verification to form model case studies with the extent of sustainability. Their priority is to eliminate a violent „city invasion“ into relationships regarding the settlement and to keep a natural balance of a village life, communities and families. They are key processes which will optimise a functional scheme (model) of the settlement and specify activities from the following „packets“:
a) instructive,
b) cultural (local, regional, folk),
c) craft, agricultural, industrial,
d) sport- relaxation.
Synthesis and summarisation lean in the presented research also on the method of research by design which presents the main result of the research.

RESULTS AND DISCUSSION

Connected with the presented research, the authors deal with the issue of securing the sustainability of the countryside. Important is the orientation on the chosen criteria from thoughtful principles of creation (functionality, hygiene of surroundings, respecting the land etc.). Sustainable means stability in different areas – social, cultural and industrial, land – spatial. Perspective development of settlements requires steps in fulfilling the following criteria and architectonic – urbanistic creation with a positive impact into surroundings, which means:

- respecting generally valid environmentally thoughtful solutions regarding emissions, energetic efficiency and hygiene of surroundings,
- creation of individual concepts regarding the particular conditions of a location,
- providing functioning and in this way keeping productive inhabitants in the central through job offer and activities dedicated to cultural – social dimension.

A problem can be in a faraway and marginal areas from the view of sustainability and permanent stay of inhabitants. Adjacent city settlements with mainly living function are sustainable thanks to the proximity of bigger cities with acceptable commuting distance for work and other activities.

Diversification of activities – life in the settlements

Diversification of activities is a condition for sustainability of life in rural surroundings. Vitková (2002) speaks about necessity of polyfunction when she stresses the benefit of diverse public space rural settlements not taking out, to the benefit of efficiency and sustainability of the settlement. Similarly also authors (Siláči and Vitková, 2017) claim that activities "stimulating" a public space and spontaneous transformation of urban spaces and their active and creative use is influence on factors that are close to the terms of the creative city. In the countryside surroundings we can analogically speak about creative rural settlements which is reached by a multifunction reflected in the countryside life and comes out of the qualities of location and it also stimulates development.

Rhythm (time layout) of the day and also the way of family life (working, social and other activities) is as follows:

- a daily period: transport to/from work and school, active spending of free time,
- evening and night period: some houseswork and sleep.

Orientation and length of periods are different when talking about families without children and families with children. A possible time shift of the borderline between a day and night shift is strongly influenced by geographical location of the settlement (Fig. 1, 2).

Active day time spent out or in the regarding space is connected with the range of activities in the settlement (village), it influences its development and quality: ground, landscape, architectonic, sociological, cultural, sport which influences at the end functional system of the surroundings. One of the methods of concept creation system of surroundings is a creation of a „space grid". It means that based on the thorough analysis and evaluation of data it is possible to model a prorable structure and layout of activities in the settlement. It is a starting point for theoretical modules from the view of ground system of a settlement. Then their transformation and application is possible into the space-ground concepts at a necessary reflexion of settlements categorisation (Kusendová et al., 2014). The aim is to head the effort into the restoration of balance and sustainability of development based on specific local economy and necessary interactive relationships in a wider space of a settlement (Ondoš, 2014).

Village in the proximity of bigger cities

There is a new residential building-up between the built-up space of cities and rural settlements and also new settlement formations whose system and form causes the loss of settlement identity, breaking the siluette, historical-cultural continuation of development, specific architectonical – urbanistic expression and scale while the loss of the presented levels is mostly unsustainable. The next problem is absence of diversity of public spaces in the suburbs. The prevalent typological form of a public space is a street while its parameters often enable only traffic access, without adjacent greenery, possibility of parking and integration of polyfunction with negative phenomenon – discontinuity of public spaces (Štepánková and Kristiánová, 2012).

In case of working mobility it is true that in adjacency of big cities the smaller the village the more living character it has got, not a productive one (Ďurček, 2014). The presented is shown in the scheme of monofunctional raster mainly of city satellites, (Fig. 3).

Villages faraway or in the proximity of smaller towns
Solution is the concept of the space which creates conditions for development of activities of social, cultural, sport dimension with a supplementary agricultural activity. Important is a possibility to perform not only basic daily activities, but also development of private and public activities, what creates a necessary condition of sustainability of living and location. Diversity – variety of activities has got a regional and local dimension, it is determined by traditions. Variability of activities and sustainable dimension of living create a direct rate.

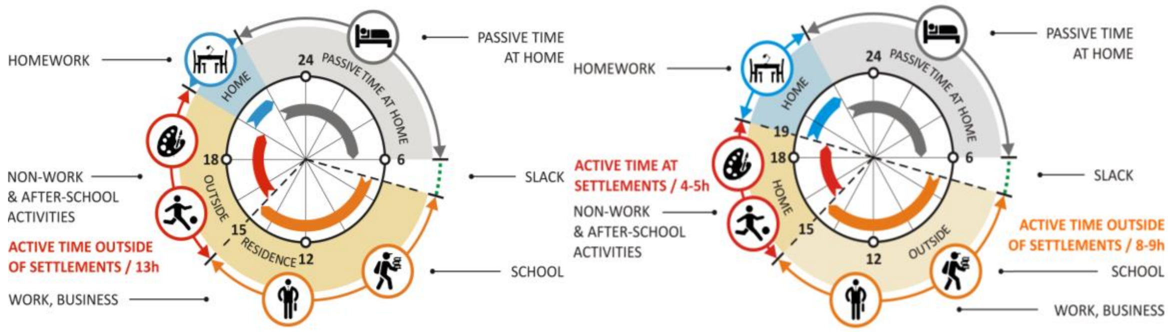


Fig. 1, 2 Graphic presentation of family time layout of the day in the monofunctional settlement and in the settlement with diversification of activities

The more activities in space (a creative settlement) there is, the more real is the possibility for sustainability and development of a settlement, (Fig. 4). If there is no functional variability there will be depreciation and even lagging, in the worse cases even dying out of the settlement.

Impact on the architecture
The study of vernacular traditions allows the architect to be more self·aware, and to be critical of his own culture's arbitrary conventions. An architect which is good at traditions can react appropriatelly on modern times by adequate transformation of architecture (Glassie, 1990). Aesthetics of architecture of rural buildings comes out of logic, decorations are on the second place. According to Glassie, H. (1990): „It represents prose more than poetry.“
Whether we speak about countryside, vernacular surroundings or rural surroundings, there is a necessity of agriculture issues. Another determinant is a traditional way of life and agricultural way of life (Donovan and Gkartzios, 2014) which transform into the expression of architecture. Traditional, logical masses and details from the past create archetypes which are transformed into the all scale of typological kinds of objects in rural settlements.

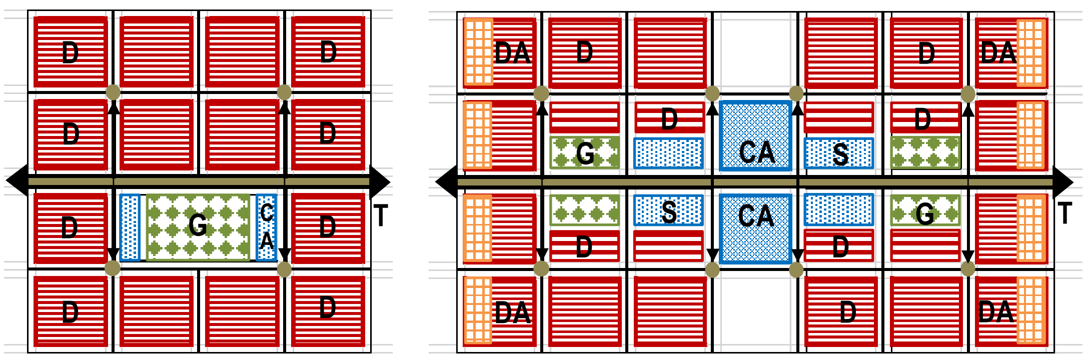


Fig. 3, 4 Monofunctional model and Model of settlement with diversity of activities

Application of theory – two examples (areas of Skalica and Markušovce)

Different locations were solved with method research by design: a remote one (Markušovce) in the area of a smaller city and area of a central settlement (Skalica). Both locations have got a potential from the view of a natural access of inhabitants as a source of a work force. At the same time in both micro regions there are villages with mostly a living function. It is a reason for establishing diversity and different activities which come out of support the location identity, tradition and narrow interraction of the country and production and specific farm culture (Ilkovič at al., 2005). Basically it is counted also with job offer for local inhabitants and lot of activities for guests, tourists and this is the way how to increase migrational growth. Expected result is keeping the active people in the place of living, sustainability of the countryside, applying the closed cycle of agriculture production, development of a suitable production and services, offer of activities for visitors and possibility for next development, Table 1.

Table 1 Basic evaluation of settlements – two study examples.

	Characteristics of Settlements			Potential of settlements			Supposition of diversified activities development			
Micro-region	Marginal zone	Center of attraction zone	Dwelling function	Tradition, production background	Cultural, historical		Production activities	Cultural activities	Sports activities	Other, e.g. tourism
Skalica		●	◐							
Markušovce	◐		●							

In example of the area of Skalica there was a stress on equal layout of activities in the ground raster: dominant vinary traditions, eco – agriculture, touristic activities, e.g. in connection with Baťa channel (Fig. 5, 6). Area of Markušovce is exceptional because of its tradition of mining and metallurgy in the surroundings, which is also dominant in the ground raster, with placing expressive touristic accents for development of „touristic development“ (e.g. instructive way of metallurgy in Germany). Together with the possibility to establish eco-agriculture and finalisation of local foods there is a possibility of ground development (Fig. 7,8).

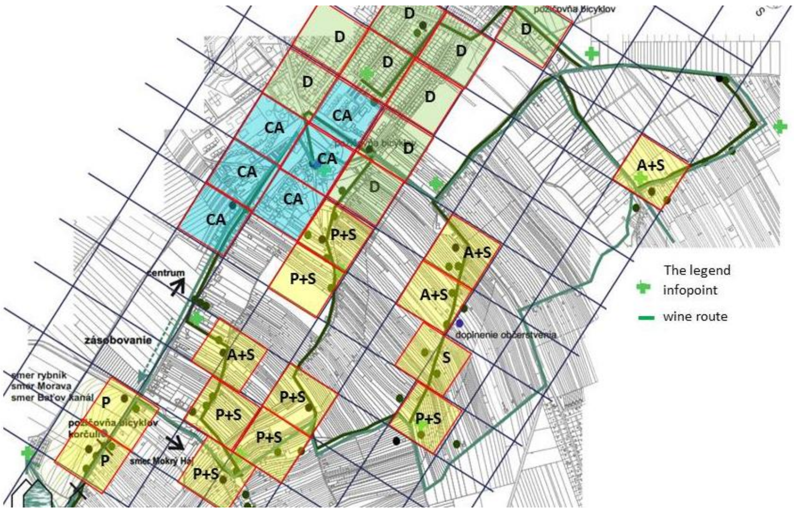


Fig. 5 Application of grids method with the diversity of activities in Skalica microregion (legend: D – dwellings, A+S – agricultural, service P+S – production, service, CA – civic amenities, R– relax)

Fig. 6 New identity was inspired by old tradition: in Skalica wine production

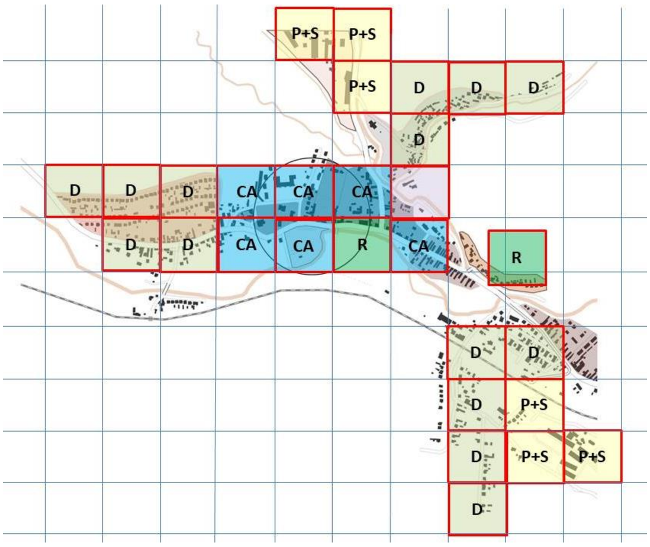


Fig. 7 Application of grids method with the diversity of activities in Markušovce (legend: D – dwellings, A+S – agricultural, service P+S – production, service, CA – civic amenities, R– relax)

Fig. 8 New identity was inspired by old tradition: Markšovce – mining industry from 19th.

CONCLUSION

A functional time cycle of a family life influences a functional – operative raster of settlements and also the scheme of sustainable surroundings as a whole. Monofunctional satellites ofliving, so-called laying block of flats in the most frequent areas close to big cities - more than 100 thousand inhabitants

live more or less sustainably only because of acceptable commuting from the time view and using the job offers but also services and activities offered in these cities.
The more remote is the settlement from the bigger cities and settlement in marginal areas of the country, the bigger is the necessity of creation conditions for multi-activities, creativity and opportunities for all categories of inhabitants. Remote settlements (villages) in relationship with bigger cities can be interesting because of specific diverse activities, oriented on traditions of the region. They colourfully characterise location and provide sustainability and they keep the identity of the city and are included in functional rasters of rural settlements. Their functioning depends on the quality of area and influences also its complex development. Without sensible concepts and saturation of development the sustainability of countryside will be very difficult to fulfill. To suppose that life in the countryside will be on the first place about agricultural activities is not real but to keep productional traditions is necessary for future generations and complexity of rural space.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to students of Magister study at FA STU, Diana Glončáková and Júlia Hanuliaková whose design studios are shown in Figure 7 and Figure 9 and were a part of research.

REFERENCES

Bóna, J., Keppl, J., Špaček, R. (1987). Kultúrna kontinuita v architektonickej tvorbe prestavby vidieka. *Zborník vedeckých a odborných prác 1987, Bratislava.* FA SVŠT in Bratislava, 66-75.

Buček, J., Ondoš, S. (2014). Úvod - prístupy k vymedzovaniu a definovaniu miest a mestských regiónov a ich využitie v urbánnych politikách štátov. In Vymedzenie miest a mestských regiónov na Slovensku, vrátane zhodnotenia funkčných typov sídiel, na báze hustoty obyvateľstva, s použitím rastrovej technológie. Bratislava : Prírodovedecká fakulta Univerzita Komenského v Bratislave, 2014, 4-22.

Donovan K, Gkartzios M. (2014). Architecture and rural planning: Claiming the vernacular. *Land Use Policy*, 41, 334-343.

Dorotjak, D. (1970). Slovenská ľudová architektúra: Názory. *Projekt – Revue slovenskej architektúry*, 12(5-6), 263.

Ďurček, P. (2014). Funkčné typy obcí a miest na základe vybraných ukazovateľov. In Vymedzenie miest a mestských regiónov na Slovensku, vrátane zhodnotenia funkčných typov sídiel, na báze hustoty obyvateľstva, s použitím rastrovej technológie. Bratislava : Prírodovedecká fakulta Univerzita Komenského v Bratislave, 2014, s 23-38.

Glassie, H. (1990). Architects, vernacular traditions, and society. *Traditional Dwellings and Settlements Review*, 1(2), 9-21.

Huba, M., 2002. Skúsenosti s uplatňovaním princípov a kritérií trvalo udržateľného rozvoja pri regionálnych výskumoch. *Acta Environmentalica Universitatis Comeniane*, 11, 37-43.

Ilkovič, J. (1998). Rodinná farma ako nový koncepčno-typologický druh v štruktúre výrobných zariadení vidieka. *ALFA STU*, 2(1-2), 9-15.

Ilkovič, J., Ilkovičová, Ľ., Baláž, J. (2005). Spatial aspects of the conversion of agricultural production. In Acta horticulturae et regiotecturae. vol. 8, supplement 2005, pp. 99-103. ISSN 1335-2563. (In Slovak: Priestorové aspekty konverzie poľnohospodárskej výroby).

Kusendová, D., Rosina, K., Hurbánek, P. (2014). Mestsko-vidiecka klasifikácia základných územných jednotiek na báze analýzy rozmiestnenia obyvateľov s použitím populačného rastra veľkosťou bunky 1 x 1 km.). In Vymedzenie miest a mestských regiónov na Slovensku, vrátane zhodnotenia funkčných typov sídiel, na báze hustoty obyvateľstva, s použitím rastrovej technológie. Bratislava : Prírodovedecká fakulta Univerzita Komenského v Bratislave, 2014, 64 – 81.

Ondoš, S. (2014). Zhodnotenie alternatív vymedzenia miest a mestských regiónov na Slovensku – záver, doporučenia a návrh. In Vymedzenie miest a mestských regiónov na Slovensku, vrátane zhodnotenia funkčných typov sídiel, na báze hustoty obyvateľstva, s použitím rastrovej technológie. Bratislava : Prírodovedecká fakulta Univerzita Komenského v Bratislave, 2014, 82-91.

Siláči, I. –Vitková, Ľ. (2017). Public spaces as the reflection of society and its culture. In Materials Science and Engineering 2017. Prague : WMCAUS, 245, 1710-1715.

Sloboda, D. (2004). Charakter sídelnej štruktúry Slovenska ako predpoklad pre komunálnu reformu. In www.konzervativizmus.sk/upload/prezentacie/Sloboda_komreforma.pdf

Šarafín, M. – Rudinský, P. (2010). Pomešťovanie – hrozba či nevyhnutnosť? Verejné priestranstvá na vidieku. In Urbanita 22(1), 48-51.

Štepánková, R. – Kristiánová, K. (2012). Verejné priestory v urbanistickej štruktúre vidieckych rezidenčných suburbií Bratislavy. In Člověk, stavba a územní plánování VI. Praha : ČVUT, 2012, 178-182.

Vitková, Ľ. (2002). Polyfunkcia – predpoklad efektívnosti urbanistických štruktúr. *ALFA STU* 1-2/A, 3-12.

Korešpondujúci autor:
doc. Ing. arch. Ľubica Ilkovičová, PhD., Fakulta architektúry STU v Bratislave, Námestie slobody 19, 812 45 Bratislava, Slovensko, e-mail: lubica.ilkovicova@stuba.sk

Abstrakt
Pri transformácii vidieckych sídiel od 90. rokov nachádzame rôzne formy ich rozvoja pod vplyvom premeny bývania. Prehlbuje sa aj funkčná diferenciácia vidieckych sídiel. Cieľom príspevku je predstaviť výskumný teoretický pohľad na problematiku všeobecného rozvoja vidieckych sídiel na Slovensku s akcentom na úlohu diverzifikácie produkčných a mimoprodukčných foriem aktivít s praktickým overením na vybraných lokalitách vidieka.
Autori sa v príspevku zaoberajú rytmom života rodín a jeho dopadu na formovanie sídla a naopak ako funkčné zameranie sídla ovplyvňuje život rodiny a existenciu sídla. Úrovne imaginárnych priesečníkov rytmu života a potrieb rodiny a aktivít vo vidieckom sídle sú podmienkou udržateľnosti a celkovej stability. V príspevku sú predstavené funkčné modely sídiel, ktoré odrážajú ich kategorizáciu a rôzne úrovne požiadaviek na udržateľnosť. Závery výskumu prezentujú architektonicko-urbanistické trendy udržateľného a ohľaduplného rozvoja no vybraných lokalitách Slovenska.

Key words: poľnohospodárstvo, udržateľnosť, modely, výroba, architektúra, tradícia, identita

THE EFFECT OF CONSTRUCTION DISPOSITION ON AIR TEMPERATURE IN MILKING PARLOURS

VLIV STAVEBNĚ-DISPOZIČNÍHO ŘEŠENÍ NA TEPLOTU VZDUCHU V DOJÍRNÁCH

Petr KUNC[1], Ivana KNÍŽKOVÁ[1],

[1]*Livestock Technology and Management, Institute of Animal Science, Prague Uhříněves, Czech Republic*

Abstract
Seven built-in parlours (A) and 6 stand-alone parlours (B) were included in the long-term follow-up. The air temperature in the exterior and in the interior of the parlour was measured throughout the year. The measured values were divided into three zones (1st zone: cold period, zone 2nd: transition period, 3rd zone: warm period). The differences in air temperatures in parlours A and B were not statistically significant in any zone. The construction disposition of the parlor did not affect the temperature conditions in the parlor interior. The air temperatures in the parlour were strongly dependent on the exterior air temperature (A: r = 0.9285; B: r = 0.9402).

Key words: parlour**,** solution, exterior air temperature, interior air temperature

INTRODUCTION

The quality of the working environment has a decisive influence on the milker's work during milking. Microclimatic conditions are one of the main components of the working environment. The most important factors include the air temperature, which significantly affects the well-being of workers (Mathauserová, 2000). When designing, the calculation temperature of the parlour is 15 °C. This temperature refers to the working area of the milker. The parlour heating must ensure a minimum temperature of 10 °C before the start of the working shift. The air temperature in the parlour must not fall below 2 °C between milking (ČSN 73 0543-2). Kunc and Knížková (1998) found that due to inadequate temperature conditions in the parlour, the temperature condition of the milker´s hands deteriorated.

The aim of the work was to find out the effect of the construction disposition of the parlours on the air temperature in these buildings.

MATERIAL AND METHODS

The measurements were carried out in field conditions. Seven built-in parlours (A) and six stand-alone parlours (B) were included in the long-term monitoring. The air temperature in the exterior and in the interior of the parlour was measured throughout the year. The measured values were divided into three zones by Novák (1994):

- 1st zone: cold period, $T_{ext} < 0$ °C
- 2nd zone: transition period, 0 °C $\leq T_{ext} < 18$ °C
- 3rd zone: warm period, 18 °C $\leq T_{ext}$

The program Statistica CZ v. 9 (StatSoft, USA) was used for statistical evaluation of the results. Data were expressed as means ± SD (standard deviation). One-way analysis of variance by ANOVA and by following select POST-HOC test (Scheffe test) were utilized 95% confidence interval was selected. The data were further subjected to regression analysis. The correlation coefficient was calculated. The orientation scale for evaluating was as follows:

- $0 \triangleleft |r| \leq 0{,}3$ ……………………low
- $0{,}3 \triangleleft |r| \leq 0{,}8$ ………………..medium
- $0{,}8 \triangleleft |r| \leq 1$ …………………..strong

RESULTS AND DISSCUSION

The table 1 (Tab. 1) shows the results of the air temperature measurement in the exterior and in each type of parlour**.**

Tab. 1 Average air temperature depending on the measuring point

	Air temperature [°C]		
	exterior	A	B
1st zone	- 5.96 ± 3.72	8.62 ± 2.45	5.88 ± 3.25
2nd zone	8.65 ± 6.92	15.43 ± 4.60	13.60 ± 4.34
3rd zone	22.63 ± 4.88	24.11 ± 3.56	23.97 ± 2.56

Based on statistical analysis of the data, statistically significant differences ($p < 0.05$) were found in the air temperature between the parlours A and the exterior in the 1st and 2nd temperature zone. In the 3rd zone, the differences between the exterior and parlour were not significant. Similar results were obtained in type B milking parlours; statistically significant differences ($p < 0.05$) existed between B milking parlours and exterior, again in the 1st and 2nd temperature zone. There were also no significant differences between the exterior and parlours in the 3rd zone.
After comparing the air temperatures between the parlours A and B in the specified temperature zones, it was found that the differences were not statistically significant in any of the monitored zones.
The calculated correlation coefficient showed that the air temperature in the parlour is strongly dependent on the exterior air temperature (A: $r = 0.9285$; B: $r = 0.9402$).

The average air temperature in both parlours A and B was low in cold period. Luymes (1990) states that the parlour air temperature should be kept at a minimum of 10 °C. Romaniuk and Overby (2003) recommend 14 ° C as the minimum air temperature in the parlour. Jarník (1973) recommends keeping the air temperature in the parlour at 15 °C. He considers this value to be essential for well-being and the biological milking process and derives it from the work environment requirements of industrial plants. However, in the monitored cold period the air temperature in the parlours A and B was in most cases kept below the recommended values. In the transitional period, the observed values did not deviate from the recommended ambient temperatures. In the warm period, the observed values do not exceed the maximum, which according to Romaniuk and Overby (2003) is 25 °C.
A strong correlation between the interior air temperature in the parlour and the exterior air temperature was found in both parlours A and parlours B. Tuure (2003) also found a strong correlation between the interior air temperature in the parlour and the exterior air temperature.

CONCLUSION

The differences in air temperatures in parlours A and B were not statistically significant in any zone. The construction disposition of the parlor did not affect the temperature conditions in the parlor interior. The air temperatures in the parlour were strongly dependent on the exterior air temperature.

Abstrakt
Cílem práce bylo zjistit vliv stavebně - dispozičního řešení dojíren na teplotu vzduchu v těchto objektech. Do dlouhodobého sledování bylo zařazeno sedm vestavěných dojíren (A) a šest samostatně stojících dojíren (B). Byla zjišťována teplota vzduchu v exteriéru a v interiéru dojíren v průběhu celého roku. Naměřené hodnoty byly rozděleny do tří pásem (1. pásmo: chladné období, 2. pásmo: přechodné období, 3. pásmo: teplé období). Rozdíly mezi teplotami vzduchu v dojírnách A a B nebyly

statisticky průkazné v žádném pásmu. Stavebně dispoziční řešení neovlivnilo teplotu vzduchu v interiéru dojírny. Teploty vzduchu v dojírnách byly silně závislé na teplotě vzduchu exteriéru (A: r = 0,9285; B: r = 0,9402).

Klíčová slova: dojírna**,** řešení, exteriérová teplota vzduchu, interiérová teplota vzduchu.

ACKNOWLEDGEMENT

Supported by Ministry of Agriculture of the Czech Republic, institutional support MZE-RO0718.

REFERENCES

ČSN 730543-2 (1997). Vnitřní prostředí stájových objektů Část 2: Větrání a vytápění. Český normalizační institut, Praha, 1997.

Jarník, J. (1973). Vztahy a vlivy technologií dojení na projektování stájí pro dojnice. In. Mezinárodní konference o strojním dojení, Brno, 1973, 107-114.

Kunc, P., Knížková, I. (1990). Termografická studie tepelné pohody dojičů během dojení. In. Aktuální otázky bioklimatologie zvířat, VFU Brno, 1998, 35-36.

Luymes, J. (1990). Ventilation of the milking complex. Farm Structures Factsheet, Ministry of Agriculture and Food British Columbia, 1990.

Mathauserová, Z. (2000). Mikroklima uvnitř budov. Státní zdravotní ústav, Geoprint, Liberec, 2000.

Novák, P. (1994). Systém vyhodnocování mikroklimatických faktorů ve vztahu k zabezpečení pohody ve stájích pro skot a prasata. Vysoká škola veterinární a farmaceutická v Brně, 1994.

Romaniuk, W., Overby, T. (2003). Farm Standards. Institute of Building, Mechanisation and Electrification of Agriculture, Warsaw, Poland, 2003.

Tuure, V. M. (2003). Cold working environments on dairy farms in Finland. *International Journal of Circumpolar Health*, 62, 190-203.

Corresponding author:
Assoc. Prof. Petr Kunc, PhD., Livestock Technology and Management, Institute of Animal Science, Přátelství 815, 104 00 Prague Uhříněves, Czech Republic, e-mail: kunc.petr@vuzv.cz

LABORATORY TESTING OF THE IMPACT OF CLIMATE CONDITIONS ON CHANGES IN THERMAL-TECHNICAL CHARACTERISTICS OF ORGANIC LITTER

LABORATÓRNE TESTOVANIE VPLYVU KLIMATICKÝCH PODMIENOK NA ZMENY TEPELNOTECHNICKÝCH VLASTNOSTÍ ORGANICKEJ PODSTIELKY

Jana LENDELOVÁ[1], Ingrid KARANDUŠOVSKÁ[1], Miroslav ŽITŇÁK[1], Tímea SZABOÓVÁ[1], Štefan BOĎO[1]

[1]*Department of Building Equipment and Technology Safety, Faculty of Engineering, Slovak University of Agriculture in Nitra*

Abstract
The aim of this work was to investigate other physical properties of separated slurry sludge and the production of pollutants in dependence on changing temperature of litter material. Thermal properties were measured using ISOMET model 2104. The measurement of thermal conductivity λ, and thermal diffusivity *a* of sample was carried out by setting the desired temperature in the air conditioning chamber of 0 °C to 40 °C in the range of 5 °C. It was found that the thermal conductivity λ of dry RMS decreases with increasing temperature and stabilized at a sample temperature of 10 °C at λ = 0.142 W.m^{-1}.K^{-1}. The thermal conductivity λ of the wet RMS (with a dry matter content of 26 ± 2.42 %) increased significantly with increasing temperature. However, at a standard temperature of 10 °C with a value of λ = 0.161 W.m^{-1}.K^{-1}. The production of ammonia and methane pollutants has an increasing trend in both dry and wet conditions as the temperature rises.

Key words: recycled manure solids (RMS), thermo-technical properties of RMS, thermal conductivity, thermal diffusivity, pollution from poultry housing litter

INTRODUCTION

Increasing demands on the quality of products of animal origin required to deal with the improvement of animal housing conditions, including climatic environmental conditions such as humidity and temperature (Balková and Pogran, 2009). Bedding is a very costly component of dairy farming that has significant implications for animal health, as well as environment (Herbut et al., 2014). The cost and availability of bedding fluctuates, and good bedding materials can be hard to find and expensive. Farmers using RMS report greater cow comfort than with other bedding materials they have used (Harrison, et al., 2006). They report a significant improvement in the welfare of housing animals, in that animals create natural bed in the organic plastic material and separated slurry handling is very simple, there is no spreading out of cubicle lying (Jelínek et al., 2006). Increased marketing of high-performance slurry separation machinery has generated interest in this practice in Europe, where there are very different climatic conditions (Zähner et al., 2009; Feiken and van Laarhoven, 2012; Marcher Holm and Pedersen, 2015). The separated slurry of manure is an organic material that is used for bedding in cubicle lying at different levels of moisture - which is related to the season, with litter preparation and litter management (Lendelová et al., 2016). The thermal comfort of dairy cows while lying is influenced by the cubicle lying construction, characterized by thermal conductivity (inversely thermal resistance), thermal diffusivity and thermal effusivity of the floor. Thermal conductivity λ (W.m^{-1}.K^{-1}) is the ability of materials to conduct heat. Insulators - materials with low thermal conductivity, less than 0.3 W.m^{-1}.K^{-1} are suitable for construction of seams. However, it is a characteristic dependent on the temperature and density of the material. Previous studies have also shown that the choice of litter material in farms can also have a significant effect on the amount of NH_3 emissions produced, although there is little information about which properties of litter materials are important in this regard (Misselbrook and Powell, 2005). The aim of this work was to investigate other physical properties of separated slurry sludge and the production of pollutants in dependence on changing temperature of litter material.

MATERIALS AND METHODS

Organic litter samples from dairy farm were used in this experiment which was obtained by separating the raw sludge of liquid manure. We focused by sampling on two characteristic conditions of litters – dry condition and wet condition, while places directly contaminated by feces were not be used. The dry samples of recycled manure solids (DRMS) were taken from the front of the cubicles – below the head barrier, wet samples from the back of the cubicles. The samples (each of 200 g) were taken from 10 cubicles of four rows. The dry matter content was determined from a part of separated dry and wet samples, the other part of dry and wet material was hermetically enclosed and used for testing of thermo-technical properties in the laboratory. Sample pre-drying was performed in the dryer HS 402 at the pre-drying temperature of 55 ± 5 °C. Drying of samples was finished in drying equipment POL-Tote SLW 115 STD; the samples were dried at 105 °C till the constant weight was reached. The tests were carried out in a BINDER-KMF climate chamber in the temperature range from 0 °C to 40 °C, in which the amount of ammonia and methane released from the material sample was monitored under the set climatic conditions, namely temperature and humidity. The INNOVA 1309 photoacoustic multichannel analyser was used together with the accessories to measure gas concentrations. Five measurement points were selected directly in the chamber. The thermal properties were measured by device ISOMET model 2104. The measurements were performed using needle probes with an appropriate range. Temperature, relative humidity and velocity of the air and sample temperature were measured by 2 devices ALMEMO 2590 - 3S through external sensors. Measurement of the thermal conductivity λ and the thermal diffusivity a of the RMS sample were performed under laboratory conditions by adjusting the required temperatures in the air-conditioning chamber from 0 °C to 40 °C at intervals of 5 °C. Based on the measured values, the graphical dependence of the thermo-technical properties on the temperature of sample was evaluated in order to find out information about the given material changes in the temperature range, which occur throughout the year in the stables.

RESULTS AND DISCUSSION

In Figure. 1 and 2, the graphical dependence of the observed thermal-technical properties on the temperature of RMS sample is evaluated. The temperature of the RMS sample was measured at the chamber air temperatures; in the graphs, the x-axis temperature of the bedding was found at the currently set chamber air temperature.

When measuring the sample of dry recycled manure solids, the average dry matter content of the sample was 58 ± 2.11 %. Figure 1 shows that the thermal conductivity λ of the dry RMS decreases with increasing temperature and has stabilized at λ = 0.142 $W.m^{-1}.K^{-1}$ at the sample temperature of 10 °C. For a range of temperatures commonly found in the year-round operation of our cattle farms, we found thermal conductivity values λ from 0.089 $W.m^{-1}.K^{-1}$ to 0.138 $W.m^{-1}.K^{-1}$; with an average value of λ = 0.111 $W.m^{-1}.K^{-1}$. The steady low thermal conductivity at temperature change indicates the suitability of the separated sludge as a litter with a proven predisposition to provide a dry, loose and formable bed. The thermal diffusivity a of the dry RMS decreases with increasing temperature in the range from $0.166.10^{-6}$ $m^2.s^{-1}$ to $0.296.10^{-6}$ $m^2.s^{-1}$. However, from a temperature of 20 °C, it can be said that even this thermo-technical property is stable around the value of a = $0.19.10^{-6}$ $m^2.s^{-1}$ whereas for dry straw it has been a = 0.186 $.10^{-6}$ $m^2.s^{-1}$ (Lendelová, 2016). By measuring of ammonia and methane production, it was shown that the CH_4 and NH_3 concentrations also increased continuously with temperature increasing. The minimum ammonia concentration was 1.02 $mg.m^{-3}$ and the maximum was 3.85 $mg.m^{-3}$. Methane concentrations as a function of litter temperature increased from 3.34 $mg.m^{-3}$ to 5.57 $mg.m^{-3}$.

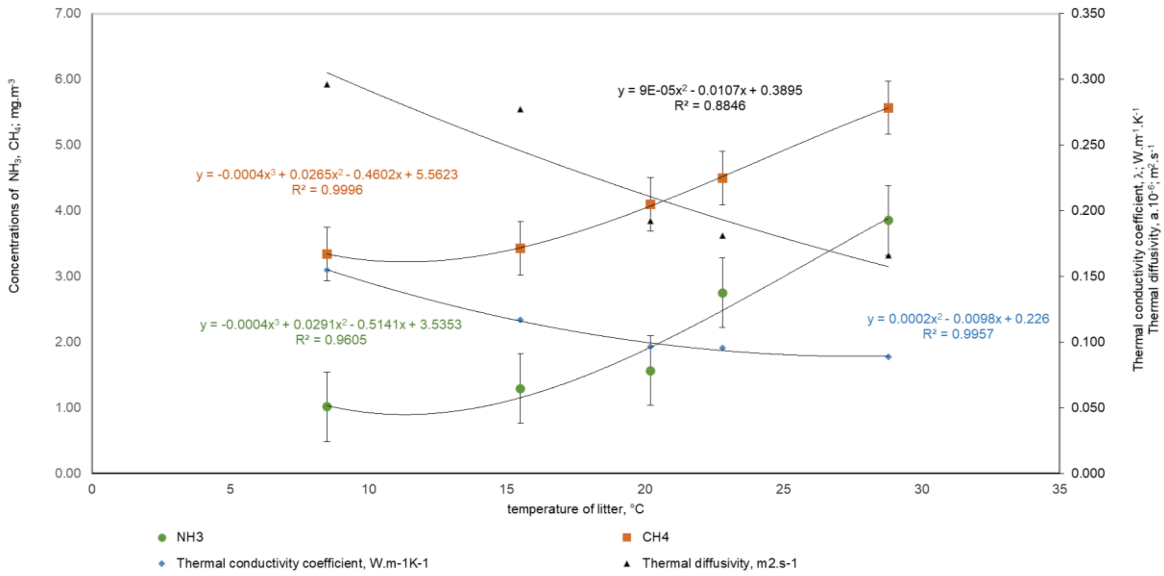


Fig. 1 The effect of temperature on the thermal properties bedding of the RMS - dry sample

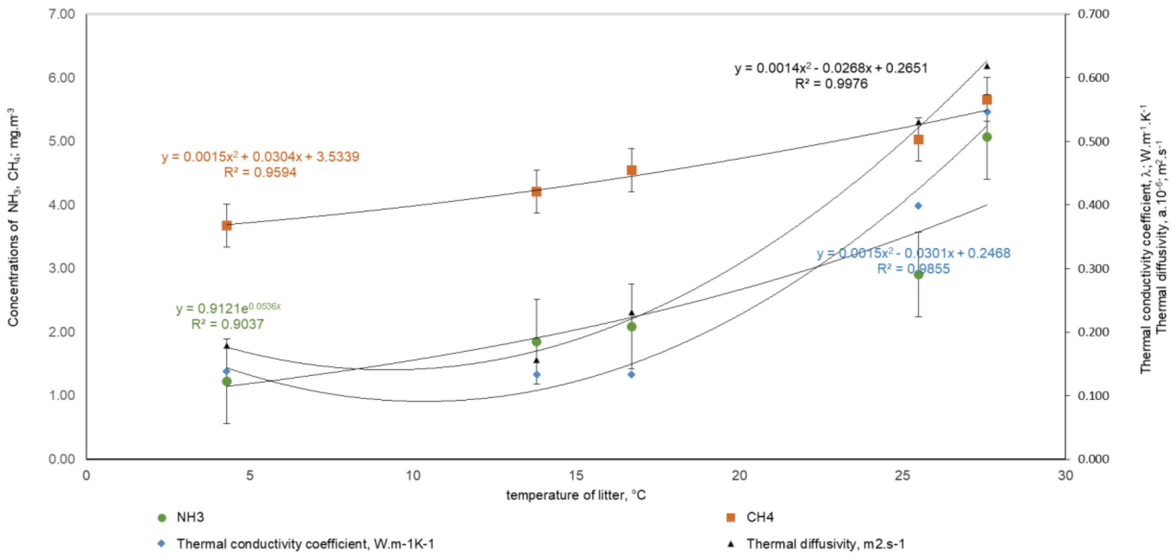


Fig. 2 The effect of temperature on the thermal properties bedding of the RMS - wet sample

When measuring the sample of wet recycled manure solids, the average dry matter content of the sample was 26 ± 2.42 %. Figure 2 shows that the thermal conductivity λ of the wet RMS increases significantly as the temperature rises, which is likely to result in the steaming of the sample due to temperature and subsequent removal of the moisture, which causes increasing of the thermal conductivity. The thermal conductivity ranges from λ = 0.155 W.m^{-1}.K^{-1} to 0.547 W.m^{-1}.K^{-1}. The thermal conductivity coefficient of wet litter has a relatively suitable average value of λ = 0.351 W.m^{-1}.K^{-1} measured for the range of temperatures occurring in year-round operation. At a standard temperature of 10 °C with a value of λ = 0.161 W.m^{-1}.K^{-1}, wet RMS can also be considered as the suitable bedding for dairy cows. The thermal diffusivity *a* of the wet RMS increases with increasing temperature, like the thermal conductivity in the range from 0.179.10^{-6} m^2.s^{-1} to 0.619.10^{-6} m^2.s^{-1}. From the temperature of 20 °C we can say that this thermal-technical property is steady around the value of *a* = 0.46.10^{-6} m^2.s^{-1}, wet straw has *a* = 0.27 .10^{-6} $m^2.s^{-1}$ (Lendelová, 2016). Gas concentrations increased continuously with increasing litter temperature. The minimum ammonia concentration was 1.23 mg.m^{-3} and the maximum was 5.07 mg.m^{-3}. Methane concentrations also increased with increasing litter temperature from 3.68 mg.m^{-3} to 5.66 mg.m^{-3}. Compared to dry litter based on RMS, the production of gases from the wet sample was higher, but there were no significant differences. However, wet organic litter can bring a bacteriological risk, which is a preferred factor negatively affecting environmental hygiene.

CONCLUSIONS

The work deals with laboratory analysis of physical and chemical properties of organic litter based on recycled manure taken directly from the operating process of the university farm. We have found that the production of ammonia and methane pollutants has an increasing trend in both dry and wet conditions as the temperature rises. When investigating the physical properties, we found that the thermal conductivity λ of dry RMS decreases with increasing temperature and stabilized at the sample temperature of 10 °C at λ = 0.142 W.m^{-1}.K^{-1}. The thermal conductivity λ of the wet RMS (with a dry matter content of 26 ± 2.42 %) increased significantly with increasing temperature. However, at a standard temperature of 10 °C with a value of λ = 0.161 W.m^{-1}.K^{-1}, wet RMS can also be considered as a suitable bedding for dairy cows.

Abstrakt

Cieľom tejto práce bolo laboratórne skúmanie fyzikálnych vlastností separovaného kalu hnojovice (RMS) a produkcie škodlivín v závislosti od meniacej sa teploty podstielkového materiálu. Vzorky organickej podstielky boli odoberané z ležiskových boxov ustajnenia dojníc. Skúšky prebiehali v klimatickej komore BINDER - KMF, v ktorej sa sledovalo množstvo amoniaku a metánu uvoľneného zo vzorky materiálu. Tepelnotechnické vlastnosti boli merané prístrojom ISOMET model 2104. Meranie tepelnej vodivosti λ a teplotnej vodivosti *a* vzorky bolo vykonávané nastavením požadovaných teplôt v klimatizačnej komore od 0 °C do 40 °C v intervale po 5 °C. Bolo zistené, že tepelná vodivosť λ suchého RMS so stúpajúcou teplotou klesá a pri teplote vzorky 10 °C sa ustálila na hodnote λ = 0,142 W.m^{-1}.K^{-1}. Tepelná vodivosť λ vlhkého RMS (s obsahom sušiny 26 ± 2,42 %) sa so vzrastajúcou teplotou výrazne zvýšila. Avšak pri normovej teplote 10 °C s hodnotou λ = 0,161 W.m^{-1}.K^{-1} môžeme aj vlhký separovaný kal hnojovice považovať ako vhodnú podstielku pre dojnice. Produkcia škodlivín amoniaku a metánu má pri vzrastajúcej teplote narastajúci trend ako v suchom tak i vlhkom stave.

ACKNOWLEDGMENT

The photoacoustic multi-gas monitor used for measurement of gas concentrations was purchased through the research project funded by the European Union entitled: ITEPAg: Application of information technologies to increase the environmental and economic efficiency of production agrosystem ITMS no. 26220220014. The knowledges gained from LivAGE (project COST) Ammonia and Greenhouse Gases Emissions from Animal Production Buildings was used.

REFERENCES

Balková, M., Pogran, Š. (2009). Assessment of microclimatic parameters in a building for heifers. *Acta technologica agriculturae*, 12, 15-18.

M. Feiken, W. van Laarhoven. (2012). Verslag van een praktijkonderzoek naar het gebruik van vaste fractie uit gescheiden mest als boxbeddingsmateriaal in ligboxen voor melkvee

Valacon Dairy. English translation Recycled manure solids (RMS) as biobedding in cubicles for dairy cattle. http://www.keydollar.eu/wp-content/uploads/2014/09/Biobedding-English-version.pdf

Harrison, E.Z., Bonhotal, J., Schwarz, M. (2008). Using manure solids for dairy barn bedding. Ithaca, NY: *Cornell Waste Management Institute*.

Herbut, P., Angrecka, S. (2014). Ammonia concentrations in a free-stall dairy barn. *Annals of Animal Science*, 14 (1), 153-166.

Jelínek, A., Kraus, R., Dědina, M. (2006). New technology of slurry processing from cattle breeding as a plastic litter for improvement of the environment and welfare of farmed animals. In *Separated slurry as plastic litter in cattle farms* (pp. 8-13). Praha VUZT.

Lendelová, J., Žitňák, M., Bošanský, M., Šimko, M., Piterka, P. (2016). Testing of property changes in recycled bedding for dairy cows. *Research in agricultural engineering*, 62, S44-S52.

A. Marcher Holm, R. Pedersen. (2015). Fiberfraktion fra gylle som strøelse i sengebåse til malkekøer FarmTest Cattle Report 98. https://www.landbrugsinfo.dk/Tvaerfaglige-emner/FarmTest/Sider/FarmTest-98-Fiberfraktion-fra-gylle-som-stroeelse-i-sengebaase-til-malkekoeer.aspx

Misselbrook, T.H., Powell, J.M. (2005). Influence of Bedding Material on Ammonia Emissions from Cattle Excreta. *Journal of Dairy Science*, 88, 4304-4312.

M. Zähner, J. Schmidtko, S. Schrade, W. Schaeren, S. Otten. (2009). Alternative einstreumaterialien in liegeboxen. *Bautagung Raumberg-Gumpenstein*, pp. 33-38. http://www.raumberg-gumpenstein.at/cm4/de/forschung/publikationen/downloadsveranstaltungen/viewdownload/381-bautagung-2009/3188-alternative-einstreumaterialien-in-liegeboxen.html

Corresponding author: doc. Ing. Jana Lendelová, PhD., Department of Building Equipment and Technology Safety, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, Nitra, 949 76, Slovakia, phone: +421 37 641 5777, e-mail: jlendelovauniag@gmail.com

BACKUP DIESEL GENERATOR CALCULATION FOR FARMS

VÝPOČET ZÁLOŽNÉHO DIESELGENERÁTORA PRE FARMY

Peter MORVAI[1], Miroslav Žitnák[1]

[1]*Department of Building Equipment and Technology Safety, Faculty of Engineering, Slovak University of Agriculture in Nitra*

Abstract
The aim of this work is to design an optimal backup electricity supply in case of power supply failure, ensuring the functionality of the building's operating systems is essential to eliminate the risks caused by a power failure. The proposed measures are intended to reduce or eliminate the risks to farmed animals that occur in the event of failure of the systems necessary for poultry farming.

Key words: backup electricity supply, operating systems, eliminate the risks, poultry farming

INTRODUCTION

Much of the sustainability debate now focuses on how to feed the world's population by 2050, when the population reaches around 9 billion people, and what role the livestock sector will play in meeting many people's food needs without causing significant negative impacts to the environment. Ventilation, lighting and heating system can consume a considerable large amount of energy. Energy savings have become increasingly important due to the climate change and rising energy prices (RANANIEMI, 2012). To ensure the electrification of the building we will design an optimal system for the safe operation of ventilation, ventilation equipment and other systems that must be functional in the event of a power failure. The design of animal housing is complicated because many environmental factors affect the production and welfare of the animals. The designer must consider that the initial investment to make the farm housing more efficient must be reflected in the improved economic productivity. The engineer must balance the costs of adjusting the environment against economic losses in a less than ideal environment (ASHRAE, 2011). Livestock welfare is a complex issue that addresses scientific, ethical and economic factors. Animal welfare and animal welfare research continues to increase in importance for the animal and meat industries. Understanding animal behaviour is key to designing effective livestock facilities. The production phases can be controlled by a well designed Hazard Analysis at Critical Control points (HACCP). The measurements were carried out in the breeding hall number 3 in Bodok with a capacity of 20 000 ROSS 308 broiler chickens. The volume of air contained in the broiler housing is 4410 m^3 ($l = 100$ m, $w = 12.6$ m, $h_{average} = 3.5$ m), depending on the area and average height of the housing. The entire air volume exchange in the summer period at maximum air flow rate according to the measured values of the technology occurs every 43 seconds, which represents the air exchange 83 times per hour (from the winter period with minimum ventilation every 38 minutes). Broiler breeding density on the farm is 47.5 $kg.m^2$ (estimated weight of adult chickens is 2.5 to 3.5 kg). The main provision of Directive EU / 2007/43 is the reduction of stocking density by setting a maximum density of 33 $kg.m^2$. Under certain conditions with a good ventilation and temperature control system it may be a maximum of 39 $kg.m^2$. In extremely good living conditions, the density can be increased by an additional 3 kg. The Directive also lays down conditions relating to lighting, bedding, feeding and ventilation. It is very important to have a backup generator in poultry farming to eliminate broiler mortality in the event of a power failure. The highest risk of mortality occurs in summer, where fresh air intake and maintenance of the THI index is indispensable for chickens. According to the THI index, chickens enter the deadly danger zone after about 5 minutes when the ventilation is inoperative in summer period. In extreme climatic conditions during the summer season, it can cause high animal mortality, leading to economic losses (Bustamante et al., 2012). The backup system provides the following functions:

- ensuring the function of temperature and humidity sensors,

- ensuring the function of ventilation and ventilation flaps,
- provision of standby lighting function,
- provision of feed (water).

MATERIAL AND METHODS

The methodology for the diesel generator calculation will be as follows:

- we find out the total installed power consumption of appliances for the given operation according to the rating plates of appliances,
- we will measure the apparent power input of individual circuits of appliances (feeding, lighting, 5pcs ceiling fans, 3pcs wall fans),
- measured maximum instantaneous current values and the total maximum current withdrawn during the summer are processed into a table and will be used for calculation.

RESULTS AND DISCUSSION

Maximum current of appliances determined from rating plates

According to Patrick et al. (2014), the exact power consumption of any appliance should be found on the manufacturer's tag identifying the electrical characteristics of the device. Energy demand of ventilation systems, feeding and lighting systems of the stable number 3 of the farm Bodok determined from the appliances rating are shown in Table 1.

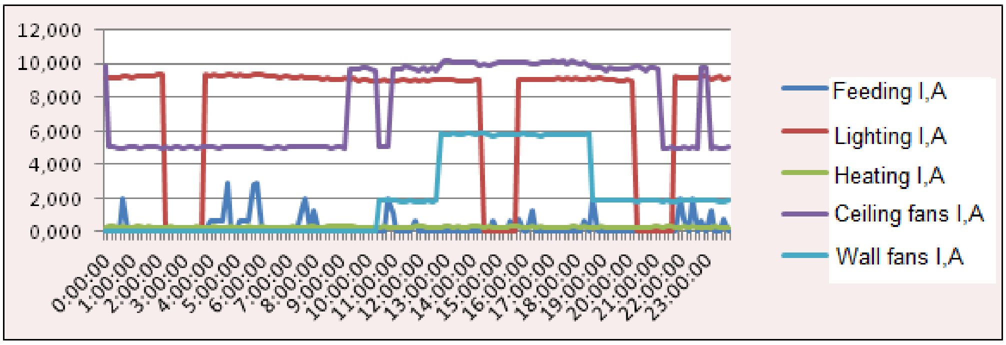
Table 1 Total installed power consumption of appliances according to rating plates

Appliance	Number of appliances	Power input of appliance P, W	Total power consumption of appliance P, W
Axial ceiling fan	5	450	2250
Axial wall fan	3	500	1500
Fluorescent light bulbs	68	15	1020
Electric motor of feeding conveyor	3	220	660
Gas heater GP 70 with fan	4	440	1760
Total installed power P, W			**7180**

Measurement of maximum current of appliances with PLC

The total current of appliances per hour and 24 hours in the summer is measured using current clamps mounted on individual phases (LEVY & SIDNEY, 2012). Current clamps are installed in the main switchboard of hall no.3. We expect the highest current drawn for diesel generator in summer when all the fans of the building and appliances are switched on (GIBSE, 2015).

We recorded the measured data on individual appliances by means of a PLC connected to the AT 50 B10 current sensors for the measurement of alternating primary mean RMS (root mean square) of the IPN current. Current sensor measurement accuracy is <± 1.5 % of I_{PN} at 25 °C. Current measurements were performed on individual circuits separately. Individual circuits are as follows: feeding, lighting, 5 pcs ceiling fans, 3 pcs wall fans. Graph 1 is drawn from the courses of the measured currents for 24 hours in summer. In the graph the course of current overlaps are visible.



Graph 1 The course of drawn currents of appliances in 24 hours in summer

In Table 2 are visible the maximum instantenaous currents of appliances, total current drawn by all appliances and apparent power consumption of appliances.

Table 2 Total installed power consumption of appliances according to measurements with PLC

Appliance	Number of appliances n, pcs	Instantaneous current taken by appliances I_{PN}, A
Axial ceiling fan	5	10.185
Axial wall fan	3	5.907
Fluorescent light bulbs	68	9.435
Electric motor of feeding conveyor	3	2.932
Gas heater GP 70 with fan	4	0.328
Total current drawn by appliances I_{PN}, A		**28.787**
Apparent power consumption of installed appliances, VA		**6621.01**

It is evident from compeering Table 1 and Table 2 that the power consumption cannot be determined by the manufactures tag. If we use for the calculation the data from Table 1 the generator would be oversized. The apparent power consumption of appliance is determined more precisely by measuring the drawn current of appliances.

Calculation of optimal diesel generator parameters according to measured current

The value of single-phase alternating current of installed appliances is 28.787 A. From this value we can calculate the eaven load of the three-phase network (for even phase distribution of appliances) as follows:

$$I = 3.I_{phase}\ , A \tag{1}$$

then:

$$I_{phase} = \frac{I}{3}, A \tag{2}$$

$$I_{phase} = \frac{28.787\ A}{3} \tag{3}$$

$$I_{phase} = 9.596\ A \tag{4}$$

For six similar objects, the total current load of one phase is six times the I_{phase} value, which is 57.576 A. If this value is taken into account by the uneven load distribution coefficient k = 1.2, then:

$$I_{phase} = 57.576\ .\ 1.2 \tag{5}$$

$$I_{phase} = 71.97\ A \tag{6}$$

From the calculated value we can calculate the apparent power input of single-phase alternating current appliances of six objects as follows:

$$S = U.I, VA \quad (7)$$
$$S = 230\,V\,.\,71{,}97\,A \quad (8)$$
$$S = 16553.1\,VA = 16.553\,kVA \quad (9)$$

To design a generator, we must multiply the current of one phase by the total number of phases. As for generators the total phase power (apparent or active) is reported then:

$$S_1 = 3\,.\,16.553\,kVA \quad (10)$$
$$S_1 = 49.659\,kVA \quad (11)$$

The power consumption of the installed appliances must be taken into account by the overlap coefficient k = 3 of an inductive appliance with a hard (heavy) start. The current drawn during start-up of the electric motor is 2 to 3 times greater than the operating current. For correct sizing of the generator we know that all electric motors are switched on one after the other. Then, at the last stage of switching on the fans and the electric motor of the conveyor for six operations, we can calculate the maximum current drawn. At the last stage of switching on the fans the maximum operating current is 1.969 A. At the same time we count on a possible switch on of the conveyor, which draws the maximum current 2.932 A. The total current is 4.901 A and multiplied by the overlap coefficient (3-1 = 2 since the operating current of the appliances is included in S1), which represents 9.802 A. For six operations, we get the value of 58.812 A (starting current). Then the apparent power represents the value:

$$S_2 = 230\,V\,.\,58{,}812\,A \quad (12)$$
$$S_2 = 13526.76\,VA = 13{,}526\,kVA \quad (13)$$

We calculate the total apparent power:

$$S = S_1 + S_2 \quad (14)$$
$$S = 49.695\,kVA + 13.526\,kVA \quad (15)$$
$$S = 63.221\,kVA \quad (16)$$

A generator with an apparent power of 64 kVA is required to ensure power supply in the event of a power failure for six similar breading halls on the fam Bodok. With a generator power factor of 0.8 the active power is 51.2 kW.

In order to ensure the supply of electricity, a generator with an apparent power of 80 KVA / 66 kW is recomended. For example a generator type ESV 80 DW-B/A can constantly supply 74.1 VA / 59.34 kW and meets our needs for a backup suplly of electricity. It is advisable to install a network analyzer (for example MERTEL MI 2892) for more accurate information on the quality of the energy supplied and the maximum instantaneous operating currents. In order to reduce the demands on generator power parameters and eliminate torque impacts on mechanically coupled technology, but also the motor bases itself, it is advisable to consider the use of soft starters or frequency converters to reduce the starting currents of electric motors. To ensure power distribution of the backup system, systems are installed with ATS (Automatic Transfer Switchers) that detect power outages automatically (they do not turn on when voltage is fluctuating) (JONES, 2008). There are solutions to reduce the inrush currents that may cause a voltage drop in the grid such as: star/ delta starter, resistor-controlled ring motor, soft starter or frequency converter (HUGHES, 2006). Applications that do not need a high nominal torque for start-up but are characterized by a high moment of inertia are also heavy-duty applications (for example, large, heavy-duty fans of the second category) (CIBSE, 2015).

CONCLUSION

The results of the work serve for the design of an optimal back-up system of the object Bodok for poultry breeding. The methodological procedure and calculations can be applied to the design of a back-up power supply for agricultural buildings in the event of a power outage from the grid. Ensuring the functioning of the building's operating systems is essential to eliminate the risks associated with the survival of animals housed. By automating the power-up process, the start-up time and operator risk of starting the machine in the event of a power failure is reduced. For more accurate analysis and design of an optimal back-up power supply we will use a network analyzer and the results of the work will be processed into a publication.

REFERENCES

ASHRAE Handbook. (2011). *Heating, Ventilating, and Air-Conditioning Applications (I-P Edition) - Design for Animal Environments*. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc [cited 14. 08. 2019].Available on: <https://app.knovel.com/hotlink/pdf/id:kt009EBQM7/ashrae-handbook-heating/design-animal-environments>.

CIBSE. (2015). *Transportation Systems in Buildings - CIBSE Guide D (5th Edition) - 8.11.3 Anti-Creep Devices.* CIBSE [cited 16. 08. 2019]. Available on: <https://app.knovel.com/hotlink/pdf/id:kt0114WMW1/transportation-systems/anti-creep-devices>.

CIBSE. (2016). *Applications and Activities - HVAC Strategies for Common Building Types - CIBSE Guide B0 5.1.2.2.* Mechanical Ventilation. CIBSE [cited 14. 08. 2019]. Available on: <https://app.knovel.com/hotlink/pdf/id:kt0114PIS6/applications-activities/mechanical-ventilation>.

EURÓPSKA KOMISIA. (2000). *The welfare of chickens kept for meat production (Broilers). Reports of the Scientific Committee on Animal Health and Animal Welfare*. European Commission, Brussels [cited 20. 08. 2019]. Available on: <https://ec.europa.eu/food/sites/ food/files/safety/docs/sci-com_scah_out39_en.pdf>.

EURÓPSKA KOMISIA. (2007). *Commissioner Kyprianou welcomes Council agreement on animal welfare rules for broilers.* European commission, Press Release IP/07/630. Brussels [cited 20. 08. 2019]. Available on: <http://europa.eu/rapid/press-release_IP-07-630_en.htm>.

HUGHES, A. (2006). *Electric Motors and Drives - Fundamentals, Types and Applications (3rd Edition) - 6.2. Run-up and Stable Operating Regions.* Elsevier [cited 22. 8. 2019]. Available on: <https://app.knovel.com/hotlink/pdf/id:kt008BVR61/electric-motors-drives/run-up-stable-operating>.

JONES, GARR M. (2008). *Pumping Station Design (Revised 3rd Edition).* Elsevier [cited 18. 08. 2019]. Available on: <https://app.knovel.com/hotlink/toc/id:kpPSDRE005/pumping-station-design/pumping-station-design>.

LEVY, SIDNEY M. (2012). *Construction Calculations Manual - 12.4.0. Electric Generators - Understanding Your Power Needs.* Elsevier [cited 18. 08. 2019]. Available on: <https://app.knovel.com/hotlink/pdf/id:kt009I2AY4/construction-calculations/electric-generators-understanding>.

PATRICK, D. R. – FARDO, S. W. – RICHARDSON, R. E. – FARDO, B. W. (2014). *Energy Conservation Guidebook*. Lilburn, Fairmont Press, 513 pp. ISBN 978-1-68015-480-1 [cited 16.8. 2019].

RAJANIEMI, M – AHOKAS, J. (2012). *A case study of energy consumption measurement in broiler production.* In biosystem engineering Special Issue, vol. 1, pp. 195-204 [cited 17.8. 2019]. Available on: <https://agronomy.emu.ee/vol10Spec1/p10s122.pdf>.

ROSS. (2018). *Ross broiler management handbook*. Aviagen. 132 pp:1-148 [cited 17.8. 2019]. Available on: <http://en.aviagen.com/assets/Tech_Center/Ross_Broiler/Ross-BroilerHandbook2018-EN.pdf>.

Corresponding authors:

Ing. Peter Morvai, Department of Building Equipment and Technology Safety, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic, petermorvai@yahoo.co.uk

DUST CONCENTRATION ANALYSIS USING RECYCLED MANURE LITTER IN DAIRY FARM

ANALÝZA KONCENTRÁCIE PRAŠNOSTI PRI POUŽITÍ PODSTIELKY Z RECYKLOVANEJ HNOJOVICE V OBJEKTE PRE CHOV DOJNÍC

Michaela NÉMETHOVÁ[1], Jana LENDELOVÁ[1], Miroslav ŽITŇÁK[1]

[1]*Department of Building Equipment and Technology Safety, Faculty of Engineering, Slovak University of Agriculture in Nitra*

Abstract

Aim of this analysis was to evaluate overall dustiness in dairy cattle housing using a separated slurry manure as bedding material. We obtained summer data on the basis of light scattering by means of a modulated infrared ray, twice in the summer period. From six measurement point and four cross-section in the stall, we got results as follows: the separated slurry manure bedding does not emit dust depending on the intensity of the ventilation rate. At the highest intensity ventilation (10), the highest dust levels were not found, The lowest dust concentrations were found in feed alley. Also, according to our concentration values we could say, that limits of the dust in the air are not exceeded.

Key words: dustiness concentration, separated slurry manure, dairy housing

INTRODUCTION

Mechanical and natural ventilation systems are used in dairy cattle houses to remove the heat, moisture, and carbon dioxide produced by the animals. As a result, large quantities of PM (Particulate matter) are released into the atmosphere (Winkel et al., 2015). High concentrations of PM can threaten the environment, as well as the health and welfare of humans and animals. Particulate matter in livestock houses is mainly coarse, primary in origin, and organic; it can adsorb and contain gases, odorous compounds, and micro-organisms, which can enhance its biological effect (Cambra-López et al., 2009). Health hazards of PM can be separated between those related to inside (concentrations), and outside (emissions) livestock houses. The most relevant health hazards of PM inside livestock houses are related to respiratory diseases (Andersen et al., 2004). PM might affect health when it is inhaled, as result of its irritant effect on the respiratory tract. In the case of diseases of the upper respiratory tract the larger particles of dust could be more infective as these are more likely to be carrying a sufficient number of microorganisms to initiate an infection. In Livestock, dust can be generated from friable bedding material, particularly if subjected to disturbance (Harry, 1978). Particle size varied amongst sources, and mainly depended on its mineral or organic origin. Nutrition are a source of dust in animal houses (Aarnink and Ellen, 2007). Generally disintegration particles from feed and outside source showed smaller sizes, compared with biological structures (feathers, hair, skin, and wood shavings), which were mainly larger than 4 μm in diameter. However, there are only a little evidence of studies related to the overal dustiness of recycled manure used as bedding material. The separated slurry of manure, also called as 'green litter', is used for bedding in the areas where the availability of standard bedding material is decreasing. It is a separated raw liquid manure or separated digested sludge from a biogas plant (Lendelová et al., 2015). Aim of this study is to evaluate dust concentration in barns with bedding based on recycled manure at the different degrees of ventilation.

MATERIAL AND METHODS

Housing

The animals are housed in a reconstructed barn with natural ventilation, using separate slurry manure as a bedding material. There are twelve fans installed in resting area - on each side along the barn there are

6 fans at a distance of 7 to 10 m. Mechanical ventilation is used in summer time from May to September. The bedding frequency is 7 days, with a bedding amount of approximately 40 kg. The longitudinal walls of the stables are open with installed nets with a diameter of 35 mm holes, entrance doors are fully opened, with the possibility of closing in the winter months. Both the side walls and the front door were fully open during the measurement. The floors in the feed alley are made of concrete, all alleys in animal zoone have a rubber floor layer on the concrete base installed. The barn is cleaned with a mechanical rake at specified intervals every 180 minutes and the other areas are cleaned by hand. There are 16 fans with a diameter of 914 mm, a capacity of 20.000 m^3/h, distributed in every 6 boxes, inclined by 10 ° and turned at an angle to the second row of blades. They are activated on 5 - 8 h a day as needed.

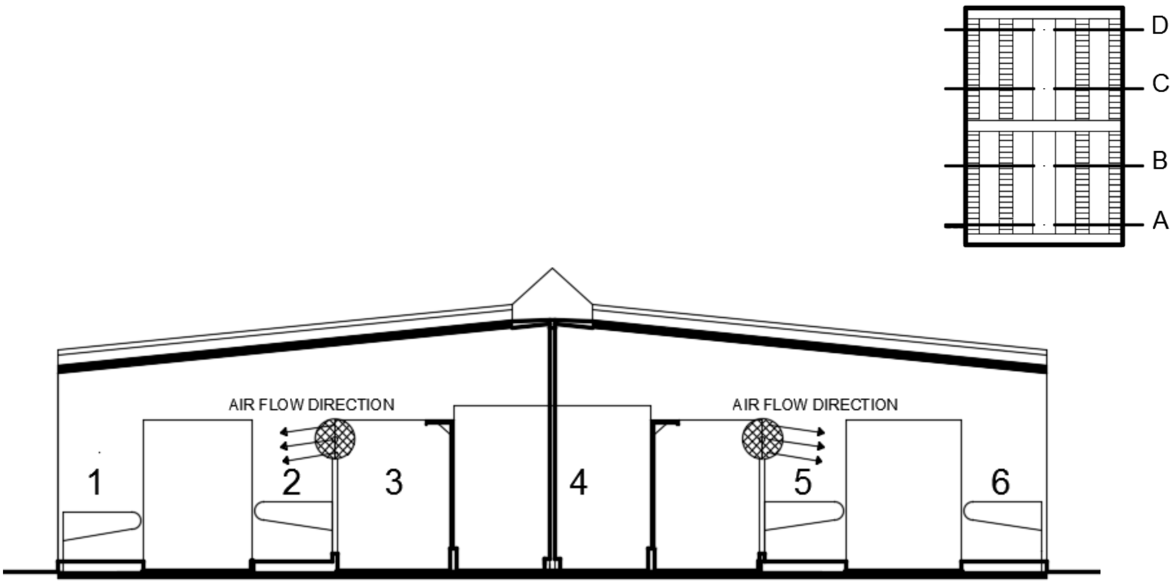


Fig. 1 Cross section of experimental stable with PM measurement points

Dustiness measurement

Dust concentration measurement positions have been settet in the facility for dairy cows using separated slurry manure as a bedding material. Dustiness concentration was measured in 6 points of object 1 (outer cubicles with separated manure), 2 (inner cubicles with separated manure), 3 (manure alley), 4 (feed alley), 5 (inner cubicles with separated manure), 6 (outer cubicles with separated manure), in 4 cross sections A, B, C, D (Fig.1). The dust concentration was measured at hight of 1.50 m (approximately the height of the human's and animal's head). Air temperature, air relative humidity and climatic conditions were also recorded at these locations. The fans have 10 ventilation rates and with the cross sections A, B, C, D were approximately midway between the two fans determined. Dust concentration was measured for 2 minutes at each measurement point at 4 different ventilation rates - 0 (off), 4, 7, and 10 as the highest air exchange intensity. Dust measurement was performed using a MicroDust instrument for CEL-712 (Casella CEL) with a measurement range of 1 $\mu g \cdot m^{-3}$ to 250 $g \cdot m^{-3}$ with 6 switchable ranges. Dust concentrations are obtained on the basis of light scattering by means of a modulated infrared ray. Data were collected several times in the summer period during a 3 h measurement at different moisture (condition) of the bedding material.

Feeding management

Cows are feed daily with average of 43.50 kg/day/cow feed per day. The feed consists of: 2 L of water, maize silage 19.50 kg, 13 kg hay lantern, 2.5 kg corn pulp and 6.5 kg soybean, canola, premixes.

Measurement of environmental variables

Authors were on the average representative conditions in stall focused. With climatic condition measuring with instrument Almemo 2590 – 4S, we recorded air temperature, air relative humidity and air flow in object. Our measurements were provided during hot days with no rainfall in summer.

Production parameters and number of animals

Average number of dairy cows is 175 in one object. They are milking 3x/day, with average milking performance 31 l/day/cow.

Statistical analysis

For statistical analysis was program Statistica 10, (STATISTICA, StatSoft CR s.r.o) used. With Anova multi – factor analysis was difference between dustiness in relative to the bedding status and different degrees of ventilation intensity evaluated. Tukey Post Hoc test was for specifically differences in evaluated factors used. Differences were considered as siginifacnt, if $p < 0.05$.

RESULTS AND DISCUSSION

Results of dustiness measurement

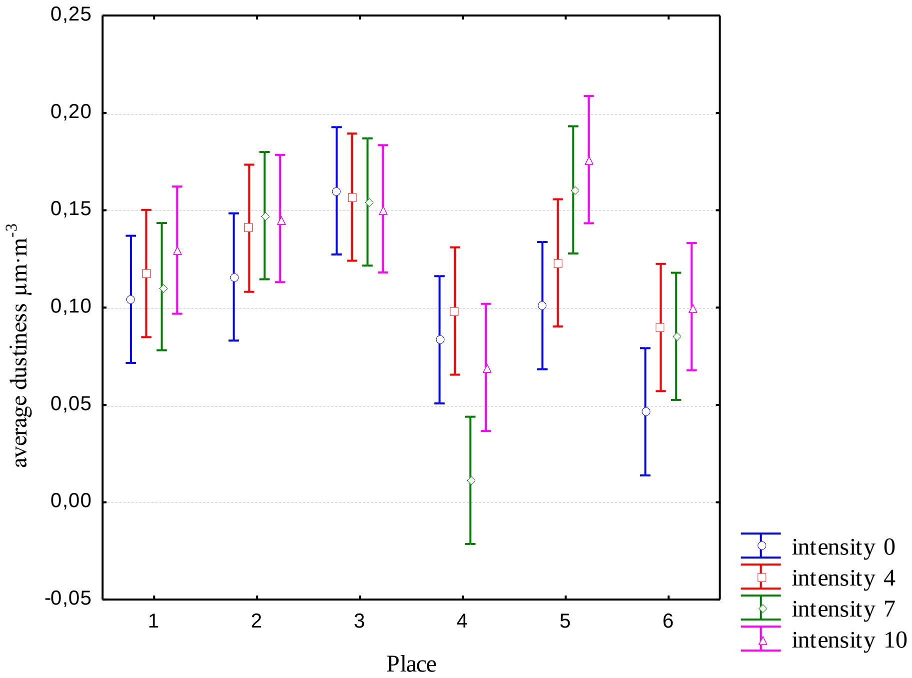


Fig. 2 Average values from dustiness summer measurement. Dustiness concentration in places of measurement and different degrees of ventilation speed are significant if $p<0.05$. P value is obtained from Tukey Post Hoc test.

Tab. 1 Significant differences from Tukey Post Hoc Test.

Interactions		
Ventilation Intensity x Place	Ventilation Intensity x Place	***p_{calc}<0.05**
0 x 3	0 x 6	0.001<0.05
0 x 6	4 x 2	0.021<0.05
0 x 6	4 x 3	0.002<0.05
0 x 6	7 x 2	0.008<0.05
0 x 6	7 x 3	0.003<0.05
0 x 1	7 x 4	0.025<0.05
0 x 2	7 x 4	0.005<0.05
0 x 3	7 x 4	0.000<0.05
0 x 5	7 x 4	0.038<0.05
4 x 1	7 x 4	0.004<0.05
4 x 2	7 x 4	0.000<0.05
4 x 3	7 x 4	0.000<0.05
4 x 5	7 x 4	0.000<0.05
7 x 1	7 x 4	0.010<0.05
7 x 2	7 x 4	0.000<0.05
7 x 3	7 x 4	0.000<0.05
0 x 6	7 x 5	0.001<0.05
7 x 4	7 x 5	0.000<0.05
7 x 4	10 x 1	0.000<0.05
0 x 6	10 x 2	0.010<0.05
7 x 4	10 x 2	0.000<0.05
0 x 6	10 x 3	0.005<0.05
7 x 4	10 x 3	0.000<0.05
0 x 3	10 x 4	0.034<0.05
7 x 5	10 x 4	0.032<0.05
0 x 4	10 x 5	0.027<0.05
0 x 6	10 x 5	0.000<0.05
7 x 4	10 x 5	0.000<0.05
7 x 6	10 x 5	0.034<0.05
10 x 4	10 x 4	0.003<0.05
7 x 4	7 x 4	0.041<0.05

* **p_{calc}** means p calculated from Tukey Post Hoc test

By provided ANOVA-multi factor analysis, we investigated the influence of factors Intensity and Place of measurement on the quantity of dust concentration in the stables. The lowest dust concentrations were found in the feed alley. At the highest intensity ventilation (10), the highest dust levels were not found, except in one case at place 5 (inner cubicles with separated manure).

Results from average microclimate conditions in stall

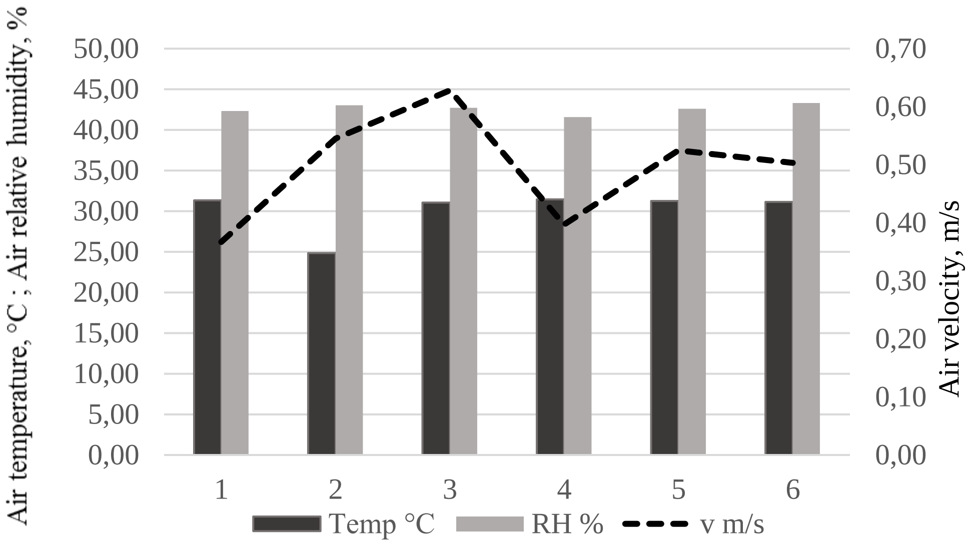


Fig. 3 Average typical microclimate condition inside the barn: Air temperature (Temp °C), Air relative humdity (RH %), air flow (v m/s) during measurement during summer months, averaged from the cross-sections A, B, C, D.

Data on PM emissions from animal housing systems are needed to estimate national emission rates (kT year^{-1}), ambient PM concentrations, and exceedances, to facilitate policy making, to adopt emission factors in legislation, to allow environmental permit granting to farmers, and to effectively develop abatement solutions. In dairy cattle housing, the concentration profile is flat during the night, but elevated and spiked during the day. For all housing systems, elevated concentrations were probably caused by the activity of the animals (e.g., due to lights being switched on, feed being delivered, milking, (Winkel et al., 2015). Our measurement was provided during day, with relatively calm indoor ambient. From our result, increasing ventilation rate does not mean increasing in dustiness concentration, no matter the bedding status. This confirms also Winkel et al. (2015), for non-growing animals, PM concentration decreased with increasing ventilation rate. This could be related with initial ventilation force, which release all particles especially on surfaces, an then, non growing animals do not create another strenght source of dustines. Schrade et al. (2017) presented a set of informations of concentrations and emissions of PM_{10} particles from individual dairy cattle housing in different season. For deep bedded stalls the concentrations ranged from 42-132 $\mu m \cdot m^{-3}$ in summer. In loose cubicle housing with straw, PM_{10} it was 14.4; 49.9 in summer, and 20.5; 42.2 $\mu m \cdot m^{-3}$ in winter. If we consider dairy housing bedded with rubber matts, PM_{10} particles in winter were 13.7; 25.5 $\mu m \cdot m^{-3}$. Highest values in summer were in matts and sawdust 370 $\mu m \cdot m^{-3}$, winter 60 $\mu m \cdot m^{-3}$. When we compared our results, values in this stall by using recycled manure bedding are strongly below values limited values for Slovakia legislation (6 $mg \cdot m^{-3}$/8h) in 355/2006 codex, but we measuerd only overall dustiness concentrations. Further research is needed to evaluate specifically particle concentrations in recycled manure bedding, related to the ventilation rate or bedding status.

CONCLUSION

Limit values of dustiness in air is 6 $mg \cdot m^{-3}$.Dustiness concentration in this dairy cattle housing system using separated slurry manure does not exceed the limit values in all measurement points at different air ventilation intensity. Based on the results, we can sumarize that the separated slurry manure does not emit dust depending on the intensity of the ventilation rate, while the dry matter content varies from 30% to 62% in summer. The lowest dust levels were found in the feeding house in both months. Overall dustiness concentration was not lower in manure alley, even if there is no big difference in air relative humidity during july and august. Further research is needed to evaluate specifically particle concetrations (PM_{10} and $PM_{2,5}$) in recycled manure bedding, related to the ventilation rate and on bedding status.

Literature

Aarnink, A.J.A., Ellen, H.H., (2007). Processes and factors affecting dust emissions from livestock production. Proceedings of DustConf. How to Improve Air Quality. International Conference, Maastricht, The Netherlands.

Andersen, C.I., G. Von Essen, S., Smith, L.M., Spencer,J., Jolie, R., Donham,K.J. (2004). Respiratory Symptoms and Airway Obstruction in Swine Veterinarians: A Persistent Problem. *American journal of industrial medicine*, 46, 386–392.

Cambra-López, M., Aarnink, A. J. A., Zhao, Y., Calvet, S., Torres, A. G. (2009). Airborne particulate matter from livestock production systems: A review of an air pollution problem. *Environmental Pollution***,** 1-17.

Government regulation of the slovak republic 355/2006 on the protection of workers against the risks related to exposure to chemical factors at work.

Harry, E.G. (1978). Air pollution in farm buildings and methods of control: A review, *Avian Pathology*, 7(4), 441-454.

Lendelová, J., Čičo, P., Žitňák, M., Mihina, Š., Pogran, Š. (2015). Effect of Climatic Conditions on Differences in Thermo-Technical Properties of Organic Bedding in Laboratory Testing.: Banská Bystrica: *Industrial Property Office of the Slovak Republic*, 1-6.

Schrade, S., Zeyer, K., Emmenegger,L., Keck,M. (2017). PM10 concentrations and emissions of six naturally ventilated dairy housings with cubicles and an outdoor exercise area. *Landtechnik*, 72(2), 101–119.

Winkel,A., Mosquera, J.,Koerkamp, P,W,G,G., Ogink,N,W,M., Aarnink,A,J,A. (2015.) Emissions of particulate matter from animal houses in the Netherlands. *Atmospheric Environment* 111, 202-212.

Corespondent author:
Ing. Michaela Némethová, Department of Building Equipment and Technology Safety, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2 , 949 76 Nitra, Slovak Republic
e-mail: xnemethova@uniag.sk

OVERVIEW OF INDUSTRIAL CHIMNEYS - MATERIALS, DEVELOPMENT OF STRUCTURES, DIFFERENCES, POSSIBILITY OF PROTECTION

PŘEHLED PROBLEMATIKY PRŮMYSLOVÝCH KOMÍNŮ - MATERIÁLY, VÝVOJ KONSTRUKCÍ, ROZDÍLY, MOŽNOST OCHRANY

Michal PEŠATA[1], Lukáš PROCHÁZKA[1], Jana BOHÁČOVÁ[1]

[1]*Katedra stavebních hmot a diagnostiky staveb, FAST, VŠB-TUO*

Abstract
The paper deals with the description of the possibilities of individual types of material that can be used for the construction of the chimney support shank. Theoretically, the current issue is described with regard to the chimney development from the second half of the 19th century to the 21st century. The text also mentions the differences between the reinforced concrete prefabricated or monolithic structures. In conclusion, a description of the possibilities of protection of the chimney shank, on the outer and inner surfaces.

Key words: ceramic industrial chimney, reinforced concrete industrial chimney, monolithic structure, prefabricated constructions, protective case, surface protection

INTRODUCTION

The actual use of artificially built or natural objects to evacuate flue gas is probably as old as the ability of today's man to use fire. Over time, our ancestors found that if the fire was kept above the cave through a rift, it reached higher temperatures and the combustion process is more efficient. In parallel with the experience with melting and utilization of metals, there were built forges, for which the chimney is necessary. Also with the development of the size of dwellings, it was necessary to divert flue gas somehow. However, these constructions had little to do with today's chimneys. Constructions known as industrial chimneys usually occur in the 19th century. With the massive increase in the use of steam engines, in virtually all sectors of industry, there has also been a need to evacuate these flue gases. The height of the chimney also helped to improve the burning conditions in the respective furnace. [1, 2, 3]

CLASSIFICATION OF INDUSTRIAL CHIMNEYS BY MATERIAL

Masonry industrial chimneys

The first industrial chimneys were made of brick. The shape of the first chimneys was initially quadrilateral, but later the octagonal shape started to be used, especially for better conditions for flue gas evacuation and greater resistance to the effects of climatic influences, especially wind. The chimneys were made of solid bricks, often fired in field conditions. In the second half of the 19th century, firms specializing in the exhibition of chimneys began to be established, some of which are still operating today. The then chimneys reached a height of about 40 m, were single-shell (flue gases are drained directly by a masonry shaft). [4, 6]

Since the beginning of the 20th century, the first protective sleeves of chimneys began to appear. At that time, only the lower part was protected at a few meters. Chimneys with a protective case at the bottom have a solid base. The flue mouth was realized as underground. Outside the pedestal, the chimney shaft is provided with tightening strips on the outer surface. These serve to create prestressing and to reduce temperature cracks. Later, chimneys started to be circular, built without a pedestal, when the shank wall was made of radial fittings lightened with cavities. The wall of such a shank is then usually tapered step by step, with the recoils positioned more frequently on the inside. We can also find a circular chimney on an octagonal pedestal. In this case it is usually a new chimney, bricked on the base of already demolished octagonal shaft. [1, 2, 3]

Over time, the protective housing begins to build at full height. In this case, it is bricked by individual sections - floors, which are bricked on the brackets of the bearing shank. At the overlap of two adjacent storeys there is always a gap allowing the chimney to move freely in the vertical direction. Until recently, these joints were sealed with asbestos ropes. [1, 2]

Figure 1 - general view of the brick shank of the chimney with octogonal cross section (left) and circular cross section (right) [2]

Reinforced concrete industrial chimneys
With the advancement of technology, chimneys of reinforced concrete began to spread up. First were created before the First World War, but main boom occurred in the second half of the 20th century. Reinforced concrete had several advantages over brick shanks. Due to its bending stiffness it is better resistant to wind. Also from an economic point of view it meant acceleration of construction and saving of material. According to the technology of construction, these buildings can be further divided into monolithic and prefabricated. [4, 5]
(a) Prefabricated chimneys
Prefabricated chimneys can be further divided according to the type of prefabricated elements into block and rings. The shank of the chimneys made of blocks is always conical and tapered with increasing height. In our country, two types of blocks were used mostly. The first is the Monnoyer type. The shank of these shaped pieces resembles ancient columns, but for the complexity of the exhibition it was abandoned. Much more widespread in our country is the “Z” system, named after the author Jindřich Zlámalík. Monolithic ribs are reinforced between the fittings. Extended cantilever shaped pieces were used for bracing the protective sleeve. The masonry of the protective casing, most often made of fireclay acid-resistant fittings or common burnt bricks, is fixed to the chimney shaft through thermal insulation of diatomaceous earth. Type T chimneys (Tomáš), created by Ing. Jiří Tomáš, are cylindrical in their entire height. The chimney shaft is made up of individual rings placed on top of each other. In the case of higher chimneys, the shank was supplemented with reinforcing ribs at the bottom. A great advantage is the very high speed of construction. [1, 2, 4, 6]

Figure 2 - general view of the chimney shaft type Monoyer (left), type "Z" (center) and type "T" (right). [2]

(b) Monolithic chimneys

Monolithic chimneys are the highest chimneys at all and are used primarily in high-performance furnaces of industrial plants such as power plants, heating plants, chemical plants, cement plants and incinerators. The shaft of these chimneys is usually conical, but in the period from about 90 years of the last century it has been also built as cylindrical. In the past, the reinforced concrete structure was built using folded formwork. Especially due to the acceleration of construction, the system was changed to a construction system using hydraulic shuttering formwork. The concrete was pumped at lower levels, into the upper parts it was moved by vertical transport. The gallery is part of the outer shaft. The most common are galleries made of reinforced concrete slab, less frequent are steel galleries. [1, 2, 3]

Figure 3 - general view of the reinforced concrete shaft of the chimney constructed using folded formwork (left) and hydraulically extendable (right) formwork. [2]

Reinforced concrete chimneys are always provided with protection of the inner surface against the effect of flue gases. The oldest and most widespread variant is the use of a masonry protective case. This protective structure consists in the masonry of the protective fittings through the thermal insulation layer, directly to the chimney shaft. The fittings are fitted over the entire height on individual consoles and thus form expansion sections (storeys). Fireclay is the most commonly used material; in the past, red brick was used in some operations and stoneware fittings could be found in operations with the presence of aggressive substances. The thermal insulation is usually made of diatomaceous earth in the form of shaped pieces or crumb. Expansion joints were sealed with asbestos ropes soaked in asphalt or with a combination of ropes with special profiles. In order to protect the entire joint, the joints were sometimes covered with lead plate. Currently, in the case of joint repair, asbestos ropes are replaced with glass ropes, or the entire gap is filled with mineral wool mats. The joint is then covered with a stainless steel cover. In newer chimneys, or in case of reconstruction of an older chimney, the sleeve is indented, or there is a steel liner or more liners installed. In both cases, a ventilated space is created between the support shaft and the flue gas discharge structure. Bearing structures of the indented sleeve or liner are designed as steel frames or as annular reinforced concrete plates, always anchored in the chimney shaft. The inserts may also be hinged to the upper support member and are also generally stabilized by means of draw bars. Compensators are used instead of asbestos ropes. [1, 2, 4, 7, 8, 10]

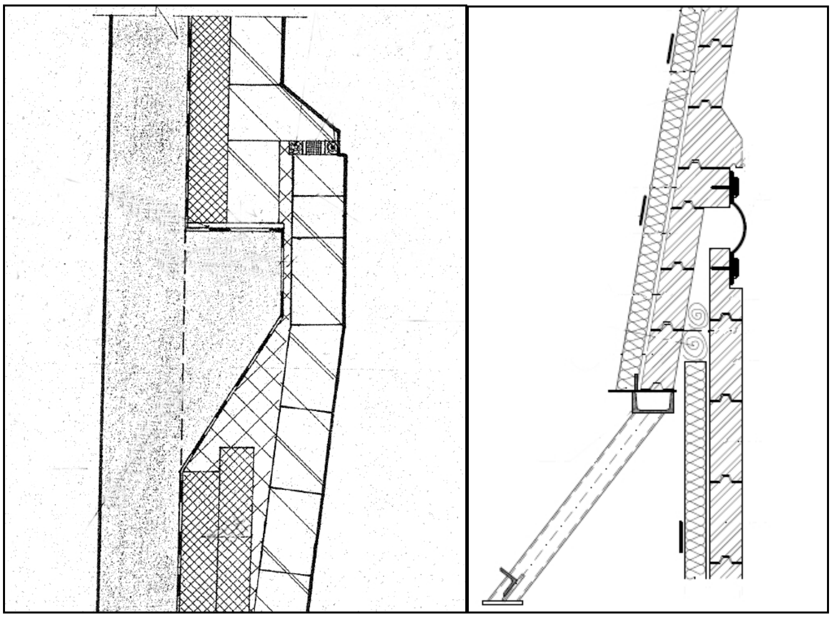


Figure 4 - schematic cross-section of the brick housing (left) and indented housing (right). [2]

Figure 5 - external view of the indented sleeve (left) and indented pad (right). [2]

The upper edge of the reinforced concrete shank, protective sleeve, thermal insulation and possibly the interspace is provided with a cover. In the past, mainly cast iron was used in the form of folded segments or segments bolted through flanges. At present the covers are made of stainless steel segments and composite material versions can be found in chimneys with aggressive operation. The cover is designed to protect the interspace and insulation from increased humidity, whether in the form of atmospheric precipitation or from condensate ingress. In the vast majority of cases, segments are sloped towards the chimney. The contact between the upper edge of the protective sleeve and the metal segments is made so that the sleeve can freely dilatate in the vertical direction. [1, 2]

In the case of monolithic chimneys, the outer surface of reinforced concrete chimney shafts is usually protected by paints. In the case of prefabricated chimneys, the shaft is generally without protection of the external surface. The chimney is divided into individual exposure zones A - C to ensure adequate protection of the shank.

POSSIBILITIES OF CHIMNEY SHANK PROTECTION

The area of highest surface protection (zone A) is located below the chimney head and roughly equal to the chimney diameter. The area of increased surface protection (zone B) below zone A should be equal to a height of approximately 5 chimney diameters. In practice, this is primarily the area of the upper level of aircraft marking. The remainder of the outer surface of the shaft includes a standard surface protection area (Zone C). In zone A it is recommended to use an epoxy two-component paint, in zone B a low-viscosity epoxy paint, resp. a polyurethane or durable acrylic paint and a conventional acrylic paint can be used in zone C. More detailed requirements for paints, including surface treatment are dealt with by renowned manufacturers within their own technological procedures. [1, 2]

SUMMARY

Industrial chimneys are widely used. Their design, construction methods and materials used are constantly evolving according to the requirements of the industry and the possibilities of construction industry.

ACKNOWLEDGEMENT

This work was created using the means assigned to VŠB-TUO by the Ministry of Education, Youth and Sports of the Czech Republic, for Student grant competition, project SP2019/22 Possibilities of using pumice-stone-concrete as linings and thermal insulation of industrial chimneys.

REFERENCES

PEŠATA, M. Building technical survey of reinforced concrete structures of chimneys of industrial buildings. Ostrava, 2017. Diploma thesis. VŠB - Technical University of Ostrava, Faculty of Civil Engineering, Department of Building Materials and Building Diagnostics, 2017, Ostrava.

PEŠATA, M. Betochem archive - drawing documentation, photo documentation, technological procedures and audit reports.

SVOBODA, L. Building materials. Bratislava: Jaga, 200.

VONKA, M. Factory chimneys - function of construction and architecture. Prague: Industrial Heritage Research Center, Faculty of Architecture, CTU, 2014.

MOUDRÝ, M. Reinforced concrete structures realized by sliding formwork method. Prague: Omega - Tempechna, 2010.

Koda: Chimney database [online]. [feeling. 11.4.2019]. Available online from http://www.koda.kominari.cz.

PEŠATA, M., BALOGH F., WAGNER, J. Building technical inspection of the inner casing of the chimney M 150 m in Mondi Štětí. Revision Report No. 2016/529/01. Ostrava: Betochem, 2016.

PEŠATA, M., BALOGH, F. Assessment of constructional technical condition of reinforced concrete shaft of chimney height 150 m in Mondi Štětí. Technical Report No. 2016/564/01 Ostrava: Betochem, 2016.

BALOGH, F., WAGNER, J. Construction technical inspection of the chimney TV 76.4 m in OZO, a.s. Revision Report 2014/335/01. Ostrava: Betochem, 2014.

EN 13084-2. Eurocode: Free-standing chimneys - Part 2: Concrete chimneys Prague: Office for Technical Standardization, Metrology and State Testing, 2008.

EN 13084-4. Eurocode: Free-standing chimneys - Part 4: Masonry liners - Design and execution Prague: Office for Technical Standardization, Metrology and State Testing, 2006.

Corresponding autor:

Ing. Jana Boháčová, PhD., Katedra stavebních hmot a diagnostiky staveb, Stavební fakulta, Vysoká škola báňská - Technická univerzita Ostrava, Česká republika, e-mail: jana.bohacova@vsb.cz

IMPACT OF INTENSITY HEATING ON CO_2 CONCENTRATION IN POULTRY BREEDING IN SUMMER AND WINTER SEASON

VPLYV INTENZITY VYKUROVANIA NA KONCENTRÁCIU CO_2 PRI CHOVE HYDINY V LETNOM A V ZIMNOM OBDOBÍ

Tímea SZABÓOVÁ[1], Ingrid KARANDUŠOVSKÁ[1], Jana LENDELOVÁ[1]

[1]*Department of Building Equipment and Technology Safety, Faculty of Engineering, Slovak University of Agriculture in Nitra*

Abstract
The aim of the work was to assess the impact of management of the heating process in broiler breeding to quality of the environment in summer and winter period. Internal and external temperature and relative humidity were measured permanently at 10 minute intervals using dataloggers comet. At the same time was measured the concentration of CO_2 in the hall with the Innova instrument. From the measurements we found out that in the hall during the almost whole measured period in summer and in winter was the required internal air temperature exceeded and thus the hall was overheated. The regression analysis was showed a significant dependence of CO_2 production on the heating intensity in summer period (R^2 = 0.431). The CO_2 concentration in the hall was higher in winter than in summer period. Subsequently, the significant dependence of CO_2 production on the heating intensity in winter period was demonstrated by regression analysis (R^2 = 0.562).

Key words: overheating, air temperature, humidity, pollutants, broilers

INTRODUCTION

The negative environmental impact of the intensification of livestock production is still strong and contributes significantly to undesirable climate change (Angel, 2006). In livestock farming, besides toxic ammonia, greenhouse gases (CO_2, CH_4, N_2O) are also produced. In poultry breeding, the largest sources of CO_2 include the fuel combustion as well as breathing of chickens and organic substances (Olanrewaju et al., 2008). Some carbon dioxide is produced by decomposition of unremoved feed residues and animal excrements, especially during their persistence in litter. The transformation of organic litter material, mainly by the litter humidification or conditioning ventilation systems, is also accompanied by the release of carbon in the form of carbon dioxide (CO_2), methane and other gases (Jelinek et al., 2001; Jelinek et al., 2004). Its high concentrations have an adverse effect on the metabolism of intensively growing fattening animals. The monitoring of carbon dioxide in chicken housing is mainly used to assess overall environmental hygiene and as indicator of ventilation. High concentrations of carbon dioxide are obviously accompanied by increased amounts of other gases, high humidity and microbial air pollution. It is generally recommended to keep CO_2 concentrations below 5,500 $mg.m^{-3}$ (Council Directive 2007/43/EC, 2007). Maximum recommended limit according to Decree of the Ministry of Agriculture of the Slovak Republic no. 230/1998 Coll. is 2,500 ppm (4,582.5 $mg.m^{-3}$ = 0.25 vol%). The aim of this study was to test a hypothesis that the interior concentration of CO_2 in chicken housing is impacted by heating intensity during summer and winter breeding period.

MATERIALS AND METHODS

The measurements were carried out in a poultry house, where was monitored hall serving fattening broiler chickens type ROSS 308. The capacity of the building is 20,000 broilers. The chickens were housed on a deep straw litter with thickness of 10 cm - 15 cm thickness depending on the age of the chickens. The total length of the hall is 102 m, with a width of 12.5 m. The breeding area for chickens is 1,081.2 m^2. Longitudinal peripheral walls of the hall consist of two ezalite boards with thickness 7 mm with a thermal insulation from polystyrene foam of 50 mm thickness. The roof structure consists of a sandwich made of ezalite and polystyrene. From the outside it is protected by corrugated sheet. The front walls are made of solid burnt brick of 470 mm thickness with 12 mm thickness lime plaster on the inside and lime-cement plaster on the outside. The floor consists of 20 mm thick cement screed, 150 mm thick concrete screed, 100 mm thick slag and 150 mm thick gravel backfill. The rear steel door is filled with foam polystyrene 30 mm thick. The heating of the hall is ensured by four gas heaters of the type ERMAF GP 70 with power of 70 kW, which work on the principle of direct combustion of natural gas, therefore there is a presumption of excessive CO_2 production in the building. Microclimatic parameters are regulated according to the values recommended by ROSS (2018). Measurements were carried out during the first 3 weeks of fattening on two places in the hall in summer and winter season. Development of interior temperature was adjusted depending on relative humidity and age of chickens. Desired internal air temperature was determined by the most frequent relative humidity range according to directive Ross (2018) from 40 % to 70 %. On the 1st day of the chickens age it was from 29.2 °C to 36 °C and on 21st day of the chickens age from 21.3 °C to 26.9 °C. Internal air temperature and relative humidity were measured in the object during summer (Fig. 1) and winter temperature extremes (Fig. 2) using the Comet S 3121 measuring instrument permanently at 10 minute intervals for 21 days of fattening. The temperature and relative humidity of the outside air were measured during the period using the COMET S3121 datalogger located near the experimental hall. At the same time, was measured CO_2 concentration in the experimental hall using an Innova instrument.

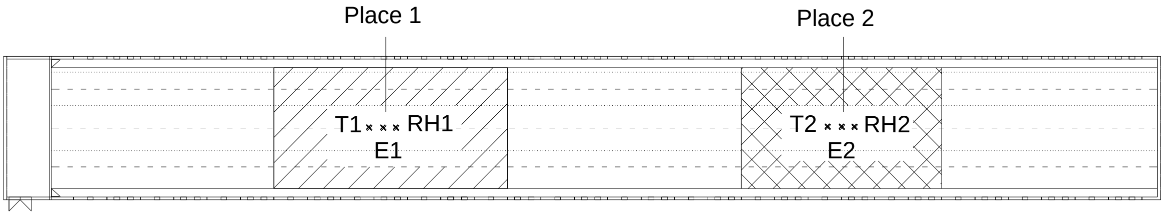


Fig. 1 Measurement points of climatic parameters in the experimental hall in the summer period S1 (T1, T2 – points of measurement of air temperature; RH1, RH2 – points of measurement of relative air humidity, E1, E2 – points of measurement of emissions)

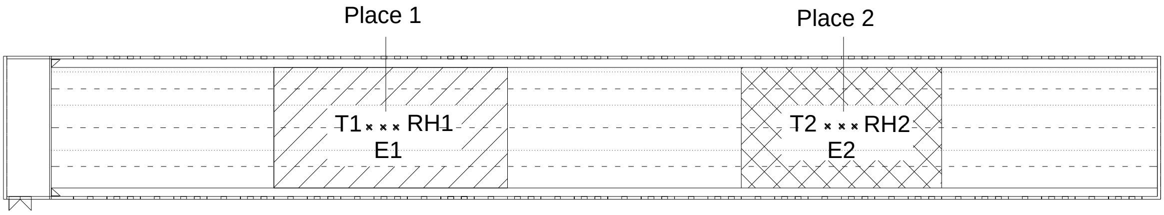


Fig. 2 Measurement points of climatic parameters in the experimental hall in the winter period W1 (T1, T2 – points of measurement of air temperature; RH1, RH2 – points of measurement of relative air humidity, E1, E2 – points of measurement of emissions)

RESULTS AND DISCUSSION

We found that the measured internal air temperature $T_{a,i}$ exceeded the required air temperature at measured relative humidity $T_{a,r}$ for 20 days of measurement in summer period S1 (ROSS limits, 2018). Temperature overlap was recorded from 1st day to 11th day of the period and from 13th day to 21st day of the period. The highest temperature difference was achieved on the 7th day of the period and it was by 4.98 °C more than the required internal air temperature. On 12th day of the period, there was a slight decrease below the required air temperature (Fig. 3). The temperature during the measuring period had mostly decreasing character. A slight increase of internal air temperature occurred on the 13th, 16th and 21st day of the period. The range of recommended temperatures represented by two curves included the occurrence of a combination of temperatures at relative humidity ranging from RH = 40 % to RH = 70 % (ROSS, 2018). In this range, the internal air temperature exceeded the required temperatures only on the 20th and 21st days of the period. The results show that the required internal air temperature was exceeded in the examined hall during the 20 days of the summer period and thus the hall was overheated. In the winter period W1 were measured lower temperature differences between the internal air temperature and the required temperature at the measured relative humidity $T_{a,r}$ than in the summer period S1. The thermal overlap was recorded during 20 days of measurement, with a more pronounced temperature overlap from 8th day to 11th day, from 13th day to 15th day, and from 17th day to 21st day. The highest temperature overlap was measured on the 9th day of the period and it was 3.75 °C more than the required temperature for the given broiler type. During the other days the temperature overlaps have been minimal. On 16th day of the period, there was even a slight drop below the required air temperature (Fig. 4). In the range of the recommended temperatures at a relative humidity ranging from RH = 40 % to RH = 70 %, the internal air temperature slightly exceeded the recommended values only on the 2nd day of the period. The required internal air temperature was exceeded during the winter period, especially in the 2nd and 3rd weeks of fattening.

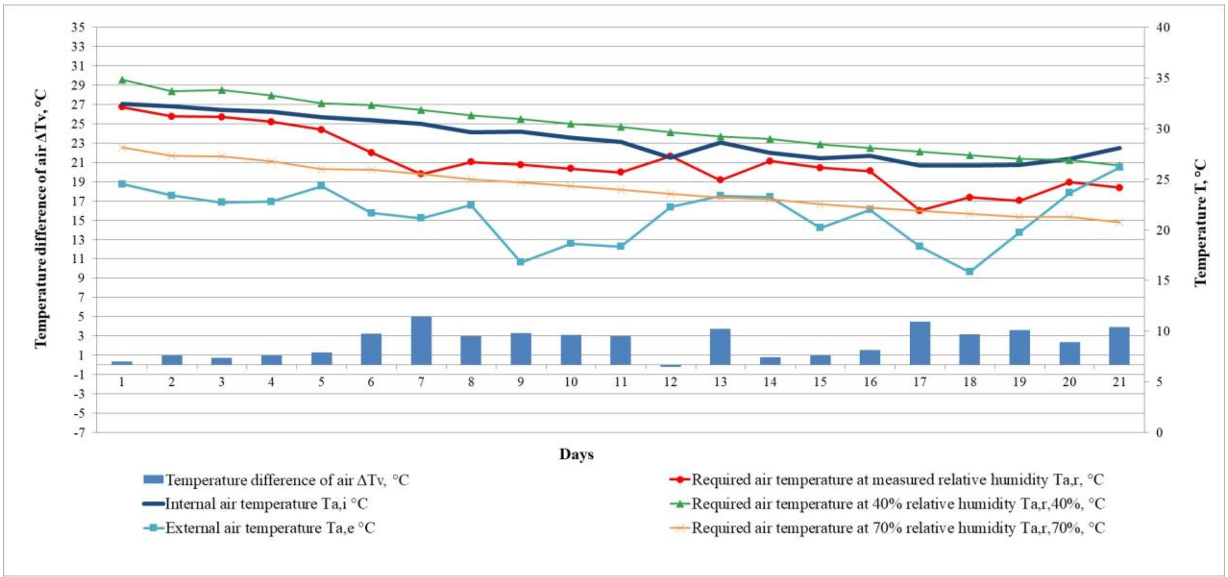


Fig. 3 Temperature difference between measured and required internal air temperature during summer period S1

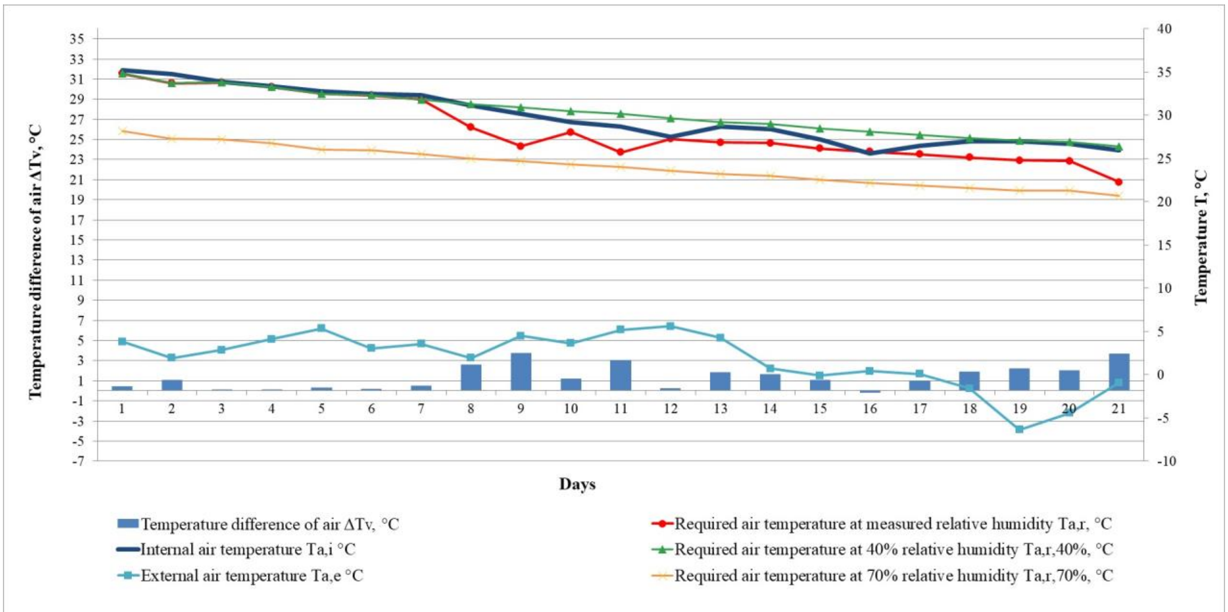


Fig. 4 Temperature difference between measured and required internal air temperature during winter period W1

The daily average CO_2 production measured during the summer S1 poeriod ranged from 3,160.07 to 5,134.53 mg.m^{-3}. The excess of CO_2 concentrations above the maximum recommended value occurred at days 4 and 6 of the breeding period and from days 17 to 21 of fattening (Fig. 5). The graph shows that the heating intensity in the hall increased and the average daily CO_2 concentration also increased when the outside air temperature was dropped. The results show that the production of CO_2 concentrations in the hall were increased depending on the heating intensity. The regression analysis at the level of $\alpha = 0.05$ was showed a significant dependence of CO_2 production on the heating intensity ($R^2 = 0.431$) expressed by the temperature overlap of the measured and the required temperature (Fig. 7a). Therefore, a reduction in heating costs could be achieved by reducing the temperature differences between the measured and the desired indoor air temperature and thereby reducing the CO_2 content of the hall.

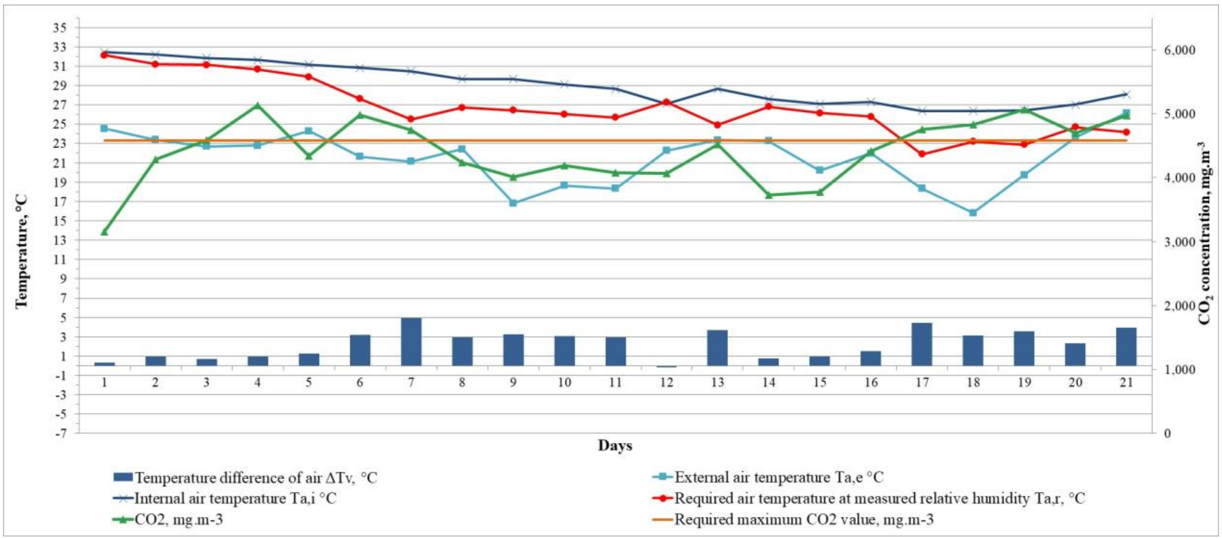


Fig. 5 Course of average daily CO_2 concentrations and internal, external air temperature and required air temperature at actual relative humidity during summer period S1

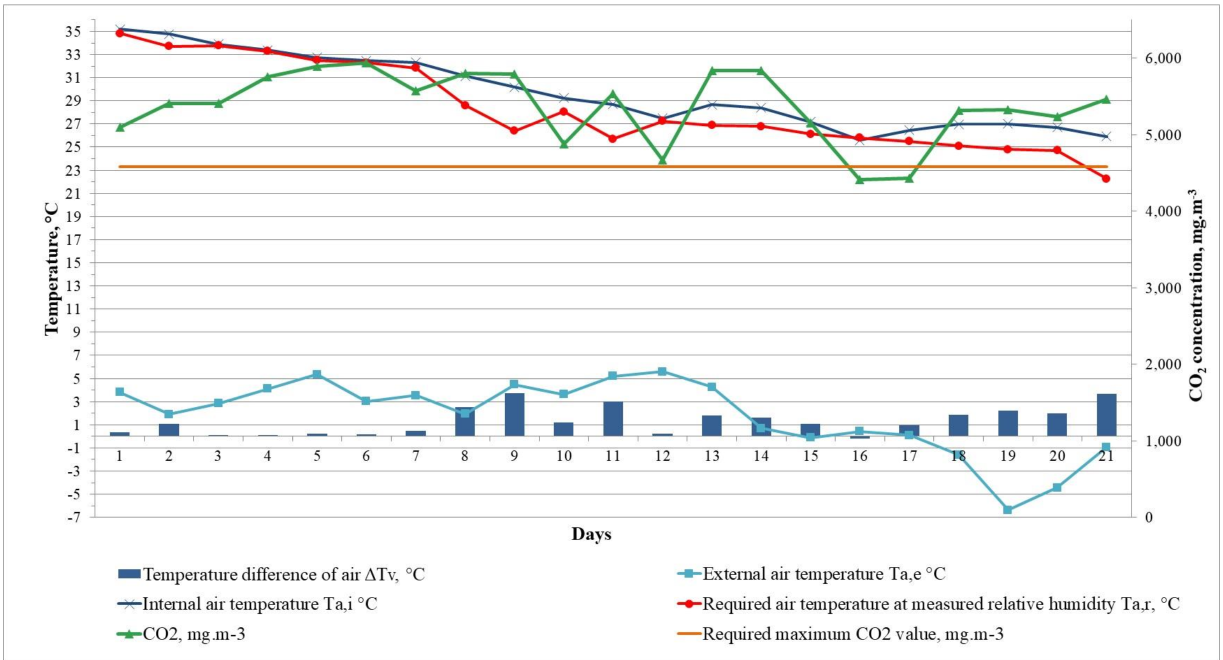


Fig. 6 Course of average daily CO_2 concentrations and internal, external air temperature and required air temperature at actual relative humidity during winter period W1

In winter it was necessary to heat the examined hall more intensively in order to reach the required indoor air temperature, which resulted in higher CO_2 concentration in the hall compared to the summer period. In the monitored winter period of W1, the daily average CO_2 production exceeded the recommended value during 19 days of breeding and ranged from 4,412.46 to 5,938.78 mg.m^{-3} (Fig. 6). The average daily CO_2 concentration was not exceeding the recommended value only on the 16th and 17th days of breeding. This is probably due to the minimum level of ventilation at the start of the period to avoid heat losses and possible air draught to which chickens are sensitive. The restricted fresh air inlet did not result in such intensive dilution of gaseous compounds in the indoor environment as in the later breeding period, when the front fans of the tunnel vacuum ventilation were also involved. As in the summer breeding period, it was demonstrated large dependence of CO_2 production (R^2 = 0.562) on the heating intensity by a regression analysis at α = 0.05 showed a (Fig. 7b). As reported by many authors (Miles et al., 2006; Olanrewaju et al., 2008), a few other factors also affect carbon dioxide levels in broiler farming. In accordance with intensive heating at the beginning of the period, the maximum CO_2 concentrations in the second period have been decreasing and slightly have been increasing at the end of the period with the age of chickens and increasing amount of excrements in the litter. This means that one source of CO_2 (gas combustion) is replaced by another source (breathing of birds, excrements). This effect is not obvious as this process enters more intensive ventilation and CO_2 is diluted with fresh air from the outside.

a b

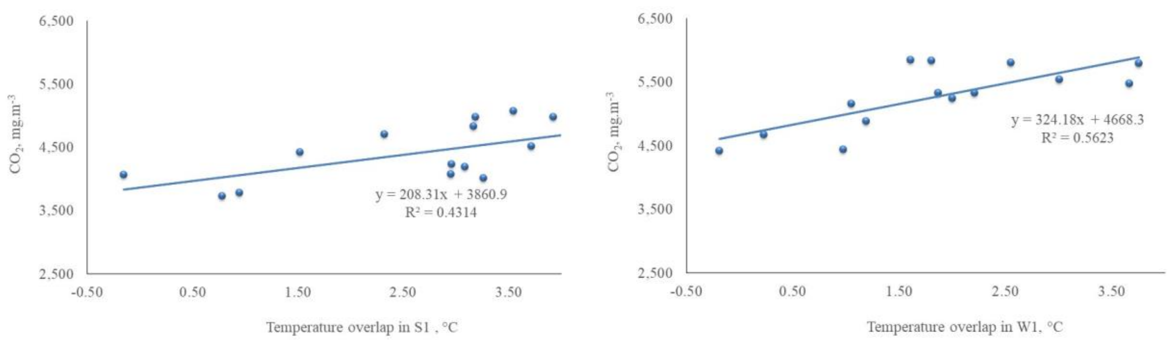


Fig. 7 Dependence of production CO_2 concentration on heating intensity during summer period S1 (R^2 = 0.431) and winter period W1 (R^2 = 0.562) on significance level α = 0.05

CONCLUSIONS

The results show that in the examined hall the required internal air temperature was exceeded and thus the hall was overheated during the first 21 days of the summer period. Reducing the CO_2 concentration below the desired maximum value could be achieved by sensitively adjusting the heating intensity, thus avoiding temperature overlaps between the actual and required internal air temperature. It would improve the quality of the environment, reduce the mortality of farmed chickens and reduce heating costs of hall.

Abstrakt

Cieľom práce bolo posúdenie vplyvu riadenia vykurovacieho procesu v chove brojlerov na kvalitu prostredia v letnom a v zimnom období. Pomocou dataloggerov comet bola permanentne v 10 minútových intervaloch meraná vnútorná a vonkajšia teplota a relatívna vlhkosť vzduchu. Súčasne bola prístrojom Innova meraná koncentrácia CO_2 v hale. Z meraní sme zistili, že v hale dochádzalo počas takmer celého meraného obdobia v lete aj v zime k prekračovaniu požadovanej teploty vnútorného vzduchu a teda k nadmernému prekurovaniu haly. Regresnou analýzou bola v letnom období preukázaná závislosť produkcie CO_2 od intenzity vykurovania (R^2 = 0.431). V zimnom období bola v hale k vyššia koncentrácia CO_2 ako v letnom období. Následne bola regresnou analýzou preukázaná závislosť produkcie CO_2 od intenzity vykurovania v zimnom období (R^2 = 0.562).

Kľúčové slová: prekurovanie, teplota vzduchu, vlhkosť, škodliviny, brojlery

ACKNOWLEDGMET

This research was supported by project NFP 26220220014 and knowledges gained from LivAGE (project COST): Ammonia and Greenhouse Gases Emissions from Animal Production Buildings was used

REFERENCES

Angel, R. (2006). Broiler production and the environment: College of agriculture and natural resources, University of Maryland, EB 368, 35 p.
http://www.agronext.iastate.edu/immag/info/eb368poultryprod.pdf

Council Directive 2007/43/EC (2007): Laying down minimum rules for the protection of chickens kept for meat production. The Council of the European Union, Luxemburg, 19–28.

Jelínek A., Češpiva M., Plíva P., Hörnig G., Stollberg U. (2001). Composting as possibility of toxic gases emissions reduction, mainly ammonia, generated during manure storage. *Research in Agricultural Engineering*, 48, 82–91.

Miles D.M., Owens P.R., Rowe D.E. (2006). Spatial variability of litter gaseous flux within a commercial broiler house: ammonia, nitrous oxide, carbon dioxide, and methane. *Poultry Science*, 85, 167–172.

Olanrewaju H.A., Dozier W.A., Purswell J.L., Branton S.L., Miles D.M., Lott B.D., Pescatore A.J., Thaxton J. P. (2008). Growth performance and physiological variables for broiler chickens subjected to short-term elevated carbon dioxide concentrations. *International Journal of Poultry Science*, 7, 738–742.

ROSS. 2018. *Ross broiler management handbook*: Preface: Aviagen, 2018, 132 pp:1-148. Available on: <http://en.aviagen.com/assets/Tech_Center/Ross_Broiler/Ross-BroilerHandbook2018-EN.pdf>.

Decree of the Ministry of Agriculture of the Slovak Republic n. 230/1998 Collection of Laws on livestock breeding and slaughter of animals.

Corresponding author:
Ing. Tímea Szabóová, PhD., Department of Building Equipment and Technology Safety, Faculty of Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia,
e-mail: timea.szaboova@uniag.sk

NEW TRENDS IN APPLICATION OF RENEWABLE AND RECYCLED MATERIALS IN CONSTRUCTION

NOVÉ TRENDY V APLIKÁCIACH OBNOVITEĽNÝCH A RECYKLOVATEĽNÝCH MATERIÁLOV V STAVEBNÍCTVE

Eva TERPÁKOVÁ[1]

[1]*Institute of Environmental Engineering, Faculty of Civil Engineering, Technical University of Kosice Vysokoškolská 4,042 00 Košice, Slovakia*

Abstract
Trends of development of advanced building materials in recent years are to focus attention on renewable and also waste materials. The aim of our research was to assess the use of cellulose fibers as a partial replacement of filler in the preparation of composites. On experiments were using two types of commercial cellulose fibers and laboratory pulp obtained from waste paper. The mechanical properties of the samples after 28 and 60 days of hardening were assessed, compressive strength values were ranging from 18.60 MPa to 25.99 MPa. The influence of cellulosic fibers on physical properties was studied mainly in terms of thermal conductivity. Compared with reference samples of composites, the thermal conductivity coefficients were reduced up to 0.299 $W.m^{-1}.K^{-1}$, which means, that experimental composites could be partially used as insulations. The research confirms the utilization of recyclable materials in composites to plasters or lightweight internal elements of rural buildings as well.

Key words: cellulose fibres, waste, renewable raw materials, composites

INTRODUCTION
With the worldwide trend of intensification of the building industry, the requirements for building materials are also increasing. It has been known from the history utilization of several kinds of natural materials, but they are mostly non-renewable raw materials (stone, aggregates, sands etc.). Therefore, in recent years, research has been carried out in the field of the treatment of various wastes and by-products for their application in the construction industry. For example, it is a substitute for inorganic material, such as various types of natural stone and aggregates, whose reserves are limited. As a result, from the middle of the last century, attention has been drawn to securing substitute resources into building production such as by-products from various industrial and agricultural activities. Various fiber materials are testing for application in construction products. Cellulosic materials are increasing in importance due to their numerous advantageous properties for application in sustainable building constructions. One of the requirements for quality of these fiber composites is to ensure adherence and cohesion of filler (fibres) with the matrix. Fibers used are above all specifically produced on the base of steel or on the base of special plastic materials for example polypropylene, polyethylene, nylon, and glass as well as. Some advantages for using these fibres into composites are based to bridge across cracks that develop in structure of composites. Thus, fiber reinforced components are expected to satisfy the strength parameters, durability and ductility, and requirements of a high performance concrete material for wide practical application (Števulová at all., 2014). It should be emphasized that the use of natural fibers in last decades includes benefits for the construction industry. They are described in the literature different experimental products using celluloses fibers (such as sisal, hemp, jute, bamboo, coconut, coir, kenaf etc.). Testing and practical application of these renewable materials as fillers in different composites is in accordance with the idea of sustainability in the construction industry (Bołtruk, Pawluczuk, 2017). Some disadvantage in natural fibers using compared to organic industrial fibers is their homogenity and sorption properties which resulting in high moisture absorption and biodegradability of final products above all. (Števulova at all., 2014). Thorough tests to assess durability of natural renewalable as well as recycled cellulosic fibers are therefore required mainly due to their hydrophility, changes of mass due to sorption/desorption processes and mechanical strength parameters,

too. However, applications of such materials require first of all procedures the verification of their essential properties, for example whether they meet the safety and hygiene requirements for use in construction. In the next steps, research must be undertaken to prepare specific building elements in order to verify their technical parameters. The entire process, from the raw material acquisition, through the production of the elements to their application to a particular structure and purpose on the construction site, must comply with standard criteria and technical requirements. This implies that the legislative guidelines must also be observed (Svoboda, at all., 2013). In case of cellulosic materials is very important question of final product stability from biodegradation processes point of view. Most of the biodegradation processes require the presence of water. It is paradox, because on the one hand, water is necessary for the performance of technological procedures, but on the other hand, causes disorders of construction. Humidity is one of the basic technical parameters which are observed continually from production of building materials up to demolition of building objects (Svoboda, at all., 2013). With higher humidity goes plenty of processes which lead to decreasing durability and reliability of construction. Practical determination of humidity of each other materials therefore becomes an important tool of quality control, technological processes while realizing up to diagnostic of corrosion. There is a correlation of humidity and related chemical and corrosion processes and durability of building materials (Dobrý, Palek, 1988). The main types of water circulation in building constructions are soaking, damping and drying. In case of cellulosic materials humidity can effect lies in the formation of available conditions to grow of biodeteriogens (Wasserbauer, 2000).
Researches on the use of renewable as well as waste cellulosic materials in modern construction are also focused on various modifications of these materials so that the resulting products meet the required technical parameters and criteria of fire resistance, hygiene and resistance to biocorrosion, etc. (Terpáková, and Sičáková, 2015). As hemp is a natural material, its durability, in particular its resistance to moisture has been also tested in past (Kidalova, 2015). The results of the absorbability and capillarity testing indicated the need for hemp surface treatments, which has been verified in the long term by several chemical and physical procedures. Conclusions from the results obtained after various physical and chemical treatments of technical hemp shives were, that is possible to prepare composite materials with coefficient of thermal conductivity up to 0.150 ≈0.400 $W. m^{-1}. K^{-1}$ which values are comparable to some commercial thermal insulation materials such as mineral wool or polystyrene (Števulová, et all. 2014).
These composites were also tested in terms of resistance to higher temperatures, the gradual thermal loading of such composites confirmed their stability up to about 300-350 ºC (Čigášová at all. 2015). Also, strength tests have confirmed that hemp shive composites as fillers can be applied as non-load-bearing elements as they exhibit compressive strengths on average up to about 8 MPa. (Terpáková, Sičáková, 2015). After experiments with renewable cellulosic materials, attention was also paid to waste materials, based on lignin-cellulose. Some of them are also industrially produced resp. used in commercial cementitious composites.
The paper deals with the testing of composites prepared from commercially available cellulosic fibres from wood and waste paper fibers. In parallel with these fibers, the possibility of processing waste paper under laboratory conditions and its incorporation into cement composites was verified as well. In article we will compare behaviours of experimental composites and its changes over time after 28 and 60 days of hardening.

MATERIALS AND METHODS

CEM I 42.5 N, the ordinary Portland cement produced by Cement Factory Ltd. (Považská cementáreň Ladce, Slovakia) was used for the preparation of the cement composites. Natural silica sand fiction size 0-1mm from Šaštín - Stráže company (Slovakia) in accordance with standard STN EN 196-1was used as filler. The two types of commercial cellulosic fibers (provided by company Greencel Ltd. Hencovce, Slovakia) used in this study were bleached wood pulp (type GW 500), marked in the text as sample set "A" and unbleached - recycled fibers (type G-500T), marked in the text as sample set "B" obtained from different recycled waste papers. The typical physical properties of cellulose fibres are shown in Tab.1.

The third type of fibers (designed in the text as sample set "C") was obtained by gradual treatment of waste paper (from cement bags). Their preparation was described in past work (Terpáková, 2017). Waste paper processing followed the experiments with ultrasonic-physical treatment of hemp shives, which were also presented in some our previous works (Terpáková, Števulová, 2014) respectively (Terpakova, Sičáková, 2015). The ultrasonic device TESON 10, manufactured by TESLA (Slovakia), was used for the experiment of cement bags pulping. The paper from the clean - original cement bag was disintegrated into squares of approximately 5 x 5 mm, soaked in deionized water for 48 hours up to constant weight. The ultrasonic treatment of the soaked paper particles was verified in a time sequence up to 120 minutes. The treated pulp was mechanically homogenized, screened through a sieve (up to 0.5 mm) and after drying at 80 °C was used to prepare composites (Terpáková, E., 2017). Deionised water prepared by RODEM 6 device with conductivity 0.05 $mS.cm^{-1}$ was used in all experiments in preparation processing of composites as mixing and curing water. Parameters of water were in accordance with standard STN EN 1008.

3 sets of experimental cellulosic fibers reinforced composites were prepared. Cellulosic fibers designed as A, B, C sets were used as particularly substitution of sand (5 and 10 wt. % from weight of inorganic filler). The mix proportions of specimens were designed with Cement/Sand (C/S) weight ratio of 1:3. Results with the same water factor of 0.6 are presented in article. Reference cement composite was manufactured without using of cellulosic fibers. Cube samples of 100 mm x100 mm x100 mm were prepared and cured under standard conditions. All of the experimental mixtures were obtained by using a laboratory mixer Matest (Italy).

Density and thermal conductivity were determined after 28 days hardening on the dried sample. Density was calculated from the weight and the determined dimensions of the individual samples. Kern balances with an accuracy of ±0.01g were used for weighting. The thermal conductivity coefficient λ ($W.m^{-1}.K^{-1}$) of samples as the main parameter of heat transport in building constructions was determined by device ISOMET 104 (Applied Precision Ltd., Germany). At the same time, tests have been carried out to assess the water absorbability which affects the durability and biodegradability of the composites. The development of their strength characteristics was evaluated over a period of 28 and 60 days.

RESULTS AND DISCUSION

Density and thermal conductivity of composites

In Tab. 1 are the values of basic physical parameters such as volume density and thermal conductivity of reference sample and composites sets A, B, C as well. While density of reference sample after 28 days of hardening reached 2110 $kg.m^{-3}$, specimens with cellulosic fibers GW-500 (sample A) in both an amount of 5 wt.% to 10 wt.% as a filler substitute, showed the decrease of values density compared to the reference sample. The same trend was achieved in case of composites sets B and sets C**.** Reduction in density values is a positive fact for practical use and corresponds with the values of thermal conductivity. (see Tab. 1). Reducing the coefficient of thermal conductivity with the increasing content of cellulose fibers was observed in all composites samples. Generally, the fiber additions into matrix have positive impact on density (cellulosic fibers into structure of composites create the voids) and thermal conductivity is enhanced when density decreases. It can be stated that the fibers used will also improve the practical application, for example when using composites in the form of plasters and mortars.

Tab. 1 Results of physical parameters of composites

Composites	Physical parameters	
	volume density ± 5 (kg.m^{-3})	coefficient of thermal conductivity $\lambda \pm 0.001$(W.m^{-1}.K^{-1})
reference	2110	0.418
A-5%	1980	0.366
A-10%	1945	0.360
B-5%	2040	0.350
B-10%	2030	0.332
C-5%	2015	0.319
C-10%	1985	0.299

Determination of water absorbability

Research of the hygroscopic properties of composites is important because a whole range of technical parameters as well as the durability of the structural elements depend on the ability to absorb water into the material structure. Water transport processes in materials and structural elements are also subject to modeling as part of the technological preparation of construction to avoid problems with the enormous build-up of moisture, which is theoretically possible in the case of porous fiber composites. Results of water absorbability of A, B, C sets of composites are presented at Fig. 1. The results of total absorbability show the expected increasing of amount of water in the all composites with the increasing content of cellulose fibers as well. Increasing the water absorbability also may be caused by rising of fiber amount in cement matrix because cellulosic fibers have hydrophilic character. Increase of water absorption values can affect, for example, the frost resistance in the event that the composite samples will be used in outdoors.

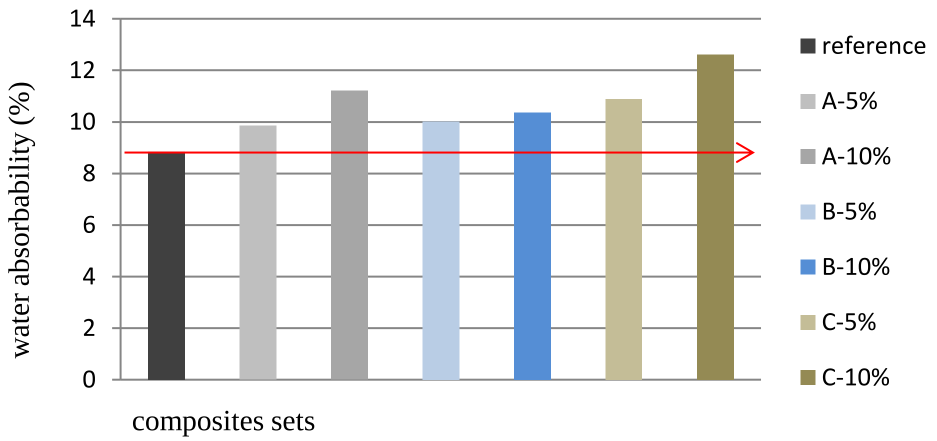


Fig.1 Results of total water absorbability of composites (testing 24 hours)

Determination of strength parameters

The mechanical properties of the composites were verified after 28 and 60 days of hardening. Tab. 2 shows changes in compressive strength, he compressive strength measurement was carried out using an ADR ELE 2000 press (International Limited, England).

Tab. 2 Development of compressive strengths f_c of experimental composites

Composites	$f_c \pm 0.01$(MPa)	
	28days	60days
reference	36.50	39.32
A-5%	25.99	26.33
A-10%	24.63	26.18
B-5%	30.77	31.40
B-10%	26.55	29.99
C-5%	22.80	23.11
C-10%	18.60	18.75

The achieved compressive strengths show that the cellulose fibers partially influenced the f_c values compared to the reference sample. However, in the application of the fibers to the composites, the method of preparation, deposition and degree of compacting of the fresh mixtures is very important. Therefore, this issue needs to be addressed in further experiments. Comparing the strength results of the individual A, B, C sets, it can be stated that the laboratory pulped pulp (set C) showed lower strength values but the indicated trend was maintained - thus higher% filler substitution corresponds to partially lower values of compressive strength. However, even the lowest value of compressive strength is 18.75 MPa after 60 days hardening, which is a positive finding from a practical point of view.

CONCLUSION

The verification of the properties of composites was provided on the base of different type technical and waste pulp because nowadays are trends of reuse of waste materials Determination of humidity of building materials is from durability and reliability very important particularly its impact to next biocorrosion processes. The aim of the paper was to point out the importance of testing of experimental composites, as the information obtained serves as a set of input data for the selection of suitable materials for the design and technological procedures. The results indicate the need to test and verify the properties of composites not only in model conditions in the laboratory, but it would certainly be interesting to carry out testing of composites in the exterior. In this case, there would still be a question of surface treatment samples, as incorporated fibers increases partially water absorption. Obviously, the issue solved in the paper confirms the need for further experimental verification of properties of these composites in the future, such as resistance to aggressive environmental influences as well as possible biocorrosion processes.

Abstrakt

Trendy vývoja progresívnych stavebných materiálov v posledných rokoch sa zameriavajú na obnoviteľné ako aj odpadové materiály. Cieľom nášho výskumu bolo zhodnotiť použitie celulózových vlákien ako čiastočnej náhrady plniva pri príprave kompozitov. Pri pokusoch boli použité dva typy komerčných celulózových vlákien a laboratórna buničina získaná z odpadového papiera. Hodnotili sa mechanické vlastnosti vzoriek po 28 a 60 dňoch vytvrdenia, hodnoty pevnosti v tlaku sa pohybovali od 18,60 MPa do 25,99 MPa. Vplyv celulózových vlákien na fyzikálne vlastnosti sa študoval hlavne z hľadiska tepelnej vodivosti. V porovnaní s referenčnými vzorkami kompozitov sa koeficienty tepelnej vodivosti znížili na 0,299 $W.m^{-1}.K^{-1}$, čo znamená, že experimentálne kompozity sa mohli čiastočne použiť ako izolácie. Výskum potvrdzuje aj využitie recyklovateľných materiálov v kompozitoch na omietky alebo ľahké vnútorné prvky vidieckych budov.

ACKNOWLEDGEMENTS

This contribution is supported by Project VEGA 2/0142/19.

REFERENCES

Bołtryk, M. and Pawluczuk, E. (2014). Properties of a lightweight cement composite with ecological organic filler. *Construction and Building Materials.* 51(31), 97-105.

Čigášová, J., Schwarzová, I., Števulová, N., Priganc, S., Kušnír, Š. (2015). Effect of thermal stress on bulk density changes of hemp hurds composites. In: Zborník recenzovaných vedeckých prác, ÚEI 2015. ed. TUKE Košice, 27-32.

Dobrý, O., Palek, L. (1988). *Concrete corrosion in building praxis*. Praha: SNTL.

Kidalová, L., Števulová, N., Terpáková, E. (2015). Influence of water absorption on the selected properties of hemp hurds composites. *Pollack Periodica*, 10(1), 123-132.

Stevulova, N., Cigasova, J., Estokova, A., Terpakova, E., Geffert, A., Kacik, F., Singovszka, E., Holub, M. (2014). Properties Characterization of Chemically Modified Hemp Hurds. *Materials*, 7(12), 8131-8150.

Svoboda, L., Bažantová, Z., Myška, M., Novák, J., Tobolka, Z., Vávra, R., Vimrová, A., Výborný, J. (2013). *Stavební hmoty.* Praha: JAGA.

Terpáková, E. (2017). Inovatívne prístupy k využitiu odpadového papiera. *Odpady*,17(3) 5-9.

Terpáková, E., Sičáková, A. (2015). Štúdium kompozitov s organickým plnivom. In:Proceedings of XXI. Conference about Structural Materials, CONSTRUMAT 2015. Brno: Vysoké učení technické, 2015, s.1-7.

Terpáková, E., Števulová, N. (2014). Vlastnosti kompozitov na báze konopného pazderia po jeho fyzikálnej úprave. In: Proceedings of XX. Conference about Structural Materials, CONSTRUMAT 2014. Ostrava: Vysoká škola báňska Technické univerzity, 2014, s. 1-12.

Wasserbauer, R. (2000). *Biological damaged of buildings.* Praha: ARCH a.s.

STN EN 196-1:2016 *Methods of testing cement* Part 1: Determination of strength (in Slovak)

STN EN 1008:2003 *Mixing water concrete*. Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete (in Slovak)

Corresponding author:
RNDr. Eva Terpáková, PhD.
Institute of Environmental Engineering, Faculty of Civil Engineering, Technical University of Košice, Vysokoškolská 4, 042 00 Košice, Slovakia
e-mail: eva.terpakova@tuke.sk

THE APIHOUSE EXPERIMENTAL CHAMBER

EXPERIMENTÁLNY OBJEKT APIHOUSE

Tibor VARGA[1], Klára MACHÁČOVÁ[2], Martin UHRÍK[3]

[1, 2, 3]*Slovak University of Technology in Bratislava, Faculty of Architecture, Institute of Ecological and Experimental Architecture.*

Abstract
The question of healthy lifestyle, of human physical and mental relaxation, is becoming increasingly topical. It concerns not only the way of eating, physical activities, use of natural building materials but also the new forms of healthy relaxation. New form of relaxing and agritourism in rural areas or natural environment is the contactless stay in a building with bees, the ApiHouse.
This study is a preparation for a broader research task aimed at examining the objective and subjective of the ApiHouse space. It should test the objective parameters of the technical and medical focus and deal with the subjective psychological parameters of the space and mental hygiene. As well as problem of placement of ApiHouse in city or rural areas. More specific formulation of the research was implemented in the form of research by design, the student workshop in FA STU Bratislava. This resulted in a great diversity of designs suggesting several groups of architectural solutions.

Key words: research by design, new relaxation form, beehive, experimental architecture, biocompatibility, small wooden structures

INTRODUCTION

The recent assignment from practice, in our case the new experimental form of healthy relaxation and alternative medical care at the same time - the ApiHouse for apirespiration therapy – along with the limited time schedule, working in teams, intense communication and confrontation of the individual designs, have created an ideal platform for the research by design methodology. Most of the student's assignments at the Faculty of Architecture is dealing with metropolitan architecture. Designing in a rural environment is an enrichment for students.
Therapies involving the honeybee have existed for thousands of years and some may be as old as human medicine itself. The ancient rock art of early hunter-gatherers depicts the honeybee as a source of natural medicine. Bee venom therapy was practised in ancient Egypt, Greece, and China—three Great Civilizations known for their highly developed medical systems. Hippocrates, the Greek physician known as the "Father of Medicine", recognized the healing virtues of bee venom for treating arthritis and other joint problems. Today, growing scientific evidence suggests that various bee products promote healing by improving circulation, decreasing inflammation, and stimulating a healthy immune response.
The medicinal use of products made by honeybees - bee venom, honey, pollen, royal jelly, propolis and beeswax - is so called APITHERAPY (or "bee therapy", from the Latin apis which means bee).
Apart from the beneficial effects of the aforementioned bee products, the APIRESPIRATION is also very beneficial for the human body - it means the breathing of the pleasantly warm bee air, about 36°C, from the beehive directly.
In the beehive environment, the air is constantly circulating due to vibration of the wings of thousands of bees. The air is saturated with water vapour, particles of isoprene, terpene, essential oils, hormones, feromones, liquid wax, alcohol, bee saliva secretions, propolis, trace elements, enzymes, choline, phytohormones, etc. By natural respiration, these substances are applied in the human body, having a positive effect on various diseases, whether as prevention, cure or stabilization.
Excellent results of apirespiration have been proven with bronchitis, asthma, allergies, diphtheria, susceptibility to infections, chronic inflammation, impaired immunity, migraines, and depression.

A study on apitherapy by inhaling the beehive air (apirespiration) was carried out by prof. Dr. Eberhard Bengsch from Max Planck Institute in Munich. (Apires.sk, 2018) His therapy is carried out using the Api-air respiration device. The beehive air is sucked in through a hose leading to the patient's inhalation mask. The patient has no direct contact with the bees.
Recently, an interest of the public as well as bee-keepers themselves in a lighter wellness or experience type of apitherapy has increased – a longer stay or sleep-over in an ApiHouse, practically on the beehives but without direct contact with the bees. This form was promoted here by the Ukrainian scientist and enthusiast, V. A. Solomki, in his publication Sleeping on Beehives, thanks to which home-made constructions of ApiHouses originate. (Solomki, 2016) Unfortunately, the knowledge of this form of bee air use as well as its effects on the human psyche have not been documented in any scientific or professional work as yet.

MATERIAL AND METHODS

Examples of an ApiHouse as a building structure may be observed in Slovakia as well as abroad. However, these are mostly simple objects of a garden shed type, only meeting the basic requirements of the particular use. Usually these are standardised garden sheds or caravans adapted to the possible manipulation with the beehives and a contactless stay of people with the bees in order to improve their health condition without further possible interactions with the interior or exterior. The workshop assignment was based on the inputs of Klaudia Kajsová - the active bee-keeper - to the given topic (from the life of bees, care of them and foremostly the rules and spatial requirements of bee-keeping). The design technical parameters consisted of the situation of a contactless coexistence of people and bees assuming the possible manipulation with the beehives without restricting the visitor, which means the interior ApiHouse space. The assignment for students was aimed at extending the understanding of the structure by more complex relationships with the surrounding environment, the play of human perceptions in the interior with possible visual connection to the exterior and the possibility to use the ApiHouse for a relaxing stay with strong links to the nature. The first workshop was mainly expected to bring various forms of student approach for a wider inspiration and defining the subject areas for their further research. The workshop was attended by 29 students of the 4th and 6th year, working individually or in groups. Total of 14 designs were prepared. The outcome was documented in the drawings, images of the mass and spatial solution, and in the form of miniature models. It turned out that the participation of students in the specification of the assignment topic and deeper contemplation over the issues resulting from the discussions was supporting their creativity in architectural designing. Several characteristic forms of architecture were created. Some approaches matched the context of the chosen surrounding environment, mostly very natural. The links to the environment were significant in the designing. Apart from the apitherapy, also mediate relax and experience of the surrounding nature to people. On the contrary, other architectural forms represent versatility in this aspect and are not closely linked to the environment (Fig. 1, Fig. 2). In other designs, a more contemplative approach of the use of the structure appears, i.e. concentration on the human beings and their mental health (Fig. 3). Finally, we have stated that the different forms of the ApiHouse structures are a contribution for the topic as well as the raise of interest in this type of tourism and relax.

Fig. 1 Belesova, Z. et al.,Versatile ApiHouse structure, universal design approach.

Fig. 2 Kruliac, D. et al.,Versatile ApiHouse structure, universal design approach.

The use of natural building materials was the common ground. When evaluating materials, also their ecological footprint has to be monitored, including the environmental consequences of their use. (Chybík, 2009) The embodied energy (EE) is the basic indicator, also identified as grey energy.
This aspect may be considered as natural for this particular topic. Recently, architecture started dealing more with a healthy interior environment, examining the impact of the building materials used on the human organism. Another aspect is the impact of the building materials use on the environment and the examination of the environmental features of the materials. The topic of energy intensity of the production and use of the building materials and their overall impact on the environment is live all around the world and not only in terms of embodied energy.

Fig. 3 Kozova, T., Contemplative ApiHouse structure.

In today's research in building materials, science deals more with their impact on the human organism. The field engaging in this impact is called the material biocompatibility, which expresses the direct and indirect interactions of the materials with the living organisms. These interactions may originate either by direct contact of the living body or tissue of the organism with a material, or indirectly, through air, weight or energy fields. The special case of these interactions of materials, between the materials and humans and between other living organisms in the residential environment (construction and tiling materials, floors, bed, sitting and other furniture) may be considered according to liveability or living suitability/capability of a material. The biocompatibility of materials is an interdisciplinary field of material engineering, ecology and medicine. From the semantic point of view, the term of material biocompatibility creates an image of a certain measure of compliance between two objects - the material and the biological object. (Katuščák 2006) In order to generally improve the environment and the aforementioned aspects of healthy living, it is necessary to implement these disciplines in the educational process of architectural designing, to teach students to work with them naturally in their future practice. Following the environmental and pragmatic analyses, wood has become an ideal

material for the structure design. As has been shown in the past, in the implemented international project of DUNA – the bird observatory on Danube, originating in cooperation of the students and pedagogues of the Bergen School of Architecture and the Faculty of Architecture STU in Bratislava, wood as a structural building material, with its qualities and forms, played the key role in the pedagogical process of the structure designing and implementation. For the self-supporting construction of these types of student projects, the wooden elements are suitable in terms of easier manufacturing, transport, installation as well as possible modification. The benefits of wooden construction as biocompatibility an environmental friendliness can be extended with capability of wooden construction of easy transport and thus much less agresive building process in remote rural and wildlife areas.
In the upcoming stages of the project, there is an ambition to implement the project at a scale of 1:1, where the students will be able to verify the qualities of the building materials chosen as well as their technical designs on particular details.

RESULTS AND DISCUSSION

The structure has to be examined from two points of view. We can talk about the objective and subjective qualities of the ApiHouse structure. The objective parameters are the ones that are accurately measurable and quantifiable. These are mainly the qualities of chemical and medical nature. This category also includes the structural and material part of architecture. The subjective qualities include the psychological impact of the space and the mental health quality.
Within the spatial evaluation of the structure, we shall analyse the exterior and interior separately. The workshop has shown us several options how to approach the issue. In terms of the exterior work, we may talk about a contextual or universal approach. The contextual one is based on the particular location, engaging the natural elements in the concept not only of the building but also in the whole stay at the ApiHouse. The location is an important factor and this approach is closer to the recreational than to the medical use of the structure (Fig. 4, Fig. 5). The universal approach designs a structure to be placed into different contexts. The functional needs of the ApiHouse are the main basis of the design rather than the environment. This approach can maximise the structure's medical potential. In terms of the interior, we may pursue two types of approach. An introvert approach offers a contemplative relaxation dimension. One should focus more on their feelings and especially on the therapy offered. An extrovert approach is the opposite example. This offers an experience connected with the stay in the space. It creates an atmosphere where the main purpose of the stay is the exploration of architecture or the views of the country. The medical dimension is a by-product.

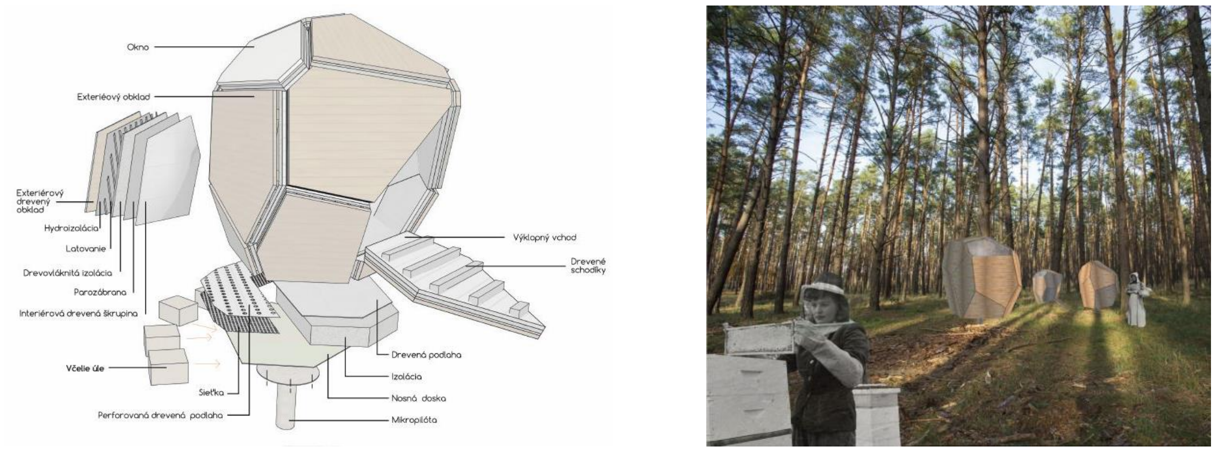


Fig. 4: Sivakova, K. et al., Environment based ApiHouse structure, contextual design approach.

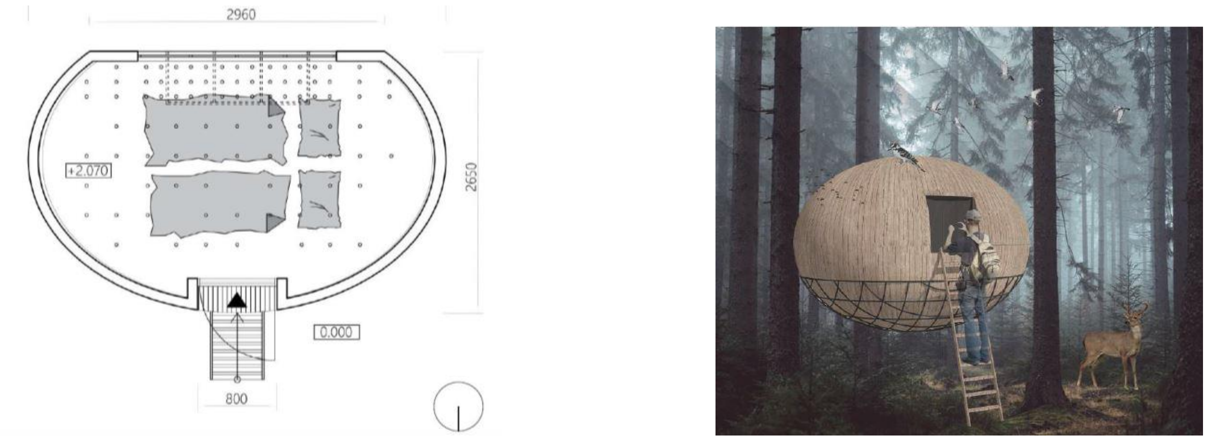


Fig. 5 Jozefík,T. et al., Environment based ApiHouse structure, contextual design approach.

The classification is not trying to determine a more or less successful concept of the ApiHouse in terms of therapeutic results. It states and categorises the workshop results. It is aimed at creating the concept of the research api chamber where the individual hypothetical design possibilities of the treatment space could be tested. (Table 1)

There are several significant indicators for designing the space for examining the apirespiration therapy. With respect to the objective research, the concept of capturing the chemical qualities of the indoor air is concerned. If we look at the issue in terms of architecture, the size of the chamber is the decisive parameter, apart from the air quality also influencing the personal experience. The light and sound comfort comprises additional architectural variables. The question is how we can support the therapeutic experience by using light. Its colour and intensity are decisive. An important phenomenon in the ApiHouse is the sound. One of the assumed curative effects is the perception of vibrations and bee sounds. The question is whether this sound should be subdued or on the contrary, intensified, and what is the relation to the sounds of the surrounding. The structure should provide modularity of space, enabling to simulate different conditions of the environment.

Table 1. Architectural design outcomes.

					
Relation with environment	Monumentality, Creation of the landmark	Monumentality, Creation of the landmark	Blend with surroundings	Ambivalent	Blend with surroundings
Design approach	Interior design as a priority – from inside to outside.	Interior design as a priority – from inside to outside.	Interior design as a priority – from inside to outside.	Utilitarian design approach	Exterior design as a priority – from outside to inside.
Context vs Versatility	Contextual with natural surroundings.	Contextual with natural surroundings.	Contextual with natural surroundings.	Versatility and variability of placement.	Contextual with natural surroundings.
Openness of structure	Extrovert character- connected to environment.	Extrovert character- connected to environment.	Introvert character.	Variability	Introvert character.
Social interaction	Group of visitors	Group of visitors	One structure, one visitor.	One structure, one visitor. .	Group of structures, group of visitor.

The research results should unify the objective health benefits for the people suffering from respiratory issues. This part, along with the chemical parameters of the space, will be solved with accurate medical measurements in cooperation with the external experts. Another part of the research is the evaluation of the subjective feeling of relax base on the architectural parameters of the space. The last expected result is the summary of the social aspect. The question is, what is relaxing for an urban person and if such a passive approach is meaningful. Data in the social topics will be collected through a questionnaire.

CONCLUSION

The article outlines the bases of the ApiHouse research in terms of architecture and examining the relation between the human psyche and space. At the same time, it aims at exploring a new type of relaxation activities possibly functioning both in the city and in a natural and rural regions. The basic goal is to define the research topic of the ApiHouse.

The workshop and student participation proved to be key to the clearer definition of the assignment and also to the outline of possible research based on ApiHouse topics. All participants were forced to shift thinking about given problems into new areas. And the student's unbiased view of the subject has been able to redefine the theme and bring a new perspective on the problem of the ApiHouse experimental chamber.

In table 1 are summarized pre-requirements that should be considered in preparation of the project. Relation with environment, design approach, context vs versatility, openness of structure and social interaction with visitor as well as local residents are vital factors that will shape not only business feasibility of Apihouse, but enrich local micro region, and enhance living in rural regions.

REFERENCES

Bengsch, E. Apiterapia včelím vzduchom. [online]. In *Apires.sk*. [cit. 2018-01-15]. Dostupné z www: <https://www.apires.sk/studia-apiterapie-vcelim-vzduchom>

Chybík, J. (2009). *Přírodní stavební materiály.* Prague: Grada Publishing. 21-22.

Katuščák, S. (2006). *Environmentálna kvalita materiálov a výrobkov.* Bratislava: Slovak University of Technology. 33.

Kotradyová, V., Uhrík, M., Varga, T., & Anderson, C. (2016). Duna - pozorovateľňa vtáctva na Dunaji, prípadová štúdia slovensko-nórskej spolupráce od návrhu k výsledku. *Alfa*, 21(3**)**. 42-49.

Krell, R. (1996). Value-added product from bee-keeping. *FAO Agricultural services bulletin No 124*, Rome: Food and Agriculture Organization of the United Nations.

Solomki, V.A. (2016). *Spánok na úľoch.* Slovenská včela Association.

What is apitherapy. [online]. In *Apitherapy.org* [cit. 2017-12-10]. Dostupné z www: <http://www.apitherapy.org/about-apitherapy/what-is-apitherapy>

Terapia včelím vzduchom. [online]. In *Apires.sk*. [cit. 2018-01-15]. Dostupné z www: <https://www.apires.sk/apiterapia/terapia/vcelim/vzduchom>

Address:

Ing. arch. Tibor Varga, PhD., Ústav ekologickej a experimentálnej architektúry, FA STU, Námestie Slobody 19, 812 45 Bratislava 1, varga@fa.stuba.sk

STATISTICAL COMPARISON OF DAYLIGHT FACTOR IN THE FEEDING PASSAGE AND MANURE CORRIDORS

ŠTATISTICKÉ POROVNANIE ČINITEĽA DENNEJ OSVETLENOSTI V KŔMNEJ CHODBE A V HNOJNÝCH CHODBÁCH

Milada BALKOVÁ[1], Dušan PÁLEŠ[2]

[1]*Katedra zariadení stavieb a bezpečnosti techniky, Technická fakulta, Slovenská poľnohospodárska univerzita v Nitre*
[2]*Katedra konštruovania strojov, Technická fakulta, Slovenská poľnohospodárska univerzita v Nitre*

Abstract
In the reconstructed building of the stable in Oponice (Slovakia) we measured the values of daylight factor. We tried to apply normal and Kernel probability distributions to them by the Pearson´s, Kolmogorov-Smirnov and Lilliefors goodness of fit tests. Parametric normal distribution has been shown to be unsuitable for measured daylight factor values, not only by the Pearson, but also by the Lilliefors test. On the contrary, the nonparametric Kernel distribution complied with the Kolmogorov-Smirnov test for manure corridors and did not fit very well for the feeding passage. We further tested the sign test and verified the hypothesis that both data sets (feeding passage and manure corridors) originated from the same probability distribution by Wilcoxon two-sample test. This hypothesis has been confirmed by both tests and all data can be considered as coming from the same population.

Key words: Kernel density estimation, goodness of fit tests, normal distribution, probability density function, cumulative distribution function

ÚVOD

Svetlo má veľký význam pri zabezpečení hygieny, čistoty a pri celkovom formovaní pracovného prostredia v hospodárskych objektoch (Sýkora, 2014). Súčasne so svetlom súvisia fyzikálne a chemické procesy v živých organizmoch (Dahl et al. 1997, 2002). Má pozitívny vplyv na zdravie, pohodu a výkonnosť hospodárskych zvierat a na bezpečnosť práce v maštali (Ofner, 2006). Pri hodnotení vplyvu svetla na zvieratá, ale aj na zamestnancov je výhodné jeho vplyvy štatisticky kvantifikovať a vyjadriť ich exaktne pomocou čísiel, aby sme sa vyhli príliš subjektívnemu hodnoteniu. Okrem jednoduchej popisnej štatistiky existuje množstvo vhodných štatistických metód, ktoré nie sú až tak často využívané. Patria k nim predovšetkým testy dobrej zhody, ktoré postavia nejakú východziu, nulovú hypotézu a presným štatistickým postupom sa overuje, či hypotézu možno prijať, alebo ju možno zamietnuť v prospech alternatívnej hypotézy. K takýmto testom patrí Pearsonov test, Kolmogorov-Smirnovov test, Lillieforsov test, znamienkový test a Wilcoxonov test (Markechová et al., 2011), použité v tejto práci. S náhodnými premennými, ktoré vznikajú pri meraní údajov, sa jednoduchšie pracuje, pokiaľ sa pre ne podarí nájsť nejaký vhodný matematický model rozdelenia pravdepodobnosti. Okrem klasických rozdelení používajúcich parametre pre presnú definíciu, z ktorých najčastejšie je používané normálne rozdelenie, je možné použiť aj neparametrické rozdelenia, ktoré sú presne definované priamo z nameraných dát. Najčastejšie používaným neparametrickým rozdelením je Kernelovo rozdelenie pravdepodobnosti (Botev et al., 2010).

MATERIÁL A METÓDY

Realizácia experimentu

Denné osvetlenie sme merali v ustajňovacom objekte pre hovädzí dobytok v Oponiciach. Maštaľ prešla rozsiahlou rekonštrukciou kvôli zlepšeniu podmienok pre zvieratá. Vyhovujúce osvetlenie je súčasťou úspešného chovu. Podrobný popis objektu možno nájsť v (Karandušovská et al., 2012,

Balková & Páleš, 2015). Na obrázku 1 uvádzame pôdorys a rez meraného objektu spolu s miestami meracích bodov.
Ako vidno z obr. 1 body merania 1-12 a 34-43 sa nachádzajú v kŕmnej chodbe a body 13-33 sú umiestnené v hnojných chodbách. V znázornených bodoch sme merali vnútornú osvetlenosť E a súčasne s ňou vonkajšiu porovnávaciu osvetlenosť E_h. Základnou podmienkou pre realizáciu merania je rovnomerne zatiahnutá obloha s rovnomerným rozložením jasu pre tmavý terén (Rybár, 1997). Merali sme dvomi rovnakými luxmetrami Testo 545.
Činiteľ dennej osvetlenosti sme vypočítali podľa vzťahu

$$D = \frac{E}{E_h}.100 \tag{1}$$

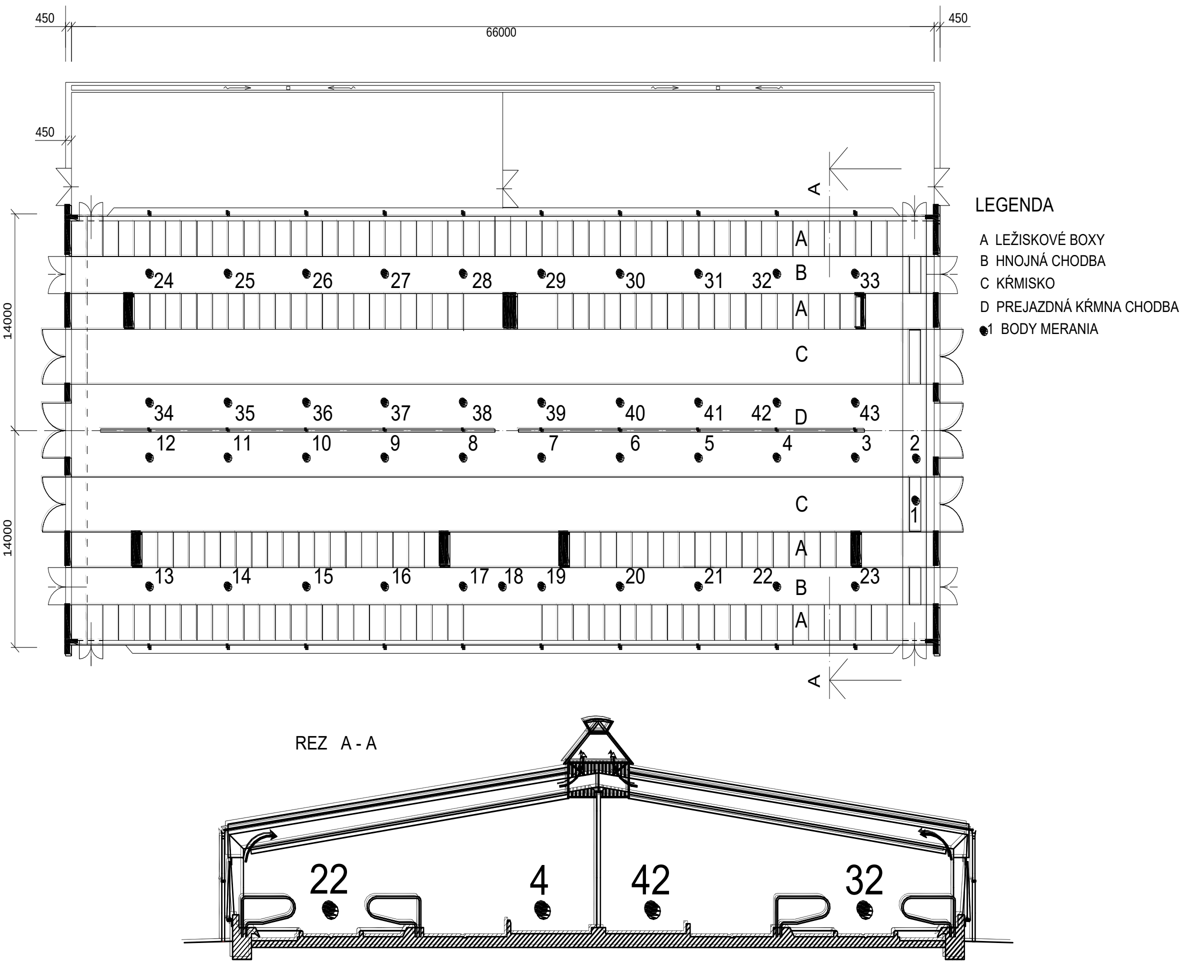
kde D – činiteľ dennej osvetlenosti [%], E – vnútorná osvetlenosť [lx], E_h – vonkajšia porovnávacia osvetlenosť [lx].
V každom meracom bode sme uskutočnili 5 meraní, z čoho vyplynulo 215 hodnôt. Z toho pre kŕmnu chodbu sme získali 110 meraní a pre hnojné chodby 105 meraní. Získané činitele dennej osvetlenosti sme spracovali pokročilými štatistickými metódami, pričom sme dbali najmä na porovnanie svetelných podmienok v kŕmnej chodbe, nad ktorou je umiestnený svetlík a v hnojných chodbách, ktorých bočné steny boli otvorené. V ďalších častiach uvádzame stručnú charakteristiku použitých štatistických metód.

Pearsonov test dobrej zhody

Pearsonov χ^2-test dobrej zhody patrí k najstarším neparametrickým testom. Je univerzálny a je ho možné použiť aj na diskrétne aj na spojité rozdelenia pravdepodobnosti. Porovnávajú sa v ňom empirické (pozorované) početnosti oproti teoretickým (očakávaným) početnostiam (Hendl, 2004, Ostertágová, 2005, Markechová et al., 2011). Daný náhodný výber x_1, x_2, ..., x_n, má rozdelenie pravdepodobnosti s neznámou kumulatívnou distribučnou funkciou F(x). Zvolíme známe rozdelenie pravdepodobnosti, so známou kumulatívnou distribučnou funkciou $F_0(x)$. Vytvoríme histogram náhodného výberu, od najmenšej hodnoty po najväčšiu, s určitým počtom neprekrývajúcich sa tried (intervalov) I_1, I_2, ..., I_k. Na vopred zvolenej hladine významnosti α testujeme nulovú hypotézu H_0: $F(x) = F_0(x)$, oproti alternatívnej hypotéze H_1: $F(x) \neq F_0(x)$. Rozdiel medzi pozorovanými a očakávanými početnosťami zachytáva testovacia štatistika (charakteristika) v tvare

$$\chi^2 = \sum_{i=1}^{k} \frac{\left(n_i - n.p_i\right)^2}{n\,p_i} \tag{2}$$

kde k je počet intervalov, n_i je pozorovaná početnosť v i-tom intervale, n . p_i je očakávaná početnosť v intervale i za predpokladu platnosti hypotézy H_0, n je rozsah výberu a p_i je teoretická pravdepodobnosť intervalu i. Táto charakteristika má pre $n \geq 50$, pri platnosti hypotézy H_0 približne chí-kvadrát rozdelenie s k – r – 1 stupňami voľnosti, kde r je počet odhadovaných parametrov. Pozorované a očakávané početnosti by sa nemali príliš líšiť, z čoho vyplýva malá hodnota charakteristiky (2) za predpokladu platnosti H_0. Kritická hodnota, pre ktorú hypotézu H_0 zamietame v prospech hypotézy H_1 je väčšia ako $\chi^2 > \chi^2_{1-\alpha,\ k-r-1}$, kde $\chi^2_{1-\alpha,\ k-r-1}$ chí-kvadrát rozdelenie, na hladine významnosti α, s k – r – 1 stupňami voľnosti, býva často uvádzané v štatistických tabuľkách, resp., ľahko sa nájde pomocou nejakého štatistického softwaru.



Obrázok 1 Pôdorys a rez meraného objektu

Kolmogorov-Smirnovov a Lillieforsov test zhody rozdelenia

Kolmogorov-Smirnovov test zhody rozdelenia umožňuje testovať zhodu empirického a teoretického rozdelenia distribučnej funkcie pre spojité rozdelenie so známymi parametrami (Hendl, 2004, Markechová et al., 2011, Ostertágová, 2012). Tento test je silnejší ako je Pearsonov test dobrej zhody a funguje aj pre výbery malého rozsahu. Teoretická distribučná funkcia musí byť definovaná nielen typom rozdelenia, ale aj všetkými jeho parametrami. Lillieforsov test naproti tomu nevyžaduje poznať všetky parametre rozdelenia a je ich možné nahradiť bodovými odhadmi zo skúmaných dát. Pri oboch testoch na určitej hladine významnosti testujeme hypotézu H_0, že teoretické a empirické rozdelenie sa štatisticky nelíšia oproti alternatívnej hypotéze H_1, že sú rozdielne. Testovacia charakteristika je daná ako najväčší rozdiel medzi známou distribučnou funkciou $F_0(x)$ teoretického rozdelenia a hľadanou distribučnou funkciou $F(x)$ empirického rozdelenia

$$d = \sup_{x \in R} \left| F_0(x) - F(x) \right| \tag{3}$$

Hypotéza H_0 sa zamieta, ak vypočítaná hodnota (3) prekročí kritickú hodnotu $d > d_\alpha(n)$, kde n predstavuje rozsah výberu, α je hladina významnosti a hodnota $d_\alpha(n)$ býva buď tabuľkovaná, alebo ľahko vypočítateľná vhodným štatistickým programom. Pri Lillieforsovom teste je postup rovnaký, len nahradenie parametrov rozdelenia ich výpočtom z nameraných dát zmení rozdelenie charakteristiky $d_\alpha(n)$, s ktorou sa porovnáva hodnota d.

Znamienkový test
Neparametrické testy, ku ktorým patrí znamienkový test a aj nasledujúci Wilcoxonov test nepožadujú žiadne podmienky na typ rozdelenia skúmaných meraní, ani na hodnoty parametrov rozdelení. (Markechová et al., 2011, Ostertágová, 2012). Samotný znamienkový test je hádam najjednoduchším neparametrickým testom. Keďže nemá veľkú silu, pre jeho použitie je potrebný veľky počet dát. Ak máme náhodný výber $x_1, x_2, ..., x_n$ pochádzajúci zo spojitého rozdelenia s neznámym mediánom x_{med}, zvolíme konštantu x_{med0} a testujeme nulovú hypotézu H_0: $x_{med} = x_{med0}$ oproti alternatívnej hypotéze H_1: $x_{med} \neq x_{med0}$. Najprv vytvoríme rozdiely x_1-x_{med0}, x_2-x_{med0}, ..., x_n-x_{med0}. Počet takýchto kladných rozdielov označíme y_+ a počet záporných rozdielov označíme y_-. Ak platí hypotéza H_0 náhodné premenné Y_+ a Y_- majú binomické rozdelenie s parametrami n a 0,5. Pre dostatočne veľké n, n > 20, vypočítame hodnotu $Y = \min(Y_+, Y_-)$ a použijeme testovaciu chrakteristiku

$$y = \frac{2Y - n}{\sqrt{n}} \quad (4)$$

ktorá má asymptoticky normované normálne rozdelenie. Hypotézu H_0 zamietame na hladine významnosti α v prípade ak $|y| > n_\alpha$, kde n_α je α-fraktil normovaného normálneho rozdelenia.

Wilcoxonov test
Použili sme Wilcoxonov dvojvýberový test, ktorý sa aplikuje pre výbery, ktoré nemajú normálne rozdelenie (Hendl, 2004, Markechová et al., 2011, Ostertágová, 2012). Niekedy tento test môžeme nájsť aj pod názvom Mannov-Whitneyov test. Majme dva nezávislé výbery z dvoch spojitých rozdelení $x_1, x_2, ..., x_m$ a $y_1, y_2, ..., y_k$. Overujeme hypotézu H_0: F = G, že oba výbery pochádzajú z rovnakého základného súboru, resp., že ich kumulatívne distribučné funkcie F a G sú zhodné, oproti alternatívnej hypotéza H_1: F ≠ G. Združíme oba výbery a usporiadame ich do neklesajúcej postupnosti. Jednotlivým prvkom takejto postupnosti priradíme poradia od najmenšieho po najväčšie 1, 2, ..., n = m + k. Označíme r^x_i poradie každého x-tého prvku v združenom rade, r^y_i poradie každého y-tého prvku a zistíme súčty takýchto poradí $s_x = \Sigma r^x_i$, $s_y = \Sigma r^y_i$. Pri veľkých rozsahoch m a k sa používa testovacia charakteristika

$$u = \frac{u_x - \frac{m.k}{2}}{\sqrt{\frac{m.k.(m+k+1)}{12}}} \quad \text{kde} \quad u_x = m.k + \frac{m.(m+1)}{2} - s_x \quad (5)$$

ktorá má za predpokladu platnosti hypotézy H_0 asymptoticky normované normálne rozdelenie. Na hladine významnosti α hypotézu H_0 zamietame ak $|u| > n_\alpha$, kde podobne ako vyššie, n_α je α-fraktil normovaného normálneho rozdelenia.

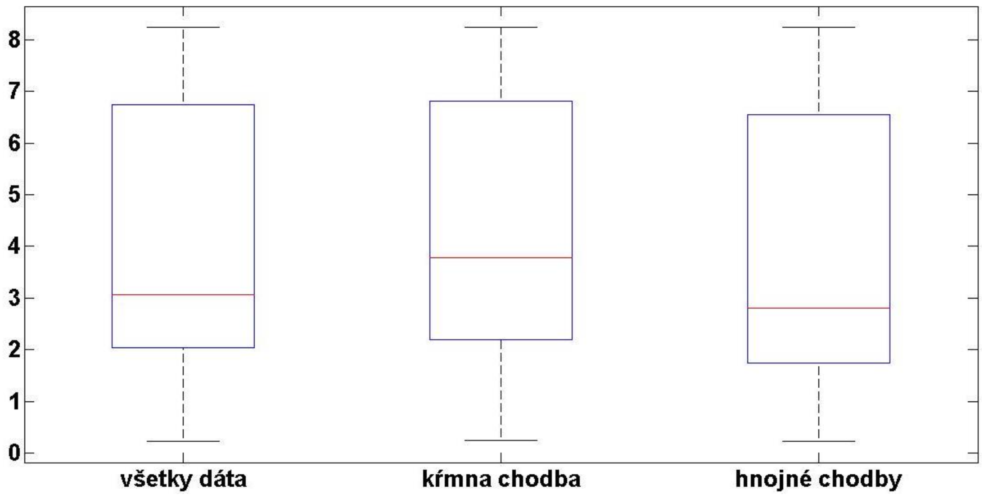
VÝSLEDKY A DISKUSIA
V Tab. 1 uvádzame namerané hodnoty v kŕmnej chodbe v meracích miestach 1-12 a 33-43, podľa usporiadania na obr. 1. Podobne nasledujúca Tab. 2 prezentuje získané dáta v hnojných chodbách, meracie body 13-32. Hodnoty z Tab. 1 a z Tab. 2 sú vynesené do krabicových diagramov na obr. 2. Každý takýto diagram uvádza maximálnu a minimálnu hodnotu získaných dát, ich 25%-ný a 75%-ný fraktil a medián, teda 50%-ný fraktil. Prvý krabicový diagram charakterizuje všetky údaje z celej maštale, druhý je pre kŕmnu chodbu a tretí pre hnojné chodby.
Cez namerané dáta sme preložili normálne rozdelenie a Kernelovo rozdelenie (Páleš & Balková, 2019). Histogram všetkých meraní a meraní rozdelených na kŕmnu a hnojné chodby uvádzame na obr. 3-5. Na týchto istých obrázkoch sú vykreslené aj spomínané normálne a Kernelovo rozdelenie nasadené na namerané údaje. Možno tak vizuálne porovnať zhodu histogramu so známymi funkciami hustoty pravdepodobnosti. Dôležitú informáciu o zhode rozdelení poskytuje aj kumulatívna početnosť údajov z histogramov a kumulatívne distribučné funkcie oboch rozdelení opäť najprv združené do spoločného obr. 6 a potom rozdelené na kŕmnu chodbu, obr. 7, a na hnojné chodby, obr. 8.

Tabuľka 1 Hodnoty činiteľa dennej osvetlenosti namerané v kŕmnej chodbe, usporiadané vo vzostupnom poradí, 110 hodnôt

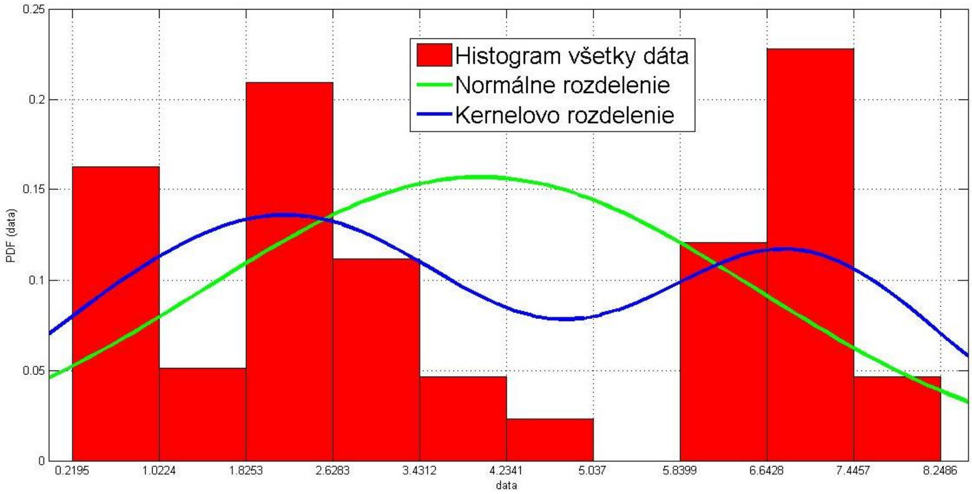
0,2493	0,8124	2,1766	2,5511	3,3827	6,2428	6,7146	7,0415	7,3755
0,2525	0,8368	2,2032	2,5770	3,6708	6,2605	6,7248	7,0531	7,3833
0,2535	1,3133	2,2453	2,6241	3,7685	6,2733	6,7524	7,0543	7,5119
0,2625	1,3658	2,2527	2,7462	3,8000	6,2940	6,7617	7,0566	7,6677
0,2667	1,6173	2,2689	2,8451	3,8212	6,2959	6,8053	7,0586	8,1128
0,4506	1,7847	2,2828	2,9220	3,8357	6,3426	6,8850	7,0586	8,2335
0,4679	1,8563	2,3118	2,9814	3,8411	6,3457	6,8902	7,0689	-
0,6006	2,0275	2,3423	3,0132	4,2794	6,4270	6,9871	7,0987	-
0,6313	2,0410	2,3853	3,0212	4,4338	6,4989	6,9947	7,1041	-
0,6324	2,0644	2,4553	3,0268	5,9975	6,4997	6,9978	7,1769	-
0,6718	2,1372	2,4814	3,2882	6,1256	6,5003	7,0059	7,2395	-
0,6792	2,1493	2,4862	3,3212	6,1597	6,5562	7,0177	7,2926	-
0,6808	2,1753	2,5279	3,3369	6,1877	6,6478	7,0192	7,3122	-

Tabuľka 2 Hodnoty činiteľa dennej osvetlenosti namerané v hnojných chodbách, usporiadané vo vzostupnom poradí, 105 hodnôt

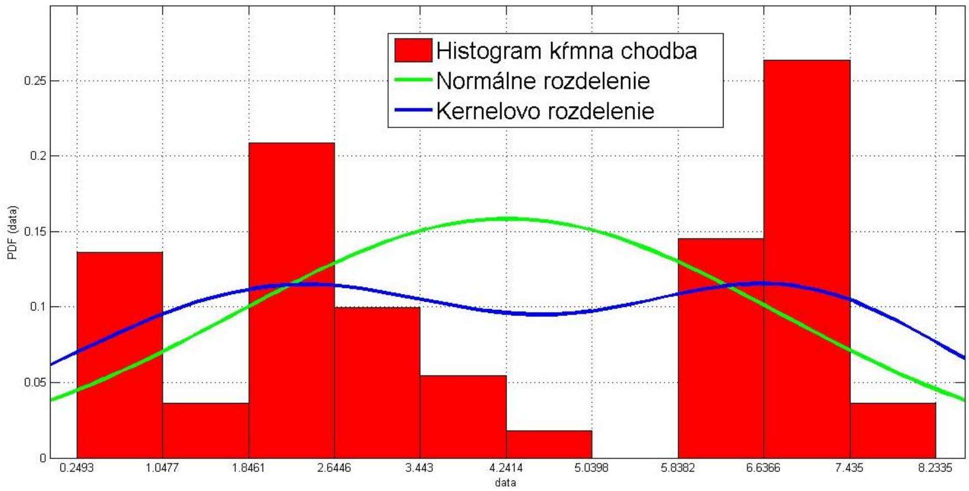
0,2195	0,6969	1,7481	2,4594	2,8032	3,8349	6,5095	7,0856	8,2486
0,2528	0,7005	1,8517	2,5052	2,8967	4,4199	6,7039	7,0864	-
0,2610	0,7036	1,9011	2,5095	2,9434	4,4202	6,7422	7,0873	-
0,2696	0,7167	1,9162	2,5223	2,9801	4,4873	6,7879	7,0992	-
0,2779	0,7767	1,9337	2,5435	2,9953	6,1828	6,8381	7,1443	-
0,4614	0,8051	1,9646	2,5503	3,0332	6,2071	6,8769	7,1685	-
0,4811	0,8266	2,2202	2,5778	3,0753	6,2113	6,8775	7,1811	-
0,4941	1,1023	2,2494	2,5878	3,1553	6,3017	6,8872	7,1886	-
0,6197	1,1199	2,2544	2,6134	3,3615	6,3371	6,9383	7,4780	-
0,6347	1,1487	2,2661	2,6247	3,3724	6,3442	6,9814	7,4851	-
0,6752	1,6055	2,3068	2,6415	3,7433	6,4252	7,0028	7,7039	-
0,6926	1,6989	2,3206	2,6582	3,7798	6,4671	7,0287	8,1081	-
0,6939	1,7200	2,4482	2,7065	3,7955	6,4890	7,0854	8,1121	-



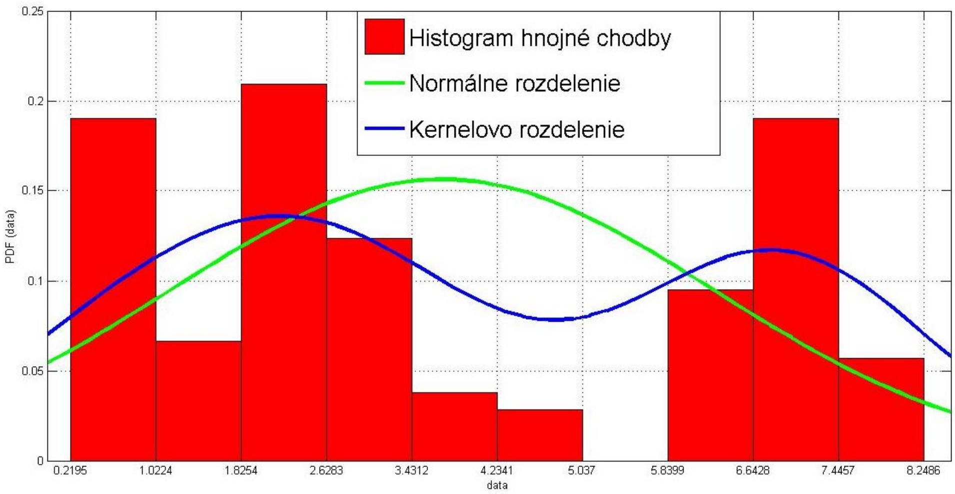
Obrázok 2 Krabicový diagram všetkých hodnôt a hodnôt rozdelených na kŕmnu a hnojné chodby



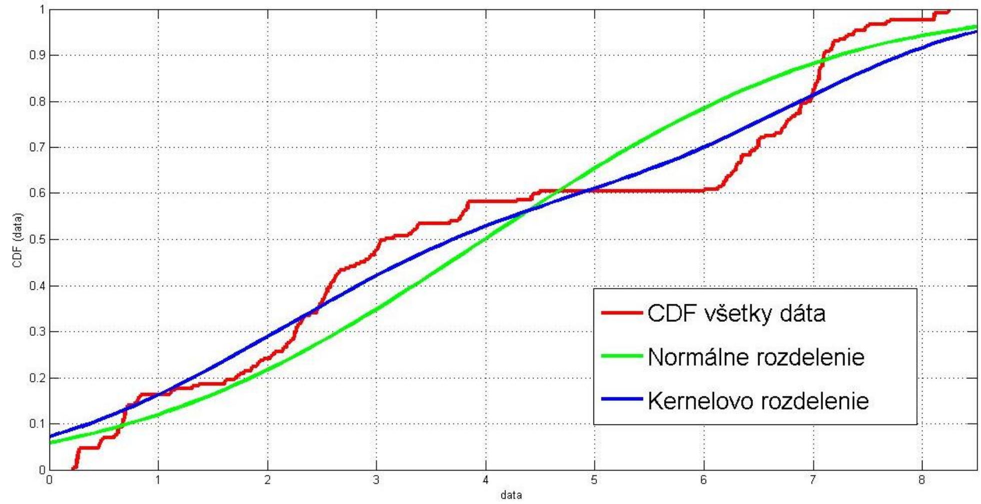
Obrázok 3 Histogram získaný zo všetkých nameraných hodnôt porovnaný s hustotami pravdepodobnosti normálneho a Kernelovho rozdelenia



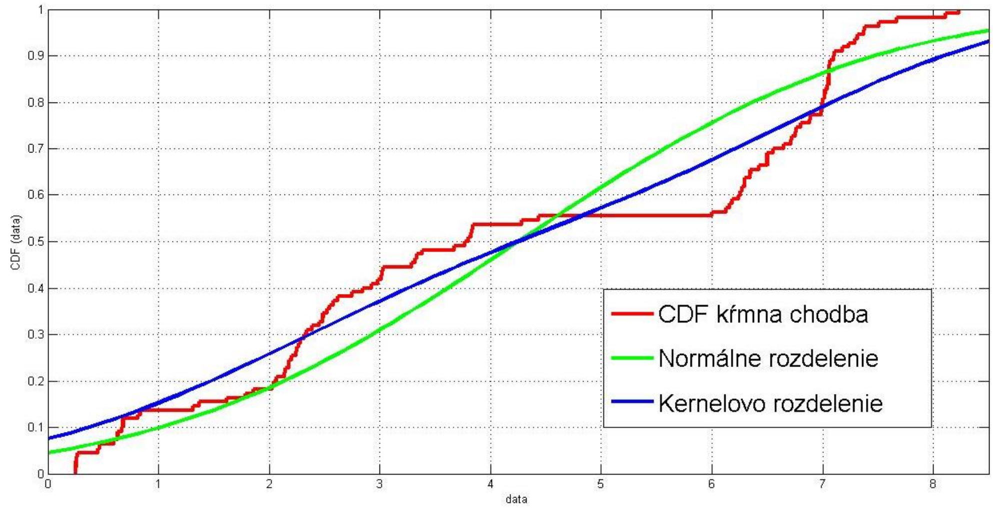
Obrázok 4 Histogram získaný z hodnôt nameraných v kŕmnej chodbe porovnaný s hustotami pravdepodobnosti normálneho a Kernelovho rozdelenia



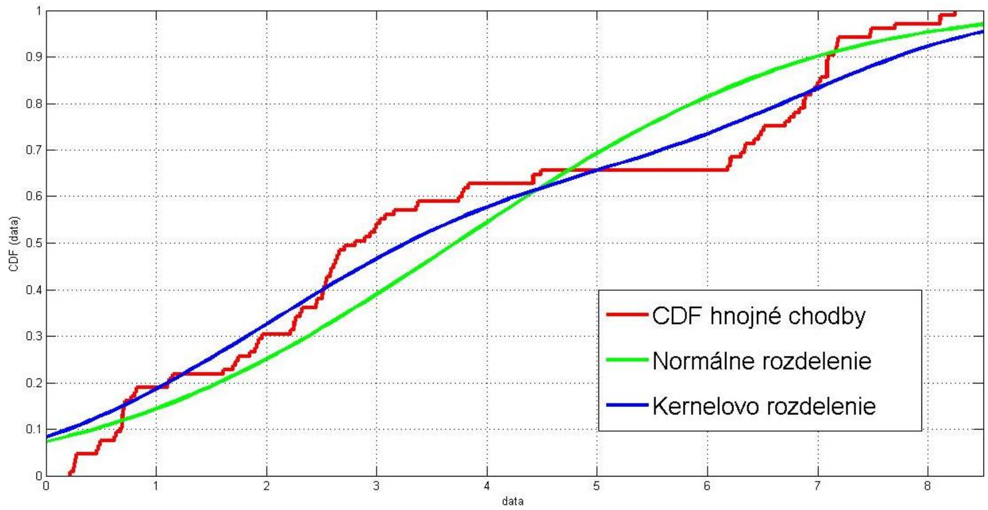
Obrázok 5 Histogram získaný z hodnôt nameraných v hnojných chodbách porovnaný s hustotami pravdepodobnosti normálneho a Kernelovho rozdelenia



Obrázok 6 Empirická kumulatívna distribučná funkcia získaná zo všetkých nameraných hodnôt porovnaná s distribučnými funkciami normálneho a Kernelovho rozdelenia



Obrázok 7 Empirická kumulatívna distribučná funkcia získaná z hodnôt v kŕmnej chodbe porovnaná s distribučnými funkciami normálneho a Kernelovho rozdelenia



Obrázok 8 Empirická kumulatívna distribučná funkcia získaná z hodnôt v hnojných chodbách porovnaná s distribučnými funkciami normálneho a Kernelovho rozdelenia

Na všetky tri súbory dát, združené dáta, kŕmnu chodbu a hnojné chodby sme aplikovali Pearsonov test dobrej zhody, Kolmogorov-Smirnovov test pre Kernelovo rozdelenie, pri ktorom sme nemuseli odhadovať žiadne parametre a Lillieforsov test pre normálne rozdelenie, pri ktorom sme z údajov zisťovali jeho strednú hodnotu a smerodajnú odchýlku. Testy hypotéz sú urobené na hladine významnosti $\alpha = 0{,}05$ a ich prehľad uvádza Tab.3.

Tabuľka 3 Vyhodnotenie testov dobrej zhody pre normálne a Kernelovo rozdelenie

Pearson	Všetky dáta		Kŕmna chodba		Hnojné chodby	
	Normal	Kernel	Normal	Kernel	Normal	Kernel
χ^2	186,5135	108,2853	115,0682	86,8091	73,7003	41,2721
$\chi^2_{1-\alpha,\ k-r-1}$	14,0671	16,9190	14,0671	16,9190	14,0671	16,9190
Kolm.-Sm.	Všetky dáta (Kernel)		Kŕmna chodba (Kernel)		Hnojné chodby (Kernel)	
d	0,1043		0,1313		0,1011	
d_α (n)	0,0918		0,1279		0,1308	
Lilliefors	Všetky dáta (Normal)		Kŕmna chodba (Normal)		Hnojné chodby (Normal)	
d	0,1901		0,2078		0,1761	
d_α (n)	0,0612		0,0850		0,0869	

Z Tab. 3 je zrejmé, že kritické hodnoty pre normálne rozdelenie boli prekročené aj pri Pearsonovom teste aj pri Lillieforsovom teste. Z toho vyplýva, že normálne parametrické rozdelenie nie je vhodné použiť na namerané údaje. Naopak Kernelovo neparametrické rozdelenie sa ukázalo ako pomerne vhodné, hoci Pearsonov test prekročil kritické hodnoty, čo mohlo byť ovplyvnené delením histogramu na intervaly. Ako ukázal Kolmogorov-Smirnovov test pre hnojnú chodbu, jeho hodnota je mimo kritickej oblasti a preto použitie Kernelovho rozdelenia nemožno zamietnuť. V kŕmnej chodbe sa testovacia charakteristika Kolmogorov-Smirnovovho testu dostala do kritickej oblasti, keď hypotézu zamietame, ale je to len veľmi tesné zamietnutie, až sa dá povedať, že Kernelovo rozdelenie je vhodnou aproximáciou pre všetky namerané dáta. Hoci výsledok pre všetky dáta v Tab. 3 je v kritickej oblasti zamietnutia hypotézy, no zase len veľmi tesne, čo mohol ovplyvniť aj väčší počet dát v kŕmnej chodbe (110), oproti hnojnej chodbe (105). Pri Pearsonovom teste sme pri počítaní kritickej hodnoty $\chi^2_{1-\alpha,\ k-r-1}$ uvažovali počet intervalov $k = 10$ a počet odhadovaných parametrov pre normálne rozdelenie $r = 2$ a pre Kernelovo rozdelenie $r = 0$.

Keďže nám ako vhodné vyšlo neparametrické Kernelovo rozdelenie, získané priamo z nameraných údajov, bez nutnosti použitia jeho parametrov, v ďalšej práci sme sa pokúsili porovnať dvomi neparametrickými testami, znamienkovým testom a Wilcoxonovým testom, rozdelenia pravdepodobnosti pre kŕmnu chodbu a pre hnojné chodby. Pri znamienkovom teste je potrebné podľa popisu vyššie zvoliť hodnotu mediánu x_{med0}, s ktorou sa porovnajú mediány oboch súborov aj pre kŕmnu chodbu aj pre hnojné chodby. Za x_{med0} sme zvolili hodnotu mediánu všetkých meraní $x_{med0} = 3{,}0753$. Pre oba súbory dát nám znamienkovým testom na hladine významnosti $\alpha = 0{,}05$ vyšlo, že hypotézu, že ich medián je práve táto hodnota, nemožno zamietnuť, čiže ich rozdelenia pravdepodobnosti sa v tomto parametri nelíšia. Silnejším testom pre porovnanie rozdelení pravdepodobnosti kŕmnej chodby a hnojných chodieb je Wilcoxonov dvojvýberový test. Opäť sme na rovnakej hladine významnosti $\alpha = 0{,}05$ zistili, že nemožno zamietnuť hypotézu, že obe množiny údajov, pochádzajú z rovnakého základného súboru a majú teda rovnaké kumulatívne distribučné funkcie.

ZÁVER

Aplikovali sme metódy pokročilej štatistiky na namerané údaje činiteľa dennej osvetlenosti. Už pri jednoduchej popisnej štatistike prezentovanej krabicovými grafmi na obr. 2 vidno, že osvetlenie kŕmnej chodby zhora svetlíkom je približne podobne rozdelené ako osvetlenie v hnojných chodbách, ktoré prichádza zboku z otvorených stien. Zobrazenia hustôt pravdepodobnosti histogramom a spojitými funkciami normálneho a Kernelovho rozdelenia, obr. 3-5, ukazujú, že normálne rozdelenie

nie je vhodnou aproximáciou, pretože má len jeden vrchol, kým histogram vykazuje skôr dvojvrcholové Kernelovo rozdelenie. Podobnú tendenciu lepšieho vystihnutia meraní Kernelovým rozdelením, možno pozorovať na kumulatívnych početnostiach dát a na kumulatívnych distribučných funkciach oboch rozdelení, obr. 6-8. Je to spôsobené práve neparametrickosťou Kernelovho rozdelenia, optimalizovaného na namerané údaje (Silverman, 1986). Hoci ako ukázali testy dobrej zhody, Pearsonov test nevyhovel ani pre Kernelovo rozdelenie. Tento test je však menej presvedčivý ako Kolmogorov-Smirnovov test, ktorý pre hnojné chodby potvrdil hypotézu Kernelovho rozdelenia a pre kŕmnu chodbu nevyhovel len veľmi tesne. Toto rozdelenie sme vzali ako relevantné pre namerané dáta (Vermeesch, 2012), lebo sa potvrdilo aj popisnou štatistikou, aj hustotami pravdepodobnosti, aj kumulatívnymi distribučnými funkciami a do značnej miery aj Kolmogorov-Smirnovovým testom. Pri porovnaní rozdelení nameraných hodnôt pre kŕmnu a hnojné chodby sa nám v zhode s prvotným náhľadom na krabicové grafy, obr. 2, potvrdilo znamienkovým a Wilcoxonovým dvojvýberovým testom, že obe rozdelenia majú na hladine významnosti $\alpha = 0{,}05$ rovnaké kumulatívne distribučné funkcie a možno ich teda pokladať za pochádzajúce z rovnakého základného súboru.

Abstrakt
V zrekonštruovanom objekte maštale v Oponiciach sme merali hodnoty činiteľa dennej osvetlenosti. Pearsonovým, Kolmogorov-Smirnovovým a Lillieforsovým testom zhody rozdelenia sme sa na ne pokúsili aplikovať normálne a Kernelovo rozdelenie pravdepodobnosti. Parametrické normálne rozdelenie sa ukázalo ako nevhodné pre namerané hodnoty činiteľa dennej osvetlenosti a to nielen Pearsonovým, ale aj Lillieforsovým testom. Naopak, neparametrické Kernelovo rozdelenie vyhovelo pre hnojné chodby Kolmogorov-Smirnovovmu testu a pre kŕmnu chodbu len veľmi tesne nevyhovelo. Údaje sme ďalej testovali znamienkovým testom a overovali sme hypotézu, že oba súbory dát (kŕmna chodba a hnojné chodby) pochádzajú z rovnakého rozdelenia pravdepodobnosti Wilcoxonovým dvojvýberovým testom. Táto hypotéza sa potvrdila oboma testami a všetky dáta možno pokladať za pochádzajúce z rovnakého základného súboru.

Kľúčové slová: Kernelovo rozdelenie, normálne rozdelenie, testy dobrej zhody, funkcia hustoty pravdepodobnosti, kumulatívna distribučná funkcia

LITERATÚRA

Balková, M., Páleš, D. (2015). *Influence of material solution of cover shells on stable daylight,* Research Agricultural Engineering, Vol. 61, Special Issue, s. S67-S73. Dostupné na internete: <http://dx.doi.org/10.17221/47/2015-RAE>

Botev, Z., Grotowski, J. F., Kroese, D. P. (2010). *Kernel density estimation via diffusion,* Annals of Statistics, 38, s. 2916-2957, [cit. 2019-08-10], URL: <https://projecteuclid.org/download/pdfview_1/euclid.aos/1281964340>

Dahl, G.E., Auchtung, T.L., Kendall, P.E. (2002). *Photoperiodic effect on endocrine and immune function in cattle.* In: Reproduction (Cambridge, England) Supplement, 2002, Vol. 56, s. 191-201, ISSN 1477-0415.

Dahl, G.E., Elsässer, T.H., Capuco, A.V., Erdman, R.A., Peters, R.R. (1997). *Effects a long daily photoperiod on milk yield and circulating concentrations of insulin-like growth factor-I.* In : Journal of dairy science. 1997, Vol. 80, No. 11, s. 2784-2789. ISSN 0022-0302.

Hendl, J. (2004). *Přehled statistických metod spracování dat.* Praha: Portál, 584 s., ISBN 80-7178-820-1.

Karandušovská, I., Mihina, Š., Boďo, Š. (2012). *Effect of differently designed systems of housing for dairy cows on ammonia and carbon dioxide concentration*, Acta Technologica Agriculturae, Vol. 15, No. 4, s. 106 – 109, ISSN 1335-2555.

Markechová, D., Tirpáková, A., Stehlíková, B. (2011). *Základy štatistiky pre pedagógov,* Nitra: UKF, 405 s., ISBN 978-80-8094-899-3.

Ofner, E. (2006). *Ziel ist ein heller Stall!*, Landwirt. Die Fachzeitschrift für die bäuerliche Familie, [cit. 2019-08-10], URL: <http://www.landwirt.com/Ziel-ist-ein-heller-Stall,,3021,,Bericht.html>

Ostertágová, E. (2005). *Pravdepodobnosť a matematická štatistika v príkladoch*. Košice: Elfa, 123 s., ISBN 80-8086-005-X.

Ostertágová, E. (2012). *Aplikácia štatistických testov dobrej zhody.* Transfer inovácii, internetový časopis o inováciach v priemysle, No. 23, s. 72-74, ISSN 1337-7094, [cit. 2019-08-07] URL: <https://www.sjf.tuke.sk/transferinovacii/pages/archiv/transfer/23-2012/pdf/072-074.pdf>

Ostertágová, E. (2012). *Aplikovaná štatistika v počítačovom prostredí MATLABu*. Košice: Equilibria, 193 s., ISBN 978-80-8143-006-0.

Páleš, D., Balková, M. (2019). *Nonparametric distribution of the daylight factor.* Mathematics in Education, Research and Application, ISSN 2453-6881, in print.

Rybár, P. (1997). *Štandartná metodika. Meranie a hodnotenie osvetlenia,* Ministerstvo zdravotníctva SR, s. 35.

Silverman, B. (1986). *Density Estimation for Statistics and Data Analysis*, Chapman and Hall, London, [cit.2019-08-10], <URL: https://ned.ipac.caltech.edu/level5/March02/Silverman/paper.pdf>

Sýkora, J. (2014). *Zemědělské stavby. Základy navrhování.* Praha : Grada Publishing, a. s., 2014, 128 s., ISBN 978-80-247–5273-0.

Vermeesch, P. (2012). *On the visualisation of detrital age distributions*, Chemical Geology, Vol. 312-313, s. 190-194, doi: 10.1016/j.chemgeo.2012.04.021.

Korešpondujúci autor:
Ing. Dušan Páleš, CSc., Katedra konštruovania strojov, Technická fakulta,
Slovenská poľnohospodárska univerzita v Nitre, Tr. A. Hlinku 2, 949 76 Nitra, Slovensko,
e-mail: dusan.pales@uniag.sk

THE INFLUENCE OF PHOTOVOLTAIC MODULE TILT ANGLE ON THE SOLAR SYSTEM ENERGY PRODUCTION
VPLYV UHLA SKLONU FOTOVOLTAICKÉHO PANELU NA ENERGETICKÚ PRODUKCIU SOLÁRNEHO SYSTÉMU

Matúš BILČÍK[1], Monika BOŽIKOVÁ[1], Patrik KÓSA[2], Marián KIŠEV[2]

[1]*Katedra fyziky, Technická fakulta, Slovenská poľnohospodárska univerzita v Nitre, Tr. A. Hlinku 2, 949 76 Nitra, Slovensko*
[2]*Katedra elektrotechniky, automatizácie a informatiky, Technická fakulta, Slovenská poľnohospodárska univerzita v Nitre, Tr. A. Hlinku 2, 949 76 Nitra, Slovensko*

Abstract
The article deals with the influence of photovoltaic module tilt angle on the photovoltaic system energy production. In central European region the optimal tilt angle of photovoltaic module is 35 °, but it depends on the photovoltaic system location and on the azimuth angle orientation of photovoltaic module. In the text are presented dependencies which characterize relation between the tilt angle of photovoltaic module and electricity energy production for different month. Data from photovoltaic system were processed by editor Microsoft Excel and software Matlab version R2015b. The basic statistical characteristics were calculated. The results of research are presented as 2 dimensional and 3 dimensional graphical relations. For all dependencies were obtained regression equations with relatively high coefficients of determinations. On the 3 dimensional relation was applied polynomial approximation of the 2nd degree. Model mathematical dependencies allow simple prediction of the photovoltaic system energy production in the real operating conditions. It can be used for the design, dimensioning and the optimization of photovoltaic power plant operating conditions.

Key words month, external factor, relation, modelling, energy, mathematic description

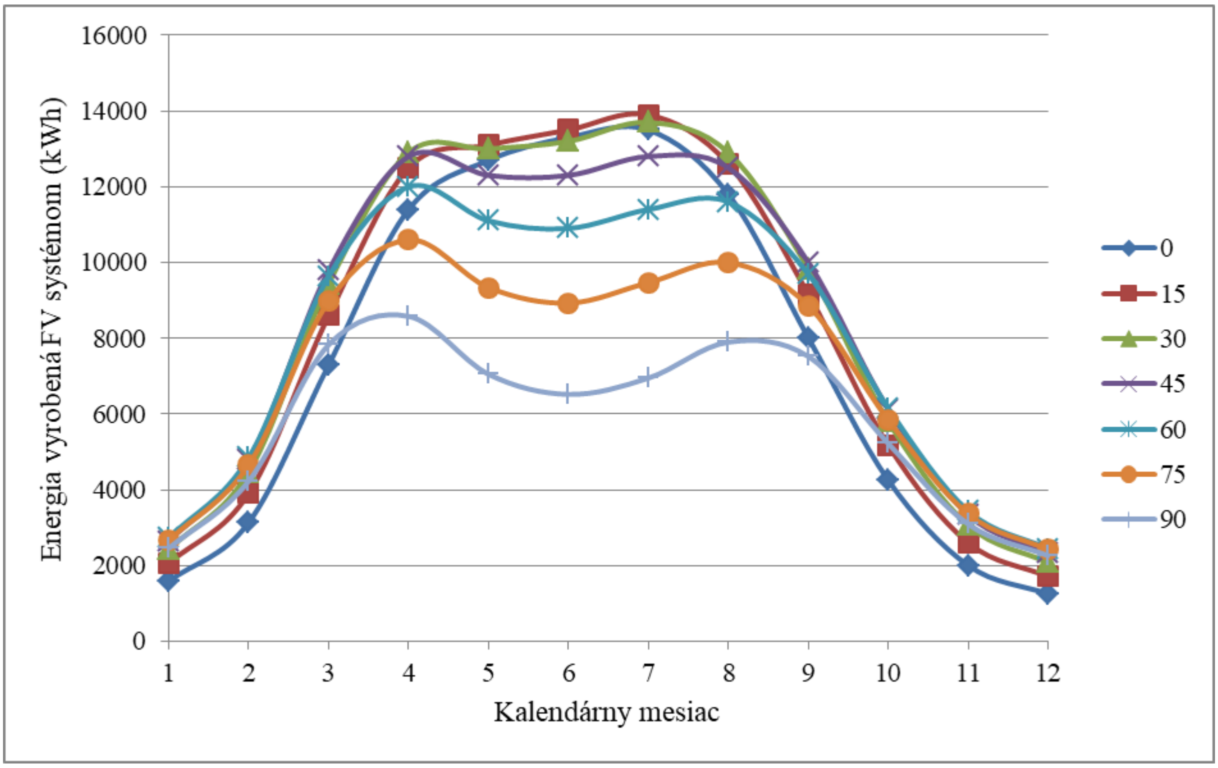
ÚVOD
V našej a zahraničnej literatúre sú prezentované možnosti využitia FV na výrobu elektrickej energie, ale vo väčšine prípadov sa jedná o informácie všeobecného charakteru, ktoré je nevyhnutné prispôsobiť na miestne špecifické podmienky využívania slnečnej energie a vhodne aktualizovať pre konkrétnu lokalitu. Z literatúry je známe, že výkon, účinnosť a tiež množstvo vyrobenej elektrickej energie FV zariadeniami sa mení v závislosti na mnohých externých aj interných faktoroch. Jedným z veľmi dôležitých faktorov je uhol sklonu FV panela. Vplyvom tohto faktora sa zaoberali mnohí zahraniční autori ako napríklad Shareef (2017), Mahdi (2010), Suman (2015), King et al. (2002), Osamede et al. (2012), Mehleri et al. (2010). Uhol sklonu FV panela sa meria vzhľadom k vodorovnej rovine a vo všeobecnosti je v rámci strednej Európy za optimálny považovaný uhol sklonu 35 °. Keďže prevádzkové podmienky sú miestne špecifické, tak optimálny uhol sklonu sa môže líšiť v závislosti od lokality a tiež azimutovej orientácie FV panelov. Ak uvažujeme o ideálnej azimutovej orientácii FV panelov na juh, tak má z pohľadu umiestnenia FV poľa význam sledovať uhol sklonu FV panela. Z uvedených dôvodov bolo cieľom prezentovaného výskumu poukázať na vplyv zmeny uhla sklonu na množstvo elektrickej energie vyrobenej fotovolitaickým systémom v reálnych prevádzkových podmienkach a kvantifikovať mieru vplyvu uhla sklonu FV panelov na energetickú produkciu FV systému v priebehu kalendárneho roka.

MATERIÁL A METÓDY
Pomocou modelového FV system bola simulovaná prevádzka FV systému počas celého roka. V priebehu simulácie bol menený uhol sklonu FV panelov v rozsahu od 0 ° do 90 °. Dáta pre funkciu modelového systemu boli zbierané v priebehu rokov 2014 – 2018. Rozsiahle dátové súbory boli

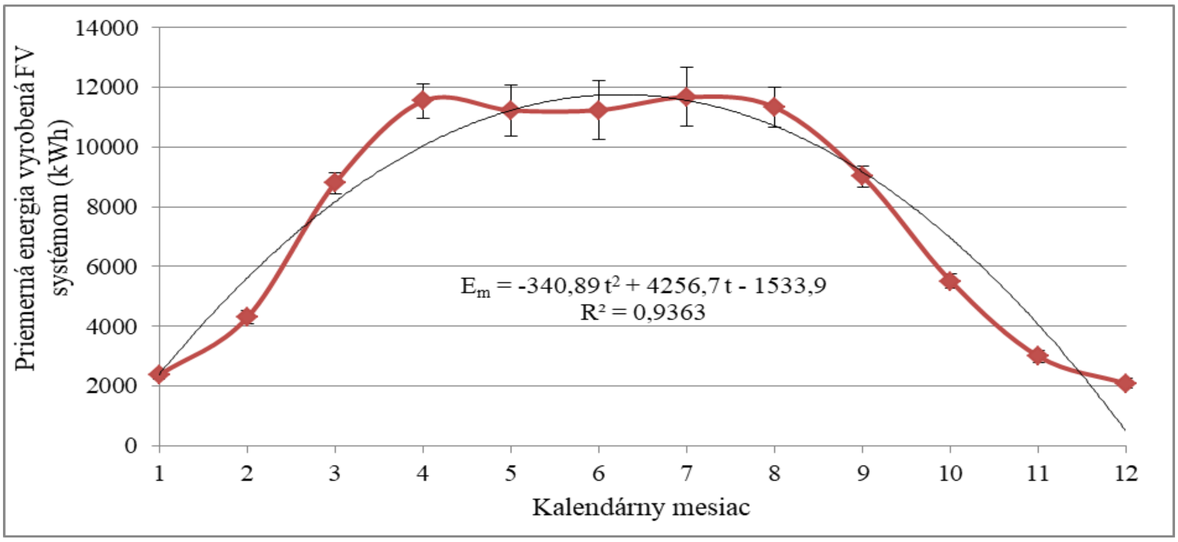
spracované pomocou tabuľkového editora Microsoft Excel, programu Matlab verzia R 2015b a tiež využitím špeciálnej aplikácie spustiteľnej pod operačným systémom Windows. Pre vytvorenie matematického modelu bola realizovaná selekcia dát, spracovanie vybraných štatistických charakteristík (koeficient determinácie, súčet štvorcov, stredná kvadratická chyba) a následne boli vytvorené grafické závislosti: energie vyrobenej FV systémom od kalendárneho mesiaca, priemernej energia vyrobenej FV systémom od kalendárneho mesiaca a energie vyrobenej FV systémom od uhla sklonu Fv panela. Tieto závislosti boli vhodne aproximované.
V programe Matlab verzie R 2015b je možné vytvárať trojdimenzionálne závislosti a vypočítať príslušné štatistické údaje s koeficientmi, tiež je možné nastavenie grafu z vizuálneho hľadiska. Po aktivácii trojrozmerných závislostí sú sprístupnené pre užívateľov jednotlivé aproximácie, ktoré možno aplikovať priamo na priebeh nameraných dát. V našom prípade bola vybraná polynomická aproximácia, ktorá sa používa na krivku, ktorá má spojitý charakter. Vypočítané boli koeficienty regresnej rovnice, dolná hranica intervalu daného koeficientu, horná hranica intervalu daného koeficientu. K trojdimenzionálnej závislosti sa vypočítali aj nasledujúce štatistické parametre: koeficient determinácie, súčet štvorcov, strednú kvadratickú chybu.

VÝSLEDKY A DISKUSIA

V rámci výsledkov sú prezentované modelované grafické závislosti. Obr. 1 znázorňuje priebeh množstva vyrobenej elektrickej energie pre jednotlivé kalendárne mesiace roka a jednotlivé uhly sklonu FV panela od 0 °, čo reprezentuje vodorovné umiestnenie FV panelov až po uhol 90 °, čo je kolmé umiestnenie FV panelov, pričom uhol sklonu FV panela bol menený po 15 °. Pri uhloch 0 °, 15 °a 30 ° je množstvo energie vyrobenej FV systémom veľmi podobné, od uhla 45 ° nastáva pokles množstva energie vyrobenej FV systémom.



Obr. 1 Závislosť energie vyrobenej FV systémom v rôznych kalendárnych mesiacoch pri uhloch sklonu od 0 ° do 90 °

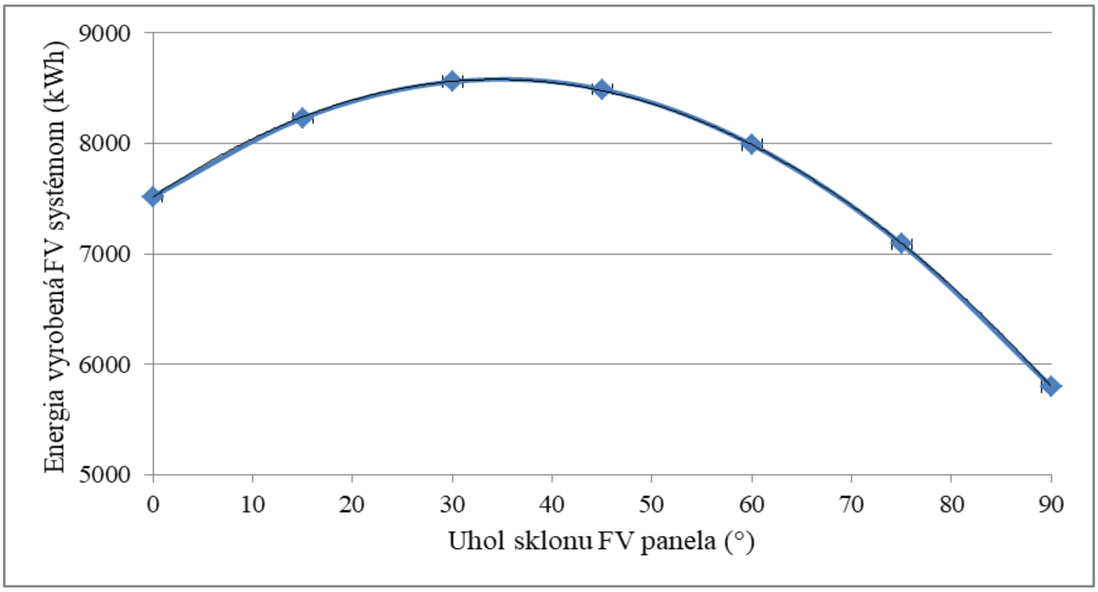


Obr. 2 Závislosť priemerného množstva energie vyrobenej FV systémom v rôznych kalendárnych mesiacoch pri uhle sklonu α_{AP} (priemernom uhle sklonu 45 °)

Komplexnejšie sledovanú závislosť reprezentuje Obr. 2, kde je znázornený reálny priebeh priemerného množstva vyrobenej elektrickej energie v jednotlivých kalendárnych mesiacoch, ktorým bola prenesená trendová spojnica, ktorú možno popísať polynomickou funkciou 2. stupňa s regresnou rovnicou uvedenou na Obr. 2 a koeficientom spoľahlivosti $R^2 = 0.9363$. V rámci grafickej závislosti na obr. 2 sú pre jednotlivé kalendárne mesiace vynesené stredné chyby aritmetického priemeru $\bar{\delta}(t)$, ktorých hodnoty sú uvedené v Tab. 1.
Všeobecnejšej zhodnotenie vplyvu uhlu sklonu FV panela na množstvo vyrobenej elektrickej energie je znázornené na Obr. 3, ktorý reprezentuje závislosť množstva elektrickej energie vyrobenej FV systémom od uhla sklonu FV panelu. Matematicky sledovanú závislosť opisuje regresná rovnica (1), ktorá predstavuje polynóm 2. stupňa s koeficientom spoľahlivosti $R^2 = 0.9999$.

$$E_m = -0{,}9\,\alpha^2 + 61{,}929\,\alpha + 7514{,}3 \qquad (1)$$

kde: E_m je energia vyrobená FV systémom za mesiac (kWh), α je uhol sklonu (°).



Obr. 3 Závislosť množstva elektrickej energie vyrobenej FV systémom od uhla sklonu FV panelu

Pri vyhodnotení dát boli priradené jednotlivým uhlom sklonu polohy (0 ° - poloha 1, 15 °- poloha 2, 30 °- poloha 3, 45 ° - poloha 4, 60 ° - poloha 5, 75 ° - poloha 6, 90 ° - poloha 7). V rámci spracovania nameraných dát boli vypočítané základné štatistické charakteristiky pre jednotlivé rady údajov. Konkrétne boli určené aritmetické priemery, odchýlky od aritmetického priemeru, rozptyly σ^2, štandardné odchýlky σ, stredné chyby aritmetického priemeru $\bar{\delta}(t)$ a mediány, z ktorých vybrané výsledky sú uvedené v Tab. 1. Z výsledkov vyplýva, že najväčšie množstvo vyrobenej elektrickej energie sa dosahuje v rámci hodnotenej lokality pri uhle sklonu z intervalu (30 ° - 45 °), pričom maximum sa dosahuje pri uhle sklonu 35 ° a v hodnotenej lokalite (Dubicko) je to pri uhle sklonu FV panelov cca 34,5 °.

Tab.1 Hodnoty energie vyrobenej FV systémom s rôznym uhlom sklonu FV panelu

Mesiac		**Uhol sklonu FV panelu**									
		0 ° poloha 1	**15 ° poloha 2**	**30 ° poloha 3**	**45 ° poloha 4**	**60 ° poloha 5**	**75 ° poloha 6**	**90 ° poloha 7**	**AP_{mesiac}**	**σ**	**$\bar{\delta}$(t)**
Január	**Energia vyrobená FV systémom v kWh**	1590	2060	2430	2650	2730	2670	2460	2370	380,64	155,36
Február		3140	3910	4470	4790	4850	4660	4230	4292,857	561,04	228,99
Marec		7300	8600	9440	9790	9640	8980	7830	8797,143	874,93	357,11
Apríl		11400	12500	12900	12800	12000	10600	8580	11540	1426,04	582,06
Máj		12700	13100	13000	12300	11100	9340	7050	11227,14	2104,31	858,9
Jún		13300	13500	13200	12300	10900	8930	6520	11235,71	2450,84	1000,34
Júl		13500	13900	13700	12800	11400	9470	6950	11674,29	2417,52	986,74
August		11800	12600	12900	12500	11600	10000	7900	11328,57	1659,36	677,29
September		8010	9160	9840	10000	9690	8860	7520	9011,429	878,02	358,38
Október		4250	5170	5800	6130	6150	5840	5220	5508,571	629,54	256,95
November		2000	2600	3060	3340	3440	3360	3090	2984,286	479,40	195,67
December		1250	1710	2080	2330	2440	2420	2260	2070	407,99	166,52
AP		7520	8230	8560	8490	7990	7090	5800			
σ^2		22040667	21856024	20159081	17005502	13075875	8694258	4704474			
Σ		4694,75	4675,04	4489,89	4123,77	3616,06	2948,60	2168,98			
Medián		7655	8880	9640	9895	9665	8895	6735			

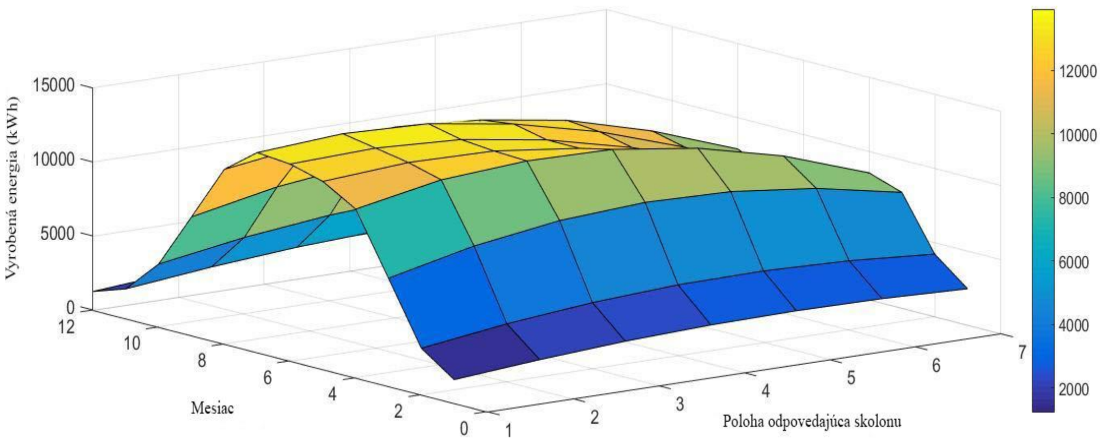
Tab. 2 Štatistické údaje trojrozmernej závislosti znázorňujúcej vplyv azimutového uhla na množstvo vyrobenej elektrickej energie

Súčet štvorcov	$1,735 .10^8$		
Koeficient determinácie	0,8723		
Stredná kvadratická chyba	$1,491.10^3$		
Regresná rovnica	$f (xy)= p00 + p10.x + p01.y + p20.x^2 + p11.x.y + p02.y^2$		
Koeficient	**Hodnota**	**Spodný interval**	**Horný interval**
p00	-2486	-4610	-3161
p10	1250	425,5	2074
p01	4206	3754	4657
p20	-202,3	-295,9	-108,8
p11	12,76	-34,17	59,69
p02	-340,9	-371,6	-310,2

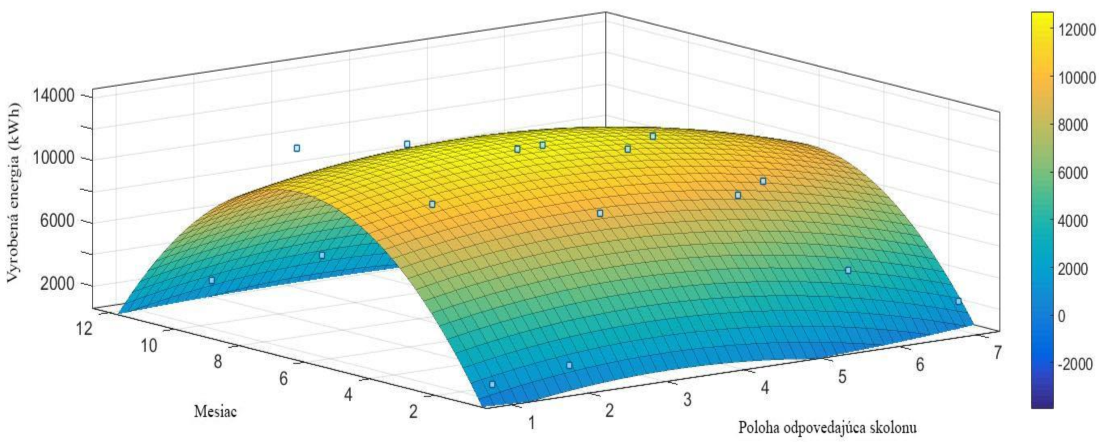
Konkrétny vplyv uhla sklonu na množstvo vyrobenej elektrickej energie FV systémom v jednotlivých kalendárnych mesiacoch roka môžeme modelovať aj pomocou trojdimenzionálnej grafickej závislosti, ktorú znázorňuje Obr. 4. Následne bola na prezentovanú trojdimenzionálnu závislosť aplikovaná polynomická aproximácia 2. stupňa, ktorá bola použitá pre os x-ovú aj pre os y-ovú, čím bola získaná modelová funkčná závislosť znázornená na Obr. 5. Kde na osi x-ovej je znázornený čas - reprezentovaný kalendárnymi mesiacmi, na osi y-ovej sú znázornené jednotlivé polohy zodpovedajúce uhlom sklonu FV panela a na osi z-ovej sú vynesené priemerné hodnoty vyrobenej elektrickej energie FV systémom.
Finálnu trojdimenzionálnu modelovú závislosť znázornenú na Obr. 5 môžeme popísať pomocou charakteristík prezentovaných v Tab. 2 a rovnicou (2) reprezentujúcou vplyv zmeny uhla sklonu FV panela v čase na množstvo vyrobenej elektrickej energie FV systémom.

$$E_m(t,\alpha) = -2486 + 1250\,t + 4206\,\alpha - 202{,}3\,t^2 + 12{,}76\,t\,\alpha - 340{,}9\,\alpha^2 \qquad (2)$$

kde: E_m je energia vyrobená FV systémom za mesiac (kWh), α je uhol sklonu (°) a t je čas (mesiac).



Obr. 4 Vplyv uhla sklonu FV panela na množstvo energie vyrobenej FV systémom v mesiacoch január – december



Obr. 5 Vplyv uhla sklonu FV panela na množstvo energie vyrobenej FV systémom po polynomickej aproximácii

ZÁVER

V dostupnej literatúre Libra, (2009) sa uvádza, že pri akejkoľvek zmene uhla sklonu FV panelu je dosahovaný pokles množstva elektrickej energie do 10 %. Meraním na modelovom FV paneli bol preukázaný značný vplyv uhla sklonu, kde pri kolmom umiestnenie FV panelu (90 °) dochádza k poklesu výroby elektrickej energie z 13200 kWh na 6520 kWh, čo predstavuje 49,39 %, naopak pri uhloch sklonu FV panela v intervale od 0 ° do 30 ° je v mesiacoch apríl až august minimálny rozdiel v množstve vyrobenej elektrickej energie 12700 kWh až 13100 kWh tzn. 3,05 %, ak však porovnáme aritmetické priemery reprezentujúce množstvo vyrobenej energie FV systémom v jednotlivých mesiacoch pre rôzne uhly sklonu, tak je zrejmé, že sa od hodnoty celkového mesačného priemeru 7668,571 kWh líšia, konkrétne sú v intervale (5800 - 8560) kWh čo predstavuje 24,37 % - 11,62 %, teda v priemere má uhol sklonu vplyv na množstvo vyrobenej energie 18 % pre sledovanú lokalitu. Značný vplyv uhla sklonu je evidentný aj z grafických závislostí prezentovaných na obr. 1-5, pričom najvšeobecnejší matematický popis vplyvu uhla sklonu predstavuje rovnica (2), ktorá zároveň umožňuje jednoduchý výpočet množstva vyrobenej el. energie FV systémom pri zadaní časového údaju a polohy zodpovedajúcej uhlu sklonu α FV panelu, čo sú v praxi veľmi jednoducho identifikovateľné parametre. Na základe modelovej rovnice je možné stanoviť energetickú bilanciu FV elektrárne s inštalovaným výkonom 100 kWp prakticky pre akýkoľvek uhol sklonu a kalendárny mesiac roka.

POĎAKOVANIE

Táto štúdia bola podporená projektom KEGA 017-SPU 4/2017 - Multimedia textbook of physics for engineers.

LITERATÚRA

King, D. L., Boyson, W. E., . Kratochvil, J. A. (2002). Analysis of factors influencing the annual energy production of photovoltaic systems. In Proc. of the 29th IEEE Photovoltaic Specialists Conference, New Orleans, LA, May 20-24, s. 1356–1361.

Libra, M, Poulek, V. (2009). Fotovoltaika: teorie i praxe využití solární energie. 1. vyd. Praha: Ilsa, 160 s. ISBN 978-80-904311-0-2

Mahdi, S. A. (2010). The Effect of Tilt Angle on the Solar Panel Output. *Journal of Kerbala University*, 8.

Mehleri, E.D., Zervas, P.L., Sarimveis, H., Palyvos, J.A., Markatos, N.C. (2010). Determination of the optimal tilt angle and orientation for solar photovoltaic arrays. *Renewable Energy*, 35(11),s. 2468–2475.

Osamede, A., James, S., Christo, P. (2012). Optimum tilt angles for photovoltaic panels during winter months in the Vaal triangle. *Smart Grid and Renewable Energy*, 3, s. 119-125.

Shareef, S. J. M. (2017). The Impact of Tilt Angle on Photovoltaic Panel Output. Journal of pure and applied sciences. 29(5), s. 112-118.

Suman, R. A. S. K. (2015). Effect of Tilt angle and Azimuth angle on Solar Output and Optimum Tilt and Azimuth angle for Chandigarh, India. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, 4.

Korešpondujúci autor:

Ing. Matúš Bilčík, Katedra fyziky, Technická fakulta, Slovenská poľnohospodárska univerzita v Nitre, Tr. A. Hlinku 2, 949 76 Nitra, Slovensko, e-mail: bilcikmatus@gmail.com

Rural Buildings in European Regions :: RUBER 2019
September 10, 2019 :: Nitra, Slovakia

ELIMINATION OF WIND FLOW VELOCITY IN AGRICULTURE

ELIMINÁCIA RÝCHLOSTI PRÚDENIA VETRA V POĽNOHOSPODÁRSTVE

Jozef BOČKAJ[1], Juraj ŽILINSKÝ[1]

[1] *Katedra konštrukcií pozemných stavieb, Stavebná fakulta, STU Bratislava*

Abstract

Main purpose of this article is to describe the current state of knowledge and implementation of the aerodynamic barriers in the field of agriculture. In the article I have described various individual parameters (such as: height, connection, density, orientation and length), which have significant effects on the speed reduction of the wind flow and with that contribute the increase of creation of required suitable microclimate in particular areas for crop culture and animal breeding.

Secondly in the article is a description of suitable proposal and use of the aerodynamic barrier based on load carrying capacity.

Key words: Aerodynamics, wind break, windward site, leeward site, airflow.

ÚVOD

Aerodynamické bariéry sú vo všeobecnosti definované ako prekážky, ktoré znižujú rýchlosť prúdenia vetra (Rosenberg, 1974) a tým prispievajú k vytvoreniu vhodnej mikroklímy v danej oblasti.

Tieto aerodynamické bariéry sa v súčasnosti požívajú na elimináciu rýchlosti vetra v poľnohospodárstve (pri chove zvierat, pestovaní rastlín a plodín), na zníženie erozívnych účinkov na pôdu, znižujú tvorbu záplav, usmerňujú vytváranie snehových závejov a taktiež vplývajú na zvýšenie kvality mikroklímy v určitých oblastiach.

Zvyčajne sú tieto bariéry vyhotovené pomocou stromov, kríkov, no môžu byť aj z jednoročných alebo trvalých rastlín (*Obr. 1*). Taktiež sa využívajú aj drevené (perforované) steny alebo steny z rôznych perforovaných materiálov (*Obr. 2*).

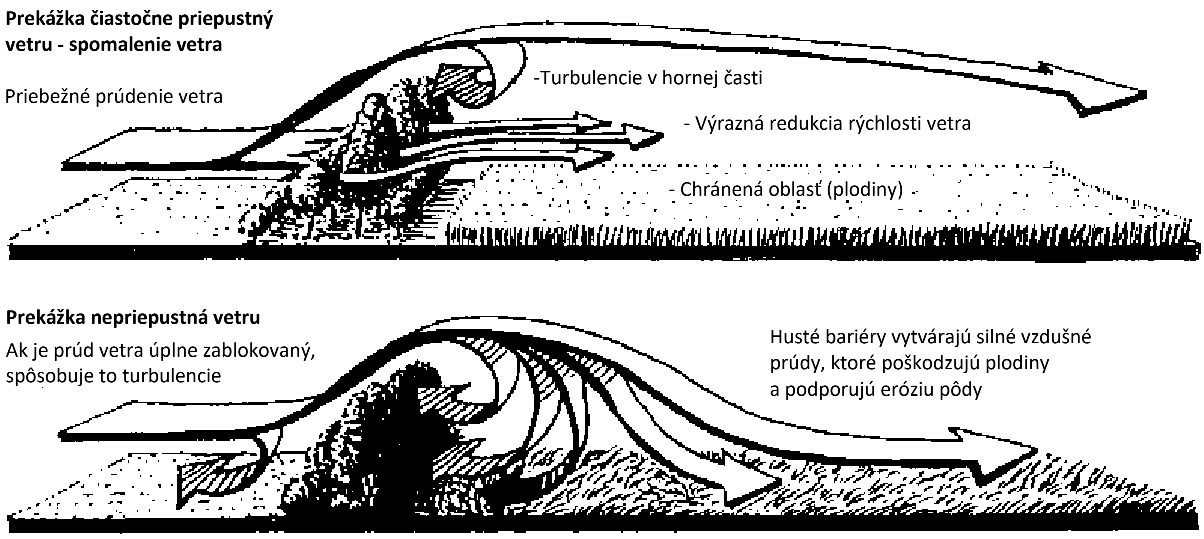
Tieto prvky môžu byť realizované jednotlivo alebo spojené do systému aerodynamických bariér, ktoré svojou prítomnosťou v prúde vzduchu znižujú účinok rýchlosti vetra nielen na samotný systém, ale aj v určitej vzdialenosti na náveternej a záveternej strane bariéry.

Obr. 1 Aerodynamická bariéra vyhotovená pomocou stromovej výsadby

Obr. 2 Aerodynamická bariéra vyhotovená pomocou drevený perforovaných stien

PRINCÍP AERODYNAMICKÝCH BARIÉR

Tieto aerodynamické bariéry rozdeľujú oblasť priebežného prúdenia vzduchu v okolí bariéry do dvoch základných častí. V prednej časti pred bariérou vzniká náveterná oblasť (pretlak) a za bariérou záveterná oblasť (podtlak) (*Obr. 3*). Účinnosť znižovania rýchlosti prúdenia a intenzity turbulencii vetra pomocou bariéry ovplyvňujú nasledovné parametre: výška, dĺžka, orientácia, šírka, spojitosť, prierez, priepustnosť. Rýchlosť prúdenia vetra taktiež môže ovplyvniť usporiadanie, zoskupenia a okolie do akého je osadená aerodynamická bariéra. (Chepil a Woodruff, 1963; Hagen a Skidmore, 1971a).



Obr. 1 Vplyv priepustnosti na prúdenie vzduchu okolo aerodynamickej bariéry (ICRAF, 1994)

ČO OVPLYVŇUJE ÚČINOSŤ BARIÉRY

Schopnosť bariéry znížiť rýchlosť prúdenia vetra je ovplyvnená vnútornými a vonkajšími vlastnosťami bariéry. Vonkajšie vlastnosti sa zaoberajú tvarovaním a zoskupením bariér ako celku, patria tu: výška, dĺžka, orientácia a spojitosť. K vnútorným vlastnostiam patrí priepustnosť bariéry - množstvo a usporiadanie pevných a otvorených častí a povrchová plocha jednotlivých častí (Zhou a kol., 2002, 2005, 2008). Opis jednotlivých parametrov je uvedený nižšie.

Celková veľkosť chránenej zóny, rozsah rýchlosti zníženia vetra v rámci zón a výsledný vplyv na mikroklímu závisí od týchto vlastností (Wang a Takle, 1996, 1997; Zhou a kol., 2005, 2008). Úpravou týchto jednotlivých vlastností na základe rôznych postupov je možné docieliť požadované podmienky v rámci chránenej zóny (Brandle, 1990).

Výška

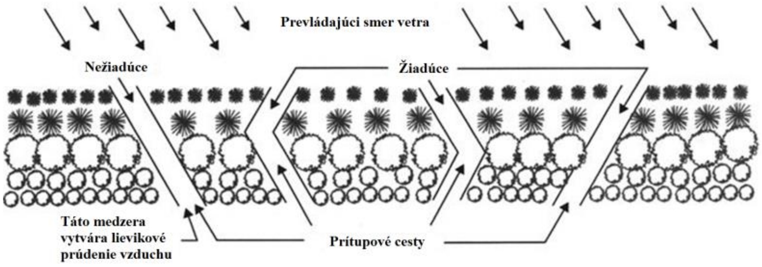
Výška aerodynamickej bariéry, často sa označuje ako účinná výška H. Je jedným z najdôležitejších faktorov, ktorá určuje ako ďaleko bude siahať chránená oblasť na záveternej strane bariéry. K najväčšiemu zníženiu rýchlosti vetra dochádza v oblasti od dvojnásobku výšky (2H) po desať násobok (10H) výšky bariéry na záveternej strane. Účinnosť týchto vetrolamov je až do dĺžky tridsať- násobku (30H) výšky prekážky.

Napríklad pri silnom vetre, kde bariéra je tvorená stromami s výškou 6 *m*, sa najväčšie zníženie rýchlosti vetra objaví vo vzdialenosti od 12 *m* do 60 *m* na záveternej strane. Oproti tomu pri bariére, ktorá má 18 *m* je chránená oblasť vo vzdialenosti od 36 *m* do 180 *m* (*Obr. 4*). Na náveternej strane bariéry sa dá namerať zníženie rýchlosti vetra vo vzdialenosti dvojnásobku (2H) výšky bariéry (Wight B., Stuhr, K., 2002).

Spojitosť

Spojitosť bariéry je nevyhnutná na dosiahnutie maximálnej účinnosti. Bariéry by nemali mať žiadne veľké medzery. Veľké medzery, totiž môžu vytvárať lievikový efekt (tzv. Venturihoefekt), ktorý sústreďuje prúdenie vetra v medzere a tým vo výraznej miere zvyšuje jeho rýchlosť oproti rýchlosti voľného prúdenia ktorý spôsobuje zhoršenie podmienok mikroklímy v danej oblasti.

Proti vysokým rýchlostiam v medzerách je možné sa brániť tvarovaním medzery (pod určitým uhlom) (*Obr.5*) alebo vytvorením ďalšej bariéry pomocou pridaných radov stromov na náveternej strane. Vhodnejšie je použitie prechodných pasáží na okrajoch bariéry (Wight B., Stuhr, K., 2002).



Obr. 5 Spôsoby tvarovania medzery (priechodu) v bariére (Wight B., Stuhr, K., 2002).

Hustota (Pórovitosť)

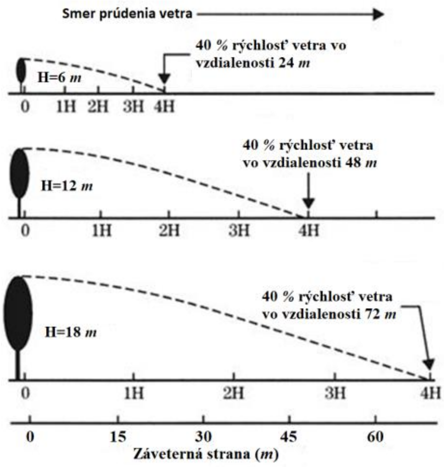
Táto vlastnosť sa považuje za pórovitosť bariéry (plnosť prierezu) ϕ, ktorá sa dá vyjadriť ako pomer medzi otvorenou oblasťou bariéry a jej celkovou plochou (a preto je vyjadrená v m^2/m^2) (Jensen, 1954; Tillie, 1992), táto vlastnosť má najvyšší vplyv na prúdenie rýchlosti vetra a intenzity turbulencií (van Eimern et a., 1964; Hagen, 1976).

Hustota je v tomto prípade špecifikovaná množstvom listov, vetiev konárov a kmeňov v bariére. Vietor prúdi okolo bariéry, no taktiež časť prúdi cez bariéru. Čím pevnejší alebo hustejší vetrolam, tým je zníženie rýchlosti vetra výraznejšie. Menej hustá výsadba stromov avšak umožňuje ochranu pre väčšie vzdialenosti. Hustota vetrolamu môže byť ovplyvnená výberom druhov stromov (ihličnaté alebo listnaté), rozmiestnením stromov, počtom a hustotou výsadby (*Obr. 6*).

Orientácia

Orientácia určuje smer a tvarovanie bariéry tak, aby odolávala pôsobeniu vetra a zároveň chránila určitú oblasť pred zvýšenými rýchlosťami vetra. Bariéra je najúčinnejšia v prípade že vietor pôsobí kolmo v smere jej vystavenia vetru.

Aby tieto bariéry boli čo najúčinnejšie je vhodné ich tvarovať do pravého uhla k nepriaznivému vplyvu vetra. Aby sa umožnili čo najvýraznejšie zmeny smeru a rýchlosti vetra je vhodné tieto bariéry realizovať vo viacerých smeroch a zoskupeniach, ako napríklad L, U alebo E (*Obr. 7*) (Irwin, K., Bratton, J., 1996).



Obr. 2 Vplyv výšky na prúdenie vetra na záveternej strane bariér (Wight B., Stuhr, K., 2002)

Rýchlosť vetra - 32 km/h
Listnaté stromy - 25-35 % hustota

H vzdialenosť od bariéry	5H	10H	15H	20H	30H
kilometre za hodinu	16	21	26	27	32
% vyjadrenie rýchlosť vetra	50%	65%	80%	85%	100%

Rýchlosť vetra - 32 km/h
Ihličnaté stromy - 40-60 % hustota

H vzdialenosť od bariéry	5H	10H	15H	20H	30H
kilometre za hodinu	10	16	19	24	31
% vyjadrenie rýchlosť vetra	30%	50%	60%	75%	95%

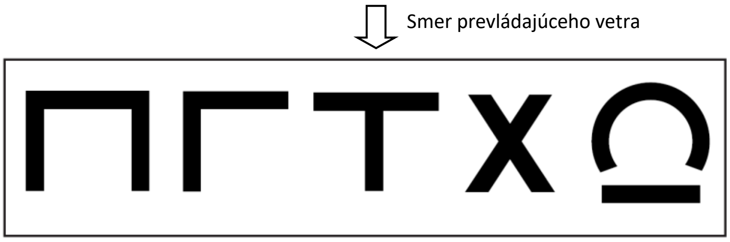
Rýchlosť vetra - 32 km/h
Viac radov - 60-80 % hustota

H vzdialenosť od bariéry	5H	10H	15H	20H	30H
kilometre za hodinu	8	11	21	27	31
% vyjadrenie rýchlosť vetra	25%	35%	65%	85%	95%

Rýchlosť vetra - 32 km/h
Plná stena - 100 % hustota

H vzdialenosť od bariéry	5H	10H	15H	20H	30H
kilometre za hodinu	8	21	29	31	32
% vyjadrenie rýchlosť vetra	25%	70%	90%	95%	100%

Obr. 6 Vplyv hustoty na zníženie rýchlosti vetra (*km/h*) (Wight B., Stuhr, K., 2002).



Obr. 7 Príklady tvarovania aerodynamických bariér
(Irwin a Bratton, 1996)

Dĺžka

Dĺžka aerodynamickej bariéry určuje veľkosť oblasti prijímajúcej ochranu pred zvýšenou rýchlosťou vetra. Pre najlepšiu ochranu by mala byť bariéra vyhotovená s nepretržitou dĺžkou a výškou najmenej v pomere 10:1. Napríklad, ak je výška bariéry 10 *m*, tak bariéra by mala mať dĺžku najmenej 100 *m* aby sa minimalizoval dopad vzduchových turbulencií okolo koncov bariéry (Wight B., Stuhr, K., 2002).

VYUŽITIE A TVORBA TÝCHTO BARIÉR V POĽNOHOSPODÁRSTVE

Zimná ochrana statkov, pestovateľských celkov a hospodárskych zvierat, hustota > 60%

Maximálne zníženie rýchlosti vetra je potrebné na ochranu pestovateľských celkov a hospodárskych zvierat v zimnom období pred chladným vetrom a unášajúcim snehom. Čím je rýchlosť prúdenia vetra pomalšia, tým bude výraznejšie zníženie účinku chladného vetra a v oblastiach snehových závejov sa tak bude koncentrovať väčšie množstvo snehu. Bariéra, ktorá sa skladá iba z listnatých stromov, nemôže v zimnom období dosiahnuť hustotu väčšiu ako 50 % (Straight, R., Brandle, J., 2007).

Požiadavky pre tvorbu bariéry:

• Na dosiahnutie hustoty vyššej ako 60 % sú potrebné najmenej dva rady ihličnatých stromov. Odporúčajú sa napríklad smreky, borievky, jedle a arborvitae (Picea, Juniperus, Abies alebo Thuja spp.), ale borovica (Pinus spp.) nie je tak hustá a má tendenciu znižovania hustoty vekom.

• Na tento účel sa môže použiť mnoho kríkov (dokonca aj bez listov) za predpokladu, že poskytujú dostatočnú hustotu, no ich použitie je vhodné iba v nízkych výškach. Napríklad ker sibírsky (Caragana spp.). alebo vŕba (Salix purpurea) sa využívajú ako aerodynamické bariéry proti tvorbe snehových závejov a tým tvoria ochranu na cestách.

• Druh zvoleného stromu musí byť odolný voči hmotnosti nahromadeného snehu na jeho častiach konároch a podobne.

• V prípade porušenia tvaru alebo štruktúry bariéry a tým zníženiu jej minimálnej hustoty, je možné zvýšenie hustoty pomocou pridania ďalších stromov (rovnakého alebo iných druhov strov) alebo celého radu stromov.

Ochrana plodín; kontrola pôdnej alebo veternej erózie, 40% - 60% hustotou

Všeobecne povedané, 40 % hustota bariéry poskytuje primeranú ochranu plodín, zatiaľ čo erózia pôdy je lepšie kontrolovaná bariérou, ktorá má hustotu 60 %.

Pre ochranu plodín a erózie pôdy je vhodné použiť bariéry s hustotou 40 %, ktoré môže primerane chrániť plodiny a pôdu. Pri 60 % hustote bariéry môže dochádzať k tvorbe snehových závejov (Straight, R., Brandle, J., 2007).

Požiadavky pre tvorbu bariéry:

• Jeden rad listnatých stromov, ako sú duby, jasene, bresty, topole atď. (Quercus, Fraxinus, Celtis, Populus spp.), vysadené od seba približne 3 *m* s hustotou 60 % , budú poskytovať primeranú ochranu plodín počas vegetačného obdobia (keď sú stromy pokryté listami).

• Jeden rad hustých ihličnanov, ako sú smreky a iné stromy uvedené vyššie, vysadené v tesnej vzdialenosti od seba (menej 3 *m*) s hustotou 60%, zatiaľ čo borovica má v priemere hustotu len 50 %.

• Dva alebo viac radov stromov zvyšuje hustotu a znižuje možnosť tvorby medzier v bariére.

• Keď sa do radu stromov pridá rad kríkov, hustota v nižších výškach sa zvýši na viac ako 60 %.

• Použitie jednej aerodynamickej bariéry pre kontrolu erózie pôdy a rozloženia snehu na poli je takmer vylúčené. Jediný rad borovíc so širokou medzerou medzi riadkami 4 *m* alebo väčší, je kompromisom. Inou alternatívou je vytvorenie systému, ktorý využíva aerodynamickú bariéru s hustotou 40 % s inými spôsobmi ochrany.

Rozloženie snehu, 30% - 40% hustota

V oblastiach, kde sneh predstavuje kritický zdroj pôdnej vlhkosti pre pestovanie plodín a krmovín, je možné navrhnúť bariéru tak, aby sa sneh rovnomerne rozdeľoval po celom poli. Bariéra by mala dostatočne znížiť rýchlosť vetra, aby vietor už nemohol unášať častice snehu, ale nie natoľko, aby vietor nemohol uniesť žiadne častice snehu, čo by viedlo k hlbokému a úzkemu snehovému záveju. Hlboké snehové záveje sa najmä v severných klimatických podmienkach na jar pomaly topia, čo bráni rovnomernému vysušeniu pôdy a oneskoreniu užívania polí. Ak je však hustota vetra výrazne nižšia ako 30 %, účinok na rýchlosť vetra je minimálny a sneh sa nebude hromadiť na poli, ale skôr v blízkosti iných prekážok, ako sú ploty, diaľnice a farmy (Straight, R., Brandle, J., 2007).
Požiadavky pre tvorbu bariéry:

• Jeden rad listnatých stromov, ako sú duby, jasene, bresty, topole atď. (Quercus, Fraxinus, Celtis, Populus spp.), vysadené od seba vo vzdialenosti 4 *m* až 5 *m*, sú určené hustotou približne 40 % (bez listov).

• Aj keď je rozloženie snehu primárnym účelom, vzdialenosť medzi bariérami by mala byť založená na kritériách ochrany plodín alebo ochrany pôdy, podľa toho, čo je relevantné pre ciele vlastníka pôdy.

• Jeden rad kríkov bez listov vysadených vo vzdialenosti asi 1 *m* je zvyčajne hustejší ako 40 %. Výsadba tejto hustoty môže stále viesť k problémom, ktoré sú vznikajú v oblastiach s vysokým výskytom prúdenia vetra a snehu. V južných oblastiach s minimálnym poklesom snehu sa jarné topenie vyskytuje dosť skoro na to, aby sa pôda mohla vysušiť, čo umožňuje včasné užívanie polí.

ZÁVER

Na elimináciu vysokých rýchlosti vetra sa v súčasnosti používajú prevažne bariéry vyhotovené pomocou stromov, kríkov alebo drevených perforovaných stien. Tento článok opisuje základné požiadavky pre vhodný návrh bariér v poľnohospodárstve.

Je vhodné poznamenať že tieto aerodynamické bariéry nemusia byť vyhotovené nielen pomocou materiálov, ktoré boli spomenuté vyššie ale aj pomocou perforovaných plastových sietí, ktorých priepustnosť by bolo možné matematicky navrhovať pri použití a splnení predchádzajúcich požiadaviek na tvorbu aerodynamických bariér v poľnohospodárstve.

Tieto sieťové aerodynamické bariéry by mohli byť použité napríklad pre ochranu voľne ustajnených zvierat. Aktuálne sa v aerodynamickom tuneli v Bratislave testujú bariéry s rôznou plnosťou prierezu a dizajnom.

POĎAKOVANIE

Tento článok vznikol za podpory Ministerstva školstva, vedy, výskumu a športu Slovenské republiky v rámci výskumu a vývoja. Operačný program pre projekt "University Science Park of STU v Bratislave", ITMS 26240220084, spolufinancovaný z prostriedkov Európskeho fondu regionálneho rozvoja.

LITERATÚRA

Brandle, J.R. 1990. Management of microclimate with wind-breaks. p. 61-69. In D. Sirois (ed.) Proc. 17th Annual Meeting, Plant Growth Regulation Society of America. St. Paul, MN. August 5- 9, 1990.

Hagen, L.J., 1976. Windbreak design for optimum wind erosion control. In: Proceedings of the Symposium: Shelterbelts on the Great Plains. Denver, CO, pp 31-36.

Chepil, W.S, Woodruff, N.P.,1963. The physics of wind erosion and its control. Advances in Agronomy 15, 211-302.

ICRAF. 1994. Agroforestry Extension Manual for Kenya, p 190.

Irwin, K., Bratton, J., 1996. USDA National Agroforestry Notes. Outdoor Living Barn: A Specialized Windbreak, p. 1-4.

Jansen, M., 1954. The model law for phenomena in the natural wind. Ingenieren 2, 121-128.

Jensen, M., 1954. Shelter Effect: Investigations into Aerodynamics of Shelter and its Effects on Climate and Crops, Danish Tech, press, Copenhagen.

Rosenberg, N.J., 1974. Microclimate: The Biological Environment. Wiley, New York.

Straight, R., Brandle, J., 2007. USDA National Agroforestry Notes. Windbreak Density: Rules of Thumb For Design, p. 1-4.

Tillie, M., 1992. Ambiance dans les batiments d´élevage bovin. Session Institut de l´Elevage, No. 222, Paris.

Van Eimern, J., R. Karschon, L. A. Razumava, and G.W. Robertson. 1964. Windbreaks and shelterbelts. Technical Note No. 59 (WMO-No.14.TP.7), Geneva, Switzerland.

Wang, H., E.S. Takle, 1996. On three-dimensionality of shelterbelt structure and its influences on shelter effects. Boundary-Layer Meteorol, 79:83-105.

Wang, H., E.S. Takle, 1997. Model simulated influences of shelterbelt shape on wind sheltering efficiency. J. Appl. Meteorol. 36:695-704.

Wight B., Stuhr, K., 2002. USDA National Agroforestry Notes. Windbreaks An Agroforestry Practice, p. 1-4.

Zhou, X.H., J.R. Brandle, E.S. Takele, and C.W. Mize, 2002. Estimation of the three-dimensional aerodynamic structure of a green ash shelterbelt. Agric. For. Meteorol, 111: 93 -108.

Zhou, X.H., J.R. Brandle, E.S Takle, and C.W. Mize, 2008. Relationship of three-dimensional structure to shelterbelt function: A theoretical hypothesis. P273-285. In D.R Batish et al. (ed.) Ecological basis of agroforestry. Taylor and Francis, Boca Raton, FL.

Zhou, X.H., J.R. Brandle, C.W. Mize, and E.S. Takle, 2005. Three-deimensional aerodynamic structure of a tree shelterbelt:Definition, characterization and working models Agrofor. Syst. 63: 133-147.

Korešpondujúci autor:

Ing. Jozef Bočkaj, Katedra konštrukcií pozemných stavieb, Stavebná fakulta, STU Bratislava, Radlinského 11, 813 68 Bratislava, Slovensko, e-mail: jozef.bockaj@stuba.sk

LIVING IN RURAL BACKGROUND

BÝVANIE VO VIDIECKOM ZÁZEMÍ MIEST

Alžbeta SOPIROVÁ

Fakulta architektúry STU Bratislava, Ústav urbanizmu a ÚP

Abstract
The dynamic social, political and economic changes and the new democratic system, based on the market economy principle, have influenced the space in the territory of larger cities in the past 20 years. Interest in the development potential, originally agricultural rural settlements located in the hinterland of Bratislava, came to the fore. These settlements are subject to continuous, spontaneous building development and pressure from investors to intensify their urban structure and extensive distribution to the surrounding agricultural landscape. Their infrastructural unpreparedness, the rise of new residential sites and the migration influx of inhabitants, are causing many problems. The image of the settlement is changing, rural identity and atmosphere are lost. The paper will focus on the comparison and evaluation of the development of new residential sites in rural settlements located in the hinterland of Bratislava in terms of selected indicators.

Key words: zázemie mesta, vidiecke sídla, expanzia, rezidenčný

ÚVOD
Nástup suburbanizácie na Slovensku po roku 1989 výrazným spôsobom zasiahol priestor v zázemí väčších miest a ovplyvnil kvalitu a spôsob života obyvateľov v tomto území. Vo vidieckych sídlach, ležiacich v dostupnosti dopravných a sídelných rozvojových osí, sa tento proces prejavil rôzne intenzívnymi formami zahusťovaním urbánnej štruktúry a expanzie do okolitej krajiny. Pretrvávajúce živelné rozširovanie novej výstavby, ktorá prekračuje hranice kompaktne zastavaného územia a zaberá poľnohospodársku pôdu spôsobilo, že mnohé tradičné dediny, s pôvodnými vidieckymi stavbami, sa postupne transformujú na rezidenčné satelity.
Razantný a živelný priebeh suburbanizácie zasiahol najintenzívnejšie Bratislavský región. V dôsledku nedokonalej legislatívy a nástrojov územného plánovania na regionálnej aj lokálnej úrovni, ktoré mali rozvoj sídiel regulovať, dochádza k nekoordinovanej novej výstavbe rezidenčných celkov. Pod tlakom investorov a za výraznej podpory zvýhodnených hypotekárnych úverov sa účelovo zaberajú nové plochy, ktoré sú ekonomicky výhodné a disponibilné z hľadiska ich vlastníctva. Zmenu poľnohospodárskej pôdy na stavebné pozemky si presadzujú developéri, ktorých projekty nie sú vzájomne zosúladené a prevádzkovo previazané s pôvodnými sídlami. Nesúlad rozvojových zámerov spôsobuje funkčnú nekomplexnosť územia, zaostávanie výstavby občianskej vybavenosti, absenciu verejných plôch, detských ihrísk a zelene a hlavne nedostatok disponibilnej dopravnej a technickej infraštruktúry, Typická pôvodná sebestačnosť a autonómnosť vidieka sa postupne narúša. Nové rezidenčné lokality sú závislé na automobilovej doprave, parazitujú na infraštrukturálnej vybavenosti pôvodnej vidieckej obce a väčšina obyvateľov každodenne migruje za prácou do miest.

ÚZEMNÉ VYMEDZENIE PREDMETU SKÚMANIA
Pod zázemím mesta sa chápe priestor, ktorý obklopuje jeho administratívne územie a siaha do vzdialenosti cca 30 km od jeho ťažiska. Podľa vzdialenosti územia od centra mesta sa v literatúre pre tento priestor používajú označenia: okrajové pásmo mesta (angl. fringebelt), mestský tieň (angl. urban schadow), vidiecke zázemie (rural hinterland) alebo medzimesto (nem. Zwishenstadt), v ktorom sa ešte uplatňuje vplyv mesta, ktorý postupne slabne. Do tohto územia sa mesto rozširuje, rozlieva, redne (angl. urban sprawl) obytnými satelitmi. Podľa Straszewicza (1985) sa v tomto priestore nachádzajú vidiecke sídla a satelity obývané ľuďmi pracujúcimi a študujúcimi v centrálnom meste.

Pre potreby výskumu sa „zázemie mesta“ zadefinovalo ako priestor za administratívnymi hranicami mesta, ktorý je tvorený sídlami, plochami areálov výroby, skladov, dopravy, technickej infraštruktúry a podobne a „medzipriestorom“, t.j. priestorom voľnej krajiny.
V rámci výskumu sa pozornosť upriamila na sídla ležiace v Bratislavskej aglomerácií, ktorá sa radí medzi ekonomicky najsilnejšie a najdynamickejšie sa rozvíjajúce regióny v sídelnom systéme Slovenska. Za ostatných dvadsať rokov nastal výrazný prílev nových obyvateľov do priľahlých vidieckych sídiel ležiacich v zázemí Bratislavy, ako aj do prihraničných území Rakúska a Maďarska (Kittsee, Wolfstahl, Rajka...). Rezidenčná suburbanizácia sa naplno rozvinula a rozvíja hlavne v tých sídlach, ktoré ležia v atraktívnom krajinnom prostredí, v optimálnej dopravnej dostupnosti do mesta a stále si zachovávajú svoju špecifickú vidiecku atmosféru a identitu.

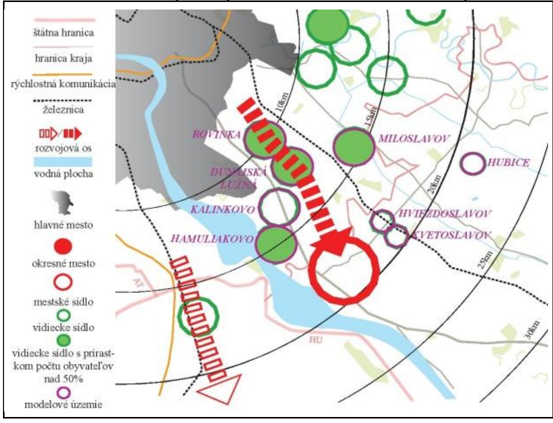
CIELE A METÓDA SKÚMANIA

V rámci výskumu sa, vo vidieckych sídlach s výraznou rezidenčnou výstavbou, vyhodnocovalo plošného rozširovanie ich zastavaného územia za hranicu intravilánu. Na základe získaných analytických poznatkov z terénnych prieskumov, voľne dostupných štatistických databáz a územnoplánovacích dokumentácií sa identifikovali a formulovali základné znaky nových obytných zón a ich dopad na kvalitu a efektivitu fungovania vidieckych sídiel. Vyhodnotením a komparáciou získaných poznatkov sa stanovili požiadavky pre rozvoj suburbánnych území.

CHARAKTERISTIKA REZIDENČNÝCH SÍDIEL

Ako modelové územia sa vytipovali vidiecke sídla Rovinka, Hamuliakovo, Miloslavov, Kvetoslavov, Dunajská Lužná, Kalinkovo, Hubice a Hviezdoslavov, ktoré sú súčasťou juhovýchodnej Dunajsko-stredskej sídelnej rozvojovej osi Bratislavského regiónu (Obr. 1). Územný rozvoj sledovaných lokalít bol zakotvený v platných územných plánoch obcí. Skúmané sídla dosiahli, za ostatných dvadsať rokov, výrazné prírastky počtu obyvateľov (od cca 20% - Hubice až po 515 % - Hviezdoslavov) (Tab. 1), ktoré sa odvíjali od dostupnosti integrovanej dopravy a súčasne značný úbytok poľnohospodárskej pôdy (od 2,5% výmery katastra - Kalinkovo až po 19,1% - Hamuliakovo, v priemere 311,2 m^2/ob.).

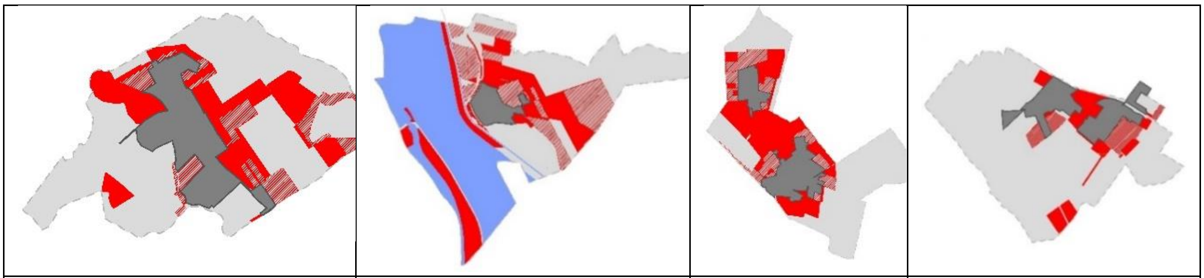
Tab. 1 Prírastky obyvateľov v modelových sídlach v rokoch 1996 - 2018 (Štatistický úrad SR, 2018)



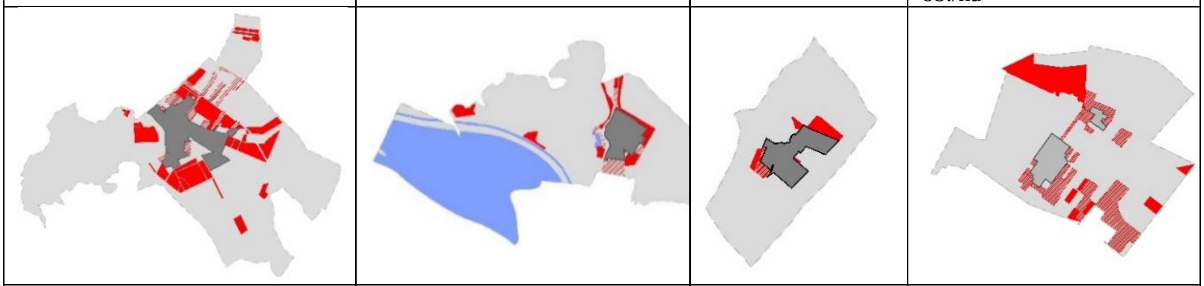
Vidiecke sídlo	Počet obyvateľov		Celkovýprírastok počtu obyv. za roky 1996 -2018 v %
	rok 1996	rok 2018	
Rovinka	1205	4319	258,5
Hamuliakovo	798	2212	83,6
Miloslavov	786	3035	286,1
Kvetoslavov	755	1524	101,9
Dunajská Lužná	2818	6698	137,7
Kalinkovo	856	1375	60,6
Hubice	506	606	19,8
Hviezdoslavov	297	1829	515,8

Obr. 1 Dunajsko-stredská rozvojová os s modelovými sídlami (Sopirová, A., Bradová, I., 2018)

Rozvoj vidieckych sídiel je legislatívne stanovený v platných územnoplánovacích dokumentáciách. Zámery navrhované v schválených územných plánoch modelových sídiel predpokladali rozšírenie pôvodného zastavaného územia o 39% - Hubice až 775% - Hamuliakovo (Obr. 2). Pri porovnávaní navrhnutých rozvojových území a z toho zrealizovaných lokalít sa dospelo k záveru, že tieto dokumenty neodzrkadľujú reálne potreby a možnosti územia. Aj keď územné plány sú výhľadové územnoplánovacie dokumenty, so stanoveným časovým horizontom realizácie zámerov, väčšina navrhnutých území je dosiaľ nezastavaných: 9% Hubice až 329% Hamuliakovo (Obr. 2). Napriek tomu sa tieto dokumenty sústavne aktualizujú, s cieľom vyčleniť nové, potenciálne plochy pre stavebný rozvoj.



Rovinka	Hamuliakovo	Miloslavov	Kvetoslavov
RZ z ÚPN: +169% intrav. z toho zrealiz.: + 63% intrav. Intenzita zást. v ZÚ: 31 ob./ha	RZ z ÚPN: +775% intrav. Z toho zrealiz.: +329% intrav. Intenz. zást. v ZÚ: 54 ob./ha	RZ z ÚPN: 683% Z toho zr..: +195% In.v ZÚ: 19 ob./ha	RZ z ÚPN: +173% intrav. z toho zrealiz.:+47% intrav. Intenz. v ZÚ: 14 ob./ha



Dunajská Lužna	Kalinkovo	Hubice	Hviezdoslavov
RZ z ÚPN: +156% intrav. z toho zrealiz.: + 33% intrav. Intenzita zást. v ZÚ: 28 ob./ha	RZ z ÚPN: +114% intrav. z toho zrealiz.: +37% intrav. Intenzita zást. v ZÚ: 25 ob./ha	RZ z ÚPN: +38% z toho zr.: +9% In.v ZÚ: 11 ob./ha	RZ z ÚPN: +453% intrav. z toho zrealiz.:223% intrav. Intenz. v ZÚ: 37 ob./ha

Obr. 2 Percentuálny pomer navrhovaných a zrealizovaných rozvojových zámerov k intravilánu sídla (Sopirová, A., Bradová, I., 2018)

Extenzívny rast sídla narúša historicky formovanú krajinnú štruktúru a znižuje ekologickú stabilitu územia. V dôsledku ekonomickej atraktivite pozemkov sa mení funkcia okolitej krajiny, zmenšuje sa poľnohospodársky využívaná pôda, časť z nej sa transformuje na zastavané územie (Obr. 3). „Mení sa vizuálny aj symbolický obraz lokality. Nová živelná výstavba preniká do pôvodnej hmotovo-priestorovej štruktúry moderným architektonicko-urbanistickým dizajnom, vytvára nové dominanty, priehľady a akcenty, prináša nezvratné zmeny do siluety sídla a obrazu krajiny“ (Sopirová, 2016).

Obr. 3 Expanziou novej výstavby do voľnej krajiny, zmena siluety sídla a obrazu krajiny, prelínanie nesúrodých architektonických foriem (foto: Sopirová, 2014)

Zo sociálneho hľadiska je suburbánne územie podľa Sedlákovej (2006) charakteristické prelínaním vidieckeho spôsobu života autochtónneho obyvateľstva s mestským spôsobom života alochtónneho obyvateľstva, ktoré sem migruje. V súčasnosti sem prichádzajú hlavne mladé rodiny s deťmi, ktoré preferujú lokalitu s priaznivým životným prostredím a úzkym kontaktom s prírodou. Carter (1995) dospel k záverom, že asimilácia nových obyvateľov je pomalá, žijú síce na vidieku ale sociálne a ekonomicky do neho nepatria.

Nové sociálno-priestorové podmienky sa prejavujú segregáciou vzťahoch a väzieb pôvodnej a novej štruktúry. Existujúca zástavba skúmaných vidieckych sídiel vykazuje nízke intenzity zástavby od 11 ob./ha – Hubice až po 54 ob./ha – Hamuliakovo (Obr. 3) a väčší podiel nezastavaných plôch, ktoré predstavujú disponibilné rezervy pre jej rozvoj. Pri zahusťovaní disponibilnej vnútornej štruktúry sídiel dochádza k reparcelácii pozemkov, novým proporciám a orientácii objektov, porušovaniu stavebnej čiary a výškovej hladiny zástavby. V mnohých prípadoch sa pre výstavbu zaberajú zadné trakty dlhých záhrad. Nové rodinné domy sú prístupné tzv. „hrebeňovou zástavbou“, pozostávajúcou z úzkych slepých ciest, vedených cez pozemok predného domu. Vzniká nová osnova ulíc, ktorá nedodržiava pôvodnú pôdorysnú stopu uličnej zástavby a narúša „rokmi formovanú logiku previazanosti prevádzkových vzťahov a smerov rozrastania sa priestorovej štruktúry“ (Sopirová, 2019). V okrajových častiach sídla vznikajú nové obytné lokality, ktoré sa vyznačujú typicky mestskými formami radovej zástavby rodinných a blokovej bytových domov (Obr. 5). Ich väzba na prevádzkovú štruktúru pôvodného vidieckeho sídla je minimálna, niektoré časti sú uzavreté, oplotené a vytvárajú v území nepriechodné bariéry.


Obr. 4. Hviezdoslavov - nová výstavby rovnakých typov rodinných domov (foto: Sopirová,2019)
Obr. 5 Dunajská Lužná - výstavba mestských bytových domov s vnútroblokmi využívanými pre sociálne kontakty obyvateľov (foto: Sopirová, 2019)

ZNAKY NOVÝCH OBYTNÝCH ZÓN

Monotónnosť územia je jedným z charakteristickým znakom nových rezidenčných zón. Plošne rozsiahle formy koncentrácie bývania prevažne rodinných domov, s rovnakou intenzitou a charakterom zástavby (Obr. 4). Tieto, niekedy až sterilne pôsobiace štvrte s nivelizovanou výškovou hladinou a častým opakovaním rovnakých typov objektov na malých pozemkoch, sú v kontraste s pôvodnou zástavbou a prispievajú výraznou mierou k strate miestnej identity, jedinečnosti a regionálnej znakovosti. Monotónnosť územia sa dá pozitívne potlačiť dynamikou reliéfu a častým striedaním typologických druhov, od izolovaných a radových rodinných domov, až po rôzne formy bytových domov.

Monofunkčnosť územia je ďalším negatívnym znakom. Prejavuje sa dominanciou rezidenčného segmentu a nerovnomerným zastúpením kvantitatívne a kvalitatívne vyhovujúcej základnej občianskej vybavenosti, služieb a športovo-rekreačných plôch. Podiel vybavenosti v území by sa mal proporcionálne zvyšovať s rastom počtu obyvateľov. Skutočnosť je taká, že väčšina nových obytných zón je závislá na existujúcich, kapacitne obmedzených zariadeniach (obchodných, školských, zdravotníckych, športových, kultúrnych zariadení).

V posledných rokoch sa aj na vidieku začína presadzovať výstavba malopodlažných bytových domov s komerčnou občianskou vybavenosťou integrovanou v ich v parteri (Obr. 7). Aj napriek flexibilite navrhovaných priestorov sú tieto často neobsadené alebo podliehajú značnej funkčnej obmene. S časovým posunom sa budujú malé nákupné centrá, spravidla lokalizované v okrajových pozíciách, pri dôležitých križovatkách a dopravných vstupov do sídla, výlučne viazané na individuálnu automobilovú dopravu (Obr. 6). Podľa Melcerovej (2012) excentrická poloha týchto zariadení zvyšuje intenzitu miestnej dopravy ale aj sociálnu segregáciu nových obyvateľov, ktorí nevyužívajú lokálne zariadenia. Nákupné centrá sa riešia s vnútornými obchodnými pasážami, ktoré suplujú chýbajúce verejné stretávacie priestory, ktoré sú obsadené statickou dopravou.. Súčasťou pasáži bývajú reštaurácie, cukrárne, detské ihriská, kultúrne zariadenia, privátne zdravotnícke a sociálne zariadenia, materské školy, kluby dôchodcov, posilňovne a pod. (Obr. 5).

Obr. 6. Nákupné centrum, situované medzi sídlami Rovinka a Dunajská Lužná (foto: Sopirová, 2019)
Obr. 7 Segregácia bývania a občianskej vybavenosti v parteri bytového domu (foto: Sopirová, 2018)

Neurčitá identifikácia územia sa vyznačuje absenciou hierarchicky vymedzených a typologicky rozmanitých, aktívnych verejných priestorov (námestí, parkov, ulíc...). V nových obytných lokalitách dominuje výlučne cestný koridor s obslužnou funkciou a plochami pre statickú dopravu.
V súčasnej dobe presýtenia realitného trhu neobývanými novými rodinnými domami, potencionálni záujemci vyhľadávajú lokality s jedinečnou atmosférou, ktorú vytvára práve existencia aktívnych verejných priestorov.
Sociálna izolácia je v nových obytných súboroch spôsobená vysokými, často nepriehľadným oploteniami rodinných domov, ktoré vymedzuje úzky, stiesnený uličný priestor bez zelene, chodníkov, možnosti parkovania a vzájomnej interakcie lokálnej komunity (Obr. 8). Niekedy sa tieto úzke, jednosmerné obytné ulice, pozitívne menia na „zelené“ koridory, ktoré aj napriek výraznému bariérovému efektu a stiesnenému uličnému priestoru, pôsobia so zeleňou príjemne a útulne (Obr. 9).
Verejné priestory sa v niektorých zoskupeniach rodinných domov nahrádzajú aj slepými ulicami, uzavretými rampou s kontrolovaným vstupom, prístupnými len pre rezidentov. Dá sa konštatovať, že tieto priestory nefungujú v súčinnosti s okolím a spôsobujú izoláciu lokálnej komunity.


Obr. 8. Obytná ulica bez chodníkov a zelene, ohradená vysokým oplotením (foto: Sopirová, 2016)
Obr. 9 Pozitívny príklad úspešného zútulnenia obytnej ulice zeleňou (foto: Sopirová, 2016)

ZÁVER

Skúmaním sa potvrdilo, že pre zvýšenie kvality bývania, vo vidieckych sídlach ležiacich v zázemí miest, je dôležité obmedziť ich extenzívny rast, optimálne limitovať ich rozširovanie a pre ďalší rozvoj hľadať disponibilný potenciál pre novú výstavbu v ich vnútornej štruktúre.
Pre celkové skvalitnenie obytného prostredia by sa mala pozornosť upriamiť na:

- zachovanie „génia loci“ danej lokality,
- koncepciu hierarchizácie jednotlivých funkčných častí sídla,

- prelínanie atribútov charakteristických pre vidiecku zástavbu s novými znakmi obytného prostredia,
- navrhovanie aktívnych verejných priestorov, ktoré môžu byť impulzom pre podporu komunitného života.
- hľadanie optimálnej miery integrácie bývania so zariadeniami občianskej vybavenosti, vrátane služieb a pracovných príležitostí, čím sa dosiahne väčšia sebestačnosť a komplexnosť územia, ako aj prevádzková efektivita a súčasne sa čiastočne zníži mobilita obyvateľov.

LITERATÚRA

Carter, H. (1995). The Study of Urban Geography. *Arnold, London, 0713165898 (UK)0470235349 (USA), 420 s.*

Melcerová, O. (2012). Riešenie negatívnych dopadov vytvárania monofunkčných obytných súborov vonkajšieho mesta. *In: Člověk, stavba a územní plánování VI. ČVUT v Praze, Fakulta stavební (2012). Str. 103-107. ISBN: ISBN 978-80-01-05025-5.*

Sedláková, A. (2006), Urbánny a suburbánny priestor - k otázke konceptualizácie prímestskej zóny. *VII. Konferencia doktorandov a vedeckých pracovníkov, Univerzita Konštantína Filozofa, Nitra, 2006, http://www.akademickyrepozitar.sk/sk/repozitar/urbanny suburbanny-priestor.pdf.*

Sopirová, A. (2016). . Sídla ležiace v zázemí miest v čase a priestore = Settlements located in the backround cities in time and space. *In Czech Journal of Civil Engineering [elektronický zdroj]. Vol. 2, iss. 1 (2016), online, s. 95-101. ISSN 2336-7148.*

Sopirová, A., Bradová, I. (2018). Verejná scéna v suburbánnych vidieckych sídlach = The Public Scene in Suburban Rural Settlements. *In Člověk, stavba a územní plánování 11, České vysoké učení technické v Praze, 2018, S. 52-69. ISSN 2336-7687. ISBN 978-80-01-06482-5.*

Sopirová, A. (2019). Transformácia okrajových mestských častí na rezidenčné predmestia Bratislavy. *In: Mestská časť Bratislava - Záhorská Bystrica ulica Československých tankistov. 1. vydanie. Bratislava : Vydavateľstvo SPEKTRUM STU, 2019, S. 16-21. ISBN 978-80-227-4878-0.*

Straszewicz, L. (1985). Strefa podmiejska, pojecia a definicje. *Acta Universitatis Lodziansis, Folia Geographica 5.*

Štatistický úrad SR. *(2018). Databáza CUBE, http://www.statistics.sk (on-line3.10.2018)*

SMALL SACRAL ARCHITECTURE IN THE COMMUNE JAROK

DROBNÁ SAKRÁLNA ARCHITEKTÚRA V OBCI JAROK

Roberta ŠTĚPÁNKOVÁ[1], Miroslav ČÍBIK[1], Ľubica FERIANCOVÁ[1]

[1]*Katedra záhradnej a krajinnej architektúry, Fakulta záhradníctva a krajinného inžinierstva, SPU v Nitre*

Abstract
The objects of small sacral architecture are an integral part of the built-up area of rural settlements and rural landscape. They represent a historical-cultural heritage and they can be taken as a potential that supports current and future process in boroughs, which are the reasons for their exploration and for taking subsequent steps leading to their preservation for future. This paper is a presentation of partial results of the research carried out within the project VEGA 1/0371/18 SakralArch: Preservation of historical legacy and architectural diversity of small sacral buildings in the cultural landscape of Slovakia, the grant agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic. The paper presents a partial research methodology and objects of small sacral architecture located in the village of Jarok in the district of Nitra. The results point to the condition of the buildings, but also to the context of their potential use and the possibility of choosing a suitable approach to the management of activities aimed at their conservation, maintenance or restoration through appropriately set spatial on local level.

Key words: small architecture, potential, local planning tools.

ÚVOD

Jednotlivé prvky drobnej sakrálnej architektúry (DSA) sú neoddeliteľnou súčasťou priestorov vidieckych sídiel a vidieckej krajiny a dotvárajú ich obraz. Tóth (2017) uvádza, že Schneeweis (1987) považuje sakrálne prvky v krajine za klenoty "Podunajskej sakrálnej krajiny" a podľa Kilitschku (1987) sú často označované ako "poľné pamätníky", ktoré sa nachádzajú pri starých hradských alebo poľných cestách, pri ich križovatkách, v historických uličných priestoroch, na námestiach a v centrách obcí, na miestach pôvodných mestských brán, vyvýšených miestach alebo ako medzníky a orientačné body a sú svedkami našej premenlivej a bohatej minulosti.
História stavania krížov pri cestách, na krížnych cestách a v chotároch obcí sa viaže na obdobie prijatia kresťanstva. Niekedy stáli na miestach, kde si ľudia v predkresťanskom období s veľkou pravdepodobnosťou uctievali rôzne božstvá. Neraz sa prícestná kaplnka stala obľúbeným pútnickým miestom (Nádaská, 2013). Rozmach nastal v 17. storočí počas rekatolizácie, keď sa kríž či kaplnka, respektíve iný objekt DSA, stali symbolom katolicizmu nad potlačením reformácie.
Kríže sa stavali ako výraz úcty a zbožnosti s jediným zámerom – aby sa pri nich ľudia pristavili v krátkej modlitbe.a podávajú svedectvo o zručnosti tvorcov, ich estetickom cítení aj o náboženskej úcte našich predkov.
Dohnalová (2015) radí objekty DSA ku kultúrnym artefaktom a konštatuje, že zhmotňujú jedinečnosť kultúry daného regiónu, obce alebo miesta. Odrážajú ich znaky a upozorňujú tak na kultúrno-historické hodnoty. Podľa Halajovej (2018) typy DSA podrobne popísali Dohnalová (2015) a Matáková (2011). Dohnalová (2015) ich rozdeľuje na osem hlavných skupín (kríž, Božia muka, kaplnka, zvonička, architektonicko-figurálna kompozícia,ostatné drobné sakrálne objekty), ktoré ďalej člení podrobnejšie.
DSA má viaceré funkcie, ktoré získala historicky. Zachováva a umocňuje duchovné hodnoty vidieckej krajiny a kresťanskú tradíciu pre budúce generácie (Tóth, 2017). Bihuňová a Michalica (2018) konštatujú, že krajina je kreovaná nie len prírodnými procesmi, ale aj ľudskými aktivitami. DSA aktuálne zohráva významnú úlohu v obnove a v tvorbe vidieckej krajiny (Tóth, Feriancová, 2013). V rámci vidieckych sídiel pozitívne vplýva na rozvoj miestneho cestovného ruchu, keďže prispieva

k zvýrazneniu lokálnej identity sídla (Kalinová, 2004). Prítomnosť kultúrnych a historických hodnôt, ktorých nositeľom sú objekty DSA, sa považuje za silné stránky v rámci SWOT analýzy Stratégie hospodárskeho a sociálneho rozvoja združenia obcí mikroregiónu Veľké Zálužie – Lehota – Jarok – Báb – Rumanová (Dubcová, Kramáreková, Morvayová, 2008).

MATERIÁL A METÓDY

Predmetom skúmania v tomto príspevku boli prvky DSA v obci Jarok, ktorá sa nachádza na západnom Slovensku, v kultúrnom regióne Ponitrie - Dolná Nitra. Obec je súčasťou Nitrianskeho kraja, okresu Nitra a nachádza sa 10 km juhozápadne od okresného mesta Nitra. Kataster obce je súčasťou Podunajskej pahorkatiny a doliny potoka Dlhý kanál. Pôvodný názov obce bol IREG, čo znamená pozemok zdedený po otcovi - dedičstvo. Obyvatelia Jarku sa živili prevažne poľnohospodárstvom. Mimo obilia pestovali hlavne konope, ktoré bolo využívané na výrobu konopného plátna a povrazov, ale z konopných semien lisovali hlavne olej (Základné info Obec Jarok; Privalincová, 2018).

Prvá zmienka o Jarku sa nachádza v tzv. "druhej Zoborskej listine" z roku 1113 napísanej v koži, na 51 riadkoch po latinsky. Jarok, obecný chotár, boli v tej dobe pravdepodobne kráľovským majetkom, pretože v roku 1349 daroval kráľ Ľudovít I. majetok Ireg vtedajšiemu významnému štátnikovi palatínovi uhorského kráľovstva, Mikulášovi Konthovi (O Obci).

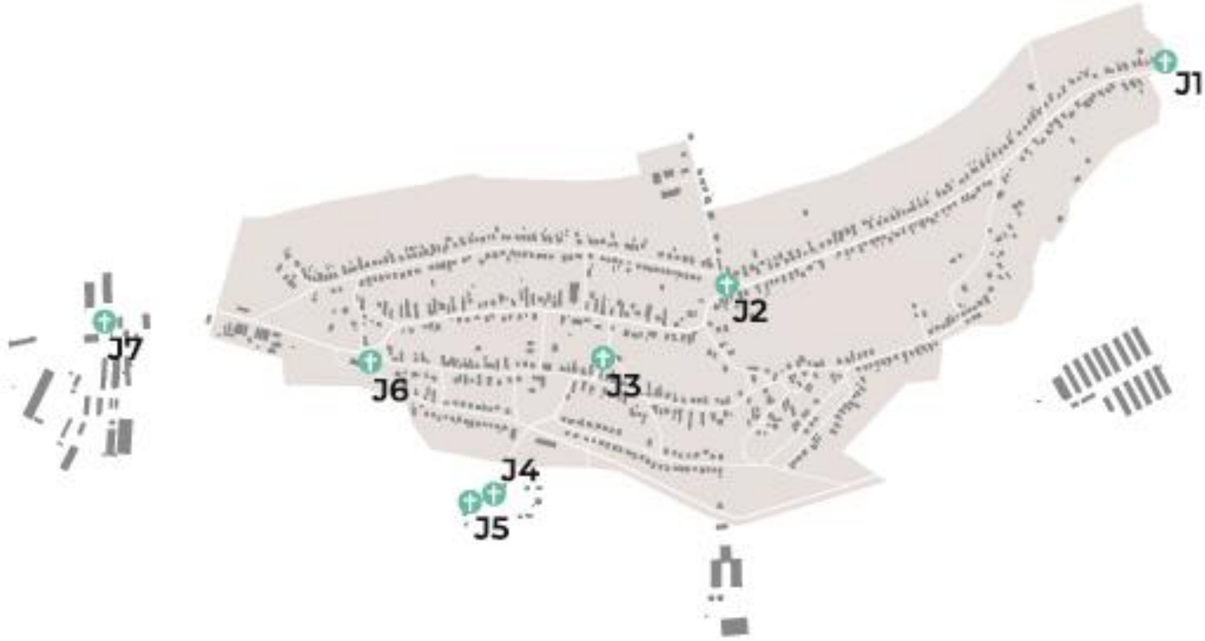
Kataster obce aj zastavané územie v smere východ-západ pretína cesta III. triedy, III/1640 Jarok – Nitra, v smere sever-juh pretína kataster cesta III/1655 Veľké Zálužie – Jarok a v smere západ-východ cesta III/1690 obec Jarok. Podľa geomorfologického členenia sa riešné územie rozprestiera v oblasti Podunajská nížina, v celku Podunajská pahorkatina, v podcelku Nitrianska pahorkatina, v časti Zálužianska pahorkatina.

Obec je pomerne bohatá na prvky kultúrno-historického dedičstva (Privalincová, 2018 a). Nachádzajú sa tu nehnuteľné národné kultúrne pamiatky, evidované v Ústrednom zozname pamiatkového fondu (ÚZPF) a architektonické pamiatky a solitéry, ktoré nie sú zapísané v ÚZPF, ale majú nesporné historické a kultúrne hodnoty. Medzi ne patria: kríž pred kostolom sv. Martina; socha sv. Vendelína - patrón pastierov a pútnikov i ako ochranca zvierat a poľnej úrody; kríž na začiatku obce pri ceste III. Triedy; kríž a socha sv. Urbana - ochranca vinohradníkov; kríž na počesť skončenia II. sv. vojny; socha sv. Floriána - patróna hasičov a záchranárov; kríž na konci obce, pri družstve. Vymenované sa zhodujú s objektami DSA, ktoré boli predmetom nášho výskumu. Výsledky prezentované v tomto príspevku sú súčasťou výskumu v rámci projektu VEGA 1/0371/18 SakralArch: Zachovanie historického odkazu a architektonickej diverzity drobných sakrálnych stavieb v kultúrnej krajine Slovenska. Prezentovaná metodika je len časťou rozsiahlej metodiky (Tóth, 2018), ktorá je použitá v rámci projektu a je zameraná na lokalizáciu, priestorový context a podrobný opis prvkov drobnej sakrálnej architektúry a ich evidenciu v historických mapových podkladoch vojenského mapovania, zhotovenie fotodokumentácie. V metodike bol postup vypracovaný podrobne (Tóth, 2018). V Tab. 1. sú prezentované výsledky prieskumu v obci Jarok. Skúmané objekty sme pracovne označili J1 – J7. Priestorový context je označený I – intravilán; I/E – poloha objektu DSA na hranici zastavaného územia s extravilánom; E – mim zastavané územie. Celkový technický stav objektu a stupeň poškodenia sme hodnotili nasledovnou (v opisnom texte s uvedením podrobností) škálou hodnotenia:

0. dobrý technický stav / zachovalý alebo rekonštruovaný objekt (poškodenie v rozsahu 0 %); 1. objekty s nepatrným poškodením (poškodenie v rozsahu 1-10 %); 2. objekty so slabým poškodením (poškodenie v rozsahu 11-25 %); 3. objekty so stredným poškodením (poškodenie v rozsahu 26-60 %); 4. objekty s ťažkým poškodením (poškodenie v rozsahu 60-69 %); 5. objekty značne poškodené / zničené (poškodenie v rozsahu 70-100 %). V snahe zistiť obdobie osadenia DSA sme overovali evidovanie objektu v historických mapových podkladoch období vojenského mapovania (1. 1782-1785; 2. 1819-1869; 3. 1869-1887).

VÝSLEDKY A DISKUSIA

V obci Jarok bolo skúmaných 7 objektov drobnej sakrálnej architektúry (J1 – J7). Všetky sa nachádzajú v dnes zastavanom území obce, prípadne na jeho okraji. Umiestnenie objektov je znázornené na Obr. 1. Podrobnejšie výsledky výskumu sú uvedené v Tab. 1. Každý objekt je slovne podrobne popísaný.



Obr. 1 Umiestnenie objektov drobnej sakrálnej architektúry v obci Jarok. Zdroj: autori 2019

J1 – Drevený kríž na začiatku obce na pravej strane v smere od Nitry (Obr. 3). Podstavec je vysoký asi 90 cm a má obdĺžnikový pôdorys 25/11 cm s tromi zvislými dekoratívnymi zárezmi. Horná časť kríža je z dreveného profilu prierezu 7/16 cm. Kríž má výšku 3,00 m a kratšie vodorovné rameno je široké 1,00 m. Na kríži je umiestnená 1,00 m vysoká plastika Krista z bližšie nezisteného kovu nedávno natretá striebornou farbou. Nad hlavou je umiestnený nápis INRI na kovovej doske rovnako natretý. Pred krížom je plocha veľkosti 3,00x3,00 m vydláždená sivou zámkovou dlažbou rozmerov 10/20 cm. Pri päte kríža je niekoľko svietnikov plast/kov, dve vázy, v jednej sa nachádza kytica z plastových kvetov. V pozadí objektu je nálet. Kríž je nepatrne poškodený.

J2 – Kríž osadený na počesť skončenia II. svetovej vojny sa nachádza v rámci zastavaného územia obce, pri ústí ulice Záhumnice do ulice Hlavnej (Obr. 4) na verejnom priestranstve. Samotný objekt kríža s podstavcom sú estetické a dôstojne pripomínajú ukončenie II. svetovej vojny. Osadený bol v roku 1948, čo dokazuje aj nápis na podstavci. Pravdepodobne bol umiestnený na mieste pôvodnej DSA, ktorú zachytáva na tomto mieste mapa tretieho vojenského mapovania z rokov 1869-1887. Kamenný kríž má betónový trojstupňový podstavec. Pôdorysné rozmery stupňov od spodného najväčšieho sú 100/45 s výškou 23 cm, 90/40 s výškou 26 cm a 8/35 cm s výškou 20 cm. Na podstavci je hranolová základňa vysoká 105 cm s pôdorysom 54/28 cm, na nej je doska vysoká 10 cm s pôdorysom 65/31 cm. Na tejto podstave je umiestnený žulový kríž s výškou 2,00 m. Kratšie vodorovné rameno má šírku 0,60 m a prierez je 10/10 cm. Zvislé rameno má po celej dĺžke dekoratívny otvor a prierez je 13/10 cm. Kríž s podstavcom sú dobrom technickom stave. Okolo kríža je nevkusná dekoratívna betónová ohrada s rovnako nevhodnou a nevkusnou kovanou bráničkou umiestnenou za krížom. Ohrada aj brána sú natreté na bielo. Ohradený pôdorys má rozmery 5,00/4,00 m. Okolo podstavca je betónový chodník a nekoncepčné neudržiavané výsadby letničkami. Pred podstavcom sú umelé kvety v plastovom kvetináči. Na stranách kríža sú dva vzrastlé ihličnany, smrek pichľavý *Picea pungens* Engelm s výškou 18,00 m, obvod kmeňa 1,45 m a duglaska tisolistá *Pseudotsuga menziesii* (Mirb.) Franco vysoká 15,00 m, obvod kmeňa 1,30 m.

J3 – Socha sv. Floriána – patróna požiarnikov umiestnená na podstavci sa nachádza v tesnej blízkosti hasičskej zbrojnice na Hasičskej ulici (Obr. 5). Výška podstavca je 1,75 m a výška sochy je 1,70 m. Podstavec má pôdorys 75/60 cm, je tvarovo štylizovaný v drieku má rozmer 40/40 cm. Platňa slúžiaca ako podstavec sochy má rozmer 75/65 cm a výšku 13 cm. Materiál podstavca aj sochy je patinovaný betón a umelý kameň. Okolie objektu je dláždené zámkovou dlažbou, bez kvetinovej výzdoby. V tesnej blízkosti objektu hasičskej zbrojnice sa nachádza zdravá breza previsnutá *Betula pendula* Roth vysoká 12,00 m s obvodom kmeňa 1,20 m.

Obr. 3 Prícestný kríž (objekt J1). Foto: Štěpánková, 2018

Obr. 4 Kríž na počesť ukončenia II. svetovej vojny (objekt J2). Foto: Štěpánková, 2018

Obr. 5 Socha sv. Floriána (objekt J3). Foto: Štěpánková, 2018

Obr. 6 Socha sv. Urbana na podstavci (objekt J4). Foto: Štěpánková, 2018

Obr. 7 Socha sv. Vendelína na podstavci (objekt J6). Foto: Štěpánková, 2018

Obr. 8 Drevený kríž (objekt J7)s nevhodnými úpravami. Foto: Štěpánková, 2018

J4 – Socha sv. Urbana – patróna vinohradníkov umiestnená na podstavci sa nachádza na južnom okraji zastavaného územia obce, v areáli vinohradu, ktorý je oplotený (Obr. 6). Výška podstavca je 1,05 m a výška sochy je 1,10 m. Podstavec má pôdorys 47/40 cm, je hranatý, v drieku má rozmer 36/36 cm. Platňa slúžiaca ako podstavec sochy má rozmer 47/40 cm a socha má podstavec 34/26 cm. Materiál

podstavca aj sochy je patinovaný betón a umelý kameň. Objekt je umiestnený na betónovom základe s pôdorysným rozmerom 110/110 cm. V pozadí objektu je náletový porast a vysadená lipa *Tilia* sp. S výškou 1,50 m, je poškodená.
J5 – Drevený kríž sa nachádza na južnom okraji zastavaného územia obce, v areáli vinohradu, ktorý je oplotený. S objektom J4 tvoria skupinu, ktorú dopĺňajú drevené poškodené lavičky. Kríž je nový, má výšku 3,50 m a vodorovné rameno má šírku 1,25 m. Profil konštrukcie kríža je 13/13 cm, je čerstvo natretý hnedou farbou. Plastika Krista je z bližšie neurčeného kovu, natretá na žltozlato. Nad vodorovným ramenom a vrcholom kríža je hnedá plechová polkruhová strieška, pod ňou nápis INRI. V pozadí kríža je náletový porast. Drevený kríž je identifikovaný aj na mape 1. vojenského mapovania (1782-1785).
J6 – Socha sv. Vendelína – patróna životného prostredia, ochrancov prírody, pastierov, roľníkov je na podstavci (Obr. 7). Nachádza sa medzi ulicami Hlavná a Pod kostolom v zastavanom území obce na voľnom priestranstve verejného priestoru pri zastávke. Socha je umiestnená na 170 cm vysokom betónovom podstavci pôdorysu 45/60 cm, v drieku 40/36 cm, na ktorom je vyrytý patinovaný nápis: „*In Honorem S. Vendelin e PHij Fidelium Oblatis curata Anno 1865 die 23. Octobris benedicta*.“ Socha sv. Vendelína má výšku 110 cm, na doske 60/45 cm. Plocha okolo objektu je vydláždená dlažbou s rozmermi 10/10 cm a 10/20 cm v rozsahu 3,00/3,00 m. Pri podstavci sú umiestnené 3 kameninové kvetináče bez výsadby, na oboch stranách objektu sú vysadené ťahavé ruže *Rosa* sp.
J7 – Drevený kríž umiestnený na západnom okraji zastavaného územia obce pri miestnej komunikácii (Obr. 8). Úpravy okolo objektu sú tvorené múrikom z tvárnic, ktorý je v tvare U s rozmermi 3,00/3,00 m, plocha je dláždená betónovou dlažbou s rozmermi 30/30 cm. K ploche vedú od komunikácie 4 betónové stupne. Kríž drevený z hranolu 15/11 cm, natretý na hnedo, farba sa miestami olupuje, je na betónovom podstavci 40/30 cm na kamennej doske 50/50 cm. Výška je 3,05 m, šírka vodorovného ramena je 0,75 m. Figúra Krista je natretá na bielo. Na vrchole je umiestnený nápis I.N.R.I. Pri päte kríža je nádoba s plastovou kyticou. Úpravy okolo objektu sú pomerne nové, nevhodné.

Obr. 2 Znázornenie skúmaných objektov drobnej sakrálnej architektúry na mape obce Jarok z obdobia 3. vojenského mapovania. Zdroj: Habsburg Empire (1869-1887), upravili Čibik, Štěpánková, 2018

Tab. 1 Hodnotenie objektov drobnej sakrálnej architektúry v obci Jarok. Zdroj: Štěpánková, 2018

Objekt	m.n.m	Ulica	Číslo cesty	Priestorový kontext	Typ objektu	Materiál objektu	Poškodenie	Nápis	Oplotenie	Vojenské mapovanie		
										1. 1782-1785	2.1819-1869	3. 1869-1887
J1	168	Hlavná	III/ 1640	I/E	kríž	drevo	1	INRI	nie	nie	áno	áno
J2	161	Hlavná/Záhumnice	III/ 1640	I	kríž	podstavec - betón, kríž - žula	1	1948	áno	nie	nie	áno *
J3	151	bez názvu	miestna spevnená	I	stĺp so sochou sv. Floriána	betón	1	nie	nie	nie	nie	áno
J4	184	bez názvu	poľná cesta	I/E	stĺp so sochou sv. Urbana	betón	3	ANNO 1821	nie	nie	áno	áno
J5	183	bez názvu	poľná cesta	I/E	kríž	drevo	0	INRI	nie	áno	áno	áno
J6	145	Hlavná/ Pod kostolom	III/ 1640	I	stĺp so sochou sv. Vendelína	betón	2	áno	nie	nie	áno	áno
J7	152	bez názvu	II/1655	I/E	kríž	drevo	2	i.n.r.i	nie	nie	áno	áno

**pravdepodobne na tomto mieste v uvedenom období existoval objekt DSA, dnes je tu kríž osadený v roku 1948*

Obec má vypracovaný Územný plán (Privalincová, 2018, a), v ktorom autorka konštatuje, že obec je pomerne bohatá na prvky kultúrno-historického dedičstva a vymenúva nehnuteľné národné kultúrne pamiatky, evidované v ÚZPF a architektonické pamiatky a solitéry, ktoré nie sú zapísané v ÚZPF, majúce historické a kultúrne hodnoty: 1. kríž pred kostolom sv. Martina; 2. socha sv. Vendelína - patrón pastierov a pútnikov i ako ochranca zvierat a poľnej úrody; 3. kríž na začiatku obce pri ceste III. triedy; 4. kríž a socha sv. Urbana - ochranca vinohradníkov; 5. kríž na počesť skončenia II. sv. Vojny; 6. socha sv. Floriána - patrón hasičov a záchranárov; 7. kríž na konci obce, pri družstve a i. Objekty sú uvedené aj na výkrese komplexného usporiadania a funkčného využívania zastavaného územia obce (Privalincová, 2018, c) ako verejnoprospešné stavby s odporučením rekonštrukcie objektov. V Záväznej časti Územného plánu (Privalincová, 2018, b) sa navrhuje rekonštrukcia miestnych pamiatok a ich okolia, prezentovať pamiatkový fond vhodnými informačnými smerovými tabuľami v rámci cykloturistiky. Súhlasíme s Kalinovou (2004), že skúmané objekty DSA v obci Jarok majú potenciál pozitívne ovplyvniť rozvoj miestneho cestovného ruchu, keďže prispievajú k zvýrazneniu lokálnej identity sídla. Výskum potvrdil názor Matákovej (2012), že zvláštnou kapitolou sa stáva tzv. obnova a skrášľovanie DSA a ich okolia novodobým nánosom konzumnej kultúry absolútneho nevkusu.

ZÁVER

Dospeli sme k poznaniu, že spôsob úpravy, údržba a skrášľovanie objektov sú realizované dobrovoľníkmi, síce aktívne, ale často s negatívnym účinkom. Za významné považujeme previazanie aktivít vedy a praxe, rovnako ako Tóth (2017), čo je predpoklad zachovania objektov DSA a ich potenciálu. Legislatívny rámec pre toto synergické spolupôsobenie by mal byť vytvorený prostredníctvom územných plánov ako záväzných dokumentov. Územnoplánovacia dokumentácia na úrovni obce a zóny je nástroj, pri tvorbe ktorého by metodika mala obsahovať legislatívnu povinnosť mapovania, hodnotenia, komplexnej dokumentácie a monitoringu pamiatkových objektov obce, a to vrátane DSA. Dôležité však je, aby v záväznej časti územného plánu boli uvedené odporučenia a usmernenia týkajúce sa spôsobu obnovy, prípadnej rekonštrukcie, úpravy okolia a skrášľovania s cieľom zachovania ich potenciálu pre ďalší komplexný lokálny rozvoj.

Abstrakt
Objekty drobnej sakrálnej architektúry sú neodmysliteľnou súčasťou zastavaného územia vidieckych sídiel a vidieckej krajiny. Predstavujú historicko-kultúrne dedičstvo a sú potenciálom, ktorý podporuje súčasné a budúce dianie v obciach, čo sú dôvody na ich skúmanie a následné kroky, vedúce k ich zachovaniu pre budúcnosť. Uvedený príspevok je prezentácia čiastkových výsledkov výskumu, ktorý je realizovaný v rámci projektu VEGA 1/0371/18 SakralArch: Zachovanie historického odkazu a architektonickej diverzity drobných sakrálnych stavieb v kultúrnej krajine Slovenska, grantovej agentúry Ministerstva školstva, vedy, výskumu a športu Slovenskej republiky. V príspevku sú prezentované objekty drobnej sakrálnej architektúry nachádzajúce sa v obci Jarok v okrese Nitra a je prezentovaná čiastočná metodika skúmania. Výsledky poukazujú na stav objektov ale aj súvislosti uplatnenia ich potenciálu a možnosti zvolenia vhodného prístupu ku manažovaniu aktivít smerujúcich ku ich zachovaniu, údržbe, či obnove prostredníctvom vhodne nastavených strategických nástrojov aj územného plánovania na lokálnej úrovni.

Kľúčové slová: malá architektúra, potenciál, nástroje plánovania

POĎAKOVANIE

Výskum prezentovaný v tomto vedeckom článku bol podporený v rámci projektu VEGA 1/0371/18 SakralArch: Zachovanie historického odkazu a architektonickej diverzity drobných sakrálnych stavieb v kultúrnej krajine Slovenska a projektu KEGA 001SPU-4/2017 Ekosystémové služby zelenej infraštruktúry grantových agentúr Ministerstva školstva, vedy, výskumu a športu Slovenskej republiky.

LITERATÚRA

Bihuňová, M., Michalica. A. (2018). Assessment of Small Sacral Objects in the Senica Region, Slovakia. In Acta horticulturae et regiotecturae, vol. 22, no.1/2019, str. 37-40. ISSN 1335-2563.

Dohnalová, B. a i. (2015). Metodika identifikace kultúrních artefaktu v krajině. Brno : Mendelova univerzita. 2015. 297 s. ISBN 978-80-7509-382-0.

Dubcová, A., Kramáreková, H., Morvayová, K. (2008) Program hospodárskeho a sociálneho rozvoja združenia obcí mikroregiónu Veľké Zálužie – Lehota – Jarok – Báb – Rumanová. [online]. 2008, 66 s. [cit. 2018-08-3]. Dostupné z: https://www.rumanova.sk/download_file_f.php?id=156612

Habsburg Empire (1869-1887) - Third Military Survey (1:25000), mapový podklad . [online]. [cit. 2018-08-14]. Dostupné z: https://mapire.eu/en/map/thirdsurvey25000/?bbox=1996991.9996982124%2C6151344.934679194%2C2004989.2237825491%2C6154211.323239888&map-list=1&layers=129

Halajová, D., Tóth, A., Halaj, P. (2018). Small Sacral Architecture and its Greenery in Lower Spiš Region in Slovakia. In Acta horticulturae et regiotecturae, vol. 22, no.1/2019, str. 29-36. ISSN 1335-2563.

Kalinová, D. a kol. (2004). Sakrálne objekty v sídlach a ich podiel na rozvoji cestovného ruchu. In Regióny – vidiek – životné prostredie, Nitra: Slovenská poľnohospodárska univerzita v Nitre, 2004, s. 44. ISBN 80-8069-437-0.

Kilitschka, W. (1987). Das Flurdenkmal in der Kulturlandschaft. In: Denkmalpflege in Niederosterreich: Kleindenkmäler. Wien : Amt der NO Landesregierrung, 1987. s. 5-9.

Matáková, B. (2011). Drobné sakrálne objekty v krajine Hornej Nitry. Lednice – MZLU, dizertačná práca, 2011, 239 s.

Matáková, B. (2012). Duchovné hodnoty vidieckej krajiny v Českej republike a na Slovensku. In Životné prostredie, 2012, 46, 4, p. 193-198. ISSN 0044-4863

Nádaská, K. (2013). Prícestné kríže a kaplnky, prejav viery našich predkov. In Katolícke noviny, 2013, č.28. [cit. 2019-06-19]. Dostupné z: https://old.katolickenoviny.sk/28-2013-pricestne-krize-a-kaplnky-prejav-viery-nasich-predkov/

O obci História obce [online]. [cit. 2019-08-3]. Dostupné z: https://www.jarok.sk/obec/o-obci/historia/

Privalincová, J. (2018, a). Územný plán obce Jarok – smerná časť [online], 2018. 68 s. [cit. 2019-08-11]. Dostupné z: https://www.jarok.sk/e_download.php?file=data/editor/60sk_12.pdf&original=text%20Smern%C3%A1%20%C4%8Das%C5%A5.pdf

Privalincová, J. (2018, b). Územný plán obce Jarok – záväzná časť [online], 2018. 32 s. [cit. 2019-08-11]. Dostupné z: https://www.jarok.sk/e_download.php?file=data/editor/60sk_13.pdf&original=text%20Z%C3%A1v%C3%A4zn%C3%A1%20%C4%8Das%C5%A5.pdf

Privalincová, J. (2018, c). Komplexný výkres priestorového usporiadania a funkčného využívania zastavaného územia – obec. Záväzná časť [online], 2018. 32 s. [cit. 2019-07-25]. Dostupné z: https://www.jarok.sk/e_download.php?file=data/editor/60sk_3.pdf&original=3a%20-%203%20000%20Zastavan%C3%A9%20%C3%BAzemie%20-%20obec.pdf

Schneeweis, E. (1987). Flurdenkmäler als Zeugnisse der Uberlieferung. In Denkmalpflege in Niederosterreich: Kleindenkmäler. Wien : Amt der NO Landesregierrung, 1987. s. 10-18.

Tóth, A., Feriancová, Ľ. (2013). Green Infrastructure in the Context of Rural Space Restoration and Design. In Nordic Journal of Architectural Research, 25(2), 2013, s. 187-212. ISSN 1893-5281.

Tóth, A. (2018). Metodika hodnotenia drobných sakrálnych objektov pre project "SakralArch: Zachovanie historického odkazu a architektonickej diversity drobných sakrálnych stavieb v kultúrnej krajine Slovenska. Rukopis.

Tóth, A. (2017). Drobná sakrálna architektúra v kontexte rozvoja obcí a mikroregiónov. In BARDKONTAKT 2017, Problematika mestských pamiatkových centier, Bardejov, 2018, pp. 212-217. ISBN 978-80-972776-7-3.

Tóth, A., Verešová, M. (2018). Small Sacral Architecture and Trees as Monuments in Diverse Cultural Landscapes of Slovakia. In Plants in Urban Areas and Landscape, Nitra, 2018, pp. 7 – 13. ISBN 978-80-552-1829-8.

Základné info Obec Jarok [online]. [cit. 2019-08-3]. Dostupné z: https://www.jarok.sk/obec/

Korešpondujúci autor:
doc. Ing. arch. Roberta Štěpánková, PhD., Katedra záhradnej a krajinnej architektúry, Fakulte záhradníctva a krajinného inžinierstva, Slovenská poľnohospodárska univerzita v Nitre, Tr. A. Hlinku 2, 949 76 Nitra, Slovensko, e-mail: roberta.stepankova@uniag.sk