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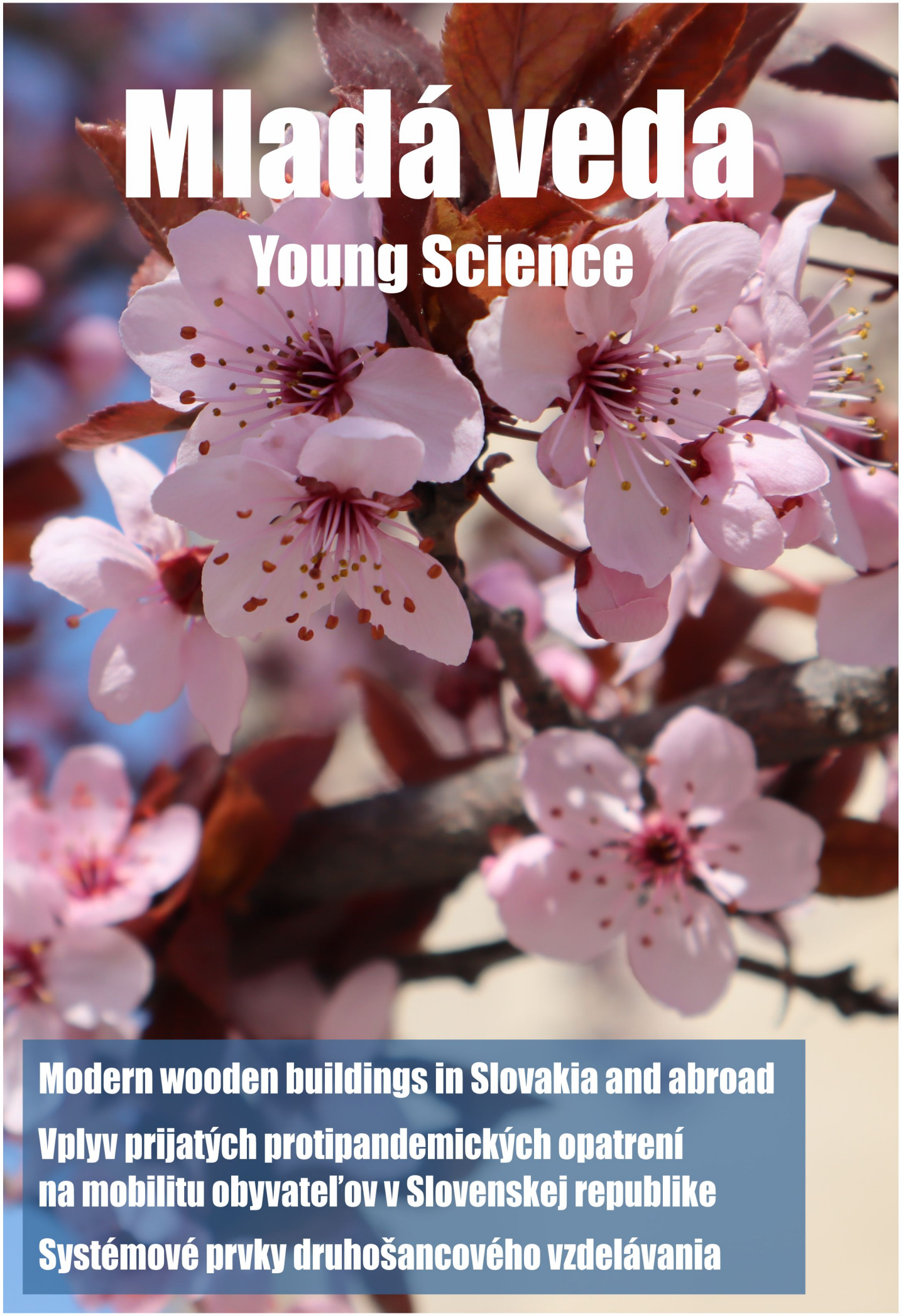

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CASE STUDY DESCRIPTING THE EFFECTIVENESS OF NON-INVASIVE WIRELESS DEHUMIDIFICATION TECHNOLOGY

PRÍPADOVÁ ŠTÚDIA OPISUJÚCA ÚČINNOSŤ NEIVAZÍVNEJ SANAČNEJ TECHNOLÓGIE BEZDRÔTOVÉHO ODVLHČOVANIA

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Patrik Šťastný works as an internal doctoral student at the Department of Building Technology, Faculty of Civil Engineering, Slovak University of Technology in Bratislava. In his research he focuses on the analysis of selected anti-humidity remediation technologies of historical constructions, especially in the field of invasive and direct remediation methods as well as technologies operating on the principle of magnetokinesis.

Abstract
The publication deals with the study of the effectiveness of the technology of wireless dehumidification of historic structures, which are highly affected by rising humidity. By applying such methods to combat moisture, it should achieve the drying of buildings without the need for invasive remediation and thus preserve the original historical material. But are these technologies effective? This question needs to be answered. Therefore, it is necessary to examine the methods and focus on their effectiveness, which should help streamline remediation, especially historical constructions. The study describes the partial values of the researched historical building located in western Slovakia, where the technology in question was applied approximately seventeen years ago.
Key words: Rising damp, remediation, magnetokinetic methods, wave electroosmosis

Abstrakt
Publikácia sa zaoberá štúdiou účinnosti technológie bezdrôtového odvlhčovania historických

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konštrukcií, ktoré sú vo vysokej miere napadnuté stúpajúcou vlhkosťou. Aplikáciou takýchto metód bojujúcich proti vlhkosti by mala docieliť vysušenie objektov bez potreby invazívneho sanačného zásahu a tým zachovanie pôvodnej historickej hmoty. Sú však tieto technológie účinné? Túto otázku je potrebné zodpovedať. Preto je potrebné dané metódy skúmať a zamerať sa na ich účinnosť, čo by malo napomôcť k zefektívneniu sanácie, najmä historických konštrukcií. Štúdia opisuje čiastkové hodnoty skúmaného historického objektu nachádzajúceho sa na západnom Slovensku, kde bola predmetná technológia aplikovaná pred približne sedemnástimi rokmi.
Kľúčové slová: stúpajúca vlhkosť, sanácia, magnetokinetické metódy, vlnová elektroosmóza

Introduction

Rising humidity, or in other words wetting of structures can be considered as a global problem affecting not only our climate zone, but on the contrary, this phenomenon can be observed globally in various types of historical structures. The influence of this moisture has also been known to mankind for a very long time, as the work of the Roman architect Vitruvi [1] suggests, where he describes certain forms of combating moisture in buildings.

The origin of moisture can be attributed to several factors, such as various accidental causes related to the penetration of water from pipes, rain gutters, condensation of water vapor, diffusion of water vapor, absorption, absorbency, capillary rise and many other phenomena. There are many buildings that lose their usefulness due to moisture, and many times this moisture results in the destruction of individual structural elements, which often leads to the complete destruction of buildings. As a good example, about half of the restoration of monuments in Belgium is related to high levels of humidity and salinity of structures [2].

Moisture found in these structures not only affects the individual structural elements of the building, but also has a negative effect on people who are in such a building and are exposed to this moisture for a long time and causes them various respiratory diseases. Kenwood drew attention to this fact as early as 1892 in his publication [3], where he described the negative effects of this moisture. Unfortunately, this fact has not been considered a real threat for many years and has been overlooked for several decades. Today, it is obvious that this problem must be tackled especially in the protection of historic buildings, as part of the preservation of cultural heritage of individual nations, but nevertheless the removal of rising moisture from historic structures is quite complicated despite the fact that this problem has been studied for some time. [4]. However, many times there is a problem in the unprofessional implementation of remediation interventions. With this type of remediation, usually only the consequence of wetting is removed from the structure and not the cause. This leads to an increase in the cost of remediation due to the need for further work.

Such a problem is largely due to the strict understanding of the Venice Charter [5], the inappropriate interpretation of which often prevents the implementation of invasive technologies by applying additional impermeable layers to listed buildings, which according to known research are very effective, but their implementation is disrupting integrity of the original structure due to the creation of a cutting joint, which is not permissible with the inappropriate interpretation of the aforementioned Venice Charter [5]. Therefore, it is

necessary to focus on research into the effectiveness of methods, the implementation of which does not disturb the original integrity.

Functioning and description of previous knowledge

Wireless dehumidification, also called magnetokinetic method, works on the principle of transformation of free energy, known as "cosmic energy " to electrical energy that can change the polarity of water molecules and push it out of the structure on which this method acts.

This electric field causes the so-called magnetic kinesis and thus sets in motion not only the water molecules but also, for example, the salts which are contained in the water. The field creates a device that is located in the interiors of the rehabilitated building and, unlike other devices, this device is not powered by a common source from the network, but works as mentioned above on the principle of using the Earth's electromagnetic energy. According to the manufacturer, this method has no effect on living organisms and its advantages also include a relatively low cost. The publication [6] states that the principle of the conversion of free energy into electricity is questioned by scientists and that this method has not been clearly demonstrated to date. The literature also states that some ideas of the operation of the devices are hypothetical and the operation has not been scientifically clarified.

The subject of this paper is to focus on the research of a non-invasive method designed to remove moisture from structures called the magnetokinetic method, the effectiveness of which is widely questioned by many experts. It is for this reason that it is necessary to examine this method in more depth and try to derive results that could confirm or refute the claims of the professional public.

The magnetokinetic method and its principles are described in the publication [7], which classifies it among electrokinetic methods, specifically in the subgroup of other methods. This technology is also described in the publication [6], which ranks it according to the construction-physical and implementation point of view into the fourth group called technologies using electro-physical principles. This publication also challenges the technology in question in terms of its functionality and relies on other publications.

Article [8] is also very beneficial, where the author refers to other authors and publications that point out the malfunction and unproven effectiveness of these technologies. The author cites some conclusions, such as [9], where it is mentioned that the standard applies to those remediation systems, whose method of use and effectiveness are credibly documented and long-term verified on objects in practice. It also [10] assesses the attitude of experts to the technology in question as highly reserved. Last but not least, it refers to the publication [11], which concludes that the change in the humidity regime of the investigated object is significantly more affected by climatic influences, especially precipitation, than the operation of a magnetic device. Consequently, based on the analysis of measurements, the use of magnetokinetic methods for basement objects is not recommended.

Methodology

As part of this research, in situ humidity measurements were performed on the structure of a historic building in western Slovakia. It should be noted that the measurements are still ongoing, and this contribution is based only on previous measurements that reflect partial

humidity values and it is assumed that the final output consisting of long-term research may change partially, but no significant change is expected and therefore these values can be considered as authoritative.

The research methodology consisted of obtaining a floor plan for marking the measurement sites, initial inspection of the examined objects, measuring the degree of wetting of structures in the interior and exterior part of the building and processing a record of this inspection and subsequent measurement with sufficient time to verify the degree of wetting.

The whole research is carried out in situ with the help of a hygrometer type Testo 616, which will help to obtain real values directly from the field.

All results were subsequently assessed according to ČSN P 73 0610 [9], which classifies humidity into five degrees (Table 1).

	Degree of humidity	**Moisture (uM) [%]**
1	Very low moisture	< 3,0
2	Low moisture	3,0 - 5,0
3	Increased moisture	5,0 – 7,5
4	High moisture	7,5 – 10
5	Very high moisture (to waterlogging)	> 10

Table 1 – Degree of wetting of the construction
Source: ČSN P 73 0610, 2000 [9]

Results

On July 17, 2020, an inspection of the first surveyed object was carried out, where an anti-wetting device has been located since about 2003, which works on the principles of magnetokinesis. During the inspection, several assessment measurements were performed at randomly selected locations, which showed the surface moisture of the structure in the range from 6.9% to 15.6%. In some places, the masonry showed only slight wetting, which, however, can be attributed to remedial plasters, which are applied to some parts of the building and further research will be needed to specify the extent of applied remedial plasters in the building.

Subsequently, the date of the first measurement was determined, at which the places where the regular humidity research will take place were determined, which will ensure the objectivity of the compared values. The first measurements in the whole building took place on July 23, 2020. The measurements indicate considerable humidity in some cases up to the wetting of the walls of the building and these values are given in Table 2 and are represented by Figure 1. The measurement conditions are given in Table 3. In places where it can be stated with certainty that surface values ranging from 10% or more, which may indicate a malfunction of the system. In several places, such as at point P7, the masonry shows high values even at a height of approx. 150 cm above floor level. High values could be caused by condensation of water vapor, but in control measurements at a height of about 220 cm, the

humidity values were at the level of 1.0%, which according to ČSN P 73 0610 [9] we consider a dry structure.

Place of measurement	Measuring height from floor [cm]	Mass moisture [%]	Measuring height from floor [cm]	Mass moisture [%]	Comment
	Date	**23.7.'20**		**23.7.'20**	
M1	30	9,7	150	0,9	
M2	30	11,2	150	1,2	
M3	50	14,3	150	12,2	h 2,2m = 1.1%
M4	30	14,7	150	7,4	
M5	30	16,4	150	1,0	

Table 2 – Results of humidity measurements on the examined object.
Source: author

Measurement date	Tair [°C]	Φ [%]
23. 7. 2020	20,0	50,0

Table 3 – Humidity measurement conditions
Source: author

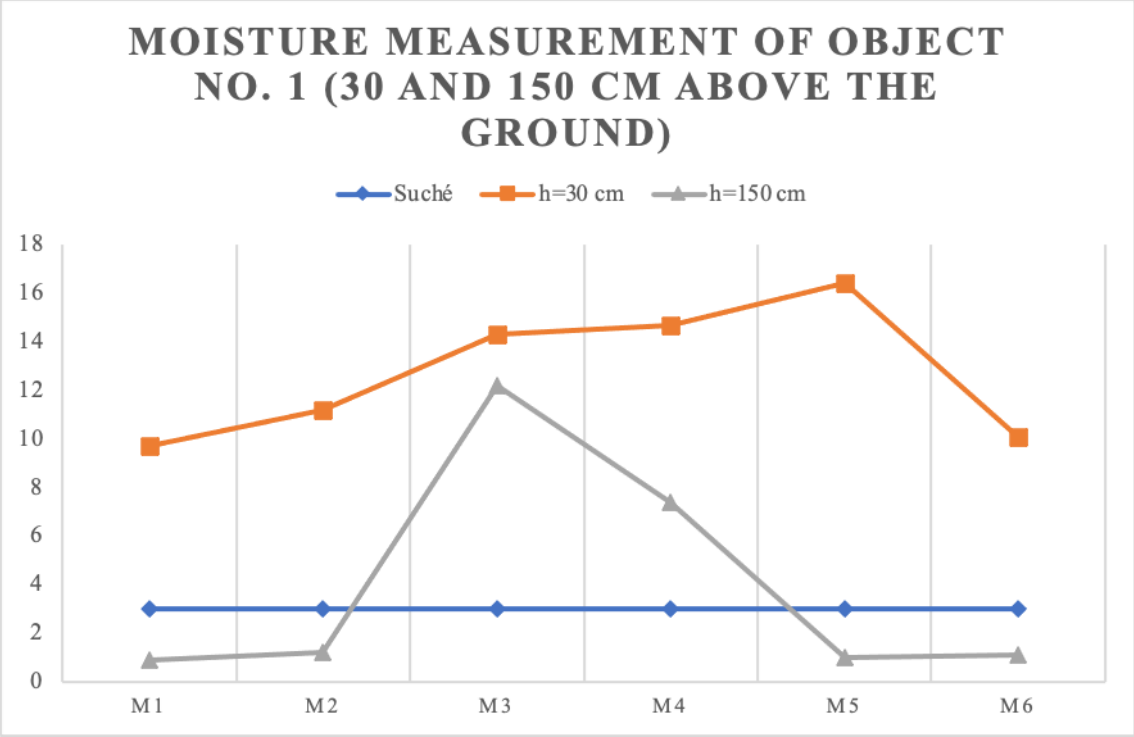

Figure 1 – Comparison of individual measurements
Source: author

Conclusion

From the values obtained so far, it can be assessed that the doubts about the investigated method are justified, but it should be noted that this research is still in its beginning and needs to be addressed in more detail. For this reason, regular exploratory moisture measurements are planned not only on the surface of the structure, but also the installation of a probe for monitoring the humidity in the structure is also planned. These measurements and the individual values in them will be carried out initially in monthly cycles until it can be stated that the given humidity rate does not decrease significantly. The expected length of measurements and recording of values in monthly intervals is planned for one year to cover all seasons and to assess the effects of individual seasons on the rate of wetting of the object, but with significant fluctuations in wetting values this time can be extended to results. Subsequently, these measurements will be performed at larger intervals, the extent of which will be determined on the basis of analyses of previous measurements. These values are then compared and also classified into humidity groups according to ČSN P 73 0610. In practice, it can be stated that the method can be considered effective if it can suppress the degree of wetting below 5%. Such research will help to objectively evaluate the results, which will be published regularly, as well as to draw individual conclusions. Long-term research will help to expand knowledge about the technology operating on the principle of magnetokinesis and will also help to design suitable remediation methods for the restoration of historic buildings, especially associated with high humidity.

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