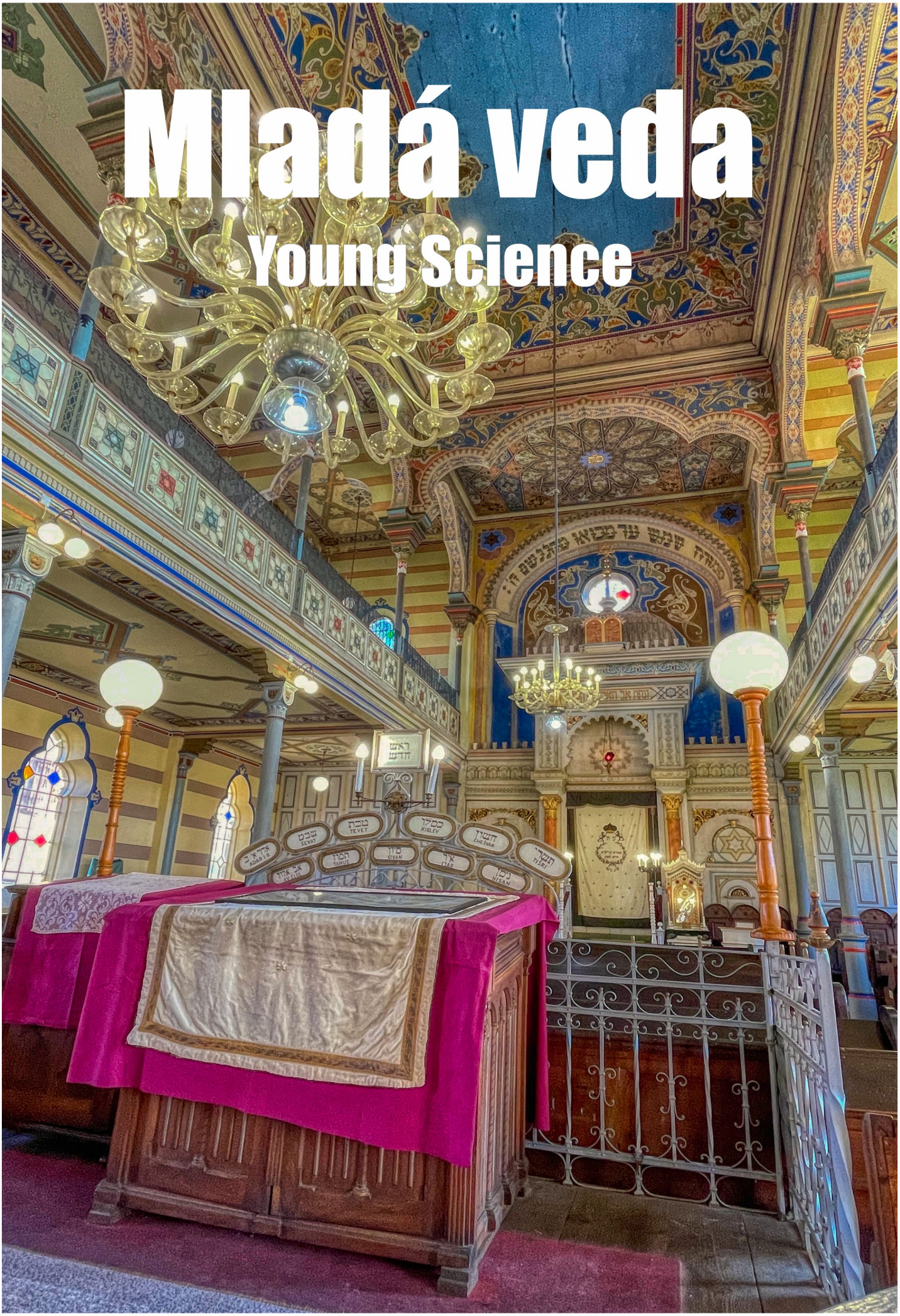
ISSN 1339-3189

3/2021

Mladá veda

Young Science



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MEDZINÁRODNÝ VEDECKÝ ČASOPIS MLADÁ VEDA / YOUNG SCIENCE

Číslo 3, ročník 9., vydané v októbri 2021
ISSN 1339-3189
Kontakt: info@mladaveda.sk, tel.: +421 908 546 716, www.mladaveda.sk
Fotografia na obálke: Ortodoxná synagóga v Prešove. © Branislav A. Švorc, foto.branisko.at

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Javorinská 26, 080 01 Prešov
Slovenská republika

Mladá veda
Young Science
ISSN 1339-3189

Vol. 9 (3), pp. 61-68

ANALYSIS OF THE EFFECTIVENESS OF REMEDIATION TECHNOLOGY WORKING ON THE PRINCIPLE OF WIRELESS DEHUMIDIFICATION

ANALÝZA ÚČINNOSTI SANAČNEJ TECHNOLÓGIE PRACUJÚCEJ NA PRINCÍPE BEZDRÔTOVÉHO ODVLHČOVANIA

Patrik Šťastný[1]

Patrik Šťastný pôsobí ako interný doktorand na Katedre technológie stavieb Stavebnej fakulty Slovenskej technickej univerzity v Bratislave. Vo svojom výskume sa venuje analýze vybraných protivlhkostných sanačných technológií historických konštrukcií, najmä na oblasť invazívnych, resp. priamych metód sanácie a taktiež aj na technológie fungujúce na princípe magnetokinézy.

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 degree of effectiveness of magnetokinetic technology, also known as wireless dehumidification technology. The publication compares two similar objects, while in one of the examined objects the remediation technology of wireless dehumidification is applied. No remediation interventions are carried out on the second examined object in the immediate vicinity. The publication describes the measured values of humidity of objects and compares the effectiveness of this technology.
Key words: remediation, rising damp, wireless dehumidification

Abstrakt
Publikácia sa zaoberá mierou účinnosti magnetokinetickej technológie, známej tiež aj ako technológia bezdrôtového odvlhčenia. Publikácia porovnáva dva podobné objekty, pričom v jednom zo skúmaných objektov je aplikovaná sanačná technológia bezdrôtového odvlhčovania. Na druhom skúmanom objekte v tesnej blízkosti nie sú realizované žiadne

[1] Adresa pracoviska: Ing. Patrik Šťastný, Slovenská technická univerzita v Bratislave, Stavebná fakulta, Radlinského 11, 810 05, Bratislava
E-mail: patrik.stastny@stuba.sk

sanačné zásahy. V publikácii sú opísané namerané hodnoty vlhkosti objektov a porovnanie účinnosti tejto technológie.
Kľúčové slová: sanácia, stúpajúca vlhkosť, bezdrôtové odvlhčovanie

Introduction

Humidity as well as wetting of historic structures can be considered a global problem regardless of climate zone. Mankind has been facing the problem of humidity since time immemorial. This fact is also evidenced by the work of the Roman architect Vituvius [1], where he describes certain forms of combating moisture. 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. In this paper, we will deal mainly with the influence of rising moisture, which penetrates into the structure, especially through the absent or non-functional waterproofing layer. This moisture, in particular by its influence, helps in particular the loss of usability and many times this moisture results in the destruction of individual structural elements, which often leads to the complete destruction of objects. It is also worth mentioning that about half of the restoration of monuments in Belgium is related to the high humidity of these buildings [2].

This moisture not only affects the individual structural elements of the buildings, but also has a negative effect on the people who are in these buildings 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. A suitable example is research [4], which has produced an overview of international works dealing with the remediation of rising damp. The article lists the publications that were collected until 2017. Figure 1 shows that publications on this topic began to have an upward trend after 2005.

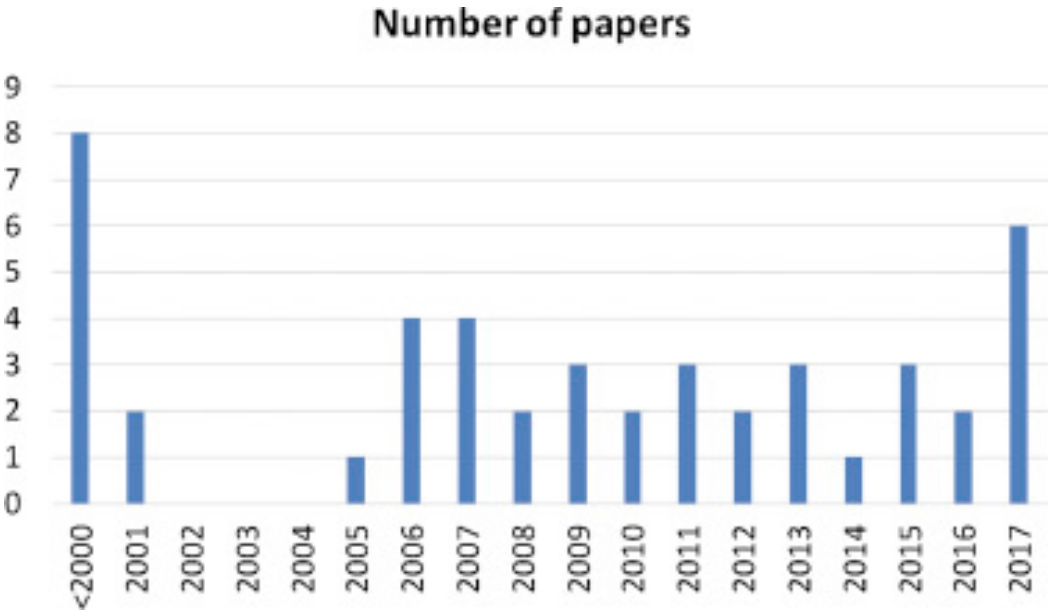

Figure 1 – International publications over the years
Source: [4]

With increasing time and increasing rate of destruction, many authors began to focus more intensively on research focused on the rehabilitation of historical constructions and the impact of moisture on these constructions [4,5,6,7]. However, inconsistencies in the implementation and publication of research remain a problem in the given research, as well as different standards, which classify the humidity as well as the salinity of the buildings that accompany wetting. However, the authors do not address this issue in this article.

Today, it is obvious that this problem must be tackled especially in the protection of historical buildings, as part of the preservation of cultural heritage of individual nations, but nevertheless the removal of rising moisture from historical constructions is quite complicated despite the fact that this problem has been studied for some time. [9]. Another problem is the unprofessional implementation of certain remediation interventions, in which only the consequence of wetting is often removed from the construction, but not the cause of this moisture, which leads over time to the re-emergence of moisture and the need for additional work and costs associated with its further removal. Many times, a strict understanding of the Venice Charter [10] adds to this fact, and its inappropriate interpretation often hinders the implementation of some invasive technologies.

The principle of operation and an overview of previous knowledge about the researched method

Methods of wireless dehumidification have been known to the professional public for a relatively long time. The principle of these devices operating on the basis of wireless dehumidification, also called the magnetokinetic method, consists in the transformation of “free, resp. cosmic energy” to electricity, which changes the polarity of water molecules and pushes them out of a sanitized construction. 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 does not affect living organisms and its advantages also include a relatively low cost. The publication [11] states that the principle of converting free energy into electricity is questioned by scientists and that this method has not yet been clearly demonstrated. The literature also states that some ideas of the operation of the devices are hypothetical and the operation has not been scientifically clarified.

In 2002, he described in Article [13] the operation of this method. The conclusions from this article point to cases of non-functional systems of the mentioned company, but further state that these problems were caused by rather poor installation, resp. mechanical damage to the system during its operation. These conclusions cannot be assessed as relevant evidence of the functioning of the system in question, as the whole article deals only with the theoretical level of functioning and is not based on any specific research or outputs carried out either in laboratory conditions or directly in the field.

The article [14] is also very beneficial, where the author refers to other authors and publications that point out the malfunction, resp. unproven effectiveness of these

technologies. The author cites some conclusions, such as [15], where it is mentioned that the standard applies to those remediation systems whose method of use and effectiveness are credibly documented and long-term proven on objects in practice. It also [16] considers the attitude of experts to the technology in question to be highly reserved. Last but not least, it refers to the publication [17], which concludes that the change in the humidity regime of the examined 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 basemented objects is not recommended. At the end of the above article, the author states that these methods cannot be recommended by experts until companies offering these methods submit relevant measurement results or statements of a prestigious, widely recognized public research organization or technical university from the Czech Republic, respectively. abroad, as the methods in question are not included in ČSN P 73 0610 and are not included in the remediation methods in the WTA guidelines.

From this point of view, it is therefore necessary to examine these methods in more detail, to understand them and subsequently to draw clear conclusions about the degree of efficiency of magnetokinesis-based devices.

Methodology

The research methodology consisted in the analysis of measured humidity values, which were carried out in situ, on two historical buildings of the same nature. Magnetokinesis technology is applied on the first examined object, no remediation interventions are carried out on the second examined object. In such a state, the possibility of comparing the same structures was expected, where the same locations of buildings, material composition and also the same influence of different weather conditions, or for example groundwater, are observed. The humidity rate was monitored for a long time and individual results were recorded. The Czech standard ČSN P 73 0610 [15] was chosen as the evaluation standard, which divides the humidity up to 5 degrees (Tab.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 constructions
Source: ČSN P 73 0610, 2000 [15]

Research results

The research focused on two neighboring buildings, the first of which can be dated to the 19th century. At this time these buildings were built on the sites of the original buildings, the construction of which can be dated several centuries back. As part of the research, inspections and subsequent in situ humidity measurements were carried out on two adjacent historical buildings. 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 first inspection of the building was performed on 17.7.2020. The method of wireless dehumidification has been applied in this building since about 2003, consisting in the placement of an anti-wetting device that 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 a larger part of the building. However, in many places, especially with age, they have lost their functionality.

The date of the first measurement and the places where the regular humidity survey will take place were determined. The first measurements in the whole building took place on July 23, 2020. Subsequently, further measurements were made on July 16, 2021. 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 1 and the measurement conditions are given in Table 2. In places where it can be stated with certainty that where it has lost its functionality, the structure exhibits surface moisture values of 10% or more, indicating a system malfunction. In several places, such as at point M2, the masonry shows high values even at a height of about 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 [15] we consider a dry construction.

Measuring point	Measuring height from floor [cm]	Mass moisture [%]		Measuring height from floor [cm]	Mass moisture [%]		Comment
	Date	**23.7.'20**	**16.7.'21**		**23.7.'20**	**16.7.'21**	
P1	**30**	9.7	7.3	**150**	0.9	1.1	
P2	**30**	14.3	8.7	**150**	12.2	7.5	h 2,2m = 1.1%
P3	**30**	14.7	12.9	**150**	7.4	7.8	
P4	**30**	16.4	14.2	**150**	1.0	1.2	
P5	**30**	14,5	11,5	**150**	10,2	10,5	

Table 1 – Values of selected humidity measurements
Source: author

Measurement date	**T_{Air} [°C]**	**Φ [%]**
23.7.2020	20.0	50.0
16.7.2021	24,0	36,0

Table 2 – Humidity measurement conditions
Source: author

The second object under investigation is located in close proximity to the object where the magnetokinesis device is applied. For the possibility of determining the efficiency, this place was chosen as the most ideal, especially due to the similarity with the examined object, for the comparison of the degree of wetting. The degree of humidity, in this case rather wetting, is given in Table 3. The building, especially in the interior part, showed high wetting at all measured points. Here, a difference can be observed compared to the first object, where the remediation plaster was applied, which gradually loses its functionality and a similar wetting is also manifested in the first examined building.

Measuring point	Measuring height from floor [cm]	Mass moisture [%]	Measuring height from floor [cm]	Mass moisture [%]	Comment
	Date	**16.7.'21**		**16.7.'21**	
P1	**30**	12.0	**150**	1.7	No remediation interventions
P2	**30**	16.0	**150**	7.9	
P3	**30**	13.3	**150**	1.8	
P4	**30**	13.3	**150**	0.9	

Table 3 – Values of selected humidity measurements
Source: author

Measurement date	**T_{Air} [°C]**	**Φ [%]**
16.7.2021	24,0	36,0

Table 4 – Humidity measurement conditions
Source: author

Conclusion

Based on previous research, it can be stated that the measured values given in the tables show a significant inefficiency of the investigated wireless dehumidification technology. In the investigated building in which the technology in question is applied, there are places where the humidity is relatively low, but this can be attributed to remedial plasters, which fulfill their

function. On the contrary, in places where these plasters are absent, resp. it is obvious that they lose their functionality, the measurements reach high values. These are just comparable to object number two, which serves as a comparison object.

It should be noted that these buildings are only a few meters apart, were built (rebuilt) in the same period and in particular are built of the same building materials. Objects also have the same use. All these aspects are very important for comparability, as it is clear that both objects have the same effects. That is why it can be assessed that the investigated method does not fulfill its function, as the first investigated object can be considered wet in most places.

However, it is necessary to focus on this research in the long term and to continue to examine the degree of efficiency not only on these constructions, but also on others where the technologies in question are applied. This should help to clarify the conclusions as to whether a given remediation method can be considered effective and functional, and thus whether such non-invasive methods can extend the life of historical buildings.

This article can also help to expand knowledge about the technology working on the principles of magnetokinesis and its effectiveness studied on specific historical objects, especially due to the above and the insufficient number of publications describing the technology.

This article was recommended for publication in a scientific journal Young Science by: doc. Ing. Oto Makýš, PhD.

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