VERIFICATION OF THE METHOD FOR ASSESSING THE SEVERITY OF THE CONDITION ETICS WITH BIOCORROSION

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ABSTRAKT CZ

The object of the study is the methodology for assessing the technical condition of the thermal insulation with biocorrosion failure. Methods of work consisted in analyzing the method of assessing the severity biocorrosion of ETICS and verification of assessment in practice through interdisciplinary diagnostics. The results of assessment of the severity are the basis for selection of measures for the sanitation of ETICS construction.

Keywords: Biocorrosion, insulation, ETICS, diagnostics

ABSTRACT

The object of the study is the methodology for evaluating the technical condition of the ETICS with Biocorrosion. Methodology of this paper consisted in analyzing the processes of assessing the severity and verification of evaluation criteria in practice through interdisciplinary diagnostics. The results of evaluation of the severity are of the basis for selection of measures for the recovery of ETICS.

Key words: biocorrosion, insulation, ETICS, diagnostics

1 INTRODUCTION

There is connection between the assessment of the severity of the ETICS technical condition and the choice of measures for the recovery of the construction. The aim of research is to verify the visual assessment of the severity of the ETICS with the findings of microbiology laboratory investigation.

Diagnosis of building construction is carried out by visual, basic, preliminary or detailed surveys, at which the procedure and extent is not mandatory, is not known, and it depends on the binding environment, requirements for building construction. In case of biocorrosion insulation it is a way to implement the diagnosis, its scope and evaluation of the results in the interdisciplinary development phase. To verify the functionality and fulfilment of the requirements that we claim on ETICS, there are developed methods:

- **non-destructive (indirect)** - minimum damage, or no damage at all of strata of thermal insulation composite system. These include a model of visual assessment and **determination of the area of biocorrosion**, evaluation of the samples of biological material by dross, laboratory cultivation of biological material, measure the size of the cracks, measuring humidity, absorbability, temperature displaying, acidity test [1].
- destructive (direct) - these methods require structural failure ETICS with the sample from the complex of strata of thermal insulation composite system. The most common way is to carry out a probe in order to verify the complex of strata, the technology implementation, laboratory verification of the physical properties, in particular plasters, and also verification **the presence and penetration of biological material into strata** [1].

As a result of the survey ETICS in relation to biocorrosion we expected the most accurate identification of biological material and its degradation effects, the degree of degradation of the individual components of the ETICS or the whole construction. The conclusions of the investigation are becoming the basis for an overall evaluation of the technical state (condition) ETICS, thus **defining the severity of the ETICS with biological colonization**. The evaluation is the basis for the selection of technologies for the recovery of the ETICS.

2 ASSESSMENT OF THE SEVERITY

Assessment of severity used in determining the technical condition of ETICS with biocorrosion is subjective, based on erudition of observer. It is based on the representation of "stains and soiling" to the total surface area of insulation [2] in the percents.

Development of colonization of microorganisms was observed by German scientists in the period of five years. For the evaluating the permissible quantity of microorganisms they used [2] the guidelines for determining quantitative representations of microorganisms on the facade, based on laboratory observed samples on an area with sides of lengths 30x30 cm [3]. The evaluation scale is simplified in the range from 0 to 10 percent, and description of the characteristics of visual perception [2], according to the following table.

Rating scale	Description / Significance
0	Visually unrecognizable - **not infected**
1	only 1-3 small points - **moderate pollution**
2	2 to several important points, stains and/or local contamination, dry, shrunk local places – bright, full range of5% - **moderate pollution**
3	A few points or spots approaching the 5 % area- **moderate pollution**
4	Coherent set of points), and/or dry, shrunk local places, total of more than 5% to 25% of the affected area with pollution- **secondary pollution**
5	Stands microorganisms from 25% to 37.5%, the coverage area of contamination by microorganisms **pollution secondary to severely**
6	Stands microorganisms from 37.5% to 50%, the coverage area by microorganisms - **pollution significant**
7	50% to 62.5% the coverage area by microorganisms - **significantly strong**
8	Deposition and surface coverage of microorganisms, pollution from about 62.5% to 75% of the examined surface area sample - **strong**
9	Deposition and surface coverage of microorganisms, pollution from about 75% to 87.5% of the examined surface area sample – **strong** to **very strong**
10	The surface covered by microorganisms almost continuously, about 87.5% and more of the total area, microorganisms are prerequisite for the development and - **extremely strong**

Tab. 1: Scale for assessment compilation of growth development [2]

Step 3 is considered as the critical extent of colonization ETICS, because the evaluation passes through the moderate pollution to 5% of the area to the secondary pollution, where is colonized with a 25% of the area [2]. The growth of microbiological material in the plaster is typically seen with the naked eye, and sometimes occurs in 3 to 5 years of age ETICS. It is affected by the primary protection of the preservation of plaster mixtures and also by amount of the release active compound over time.

The requirement to assess the state biocorrosion of ETICS resulted from the practice, for the needs of complaint procedures, policy proposals, forecasting of development of the negative impact. Assessment of severity is based on valid legislation in Slovakia, in particular the Commercial and Civil Code [1]. Three-stage evaluation model (range: aesthetic deficiency, defect common and fundamental defect) is application of the output analysis of the possible consequences of colonization

by microorganisms ETICS. It uses knowledge from the consequences of related scientific disciplines. Significance of the consequences is quantified with using a scale for assessments of growth development [2].

Index	Category of the severity	Assessment of the severity by representation of microorganisms on the ETICS area
1	minimum	**Aesthetic deficiency**, colonized is only the surface of ETICS, mostly by unicellular microorganisms, without the protection of slime and on the surface are not observed cracks and defects of ETICS. **Colonization in the range from 0% to 25% (Rating Scale 0 - none, 2 - moderate pollution, 3 - moderate and 4 - secondary pollution).**
2	major	**Defect common**, the surface of ETICS is colonized and there is demonstrated penetration of microorganisms (mainly fungi) into the strata ETICS, unprotected microorganisms with slime, there is not diagnosed presence of higher organisms such as mosses and lichens, and the desired properties of ETICS are preserved in order to protect the internal environment of buildings. Colonization of more than 25% to over 62.5%, there are recorded cracks or defects ETICS (Rating Scale 5 - severely, 6 - Significant, 7 - significantly strong).
3	hazardous	**Defect fundamental**, the surface of ETICS is colonized and there is demonstrated penetration of microorganisms into the strata ETICS, protection of microorganisms with slime, there is diagnosed presence of higher organisms such as mosses and lichens, and the desired properties of ETICS in term of protect the internal environment of buildings are reduced below the standard requirements, the use properties of the entire structure ETICS are reduced, there is reduced functionality or security ETICS. **Colonization of more than 62.5% to over 87.5%, there are recorded cracks and defects of ETICS (Rating Scale 8 - strong, 9 - very strong, 10 - extremely strong).**

Tab. 2: Classification of the severity of the technical condition with using a scale for the assessment compilation of the growth of development according to [2] and [1].

Deficiency of visual diagnosis and assessment of severity consist of erudition of person to a given issue and his subjective view and also in an ambiguous way of reading contamination, selecting sites for reading and so on. For this reason are conducted field tests at the Department of Building in Bratislava as part of research, by which are further verified visual evaluation mechanisms.

2. THE CASE PAPER FOR VERIFICATION OF THE ASSESSMENT OF SEVERITY

The subject of research was the facade surface with thermal insulation and visually identified "soiling" mostly black or green colours that occur on the north-facing side, locally, in areas under sheeting windowsills, in typically vertical direction and in surface typically horizontal band display. Multicolour facade is depicted, with predominant shades of white contrasting with saturated yellow and gray. From a visual diagnosis of the occurrence of microorganisms it showed that only colonized is the surface of ETICS mostly by microorganisms of green or black colours, unprotected with slime. On the surface, there were no cracks or defects. From the colour scale of biological material can be estimated origin of microorganisms, while the green colour indicates the presence of algae with a higher need for external humidity and black coloration indicates the presence of micromycetes or dead algae residues. Visual perception of soiling facade tells about the exceeding the critical values according to [2], i.e. degree 3, when the moderate pollution up to 5% of the area passing through the evaluation on secondary pollution, which is colonized by up to 25% of the area. According to the three-stage evaluation mechanism of severity of technical condition it is a aesthetic deficiency that does not affect the functionality or security ETICS construction and the consequences can be remedied

by normal cyclical maintenance. Locally, however, there were recorded locations, copying the run-off from windowsills in low lining or escape of heat from the interior in contact with the window frame and windowsill, the equivalent to 5% of the total area.

Fig. 1: North Side - contamination by the biological materials (author)

2.1 The taking of biological material

Sampling and subsequent mycological analysis of the external environment of apartment building was conducted within the local examination. When sampling, the relative air humidity was 67.9% and outside air temperature was 7.8 ° C. There was obtained air sampling (airborne fungus with the possibility of deposition on the examined surfaces - the facade) and samples from the external surfaces of buildings.

Fig. 2: Practical performance - taking of samples with piece of tape from the surface of contaminated plaster (author)

Taking of samples were carried with piece of tape:

- examined facade with different coloured finish with no visible fungal increase,
- examined facade with gray, black and green spots possible fungal to algae growths),
- holes by destructive probe from ETICS plasters,
- samples from control buildings opposite the examined facade with no visible colour change, green or black deposits, one plaster was of the same type on the insulation construction and another plaster based on lime.

Fig. 3: Practical performance - taking of samples with piece of tape under the surface in contaminated areas. It is a basis for assessing of biodegradation activity and proposed solutions (Author), [5].

2.1 Laboratory examination

The isolation of pure cultures of microorganisms on the surfaces of building materials is not easy. Given the fact that the laboratory the most provable analysis of biodeterioration (microbial corrosion) of building materials by eukaryotic microorganisms (microscopic fungi - “fungi" and algae) includes just mycological tests [5], on the facade with insulation and the surrounding outdoors have been conducted comprehensive qualitative and quantitative mycological examination. The relevant microbial findings were then tested for their biodegradation potential on the components of the construction materials. From the demonstration of biodegradation activities was expecting the final outcome of assessing of the seriousness of the technical state of ETICS with biocorrosion.

2.2 Results of samples

All isolated microscopic filamentous fungi belonged to the normal outer mycoflora in colder times of the year (the incidence is similar in all tested surfaces - "dirty, clean" and also in the air).

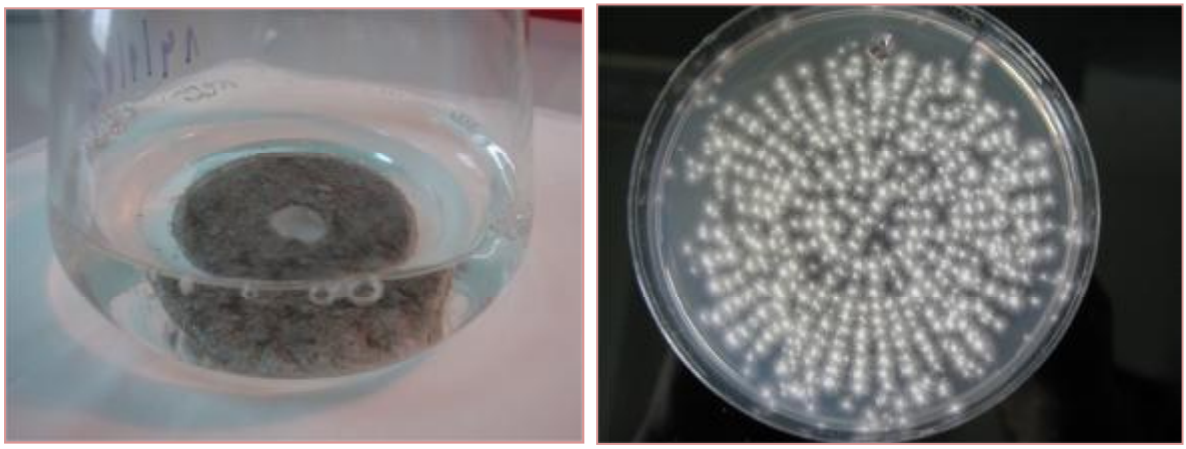

Fig. 4: Practical exercise - isolation microorganisms from the sample. Left: the finish bore of ETICS with a reinforcing layer. Right: microscopic observation of capture of micromycetes [5].

There was found out predominance of melanised fungi that are in term of colonization of surfaces considered as secondary colonizers, requiring increased humidity of growth medium. Furthermore, Alternaria sp. and C.cladosporioides were present out of dead plant material (fallen leaves, etc.). Penicillium sp. and Trichoderma sp. are typical ubiquitous airborne fungi. Mucorrhoea indicate the presence of an organic substrate (component plasters, paints, as well as an organic powder on its

surface). They are able to decompose organic substrate through the rich enzymic feature. Identified tertiary colonizers (acremonium, phoma) are able to colonize environment with very high content of use humidity [5].

From the assessment of the biodegradation activity of tested representatives of fungal isolates was found that neither of them was capable to dissolve or mineralize the lime substrate (CaCO3). All present isobaths were decomposing the cellulose (saccharolytic activity) [5].

micromycete	**cellullose**	**CaCO3 - mineralization**	**CaCO3 - solubilization**
Alternaria sp.	*/–	–	–
C.cladosporioides	*	–	–
C.sphaerospermum	*	–	–
Chaetomium sp.	*	–	–
Penicillium sp.	*	not tested	not tested
Trichoderma sp.	*	–	–

Tab. 3: The evaluation of biodegradation activity pattern (* - positive reaction - negative reaction) [5]

Through the essential knowledge was found that the samples after the bore from the plasters showed in two cases (from 3 of the implemented samples) that the on side of contact of the reinforcing layer and the insulator or on stratum of the obtained insulator was presence of Nigrospora sp., Phoma sp., Ph. cruris-hominis, and Chaetomium sp., Phoma sp., Ph. crusis-hominis [5].

3 DISCUSSION

Based on a visual survey, the first planned conclusion and evaluation of thermal insulation with microbiological attack was marked as aesthetic deficiency, without finding surface breaking cracks, peeling off and other deformation of the construction. Colonization, calculated on the facade area by free observation did not exceed the 25%. There have also been reported locally raised "colourfulness soiling". Protection of microorganisms with slime was observed.

The laboratory examination has been performed in order to verify the initial assessment of the severity and for the avoidance of doubt for the decision making process when selecting technologies for the recovery. The penetration of microorganisms into the strata in two, three randomly made samples was examined by destructive method and dross. Positive results of laboratory examination is the identification of microorganisms as common, freely occurring in the environment and also for microorganisms without degradation effects on plasters based on lime substrates. Based on laboratory testing it is appropriate to consider the shift of assessment of severity of the technical state of ETICS with biocorrosion at level 2 in the three-stage evaluation model. The state is possible to considered as a common defect after verification, when was recorded except the colonization of the ETICS surface by unicellular microorganisms, without the protection of slime also the penetration of micromycetes into strata insulation. Assessment of the severity predicts the possible reduction of performance ETICS with maintaining the required standard properties. The consequences of colonization, however, can be corrected or repaired by routine repair and subsequent maintenance.

4 CONCLUSION

The presented results of the verification assessment of the severity of the ETICS we consider as beneficial for the further development of the issue, the development of diagnosis and the need for further testing assessment methodologies that are presented by foreign authors, or are used in our regulatory conditions. Diagnostic tool that allow with great precision to determinate the severity and

consequences of biocorrosion the insulation can also be effectively used for particular, alternative proposals for technical and technological solutions for recovery.

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