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Evaluation of ETICS Characteristics that Affect Surface Mould Development

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1 Introduction

ETICS are nowadays often used in Europe for new constructions and for thermal refurbishment of building facades. These systems present several advantages in comparison with other insulation solutions, such as the correction of thermal bridges, reduction of interior water condensation and increase of thermal efficiency, while maintaining the aesthetic appearance of the building, with relatively low installation cost and ease of application.

Nevertheless, biological growth has been identified as one of ETICS main disadvantages, with several ETICS facades showing this problem only few years after the building construction/intervention. Over time, biological growth causes cladding defacement, though it might not have major influence on the thermal performance of the system itself, however, altering the aesthetic appearance of the building. This situation commonly leads to a disapproval of the building owner, ending up with several economic and social consequences, that limit the full implementation and a wider diffusion of ETICS.

Factors influencing mould growth on ETICS include nutrient availability, temperature, pH and moisture which seems to be the key factor. Extensive fungal development is linked to high levels of surface moisture content, resulting from the combined effect of surface condensation, drying process as well as from the finishing render composition. When the drying process is slow, the surface moisture content remains high for long periods, increasing the risk of biocolonization. Thus, the main parameters affecting biological colonization on ETICS are thought to be the composition of the different elements (insulation material, base coat mortar and finishing coat) and the behaviour of the system concerning water absorption and drying. It is therefore essential to understand the hygrometric properties of ETICS and their composition in order to correlate them with biological growth.

2 Materials and Methods

Seven different ETICS solutions were tested for mould growth and water behavior (capillary absorption and drying capacity). The thermal insulation materials of each solution were also individually tested for mould growth. There are four types of insulation materials, including mineral wool (MW), expanded polystyrene from two different manufacturers (EPS-1 and EPS-2) and expended cork (ICB).

The resistance of the different ETICS and insulation materials to mould growth was assessed using a method adapted from ASTM D 5590-17 (2017) and ASTM C1338-19 (2019). Three fungal species were used in this study: spore suspension of *Aspergillus niger* and *Penicillium funiculosum*, applied together, and *Aureobasidium pullulans*, applied alone. A third group of test specimens was exposed in the same conditions but without any sterilization or inoculation thus allowing their natural inocula to potentially develop. Each week, the samples were rated for mould growth.

Water performance of ETICS was assessed through capillary absorption and drying capacity. Capillary absorption tests were performed according to ETAG 004 (EOTA, 2013) and drying test was performed following the recommendations of EN 16322 (2013).

3 Results and Discussion

The results of the average rate of mould growth for ETICS surface finishing layer considering all type of inoculation were the same during or at the end of the test: zero (no growth). The fact that no growth occurs for any ETICS surface after 4 weeks of testing can be explained by the presence of biocide on the finishing render. For the insulation materials and after 4 weeks of incubation, an appreciable amount of mould growth was observed on the ICB samples, rated as 2 or more for every type of inocula (natural or artificial), with all samples presenting more than 10% of their surface contaminated. For EPS-1 samples, no growth was reported at any time during the test, however, this is not the case of the EPS-2, where some samples presented traces of growth, especially when considering natural inocula. MW samples presented no growth for the *A. pullulans* inoculation and traces of growth since the first week of observations for the *A. niger* and *P. funiculosum* inoculation. Only one of the three MW tested samples showed traces of growth (rated as 1) after 4 weeks testing for natural inocula.

With regards to capillary absorption and drying capacity, sample S3 presents the highest value of capillary absorption at 1h and 24h, whereas sample S1 presents the lowest values. In fact, samples S1 and S2, both with cement-based matrix in the base coat, presented lowest capillary water absorption, and, as a consequence of low water content, also the fastest drying capacity. All samples achieved values of capillary absorption after 1h testing that are lower than 1 kg/m^2, which is the value required by ETAG 004. Therefore, all solutions have an adequate performance with regards to capillary absorption and drying. The results obtained for drying test are in line with those obtained for capillary water absorption, since samples that generally absorb more water are those that present higher drying rates, allowing fast removal of absorbed water. Additionally, a high correlation was obtained between the capillary absorption coefficient and drying rate 2 (R^2=0.77).

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