

ETICS External Insulation Systems: The Impact of Installation on Durability Assessment

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Abstract

This article aims to draw attention to the main issues related to the installation of external thermal insulation composite systems (ETICS), which have been widely used for the thermal insulation of buildings since the late 1970s. Although the tools for assessing these systems are now well consolidated, a critical issue remains concerning the assessment of their installation and the regulatory gap in this area, particularly in Italy.

This work reports the outcomes of numerous experimental investigations carried out at ITC-CNR (Construction Technologies Institute of the National Research Council of Italy), which has long been engaged in the evaluation of ETICS, focusing in particular on the assessment of system durability and the main problems that have emerged, which are very often correlated with improper installation. Correct installation is crucial to ensure both the durability and the effectiveness of the system. Durability refers to the ability of the system to maintain its uniform appearance over time, avoiding physicochemical defects; effectiveness is more closely related to the long-term preservation of thermal insulation performance. Degradation related (also) to poor installation is instead more visible and therefore easier to monitor over time, as detachments, blistering, cracking, etc. appear over the years and very likely already at the first seasonal changes.

Keywords: Construction Product, Durability, Façade, Installation.

1. Introduction

In Europe, the construction sector is strongly involved—both politically and operationally—by the Energy Performance of Buildings Directive which aims at decarbonising the European building stock by 2050 [1]. Buildings account for 40% of the Union's energy consumption, use more than half of the natural gas consumed annually, and thus contribute to one third of energy-related emissions.

The European building stock is old: most buildings were constructed before the 1980s, i.e. before energy efficiency became a design parameter. The slow pace of renovation, with a refurbishment rate of around 1% per year, makes intervention on a very outdated building stock urgent. In

this context, reducing energy consumption and upgrading existing buildings are two areas where envelope insulation is the most effective measure, placing ETICS at the core of energysaving strategies for achieving the objectives of the Directive.

From a market perspective, data from the European Association for External Thermal Insulation Composite Systems (EAE) show overall growth of ETICS in the main European countries, with an increase of installed surface area of 16.4% between 2020 and 2024 [2]. Countries with stable regulatory frameworks record higher growth rates, whereas markets characterised by discontinuous political cycles experience significant fluctuations, leading

to uneven deployment of these systems across Europe. Achieving a substantial reduction in heating and cooling demand, improving indoor comfort, and avoiding energy waste requires not only proper design and performance assessment of ETICS, but also correct installation.

Performance assessment of these systems is voluntary and aimed at obtaining CE marking for free circulation within the European market, in accordance with the principles set out in the Construction Products Regulation (EU) 2024/3110 [3].

The reference normative document for ETICS is the European Assessment Document (EAD) No. 040083-01-0404 [4]. This document serves as a technical specification developed by a working group coordinated by the ITC-CNR, acting as the Italian Technical Assessment Body (TAB) within EOTA (European Organisation for Technical Assessment), the body responsible for coordinating the European certification.

The EAD represents the assessment basis for the European market through individual European Technical Assessments (ETAs) and includes test methods for evaluating these systems by measuring significant performances at different levels of complexity: from the performance of individual products, where relevant for overall system assessment, to the interaction between components, up to assessment of the entire system by full-scale testing, such as durability tests discussed in this paper.

In addition, the EAD provides the core principles of factory production control, defined jointly by the assessing body and the manufacturer, to ensure performance consistency over time and enable CE marking.

2. Methodology

2.1. Tools for assessing durability and the main defects identified in the Laboratory

Within EAD 040083-01-0404, the estimated working life of ETICS is 50 years for systems incorporating well-established insulation materials such as expanded polystyrene (EPS) and mineral wool (MW), and 25 years for systems including insulation materials mentioned in the EAD that have a more recent market presence.

Durability assessment of ETICS is based on experimental testing of a system installed on a test wall with a minimum surface area of 6 m² and a window opening of 0.50±0.1 × 0.50±0.1 m (Figure 1).

The Test Cycles are Carried out by Coupling Two Different Climatic Chambers to the Wall in Order to Perform:

- 80 heat-rain (HW) cycles, each lasting 6 hours, reaching a temperature of 70 °C followed by water spraying at +15 ± 5 °C;
- 5 heat-cold (HC) cycles, each lasting 24 hours, reaching a temperature of 50 °C with a maximum humidity of 10%, followed by exposure to -20 °C for specified durations;
- 30 wetting-freezing-thawing (WFT) cycles, each lasting 16 hours, during which the surface is sprayed with water at +15 ± 5 °C, then rapidly cooled to -20 °C and maintained for specified durations.

The latter cycle was specifically developed for evaluating systems installed in particularly rainy climates and was already included in the European standard EN 16383 [5].



Figure 1: Photo of the Test Wall on Which the Complete System is Installed (Photo: ITC).

To pass the test according to the reference standard, the specimen must undergo at least the first two cycles (HW and HC) and must not show, during or after testing, defects such as blistering, detachment of any finishing layer, flaking, breakages, or cracks wider than 0.2 mm, which would allow water penetration in addition to causing visual defects.

Many of the systems subjected to the cycles perform positively, particularly in the first two test phases; others, however, show a series of defects such as those listed and illustrated in Figures 2 to 6. It is important to note that laboratory installation is carried out by the manufacturer, who naturally relies—or should rely—on specialised contractors. It should also be specified that the verifications included in the EAD do not provide tools to precisely determine the cause of observed defects, i.e. whether they are due to installation errors or incompatibility between system components. Observation of the specimens frequently reveals damage attributable to common installation defects, as codified in the application manuals issued by the European Association for ETICS (EAE) [6]. Furthermore, subsequent testing using identical products but adhering to proper installation practices yielded positive results, confirming that the initial failures were indeed caused by installation errors.

Installation Shall Comply with Appropriate Timing and Technical Precautions. Good Practice Manuals Usually Refer to the Following Key Installation Stages:

• Substrate Preparation-Surface Suitability

An inadequately consolidated plaster or substrate will prevent proper bonding with the system, inevitably leading to cracks, fissures, and system detachment.

• Bonding the Insulation

This phase is crucial for the success of an ETICS. The most common errors relate to:

- Positioning of Insulation Boards
- Bonding Method

For board positioning, particular attention must be paid to staggering joints, especially around corners and window openings, avoiding alignment of openings with board joints, which would inevitably lead to cracking. Boards must be placed tightly together, ideally eliminating all gaps, which must never be filled with mortar to avoid thermal bridges, discontinuities, air circulation, cracks, etc.

Bonding of boards (particularly EPS) must be carried out by applying a continuous perimeter bead of adhesive and two or three central spots, ensuring a contact area of at least 40%. This ensures anchoring at the edges to prevent movement

of adjacent boards and support at the centre to avoid board curvature, leaving a maximum of 60% free surface to allow minimal deformation to compensate for thermal stresses. Mineral wool boards may be fully bonded due to their higher dimensional stability, and fixings must follow a W-pattern to secure board corners.

Board flatness and adhesion to the substrate must be ensured. Air circulation between the board and the substrate must be absolutely avoided, as it would compromise the partial or total effectiveness of the insulation material (thermal bypass).

2.1.1. Mechanical Fixing

Errors related to anchors partly derive from design—definition of anchor type and sizing, substrate suitability, number and placement with respect to building location and climate zone—and partly from installation practice, mainly concerning installation timing, fixing layout, and positioning of the anchor plate relative to the surface (flush or recessed). Damage resulting from anchor head protrusion includes not only thermal bridging but, above all, a discontinuity through which water can penetrate, leading to progressive cracking (Figure 5).

2.1.2. Application of the Reinforced Base Coat

The reinforced base coat protects the system from mechanical stresses and hygrothermal loads; incorrect application leaves the system “unprotected.” Common errors include incorrect positioning of the mesh within the render, which should be embedded centrally or even in the outer two-thirds of the layer, with a 10 cm overlap between mesh sheets, applied in two coats. Failure to overlap leaves joint areas exposed to thermal-hygrometric stresses, potentially leading to façade cracking. Incorrect mesh overlap around window corners can cause severe cracks (Figure 2).

2.1.3. Finishes

Color variations and staining (Figure 4) typically occur when the finishing coat is applied without adhering to the required drying times of the underlying layers. Environmental factors and application temperatures significantly impact the external layer; for instance, heavy rain on an immature finish can lead to surface leaching and material loss.

The list could be much longer; reference is therefore made to good practice manuals, emphasising that installation-related errors are very difficult to remedy afterwards.



Figure 2: Detail of Cracks on the Surface of the Specimen Originating from the Corner of the Opening (Photo: ITC).



Figure 3: Detail of detachment between the render layer and the insulation along the edge of the specimen (Photo: ITC).



Figure 4: Detail of a Portion of the Specimen Showing Stains on the Surface of One of the Finishing Coats (Photo: ITC).



Figure 5: Detail of Surface Protrusion of the Fixing Anchor Head and Related Cracking (Photo: ITC).



Figure 6: Detail of Various Defects on the Surface of the Base Coat Layer after the Test Cycles (Photo: ITC).

2.2. Tools for Assessing Installation in Europe

In this regard, the situation does not follow common European rules but is highly diversified at national and even local levels. Analysing each country's organisational framework would be lengthy and complex; however, it is worth noting that where binding regulations do not exist, voluntary schemes are in place, for example in Ireland and the United Kingdom, operating thanks to a direct link between manufacturer and installer.

Manufacturers must request an assessment of their ETICS, and installers must qualify and obtain certification for each ETICS they install. In these schemes, both manufacturers and installers must fulfil fundamental obligations: manufacturers must train and instruct installers and monitor them through references, inspections, and site visits; installers must demonstrate to manufacturers their ability to install the system according to its specific requirements, both theoretically (training and qualifications) and practically, through technical documentation evidencing site activities at critical stages, as specified by procedures.

Other virtuous countries—Germany, Austria, Poland, and France, with some differences—have vocational construction schools, qualified installers, and surveillance systems intended to ensure correct installation. Others rely on regulations, laws, standards, and assessment schemes that may be mandatory or voluntary.

In Italy, the framework is far less organised. Recent initiatives include the publication in 2018 by UNI (Italian Standards Body) of two standards addressing respectively the design and installation of ETICS, recalling key principles of correct application, and the requirements for professional profiles involved in ETICS installation, within the broader EU framework for professional activities. The latter standard defines specific tasks for professional activity, distinguishing between basic installer and team leader roles [7,8]. These recommendations fall within the scope of the international standard EN ISO/IEC 17024, which specifies principles and requirements for bodies certifying persons against specific criteria, including the development and maintenance of certification schemes [9].

Other local initiatives exist but have had limited market impact. As a result, assessment of installation quality in Italy remains poorly developed, uncoordinated, and largely left to the initiative of a few enlightened manufacturers or installers.

3. Conclusion

At the system assessment level, tools exist at European level to verify ETICS performance. However, it should be noted that these assessment tools enable CE marking but do not guarantee quality; rather, they make manufacturers responsible for placing products on the market with reliable technical information that is maintained over time. In the near future, ETICS incorporating traditional insulation materials with consolidated use will be subject

to a mandatory harmonised standard, as announced by the European Commission, while EADs may remain applicable—with modifications—for less conventional systems.

Both the future harmonised standard and the EAD will have to comply with the new Construction Products Regulation (EU) 2024/3110, which introduces significant innovations in the construction sector, focusing on sustainability and digitalisation. Sustainability and environmental performance are included as essential characteristics, mandatorily assessed through Life Cycle Assessment (LCA) and Environmental Product Declarations (EPDs).

Installation and its assessment remain excluded from the Construction Products Regulation, with only isolated best practices in some countries that cannot be easily replicated in Italy due to different cultural and legal contexts. The reduction in the number of certified installers recorded in Italy in recent years is an alarming signal: without qualified skills, it will not be possible to guarantee durable interventions aligned with the Directive's objectives.

The training of specialized construction firms should be promoted, alongside enhanced coordination between manufacturers and installers. This approach is essential to avoid reliance on unskilled labor, which often underestimates the critical role of correct installation in ensuring the long-term durability and thermal efficiency of these systems.

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