Guidance Note 1

BBA External Wall Insulation Systems (EWIS) The Assessment of Resistance to Wind Load

PRODUCT CERTIFICATION AUDIT & INSPECTION TEST SERVICES

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1 Introduction

This Guidance Note provides information on establishing the resistance to wind load of external wall insulation systems (EWISs) for the system types commonly installed in the UK.

This document imposes no obligation to adopt the guidance given. However, if the principles set out below are followed, it provides a mechanism for satisfying the requirements of the various national Building Regulations in relation to the structural stability of these systems.

2 Scope

This Guidance Note outlines the EWISs commonly installed in the UK, their composition, primary wind load transfer mechanisms to the substrate wall and relevant possible failure modes[(1)]. The systems considered are only for application to the outside of external walls constructed from conventional masonry, normal weight concrete, lightweight concrete, autoclaved concrete or no-fines concrete, or sheathed frame structures.

(1) The list of possible failure modes presented in this document does not represent all possible failure scenarios, other potential failures due to installations and maintenance should also be considered. The design, specification and installation of the EWIS must only be carried out by suitably trained and competent personnel in accordance with the specific system requirements.

Both positive and negative wind loads act on the system. Only the resistance to negative wind load (which causes tension in the system) is considered in this document, as it is deemed to be the most unfavourable. Negative wind load effects should also be considered in accordance with BS EN 1991-1-4 : 2005 + A1 : 2010 and its UK National Annex.

A system's resistance to negative wind load may be determined by a full-scale dynamic wind suction test (dynamic wind uplift test) or, alternatively, via a small scale pull-through or static foam block test and pull-out tests on the fixings, coupled with bond strength tests between the render/adhesive and the insulation.

The method of testing depends on the type of system and the primary fixing mechanism. The resistance of the individual components is based on limit state design (LSD) using design assisted by testing in accordance with BS EN 1990 : 2002 + A1 : 2005. Adopting this principle, characteristic strengths are established that are then divided by an appropriate partial factor according to the failure mode to generate the design resistance of the system.

When establishing design resistance from the capacity of individual component interfaces, the minimum design resistance from the set of each interface is reported as the design resistance of the system. The design resistance relating to mechanical fixings is calculated, based on the number of fixings provided per unit area, to provide a resistance pressure allowing direct comparison with bond resistance results and applied design wind pressures.

This document assumes that the substrate wall is structurally suitable for fixing an external wall insulation system to. The structural suitability should be confirmed by an appropriately experienced and competent professional on a project-specific basis.

For mechanically fixed samples with less than 40% supplementary adhesive the action of the self-weight of the system (calculated in accordance with BS EN 1991-1-1: 2002 + A1 : 2010) should also be considered for each EWIS. The system should be checked using the largest insulation thicknesses with the heaviest rendering system, coupled with fixings of least strength and stiffness (when applicable). Verification of such actions is outside the scope of this Guidance Note.

3 Types of External Wall Insulation Systems (EWIS) for Masonry Substrates

- Adhesively fixed
- Mechanically fixed
- Rail fixed
- Combined fixing system incorporating any of the above

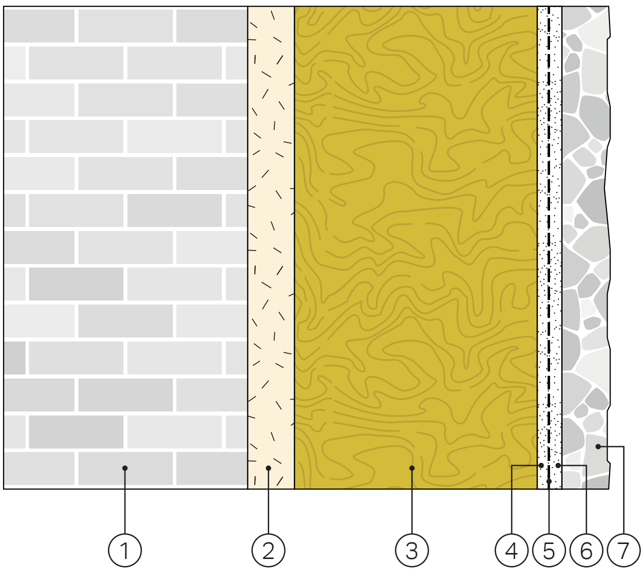
3.1. Types of Adhesively Fixed Systems

The system is either fully bonded (that is, with adhesive over the entire surface of the boards/slabs) or partially bonded, in strips and/or dabs. This system can also be used with the addition of supplementary fixings.

3.1.1. Purely Adhesively Fixed

This type of system can be fully bonded (as shown in Figure 1) or partially bonded. For a purely adhesively fixed EWIS, the negative wind load transfer mechanism to the substrate wall relies on the bond resistance between the components.

Figure 1 - Cross-section: adhesively fixed EWIS (fully bonded)



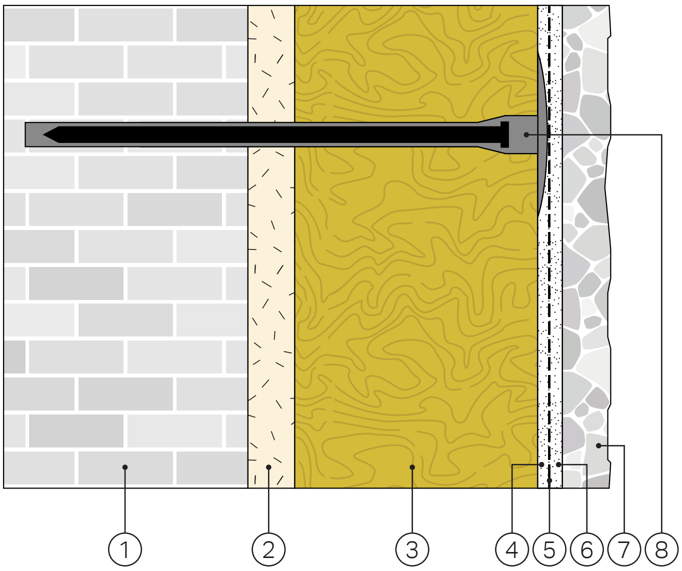
1. Substrate
2. Adhesive
3. Insulation
4. Basecoat
5. Reinforcing mesh
6. Basecoat
7. Finishing coat

3.1.2. Adhesively Fixed, with Supplementary Mechanical Fixings

This type of system can be fully bonded or partially bonded but, in addition, supplementary fixings are used (Figure 2). As with a purely adhesively fixed system, the negative wind load transfer mechanism to the substrate wall relies on the bond resistance between the components.

The supplementary mechanical fixings are used primarily to provide temporary stability to the insulation boards until the adhesive has sufficiently cured. The contribution of the supplementary mechanical fixings to negative wind load resistance should not be considered in the assessment of the resistance of the system in its permanent condition.

Figure 2 - Adhesively fixed EWIS, with supplementary mechanical fixings



1. Substrate
2. Adhesive
3. Insulation
4. Basecoat
5. Reinforcing scrim
6. Basecoat
7. Finishing coat
8. Supplementary mechanical fixing

3.1.3. System Resistance Mechanisms and Failure Modes

Adhesively fixed systems have two primary failure mechanisms (bond and tensile failures) within the four primary interfaces (see System resistance mechanism, in Table 1).

Table 1 Adhesively fixed EWIS – system resistance mechanisms and failure modes

System resistance mechanism	Failure modes
Bond resistance between insulation and render system	Basecoat bond failure, cohesive and/or adhesive
Tensile resistance of insulation material	Failure perpendicular to the face of insulation material
Bond resistance of adhesive and insulation material	Adhesive bond failure, cohesive and/or adhesive
Bond resistance of adhesive and substrate wall	Adhesive bond failure such splitting or peeling from substrate

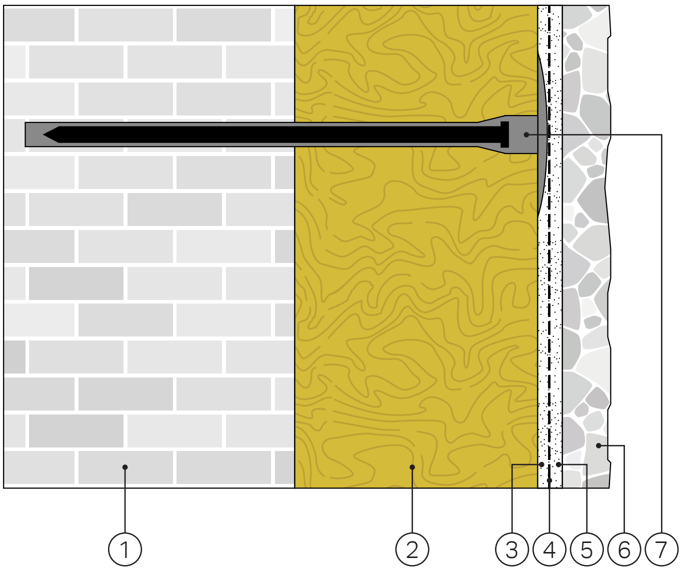
3.2. Types of Mechanically Fixed Systems

The system is either fixed to the substrate with mechanical fixings only, or with mechanical fixings and supplementary adhesive. The fixings may be installed through the insulation (before reinforcing mesh is applied), or through the insulation and the basecoat/reinforcing mesh.

3.2.1. Purely Mechanically Fixed – Through the Insulation

The load transfer mechanism to the substrate wall of purely mechanically fixed systems relies solely on the mechanical fixings (see Figure 3). The designer should verify that the pull-out resistance of the fixings from the substrate, and pull-through resistance of the fixing through the insulation, provide adequate strength and stiffness to resist the applied actions in a safe and serviceable manner. The designer should also satisfy themselves that the fixings are adequate to resist the combined wind action shear and dead load, and that the render bond strength with the insulation is adequate to resist the applied wind load.

Figure 3 - Purely mechanically fixed EWIS



1. Substrate
2. Insulation
3. Basecoat
4. Reinforcing scrim
5. Basecoat
6. Finishing coat
7. Mechanical fixing

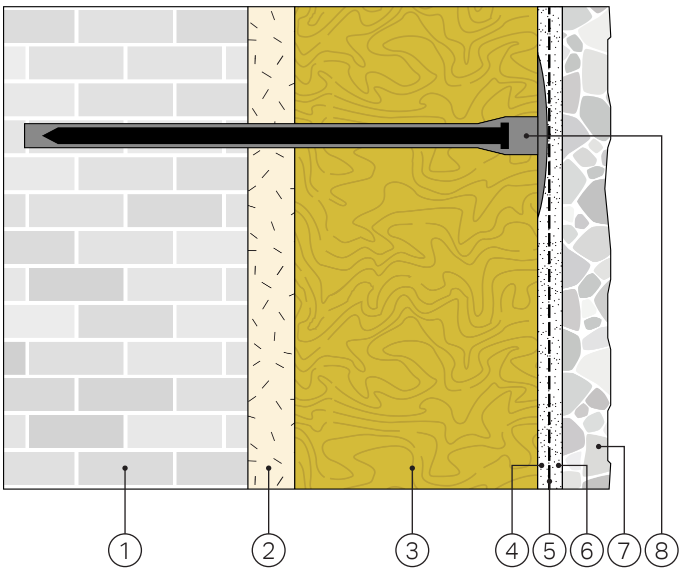
3.2.2. Mechanically Fixed, with Supplementary Adhesive – Through the Insulation

The load transfer mechanism to the substrate wall of a mechanically fixed system with supplementary adhesive relies on the mechanical fixings (Figures 4 and 5). The designer should verify that the pull-out resistance of the fixings from the substrate, and pull-through resistance of the fixings through the insulation, provide adequate strength and stiffness to resist the applied actions in a safe and serviceable manner.

The adhesive is used to support the permanent self-weight of the system and level out variations in the substrate. The designer of the system should satisfy themselves that the bond strength between the reinforced basecoat and insulation is acceptable.

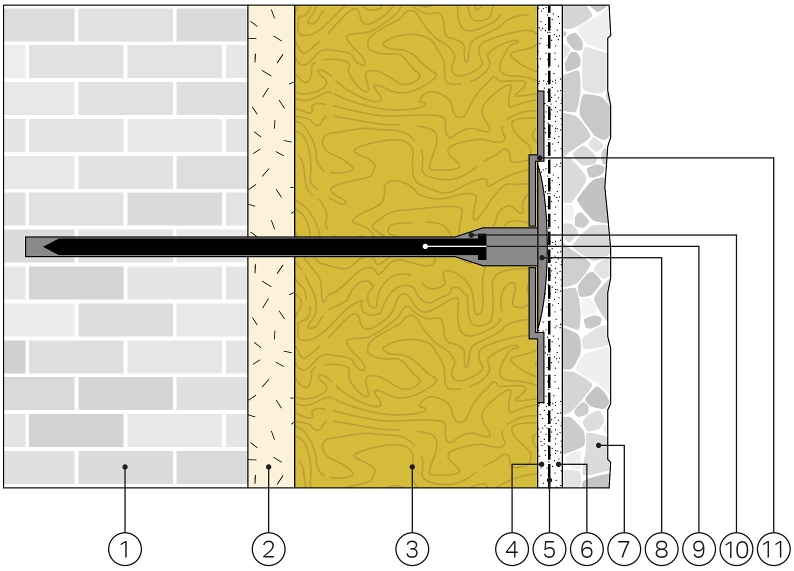
An extender washer is often used to enhance the pull through resistance of the fixing – see Figure 5

Figure 4 - Mechanically fixed EWIS, with supplementary adhesive



1. Substrate
2. Supplementary adhesive
3. Insulation
4. Basecoat
5. Reinforcing scrim
6. Basecoat
7. Finishing coat
8. Mechanical fixing

Figure 5 - Mechanically fixed EWIS (and extender washer), with supplementary adhesive



1. Substrate
2. Supplementary adhesive
3. Insulation material
4. Basecoat
5. Reinforcing mesh
6. Basecoat
7. Finishing coat
8. Fixing plate
9. Mechanical fixing
10. Fixing shaft
11. Extender washer

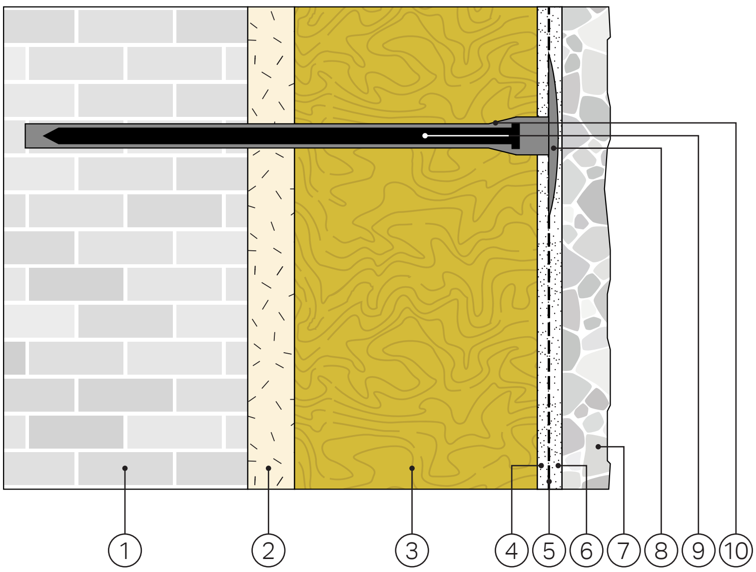
3.2.3. Mechanically Fixed, with Supplementary Adhesive – Through the mesh

In this case, the load transfer mechanism to the substrate wall relies on the mechanical strength of the mesh-reinforced basecoat (see Figure 6).

The adhesive is used in this system to level the substrate and to help support the self-weight of the system.

The designer should verify that the pull-out resistance of the fixings from the substrate, provide adequate strength and stiffness to resist the applied actions in a safe and serviceable manner. The contribution of the supplementary adhesive to negative wind load resistance should be disregarded for this calculation.

Figure 6 - Mechanically fixed EWIS, with supplementary adhesive: fixed through the insulation and mesh



1. Substrate
2. Supplementary adhesive
3. Insulation
4. Basecoat
5. Reinforcing scrim
6. Basecoat
7. Finishing coat
8. Fixing plate
9. Mechanical fixing
10. Fixing shaft

3.2.4. System Resistance Mechanisms and Failure Modes

Mechanically fixed systems can have the failure modes as described in Table 2.

When assessing these modes of failure, the contribution of the supplementary adhesive is disregarded.

Table 2 – Mechanically fixed EWIS – system resistance mechanisms and failure modes

System resistance mechanism	Failure modes
The resistance of mechanically fixed systems to negative wind load can be determined by a full-scale dynamic wind uplift (DWU) test in accordance with ETAG 004 (to be replaced by a European Assessment Document (EAD) at some point in 2019). Alternatively, the designed resistance of the system can be obtained by calculation although this may give an overly conservative result. The calculation method should not be used for systems mechanically fixed through the mesh as the effect of the mesh is not accounted for in a calculation method.	For systems fixed through the insulation: Pull out failure of the fixings from the substrate Pull through of the fixing through the insulation Basecoat bond failure, cohesive and/or adhesive
	For systems fixed through the mesh: Mesh rupture at the fixing head, with subsequent pull-through failure of the fixing through the insulation material

3.2.5. General Comments Relating to Mechanically Fixed Systems

The specific mechanical fixings given in the relevant BBA Certificate for use with the Certified EWIS could be replaced by the designer with alternative mechanical fixings with the same resistance values, provided:

- The insulation material remains the same and with the same minimum thickness
- The pull-out resistance is equal or better
- The fixing plate stiffness and load resistance is equal or better
- The plate diameter is equal or greater.

4 EWIS Rail Systems

4.1. Types of Mechanically Fixed Rail Systems

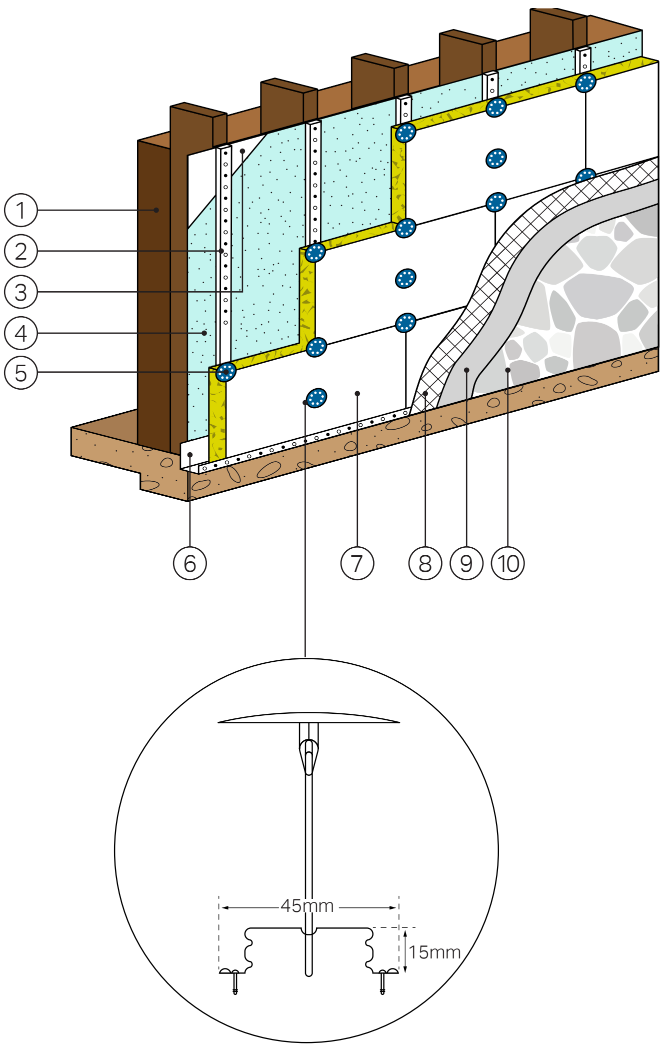
The EWIS system is mechanically fixed to the substrate via profiles (see Figures 7 and 8). The system is for application to the outside of external walls of timber or steel frame structures sheathed with boards.[1]

(1) BBA Certificates have included the following board types:

- calcium silicate boards
- cement bonded particle boards
- oriented strand boards
- plywood boards.

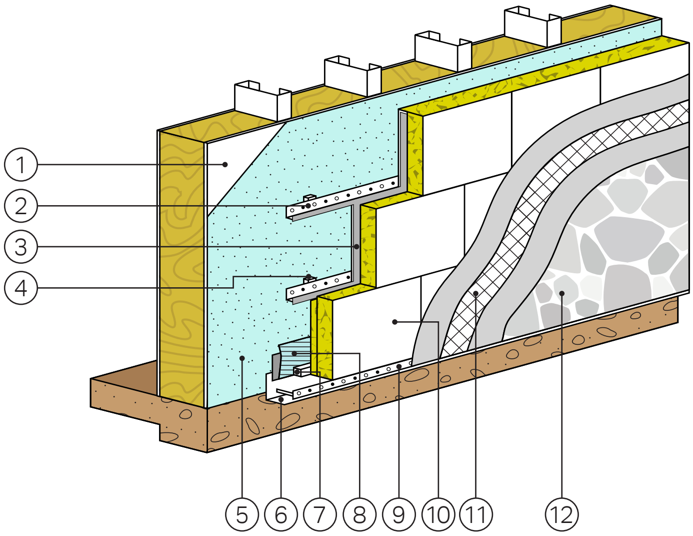
The resistance of mechanically fixed EWIS to negative wind load should be determined by full-scale DWU testing (using T-rails or top-hats). In addition, when top hat profiles or direct fixing is used, the resistance of mechanically fixed EWIS to the combined self-weight of the system and wind action should be determined by full-scale combined wind/shear/load tests.

Figure 7 - Mechanically fixed EWIS with vertical top hat profiles



1. Timber frame
2. Top hat rail profile
3. Sheathing board
4. Breather membrane
5. Mechanical fixings
6. Base rail
7. Insulation
8. Base coat with reinforcing mesh
9. Primer
10. Finishing coat

Figure 8 - Mechanically fixed EWIS with vertical T-rail profiles



1. Sheathing board
2. Holding track
3. T-spline
4. PVC packer
5. Breather membrane
6. Continuous flashing
7. PVC packer
8. Flashing
9. Starter track with weep holes
10. Insulation board
11. Reinforcing mesh embedded in base coat
12. Finishing coat

4.2. System Resistance Mechanisms and Failure Modes

Mechanically fixed systems with vertical profiles have different failure mechanisms across the interfaces. Each interface has a resistance and therefore a partial factor needs to be applied to each resistance to establish the design resistance. The design resistance of the system under lateral wind load is the minimum of the design resistances of the failure mechanisms (see Table 3).

Table 3 – Mechanically fixed EWIS with rail profiles – load transfer mechanisms and failure modes

System resistance mechanism	Failure modes
Determined by the DWU test	Basecoat bond failure, cohesive and/or adhesive
	Pull-out failure of the insulation fixing from the top-hat profiles
	Pull-through failure of the insulation fixings through the insulation material
	Pull-through failure of the profile fixing head through the profile
	Pull-out failure of the profile fixing from the sheathing board, base material splitting, base material cracking

The resistance of these systems to negative wind load must be determined by a full-scale DWU test.

When assessing these resistances and their modes of failure, the failure pressure obtained during the DWU test is the contribution of all the system components, and is only valid for the specific fixing pattern and components used in the tested system. If supplementary adhesive is used, its contribution will be included within the test outcome; its contribution to the resistance achieved, however, cannot be quantified.

When installing the system on site, the adhesive coverage cannot be lower than that applied during the test.

4.3. General Comments Relating to Mechanically Fixed Rail Systems

The system wind load characteristic resistance is required, in accordance with ETAG 004. It is derived from the resistance value obtained from the DWU test.

This characteristic value is then divided by a material partial factor to obtain the design wind load resistance for the tested system. The design resistance values cannot be extrapolated, and the designer should satisfy themselves that:

- The fixing pattern is the same as that used for the DWU test.
- The in-situ pull-out capacity of any alternative profile fixing from site-specific tests is equal to, or greater than, the calculated designed wind load.

5 Wind Load Resistance Assessment Methodology

5.1. Building structure

- The designer should establish that the existing building structure has adequate strength and stability to withstand all possible loads and load combinations, including the ones imposed by the installation of the EWIS.
- The designer should seek confirmation that the building structure has adequate durability and serviceability to carry the proposed EWIS.

5.2. Design process

- The designer should satisfy themselves that the proposed EWIS is compatible with the building structure and consider serviceability, durability, material compatibility, the height of installation and fire aspects.
- All possible wind load loads, wind load combinations and aerodynamic effects should be considered in accordance with BS EN 1991-1-4 : 2005 + A1 : 2010 and its UK National Annex. When calculating the wind load resistance of the system, all load combinations that are possible simultaneously with the wind effects should be satisfied.
- In-situ pull-out / pull off tests should be carried out to confirm the suitability of the substrate to receive the proposed EWIS.(1)

(1) Pull-out resistances declared in a current European Technical Assessment (ETA) document for a specific fixing could be used, provided the substrate and installation conditions are the same.

All failure modes as described in this document should be calculated, resulting in design resistance which should exceed the design wind loading.

6 References

BS EN 1990 : 2002 + A1 : 2005 Eurocode – Basis of structural design

BS EN 1991-1-1: 2002 + A1 : 2010 Eurocode 1 – Actions on structures – General Actions – Wind actions

ETAG 004 : External thermal insulation composite systems (ETICS) with rendering

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