Xella Deutschland GmbH
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Düsseldorfer Landstraße 395
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Natters-Innsbruck, 12.11.2017

Home of the Neudecker family,
Stulln, Germany:
Partial survey of ETICS facade

Expert opinion

1 Commission
1.1 Date of commission 10.07.2017
1.2 Customer Xella Deutschland GmbH
Düsseldorfer Landstraße 395
D-47259 Duisburg, Germany

1.3 Represented by Dr Holger Griebel,
Head of Product Management Multipor

1.4 Subject of commission Inspection of a 20-year old external thermal
insulation composite system (ETICS)
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The expert opinion comprises 16 pages with 29 photographs
2 General background to the expert opinion

Purpose of the expert opinion

This expert opinion is intended to establish the condition of the current facade. Any other direct or indirect use without the prior written permission of the author is expressly prohibited.

Copyright

The report is subject to copyright and is my intellectual property. It may be used by the customer without restriction for all matters relating to the present commission. Any other use or publication of the report or part thereof, and in particular of the images contained in it, in whatever form, requires the author’s prior written permission. The same applies to all natural and legal entities who become aware of or in possession of this report.

Declaration of impartiality

I hereby declare that I am impartial and independent of the customer.

State of knowledge – Right to review

The following findings relate to the time of the inspection and to the verbal and written information obtained. Should I subsequently obtain further insights in whatever form, I reserve the right to revise my expert opinion.

3 Basic principles

3.1 Customer documentation None
3.2 Survey Site inspection on 21.08.2017
3.3 Miscellaneous Written correspondence Personal data
Subject

The company Xella had the opportunity to open a 20-year-old external thermal insulation composite system (ETICS) comprising mineral-based Multipor insulation board and to have it surveyed to see how it had withstood the test of time.

The rendered external walls of a residential home in D-92551 Stulln were due for refurbishment and repainting. This provided an opportunity to open the aged facade and inspect the layer structure and design details.

The facade was to be opened in several places by an independent expert to assess and report on its condition after so many years of service.

I was commissioned with this task.

An exchange of information between Xella and myself took place beforehand which mainly involved the sending of elevation photographs of the family home of [redacted] (Upper Palatinate, Schwandorf district, approx. 80 km east of Nürnberg). The photographs were used to select a side for inspection.

It was also necessary to arrange access to the facade for inspection. Scaffolding was provided which would subsequently be used for the refurbishment work.
5 Survey & expert opinion

Normally the survey and report are written up separately. However, in this case it makes more sense to arrange the survey and expert opinion consecutively for each section since this gives a better overview.

5.1 Survey

In order to survey the facade, I conducted a personal inspection and created an accompanying photographic record:

5.1.1 Photographic record

I used several photographs to illustrate my findings below, which were taken either by me or by other persons present.

At this point I would like to thank the people who were kind enough to take photographs for me while I was occupied with other manual tasks. This has allowed me to produce a more comprehensive photographic record. Note image sources!

5.1.2 Site inspection

Xella arranged the site inspection for the 22.09.2017, starting at 11:00.

Present at the site:

Homeowner:

Xella Deutschland:

Dr Holger Griebel
Frank Georgi
Hans-Peter Schweiger
Stefan Niedzwetzki

Consultant:

Michael Hladik

Xella Deutschland:

Olaf Kruse
Press officer Xella Deutschland
Dr Holger Griebel
Xella Head of Product Management Multipor
Frank Georgi
Xella Head of Applications Engineering Multipor
Hans-Peter Schweiger
Factory manager of Xella Stulln
Stefan Niedzwetzki
Xella demonstration consultant Multipor

Consultant:

Michael Hladik

Accredited expert witness and building consultant specializing in rendering and external thermal insulation composite systems
The building in question is a detached family home built in the 1950s. Roller shutter boxes for the windows are integrated into the existing masonry. The facade has no visual signs of defects or damage. There is some grey discoloration on the facade surface which is entirely in keeping with a building of this age. This grey discoloration is mainly caused by airborne dust pollution. There are no obvious signs of microbial attack.

Small, evenly distributed circular marks are present, though barely perceptible with the naked eye. These indicate the positions of the anchor fixings. A photographic record of these marks has been created using image processing.

A faint, slightly paler strip approximately 2 cm wide running along the lower edge of the facade indicates the location of the integrated metal base rail.

Expert opinion: The slightly paler outlines of the anchor fixings and the base rail are caused by thermal effects. The metal base rail and the metal expanding pins of the anchors conduct a minimal amount of heat from the substrate (masonry, heated on the inside and insulated on the outside) to the ETICS surface, causing slightly elevated surface temperatures in these areas. Consequently, the facade surface dries more quickly in these areas when damp (rain, mist). This makes these areas less susceptible to soiling than other areas of the facade. This is what produces lighter patches in an otherwise grey facade.

The anchor plates beneath the surface layer also created partially warmer areas. Investigations and my own measurements on other buildings have revealed surprising temperature differences of only 0.2°C between the facade surface and the outlines.

The anchors used nowadays have very low thermal transmittance (low Chi value) and are additionally embedded in the insulation. Base rails nowadays are made from plastic, which has better thermal properties.
Suitable sampling points were identified in advance:
1. Top left corner of right-hand window on upper floor
2. Right-hand side of upper floor at roof connection
3. Bottom left corner of left-hand window on ground floor at windowsill connection
4. Right-hand side of ground floor in the blank wall

Expert opinion: The sampling points were selected on the basis of extensive experience of building practice; the survey focuses on cracks in the facade surface and in particular, the construction of ETICS connections.

The scaffolding provided by the customer allowed direct access to the sampling points.

Expert opinion: This type of survey can also be done from a lift platform. In this case, however, scaffolding was erected because it gives several people direct access to the sampling points and can also be left in place for closing the wall openings (sampled areas) and subsequently repainting the facade.

Sampling point 1:
The approx. 40 x 40 cm opening was marked out and cut with a multi-tool to remove only the surface layer (render).
Expert opinion: An ETICS comprises 3 layers: The adhesive layer, the insulating layer and the surface layer. The surface layer also consists of three components: The base coat render, the reinforcement mesh embedded in it and the finishing render. The functions of these different layers are indicated by their name. The layers are interdependent, which ensures the system durability – provided that it is correctly installed.

Removal of the surface layer exposed the insulating core. An anchor was visible and there was a crack in the insulating core running from the inside corner of the window diagonally up to the right.

The section of render removed had a thin layer of insulation adhering to it.

Expert opinion: To comply with standards, the mineral foam insulation must be mechanically fastened with anchors fixings in addition to the adhesive bond. The mineral foam insulation (Multipor) has only low material strength due to its high pore volume. When handling the insulation during application, only a small amount of force is needed to break off parts of board.

A section of the insulation board had been cut out to form the window opening; this created an L-shaped insulation board, one leg of which subsequently cracked. However, this crack is not a defect. The two broken parts were tightly butted up together.

The anchor fixing is still functional. It is firmly seated in the substrate and can only be pried out with a nail puller.

Expert opinion: The mineral insulation boards were bonded and anchored at the time, although this only became a mandatory requirement later.
To remove the insulation with the minimum damage possible, an inspection gap approx. 4 cm wide was cut first on the left-hand side of the sampling point. The position of the adhesive joint was located on the left-hand window reveal and then the insulation board was undercut, leaving only the adhesive on the substrate. In this way, it was possible to take hold of the left and right side of the section of insulation board and remove it in one piece. The exposed adhesive layer (shown in the photograph with remains of the back of the insulating board adhering to it) had been applied virtually as a full bed.

The thickness of insulation does not correspond to the full depth of the reveal. The ETICS was applied to the existing masonry and the reveal of the existing masonry was not insulated. See images 28 and 29.

It was important to establish whether the crack in the insulation board occurred at the time of installation or during its subsequent service life. The ridge on the back of the removed section of render lines up with the crack in the insulation. The ridge occurred because the base render was able to slightly penetrate the crack. This indicates that the crack was present at the time of installation.

There is no adhesive on the sides of the crack.

Expert opinion: A crack through the insulation creates a type of head joint. Both bed and head joints in ETICS are always left unmortared, and the same applies to a board that has broken in two.
To determine how the adhesive layer was constructed, the adhesive joint was tapped with a ruler. No deep cavities were found. This indicates that the bonded joint was correctly executed.

Expert opinion: Insulation boards should be bonded using the 'edge bead-point' method in which a bead of adhesive is applied all round the perimeter of the board with spots of adhesive dotted in the middle. Often 'spot bedding' alone is used, which is not permitted because it enables air to circulate between the insulation board and the masonry if the ETICS connections are not tightly sealed (plinth, cornices). This circulating air back-ventilates the insulating layer, greatly reducing the insulating effect or even destroying it completely.

There was no visible cracking (diagonal cracking) in the corner of the removed section of render. A simple breaking test established whether diagonal reinforcement (mesh strips) had also been installed at the corner of the opening.

The deliberately broken piece of render revealed that there was no diagonal reinforcement.
Expert opinion: The render reinforcement is a type commonly used at the time. Additional reinforcement first became necessary to prevent diagonal cracking with the emergence of thin-film rendering systems.

Openings can be regarded as a type of defect in the render reinforcement. Stress peaks can occur in the surface reinforcement at the corners of openings, resulting in diagonal cracks running outwards. To prevent this, mesh reinforcement strips are inserted in the surface reinforcement at each inside corner of openings. This is a mandatory requirement, irrespective of the type of ETICS.

The reinforcement mesh is embedded in the middle of the reinforcement layer, which is up to 10 mm thick.

19 Reinforcement layer up to 10 mm thick, mesh embedded in the middle. Image: Malerzeitschrift MAPPE

Expert opinion: The standard thickness of the reinforcement layer (reinforced base render) is approx. 5 mm, with mesh embedded into the top third. This reinforcement layer is up to 10 mm thick. This exceedance of the nominal specification is not a problem with this insulation and evidently may even compensate for other defects – e.g. no diagonal reinforcement, no expansion gap in window sills.

Sampling point 2:
The ETICS in sampling point 1, which is exposed to direct weathering, was found to be completely dry.

Because it makes no sense to damage an intact facade by sampling it, the consensus was to refrain from opening the designated sampling point 2, which is underneath a roof overhang and is thus more protected from the weather.
Sampling point 3:
The bottom inside corner of the window on the ground floor showed clear signs of weathering.

![Window sill - window reveal](image)  
Image: SV Hladik

The window sill was fitted with push-in end caps which were embedded in the render. The reveal render sits on top of the end caps. Although the end caps are fully pushed into the sill, with no expansion gap provided to accommodate any temperature-related heat changes within the windowsill, there was no evidence of cracking or spalling.

![Window sill with rendered end caps](image)  
Image: Malerzeitschrift MAPPE

Expert opinion: Window sills with rendered end caps always need an expansion gap to prevent temperature-induced length changes within the windowsill causing cracking and spalling. In this instance there are no expansion gaps, but neither are there any signs of damage. The reason for this is the solid, thickly applied render layer, which was evidently able to absorb any deformation arising from these length changes without sustaining any damage.

The installation angle and outward slope of the windowsill of approximately 2 to 3 degrees does not comply with current codes of practice. Nowadays an angle of at least 5 degrees is required to ensure good rain drainage. Nevertheless, there was no evidence of any irregularities at this sampling point.

Sampling point 3 was sampled in the same way as sampling point 1:
- mark
- remove the surface layer
- undercut the insulation from the window reveal
- remove the insulation

The ETICS was again found to be completely dry.
Expert opinion: It was surprising that the insulation showed no signs of moisture loading despite the fact that the connection point is exposed to intense weathering and there are clear signs of soiling on the outside (see Image 20). It is clear that the connection joints were constructed with a durable raintight seal.

When the surface layer in the reveal was folded down, it was evident that the ETICS (a) had been applied to the existing masonry, as already established with sampling point 1. The existing reveal (b) was not insulated, but simply rendered flush with the surface layer.

Sealing tape had been inserted where the surface layer connects to the left end of the windowsill (yellow arrow).

The sealing tape also runs around the side of the end cap and continues along the underside of the windowsill.
Expert opinion: The sealing tape is a precompressed foam tape which is relatively thin on the roll but expands when fitted between joint faces to provide a seal against driving rain. In this case the sealing tape had been installed very proficiently and has clearly fulfilled its function in the long term.

No sealing tape had been fitted to the existing reveal because only the render layer had been applied in this area. The existing reveal would have to have been cut back in order to insulate it. The area at the back of the reveal was clearly less exposed to the weather, so even when the render layer was removed, no signs of moisture were found. It is also possible that the very thick render layer on top of the end cap was strongly bonded and provided an adequate seal.

The ETICS was fitted to the facade only, not to the existing reveals. The header faces of the Multipor insulation boards form the front part of the reveals, which have become wider as a result of the insulation work.

The render layer in the reveals bridges the existing reveal (behind and to the right of the blue line) and the header faces of the facade insulation boards. Yellow arrow.
Sampling point 4:
Sampling point 4 is on the ground floor, but since the facade here shows no signs of cracking or other defects, as with sampling point 2, we agreed that it would be pointless to use a destructive testing method to inspect a clearly intact facade. Also, because the ETICS was found to be completely dry in sampling point 3, which is exposed to direct and intensive weathering, we decided not to proceed with sampling point 4.

Summary

The opening of the approx. 20-year-old external thermal insulation composite system has brought to light several details:

1. The ETICS was basically of high quality workmanship, although there are some shortcomings in the installation method when viewed from today’s perspective: the absence of diagonal reinforcement strips, the uninsulated reveal and the metal base rail. The lack of diagonal reinforcement was clearly offset by the thicker reinforcement layer, so even after decades there were no signs of diagonal cracking.

2. In principle, the uninsulated existing reveals can be problematic in terms of building physics because they can provide a thermal bridge from inside out. This could create colder surfaces on the inside around the windows which encourages mold growth. However, according to the homeowners, there are no problems around the inside of the windows.

3. The slightly paler vertical stripes on the bottom edge of the facade were not inspected separately. The faint discoloration is created by the metal base rail installed there. Metal profiles were the only type of base rail in use at the time the facade was constructed. Plastic profiles were not yet on the market.
4. Algae and fungi are often the cause of complaints associated with ETICS. No signs of microbial attack were found on this approximately 20-year-old, west-facing facade. The thick reinforcement layer (reinforced base render), mineral-based finishing render and mineral-based insulation have formed a homogenous system. When a facade like this is dampened by dew or direct rain, the system absorbs the moisture and, by the same token, quickly dries out again. This prevents moisture accumulating, which is the chief requirement for microbial infestation.

5. The external thermal insulation composite system made from MULTIPOR mineral foam insulation boards showed no abnormalities whatsoever after a lifespan of approx. 20 years. In particular, there were no signs of moisture ingress or voids, either immediately behind the render, which had remained crack free, or in the connections to this surface layer, which are prone to such issues. Neither did the installation faults identified have any adverse effects on the overall system.

Accredited expert witness and building consultant

Michael Hladik
Specialist in interior plaster, exterior render and external thermal insulation composite system diagnostics

The expert opinion comprises 16 pages with 29 images