Assessment of compliance of the Brick to Click cladding system

This engineering judgement, produced by Oculus Architectural Engineering Limited, is an evaluation of the following product's ability to fulfil the following performance requirements of the New Zealand Building Code (NZBC) based on the available international performance documentation referenced below:

- B1 Structure,
- B2 Durability,
- C3 Fire affecting areas beyond the source,
- E2 Exterior Moisture

This engineering judgement has been made based on the information provided to us and assuming the product will be utilised in accordance with the manufacturer's details.

Limitations:

This judgement only covers use of the Brick to Click system in the applications described below where the system is installed onto timber or steel stud framing, mass timber or precast concrete walls. We understand the system is to be installed as part of a rainscreen cladding system where the Brick to Click cladding forms the outermost water shedding layer within the assembly.

The subframe system to which the brick tiles are affixed is intended to create a ventilated cavity that, when coupled with openings in the cladding at the top and base of the cladding will promote ventilation and aid drying of any residual water that may enter the cavity. As the cladding can be expected to allow some water to penetrate beyond the cladding line, we expect the system to be installed over a rigid sheathing board that creates an air barrier at the back of the cavity that may be assumed to prevent any water penetrating further into the assembly. We also assume that cross cavity flashings will be provided at each storey to drain any water reaching this layer to drain to the exterior of the building, back through the cladding line.

In relation to code clause B1:
This judgement is valid where the proposed building's expected wind and seismic loads do not exceed the maximum allowable values outlined in this report.

In relation to code clause B2:
This judgement is valid where the proposed building is located in NZS 3604 corrosivity zones B to D. This document does not cover use of the system in corrosivity zone E, in these applications seek professional advice.

In relation to code clause C3:
Where compliance is demonstrated through one of the compliance pathways outlined in the MBIE fire guidance document (Fire performance of external wall cladding systems). The performance of the complete cladding system and therefore compliance is dependant on the other components making up the complete system or assembly meeting the specific requirements outlined for each compliance pathway contained within the document.

In relation to code clause E2:
Where the system in installed as part of a drained and back ventilated rainscreen cladding system and is therefore reliant on the inclusion of a continuous weather resistant barrier installed behind the cladding system to prevent water penetration into the structural wall.

22/09/2020

System description:

The Brick to Click cladding system is a brick tile rainscreen cladding system supplied by The Tile People. The system consists of extruded brick tiles that feature an integral hook profile on the reverse side of the tile. The hook profile enables the brick tiles to slot onto horizontal that support the tiles. The system is then supported by the Nvelope NV1 subframe system consisting of a T shaped vertical rail and series of brackets installed to connect the vertical rail and attached cladding back to the structural wall.

Figure 1 – Image of the Brick to Click tile and rail system

Compliance documentation provided by The Tile People:

- DCA Brick to Click Drawing - Substrate Fastener Options (15/07/2020)
- Ceramic tiles - Environmental Product Declaration (19/05/2016)
- Nordfox Partlist_2.0
- SFS intec Technical Value SN3 4.8 (07/2012)
- WarringtonFire AS1530.1 20200814 RTF200236 R1.0 (03/08/2020)
- Nvelope NV1 System Span Tables (04/06/2020)

Additional compliance documentation reviewed by Oculus:

- Nvelope NV1 Technical Specification (02/2015)
- Nvelope Rainscreen Systems – BBA Certificate 19-5671 (24/06/2019)
- Brick to Click Cladding System – Capacity of connection between tile rail and Nvelope vertical rail (11/09/2020)

Performance in relation to the New Zealand Building Code:

B1 Structure:

The objectives and functional requirements of NZBC clause B1 relevant to this product are listed below:

Objectives:

- **B1.1(a)** "Safeguard people from injury caused by structural failure"
- **B1.1(b)** "*Safeguard people from loss of amenity caused by structural behaviour.*"
- **B1.1(c)** "Protect other property from physical damage caused by structural failure"

Functional Requirements:

- **B1.2** *"Building elements shall withstand the combination of loads that they are likely to experience during construction or alteration and throughout their lives."*

When installed within a rainscreen cladding installation the cladding panels and supporting components must be sufficient to resist any loads imposed on the cladding system. Examples of the typical types of load applied to the cladding system would include but are not limited to, self weight, wind loading, & seismic loading.

The following section summarises our assessment of the Brick to Click cladding system in relation to the load cases identified. Note that it is the responsibility of the building designer to verify that the chosen specification is suitable for use in the specific application.

Wind

In a typical assembly, it is assumed an air barrier will be created behind the cladding line at the back of the rainscreen cavity. The cavity is assumed to features openings for drainage and ventilation that enable the space behind the cladding line to pressure equalize with the environment and therefore any wind pressure effectively resisted by the air barrier behind. In theory, this approach should result in a zero-wind pressure being applied to the cladding itself.

However, a conservative approach is to assume the cladding system may have to resist the full design wind load without pressure equalisation.

The Nvelope NV1 System span table document outlines the maximum acceptable spacing of the supporting brackets for a given stud spacing for ultimate limit state (ULS) wind loads up to 6.0 kPa from timber stud, steel stud and concrete substrates. Provided these limits are adopted for the expected ULS wind load we believe the subframe will meet the requirements of code clause B1.

To verify the performance of the cladding system connection to the subframe Oculus have produced a set of design calculations outlining how the capacity of the cladding system to subframe connection is greater than the rated capacity of the subframe and therefore compliant where the limits set out in the Nvelope span tables are adopted to suit the project specific wind loads.

Gravity

The Brick to Click tiles have a weight around 1 kg each with a calculated approximate density of 1825 kg/m^3. Therefore, where the average tile depth is 22mm the cladding system installed can be assumed to have a weight of approximately 40 kg/m^2.

The brick tiles are supported by a horizontal cladding rail though hooks on the reverse side of the tile slotting over the horizontal rail.

Again, the Nvelope NV1 subframe system span tables list various deadload bracket configurations for given rail lengths, stud spacing, and fixed bracket lengths. Provided these limits are adopted for a cladding weight of

conservatively rounded up to 50 kg/m^2 to account for the additional weight of the support rails and ancillary components. We are satisfied that the subframe will be adequate to resist the gravitational load of the cladding system.

Again, to verify the performance of the cladding system connection to the subframe Oculus has produced a set of design calculations outlining how the capacity of the cladding system to subframe connection suitable to resist the gravitational load of the cladding.

Seismic

Oculus are not aware of any seismic testing the Brick to Click system has been subjected to at the time of writing. That said, by inspection, the cladding system is expected to perform very well during a seismic event. The tile to horizontal rail connection allows differential horizontal movement between the tiles and supporting structure while the horizontal rails and subframe are expected to bend and rotate about their fixings to accommodate the movement of the structural wall.

Again, without evidence of a seismic racking test, Oculus can only provide an estimate of the level of performance that could be achieved by the system. However, we are confident that the system could accommodate a serviceability limit state (SLS) interstorey drift of up to 1% without sustaining permanent damage that could compromise the weathertightness performance of the cladding system.

While we are confident that the system could accommodate a ultimate limit state (ULS) interstorey drift of up to 2.5% without becoming detached from the building's structure.

It should be noted that the Nvelope span tables do not appear to consider the effects of seismic loading. In areas of higher seismic activity, the seismic acceleration coefficient should be determined in accordance with section 8 of NZS 1170.5:2004 to determine if the seismic load case governs design.

In general, we expect wind loads to govern when compared to horizontal seismic load where wind pressures exceed 1.5 kPa. Similarly, we expect vertical seismic load can be omitted in areas of lower seismic activity by conservatively increasing the estimated weight of the cladding system to 70 kg/m^2.

Note it is the responsibility of the designer to ensure the cladding system is designed to withstand all loads that may be imposed upon the system to ensure compliance with code clause B1.

B2 Durability:

The objective and functional requirement of NZBC clause B1 relevant to this product are listed below:

Objective:

- **B2.1** "*The objective of this provision is to ensure that a building will throughout its life continue to satisfy the other objectives of this code."*

Functional Requirement:

- **B2.2** *"Building materials, components and construction methods shall be sufficiently durable to ensure that the building, without reconstruction or major renovation, satisfies the other functional requirements of this code throughout the life of the building."*

The Brick to Click cladding system consists of fired clay brick tiles supported by an aluminium horizontal rail fixed to the Nvelope subframe. The subframe system consists of aluminium rails and brackets fixed together using stainless-steel fasteners.

Fired clay brick is widely recognised as an inherently durable material where historic buildings across New Zealand and the rest of the world serve as evidence of the materials durability. Depending on the minerals and

salts present in the brick during manufacture, it is normal for some efflorescence to occur as these minerals and salts are carried to the surface of the brick and deposited where water within the pores of the brick evaporates. These deposits are mostly superficial and only effect the aesthetic appearance of the brick.

The subframe components similarly are widely accepted as inherently durable and likely to achieve a 50-year service life. The durability claim of the subframe system is further supported by the BBA certificate which states the system "can be expected to have a service life in excess of 35 years in normal UK conditions".

As a result, we would be confident that the Brick to Click cladding system and Nvelope NV1 subframe could achieve the minimum durability requirement of the NZBC of at least 15 years given the inherent durability of the materials used to manufacture the cladding system. Provided the system is installed within NZS 3604 zone exposure zones up to zone C.

Please note that, within zone D or geothermal areas where specialist advice should be sought to verify that the durability requirement of the NZBC can be achieved.

Based on the information contained above we believe that this product will fulfill the performance requirements clauses of B2:

- **B2.3.1** *"Building elements must, with only normal maintenance, continue to satisfy the performance requirements of this code for the lesser of the specified intended life of the building, if stated, or:"*
  - **(*b*)** *15 years if:*
    - **(*i*)** *Those building elements (including the building envelope, exposed plumbing in the subfloor space, and in-built chimneys and flues) are moderately difficult to access or replace, or*
- **B2.3.2** *"Individual building elements which are components of a building system and are difficult to access or replace must either:"*
  - ***(a)*** *"All have the same durability"*
  - ***(b)*** *Be installed in a manner that permits the replacement of building elements of lesser durability without removing building elements that have greater durability and are not specifically designed for removal and replacement.*

C3 Fire affecting areas beyond the source:

The objective and functional requirement of NZBC clause C3 relevant to this product are listed below:

Objectives:

- **C1(a)** "*Safeguard people from an unacceptable risk of injury or illness caused by fire.*"
- **C1(b)** *"protect other property from damage caused by fire"*

Functional Requirements:

- **C3.1** *"Buildings must be designed and constructed so that there is a low probability of injury or illness to persons not in close proximity to a fire source."*
- **C3.2** *"Buildings with a building height greater than 10 m where upper floors contain sleeping uses or other property must be designed and constructed so that there is a low probability of external vertical fire spread to upper floors in the building."*
- **C3.3** *"Buildings must be designed and constructed so that there is a low probability of fire spread to other property vertically or horizontally across a relevant boundary."*

The MBIE External Wall Cladding system vertical fire spread – risk assessment approach outlines the following fire testing pathways which would be relevant to the product depending on the risk classification of a given building from Table 1 of the MBIE guidance document:

Low:
For buildings categorized as low risk (<10m high) there are no requirements for fire testing protocols P1 to P5 and therefore all products are suitable for use in these applications.

Medium:
For buildings classified as medium risk, any of the compliance pathways P1 to P5 can be used.

High:
For buildings classified as high risk, compliance pathways P2 – P5 can be used.

Descriptions of the MBIE guidance compliance pathways are summarised below:

P1. All cladding and rigid air barriers used in the external wall construction may be individually tested using ISO 5660-1 to meet requirements in C/AS2 to C/AS7 Paragraph 5.8. Insulation products, and filler materials (not including gaskets, sealants etc) to be limited combustibility*. Timber framing and combustible battens may be permitted in buildings with a building height of up to 25m, and must be properly encapsulated and/or protected (see P5) in buildings with a building height over 25m. All external wall cavities need to be fire stopped using cavity barriers at each floor level and at the junctions to other vertical fire separations. ACP materials must be tested without Aluminium (metal) facing as per C/AS2 to C/AS7 Appendix C7.1.5.

P2. External wall cladding system may meet the performance criteria given in BR 135 for cladding systems using full scale test data from BS 8414-1:2002 or BS 8414-2: 2005; or

P3. External wall cladding system may pass the NPFA 285 full scale test; or

P4. External wall cladding system may meet 'EW' classification in AS 5113; or

P5. All cladding, framing**, battens, insulation products**, rigid air barriers and filler materials (not including gaskets, sealants etc) used in the external wall construction may be of limited combustibility*. If vapour barriers, drainage mats, building wraps or similar are not of limited combustibility* then all external wall cavities need to be fire stopped using cavity fire barriers at each floor level.

* Limited combustibility means the product/material meets one or more of the following criteria:

1. A1 or A2 classification in accordance with EN 13501-1:2007+A1:2009.
2. Non-combustible or not combustible when tested to AS 1530.1 or ISO 1182.
3. Concrete, brick/block masonry, stone, glass, ceramic tiles, aluminium and steel with or without paint or similar thin surface coatings not exceeding 1 mm thickness.

** Timber framing (or combustible insulation products within a framed wall assembly) may be used if a robust protective lining material (being of limited combustibility) is fixed to the exterior side of the framing and can be demonstrated to remain in place and protect the framing during the period of external fire exposure. 'Protect framing' can be assumed to be achieved if the protective lining material as part of a light timber frame wall exposed to the test conditions of AS 1530.4 can be shown to prevent charring of the timber frame for a period of 30 minutes. One way to determine this is to limit the temperature on the cavity side of the fire-exposed protective lining material during the test period to be no greater than 300 degrees Celsius.

System testing:

Brick tiles:
To our knowledge, at the time of writing the Brick to Click system has not been subjected to a full scale fire test, like the BS 8414-1 or -2, NFPA 285, or AS 5113. However, the brick material used to manufacture the brick tiles has been tested to AS 1530.4 as evidenced in the WarringtonFire Test report RTF200236 R1.0 dated 03/08/2020.

The report states that the per clause 3.4 of AS 1530.1:1994 the material can be deemed non-combustible where the results table shows there was no duration of flaming or a temperature rise of more than 50 degrees in both the furnace and surface thermocouples.

It is noted that the material was tested after having its glazed finish removed through a grinding process. While Oculus cannot guarantee performance of the glazed finish applied to the brick in relation to the test procedure, we are reasonably confident the finish would not adversely effect the performance of the product under the conditions of the test.

Subframe:
The Nvelope subframe system can be deemed non-combustible by way of it being comprised primarily of aluminium and stainless steel. Both materials are listed within the MBIE guidance document as materials that can be deemed non-combustible by inspection. This is further evidenced and supported by the BBA certificate which states; “the aluminium bracket, rails and associated rail-to-bracket fixings are non-combustible and, therefore are classified as Class A1”.

The certificate goes on to identify the polypropylene insulation pads as; “unlikely to significantly affect the overall fire performance of the cladding.” We would agree with this assessment pointing to the statements within the MBIE guidance suggesting that materials such as gaskets, sealants, and paint coatings less than 1mm can be omitted from assessment within the compliance pathways where the assumption is that were these elements combustible they would have a negligible contribution to the spread of flame as they comprise only a small amount to the overall façade build up.

Other assembly components:
Oculus has not included any ancillary components (rigid air barriers, building wraps, insulation products, sealant and gaskets, ect) within this engineering judgement due to the vast variation in the testing data available for seemingly similar products that could also be featured in a complete wall assembly. As a result, it is the responsibility of the designer to determine the suitability of any additional components within the wall assembly.

The designer must locate any available testing information for any other components within the assembly and determine if the complete assembly is compliant with at least one of the compliance pathways defined in the MBIE guidance document. To assist the designer in determining how their assembly complies, the following compliance pathways that could be utilised have been set out below.

Possible compliance pathways:

Based on the information above, the Brick to Click cladding system may be used as an external cladding material in the following cases, corresponding to the risk classification set out in table 1 of the MBIE guidance document:

Low risk buildings:
Low risk buildings are not subject to any material restrictions in relation to combustibility, and therefore, the Brick to Click system may be used in this application with no restrictions on the other components that make up the assembly.

Medium risk buildings:
Compliance may be demonstrated through compliance pathway P1 where all cladding materials, rigid air barriers, Insulation, and filler materials; (excluding gaskets and sealants) used on construction are of limited combustibility* (per the definition above from the MBIE guidance document).

As the product is deemed non-combustible in accordance with AS 1530.1, compliance pathway P1 may be used for “Medium risk” buildings where the other components of the wall assembly listed above also achieve a limited combustibility classification.

High risk buildings:
As no full-scale testing (BS 8414, NFPA 285, or AS 5113) featuring the Brick to Click system has been conducted at the time of writing. The only option to demonstrate compliance with code clause C3 in a high-risk building is pathway P5. Compliance pathway P5 can be adopted in applications where all components in the wall assembly can be classified as being of limited combustibility* (per the definition above from the MBIE guidance document).

Designers should note, that in assemblies where the cladding is installed over combustible framing (i.e timber) there is a requirement to provide protection to the framing in order to meet the requirements of compliance pathway P5. The guidance document defines the need for a robust protective lining material (non-combustible) to be fixed to the exterior side of the framing that is capable of remaining in place and can “protect the framing” during the period of external fire exposure.

The guidance document states that a material can be assumed to “protect the framing” where; the protective lining material as part of a light timber frame wall exposed to the test conditions of AS 1530.4 can be shown to prevent charring of the timber frame for a period of 30 minutes. One way to determine this is to limit the temperature on the cavity side of the fire-exposed protective lining material during the test period to be no greater than 300 degrees Celsius.

E2 Exterior moisture:

The objectives and functional requirements of NZBC clause E2 that are relevant to this product are shown below:

Objectives:

- **E2.1** *“The objective of this provision is to safeguard people from illness or injury that could result from external moisture entering the building.”*

Functional Requirement:

- **E2.2** *“Buildings must be constructed to provide adequate resistance to penetration by, and the accumulation of, moisture from the outside.”*

At the time of review, Oculus had not been provided with manufacturer installation details and cannot therefore comment on their compliance potential. However, it is understood the Brick to Click tiles are intended to be installed as part of a rainscreen cladding system where the panels form the outermost water shedding layer within the assembly. In the completed wall assembly, the weather resistant line is located at the back of the rainscreen cavity provided by a flexible building wrap and/or rigid air barrier. In a system like this the cladding line is expected to deflect most of the water hitting the façade but is not intended to create a perfect barrier so some water penetration behind the cladding is to be expected.

Where water does penetrate the cladding line, the cavity between the cladding and structural wall is expected to help prevent water being able to migrate further into the assembly and allow water to drain down to the base of the cladding or midfloor joints where flashings direct the water out back through the cladding line. These openings at each level encourage ventilation which aid drying of any residual water in the cavity and drying of the structural wall should these other weathertightness measures fail.

A self adhered weather resistant barrier installed at the back of the rainscreen cavity is recommended to prevent any water reaching the back of the cavity migrating further into the assembly and provide resilience against building movements (live load & seismic) to ensure weathertightness performance is not compromised.

Assuming these features are incorporated into the proposed design and good detailing practice is adopted around more challenging details and junctions (i.e window openings, service penetrations, cladding junctions, ect). We believe that this product, when installed as part of a rainscreen cladding assembly, will fulfill the performance requirements clauses of E2:

- **E2.3.2** *"Roofs and exterior walls must prevent the penetration of water that could cause undue dampness, damage to building elements, or both."*
- **E2.3.3** *"Walls, floors, and structural elements in contact with, or in close proximity to, the ground must not absorb or transmit moisture in quantities that could cause undue dampness, damage to building elements, or both."*
- **E2.3.5** *"Concealed spaces and cavities in buildings must be constructed in a way that prevents external moisture being accumulated or transferred and causing condensation, fungal growth, or the degradation of building elements."*
- **E2.3.6** *"Excess moisture present at the completion of construction must be capable of being dissipated without permanent damage to building elements."*
- **E2.3.7** *"Building elements must be constructed in a way that makes due allowance for the following:"*
    - **(a)** *"the consequences of failure:"*

Closure:

This report is an opinion of the probable performance of the system based on the information provided to us. We have assumed the system will be designed into projects by suitably qualified designers using good detailing practice. Designers need to consider the site-specific loads and requirements and adjust features and details of the system accordingly without altering the key performance parameters noted above.

Please do not hesitate to contact the undersigned with any questions,

Regards,

Peter Raimondo, CPEng, B.A.Sc, P.Eng (Ontario)
Senior Building Enclosure Engineer
Oculus Architectural Engineering Ltd.

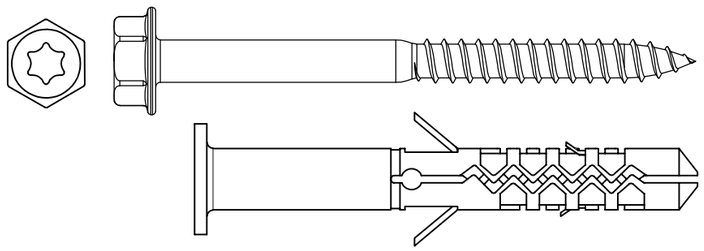
22/09/2020

Referenced Compliance Information:

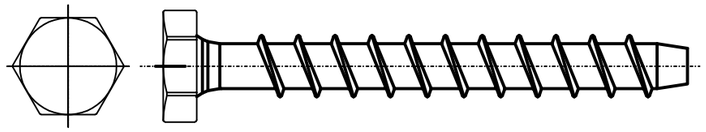
Digital copies of the compliance information referenced in this report can be found at the link below:

https://drive.google.com/drive/folders/1WMedlSiUww0VXjeUI31sNhaLEwy-2q9Q?usp=sharing

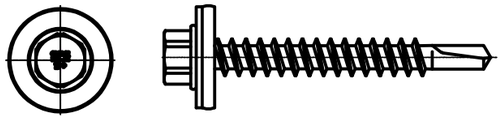
SUBSTRATE FASTENER OPTIONS



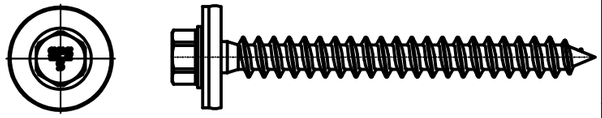
BLOCK WALL FASTENER
SFS MBRK 10X80



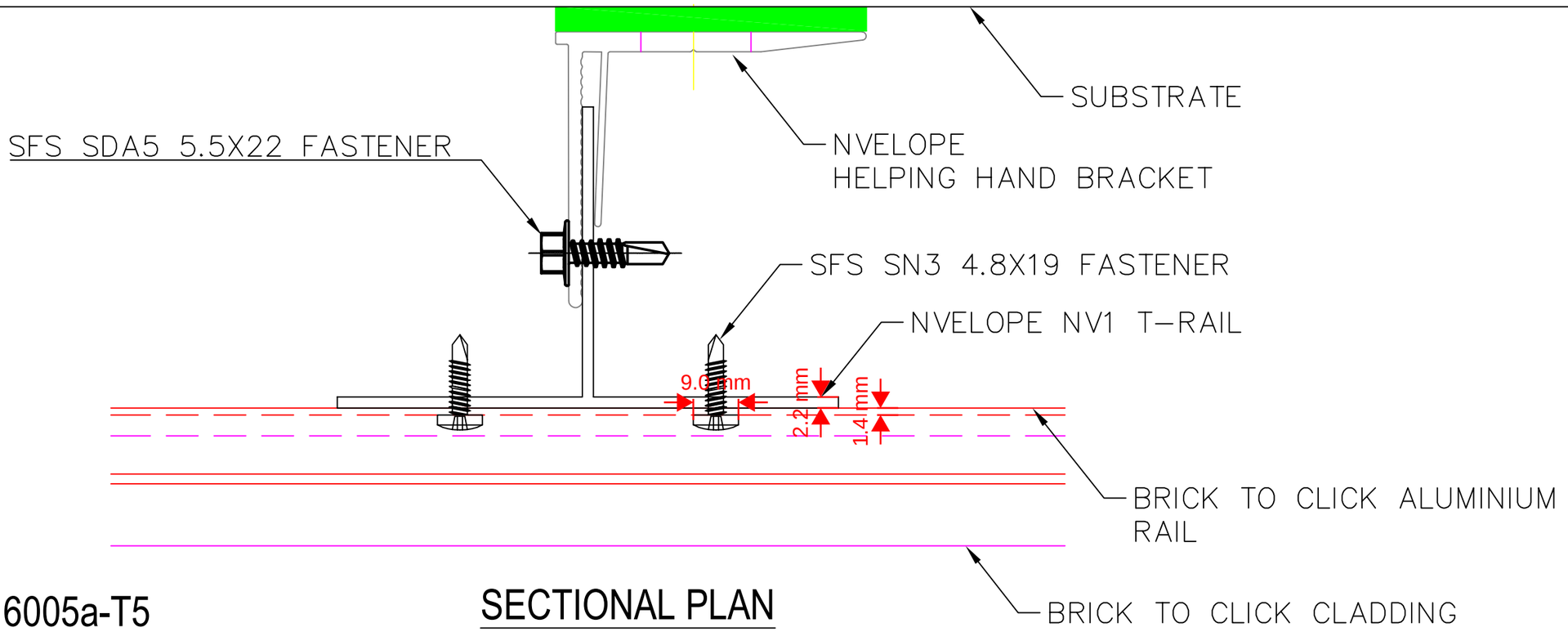
CONCRETE SUBSTRATE FASTENER
SFS MULTI-MONTI 10X85



STEEL STUD FASTENER
SFS SX3 6.0X48



TIMBER STUD FASTENER
SFS TDA 6.5X60



ALUMINIUM GRADE 6005a-T5

SECTIONAL PLAN

DYNAMIC COMPOSITE TECHNOLOGIES
UNIT 8 / 171-175 NEWTON ROAD WETHERILL PARK
PH: 02 8788 9555 FAX: 02 9604 7468
WWW.DCTECH.COM.AU

DRAWING NAME: DCA BRICK TO CLICK	ISSUED: 15/07/2020	REV: 0	SIZE: A3	SCALE: 1:1
	DRAWN BY: ALEX G	APPROVED BY: ALEX G		
DESCRIPTION: FASTENERS FOR DCA BRICK TO CLICK		DWG NO: NVP-DCA-B2C-002	SHEET: 2 OF 2	

ENVIRONMENTAL PRODUCT DECLARATION

according to ISO 14025 and EN 15804

Owner of the Declaration	Bundesverband Keramische Fliesen e. V.
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-BKF-20160002-IBE1-EN
Issue date	19.05.2016
Valid until	18.05.2021

Ceramic tiles

Bundesverband Keramische Fliesen e. V.

Institut Bauen und Umwelt e.V.

www.bau-umwelt.com / https://epd-online.com

1. General information

Bundesverband Keramische Fliesen e. V.	Ceramic tiles
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the Declaration** Bundesverband Keramische Fliesen e. V. Luisenstrasse 44 10117 Berlin Germany
Declaration number EPD-BKF-20160002-IBE1-EN	**Declared product / Declared unit** 1 m² ceramic tiles
This declaration is based on the Product Category Rules: Ceramic tiles, 07.2014 (PCR tested and approved by the Council of Experts (CoE))	**Scope** This document refers to ceramic tiles by the Bundesverband Keramische Fliesen e. V. The LCA data was recorded in 2014 in member plants of the association. The LCA is representative for 9 companies and 11 plants in the association which manufacture around 70% of the total domestic production volume. The holder of the Declaration is liable for the information and evidence on which it is based; liability by IBU with regard to manufacturer's information, life cycle assessment data and evidence is excluded.
Issue date 19.05.2016	
Valid until 18.05.2021	
	Verification The DIN EN 15804 CEN standard serves as the core PCR. Independent verification of the Declaration according to /ISO 14025/ ☐ internal ☒ external
Prof. Dr-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	
Dr Burkhart Lehmann (Managing Director IBU)	Dr. Frank Werner, (Independent verifier appointed by the CoE)

2. Product

2.1 Product description

Ceramic tiles are produced by extrusion or dry-pressing techniques. They are formed, dried and then fired once or twice in order to develop the desired and required characteristics.
The products under review here involve wall and floor tiles in all formats, surface finishes (e.g. glazed and/or coated and unglazed) and colours as well as all defined classification and evaluation groups. Ceramic tiles are generally classified as earthenware, stoneware, porcelain tiles and split tiles. Earthenware is more porous
and displays a higher degree of water absorption. It is glazed and largely used in interior applications while stoneware and porcelain tiles have essentially low water absorption. This makes them more resistant to frost as well as being particularly
durable as floor coverings. The situation is similar for split tiles, i.e. extruded products.

2.2 Application

Ceramic tiles are largely used as wall and floor coverings in interior and exterior applications. Apart from applications in living areas, e.g. bathrooms, kitchens, hallways and porches as well as in living rooms and bedrooms, on balconies and patios, they are also used in commercial and industrial areas, in public buildings, indoor swimming pools and on facades etc. on account of the possibilities offered in terms of combining design and durability.

2.3 Technical data

The following section outlines details on product performance in terms of their essential characteristics in accordance with EN 14411, where included and specified in the Declaration of Performance.
As no specific values can be provided for the average product declared in this EPD, the requirements are outlined below in accordance with a defined product class.

1. Water absorption
Ceramic tiles are classified in groups I to III with regard to water absorption and design. Water absorption as a mass percentage is >0.5% to <10% depending on the group and measured in accordance with /DIN EN ISO 10545-3/.
2. Breaking load (requirements in accordance with /DIN EN 14411/):

dependant on tile application and classification group
- Breaking load for tile thickness ≥ 7.5 mm: min. 600 – min. 1,300 N
- Breaking load for tile thickness < 7.5 mm: min. 200 – min. 600 N

3. Bending strength (requirements in accordance with /DIN EN 14411/):
dependant on tile application and classification group:
- Bending strength: min. 8 – min. 30 N/mm²

2.4 Placing on the market / Application rules

Directive (EU) No. 305/2011 applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland). The products require a Declaration of Performance issued by the manufacturer taking consideration of /EN 14411:2012 Ceramic tiles - Definition,
classification, characteristics, evaluation of conformity and marking / and CE-marking.

The respectively valid national specifications and processing information supplied by the adhesive and grout manufacturers must be observed for use.

2.5 Delivery status

Depending on the respective area of application, ceramic tiles are manufactured and supplied in various formats, thicknesses, colours and decors (glazed or unglazed). Quality features in terms of dimensions and surface finish in accordance with /DIN EN ISO 10545-2/.

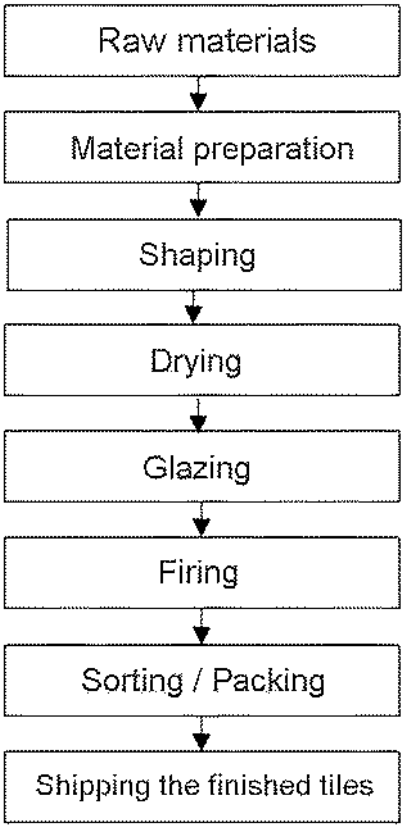
2.6 Base materials / Ancillary materials

Ceramic tiles are manufactured from a raw material mixture
comprising the following essential components:
• Clay approx. 45 - 60%
• Feldspar approx. 25%
• Kaolin approx. 7%
• Limestone approx. 3%
• Sand approx. 3%
• Glaze/Coating approx. 4%

Clay/Caolin: Natural earths of varying natural mineral composition. Materials are quarried close to the surface in selected natural mineral deposits.
Sand / Powdered limestone:
Added as leaning agents to balance the natural fluctuations of the mineralogical
composition of the raw clay in the case of very oil (fine-grained) clay.
Other natural clay components:
Clay contains natural deposit components of varying percentages such as colouring ferrous oxide, for example.
For this reason, yellowish to dark red fired colours can arise depending on the clay involved.
Dyes:
Depending on the natural raw material composition, colour additives are added to the
masses to be produced, e.g. coloured spinels such as iron oxide Fe_3O_4 (magnetite). During the firing process, these colour additives lead to the requisite reactions and ultimately the desired colours.
Glazes:
Containing clay, feldspar and glass frits, for example. Glass frits arise when glass powder is heated until the particles evaporate and condense but without the entire mixture becoming viscous. The goal is to achieve a mass of similar components and to convert water-soluble components contained into insoluble compounds.

2.7 Manufacture

The manufacturing process for ceramic tiles is broken down into various process steps such as preparing the base materials, shaping, drying, glazing where necessary and firing the tile
blanks. Clay, kaolin, quartz and feldspar serve as ceramic raw materials. The base materials are crushed and ground, weighed by formula, mixed with water in a mixer and homogenised (ceramic
mass).
A distinction is made between two different shaping processes: In the so-called dry press process, the raw material mass is pressed into the future tile mould as granulate; extrusion pressing involves pressing the pulpy
raw material mass through the mould templates. The shaped blanks are then dried and fired with or without a glaze. After firing, the tiles are sorted and packed for shipping.
Manufacturing process for ceramic tiles (glazed):



The manufacturers are subject to initial, internal and external monitoring in accordance with the Construction Products Regulation (EU 305/2011). Internal monitoring is performed on the basis of a quality management system (QMS) in accordance with or based on /DIN EN 14411/, /ISO 9001/ and /ISO 50001/.
External monitoring is performed by independent certification agencies (notified bodies).

2.8 Environment and health during manufacturing

The tile manufacturers subject to this EPD carry out environmental control systems, /EMAS/, for example. Health and safety and industrial safety are attributed a high degree of attention. The occupational limit values are significantly fallen short of. No more extensive measures are required based on production conditions.
Water/Soil:
No contamination of water or soil. In many of the plants reviewed, the process is free of waste water. The mixing water used is released as water vapour during the drying process and redirected into the internal water circuit where it is reused.
Air:
Natural gas is used in the firing process. The emissions from the firing process are below the stringent limit values of the /TA Luft/. Environmental protection measures are aligned towards as low energy consumption as possible and low-emission waste air.

2.9 Product processing / Installation

Further processing of the tiles generally involves the use of wet cutters or breaking. Tiles can be glued using tile adhesive or laid in a mortar bed.
The weights of individual elements are below the recommendations of the professional liability association.
When processing the tiles, industrial protection measures are adhered to in accordance with the rules of the professional liability associations and manufacturer recommendations. Cutting work generally involves specified wet processes.
Leftover tiles are collected separately and recycled.

2.10 Packaging

Packaging materials incurred on the building site are redirected into the economic cycle as recycled products.
Packaging materials such as cardboard (/EWC/ 15 00 01), PE foil and strips (both /EWC/ 15 00 02) are collected separately and redirected into the economic cycle by the VfW (Vereinigung für Wertstoffrecycling) or comparable organisations as recycled products, or utilised energetically.
Wooden pallets (/EWC/ 15 00 03) are taken back by the building trade (reusable pallets remunerated in the German deposit system) which returns them to the manufacturing plants.

2.11 Condition of use

The components of ceramic tiles are bound as solid substances in the use stage thanks to the sintering process at high temperatures (ceramic compound).

2.12 Environment and health during use

Ceramic tiles do not emit any substances which are hazardous to health or the environment, are free of VOC as well as being neutral in terms of indoor air.

2.13 Reference Service Life

The reference service life for ceramic tiles is generally significantly longer than 50 years, confirmed by the list of useful lives for components issued by the BNB /BNB 2011/. Standard use extends to 80 to 150 years and more in some cases.
A Reference Service Life according to /ISO 15686/ is not indicated.

2.14 Extraordinary effects

Fire
Ceramic tiles are not flammable. In the event of a fire, no toxic gases and vapours arise which impair visibility. The products fulfil the requirements of /DIN EN 14411/ and are classified as Class A (non-combustible) in accordance with /DIN 13501-1/ (see /96/603 EC/).

Fire protection

Description	Value
Building material class	A
Burning drips	-
Smoke gas development	-

Water
Ceramic tiles are suitable for lining drinking water containers (e.g. water supply). Hazards caused by water can be excluded.

Mechanical destruction
If the coating layer displays a hole or indent, it can be repaired using the appropriate hard waxes or similar and individual tiles can be easily replaced where they display more extensive damage.
Damaged tiles are not associated with any pollution for the environment or persons.

2.15 Re-use phase

Depending on the quantity and material, tiles can be reused in line with their original application when buildings are de-constructed in a targeted manner. Likewise, tiles can remain on the surface and be glued over.
Single-variety element residue can be taken back by fireclay manufacturers and reused in ground form as leaning agents in production. This practice has been applied with broken product for decades.
The possibilities of further use involve as aggregates for crushed brick concrete, as filling or bulk material in the area of road-making and civil engineering.

2.16 Disposal

Where the recycling options indicated above are not practical, element residue, broken product and product residue incurred on the building site are easy to dispose of and do not pose any risks for the environment.
Waste key: /EWC/ 170103 (tiles and ceramic)
Owing to the chemically neutral, inert and immobile performance of ceramic tiles, they can be stored in class 0 and 1 landfills in accordance with the /TA Siedlungsabfall/.

2.17 Further information

Further information is available at www.fliesenverband.de.

3. LCA: Calculation Rules

3.1 Declared unit

The Declaration is based on the production of 1 m² average ceramic tiles. Please refer to the table for conversion factors.

Declared unit

Description	Value	Unit
Declared unit	1	m^2
Basis weight	18.65	kg/m^2
Conversion factor to 1 kg	0.0536	-

3.2 System boundary

The following life cycle phases are considered: product stage, construction of the building structure, use stage, end-of-life stage, benefits and loads beyond the system boundaries.
The EPD system boundaries follow the modular approach outlined in the /EN 15804/. The declared modules are outlined briefly below.
Type of EPD: “cradle to grave”

Modules A1 to A3 comprise the manufacturing phase:

- A1 Raw material supply and processing and poss. finishing processes for secondary materials serving as input (e.g. recycling processes)
- A2 Transport to manufacturer
- A3 Production

The data on energy, material and waste flows is queried within the framework of data collation in the plants.
The possible recycling of product waste incurred during production is allocated as zero to the benefit of a conservative calculation approach. It does not have any noteworthy market value nor does it cause any acceptance costs and can therefore be regarded as a by-product. Integration of biogenic CO_2 in the wooden pallets is included. Consideration is only taken of defective pallets which are in fact disposed of. The paper and/or cardboard used primarily comprises recycled fibres with a low percentage of primary fibres for technical reasons. Disposed of paper/cardboard is not therefore attributed a credit, e.g. for energy use during thermal utilisation.
Module A4 includes transport to the customer and/or construction site. This data is also collected in the plants and refers to domestic transport.
Module A5 includes the assembly expenses incl. disposal of packaging. This EPD exclusively analyses the influence of plastic and paper packaging disposal incl. transporting packaging for disposal. Thermal processing in a plant with R1<0.6 is assumed for the packaging (with the exception of paper/cardboard). The loads from the incineration process are declared in Module A5; the remaining credits are declared in Module D.
The material expenses associated with tile adhesive and grouting mortar as well as cuttings are not analysed in this LCA as there can be major differences in volumes depending on the respective application. The material expenses associated with tile adhesive and grouting mortar are outlined in the Declaration for a typical standard application but are not included in the LCA.
Module B1 concerns the use of tiles with regard to emissions into the environment. The module is declared. No indoor emissions presenting a hazard for health can be anticipated when using tiles.
Module B2 includes the expenses associated with cleaning using water and cleaning agents. A typical cleaning cycle must be indicated separately for floor and wall tiles in the EPD. The environmental impact of annual expenses associated with cleaning 1 m² wall tiles is indicated in the LCA. If the sum is divided by 4 (wall tiles cleaned 4 times a year) and then multiplied by the number of cleaning processes per year for floor tiles, the planner can calculate the total impact of cleaning, including concerning floor tiles.
Modules B3 to B5 concern the repair, substitution and full replacement of tiled floors. These modules are considered in the study and declared in the EPD. When installed as designated, no repair, replacement or substitution is necessary.
Modules B6 and B7 are considered in the study and declared in the EPD. There are no environmental impacts here as the product does not require water or electricity in order to work. The expenses associated with cleaning are declared in B2.
The **C Modules and Module D** refer to analysis of tile disposal following use where maximum two scenarios (both 100%) are taken as a basis for calculation. EoL scenario 1 refers to material utilisation as mineral filling materials in the construction industry. EoL scenario 2 outlines disposal at a building rubble landfill.
Details on modules concerning subsequent use:
Module C1 includes the expenses associated with de-construction, primarily diesel consumption by demolition machines.
Module C2 includes transport to the landfill and/or to recycling.
Module C3 comprises processing building materials for later use as mineral bulk goods.
Module C4 involves waste disposal, i.e. disposal in the building rubble landfill.
Module D includes the credit for expenses saved, i.e. savings in primary material and primary energy by using recycled grit and by thermal utilisation of packaging.
Waste impact is considered in the modules in which such waste is incurred.
Machinery, plants and infrastructure required in the manufacturing process are ignored.

3.3 Estimates and assumptions

The glaze formula is not usually available to the companies as mostly readymade glazes are procured. As the formula for these readymade glazes and glaze frits is often a secret, the average composition of the glaze is estimated as outlined below.
Solid information is available on the average components of the glass frits and type of aggregates. Aggregates are considered in even percentages.
The glaze recipe used for calculation is depicted in the following table.

Table: Glaze formula

Components	Mass percentage
Glass frits	60%
Aggregates:	
Aluminium oxide AL_2O_3	8%
Iron oxide Fe_2O_3	8%
Lime CaO	8%
Zinc oxide ZnO	8%
Zirconium oxide ZrO_2	8%
Total	100%

3.4 Cut-off criteria

All data from the operating data survey was taken into consideration, i.e. all starting materials used according to the formula, the thermal energy used as well as electricity. Accordingly, material and energy flows with a share of less than 1 per cent were also considered. No material flows are neglected which make a significant contribution to environmental impact by the product.

3.5 Background data

Data sets are available in the GaBi /GaBi ts/ data base for the base materials used in the corresponding formulae as well as for the provision of energy and all other requisite background data (e.g. waste processing, transport processes). The data base was last updated in 2014.

3.6 Data quality

The data is of good quality. The primary data has been collated carefully; all relevant energy and material flows have been taken into consideration.
Both primary and background data refer to data from 2009 to 2014.

3.7 Period under review

The manufacturing data represents an average over the entire year 2014.

3.8 Allocation

The production process does not produce any by-products. Accordingly, no allocation is integrated in the software model used.
Product waste used internally is ground and added to the base materials. Some of the product waste is recycled externally. The subsequent processing and recycling steps are not taken into consideration.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context and/or the product-specific characteristics of performance are taken into account.

4. LCA: Scenarios and other technical information

The following technical information forms the basis for the declared modules or can be used for developing specific scenarios within the context of a building assessment.

Transport to construction site (A4)

Description	Value	Unit
Litres of fuel (per FU)	0.031	l/100 km
Transport distance (national)	300	km
Capacity utilisation (including empty runs)	85	%

The average national transport distance calculated in the data survey is declared in this Declaration. Specific transport distances can be derived from this distance.

Construction installation process (A5)

Description	Value	Unit
Ancillary material grouting mortar per m²	approx. 3	kg

The volume of product waste during assembly varies depending on the application and is not therefore declared in the EPD. The declared environmental results from A1-A3, A4 and C and D are supplemented by the cutoff rate to enable inclusion of the environmental impact incurred by assembly waste. (Example: a 3% cutoff/breakage rate gives rise to a factor of 1.03 x environmental impact.)

Use (B1)

Ceramic tiles are extremely robust and avail of a hard and abrasion-resistant surface. Environmental impacts during use are therefore excluded (please refer to section 2.12 Use).

Description	Value	Unit

Maintenance (B2)

Description	Value	Unit
Water consumption per cleaning cycle	2E-06	m^3
Ancillary material cleaning agent per cleaning cycle	0.0003	kg

The number of cleaning cycles per year can vary extremely depending on the type of use, e.g. in private areas, in business premises or in hospitals. If the surface is very dirty, additional quantities of cleaning agent may be necessary. Cleaning can be carried using water with or without cleaning agent. Electricity is not required for the cleaning process. It may be possible to remove coarse dirt using a brush.
Scenario for cleaning wall tiles:
A cleaning interval of every 3 months (4 times a year) using the indicated quantities of water and tensides can be regarded as typical for private areas.
Scenario for cleaning floor tiles:
A cleaning interval of once a week (52 times a year) using the indicated quantities of water and tensides can be regarded as typical for private areas.
Exceptions as per /CET PCR 2014/

Where hygiene requirements or highly-frequented areas demand more frequent cleaning, the environmental results in B2 can easily be multiplied. The environmental results in section 5 refer to annual cleaning of wall tiles.

Ceramic tiles are exceedingly durable floor coverings. Repair (Module B3), replacement (Module B4) or refurbishment (Module B5) during use is seldom necessary. The environmental impacts can be ignored /CET PCR 2014/.

End of Life (C1-C4)

Description	Value	Unit
Waste type collected separately	-	kg
Collected as mixed construction waste	-	kg
For re-use	-	kg
For recycling Scenario EoL 1	18.65	kg
For energy recovery	-	kg
For landfilling Scenario EoL 2	18.65	kg

Re-use, recovery and recycling potential (D), relevant scenario information

Module D includes credits from material recycling of tiles in the form of mineral bulk goods (concerns EoL 1) and credits from thermal utilisation of the packaging.

Description	Value	Unit

5. LCA: Results

The following tables contain the results of the LCA in relation to the various life cycle stages. The modules marked MND are also declared in this case but can not be shown for space reasons. The respective modules are indicated as zero as a result of their non-existent environmental impact. Basic information on all declared modules is supplied in section 4.
Two end-of-life (C3, C4 and D) scenarios are evaluated: Scenario 1 considers 100% material recycling with a credit for aggregate; Scenario 2 reflects the results of 100% disposal in a building rubble landfill.

SYSTEM BOUNDARIES (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

Product stage			Construction process stage		Use stage							End-of-life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacture	Transport from manufacturer to site	Assembly	Use / Application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / Demolition	Transport	Waste processing	Disposal	Reuse, recovery or recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² average tiles (18.65 kg/m²)

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
GWP	[kg CO_2 equiv.]	12.94	0.26	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.00	0.00	0.30	-0.10	-0.05
ODP	[kg CFC11 equiv.]	5.66E-10	3.20E-13	7.00E-14	0.00E+0	6.68E-14	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.20E-14	2.10E-14	7.70E-13	0.00E+0	0.00E+0	4.81E-12	-4.90E-12	-2.60E-12
AP	[kg SO_2 equiv]	2.42E-2	6.50E-4	1.10E-5	0.00E+0	4.72E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.90E-5	4.30E-5	3.50E-4	0.00E+0	0.00E+0	1.83E-3	-2.80E-4	-6.00E-5
EP	[kg $(PO_4)^{3-}$equiv.]	2.69E-3	1.80E-4	2.40E-6	0.00E+0	1.63E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.10E-5	1.20E-5	8.70E-5	0.00E+0	0.00E+0	2.50E-4	-5.30E-5	-8.20E-6
POCP	[kg ethene equiv.]	2.10E-3	-1.90E-4	5.20E-7	0.00E+0	1.46E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	4.40E-6	-1.20E-5	5.00E-5	0.00E+0	0.00E+0	1.70E-4	-3.10E-5	-6.20E-6
ADPE	[kg Sb equiv.]	1.17E-4	1.30E-8	1.00E-9	0.00E+0	9.84E-10	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	5.20E-10	8.80E-10	8.40E-8	0.00E+0	0.00E+0	1.10E-7	-1.80E-8	-7.40E-9
ADPF	[MJ]	207.28	3.49	0.02	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.14	0.23	0.93	0.00	0.00	3.93	-1.21	-0.66

Legend	GWP = Global warming potential; ODP = Ozone depletion potential; AP = Acidification potential; EP = Eutrification potential; POCP = Photochemical ozone creation potential; ADPE = Abiotic depletion potential non-fossil resources; ADPF = Abiotic depletion potential fossil fuels

RESULTS OF THE LCA - RESOURCE USE: 1 m² average tiles (18.65 kg/m²)

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
PERE	[MJ]	17.57	0.27	0.66	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.07	0.00	0.00	0.00	-0.21	-0.10
PERM	[MJ]	0.66	0.00	-0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERT	[MJ]	18.23	0.27	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.07	0.00	0.00	0.40	-0.21	-0.10
PENRE	[MJ]	219.88	3.50	0.41	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.14	0.23	0.96	0.00	0.00	0.00	-1.38	-0.75
PENRM	[MJ]	0.38	0.00	-0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	[MJ]	220.26	3.50	0.02	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.14	0.23	0.96	0.00	0.00	4.09	-1.38	-0.75
SM	[kg]	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.55	0.00
RSF	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m³]	3.27E-2	1.50E-4	2.60E-4	0.00E+0	1.11E-5	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	6.03E-6	1.02E-5	2.39E-4	0.00E+0	0.00E+0	7.74E-4	-2.27E-4	-1.02E-4

Legend	PERE = Renewable primary energy as primary energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES:

1 m² average tiles (18.65 kg/m²)

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
HWD	[kg]	1.29E-4	2.82E-6	1.33E-8	0.00E+0	7.60E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.10E-7	1.87E-7	5.22E-7	0.00E+0	0.00E+0	1.27E-6	-8.27E-7	-3.72E-7
NHWD	[kg]	4.16E-1	8.74E-4	1.96E-4	0.00E+0	3.48E-5	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.42E-5	5.79E-5	5.13E-4	0.00E+0	0.00E+0	1.87E+1	-7.54E-1	-2.86E-4
RWD	[kg]	5.15E-3	4.65E-6	9.87E-7	0.00E+0	7.24E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.82E-7	3.08E-7	1.07E-5	0.00E+0	0.00E+0	6.50E-5	-6.85E-5	-3.64E-5
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.65	0.00	0.00	0.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	[MJ]	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Legend	HWD = Hazardous waste for disposal; NHWD = Non-hazardous waste for disposal; RWD = Radioactive waste for disposal; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy

Module B2 refers to **the annual cleaning expenses for the wall tiles scenario.** Basic information on cleaning is contained in section 4 of this EPD. The annual expenses can then be multiplied by the assumed life cycle (in years) in order to obtain the B2 result for the entire life cycle.

6. LCA: Interpretation

Manufacturing (Modules A1-A3)
As illustrated in the following figure, an analysis of the potential environmental impacts indicates a significant dominancy by direct energy consumption in the plants. In particular, the global warming potential (GWP), photochemical ozone creation potential (POCP) and ozone depletion potential (ODP) reveal significant contributions within manufacturing (Modules A1-3). A relevant influence is also indicated by the acidification potential (AP) and the eutrification potential (EP). With contributions exceeding 70%, the energy-related categories of “non-renewable primary energy requirements” (PENRT) and abiotic consumption of fossil resources (ADPF) are also heavily dominated by direct energy consumption.
The preliminary products indicate a relevant to moderately important influence. At 28%, the contribution made by AP is the highest; in most of the other categories (except ADPE), percentages are between 14% and 25%.
The glaze is evaluated as an independent material group separate from the preliminary products. Its contribution is of significance in some impact categories, especially ADPE. This high influence is caused by zinc oxide. ADPE is almost exclusively caused by this preliminary glaze product. A relevant influence is also obvious within the ODP. The other categories under review are of moderate importance.
In terms of primary energy requirements and the ADPF closely associated with them, the values here have a minor influence.
Accounting for approx. 10%, the plant process which summarises all processes within the plant (direct emissions of body but also waste water and waste treatment and provision of process water) plays a certain role in each of the three impact categories. This concerns the AP, EP and POCP categories. Other environmental impacts are marginally caused by expenses during the plant process.
Transport is of subordinate significance. The greatest contribution is made by the eutrification potential which can be regarded as of moderate importance.
Packaging has a negligible impact in the evaluation.
The RWD waste volume (see LCA results in section 5) is caused by the power mix which includes percentages of electricity from nuclear power stations. The other waste volumes (NWD and NHWD) are significantly influenced by the “upstream chains” associated with raw materials and the provision of energy.

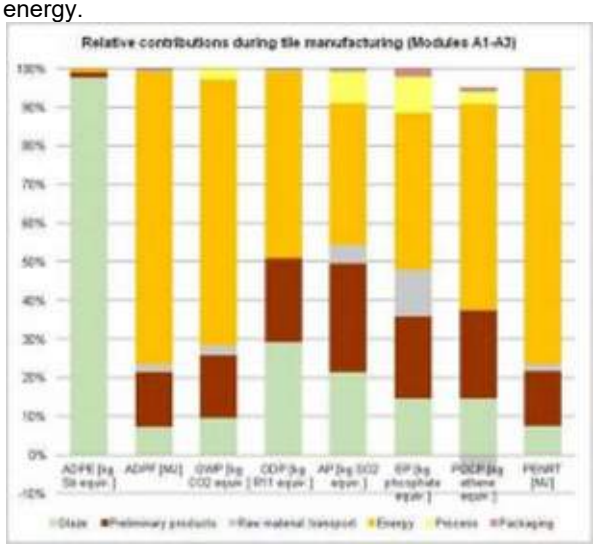


Fig.: Relative contributions during tile manufacturing (Modules A1-A3)

Total life cycle
The entire life cycle is considered in this EPD. The significant dominance of raw material supply and manufacturing is however distributed across a long life cycle of 50 years and more. Transport to the place of use, cleaning during the use phase and disposal play a subordinate role (<10%) regardless of the type of disposal scenario.
This EPD reflects the environmental impacts of average tile manufacturing in relation to a declared unit of one square metre. The following claims can be made regarding fluctuations by the recognised primary parameters:
Energy consumption by the individual plants has (with some exceptions) a direct connection with production. Depending on the thickness of the tile, energy consumption tends to increase or decrease.
Fluctuations range from minus 50% to plus 70% of the average value.
In terms of the preliminary products used, fluctuations are minor thanks to their degree of homogeneity. The formulae are largely similar.

7. Requisite evidence

Evidence, e.g. on leaching, VOC emissions or similar, are not required according to the PCR as they are not of relevance for this product group.

8. References

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DIN EN ISO 10545-3: 1997-12
Ceramic tiles – Determination of water absorption, apparent porosity, apparent relative density and bulk density

DIN EN 14411:2012-12
Ceramic tiles – Definitions, classification, characteristics, evaluation of conformity and marking

DIN EN ISO 15686: [WF1] 2011-05
Buildings and constructed assets – Service life planning

DIN EN ISO 50001: 2011-12
Energy management systems – Requirements with guidance for use: Specifications for systematic energy management

DIN EN ISO 9001: 2015-11
Quality management - Requirements

DIN 13501-1: 2010-01
Fire classification of construction products and building elements

96/603 EC
Decisions by the European Commission on fire classification of construction products without further testing dated 04.10.1996

EWC
Ordinance on the European
List of Wastes (AVV)

EMAS
Ordinance (EC) No. 1221/2009 of the European Parliament and Council dated 25 November 2009 on voluntary participation by organisations in a common system for environmental management and audit scheme and on replacing Ordinance (EC) No. 761/2001, as well as the Commission decisions 2001/681/EC and 2006/193/EC

GaBi ts
GaBi ts data set documentation for the software system and data bases, LBP, University of Stuttgart and thinkstep AG, Leinfelden-Echterdingen, 2014 (http://documentation.gabi-software.com/)
[WF1]Tet

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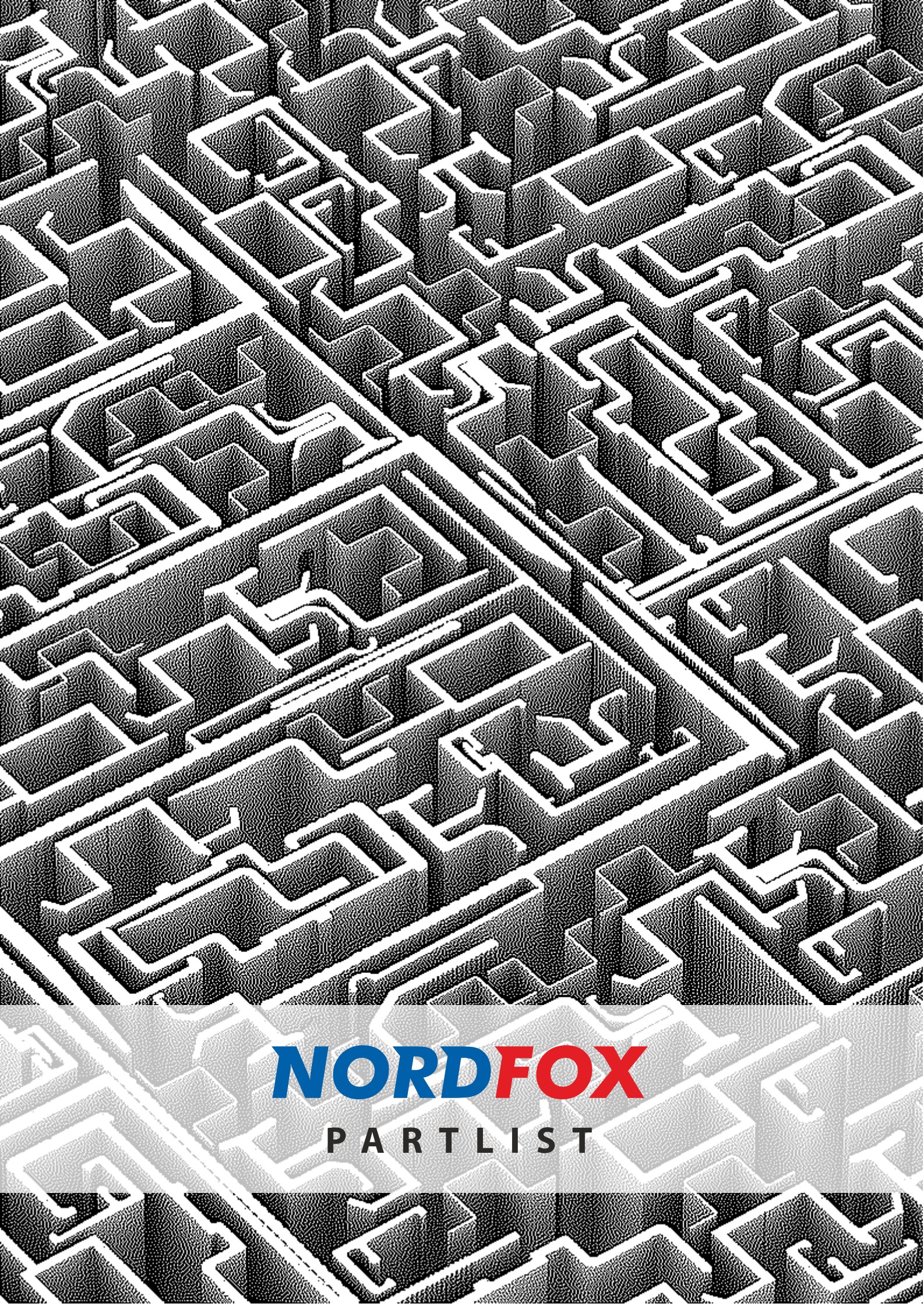


NORDFOX

PARTLIST

CONTENTS

GENERAL INFORMATION ABOUT THE NORDFOX SYSTEMS

The hinged facade system NORDFOX is available in various modifications and can be used in construction for cladding with all materials on the market, from ceramic granite and natural stone to tempered glass and stemalite.

The elements of the facade system frame (guides, bearing and supporting brackets, carriages, bracket extension, auxiliary profile, fasteners and decorative elements) are made of extruded alloy profiles.

The abutment elements are made of sheet-coated galvanized cold-rolled steel with a polymer coating. NORDFOX system can be anodized or painted.

Thermal breaks are made of foamed PVC.

The NORDFOX facade system is used on buildings for various purposes at all levels of responsibility, fire resistance and functional and structural hazard classes.
Fire hazard class of all metal elements - A1 (according to European Standard EN 13501). This is the highest fire safety class (analogue in Russia - K0).
Offset of facing from the wall surface from 60 to 1000 mm supporting structures and up to 300 mm sandwich panels.

The gaps between the facing plates are 6-8 mm.

System operating conditions: from -50°C to +80 °C.
It is planned to install NORDFOX hinged facade systems in various wind areas and use on buildings erected in areas with seismicity up to 9 points inclusive.

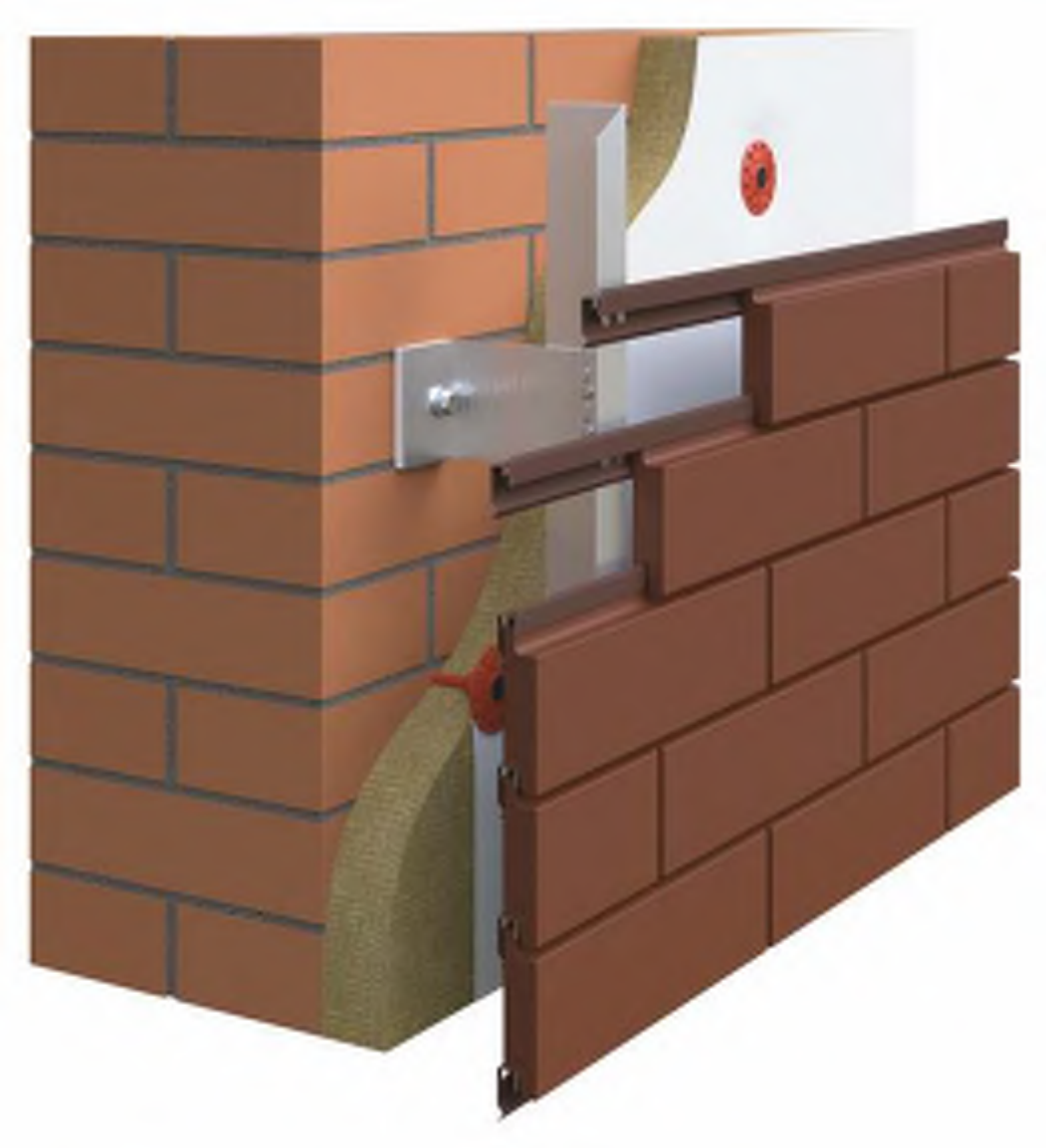
The operational life in non-aggressive, slightly and medium aggressive environments is 50 years.

The presence of reinforced brackets and rails allows you to install the NORDFOX system with fastening to the ends of monolithic floors without intermediate fastening to the wall filling.

The presence of an extension bracket allows you to quickly increase the relative facade from the wall. Special brackets with a developed truss-type cross-section in NORDFOX systems ensure that there is no deflection (shrinkage) of the brackets in the vertical plane from the weight load of the facing material.

The minimum bracket size in the NORDFOX system is 40mm. This reduces the cladding relative to the wall plane.
High factory availability of components (95%) allows constructively limiting the influence of the human factor (qualifications of installers) during installation.

TONGUE-AND-GROOVE CONCRETE SLIPS



Facade System MTC-v-350

FACING MATERIAL:
tongue-and-groove brick-like concrete slips

FIXING:
concealed with stainless steel bars or polymercoated galvanized steel bars

MAX FACING SIZES:
400x200mm (horizontally and vertically).

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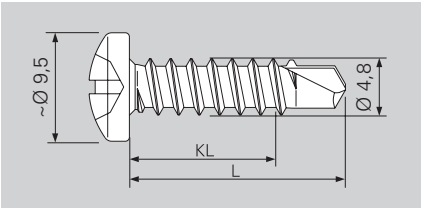
SN3 Ø 4,8

Application

Self drilling fastener, stainless steel A2, for aluminium applications



KL= clamping length L = length

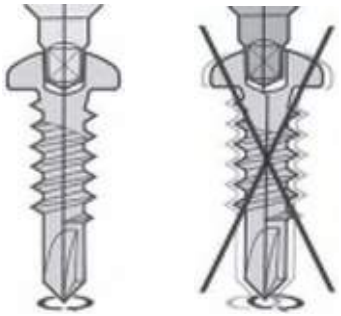
Head shape / drive

Pan-head / SR drive

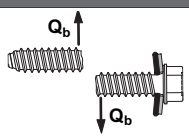
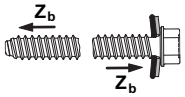
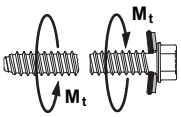
Additional informations

Fastener:

- stainless steel A2, self drilling fastener
- SR recess - stick-fit, wobble free



Technical value

Shear load Q_B (N)	Tensile fracture Z_B (N)	Torsion M_t (Nm)
		
5'300 N	**7'500 N**	**5,8 Nm**

Handling guideline for automatic processing

- speed under load 1800 - 2000 U/min.
- axial load 200 - 300 N
- trouble-free processing with SR drive

All calculations, measurements, fasteners and design methods have to be verified by a responsible designer or engineer, regarding the corresponding structure and load. Please consult your national norms and approvals.

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Reaction-to-fire test report

Combustibility performance of a building material in accordance with AS 1530.1:1994 (R2016)

Test sponsors: Design Central Australia Pty Ltd

The Tile People Ltd

Product: Brick to Click® (unglazed)

Job number: RTF200236

Test date: 3 August 2020 Revision: R1.0

Quality management

Version	Date	Information about the report			
R1.0	14 August 2020	Description	Initial issue.		
			Prepared by	Reviewed by	Authorised by
		Name	Muntaqim Pereira	Anthony Rosamilia	Tanmay Bhat
		Signature			

Contents

1. Introduction

This report documents the findings of the fire hazard properties of Brick to Click® (unglazed) tested on 3 August 2020 in accordance with AS 1530.1:1994 (R2016).

Warringtonfire Australia did the test at the request of the test sponsors listed in Table 1.

Table 1 Test sponsor details

Test sponsor	Address
Design Central Australia Pty Ltd	15 King William Road Unley SA 5061 Australia
The Tile People Ltd	Unit 4, 460 Rosebank Road Avondale Auckland 1026 New Zealand

2. Test specimen

The description of the specimen given below has been prepared from the information provided by the test sponsor, unless otherwise specified. Warringtonfire was not involved in any selection or sampling procedure but was commissioned to modify the specimens to make them meet the geometric requirements of AS 1530.1:1994 (R2016). All measurements – unless indicated – were measured by Warringtonfire Australia.

Table 2 describes the sampled product. Details of specimen geometry are summarized in Table 3.

Table 2 Product description

Item	Detail
Product	Brick to Click® (unglazed)
General description	Ceramic material which is comprised of clay, feldspar, kaolin and sand. The material (German Clinker) is extruded from a moist line of clay and is heated for approximately 50 hours at more than 1200 °C (2200 °F) in a tunnel kiln. The product was received by Warringtonfire Melbourne in its original glazed final product. Uniform discs with an average thickness of 10 mm were prepared from it, with its glaze component removed. The glaze was removed through grinding.
Photograph of specimen	
Pre-conditioning density	2,246 kg/m^3
Average density after conditioning	2,244 kg/m^3
Colour	Brick red

Table 3 Specimen geometry

Parameter	Unit	Specimen number				
		1	2	3	4	5
Diameter	mm	45.0	45.0	45.0	45.0	45.0
Height	mm	50.1	48.7	48.8	48.7	49.1
Volume	cm^3	79.7	77.5	77.6	77.5	78.1

3. Test Procedure

3.1 Procedure

The test apparatus consisted of a furnace with refractory tube surrounded by a heating coil. The furnace was enclosed in an insulated surround and mounted on a stand. It was equipped with a specimen holder and a device for inserting the specimen holder into the furnace tube. Mineral insulated stainless-steel sheathed thermocouples were used to measure the specimen temperatures at the following locations:

- at the specimen centre
- on the specimen surface
- furnace (mid-depth and 10 mm away from wall)

The average furnace temperature was stabilised for at least 10 minutes at 750 °C (± 5 °C) with a maximum drift of ± 2 °C before testing. The mass of each specimen was determined to an accuracy of 0.1 g before testing.

Table 4 details the test procedure for this reaction-to-fire test.

Table 4 Test procedure

Item	Detail
Statement of compliance	The test was performed in accordance with the requirements of AS 1530.1:1994(R2016).
Variations	A suitable alternative insulating material was used to fill the annular space between the furnace tubes, as specified in clause 4.2 of ISO 1182:2010. During the tests, the thermocouples did not reach equilibrium. The tests were ended after 3600 seconds as described in section 7.4.7 of ISO 1182:2010.
Pre-test conditioning	The specimens were conditioned inside a ventilated oven maintained at a temperature of 60 ± 5 °C for 24 hours. The samples were then cooled to room temperature in a desiccator until immediately prior to testing.
Specimen preparation and mounting	Prior to testing, the discs were stacked and tied together using two fine nickel-chromium wires.
Number of replicate tests	Five
End of test	3600 seconds – as described in section 7.4.7 of ISO 1182:2010.
Test operator	Muntaqim Pereira

3.2 Combustibility criteria

According to clause 3.4 of AS 1530.1:1994 (R2016), a material is considered to be combustible under any of the following circumstances:

- The duration of sustained flaming is greater than zero – as determined by summing the individual durations of flaming of 5 seconds or longer for all the samples and dividing by five.
- The arithmetic mean of the temperature rise of the furnace thermocouple exceeds 50 °C.
- The arithmetic mean of the specimen surface thermocouple temperature rise exceeds 50 °C.

4. Test results

Table 5 shows the summary of observations and calculations of the material samples.

Table 5 Test calculations

Parameter	Symbol or expression	Unit	Results					Arithmetic mean = ∑results/5
			1	2	3	4	5	
Total duration of sustained flaming	Cumulative total of duration of flaming (> 5 s)	s	0	0	0	0	0	0
Test duration		s	3600	3600	3600	3600	3600	3600
Specimen mass								
Initial specimen mass	m_{si}	g	178.1	175.7	174.3	174.6	175.6	
Final specimen mass	m_{sf}	g	178.1	175.5	174.1	174.5	175.5	
Mass loss	$\Delta m = (m_{si} - m_{sf})/m_{si}$	%	0.0	0.1	0.1	0.1	0.1	0.1
Furnace thermocouple temperatures								
Initial	T_{fi}	°C	753.9	746.6	748.6	747.9	746.0	
Maximum	T_{fm}	°C	790.6	775.0	779.4	788.6	781.1	
Final	T_{ff}	°C	787.5	773.8	777.5	788.1	780.5	
Temperature rise	$\Delta T_f = T_{fm} - T_{ff}$	°C	3.1	1.2	1.9	0.5	0.6	1.5
Specimen centre thermocouple temperatures								
Maximum	T_{cm}	°C	767.4	751.7	759.4	752.3	752.9	
Final	T_{cf}	°C	767.3	751.5	759.2	752.2	752.6	
Temperature rise	$\Delta T_c = T_{cm} - T_{cf}$	°C	0.1	0.2	0.2	0.1	0.3	0.2
Specimen surface thermocouple temperatures								
Maximum	T_{sm}	°C	796.9	789.9	798.3	780.7	791.5	
Final	T_{sf}	°C	796.2	789.7	798.2	780.3	791.2	
Temperature rise	$\Delta T_s = T_{sm} - T_{sf}$	°C	0.7	0.2	0.1	0.4	0.3	0.4

4.1 Observations

- No significant events were observed for the duration of the tests.

4.2 Combustibility

The material is not deemed combustible according to the test criteria for combustibility specified in clause 3.4 of AS 1530.1:1994 (R2016).

5. Application of test results

5.1 Test limitations

These test results relate only to the behaviour of the test specimens of the material under the particular conditions of the test and they are not intended to be the sole criterion for assessing the potential fire hazard of the material in use.

Any significant variation with respect to size, construction details, loads, stresses, edge or end conditions is not addressed by this report. Any differences in composition or thickness of the product may significantly affect the performance and will therefore invalidate the test results. It is recommended that any proposed variation to the tested configuration should be referred to the test sponsor. The test sponsor should then obtain appropriate documentary evidence of compliance from Warringtonfire Australia Pty Ltd or another registered testing authority.

It is the responsibility of the supplier of the product to ensure that the product which is supplied for use is identical to the specimens which were tested specimens.

This report details methods of construction, the test conditions and the results obtained when the specific element of construction described here was tested following the procedure outlined in AS 1530.1:1994 (R2016). Any significant variation with respect to size, colour or composition is not addressed by this report.

It is recommended that any proposed variation to the tested configuration should be referred to the test sponsor who should then obtain appropriate documentary evidence of compliance from Warringtonfire Australia Pty Ltd or another registered testing authority.

5.2 Uncertainty of measurements

This report has been prepared based on information provided by the test sponsor. Warringtonfire has not verified the accuracy and/or completeness of that information and will not be responsible for any errors or omissions that may be incorporated into this report as a result.

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8.2 NV1 System span tables

8.2.1 NV1 System Fixed to Steel Stud Substrate

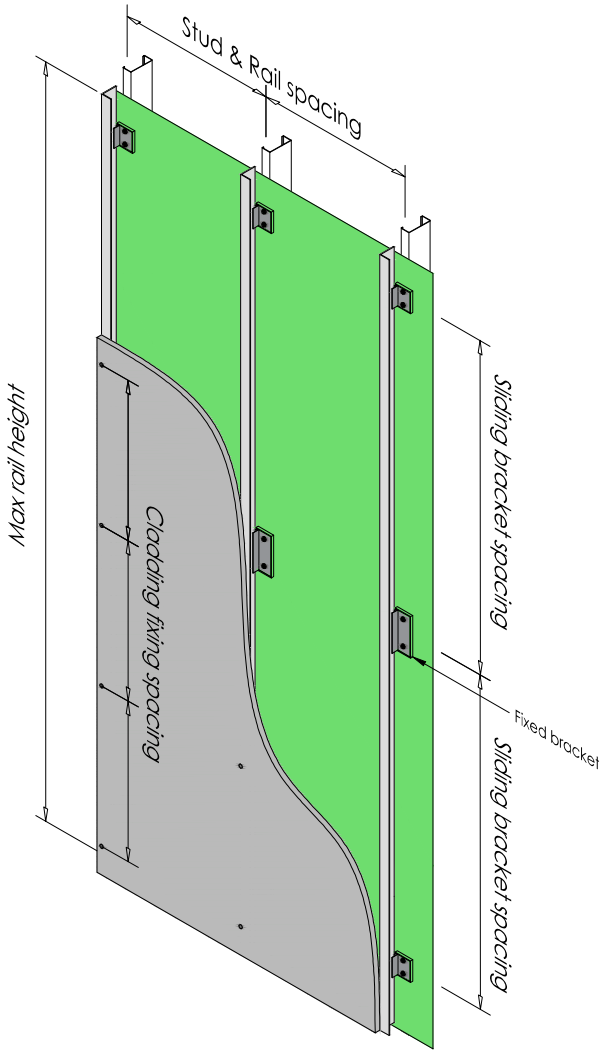


Table 61 – NV1 system component spacing for 70 kg/m² cladding weight, fixed to steel stud substrate

ULTIMATE WIND LOAD (kPa)	STUD SPACING (mm)	MAX VERTICAL SPACING OF SLIDING BRACKETS (mm)	MAX VERTICAL SPACING OF CLADDING FIXINGS (mm)
1.00	300	1700	600
	400	1550	600
	450	1500	600
	600	1350	600
	1200	500	500
1.25	300	1600	600
	400	1450	600
	450	1400	600
	600	1100	600
	1200	400	400
1.50	300	1500	600
	400	1350	600
	450	1300	600
	600	950	600
	1200	350	350
1.75	300	1400	600
	400	1300	600
	450	1100	600
	600	800	600
	1200	300	300
2.00	300	1350	600
	400	1100	600
	450	1000	600
	600	700	600
	1200	250	250
2.25	300	1300	600
	400	1050	600
	450	900	600
	600	600	600
	1200	200	200
2.50	300	1250	600
	400	950	600
	450	800	600
	600	550	550
	1200	200	200
2.75	300	1050	600
	400	850	600
	450	750	600
	600	500	500
	1200	150	150
3.00	300	1050	600
	400	800	600
	450	650	600
	600	450	450
	1200	150	150
3.50	300	950	600
	400	650	550
	450	550	500
	600	400	350
	1200	150	150
4.00	300	850	600
	400	600	500
	450	500	450
	600	350	300
	1200	100	100
5.00	300	650	550
	400	450	400
	450	400	350
	600	250	250
	1200	100	100
6.00	300	550	450
	400	400	300
	450	300	300
	600	200	200
	1200	50	50

Notes to table:

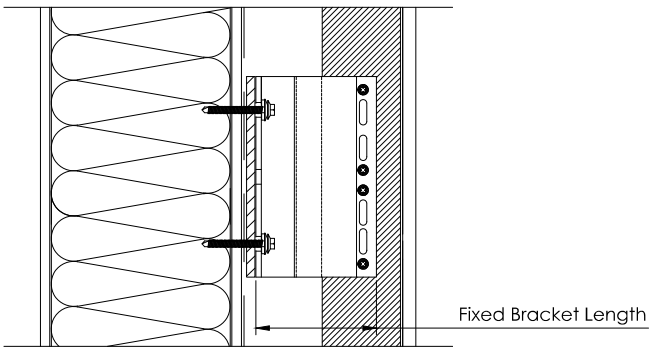
1. Wind load shall be determined in accordance with AS/NZS 1170.2-2011.
2. Stud framing is assumed to be G2 grade steel Z275 to AS1397 with a base metal thickness of 1.15mm. All stud framing shall be designed in accordance with AS/NZS 4600:2018.
3. Fixing between the sliding support bracket and stud to be 2/SX3-6.0x48 hex head fixings (ultimate pull out/over 0.97 kN per single fixing). Where fixing into other substrates, the fixing pull out/over ultimate capacity shall be ≥ 0.97 kN per single fixing.
4. Maximum cladding weight is 70 kg/m².
5. The deflection of members is no more than span/400 when subjected to serviceability wind load of 65% of ultimate wind loads.
6. Fixing between cladding and vertical rail to be 1/12-16x25 hex head (ultimate pull out capacity of 1.34 kN and shear connection capacity of 2.90 kN per single fixing).
7. The adequacy of the cladding material to support the wind load for the spans given in the table shall be confirmed by others. Some spans listed in the table may not be suitable for a particular cladding type.

Table 62 - NV1 fixed bracket type for 70 kg/m² cladding weight, fixed to steel stud substrate

RAIL LENGTH (mm)	STUD SPACING (mm)	FIXED BRACKET LENGTH (MM)									
		40	60	90	120	150	180	210	240	270	300
		Fixed bracket type									
1000	300	Single	Single	Single	Single	Single	Double	Double	Double	Double	Double
	400	Single	Single	Single	Double	Double	Double	Double	Double	2xDouble	2xDouble
	450	Single	Single	Single	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble
	600	Single	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	2xDouble
	1200	Double	2xDouble	2xDouble	2xDouble	2xDouble	-	-	-	-	-
1500	300	Single	Single	Single	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble
	400	Single	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	2xDouble
	450	Single	Double	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	2xDouble	2xDouble
	600	Single	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	-	-	-
	1200	Double	2xDouble	2xDouble	-	-	-	-	-	-	-
2000	300	Single	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	2xDouble
	400	Single	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	2xDouble	-	-
	450	Single	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	-	-	-
	600	Double	2xDouble	2xDouble	2xDouble	2xDouble	-	-	-	-	-
	1200	2xDouble	-	-	-	-	-	-	-	-	-
2700	300	Single	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	2xDouble	-	-
	400	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	-	-	-	-
	450	Double	2xDouble	2xDouble	2xDouble	2xDouble	-	-	-	-	-
	600	Double	2xDouble	2xDouble	-	-	-	-	-	-	-
	1200	-	-	-	-	-	-	-	-	-	-
3300	300	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble	-	-	-	-
	400	Double	2xDouble	2xDouble	2xDouble	-	-	-	-	-	-
	450	Double	2xDouble	2xDouble	2xDouble	-	-	-	-	-	-
	600	2xDouble	2xDouble	-	-	-	-	-	-	-	-
	1200	-	-	-	-	-	-	-	-	-	-
4000	300	Double	2xDouble	2xDouble	2xDouble	2xDouble	-	-	-	-	-
	400	Double	2xDouble	2xDouble	-	-	-	-	-	-	-
	450	Double	2xDouble	2xDouble	-	-	-	-	-	-	-
	600	2xDouble	-	-	-	-	-	-	-	-	-
	1200	-	-	-	-	-	-	-	-	-	-

Notes to table:

1. Wind load shall be determined in accordance with AS/NZS 1170.2-2011.
2. Stud framing is assumed to be G2 grade steel Z275 to AS1397 with a base metal thickness of 1.15mm. All stud framing shall be designed in accordance with AS/NZS 4600:2018.
3. Fixing between the fixed support bracket and stud to be 2/SX3-6.0x48 hex head fixings (ultimate pull out/over 0.97 kN per single fixing). Where fixing into other substrates, the fixing pull out/over ultimate capacity shall be ≥ 0.97 kN per single fixing.
4. Maximum cladding weight is 70 kg/m².
5. The deflection of members is no more than span/400 when subjected to serviceability wind load of 65% of ultimate wind loads.
6. Fixing between cladding and vertical rail to be 1/12-16x25 hex head (ultimate pull out capacity of 1.34 kN and shear connection capacity of 2.90 kN per single fixing).
7. The adequacy of the cladding material to support the wind load for the spans given in the table shall be confirmed by others. Some spans listed in the table may not be suitable for a particular cladding type.



8.2.2 NV1 System Fixed to Timber Stud Substrate

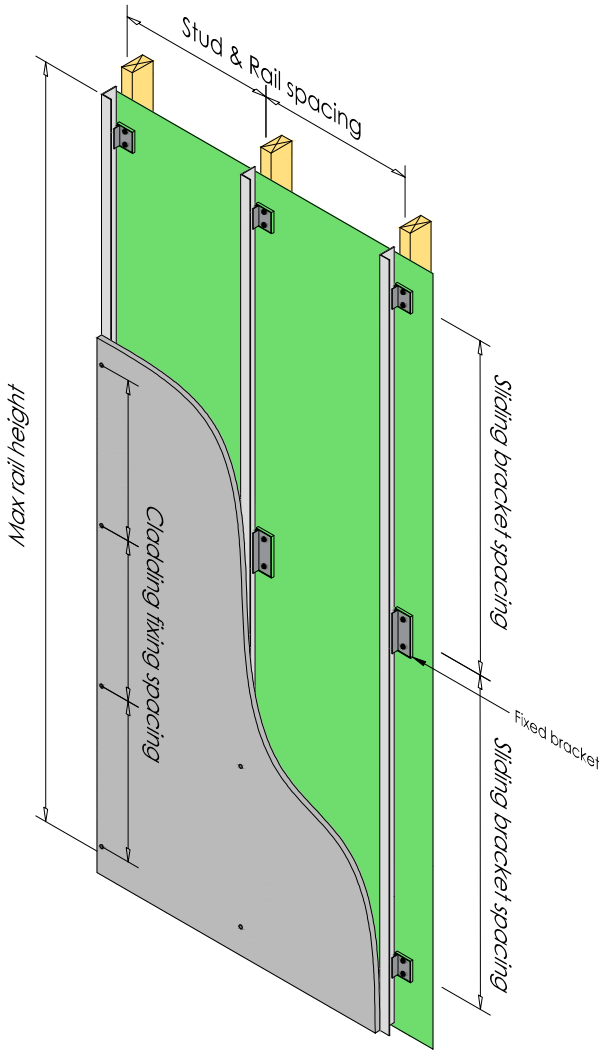


Table 69 – NV1 system component spacing for 70 kg/m² cladding weight, fixed to timber stud substrate

ULTIMATE WIND LOAD (kPa)	STUD SPACING (mm)	MAX VERTICAL SPACING OF SLIDING BRACKETS (mm)	MAX VERTICAL SPACING OF CLADDING FIXINGS (mm)
1.00	300	1700	600
	400	1550	600
	450	1500	600
	600	1350	600
	1200	950	600
1.25	300	1600	600
	400	1450	600
	450	1400	600
	600	1250	600
	1200	750	550
1.50	300	1500	600
	400	1350	600
	450	1300	600
	600	1050	600
	1200	650	450
1.75	300	1400	600
	400	1300	600
	450	1250	600
	600	1000	600
	1200	550	350
2.00	300	1350	600
	400	1200	600
	450	1050	600
	600	950	600
	1200	450	300
2.25	300	1300	600
	400	1050	600
	450	1000	600
	600	900	600
	1200	400	300
2.50	300	1250	600
	400	1000	600
	450	950	600
	600	850	550
	1200	350	250
2.75	300	1050	600
	400	950	600
	450	950	600
	600	850	500
	1200	350	250
3.00	300	1050	600
	400	950	600
	450	900	600
	600	800	450
	1200	300	200
3.50	300	1000	600
	400	900	550
	450	850	500
	600	800	350
	1200	250	150
4.00	300	950	600
	400	850	500
	450	800	450
	600	700	300
	1200	200	150
5.00	300	850	550
	400	850	400
	450	800	350
	600	550	250
	1200	150	100
6.00	300	800	450
	400	750	300
	450	700	300
	600	450	200
	1200	150	100

Notes to table:

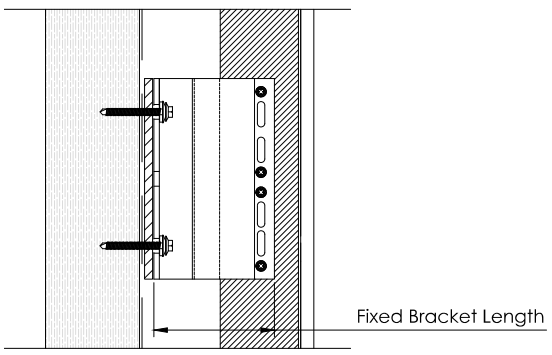
1. Wind load shall be determined in accordance with AS/NZS 1170.2-2011.
2. Stud framing is assumed to be MGP10 timber conforming with AS/NZS 1748 with a Joint group of JD5 in accordance with AS 1720.1-2010.
3. Fixing between the sliding support bracket and stud is assumed to be 2/TDA-S-6.5x64 hex head fixings with 41mm embedment giving an ultimate pull out/over capacity of 2.37 kN per single fixing. Where fixing into other substrates, the fixing pull out/over ultimate capacity shall be ≥ 2.37 kN per single fixing.
4. Maximum cladding weight is 70 kg/m².
5. The deflection of members is no more than span/400 when subjected to serviceability wind load of 65% of ultimate wind loads.
6. Fixing between cladding and vertical rail to be 1/12-16x25 hex head (ultimate pull out capacity of 1.34 kN and shear connection capacity of 2.90 kN per single fixing).
7. The adequacy of the cladding material to support the wind load for the spans given in the table shall be confirmed by others. Some spans listed in the table may not be suitable for a particular cladding type.

Table 70 - NV1 fixed bracket type for 70 kg/m² cladding weight, fixed to timber stud substrate

RAIL LENGTH (mm)	STUD SPACING (mm)	FIXED BRACKET LENGTH (MM)									
		40	60	90	120	150	180	210	240	270	300
		Fixed bracket type									
1000	300	Single	Single	Single	Single	Single	Double	Double	Double	Double	Double
	400	Single	Single	Single	Double	Double	Double	Double	Double	Double	Double
	450	Single	Single	Single	Double	Double	Double	Double	Double	Double	Double
	600	Single	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble
	1200	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
1500	300	Single	Single	Single	Double	Double	Double	Double	Double	Double	Double
	400	Single	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble
	450	Single	Double	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble
	600	Single	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble
	1200	Double	Double	Double	Double	2xDouble	2xDouble	-	-	-	-
2000	300	Single	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble
	400	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble
	450	Single	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble
	600	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
	1200	Double	Double	2xDouble	2xDouble	2xDouble	-	-	-	-	-
2700	300	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble
	400	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-
	450	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
	600	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-	-
	1200	-	-	-	-	-	-	-	-	-	-
3300	300	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-
	400	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
	450	Double	Double	Double	Double	Double	2xDouble	2xDouble	-	-	-
	600	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-	-	-
	1200	-	-	-	-	-	-	-	-	-	-
4000	300	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
	400	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-	-
	450	Double	Double	Double	Double	2xDouble	2xDouble	-	-	-	-
	600	Double	Double	2xDouble	2xDouble	2xDouble	-	-	-	-	-
	1200	-	-	-	-	-	-	-	-	-	-

Notes to table:

1. Wind load shall be determined in accordance with AS/NZS 1170.2-2011.
2. Stud framing is assumed to be MGP10 timber conforming with AS/NZS 1748 with a Joint group of JD5 in accordance with AS 1720.1-2010.
3. Fixing between the fixed support bracket and stud is assumed to be 2/TDA-S-6.5x64 hex head fixings with 41mm embedment giving an ultimate pull out/over capacity of 2.37 kN per single fixing. Where fixing into other substrates, the fixing pull out/over ultimate capacity shall be ≥ 2.37 kN per single fixing.
4. Maximum cladding weight is 70 kg/m².
5. The deflection of members is no more than span/400 when subjected to serviceability wind load of 65% of ultimate wind loads.
6. Fixing between cladding and vertical rail to be 1/12-16x25 hex head (ultimate pull out capacity of 1.34 kN and shear connection capacity of 2.90 kN per single fixing).
7. The adequacy of the cladding material to support the wind load for the spans given in the table shall be confirmed by others. Some spans listed in the table may not be suitable for a particular cladding type.



8.2.3 NV1 System Fixed to Concrete Substrate

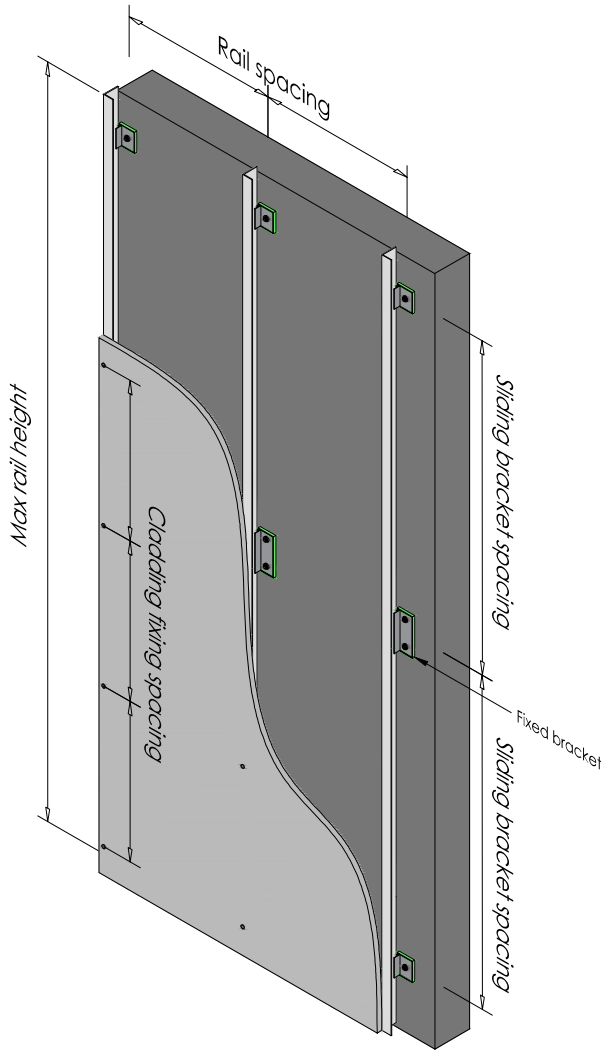


Table 77 – NV1 system component spacing for 70 kg/m² cladding weight, fixed to concrete substrate

ULTIMATE WIND LOAD (kPa)	MAX HORIZONTAL SPACING OF VERTICAL RAILS (mm)	MAX VERTICAL SPACING OF SLIDING BRACKETS (mm)	MAX VERTICAL SPACING OF CLADDING FIXINGS (mm)
1.00	300	1700	600
	400	1550	600
	450	1500	600
	600	1350	600
	1200	950	600
1.25	300	1600	600
	400	1450	600
	450	1400	600
	600	1250	600
	1200	850	550
1.50	300	1500	600
	400	1350	600
	450	1300	600
	600	1050	600
	1200	800	450
1.75	300	1400	600
	400	1300	600
	450	1250	600
	600	1000	600
	1200	800	350
2.00	300	1350	600
	400	1200	600
	450	1050	600
	600	950	600
	1200	750	300
2.25	300	1300	600
	400	1050	600
	450	1000	600
	600	900	600
	1200	700	300
2.50	300	1250	600
	400	1000	600
	450	950	600
	600	850	550
	1200	700	250
2.75	300	1050	600
	400	950	600
	450	950	600
	600	850	500
	1200	650	250
3.00	300	1050	600
	400	950	600
	450	900	600
	600	800	450
	1200	600	200
3.50	300	1000	600
	400	900	550
	450	850	500
	600	800	350
	1200	500	150
4.00	300	950	600
	400	850	500
	450	800	450
	600	750	300
	1200	450	150
5.00	300	850	550
	400	850	400
	450	800	350
	600	700	250
	1200	350	100
6.00	300	800	450
	400	750	300
	450	700	300
	600	600	200
	1200	300	100

Notes to table:

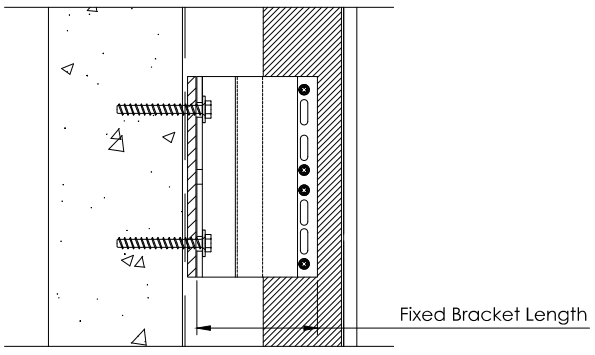
1. Wind load shall be determined in accordance with AS/NZS 1170.2-2011.
2. Fixing between the sliding support bracket and concrete substrate is assumed to be one fixing with a washer of minimum size 20mm diameter x 2.0mm thickness giving an ultimate pull out/over capacity of 2.60 kN per single fixing. Where fixing into other substrates, the fixing pull out/over ultimate capacity shall be ≥ 2.60 kN per single fixing.
3. Maximum cladding weight is 70 kg/m².
4. The deflection of members is no more than span/400 when subjected to serviceability wind load of 65% of ultimate wind loads.
5. Fixing between cladding and vertical rail to be 1/12-16x25 hex head (ultimate pull out capacity of 1.34 kN and shear connection capacity of 2.90 kN per single fixing).
6. The adequacy of the cladding material to support the wind load for the spans given in the table shall be confirmed by others. Some spans listed in the table may not be suitable for a particular cladding type.

Table 78 - NV1 fixed bracket type for 70 kg/m² cladding weight, fixed to concrete substrate

VERTICAL RAIL LENGTH (mm)	HORIZONTAL SPACING OF VERTICAL RAILS (mm)	FIXED BRACKET LENGTH (MM)									
		40	60	90	120	150	180	210	240	270	300
		Fixed bracket type									
1000	300	Single	Single	Single	Single	Single	Double	Double	Double	Double	Double
	400	Single	Single	Single	Double	Double	Double	Double	Double	Double	Double
	450	Single	Single	Single	Double	Double	Double	Double	Double	Double	Double
	600	Single	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble
	1200	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
1500	300	Single	Single	Single	Double	Double	Double	Double	Double	Double	Double
	400	Single	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble
	450	Single	Double	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble
	600	Single	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble
	1200	Double	Double	Double	Double	2xDouble	2xDouble	-	-	-	-
2000	300	Single	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble
	400	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble
	450	Single	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	2xDouble
	600	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
	1200	Double	Double	Double	2xDouble	2xDouble	-	-	-	-	-
2700	300	Single	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble
	400	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-
	450	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
	600	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-	-
	1200	-	-	-	-	-	-	-	-	-	-
3300	300	Double	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-
	400	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
	450	Double	Double	Double	Double	Double	2xDouble	2xDouble	-	-	-
	600	Double	Double	Double	Double	2xDouble	2xDouble	-	-	-	-
	1200	-	-	-	-	-	-	-	-	-	-
4000	300	Double	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-
	400	Double	Double	Double	Double	2xDouble	2xDouble	2xDouble	-	-	-
	450	Double	Double	Double	Double	2xDouble	2xDouble	-	-	-	-
	600	Double	Double	Double	2xDouble	2xDouble	-	-	-	-	-
	1200	-	-	-	-	-	-	-	-	-	-

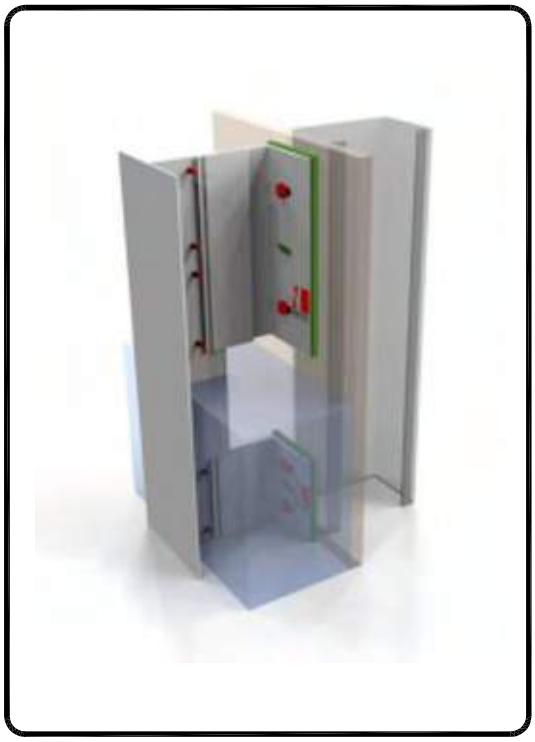
Notes to table:

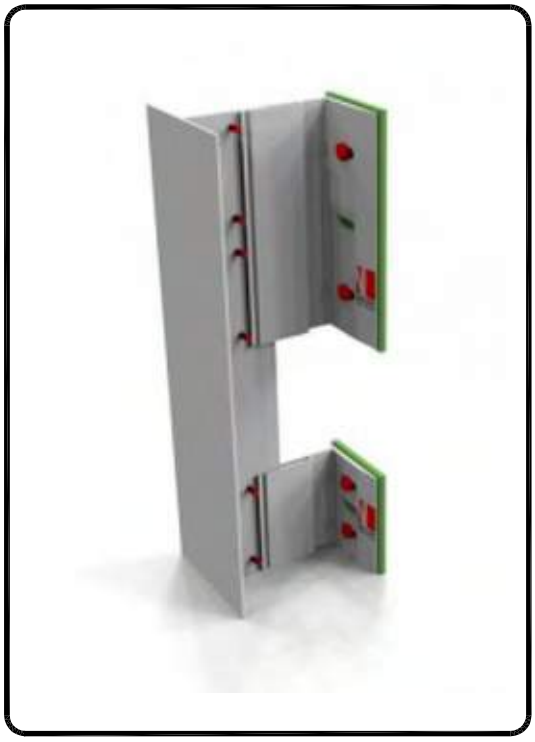
1. Wind load shall be determined in accordance with AS/NZS 1170.2-2011.
2. Fixing between the fixed support bracket and concrete substrate is assumed to be two fixings with a washer of minimum size 20mm diameter x 2.0mm thickness giving an ultimate pull out/over capacity of 2.60 kN per single fixing. Where fixing into other substrates, the fixing pull out/over ultimate capacity shall be ≥ 2.60 kN per single fixing.
3. Maximum cladding weight is 70 kg/m².
4. The deflection of members is no more than span/400 when subjected to serviceability wind load of 65% of ultimate wind loads.
5. Fixing between cladding and vertical rail to be 1/12-16x25 hex head (ultimate pull out capacity of 1.34 kN and shear connection capacity of 2.90 kN per single fixing).
6. The adequacy of the cladding material to support the wind load for the spans given in the table shall be confirmed by others. Some spans listed in the table may not be suitable for a particular cladding type.



aluminium support system for
rainscreen cladding

NVELOPE NV1 SYSTEM





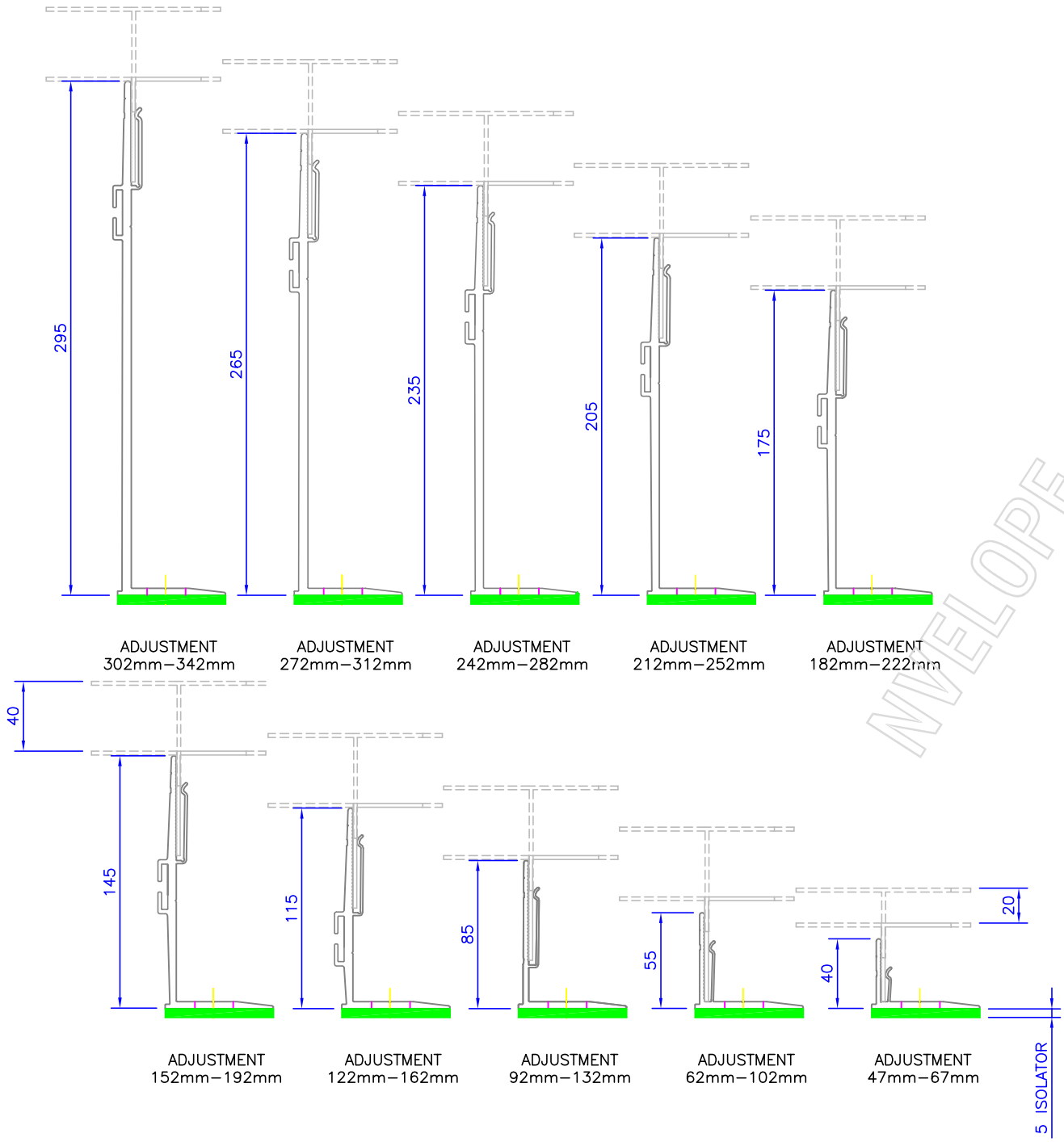
LEGEND:

A – Cladding
B – Cladding–rivet

1 – SFS steel wall + cement board
2 – Nvelope – support bracket
3 – Stainless steel fixing
4 – T–(L) profile vertical
5 – Self drilling stainless steel screw SR2 4.2 x 16
7 – Tthermal insulation
8 – Ventilation Cavity
10 – NVELOPE Thermal isolator
11 – Corner Bracket
12 – Corner Rail

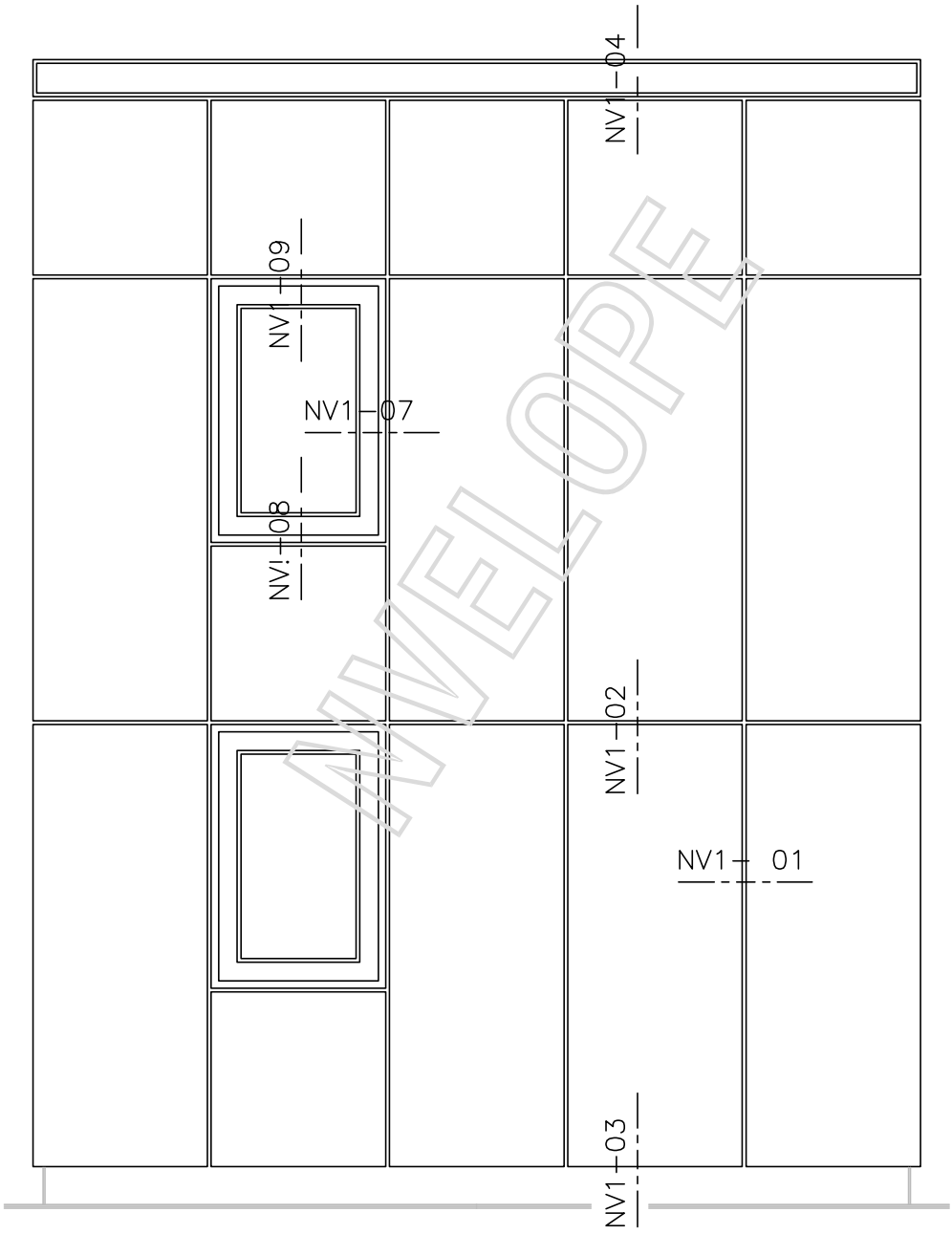
CONTENTS:

NVELOPE
MAKING CLADDING HAPPEN

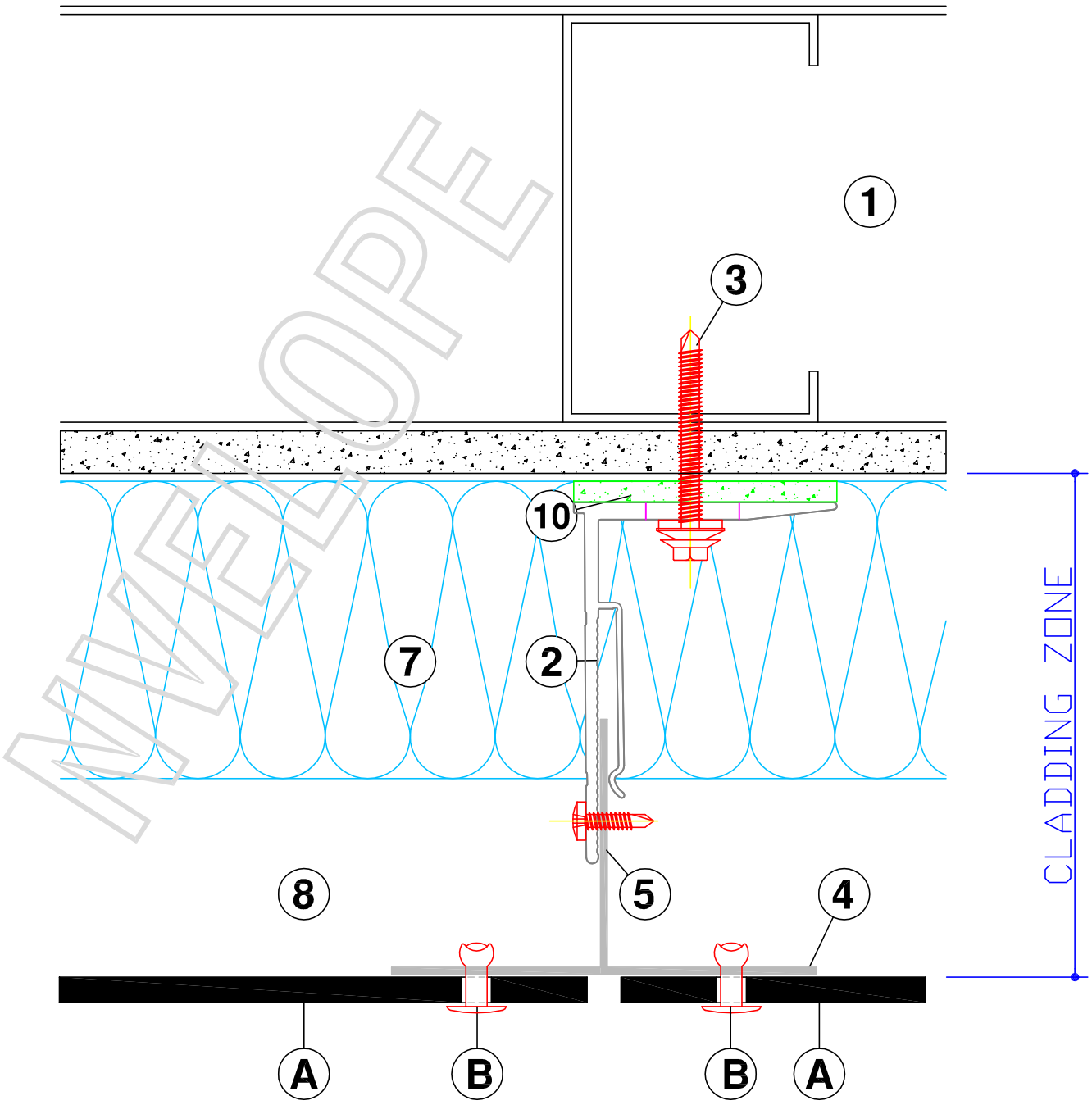


BRACKETS	Adjustment range for each bracket (mm)	
Nvelope 40	from 47	to 67
Nvelope 60	from 62	to 102
Nvelope 90	from 92	to 132
Nvelope 120	from 122	to 162
Nvelope 150	from 152	to 192
Nvelope 180	from 182	to 222
Nvelope 210	from 212	to 252
Nvelope 240	from 242	to 282
Nvelope 270	from 272	to 312
Nvelope 300	from 302	to 342

HORIZONTAL SECTIONS
TOLERANCES FOR ADJUSTMENT

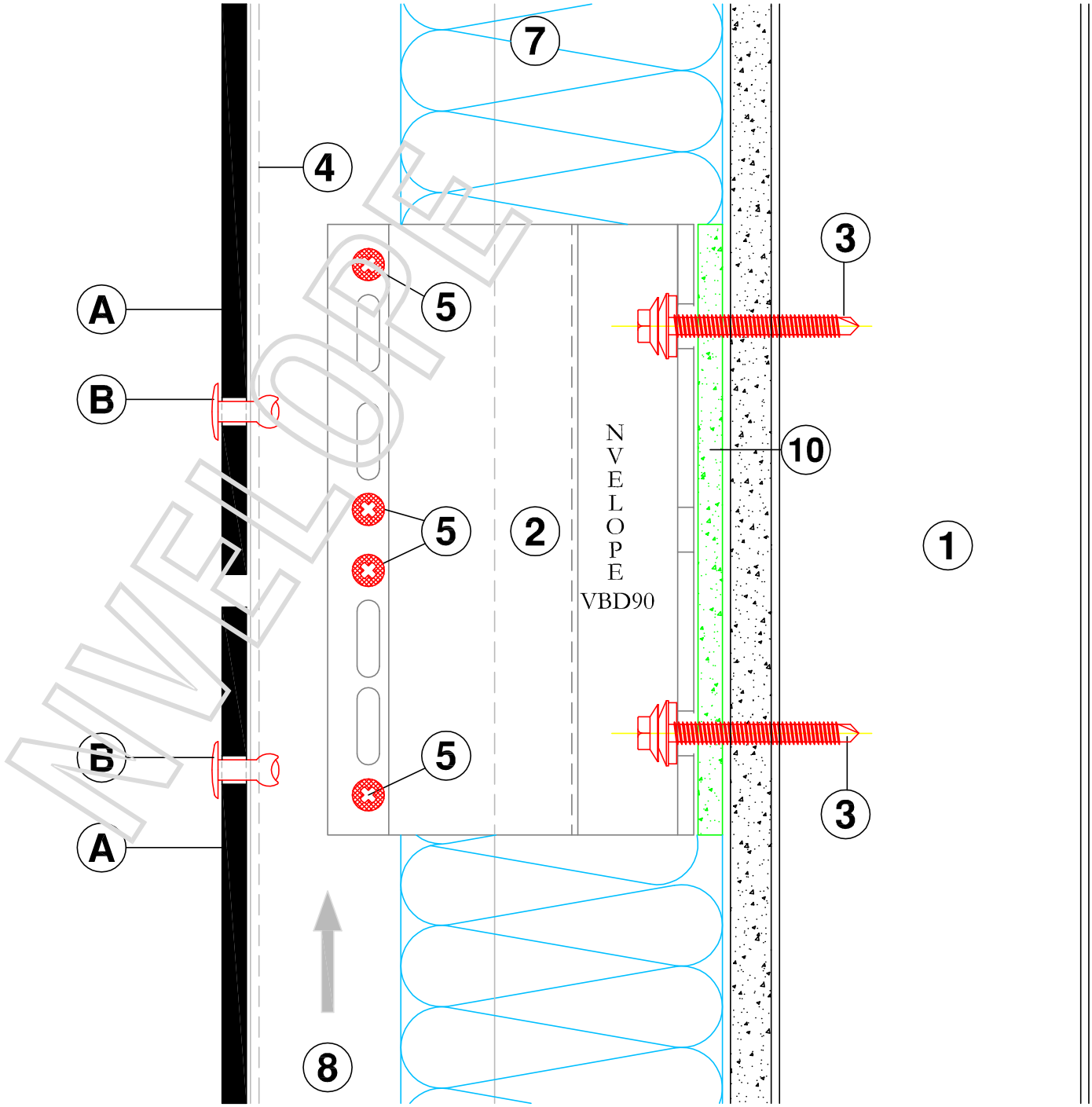


VIEW OF CLADDING - DETAIL LOCATIONS

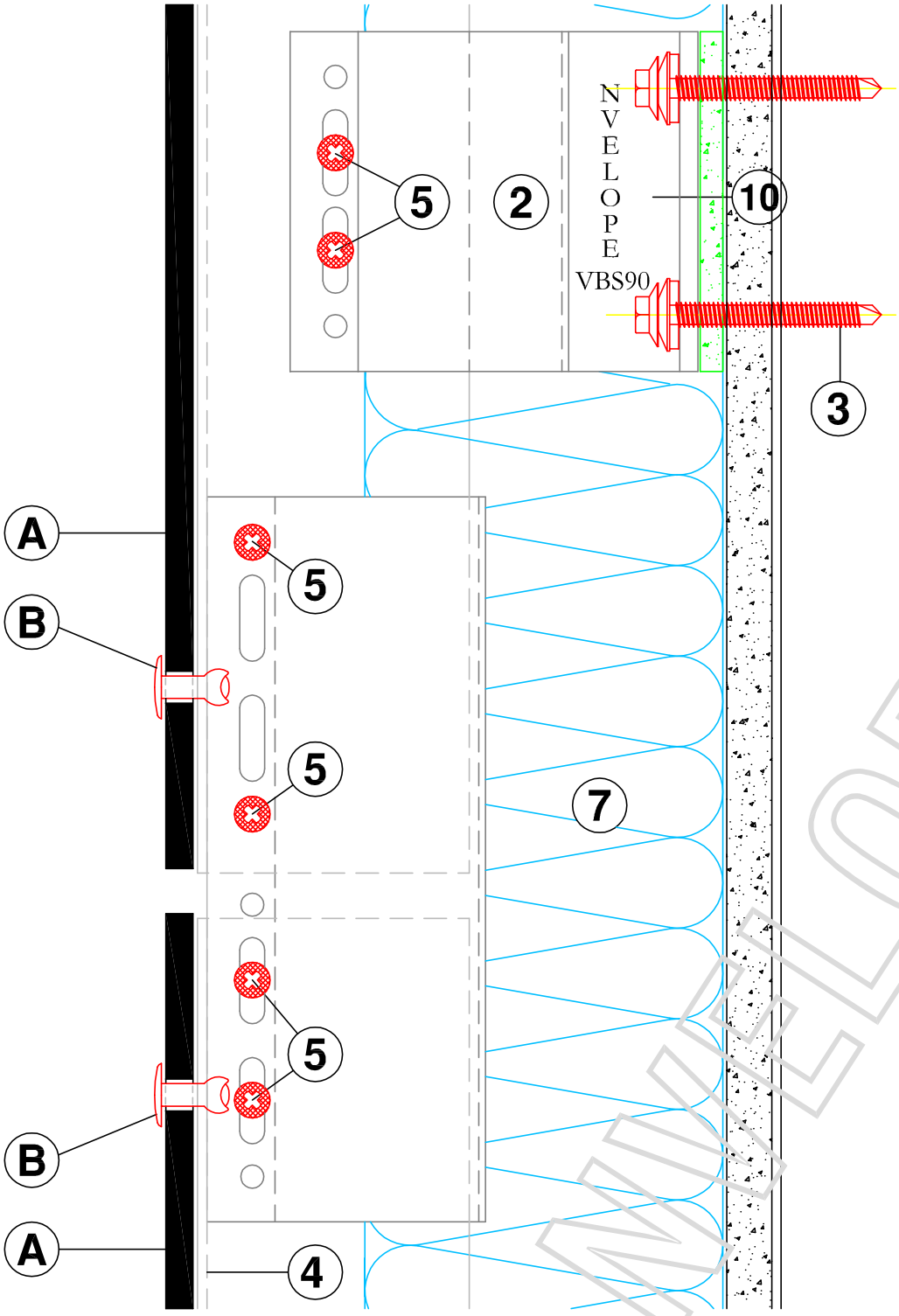


NVELOPE

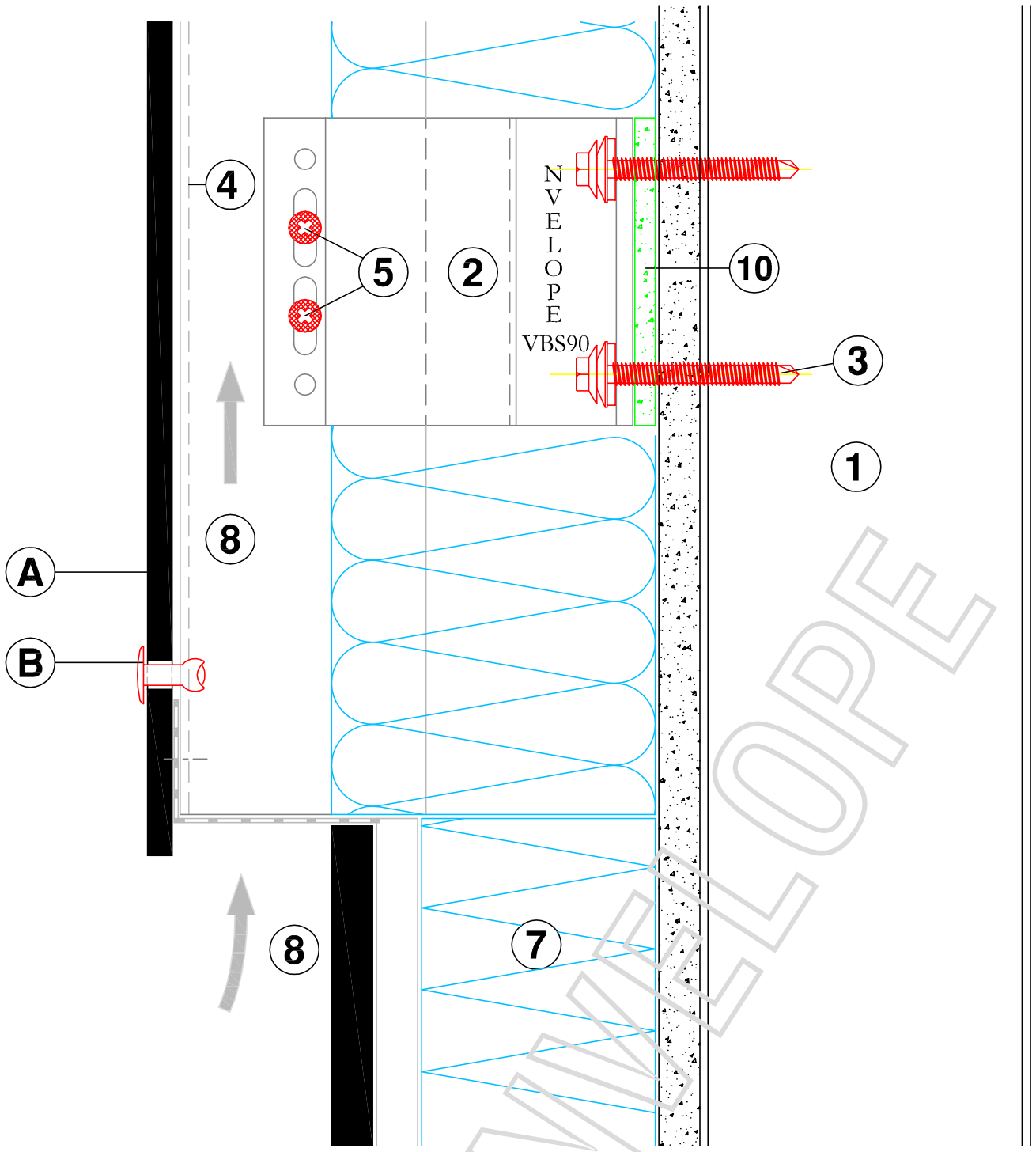
HORIZONTAL SECTION - NVELOPE 90



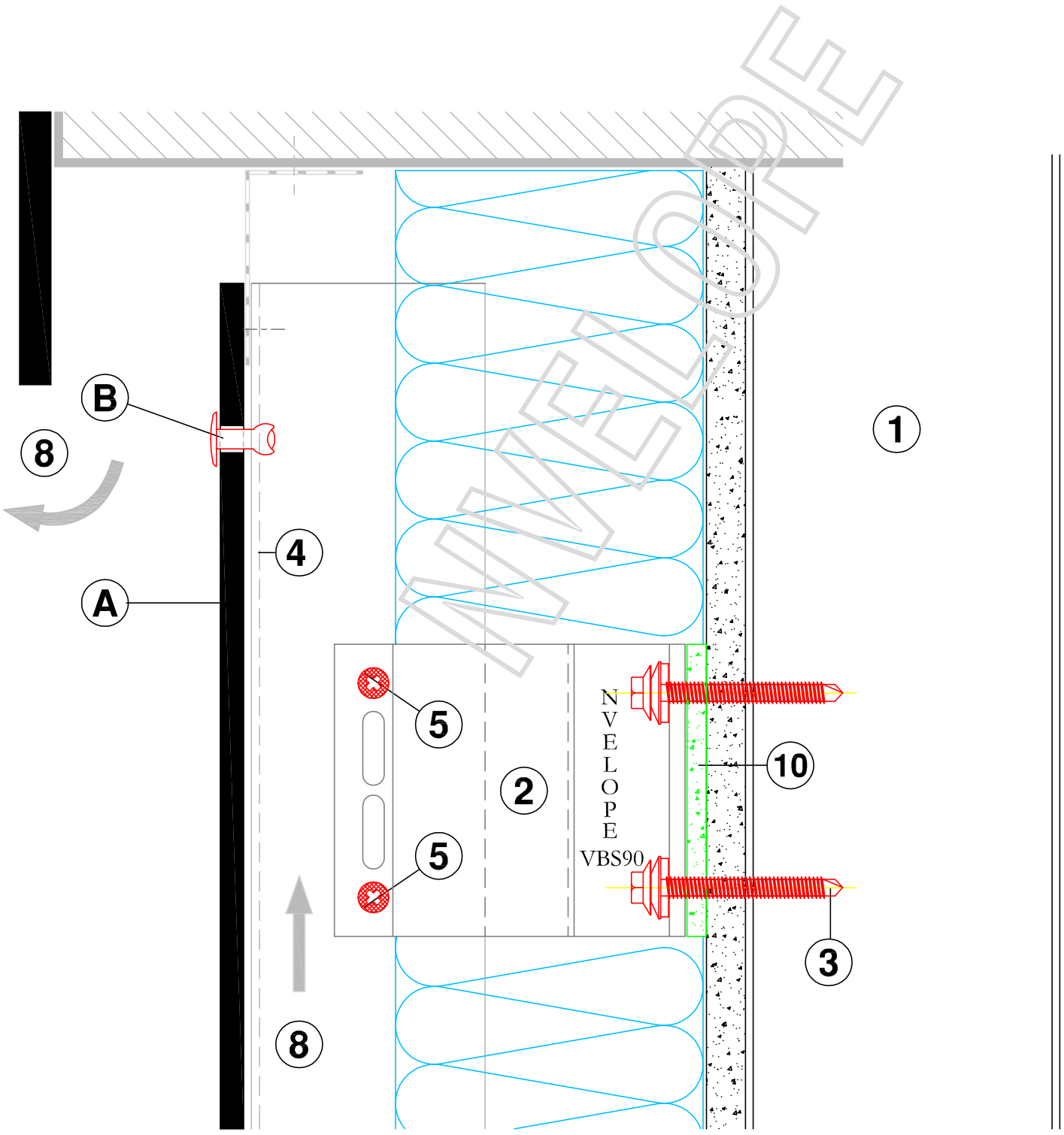
VERTICAL SECTION - NVELOPE DOUBLE 90 FIXED POINT



VERTICAL SECTION - RAIL JOINT OF PROFILE

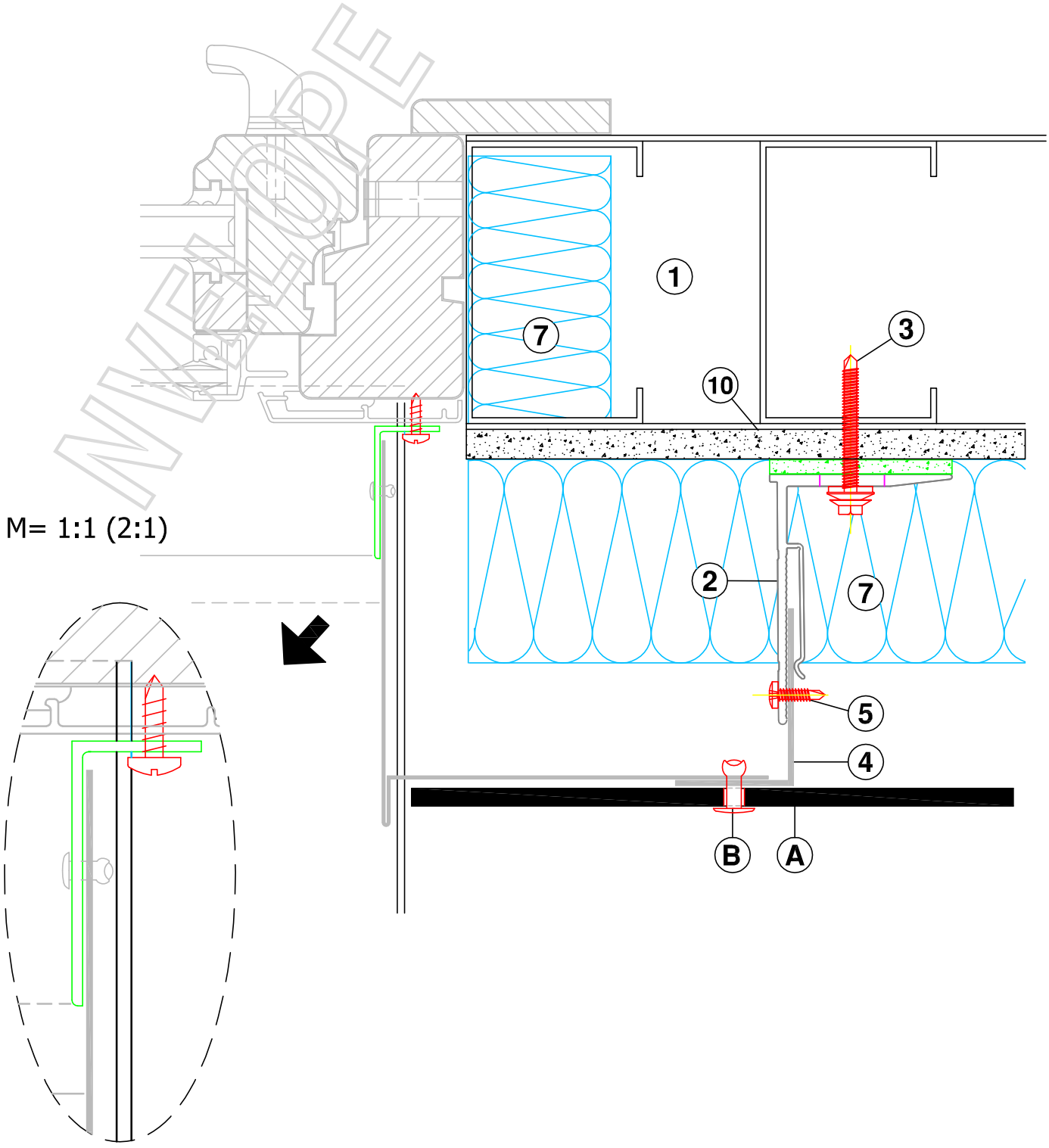


VERTICAL SECTION - BASE OF CLADDING

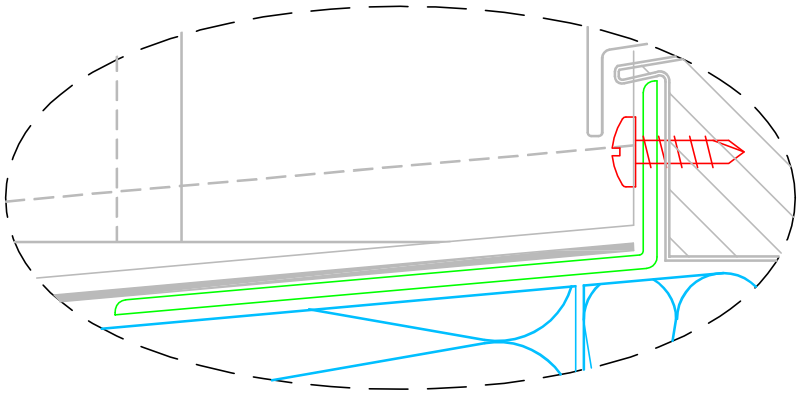


VERTICAL SECTION - TOP OF CLADDING

NVELOPE
MAKING CLADDING HAPPEN



HORIZONTAL SECTION - WINDOW JAMB DETAIL



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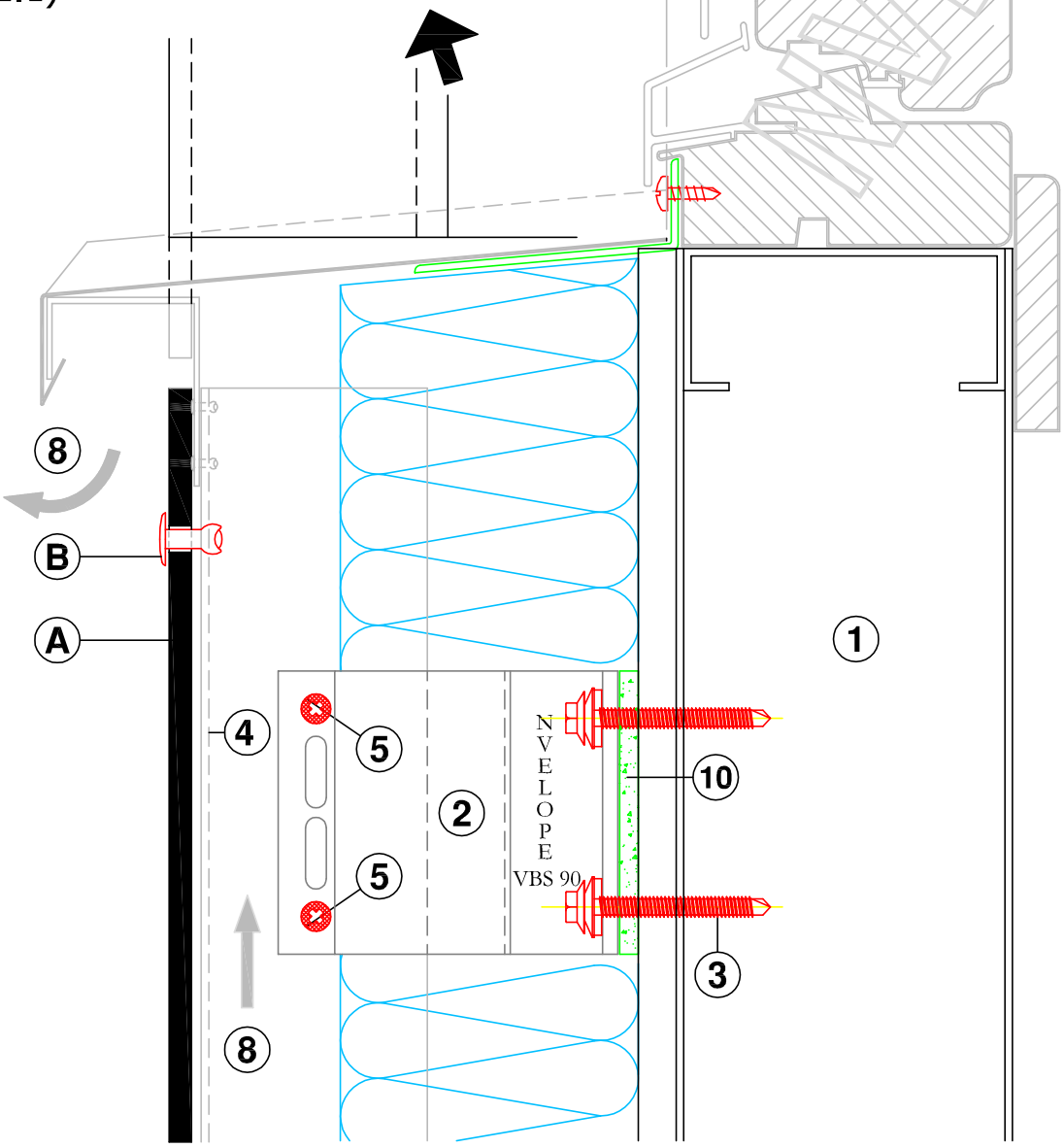
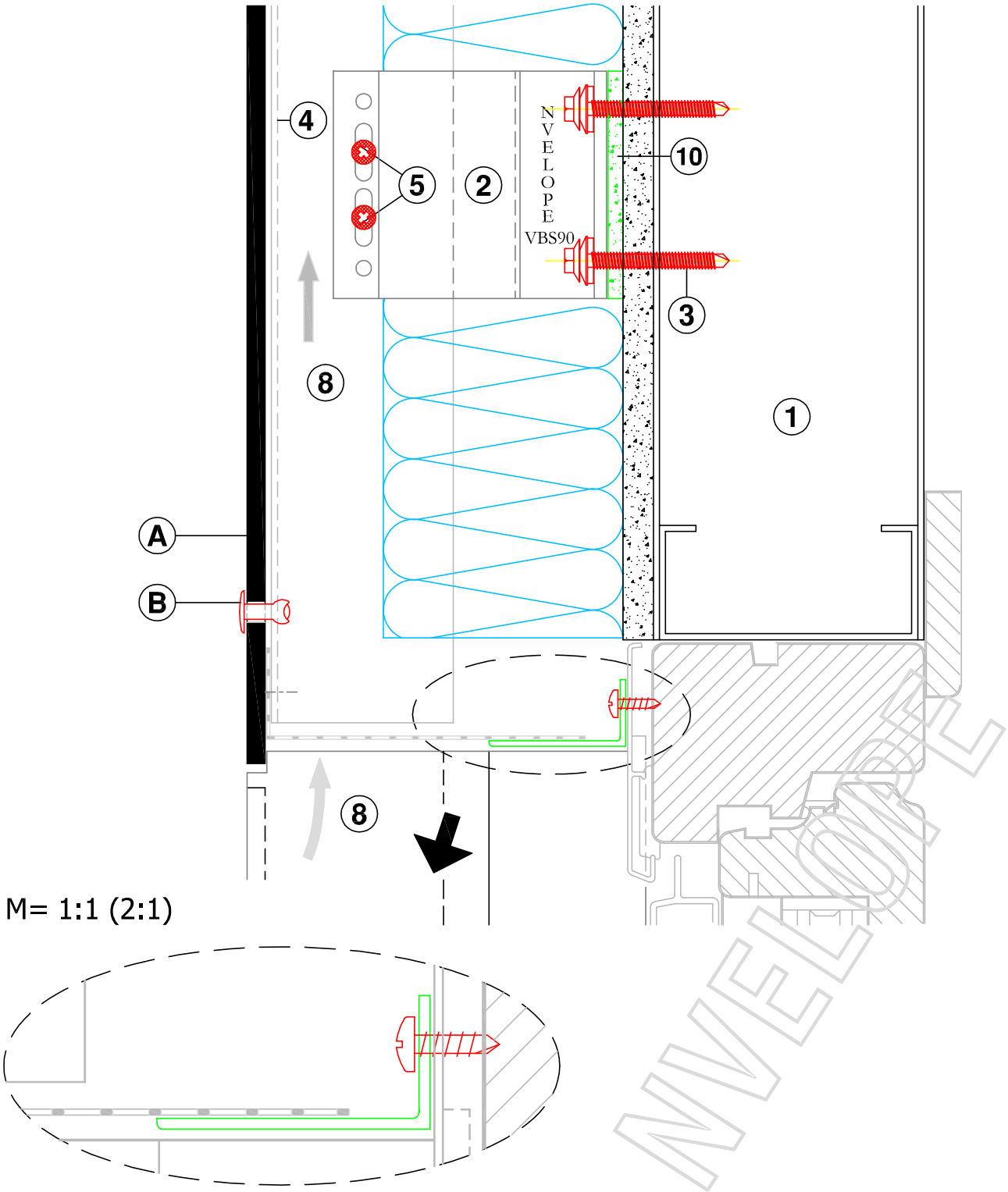
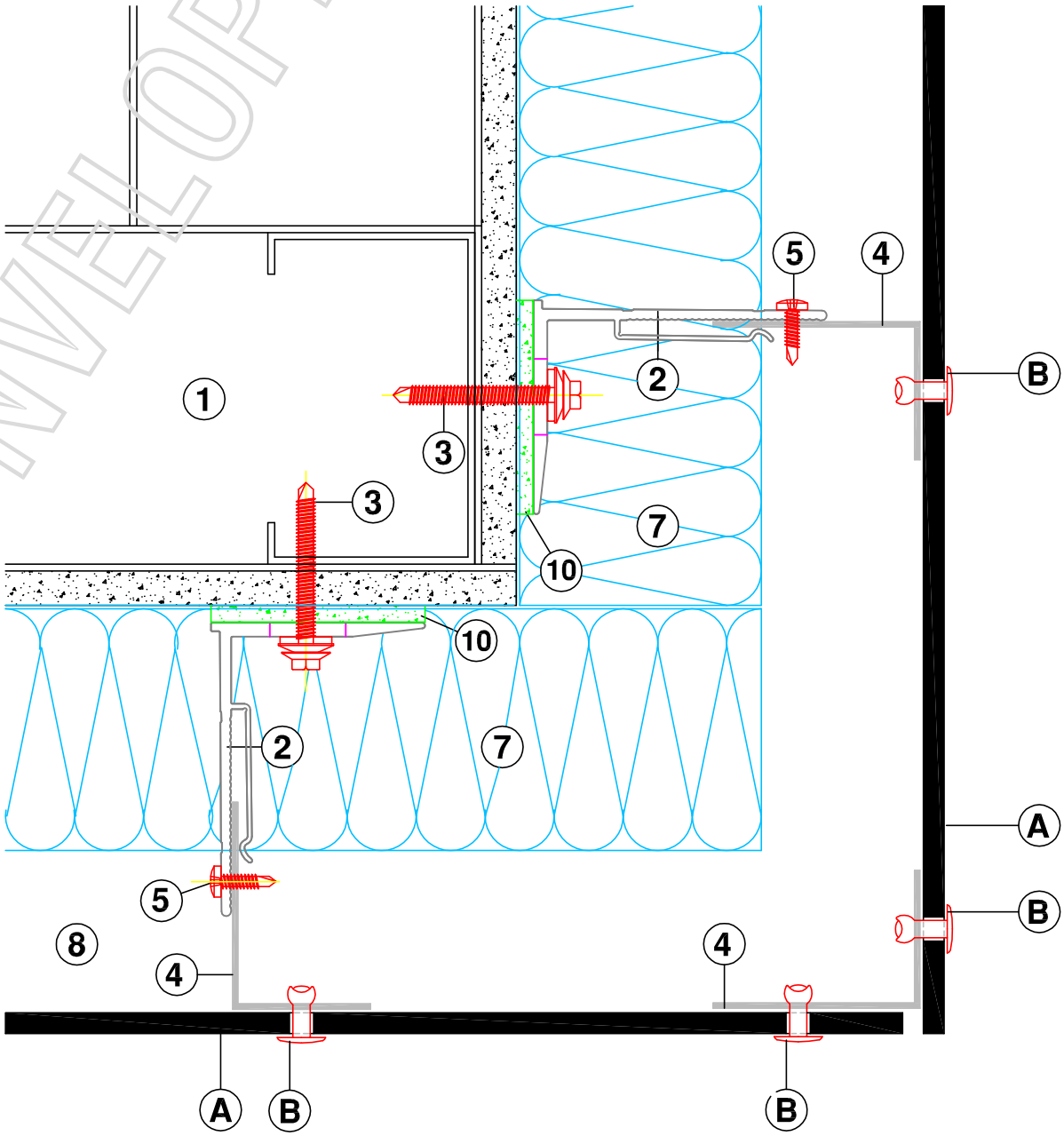


VERTICAL SECTION - WINDOW SILL DETAIL

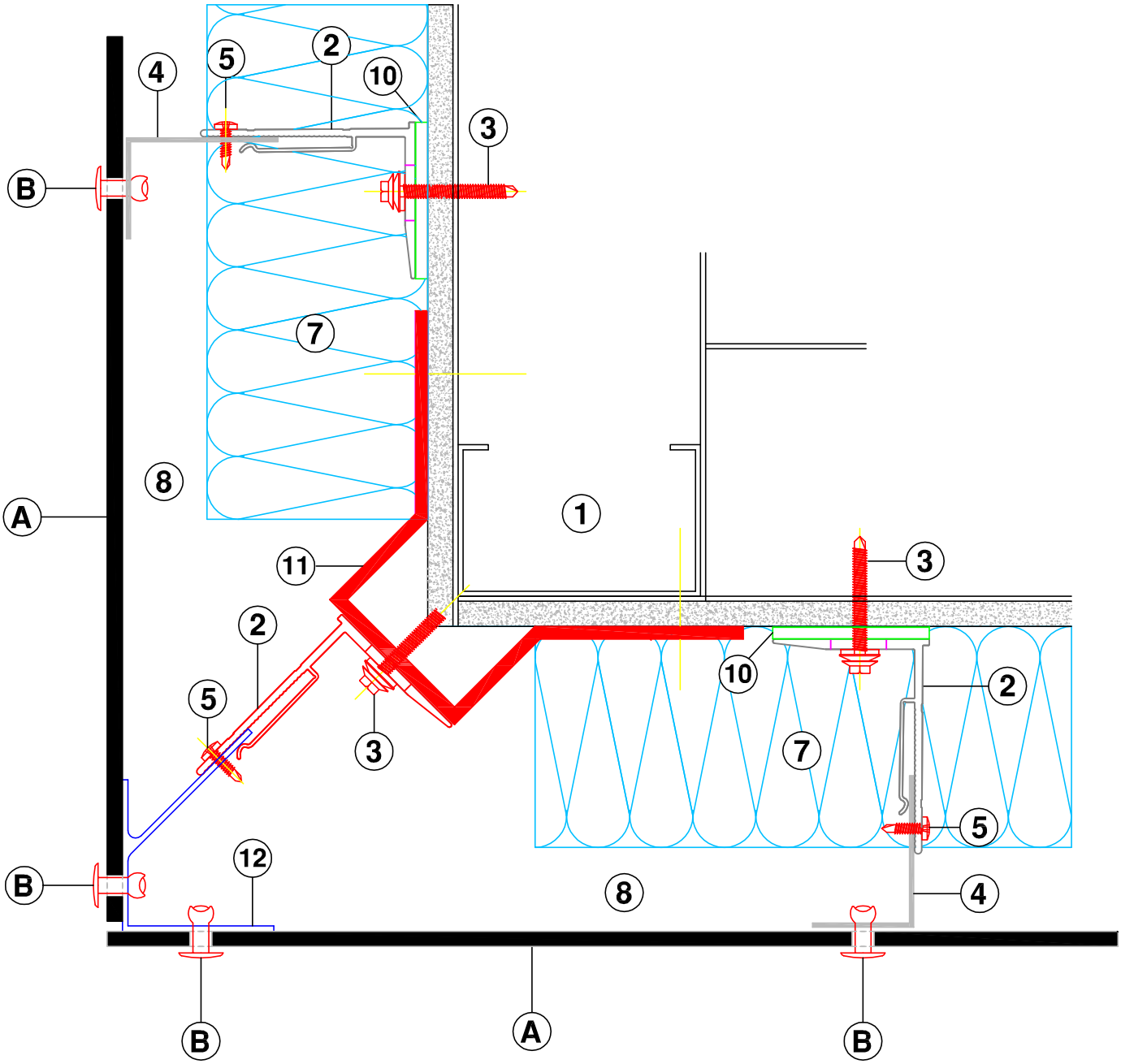


VERTICAL SECTION - WINDOW HEAD DETAIL

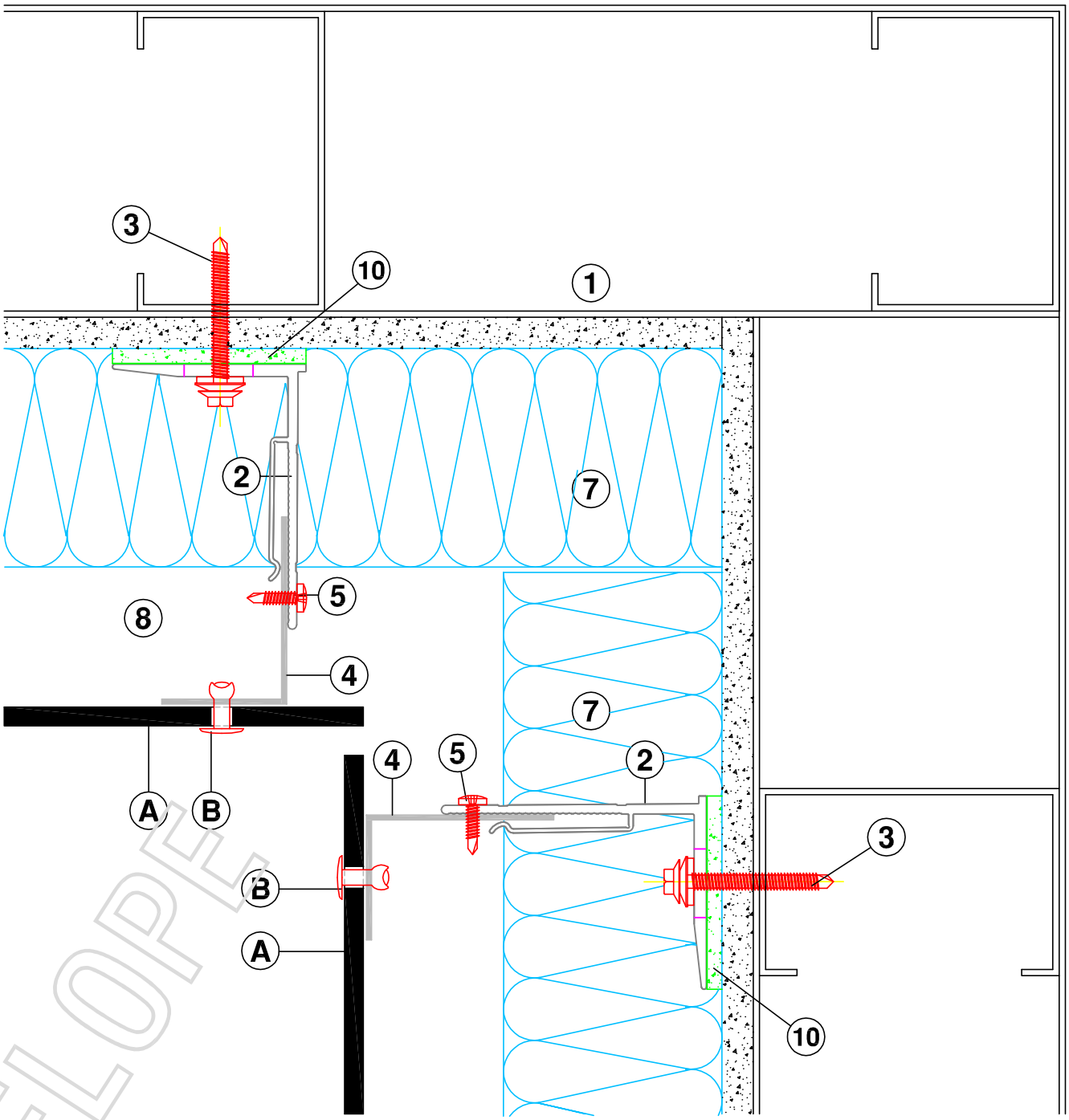


HORIZONTAL SECTION - EXTERNAL CORNER

NVELOPE RAINSCREEN SYSTEMS Ltd - tel - 01707 333396 - fax - 01707 333343



HORIZONTAL SECTION - EXTERNAL CORNER - WITH CORNER BRACKET



NVELOPE

HORIZONTAL SECTION - INTERNAL CORNER

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Agrément Certificate
19/5671
Product Sheet 1

NVELOPE RAINSCREEN SYSTEMS

NVELOPE RAINSCREEN CLADDING SUPPORT SYSTEMS

This Agrément Certificate Product Sheet (1) relates to Nvelope Rainscreen Cladding Support Systems, for use as a sub-frame to support cladding on the external or internal wall structure of new or existing buildings.

(1) Hereinafter referred to as 'Certificate'.

CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Mechanical resistance and stability — the systems can be designed to support the cladding and to transfer the design loads to the substrate wall structure safely (see section 6).

Behaviour in relation to fire — the systems (fixings, brackets, rails, carriers and adaptors) have an A1 reaction to fire classification in accordance with the national Building Regulations (see section 7).

Drainage and ventilation — provided correct details are adopted, the systems can provide adequate drainage and ventilation behind the cladding (see section 8).

Durability — the systems will have a service life in excess of 35 years (see section 10).

The BBA has awarded this Certificate to the company named above for the systems described herein. These systems have been assessed by the BBA as being fit for their intended use provided they are installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of First issue: 24 June 2019

Paul Valentine
Technical Excellence Director

Claire Curtis-Thomas
Chief Executive

The BBA is a UKAS accredited certification body – Number 113.
The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk
Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.
Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

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Regulations

In the opinion of the BBA, Nvelope Rainscreen Cladding Support Systems, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements of the following Building Regulations (the presence of a UK map indicates that the subject is related to the Building Regulations in the region or regions of the UK depicted):

The Building Regulations 2010 (England and Wales) (as amended)

Requirement:	**A1**	**Loading**
Comment:		The systems can be designed to adequately transfer the design loads from the cladding to the substrate wall structure. See section 6 of this Certificate.
Requirement:	**B4(1)**	**External fire spread**
Comment:		In England, the systems are unrestricted by this Requirement. See section 7.1 of this Certificate.
Regulation:	**7**	**Materials and workmanship (applicable to Wales only)**
Regulation:	**7(1)**	**Materials and workmanship (applicable to England only)**
Comment:		The systems are acceptable. See section 10.1 and the *Installation* part of this Certificate.
Regulation:	**7(2)**	**Materials and workmanship (applicable to England only)**
Comment:		The systems are unrestricted by this Regulation. See section 7.1 of this Certificate.

The Building (Scotland) Regulations 2004 (as amended)

Regulation:	**8(1)**	**Durability, workmanship and fitness of materials**
Comment:		The systems are acceptable. See section 10.1 and the *Installation* part of this Certificate.
Regulation:	**9**	**Building standards applicable to construction**
Standard:	1.1(a)(b)	Structure
Comment:		The systems can be designed to adequately transfer the design loads from the cladding to the substrate wall structure, with reference to clause 1.1.1[(1)(2)] of this Standard. See section 6 of this Certificate.
Standard:	2.6	Spread to neighbouring buildings
Comment:		The systems can contribute to satisfying this Standard, with reference to clause 2.6.4[(1)(2)]. See section 7.1 of this Certificate.
Standard:	2.7	Spread on external walls
Comment:		The systems can contribute to satisfying this Standard, with reference to clause 2.7.1[(1)(2)]. See section 7.1 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The systems can contribute to meeting the relevant Requirements of Regulation 9, Standards 1 to 6, and therefore will contribute to a construction meeting a bronze level of sustainability as defined in this Standard.

(1) Technical Handbook (Domestic).
(2) Technical Handbook (Non-Domestic).

The Building Regulations (Northern Ireland) 2012 (as amended)

Regulation:	**23**	**Fitness of materials and workmanship**
Comment:		The systems are acceptable. See section 10.1 and the *Installation* part of this Certificate.

Regulation:	**30**	**Stability**
Comment:		The systems can be designed to adequately transfer the design loads from the cladding to the substrate wall structure. See section 6 of this Certificate.
Regulation:	**36(a)**	**External fire spread**
Comment:		The systems are unrestricted by this Regulation. See section 7.1 of this Certificate.

Construction (Design and Management) Regulations 2015
Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See section: 3 *Delivery and site handling* (3.2 and 3.6) of this Certificate.

Additional Information

NHBC Standards 2019

In the opinion of the BBA, Nvelope Rainscreen Cladding Support Systems, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements in relation to *NHBC Standards*, Part 6 *Superstructure (excluding roofs)*, Chapter 6.9 *Curtain walling and cladding*.

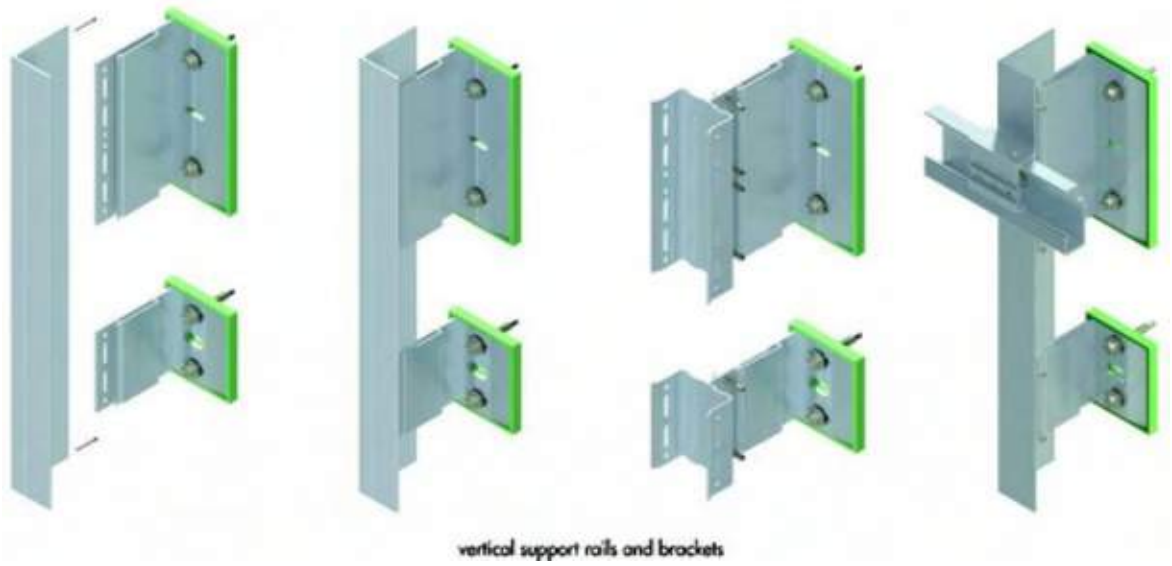
Technical Specification

1 Description

1.1 Nvelope Rainscreen Cladding Support Systems are attached to the external or internal wall structure of buildings (see Figure 1) and consist of:

- NV Brackets — fitted to the substrate using appropriate fixings (outside the scope of this Certificate). Brackets feature a polypropylene thermal insulation pad (insulating properties outside the scope of this Certificate) fitted to the heel. Two variants of the brackets are available: single and double. The single brackets have a height of 75 mm and the double brackets, 150 mm, both with a thickness range of 2.8 to 5.3 mm
- Nvelope Uni-Carriers — vertical 'U' section profiles, fixed to the NV Brackets using self-drilling screws (see Figure 2), used to support timber battens to which cladding panels can be fixed. Four variants of carrier are available, with widths of 50 or 100 mm, and heights of 75 or 150 mm
- Nvelope L and T Rails — rails of 'L' and 'T' profile with a 2.2 mm thickness and the dimensions shown in Figure 2, fixed to the NV Brackets using self-drilling screws, which provide a fixing area for the cladding panels
- NH2 Adaptor — an adaptor, slotted upright into the vertical bracket, with the adaptor 'helping hands' orientated over the top of the vertical bracket (see Figure 3). The 'helping hands' of the adaptor are then ready to receive an L or T rail in the horizontal orientation
- the NV3 System — consisting of the NV3 Horizontal Rail and the associated hanger components (NV3 TUFS Hangers), and with details as shown in Figure 4.

Figure 1 Typical rail/bracket arrangement



1.2 The components (see Figure 2) are manufactured from aluminium alloy, to a minimum grade of EN AW 6005A T6 to BS EN 573-3 : 2013, apart from Nvelope Uni-Carriers which are manufactured from aluminium alloy to a minimum grade of EN AW 6063 T66 to BS EN 573-3 : 2013. The components have the characteristics described in Tables 1 to 4 (in section 6 of this Certificate).

Figure 2 Component details

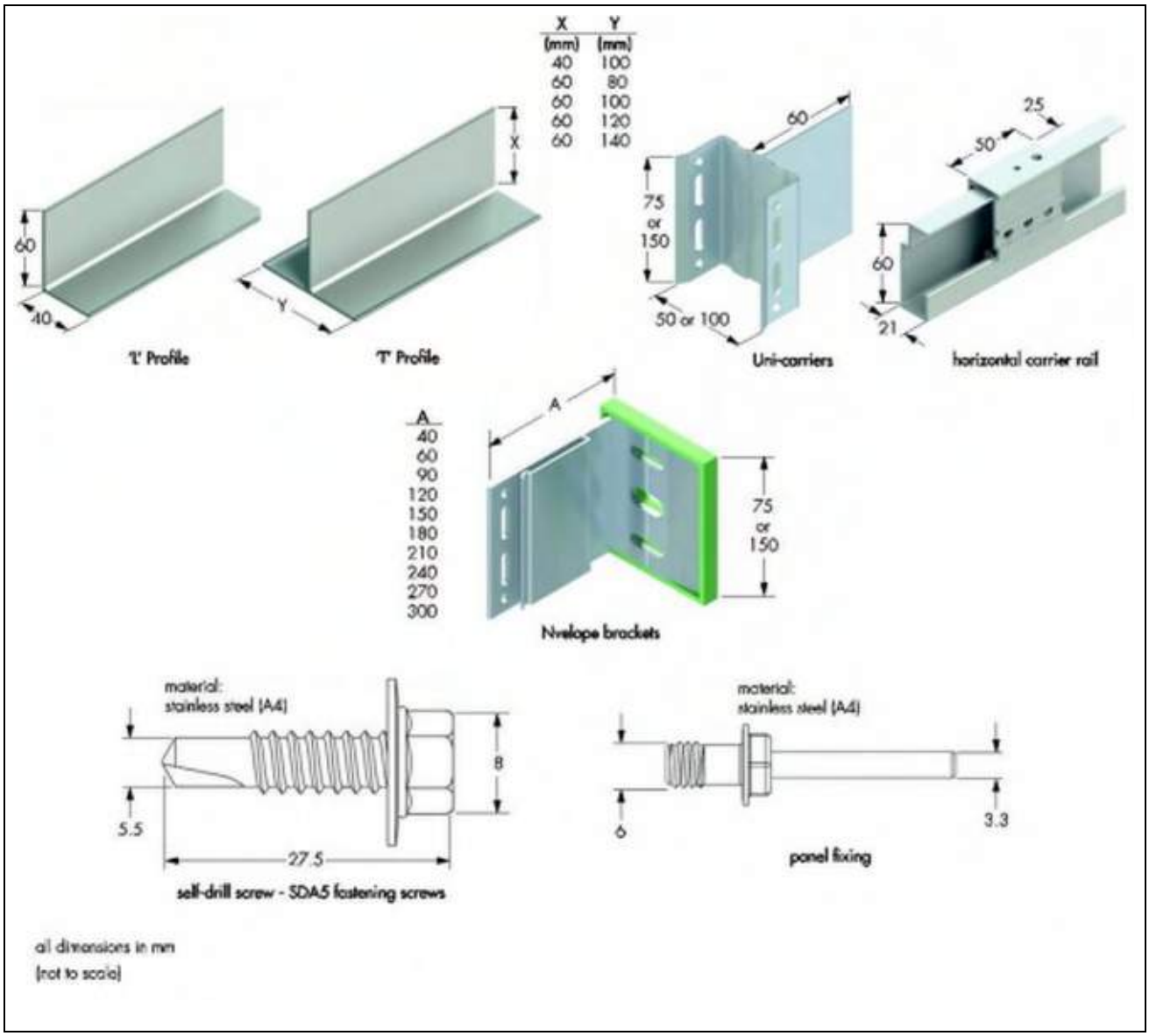
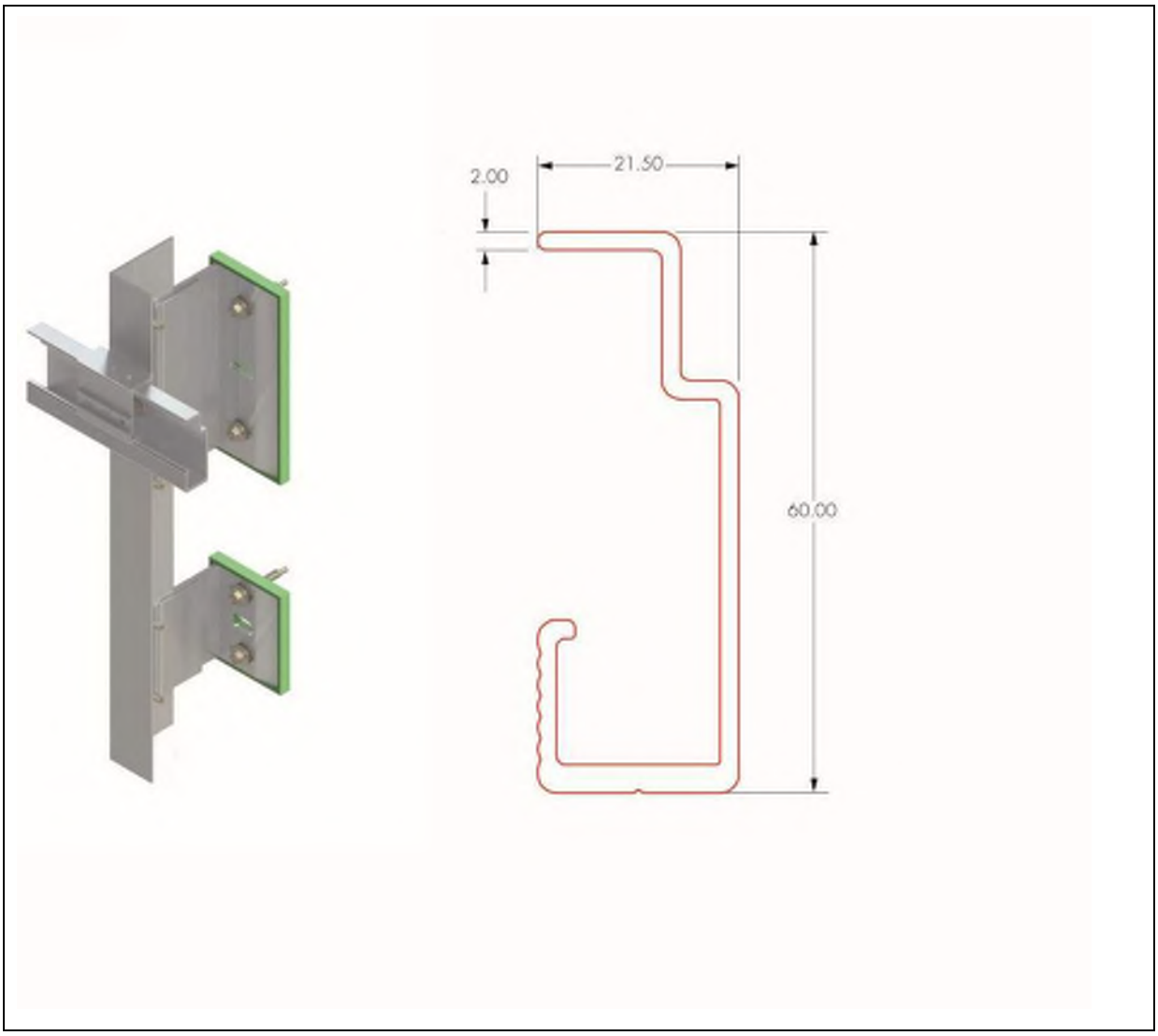


Figure 3 NH2 Adaptor

Figure 4 The NV3 System and NV3 Horizontal Rail (all dimensions in mm)



1.3 The brackets are fixed to the substrate wall structure using stainless steel anchors of a predetermined size. The support rails are secured to the brackets using stainless steel screws as specified in Figure 2.

1.4 Components specified for use with the systems, recommended by the Certificate holder but outside the scope of this Certificate, include:

- 10 mm Diameter Primary Fixing — a plastic anchor consisting of a plastic sleeve made of polyamide and an accompanied specific screw of stainless steel, used as primary fixing to concrete, block work and brick substrate walls
- SX5 Fastening Screws — self-drilling and self-tapping screws made of austenitic stainless steel grade A4 with a washer made of aluminium, or stainless steel A4 with vulcanised EPDM sealant, used as primary fixing to steel frame
- SDA5 Fastening Screws — stainless steel screws grade A4, used as NV3 Horizontal Rail to vertical L or T rail fixings and for fixing bracket to rail
- cavity barriers.

2 Manufacture

2.1 The components are manufactured from extruded sections of aluminium alloy.

2.2 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

3 Delivery and site handling

3.1 The aluminium brackets are wrapped on pallets. Every pallet carries a label bearing the manufacturer's name and a label bearing the BBA logo incorporating the number of this Certificate.

3.2 Packs of rails should be stacked horizontally, on sufficient bearers to prevent distortion, to a maximum height of one metre. Other components should be stored safely until ready for use.

3.3 The pallets should be stored on a dry, flat and level surface, suitably protected from the weather. Ancillary items should be stored in separate boxes.

3.4 The brackets are delivered to site in cartons of a size suitable for manual handling.

3.5 The systems should be handled with care. Damaged items should be discarded.

3.6 Protective clothing should be worn, as required, and all health and safety regulations observed. Care should be taken when handling long lengths of rail, especially at height.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on Nvelope Rainscreen Cladding Support Systems.

Design Considerations

4 Use

4.1 Nvelope Rainscreen Cladding Support Systems, when installed in accordance with this Certificate, are satisfactory for use in back-ventilated and drained cavity rainscreen cladding systems, as well as for internal cladding systems as a sub-frame to support cladding on the external or internal wall structure, of new and existing buildings.

4.2 The systems are applied to the outside of the external or internal wall structures of new or existing buildings. Application must be carried out strictly in accordance with this Certificate and the Certificate holder's instructions, by installers approved by the Certificate holder.

4.3 The substrate wall to which the systems are to be fixed must be structurally sound, watertight and satisfy the requirements of the relevant national Building Regulations and Standards with respect to heat and sound transmission.

4.4 It is important for designers, planners, contractors and/or installers to ensure that the systems and the substrate wall have adequate structural capacity to support cladding panels in accordance with the design and installation requirements of the cladding panel supplier.

5 Practicability of installation

The systems are designed to be installed by cladding contractors who are suitably qualified. Further advice can be provided by the Certificate holder.

6 Mechanical resistance and stability

6.1 The substrate wall to which the cladding components are to be fixed should be designed and constructed in accordance with the requirements of the relevant national Building Regulations and Standards.

6.2 Assessment of structural performance of the systems for individual buildings must be carried out by a designer or a suitably qualified and experienced individual to ensure that:

- the support systems and cladding to be supported are compatible
- any thermal expansion effects of both the support systems and the cladding to be supported are taken into account in the design and detailing.
- the specified fixings have adequate tensile and pull-out strength to resist the applied actions
- the fixing of the support brackets to the supporting wall has adequate tensile, shear and pull-out strength, and corrosion resistance (outside the scope of this Certificate). An appropriate number of site-specific pull-out tests must be conducted on the substrate wall to determine the minimum pull-out resistance to failure of the fixings. The characteristic pull-out resistance should be determined in accordance with the guidance given in EOTA TR055 : 2016, using 50% of the mean value of the five smallest measured values at the ultimate load.

6.3 The supporting wall must be able to resist the gravity load from the self-weight of the cladding, the wind actions and any racking loads, on its own. No contribution from the cladding system may be assumed in this respect.

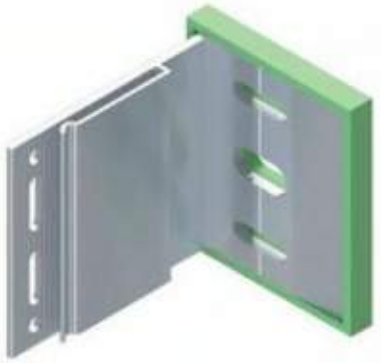
6.4 The wind loads on the wall should be calculated in accordance with BS EN 1991-1-4 : 2005 and its UK National Annex. Due consideration should be given to the high-pressure coefficients applicable to corners of the building as recommended in this Standard. In accordance with BS EN 1990 : 2002 and its UK National Annex, it is recommended that a partial load factor of 1.5 is used to determine the ultimate wind load to be resisted by the systems.

6.5 A combination of horizontal and vertical actions must be checked by an appropriately qualified design engineer, in accordance with BS EN 1999-1-1 : 2007 and BS EN 1999-1-3 : 2007, and their UK National Annexes, in conjunction with BS EN 1990 : 2002 and all relevant standard parts and its corresponding UK National Annex.

6.6 Details of the brackets, NH2 Adaptor and Uni-Carriers, with their design loadbearing resistances, are shown in Tables 1, 2, 3 and 4. The design loadbearing resistance of the connections should be greater than that of the bracket and adaptor as tabulated.

Table 1 NV Bracket — single (75 mm) — design resistances (for bracket out-stand leg)

Bracket leg length (A)[1] (mm)	Projection range[2] (mm)	Code	Design resistance (kN)	
			Vertical (shear)	Horizontal (axial)
40	47–67	VB040S	3.68	14.73
60	62–102	VB060S	2.45	14.73
90	92–132	VB090S	1.63	14.73
120	122–162	VB120S	1.23	14.73
150	152–192	VB150S	0.98	14.73
180	182–222	VB180S	0.82	14.73
210	212–252	VB210S	0.70	14.73
240	242–282	VB240S	0.61	14.73
270	272–312	VB270S	0.54	14.73
300	302–342	VB300S	0.49	14.73



(1) See Figure 2.
(2) Distance between back face of bracket to face of rail profile (see Figure 1).

Table 2 NV Bracket — double (150 mm) — design resistances (for bracket out-stand leg)

Bracket leg length (A)[1] (mm)	Projection range[2] (mm)	Code	Design resistance (kN)	
			Vertical (shear)	Horizontal (axial)
40	47–67	VB040D	5.53	29.45
60	62–102	VB060D	3.68	29.45
90	92–132	VB090D	2.56	29.45
120	122–162	VB120D	1.84	29.45
150	152–192	VB150D	1.47	29.45
180	182–222	VB180D	1.23	29.45
210	212–252	VB210D	1.05	29.45
240	242–282	VB240D	0.92	29.45
270	272–312	VB270D	0.82	29.45
300	302–342	VB300D	0.74	29.45

(1) See Figure 2.
(2) Distance between back face of bracket to face of rail profile (see Figure 1).

Table 3 Nvelope Uni-Carriers — design resistances

Description	Code	Design resistance (kN)	
		Vertical (shear)	Horizontal (axial)
50 mm carrier (single)	UC050S	13.60	17.00
50 mm carrier (double)	UC050D	13.60	34.00
100 mm carrier (single)	UC100S	13.60	17.00
100 mm carrier (double)	UC100D	13.60	34.00

Table 4 NH2 Adaptor — design resistances

Description	Design resistance (kN)	
	Vertical (shear)	Horizontal (axial)
NH2 Adaptor	11.15	21.5

6.7 Details of the screws for connecting the support rails to the brackets are shown in Figure 2. For details of the fixings' suppliers, the advice of the Certificate holder should be sought.

6.8 The design of the rails and associated connections must satisfy the requirements of BS EN 1999-1-1 : 2007, using the mechanical properties of the aluminium grade adopted. Mid-span deflections should be limited to span/200 and cantilever deflections limited to span/150.

6.9 The geometric properties of the rail sections (L and T rails) can be found in detail in Table 5, and used by the structural designer for the rail design.

6.10 In general, the rails should be fixed at mid-length using normal clearance holes (fixed point), and allowed to expand toward the ends using slotted holes (flexible or sliding point) (see Figures 1 and 2). To allow for expansion, a minimum gap of 2.5 mm per metre length should be provided. For standard three-metre long rails, a gap of 8 mm between adjacent rails is adequate. For calculation purposes, the coefficient of thermal expansion for aluminium may be taken as $23 \times 10^{-6} \cdot K^{-1}$. Existing movement joints in the supporting structure should be maintained through the rail system.

6.11 The design and the installation must be checked by a suitably qualified chartered engineer or other appropriately qualified person.

6.12 Any insulation behind the cladding must be suitably fixed to the supporting wall and protected, to resist the forces of wind suction. Insulation should be, at least, of the semi-rigid type (eg boards or batts).

Impact loading

6.13 The impact resistance of a cladding system is a function of the support framing arrangement and the cladding panel used. The structural engineer should ensure that the cladding system incorporating the Nvelope Rainscreen Cladding Support Systems has adequate impact resistance for the support frame arrangement and cladding panels used, for the intended Use category as defined in EAD 090062-00-0404 : 2018, Table G.2.

Table 5 'L' Profile, 'T' Profile and NV3 Horizontal Rail section details

	dimension (X) (mm)	dimension (Y) (mm)	thickness (mm)	area (mm^2)	Second moment of area I_{xx} (mm^4)	Second moment of area I_{yy} (mm^4)	Radius of gyration Axis x-x (mm)	Radius of gyration Axis y-y (mm)	Distance to centre of gravity C (mm) x	Distance to centre of gravity C (mm) y
'L' Profile Rail section (see Figure 2)	40	60	2.2	203.06	147048	43780	26.91	14.68	8.83	18.83
'T' Profile Rail section (see Figure 2)	40	100	2.2	282.16	30222	170224	10.35	24.56	50	33.41
	60	80	2.2	279.20	90935	86981	18.05	17.65	40	46.31
	60	100	2.2	320.38	96058	170236	17.32	23.05	50	47.91
	60	120	2.2	371.64	103634	298372	16.70	28.33	60	49.14
	60	140	2.2	413.72	106966	474532	16.08	33.87	70	50.13
NV3 Horizontal Rail section (see Figure 4)	22	60	2	246	109967	13352	21.1	7.4		

7 Behaviour in relation to fire

7.1 The aluminium brackets, rails and associated rail-to-bracket fixings are non-combustible and, therefore, are classified as Class A1 in accordance with the national Building Regulations and are not subject to any restriction on building height or proximity to boundaries.

7.2 Nvelope NV Brackets feature polypropylene insulation pads, used to reduce the risk of cold bridging across the bracket/wall interface. They are largely protected by the cladding panels and, as they are considered to be present in relatively small quantities, are unlikely to significantly affect the overall fire performance of the cladding.

7.3 Designers should refer to the relevant national Building Regulations and guidance for detailed conditions of use, particularly in respect of requirements for substrate fire performance, cavity barriers and combustibility limitations for other materials and components used in the overall wall construction (for example, thermal insulation and cladding).

8 Drainage and ventilation

8.1 The systems, when incorporated in back-ventilated and drained cavity rainscreen cladding systems, will not have an adverse effect on the removal of water from the cavity by drainage and ventilation.

8.2 For the effective removal of moisture from the cavity, a minimum ventilation area of 5000 mm^2 per metre run of cladding must be provided at the building base point and at the roof edge. To prevent the ingress of birds, vermin, insects and/or rain, all ventilation openings should be suitably protected with a ventilation protection mesh, perforated sheet or similar, or should be baffled.

8.3 The air space between the back of the cladding panels and the supporting wall (or insulation where installed within the cavity) should be as wide as possible, allowing for normal building tolerances. Guidance on recommended cavity widths is given in *NHBC Standards* 2019, Chapter 6.9.

8.4 The ventilation pathways behind the cladding must not be allowed to become blocked, or the insulation dislodged, where it may be vulnerable to wetting.

8.5 As the aluminium is sourced from naturally occurring ores, the components are non-toxic during fabrication and in normal use and, as they are non-combustible, do not produce toxic effects when exposed to fire.

9 Maintenance

The systems are confined behind the cladding panels and do not require special maintenance.

10 Durability

10.1 The systems, when used as prescribed in this Certificate, can be expected to have a service life in excess of 35 years in normal UK conditions.

10.2 Unprotected aluminium interacts with cement-based materials, resulting in severe corrosion. Therefore, aluminium brackets should be used with polypropylene isolator pads (which are supplied with the brackets), when brackets are used in masonry walls.

11 Reuse and recyclability

The components contain polypropylene and aluminium, which can be recycled.

Installation

12 General

12.1 The systems must be installed in accordance with the manufacturer's recommendations, the requirements of this Certificate and any specifications laid down by the project consulting engineer or designer.

12.2 The Certificate holder can provide technical assistance at the design stage, and installation assistance at the start of the installation.

13 Procedure

13.1 Based on a preliminary survey of the wall and architectural/structural design, a grid layout for the sub-frame is first prepared.

13.2 The brackets (with the isolator pad) are fixed to the substrate wall using stainless steel fixings of an appropriate size as determined by design (see sections 1.4 and 6.4).

13.3 The rails are inserted into the brackets and, after adjustment for line and level, fixed to the brackets using self-drilling stainless steel screws, as determined by design.

13.4 The rails are normally attached to the substrate wall to span one storey height. They are normally anchored at mid-span using the round holes on the brackets (fixed point/dead loads), and allowed to expand at the ends using the elongated holes on the brackets (flexible point).

13.5 Where specified, insulation should be tightly butted around the brackets and secured to the substrate wall using the appropriate fixings.

13.6 Where required to protect the substrate wall or insulation from wind-driven rain, an appropriate vapour permeable membrane should be applied to the surface.

13.7 Cladding panels (outside the scope of this Certificate) deemed to be compatible with the systems are appropriately fixed to the vertical rails.

14 Investigations

14.1 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

14.2 An assessment was made of the systems' resistance to wind loading based on calculations to BS EN 1999-1-3: 2007, durability and behaviour in relation to fire.

14.3 Based on a user survey, an assessment was made of the systems' practicability of installation and performance in use.

Bibliography

BS EN 573-3 : 2013 *Aluminium and aluminium alloys — Chemical composition and form of wrought products — Part 3: Chemical composition and form of products*

BS EN 1990 : 2002 + A1: 2005 *Eurocode — Basis of structural design*
NA to BS EN 1990 : 2002 + A1 : 2005 *UK National Annex for Eurocode — Basis of structural* design

BS EN 1991-1-4 : 2005 + A1 : 2010 *Eurocode 1: Actions on structures — General actions — Wind actions*
NA to BS EN 1991-1-4 : 2005 + A1 : 2010 *UK National Annex to Eurocode 1 — Actions on structures — General actions — Wind actions*

BS EN 1999-1-1 : 2007 *Eurocode 9 Design of aluminium structures — General structural rules*
NA to BS EN 1999-1-1 : 2007 + A1 : 2009 *UK National Annex to Eurocode 9 — Design of aluminium structures — General structural rules*
BS EN 1999-1-3 : 2007 + A1: 2011 *Eurocode 9 — Design of aluminium structures — Structures susceptible to fatigue*
NA to BS EN 1999-1-3 : 2007 + A1 : 2011 *UK National Annex to Eurocode 9 — Design of aluminium structures — Structures susceptible to fatigue*

EAD 090062-00-0404 : 2018 – *Kits for external wall claddings mechanically fixed*

EOTA TR055 : 2016 *Design of fasteners based on EAD 330232-00-0601*

15 Conditions

15.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

15.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

15.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

15.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

15.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

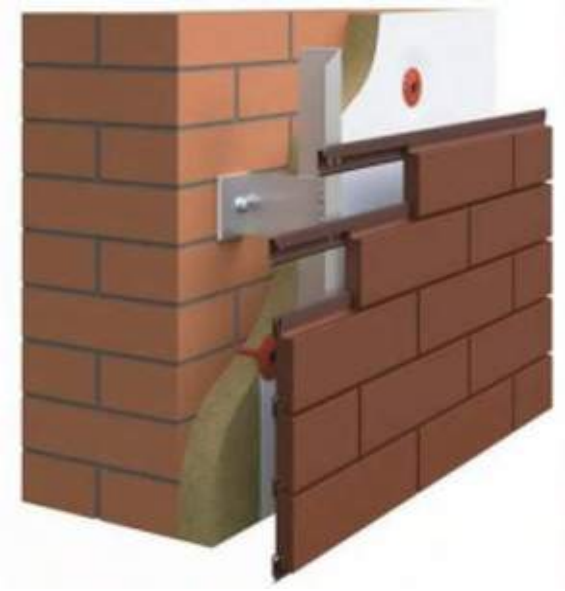
- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

15.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

Brick to Click Cladding System - Capacity of connection between tile rail and Nvelope vertical rail:

Calculation date: 11/09/2020

Typical installation detail:



As shown above the tiles are supported by horizontal rails spaced vertically to suit the size of the hight of the brick tile specified.

Setout geometry:

Maximum height of brick tile & spacing of horizontal rails, H =	100	mm
Maximum horizontal spacing of vertical rails, V =	1200	mm

Self weight & wind loading:

Equivalent loads in N/m^2:

Approximate weight of tiles per square meter:	40	kg/m^2
Maximum allowable wind pressure:	6	kPa

Gd = 392.4 N/m^2

Wu = 6000 N/m^2

Force applied at connection between horizontal and vertical rails:

Vertical shear force (Vd) resulting from tile self weight:

V = Gd x H x V

V = 392.4 N/m2 x 0.1 m x 1.2 m = 47.1 N

Horizontal tensile force (Nd) resulting from max wind load:

N = Wu x H x V

N = 6000 N/m2 x 0.1 m x 1.2 m = 720 N

<u>Load combinations:</u>

Permanent load only combination: Ed = 1.35 G AS/NZS 1170.0:2002 - 4.2.2(a)

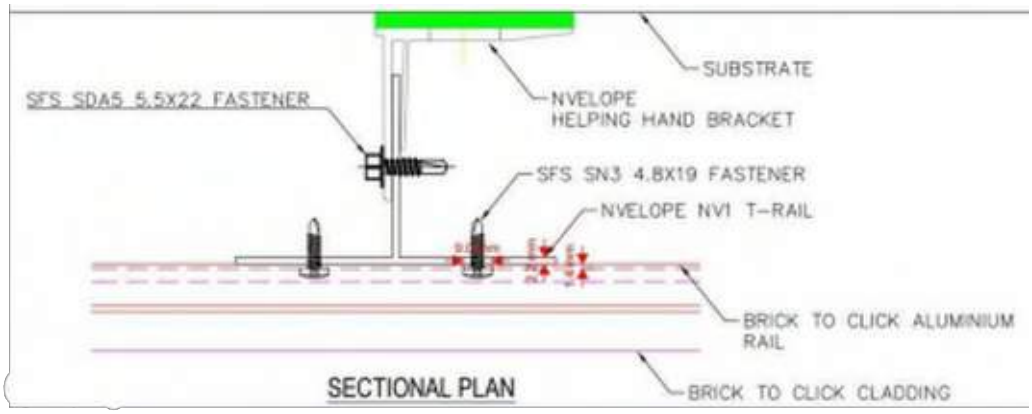
Shear force: Vd = 1.35 x V = 1.35 x 47.1 N = 63.6 N

Combined permanent and wind load combination: Ed = 1.2 G, Wu AS/NZS 1170.0:2002 - 4.2.2(d)

Shear force: Vd = 1.2 x V = 1.2 x 47.1 N = 56.5 N
Tensile force: Nd = 720 N = 720 N

Connection between horizontal tile rail and vertical cladding rail:

The diagram below shows the connection between the horizontal aluminium cladding rail and the vertical Nvelope NV1 T-rail



<u>Capacity of connection between horizontal and vertical rail:</u>

Shear strength of screw fastener through and/or into aluminium: **NZS 1664.1:1997 - Clause 5.3.2**

Fastener size: Gauge 10
Nominal shank diameter of fastener: 4.88 mm

Shear capacity of fastener given by: $\phi P_{as} = n \times \phi_{sc} \times P_{ns}$ - Equ 5.3.2.2(1)

Where:
Capacity factor for screw connections: ϕ_{sc} = 0.5 - Clause 5.3.1
The number of fasteners in the connection: n = 2

and, P_{ns} is the smallest of:

$P_{ns} = \frac{\varphi_y}{\varphi_{sc}} DF_{by1}t_1$ = (0.95/0.5) x 4.88 x 386 x 1.4 = 5010.6 N

$P_{ns} = \frac{\varphi_y}{\varphi_{sc}} DF_{by2}t_2$ = (0.95/0.5) x 4.88 x 386 x 2.2 = 7873.8 N

$P_{ns} = \frac{\varphi_u}{1.2\varphi_{sc}} DF_{bu1}t_1$ = (0.85/1.2 x 0.5) x 4.88 x 552 x 1.4 = 5342.6 N

$P_{ns} = \frac{\varphi_u}{1.2\varphi_{sc}} DF_{bu2}t_2$ = (0.85/1.2 x 0.5) x 4.88 x 552 x 2.2 = 8395.6 N

Where:
Bearing yield strength of headside member: F_{by1} = 386 N/mm^2
Bearing yield strength of pointside member: F_{by2} = 386 N/mm^2 For 6005 - T5 per NZS
Bearing ultimate strength of headside member: F_{bu1} = 552 N/mm^2 1664.1:1997 - Table 3.3(A)
Bearing ultimate strength of pointside member: F_{bu2} = 552 N/mm^2
Nominal diameter of the screw: D = 4.88 mm

Thickness of the headside member: t_1 =	1.4	mm	
Thickness of the pointside member: t_2 =	2.2	mm	
Therefore ϕPas = 0.5 x 2 x 5010.6N =	5011	N	
The capacity of the connection exceeds the maximum expected shear force.			**Utilisation Factor = 1.3 %**
Pull out strength of screw fastener in aluminium:			**NZS 1664.1:1997 - Clause 5.3.3.2**
Fastener size:	Gauge 10		
Nominal shank diameter of fastener:	4.88	mm	
Pull out strength of fastener given by: $P_{at} = \phi_{sc} \times n \times 0.85 \times t_c \times D \times F_{tu2}$			- Equ 5.3.3.1 & 5.3.3.2
Where:			
The number of fasteners in the connection: n =	2		
Capacity factor for screw connections: ϕ_{sc} =	0.5		- Clause 5.3.1
Thickness of the point side aluminium sheet: t_c =	2.2	mm	
Nominal diameter of the screw: D =	4.88	mm	
Tensile ultimate strength of the pointside member: F_{tu2}=	262	N/mm^2	For 6005 - T5 per NZS 1664.1:1997 - Table 3.3(A)
Design pull out capacity of fastener: P_{at} =	2391	N	
Pull over (or pull through) strength of fastener through aluminium:			**NZS 1664.1:1997 - Clause 5.3.3.3**
Fastener size:	Gauge 10		
Nominal shank diameter of fastener:	4.88	mm	
Screw head diameter:	9	mm	<- TBC
Pull over strength of fastener given by: $P_{at} = \phi_{sc} \times n \times C \times t_1 \times F_{tu1} \times (D_{ws} - D_h)$			- Equ 5.3.3.1 & 5.3.3.3
Where:			
The number of fasteners in the connection: n =	2		
Capacity factor for screw connections: ϕ_{sc} =	0.5		- Clause 5.3.1
Fastener location: C =	1.0		Valley fastening
Thickness of the headside member: t_1 =	1.4	mm	
Tensile ultimate strength of the headside member: F_{tu1}=	262	N/mm^2	
Screw head or washer diameter: D_{ws} =	9	mm	
Diameter of screw hole in material: D_h =	4.88	mm	
Design pull over capacity of fastener: P_{at} =	1511	N	
The capacity of the connection exceeds the maximum expected tensile force.			**Utilisation Factor = 47.6 %**
Capacity of fastener subject to combined tension and shear:			**NZS 3404:1997 - Clause 9.3.2.3**

$$\left(\frac{V_f^*}{\phi V_f}\right)^2 + \left(\frac{N_{tf}^*}{\phi N_{tf}}\right)^2 \leq 1.0$$

Where:

V_f^* = Design shear force =	56.5	N
ϕV_f = Shear capacity of connection, ϕQn =	5011	N
N_{tf}^* = Design tensile force =	720	N
ϕN_{tf} = Tensile capacity of connection, ϕQn =	1511	N

(57/5011)^2 + (720/1511)^2 = **0.23** **<1.0**

Fastener capacity is greater than the design loads