EAD **220078-00-0401**

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European Assessment Document for

Kits for green roofs with green roofing elements made of plastic and its fixing devices

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

This EAD covers the assessment of kits for green roofs composed of green roofing elements made of plastic (PP or PE/PP)[1] manufactured using injection moulding technology and their fixings devices made of stainless steel. The plastic green roofing elements may or may not include recycled material and they do not contain chemical substances preventing root penetration; therefore, they are root-proof.

The green roofing elements may have special shape that allow the water drainability.

The EAD is applicable to the kits for green roofs belonging to the following types:

Type A: Green roofing honey-comb and its fixing device.

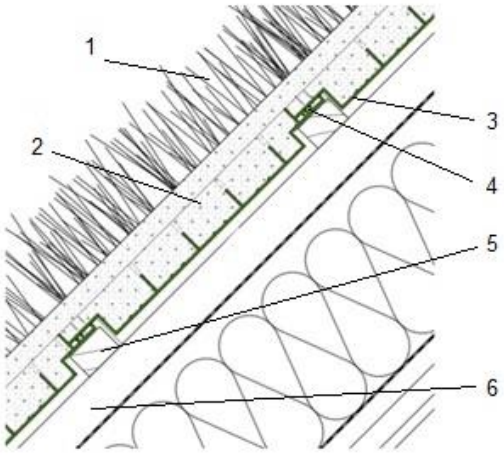
- Plastic green roofing elements with honey-comb-structure for storage of substrate for planting. These elements are supported continuously by a substructure (e.g., made of timber) and lengthwise, the sides overlap each other.

- Special clips made of stainless steel according to EN 10088-5[2]. The clips fix the plastic element to the substructure without having to drill holes in the plastic elements. Number and position of these clips is defined in the Manufacturer's Product Installation Instructions (MPII).

Type B: Green roofing case and its fixing device.

- Plastic green roofing elements in form of case or tray for storage of substrate for planting. These elements have special shapes for being installed in a lock-key way hung on the substructure (e.g., made of timber), the sides overlap each other.

- Special clips made of stainless steel according to EN 10088-5. The clips fix the plastic element to the substructure against wind suction without having to drill holes in the plastic elements. Number and position of these clips is defined in the MPII. Usually, position is at the roof edges.



Legend:
1. Plants.
2. Substrate for plants.
3. Green roofing elements.
4. Fixings.
5. Roof substructure.
6. Roof (different layers).

Figure 1.1: Section with greening (example).

1 PP = Polypropylene; PE/PP = Polyethylene / Polypropylene.

2 All undated references to standards or to EADs in this EAD are to be understood as references to the dated versions listed in chapter 4.

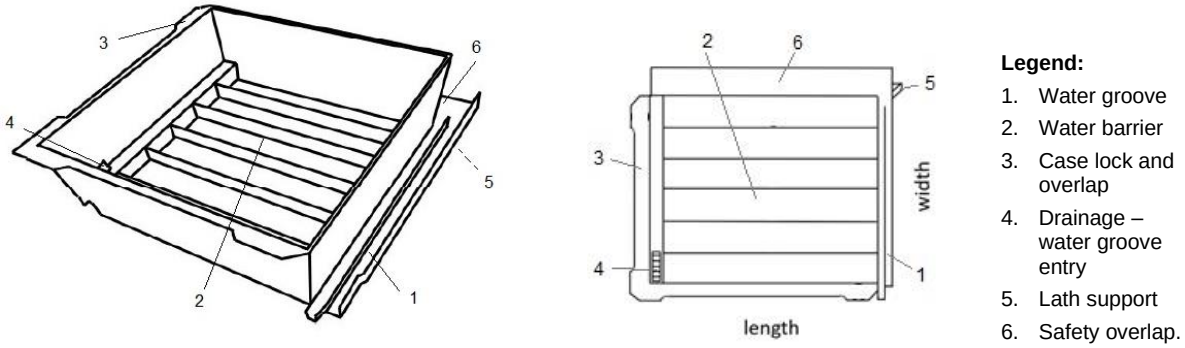


Figure 1.2: Green roofing case (example).

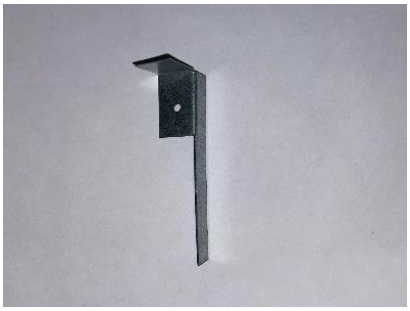


Figure 1.3: An example of a possible clip for fixing of all types of green roofing elements without necessity to drill holes to the green roofing element.

The product is not covered by a harmonised European standard (hEN).

The product is not fully covered by the following harmonised technical specification: EAD 220009-00-0401. The product in EAD 220009-00-0401 is composed of several layers of different materials that are installed on the roof structure with a waterproofing layer, however, the product covered by the present EAD 220078-00-0401 is composed of precast elements that are the containers for the different layers for the green roofing and the fixing that are necessary for its installation on the roof structure.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement, and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The kits for green roofs are intended to be used as additional finishings of roofs that able to support the substrate for greening.

The green roofing elements are intended to contain the substrate for plants and, if relevant, the filtration layer and hydrophilic mineral wool or similar material. They are placed above the roofing waterproofing layer on a roof substructure (e.g., timber substructure). This substructure is not part of the kit covered by this EAD.

Kit for green roofs Type A (see clause 1.1) is applied on single- or double-pitch roofs with a slope ranging between 22° and 45° with respect to the horizontal plane.

Kit for green roofs Type B (see clause 1.1) is applied on single- or double-pitch roofs with a slope ranging 5° - 45° with respect to the horizontal plane.

The kit for green roofs transfers loads from greening, wind and snow to the substructure. It is not accessible. Point loads are not foreseen. For installation and maintenance work the roof is intended to be entered only by single persons using walk planks or ladders for load distribution.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the kit for green roofs for the intended use of 25 years when installed in the works /provided that the kit for green roofs is subject to appropriate installation (see 1.1). These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[3].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

[3] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of the kit for green roofs is assessed in relation to the essential characteristics.

Table 2.1.1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.1	class
2	External fire performance of roofs	2.2.2	class
Basic Works Requirement 4: Safety and accessibility in use			
3	Load-bearing capacity: downward loads/ uniformly distributed load	2.2.3.1	level
4	Load-bearing capacity: uplift loads/ wind suction	2.2.3.2	level
5	Load-bearing capacity in the plane of the roof resulting from the roof slope	2.2.3.3	level
6	Influencing factors. Temperature	2.2.4.1	level
7	Influencing factors. Ageing and environmental influences	2.2.4.2	level
8	Influencing factors. Alternating climate behaviour.	2.2.4.3	level
9	Influencing factors. Long-term influence of loads (aspects of time dependent exposure)	2.2.4.4	level
10	Dimensional tolerance	2.2.5.1	level
11	Weight tolerance	2.2.5.2	level

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer, and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

If for any components covered by harmonised standards or European Technical Assessments the manufacturer of the component has included the performance regarding the relevant essential characteristic in the Declaration of Performance, retesting of that component for issuing the ETA under the current EAD is not required.

2.2.1 Reaction to fire

The kit for green roofs shall be tested, using the method(s) relevant for the corresponding reaction to fire class according to EN 13501-1. The kit for green roofs shall be classified according to the Commission Delegated Regulation (EU) No 2016/364 in connection with EN 13501-1.

Regarding the testing according to EN ISO 11925-2, the specimens shall be cut from the green roofing element in dimensions as requested by the test standard. Testing shall be performed on free-hanging specimens. The following parameters shall be considered within the tests:

- product types of a product family (as defined by a certain combination of raw materials and a certain type of production process);
- density / weight per unit area;
- thickness of the various walls of the elements;

The results of test are valid for:

- the same material and shape configuration;
- the same density / weight per unit area as tested or the range between those values assessed:
- the same thickness as tested or the range between those values assessed;

The fixing clip made of stainless steel is considered to satisfy the requirements of class A1 of reaction to fire performance in accordance with the Decision 1996/603/EC amended by the Decision 2000/605/EC without the need for testing on the basis of its fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

2.2.2 External fire performance of roofs

The roof (including the complete roof covering) in which the kit for green roofs is intended to be incorporated, installed or applied shall be tested according to the test method referred to in EN 13501-5 and relevant for the corresponding external fire performance roof class, in order to be classified according to Commission Decision 2001/671/EC amended by Commission Decision 2005/823/EC.

Rules within the direct field of application of test results are given in EN 13501-5 and extended application of test results shall be made according to CEN/TS 16459.

The ETA shall clearly define the test assembly and components of the roof(s) that is/are subject to the classification.

2.2.3 Load-bearing capacity

The assessment of the load-bearing capacity of the kits for green roofs is carried out by means of the assessment of the following essential characteristics of the green roofing elements which are representative of the kits for green roofs:

- Load-bearing capacity: downward loads/ uniformly distributed load. See clause 2.2.3.1.
- Load-bearing capacity: uplift loads/ wind suction. See clause 2.2.3.2.
- Load-bearing capacity in the plane of the roof resulting from the roof slope. See clause 2.2.3.3.

All these assessments shall be carried out under standard atmospheric conditions (23 ± 2) ºC / (50 ± 10) % RH (from now on 23/50), Class 2, according to EN ISO 291.

2.2.3.1 Load-bearing capacity: downward loads/ uniformly distributed load

Load-bearing capacity where applied downward loads / uniformly distributed load shall be assessed according to clause A.2.

Arithmetic average value of the ultimate load $F_{u,m}$ in [kN] and the equivalent distributed load $q_{k,m}$ in [kN/m^2] and characteristic value determined according EN 1990/Table D1, $V_{x,unknown}$ (the variation coefficient shall be based on the standard deviation of the logarithmic values) of the ultimate load $F_{u,C}$ in [kN] and the equivalent distributed load $q_{k,C}$ in [kN/m^2] shall be stated in the ETA.

2.2.3.2 Load-bearing capacity: uplift loads/ wind suction

For cases when the stability of the roofing against possible uplift load is secured by full anchoring to the supporting structure by metal clips, the load-bearing capacity where applied uplift loads / wind suction shall be assessed according to clause A.2, with the test specimens and the supporting structure (items 2, 3 and 5 in Figure A.2.1) in the inverted position, thus inverting the direction of loading.

Arithmetic average value of the ultimate load $F_{u,m}$ in [N] and the equivalent distributed load $q_{k,m}$ in [kN/m^2] and characteristic value determined according EN 1990/Table D1, $V_{x,unknown}$ (the variation coefficient shall be based on the standard deviation of the logarithmic values) of the ultimate load $F_{u,C}$ in [N] and the equivalent distributed load $q_{k,C}$ in [kN/m^2] shall be stated in the ETA.

2.2.3.3 Load-bearing capacity in the plane of the roof resulting from the roof slope

The resistance of the green roofing element made of plastic to loads in the plane of roofing shall be assessed according to clause A.3.

Arithmetic average value and characteristic value determined according EN 1990/Table D1, $V_{x,unknown}$ (the variation coefficient shall be based on the standard deviation of the logarithmic values) of the ultimate load acting in the roof plane $F_{sl,m}$ in [kN] & $F_{sl,C}$ in [kN] respectively, shall be stated in the ETA.

2.2.4 Influencing factors

The assessment listed under section 2.2.3 shall be carried out under short-term loading and under standard atmospheric conditions. With regard to the assessment of the load-bearing capacity of the green roofing elements, the long-term behaviour considering the use conditions and environmental influences shall also be assessed.

At least the following influences shall be taken into consideration:

- Temperature.
- Ageing and environmental influences.
- Long-term influence of loads (aspects of time dependent exposure).

Due to the complex structure of the green roofing element made of plastic full-scale tests shall be considered to determine the aspects of time dependent exposure.

The influence factors K_{θ}, K_{uFS}, $K_{uSAS,}$ $K_{uSW,}$ and K_{uACT} describing the changes of the flexural strength due to load duration, ageing/weathering and temperature, shall be determined and shall be stated in the ETA.

The influence factor C_T describing the change of deflection as a function of time shall be stated in the ETA.

2.2.4.1 Temperature

A generic simulation model (a model to calculate the simultaneous heat and moisture transport in building components under real climate conditions) shall be used to determine the maximum surface temperature to be expected if a minimum of greening is used.

Flexural strength shall be determined for each direction separately on 5 test specimens by testing according to test method A given in EN ISO 178, Clause 8.7. The test specimens shall be prepared from green roofing element made from plastic. Shape and dimensions of test specimens shall be selected according to EN ISO 178, Clause 6.1.3. Preparation, control and number of test specimens shall be taken according to EN ISO 178, Clause 6.3 to 6.5. In case of anisotropic material (flexural properties depend on the direction) EN ISO 178, Clause 6.2 shall be followed. The test specimens shall be tested under standard atmospheric conditions, Class 2, 23/50 (EN ISO 291) as well as under increased temperature. The increased temperature shall be at least 40°C. Arithmetic average of flexural strength σ_{fM} [MPa] shall be calculated for each direction separately.

The temperature influence factor K_{θ} shall be determined by calculating the ratio of the obtained arithmetic average value of the flexural strength determined under standard atmospheric conditions, to obtained arithmetic average value of the flexural strength at increased temperature. The value of the temperature influence factor K_{θ} shall be stated in the ETA.

2.2.4.2 Ageing and environmental influences

Determination of flexural strength as in clause 2.2.4.1 shall be used to determine the influence factors for ageing and environmental influences. The influence of different substances, leading to embrittlement, shall be determined (exposure of UV radiation shall be excluded by the roof construction). The samples (minimum 8 per test) of the plastic shall be taken from the green roofing elements and tested under standard atmospheric conditions, Class 2, 23/50 (EN ISO 291) as well as under conditioning. Referring to EN ISO 175 the validation of chemical resistance occurs by storage (conditioning) in:

- 5% fertilizer solution.
- 5% sulfuric acid solution.
- Embedding in substrate, completely covered by water.

The samples shall be stored at a temperature of (55 $\pm$ 2) °C for 180 days.

The below stated ageing and environmental influence factors referring to each conditioning type:

K_{uFS} ageing and environmental influence factor referring to conditioning in 5% fertilizer solution.

K_{uSAS} ageing and environmental influence factor referring to conditioning in 5% sulfuric acid solution.

K_{uSW} ageing and environmental influence factor referring to conditioning in substrate covered by water.

Shall be determined by calculating the ratio of the obtained arithmetic average value of the flexural strength determined under standard atmospheric conditions to the specific conditioning type. The value of the factors K_{uFS}, K_{uSAS} and K_{uSW} shall be stated in the ETA.

2.2.4.3 Alternating climate behaviour

10 specimen such as for 2.2.4.1 shall be made and stored under the following conditions:

- 72°h immersion in water at a temperature of 23°C, 50% RH.
- 24°h freezing at a temperature of -20°C.
- 72°h drying at a temperature of 60°C.

The specimen shall be submitted to 10 cycles, after the last one, as soon as the drying is cancelled, then they shall be stored at room temperature for 2 hours and measured.

Flexural strength according to EN ISO 178 and the alternating climate test influence factor K_{uACT} as a ratio of the obtained arithmetic average value of the flexural strength determined under standard atmospheric conditions to arithmetic average value of flexural strength obtained after alternating climate testing shall be determined.

The value of the factor K_{uACT} shall be stated in the ETA.

2.2.4.4 Long-term influence of loads (aspects of time dependent exposure)

The flexural creep test resulting in creep curves shall be carried out.

The test setup including supporting conditions of the test element shall be the same as with the short-term load tests as described in clause 2.2.3.1 considering an applied long-term constant load instead of a constant incremented load as defined in clause A.1.

A time measuring device with the accuracy of 0,1 % shall be used.

The influence of the long-term effect of permanent loads, creep failure tests shall be carried out for the green roofing element, where a percentage of the short-term load-bearing capacity (representing the real permanent load) shall be applied for minimum 1000 hours as a constant load. The creep curves shall be stated in order to be able to extrapolate the anticipated load-bearing capacities over the assumed working life (for instance as shown in EAD 220089-00-0401 Annex C/ figure C.1.6 for PVC). Therefore, the measured results shall be represented in a double logarithmic time-deflection-curve (deflection (f) in mm as a function of load duration (t) in hours).

The time-to-fracture-tests shall be carried out applying 80 % / 60 % / 40 % and 20 % of the short-term ultimate load-bearing capacity defined in clause 2.2.3.1.

The measured results of the individual trials shall be represented in a double logarithmic time-breaking load curve. The characteristic breaking load shall be determined with a linear extrapolation of this curve to 200.000 hours. The influence factor C_T shall be determined by calculating the ratio of the value $f_{200,000\ hours}$ (relating to the assumed working life) to the value $f_{0.1h}$.

The tests at different percentages of the short-term load-bearing capacity may be carried out successively or rather, for saving time, simultaneously.

The influence factor C_T shall be stated in the ETA.

2.2.5 Dimensional and weight tolerances

2.2.5.1 Dimensional tolerance

The dimensional tolerances (width, length, thickness) of the green roofing element and the clip shall be determined by measurements using standard atmosphere 23/50, Class 2, according to EN ISO 291. The thickness, length and width shall be measured to the nearest 0,1 mm, without damaging the surface.

At least five test specimens shall be tested. Three measurements of each dimension shall be performed on each test specimen. For each dimension, the median (ISO 3534-1, clause 1.13) of all measurements on all test specimens shall be determined separately. The two-sided confidence interval of mean value of each dimension separately at the confidence level 95 % according to ISO 2602, clause 6.2 shall be calculated with accuracy integer.

The arithmetic average of the length l [mm], width b [mm], thickness d [mm] and two-sided confidence interval of relevant dimension shall be stated in the ETA (separately for each dimension).

2.2.5.2 Weight tolerance

The green roofing element weight tolerance shall be determined on at least five test specimens. The tests shall be performed using scales with an accuracy of at least 0,001 kg using standard atmosphere 23/50, Class 2, according to EN ISO 291.

The two-sided confidence interval of arithmetic average value of product weight at the confidence level 95 % according to ISO 2602, clause 6.2 shall be calculated with accuracy 0,01 kg.

The two-sided confidence interval of arithmetic average product weight m [kg] shall be stated in the ETA.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Decision 1998/600/EC amended by Commission Decision 2001/596/EC.

The applicable AVCP system is 3 for any use except for uses subject to regulations on reaction to fire.

For uses subject to regulations on reaction to fire the applicable AVCP systems regarding reaction to fire are 1, or 3, or 4 depending on the conditions defined in the said Decision.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1.

The manufacturer (regarding the components he buys from the market with DoP) shall take into account the Declaration of Performance issued by the manufacturer of that component. No retesting is necessary.

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Inspection certificate according to clause 3.1 of EN 10204 for fixing clip	EN 10204	As defined in the control plan	---	each delivery
2	Nature of recycled plastic material (if relevant)	relevant test methods coming from EN 15347	As defined in the control plan	---	each delivery
3	Flexural tests of the green roofing element	Four-point bending tests based in clause A.2.	As defined in the control plan	1	1 per production batch with a maximum of 4 times a year, always at modification of product process
4	Reaction to fire of the green roofing element	Indirect testing as defined in the control plan and direct testing in accordance with clause 2.2.1	class	1	2 per year (direct testing)
5	Appearance	visually	As defined in control plan	1	1 per production batch
6	Geometry	Clause 2.2.5.1	As defined in control plan	1	1 per production batch
7	Weight	Clause 2.2.5.2	As defined in control plan	1	1 per production batch
8	Weight per unit area	As defined in control plan	As defined in control plan	1	1 per production batch

3.3 Tasks of the notified body

The intervention of the notified body under AVCP system 1 is only necessary for reaction to fire for products/materials for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g., an addition of fire retardants or a limiting of organic material).

In this case the cornerstones of the actions to be undertaken by the notified body under AVCP system 1 are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire					
1	Where the intervention of the Notified Body is necessary only because the conditions for the applicability of system 1 are fulfilled for reaction to fire, the notified body will consider especially the clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification (e.g., an addition of fire retardants or a limiting of organic material).	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacture r	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire					
2	Where the intervention of the Notified Body is necessary only because the conditions for the applicability of system 1 in the Decisions regarding reaction to fire are fulfilled, the notified body will consider especially the clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification (e.g., an addition of fire retardants or a limiting of organic material)	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	As defined in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacture r	1/year

4 REFERENCE DOCUMENTS

EAD 220089-00-040	Self-supporting translucent roof kits with covering made of plastic sheets.
EN 10088-5:2009	Stainless steels - Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes.
EN 10204:2004	Metallic products - Types of inspection documents.
EN 13501-1:2018	Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests.
EN 13501-5:2016	Fire classification of construction products and building elements - Part 5: Classification using data from external fire exposure to roofs tests.
EN 15347:2007	Plastics - Recycled plastics - Characterization of plastics wastes.
EN 1990:2023	Eurocode: Basis of structural and geotechnical design.
EN ISO 175: 2010	Plastics - Methods of test for the determination of the effects of immersion in liquid chemicals (ISO 175:2010).
EN ISO 291:2008	Plastics - Standard atmospheres for conditioning and testing (ISO 291:2008).
EN ISO 11925-2:2020	Reaction to fire tests - Ignitability of products subjected to direct impingement of flame - Part 2: Single-flame source test (ISO 11925-2:2010).
EN ISO 178:2019	Plastics - Determination of flexural properties.
ISO 2602:1980	Statistical interpretation of test results. Estimation of the mean. Confidence interval.
ISO 3534-1:2006	Statistics - Vocabulary and symbols - Part 1: General statistical terms and terms used in probability.
CEN/TS 16459:2019	External fire exposure of roofs and roof coverings – Extended application of test results from CEN/TS 1187.

ANNEX A: LOAD-BEARING CAPACITY TESTING

The purpose is to establish the effect of the loads acting on the kit for green roofs.

A.1 - General aspects

The testing procedure consists of applying a continuous load where the graphic load-displacement shall be measured until failure (ultimate load).

Load shall be applied in constant speed (1 ± 0,5) mm/min on the profile in order to avoid a dynamic failure of the test specimen.

Failure is defined by any one of the following events:

1. Any component (green roofing element or fixing device) breaks.
2. The green roofing element reaches the ultimate displacement defined in the MPII. When the MPII does not give such information, L/50 mm of displacement shall be used (where L = Spacing (distance) of the supports, see Figure A.2.1).
3. Any component (green roofing element or fixing device) disassembles.

If not otherwise indicated, at least 5 test specimens of five different batches shall be performed.

Basic statements for testing devices are:

- A loading system capable of providing a continuous load that does not lead to a brief overload, and that the load is maintained within ± 1% of the applied load. During a creep test performed before failure of the test piece shall be ensured that none is transmitted to the adjacent loading system shock waves occurring at the moment of failure. The loading system shall allow fast, smooth and reproducible loading.
- Load distributing instruments are specified in each relevant subclause (see clause A.2 & A.3).
- Deflection measuring device, any non-contact or contact device capable of measuring deflection of the test piece under load without affecting its behaviour by mechanical influences, other physical influences, or chemical influences. Equipment accuracy the measuring deflection shall be within ± 0,01 % of the total deflection. Point of measurement are given in each relevant subclause (see clause A.2 & A.3).
- Gauge for determination of dimensions with the accuracy of 0,1 mm and for determination of spacing of the supports (L) with accuracy of 0,1 % of the distance (spacing) shall be used.

A.2 - Four-point-bending test with horizontal setup

Test procedure shall consider the general aspects defined in clause A.1.

Four-point-bending testing with horizontal setup shall be carried out according to the arrangement defined in Figure A.2.1.

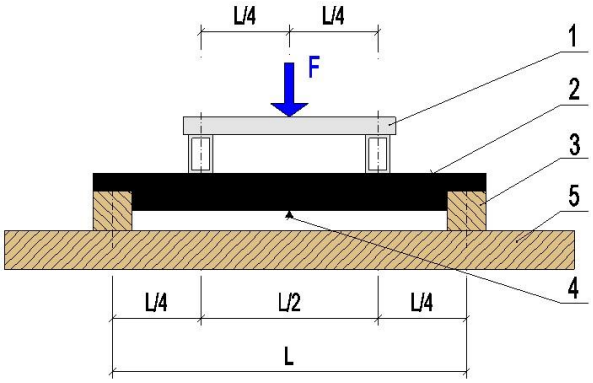
Test specimen supports shall correspond to the real assembled conditions according to the MPII. The distance of the supports (centre distance and clear span) to be considered in the testing shall be stated in the ETA.

Two-line loads shall be applied parallel to the long side and symmetrically to the middle axis of the green roofing element. The line loads shall be applied by means of a steel construction, which shall have an axial spacing of circa 1/2 of the axial span between the supports.

Considering the failure load (F) resulting from four-point-bending test the equivalent uniformly distributed load q_K, which the kit is able to carry, shall be determined according to equation A.2.1.

$q_k = F/A$ [kN/m²] (A.2.1)

where F is the acting force and A is the area of the green roofing element, i.e., the area taken by one green roofing element in the completed roofing.



Legend:

1 Steel load distributing instrument (for details see Figure A.2.2).
2 Green roofing element made of plastic.
3 Support – timber lathing.
4 Deflection measurement device.
5 Rafter – timber beam.
L Spacing(distance) of the supports.

Figure A.2.1: Test rig for determination of load-bearing capacity for downward loads/distributed load.

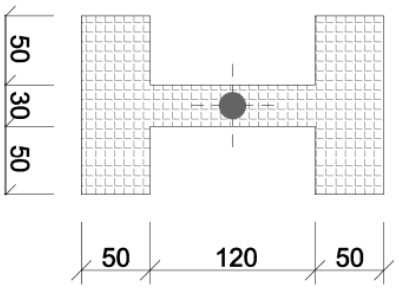


Figure A.2.2: Contact area of the load distributing instrument (dimensions in mm).

A.3 - Four-point-bending test with sloped setup

Test procedure shall consider the general aspects defined in clause A.1.

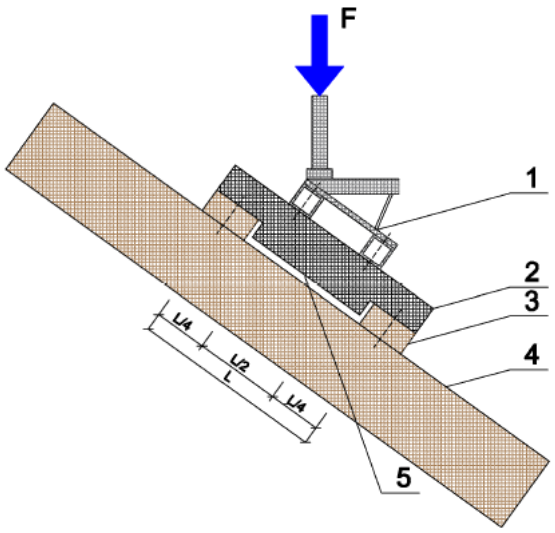
Four-point-bending testing with sloped setup shall be carried out according to the arrangement defined in Figure A.3.1.

The load shall be applied by the steel load distributing instrument described in Figure A.3.2. The green roofing element made of plastic shall be at inclined position with angle α corresponding to the maximum slope given in the MPII (when the MPII does not give such information, depending on the kit type, the maximum slope given in clause 1.2.1 shall be used). The green roofing element shall be fixed according to the MPII.

The force component acting in the roof plane F_{sl} is determined according to equation A.3.1.

$F_{sl} = F \cdot \sin\alpha$ [kN] (A.3.1)

where F is the vertical force and α is the angle of the roof to horizontal plane.



Legend:

1 Steel load distributing instrument (for details see Figure A.3.2).
2 Green roofing element made of plastic.
3 Support – timber lathing.
4 Rafter – timber beam.
5 Deflection measurement device.
L Spacing(distance) of the supports.

Figure A.3.1: Test rig for determination of load-bearing capacity in the plane of the roof resulting from the roof slope.

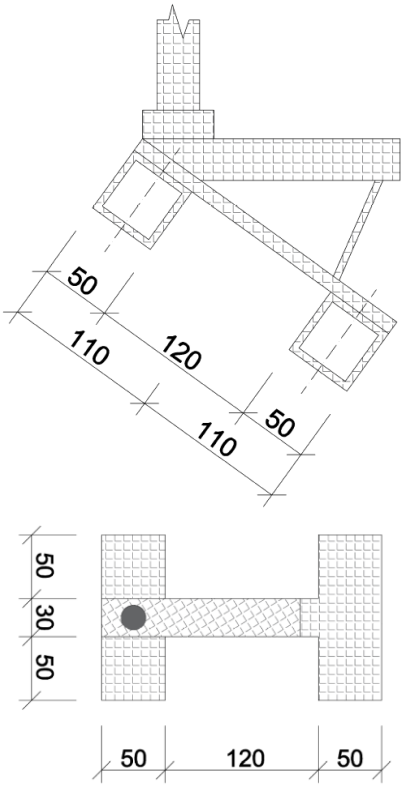


Figure A.3.2: Steel load distributing instrument (dimensions in mm) and it´s contact area.