Technical Application Document

Reference Technical Appraisal **5/15-2454**

Supersedes and replaces Technical Appraisal no. 5/11-2218

Extruded polystyrene (XPS) boards

Inverted insulation method
Inverted insulation for terrace roofs
Inverted roof

JACKODUR terrace roof

Relevant to standard	**NF EN 13164**

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Commission tasked with issuing Technical Appraisals
(Order of 21 March 2012)

Specialised Group no. 5.2

Products and procedures for sealing roofs, buried walls and basement waterproofing

Seen for registration 18 November 2015

Secretariat of the commission of Technical Appraisals
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On 18 May 2015, Specialised Group no. 5.2 "Products and procedures for sealing roofs, buried walls and basement waterproofing" of the Commission tasked with issuing Technical Appraisals examined the request relative to "JACKODUR terrace roof" inverted roof insulation procedure presented by Jackon Insulation GmbH. The present document, with the Technical File compiled by the applicant in annex, transcribes the Appraisal issued by Specialised Group no. 5.2 "Products and procedures for sealing roofs, buried walls and basement waterproofing" on the installation arrangements proposed for utilization of the procedure in the intended application area and under the prevailing conditions of European France. This document cancels and replaces Technical Appraisal no. 5/11-2218.

1. Brief definition

1.1 Brief description

Method of inverted roof thermal insulation using two types of extruded polystyrene (XPS) boards – JACKODUR KF 300 Standard SF and JACKODUR Plus 300 Standard SF – with different thermal properties, laid in an independent bed on waterproof linings, with effective dimensions:

- Length x width: 1 250 x 600.
- Thicknesses:
  - JACKODUR KF 300 Standard SF: ranging from 50 to 320 mm (in increments of 10 mm).

    Boards manufactured at the German factory have thicknesses ranging from 50 to 320 mm.

    Boards manufactured at the Belgian factory have thicknesses ranging from 50 to 160 mm.
  - JACKODUR Plus 300 Standard SF: 50, 60, 70, 80, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190 and 200 mm.

    JACKODUR Plus 300 Standard SF boards are manufactured at the German manufacturing facility.

The method protects the covering from climatic effects and from punctures. It does not require a specific vapor barrier. It can be used for new construction or in the renovation of existing roofs:

- In lowland climates, on load-bearing elements in:
  - masonry according to NF P 10-203 (ref. DTU 20.12) and NF P 84-204 (ref. DTU 43.1) or according to a Technical Appraisal, of minimum slope zero (0 %) to 5 % and being intended for the following roof applications:
    - inaccessible roofs, including passageways, except temporary rainwater retention,
    - technical roofs or roofs with technical zones, including platform tracks. The maximum permissible pressure is 60 kPa,
    - roofs accessible to pedestrian traffic and to residence with protective ballast, including roofs protected directly by floating pavers on pedestals. The maximum permissible pressure is:
      - 60 kPa with protective ballast,
      - 40 kPa with floating pavers on pedestals,
    - garden roofs. The maximum permissible pressure is 60 kPa,
    - planted terraces and roofs,
  - CLT boards which are the object of a Technical Appraisal favourable to their use in inverted roof applications. The minimum slope and intended use (inaccessible roofs without temporary rainwater retention, technical roofs without platform tracks, accessible roofs protected by floating pavers on pedestals, planted roofs) shall comply with the Technical Appraisal of the load-bearing element,
  - reinforced cellular concrete pavers which are the object of a Technical Appraisal favourable to that application. The slope shall be ≥ 1 %. The intended application area complies with that indicated in the Technical Appraisal of the paver.
- In mountain climates, terraced roof applications as permitted for lowland climates excepting protection by floating pavers on pedestals and by planting, on load-bearing masonry elements according to NF DTU 43.11 or to a Technical Appraisal, with a minimum slope of 1 %. The maximum permissible pressure is 60 kPa.
  In mountain climates, the JACKODUR WA solution is mandatory.

Except in the case of protection by floating pavers on pedestals for which it is optional, the method should be associated with a separation layer installed between the insulation and the protection:

- Either non-woven material,
- or JACKODUR WA non-woven material,
- or a drainage system or drainage layer that is the object of a Technical Appraisal favourable to inverted roof applications.

1.2 Placement on the market

In application of (EU) Regulation no. 305/2011, the products JACKODUR KF 300 Standard SF and JACKODUR Plus 300 Standard SF are subject to a Declaration of Performance (DoP) issued by Jackon Insulation GmbH according to the NF EN 13164 standard.

Products that comply with that DoP bear the CE mark.

1.3 Identification

The labelling of the packages includes the commercial name, batch reference, dimensions, number of boards, ACERMI mark (if applicable) and the CE mark.

Each board is printed with the commercial designation and a manufacturing code.

The colour of the boards is purple; the boards are assembled at the factory by gluing in a multi-layer configuration for thicknesses ≥ 80 mm.

2. APPRAISAL

2.1 Application area

Identical to the application area proposed by the Technical File.

2.2 Evaluation of the method

2.21 Suitable for use

Fire safety

In the laws and regulations currently in force, the provisions applicable to the proposed roofs touch upon the reaction to fire from the exterior and interior sources.

Regarding fire from exterior sources

Reaction to fire in roofs constructed with heavy protection in compliance with those of the Order of 14 February 2003 satisfies the requirements relative to exterior fire (article 5 of the Order of 14 February 2003); the method with other protective ballast is not classified.

Regarding fire from interior sources

The applicable regulatory provisions depend on the destination of the facilities and on the nature and classification of the reaction to fire of the insulation and of its support.

Earthquake safety

According to seismic regulations as defined by:

- Decree no. 2010-1254 relative to the prevention of seismic risk;
- Decree no. 2010-1255 concerning the delimitation of the French seismicity zones;
- Order of 22 October 2010 (amended) relative to classification and earthquake-resistant construction rules applicable to buildings of the class known as "at normal risk".

The method can be implemented respecting the requirements of the Technical File on buildings of the category of importance I, II, III and IV, situated in seismicity zone 1 (very low), 2 (low), 3 (moderate) and 4 (average), on soils of class A, B, C, D and E.

Prevention of accidents during installation or maintenance

The method has a Safety Data Sheet (SDS). The purpose of the SDS is to inform persons using this method about the dangers associated with its use and about the preventive measures to follow in order to avoid those dangers, especially by wearing Personal Protective Equipment (PPE). The SDS is available from Jackon Insulation GmbH.

Environment and health data

There is an EPD relative to JACKODUR KF 300 Standard SF boards.

JACKODUR Plus 300 Standard SF boards do not have any Environmental Product Declaration (EPD) and therefore cannot claim any specific environmental performance. Note that EPDs are not considered when determining the suitability for use of the product.

Note that environmental declarations are not considered when determining the suitability for use of the method.

Thermal insulation

Calculation of the thermal performance makes it possible to verify that the method complies with regulations relative to new construction, provided that the insulation board is thick enough. Verification must be conducted according to Thermal Ordinance 2005 by using the calculation method accepted by the CTAT (*Comité Thermique de l'Avis Technique* [Technical Appraisal Thermal Committee]) on 17 September 2003, supplemented on 12 October 2004, the general procedure of which is indicated in *chapter 9* of the Technical File.

The Order of 26 October 2010 (Thermal Ordinance 2012) does not impose minimum requirements on the thermal transmittance of linings/walls. The thermal transmittance of linings/walls is used as an input parameter in the calculation of the bioclimatic (Bbio) demand and of the overall [energy] consumption of the building, which are subject to the regulatory requirements imposed by the Order. Verification with regard to the Thermal Ordinance is carried out on a case-by-case basis using the rules of regulatory calculations (Th-BCE and Th-bât).

Paragraph 8 and Annex A indicate the method for calculating the overall [heat] transfer coefficient of the roof (Up). The thermal resistances of the insulation board [were] certified by ACERMI for 2014. Notwithstanding this, the user must verify that the ACERMI certificate is still valid; failing that, the Th-U rules must be applied to determine the effective thermal resistance of the insulation.

For new construction subject to Thermal Ordinance 2005, linings that incorporate the insulation waterproofing aid JACKODUR KF 300 Standard SF and JACKODUR Plus 300 Standard SF must satisfy the requirements of table VIII of section 1/5 "Coefficient $U_{bât}$" of the Th-U rules, which defines the maximum permissible area coefficient (Up) for the roof lining.

Roof accessibility

Refer to § *1.1*.

Use in mountain climates

This method can be used under the conditions specified in NF DTU 43.11 (Avril 2014) on load-bearing masonry elements.

The JACKODUR WA solution is mandatory.

Use in outlying regions

Not claims are made relative to the use of this insulation method in French territories outside Europe (*Départements et Régions d'Outre-Mer*).

2.22 Durability – maintenance

The durability of the JACKODUR terrace roof method is acceptable in the proposed application area.

Maintenance

cf. *the standards NF P 84 204 and NF P 84-208 (ref. DTU 43.1 - DTU 43.5)*, and
chapter 1 of the Technical File.

2.23 Production

Carried out in the factory, it includes the necessary self-monitoring.

2.24 Installation

The installation is carried out by qualified roofing/waterproofing companies. Subject to that condition, it presents no particular problem.

Jackon Insulation GmbH provides technical assistance on request.

2.3 Technical Specifications

2.31 Case of complete renovation

- Prior to installation, the project owner or his representative must have the stability of the construction verified under the provisions of standard NF P 84-208 (ref. DTU 43.5) relative to the risks of water accumulation;
- Note that existing construction (cf. *Paragraph 5* of the Technical File) is subject to the provisions of the Order of 3 May 2007.

2.32 Condition of installation

Case of application on existing roofs, the waterproof covering having been replaced (i.e. on a new covering): the provisions relative to the renovation of waterproof coverings must be met according to the standard NF P 84-208 (ref. DTU 43.5).

2.33 Maintenance

Note that this system requires the following of the project owner:

- An inspection – annually and whenever necessary – of the movable protective ballast;
- Supplementary overflows/scuppers and a more frequent inspection of the correct function of rainwater drain inlets.

Conclusions

Overall appraisal

The use of the method in the accepted application area (cf. paragraph 2.1) and amended by the Technical Specifications is granted a favourable appraisal.

Expiration date

31 May 2020

For Specialised Group no. 5.2
President

3. Additional notes from the Specialised Group

a) New claims incorporated in this revision include:

- The extension of the thickness range to 320 mm for the boards of the JACKODUR KF 300 Standard SF product range.
- New boards under the commercial name JACKODUR Plus 300 Standard SF.
- JACKODUR WA non-woven fleece having been the subject of a CTAT decision.
- Addition of load-bearing elements made of CLT boards subject to Technical Appraisal intended for terrace roof applications with inverted insulation.
- Addition of mountain climate on load-bearing masonry element for the intended applications.

b) We hereby advise users of the inverted insulation installation methods that the declared and certified ACERMI thermal conductivity values cannot be used alone, but rather must be adjusted using correction factors according to § 8 of the Technical File and to annexes A and B, in order to obtain the values of $\lambda_{effective}$.

c) Except in the case of protection by floating pavers on pedestals for which it is optional, the method should always be associated with a separation layer installed between the insulation and the protection:

d) Use of the method under floating pavers on pedestals is limited to thicknesses from 50 to 120 mm for JACKODUR KF 300 Standard SF boards and from 50 to 180 mm for JACKODUR PLUS 300 Standard SF boards. The permissible pressure under each pedestal is 40 kPa.

e) The Technical Appraisal or the Technical Application Document of the drainage system or of the drainage layer mentioned in the Technical File can impose a minimum slope of 2 %. This requirement must be taken into account in the contract-specific documents (DPMs).

Reporter of Specialised Group no. 5.2

Technical File
compiled by the applicant

A. Description

1. Principle

1.1 Application area

Method of inverted roof thermal insulation using two types of extruded polystyrene (XPS) boards – JACKODUR KF 300 Standard SF and JACKODUR Plus 300 Standard SF – with different thermal properties, laid in an independent bed on waterproof linings, with effective dimensions:

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- Thicknesses:
  - JACKODUR KF 300 Standard SF: ranging from 50 to 320 mm (in increments of 10 mm).

    Boards manufactured at the German factory have thicknesses ranging from 50 to 320 mm.

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The method protects the covering from climatic effects and from punctures. It does not require a specific vapor barrier. It can be used for new construction or in the renovation of existing roofs:

- In lowland climates, on load-bearing elements in:
  - masonry according to NF P 10-203 (ref. DTU 20.12) and NF P 84-204 (ref. DTU 43.1) or according to a Technical Appraisal, of minimum slope zero (0 %) to 5 % and being intended for the following roof applications:
    - inaccessible roofs, including passageways, except temporary rainwater retention,
    - technical roofs or roofs with technical zones, including platform tracks. The maximum permissible pressure is 60 kPa,
    - roofs accessible to pedestrian traffic and to residence with protective ballast, including roofs protected directly by floating pavers on pedestals. The maximum permissible pressure is:
      - 60 kPa with protective ballast,
      - 40 kPa protected by floating pavers on pedestals (JACKODUR KF 300 Standard SF boards in thicknesses ranging from 50 to 120 mm and JACKODUR Plus 300 Standard SF boards
        in thicknesses ranging from 50 to 180 mm),
    - garden roofs. The maximum permissible pressure is 60 kPa,
    - planted terraces and roofs,
  - CLT board which is the object of a Technical Appraisal favourable to its use in inverted roof applications. The minimum slope and intended use (inaccessible roofs without temporary rainwater retention, technical roofs without platform tracks, accessible roofs protected by floating pavers on pedestals, planted roofs) shall comply with the Technical Appraisal of the load-bearing element,
  - reinforced cellular concrete pavers which are the object of a Technical Appraisal favourable to use in inverted terrace roofs for inaccessible, technical and planted applications. The slope shall be ≥ 1 %. The intended application area complies with that indicated in the Technical Appraisal of the paver.
- In mountain climates, terraced roof applications as permitted for lowland climates excepting protection by floating pavers on pedestals and by planting, on load-bearing masonry elements according to NF DTU 43.11 or to a Technical Appraisal, with a minimum slope of 1 %. The maximum permissible [compressive] strength is 60 kPa.
  In mountain climates, the JACKODUR WA solution is mandatory.

Except in the case of protection by floating pavers on pedestals for which it is optional, the method should be associated with a separation layer installed between the insulation and the protection:

- Either non-woven material,
- or JACKODUR WA non-woven material,
- or a drainage system or drainage layer that is the object of a Technical Appraisal favourable to inverted roof applications.

1.2 JACKODUR WA solution

The JACKODUR WA solution differs from classic insulation through the placement of JACKODUR WA specific filter layer between the JACKODUR
insulation layer and the protective ballast.

Placement of JACKODUR WA non-woven filter layer between the insulation and the ballast specifically enables the roof to achieve increased thermal performance.

In mountain climates, the JACKODUR WA solution is mandatory.

1.3 Chemical compatibility

Certain chemical products can degrade extruded polystyrene boards by dissolution. The main products to avoid are ones containing aldehydes, aromatic amines, esters, polyglycol esters, hydrocarbons, ketones, essential oils and solvents in general.

A list indicating the compatibility of JACKODUR boards with common chemical products is available from the manufacturer.

1.4 Roof maintenance

The maintenance complies with the requirements of the standard NF P 84-204 (DTU 43.1).

Herbicides must be compatible with the boards and with the covering. They must not contain any of the chemical substances that the compatibility list recommends to avoid. The commercial list of herbicides is available from the manufacturer.

The rainwater drainage systems must be inspected during maintenance visits and cleaned if necessary. It is also necessary to restore order to the protection system. If the latter must be moved, put it back in place rapidly.

In the specific case of protection by means of floating pavers on pedestals, care must be taken to ensure that the gaps between the pavers stay clean and that any trash that accumulates under the pavers is removed. In that case, we recommend removing it with a high pressure power washer.

1.5 Technical support

JACKON Insulation GmbH provides technical support on request.

2. Intended use

See *tables 1, 1b, 1c, 1d* at the end of the Technical File and *§ 1.1*.

3. Underlying provisions

3.1 Load-bearing elements

- Load-bearing masonry elements must comply with the requirements of NF P 10-203-1 (reference DTU 20.12 P1); a slope of 0 % is permissible, in lowland climates, for inaccessible terrace roofs, for technical terraces or ones in technical zones, for terraces accessible to pedestrians and to residence where protected by floating pavers on pedestals, for terrace garden roofs and for planted terraces and roofs.

  The Technical Application Document of certain drainage systems can indicate a minimum slope of 2 %;
- The slope of load-bearing elements comprising CLT boards is specified in their Technical Appraisal;
- The slope of load-bearing elements comprising reinforced cellular concrete pavers is specified in their Technical Appraisal.

3.2 Waterproof coverings

Traditional asphalt waterproof coverings shall comply with the standard NF P 84-204-1-2 (reference DTU 43.1 P1-2).

Non-traditional asphalt waterproof coverings, and mixed ones under asphalt, shall comply with the requirements of their Technical Appraisal.

Waterproof coverings comprising bitumen sheets, synthetic membranes or liquid waterproofing systems (LWS) shall comply with the requirements of their Technical Application Document which specifies the conditions for use under inverted insulation.

4. Installation of inverted insulation – new construction

4.1 Installation of JACKODUR boards

cf. *figures 1 and 1b.*

The boards are laid in a single layer, independently on the covering, in a quinqunx and with fitted joints. The shiplap edges overlap by a half-thickness.

The independence is achieved by rolling out a dissociation layer over the dry surface with 10-cm overlaps (cf. *§ 7.22*). The use of that layer is not required on a covering:

- consisting of poured asphalt;
- a mixed covering under poured asphalt;
- a self-protected covering of flakes or aggregate.

In all other cases, refer to the Technical Application Document of the waterproof covering.

4.2 JACKODUR WA solution – installation of the specific filter layer

cf*. figure 2.*

4.21 General case

The JACKODUR WA specific filter layer is laid loosely on the insulation boards.

The continuity between successive widths of non-woven material is achieved by overlapping (by at least 15 cm) and the non-woven material must also extend the length of flashings and protrusions. The rise at the edge of flashings (parapet walls, skylights, etc.) must be of a height equal to 2 cm more than the thickness of the protective ballast (except with floating pavers on pedestals).

In the case of protective ballast provided by floating pavers on pedestals, the additional 2 cm must be measured starting from the top of the insulation boards.

The rise along the periphery of the roof consists of simply folding the rolled out fabric.

The rise at individual discontinuities (skylights, chimneys, etc.) is formed preferably after the full widths of non-woven material are laid on the uninterrupted areas of the roof, for example by trimming strips of non-woven material to wrap around the individual discontinuities, most often by folding strips of non-woven material around the discontinuity and (according to the dimensions of the pieces applied) by then gluing them onto the non-woven material of the open (flat) area of the roof.

The widths of non-woven material are overlapped in the direction of the water flow. In the case of zero slope (0 %), the overlap is oriented toward the nearest rainwater drain inlet.

Depending on the configuration of the terrace (raised shape in a specific area, e.g.: skylights, chimneys, etc.), the required continuity of the non-woven material may necessitate trimming, overlaying or combining pieces of non-woven material. If the piece of non-woven material is less than 1 m in any dimension, then it must be glued by means of a flexible adhesive putty, a strip of double-sided adhesive tape or a strip of single-sided adhesive tape.

4.22 Repair of the JACKODUR WA specific filter layer

If the non-woven material is damaged or punctured, it must be repaired using a large patch created from a piece of non-woven material. If the patch has an area of less than 1 m², the procedure to follow is described in *§ 4.21*.

4.23 Thermal calculation

When the WA non-woven material is installed, the thermal calculation is made according to *annex B*; otherwise *annex A* is used.

4.3 Installation of the drainage system or drainage layer

The drainage system or drainage layer must have a Technical Application Document favourable to its use in inverted insulation according to the accessibility of the roof. The installation shall be carried out in compliance with its Technical Application Document. It shall be placed between the insulation board layer (with or without JACKODUR WA) and the protective ballast.

4.4 Protective ballast

A protective ballast is mandatory, irrespective of the system used to apply the covering. It is installed progressively with the installation of the boards.

4.24 Movable protection

cf. *table 1, figures 3.*

Protection by means of a gravel layer according to *§ 7.26*, with placement of an intermediate separation layer (non-woven, JACKODUR WA specific filter layer, drainage layer installed according to *§ 4.3*).

Movable protection is used for inaccessible terrace roofs and in the zones of technical terraces not open to circulation, or in technical zones.

Protection by means of an aggregate layer specified in *§ 7.2711*, with placement of an intermediate separation layer (non-woven, JACKODUR WA specific filter layer or drainage layer) installed according to *§ 4.21*.

The thickness of the protection depends on the thickness of the insulation:

- Insulation thickness 50 to 80 mm: aggregate 60 mm;
- Insulation thickness 90 to 100 mm: aggregate 80 mm;
- Insulation thickness 110 to 180 mm: aggregate 100 mm;
- Insulation thickness 190 to 220 mm: aggregate 140 mm;
- Insulation thickness 230 to 250 mm: aggregate 160 mm;
- Insulation thickness 260 to 290 mm: aggregate 180 mm;
- Insulation thickness 300 to 320 mm: aggregate 200 mm.

At least one supplementary overflow per area collected shall be installed in addition to the standard rainwater drainage inlets; the cross-section of the overflow/scupper must be at least 28 cm² (cf. *standard NF P 84-204 - DTU 43.1*). The overflows/scuppers are flush with the surface of the insulation if sloped and raised if the slope is zero; the overflows are equipped with a gravel retention grille. Their purpose is to signal a failure of the rainwater drainage system, which must then be inspected.

A specific maintenance routine must be planned for these terrace roofs (verification of the aggregate layer, inspection of the rainwater drainage system, etc.) That maintenance, which is the responsibility of the project owner, must be carried out at least once per year and whenever necessary (for example: after strong winds and/or heavy precipitation).

Specific case:

In the case of the following building heights and from the wind zones of the amended NV 65 snow and wind regulations:

- Greater than 28 m in zone 1 - all sites or zone 2 - standard site;
- Greater than 20 m in zone 2 - exposed site or zone 3 - standard site;
- Any [height] in zone 3 - exposed site or zone 4 - all sites, and with depression due to wind ≤ 4 712 Pa.

The selected grain size of the gravel shall be as large as possible and the protection is supplemented by a 2-m width of dry-laid concrete pavers along the perimeter of the terrace roof and structures in compliance with *§ 4.421*:

- Either directly on the aggregate;
- or on a non-woven separation layer;
- or on the drainage system laid according to its Technical Application Document.

4.25 Passageways, technical terraces or technical zone terraces, platform tracks and passageways

4.421 Passageways

Passageways are made with dry-laid pavers of the thickness listed in table 2a:

- Either directly on the aggregate;
- or on a non-woven separation layer;
- or on the drainage system laid according to its Technical Application Document.

4.422 Technical terraces or technical zone terraces (without platform tracks)

Technical terraces or technical zone terraces are made with dry-laid pavers of the thickness listed in table 2a:

- Either directly on the aggregate;
- or on a non-woven separation layer;
- or on the drainage system laid according to its Technical Application Document.

4.423 Platform tracks on technical terraces or technical zone terraces

Reinforced concrete slab cast on:

- Either a separation layer according to the standard NF P 84-204 (reference DTU 43.1);
- or a JACKODUR WA filter layer + 100 μm synthetic film;
- or drainage system installed according to its Technical Application Document.

Those reinforced concrete works shall be dimensioned in compliance with NF P 84-204 (DTU 43.1) and according to annex D and the standard NF P 10-203-1-1 (reference DTU 20.12 P1-1) starting from the values of "Rcs_{min}" and "ds_{min} - ds_{max}" specified in *table* 3 at the end of the Technical File. The values of "Rcs_{min}" and "ds_{min} - ds_{max}" are

specified in compliance with the *e-Cahier of the CSTB* 3230_V2 of November 2007.

The partitioning of the slab and the water channels must comply with *§ 6.6.4.2.2* of NF P 84-204 (DTU 43.1).

4.43 Hard protection for pedestrians and residence

cf. *tables 1b and 1c.*

4.431 Dry-laid prefabricated pavers

According to the standard NF P 84-204-1-1 (reference DTU 43.1 P1-1), contiguous pavers must be laid dry, with tight joints, on a bed of 3/8 aggregate at least 3 cm thick, with an intermediate non-woven separation layer previously placed on top of the insulation boards.

In the case of the JACKODUR WA specific filter layer solution described in § 4.2 above, the JACKODUR WA non-woven specific filter layer is placed directly on top of the insulation boards, replacing the non-woven separation layer.

The maximum working pressure of the JACKODUR boards is 60 kPa.

A drainage system can be installed between the insulation boards and the pavers laid on aggregate layer. The drainage system is installed in compliance with its Technical Application Document; the Technical Application Document of the drainage system specifies a slope of at least 2 %. It is compatible with the installation of the JACKODUR WA solution.

The thickness of the prefabricated pavers to be installed depends on the thickness of the insulation and is listed in table 2a at the end of the Technical File.

4.432 Floating pavers on pedestals

cf. *figure 4.*

The pedestals are placed directly on the JACKODUR boards, or on the non-woven specific filter layer in the JACKODUR WA solution.

The thickness of the concrete pavers is listed in table 2b.

The maximum working pressure is 40 kPa under each pedestal.

The specifications concerning the pedestals meet the requirements of the standard NF P 84-204-1 (reference DTU 43.1 P1) or of the Technical Application Document of the waterproof covering, specifically:

- For the height of at least 10 cm of the waterproof flashing (cf. *standard NF P 10-203-1-1 - reference DTU 20.12 p1-1*);

and

- The protection of the waterproof flashings, if the waterproof flashing extends above the prefabricated pavers.

The use of this hard protection is possible only for a maximum insulation thickness of up to 120 mm for the JACKODUR KF 300 Standard board and 180 mm for the JACKODUR PLUS 300 Standard SF board.

4.433 Sealed or glued tiles

A drainage system is installed between the insulation boards and the hard protection.

Solution A:

Solution A applies only for private-use terraces with an area of 100 m² or less.

A partitioned slab made of reinforced mortar or a cast-in-situ reinforced concrete slab is installed on the separation layer according to the standard NF P 84-204 (reference DTU 43.1), with the placement of a non-woven layer between the installation boards and the separation/drainage layer in aggregate.

A frost-proof ceramic floor covering is added to it:

- sealed with adhesive according to the standard NF P 61-202-1 (ref. DTU 52.1);
- Glued according to the standard NF DTU 52.2 P1-1-3.

In the case of the JACKODUR WA solution described in *§ 4.21* above, the JACKODUR WA non-woven material is placed directly on top of the insulation boards, underneath the gravel comprising the drainage layer.

Solution B:

This solution comprises a drainage system with a Technical Appraisal that is favourable for this application. The solution is placed between the insulation boards and the hard protection.

Solution B is applicable for all terrace roofs with a slope of at least 2 %.

The hard protection is installed on the drainage system in compliance with its Technical Application Document and comprises:

- A partitioned mortar slab, or a reinforced concrete slab, cast-in-situ and installed on that drainage layer. The installation shall comply with the standard NF P 84-204 (reference DTU 43.1);
- The frost-proof ceramic floor covering is installed according to DTU 52.1 and 52.2.

4.434 Concrete pavers

The pavers are laid on the sand bed, with a non-woven layer installed between the insulation boards and the sand; the non-woven material supplements the installation specified by *§ 6.6.3.3.5* of the standard NF P 84 204-1-1 (reference DTU 43.1 P1-1).

In the case of the JACKODUR WA solution described in § 4.21 above, the JACKODUR WA non-woven material is placed directly on top of the insulation boards.

4.435 Cast-in-situ concrete slab

The application of this type of works is limited to pedestrian access.

The protection can be implemented by a partitioned layer of cast-in-situ concrete. It should have a separation layer:

- In compliance with the standard NF P 84-204-1

(DTU 43.1); or

- Comprising a drainage layer with a Technical Application Document favourable to its use with inverted insulation intended for roof applications. The installation shall be carried out in compliance with its Technical Application Document.

4.4351 General case of DTU 43.1: surface < 500 m² or effective [thermal] resistance of the insulation < 2 m².K/W

The specifications for the cast-in-situ concrete slab are as follows:

- Thickness: at least 6 cm;
- Concrete: 350 kg of cement per m³ of concrete;
- Reinforcement (minimum): 150 x 150 welded mesh, diameter 4 or of equivalent cross-section;
- Partitioning by joints of at least 2 cm width placed at 4-to-5-m intervals in both directions in the central area and along the edge of raised surfaces and protrusions;
- The joints apply to the full thickness of the slab, reinforcement being interrupted at the joints;
- The joints are treated with a rot-proof product or system and designed to withstand cyclical deformation;
- The tolerances and materials shall comply with the standard NF P 84 204-1 (DTU 43.1).

4.4352 Specific case of a terrace of more than 500 m² and an insulation board with effective thermal resistance ≥ 2 (m².K)/W

In this case, the protective slab shall be sized according to the standard NF P 11-213-2 (DTU 13.3 - part 2) taking into account the values Rcs_{min} of working resistance and "ds_{min} ds_{max}" listed in *table 3*.

The slab is partitioned by joints with a minimum width of 0.02 m:

- In the uninterrupted area at 10-m intervals in both directions;
- At the edges of raised surfaces and protrusions.

The joints apply to the full thickness of the slab. The reinforcement is interrupted at the joints. For pedestrian-accessible terraces, contract-specific documents (DPMs) can specify combined joints be as specified in NF DTU 43.11.

4.44 Protection of flashings

cf. *figures 5a and 5b.*

The protection of waterproof flashings shall comply with the requirements of standards NF P 10-203-1 and NF P 84-204-1 (reference DTU 20.12 P1
- DTU 43.1 P1) or of the Technical Application Document of the waterproof flashing. The can be thermally insulated according to the requirements of the *e-Cahier of CSTB* 3741 of January 2014.

The flashings of inaccessible or technical terrace roofs can be protected (and thermally insulated) by a bed of JACKODUR KF 300 Standard SF or JACKODUR Plus 300 Standard SF boards and a flat 6-mm-thick fibre-cement sheet according to the standard NF EN 12467 of category A.

The sheets must be glued to the insulation boards by dots of single-component polyurethane glue without solvent (cf. *§ 7.25*), leaving 5-mm joints between adjacent sheets.

The assembled components are held together at the head by a clamp and at the foot by the protective ballast. The support must be designed in such a way that a slope of 2 % is formed from the apron flashing towards the roof.

The insulation boards of concealed flashings (below the level of floating pavers on pedestals) do not require protection.

4.5 Roof details

4.51 Raised surfaces, expansion joints, penetrations

cf. *figures 6, 7 and 8.*

Details, raised surfaces, expansion joints and penetrations must meet the requirements of the standards NF P 10-203-1 and NF P 84-204-1 (reference DTU 20.12 P1 - DTU 43.1 P1), specifically with regard to the requirements concerning the height above the insulation boards in the case of protection by floating pavers on pedestals and with regard to [the height] above heavy protection in the other cases.

4.52 Rainwater drainage

cf. *figures 9 and 10.*

The water is drained at two levels:

- At the level of the waterproof covering,

and

- At the level of the surface of the insulation boards.

Rainwater drainage at the level of the waterproof covering shall comply with the standard NF P 84-204-1 (reference DTU 43.1 P1).

Rainwater drainage at the level of the surface of the inverted insulation occurs via the same rainwater inlet through a gravel retention grille installed on the insulation board. The width of the [adapter/flange] plate of that gravel retention grille is inserted far enough into the drain hopper, e.g. by means of three centring legs.

Depending on the project, overflow/scuppers are required (cf. *§ 4.41*).

5. Inverted insulation installation: Case of renovation projects

5.1 Preconditions

The new waterproof covering shall be installed according to the standard NF P 84-208-1 (reference DTU 43.5 P1) or according to the requirements of its Technical Appraisal favourable to its use in roof renovation applications.

In the case of the JACKODUR WA solution described in *§ 4.2* above, the specific filter layer is installed on top of the insulation boards.

5.2 Installation of the insulation

On the covering renovated accordingly, the insulation is installed according to the specifications of *§* 4.

5.3 Installation of the protection

The following specific method must be used when installing the protective ballast:

a) Inspect the existing heavy protection: grain size, cleanliness, thickness, exposed areas;

b) Verify that the structure can support the load imparted by the heavy protection to be installed, as well as the stockpiling of the existing movable protection.

c) Collect the aggregate in moderately sized piles;

d) Proceed to install the new waterproof covering and install the insulation boards;

e) Put the heavy protection back in place while taking the following precautions:

- If additional aggregate must be added, the recovered aggregate (intended grain size ≥ 10) shall be spread on the central area of the terrace with additional 10/18 or 15/30 aggregate till the required thickness is achieved; add aggregate at the required thickness along the perimeter to a width of at least 2 m;
- If the aggregate (recovered or additional) is of grain size < 15 or includes high fines content, install an intermediate non-woven separation layer.

5.4 Roof details

The specific points shall comply with the requirements of the standards NF P 84-204-1 (reference DTU 43.1 P1) and NF P 84-208-1 (reference DTU 43.5 P1).

5.41 Raised surfaces

Elevate the raised surfaces till they exceed the height of the protection, or above the insulation boards in the case of protection by floating pavers on pedestals, according to the standards NF P 10-203-1, NF P 84-204-1 and NF P 84-208-1 (references DTU 20.12 P1, DTU 43.1 P1 and DTU 43.5 P1).

In the case of a recess forming an existing dripstone, fill the space under the recess with a meshed mortar or compatible insulation (fixed) to create the new support for the flashing.

In the case of a gutter lead, raise the waterproof flashing by the required height and rebuild the run-off water system at a higher level.

The waterproof covering can also be extended over the parapet wall to the outer edge, where possible, while maintaining a minimum height of 50 mm between the top of the movable protection and the upper part of the parapet wall as shown in *figure 19* of the standard NF P 10-203-1-2 (reference DTU 20.12 P1-1).

The flashings of inaccessible terrace roofs and technical terraces or technical zone terraces can be thermally insulated as described in *§ 4.44* above.

5.42 Expansion joints on double upstand

If the height of the upstands becomes less than 10 to 15 cm above the protective ballast, in the case of zero slope - of garden terrace roofs - of planted terraces and roofs, chamfer the inner edges of the upstands to create a raised flat joint.

5.43 Rainwater drainage

cf. *§ 4.52.*

6. Specific applications

6.1 Garden terrace roofs

cf. *table 1d*.

6.11 Waterproof covering

Permissible waterproof coverings comply with:

- Either the standard NF P 84-204-1-1 (reference DTU 43.1 P1-1) for traditional garden-type asphalt;
- or a Technical Appraisal in the case of non-traditional or mixed asphalt under asphalt favourable to use in garden terrace roof applications;
- or a Technical Application Document based on bitumen sheets, or with a synthetic membrane, specific to garden terrace roofs.

6.12 Installation of the insulation boards

It is carried out according to *§ 4.1 et 4.2*.

6.13 Drainage layer and filter layer

They are laid according to *§ 9.3.2* of the standard NF P 84-204-1-1 (reference DTU 43.1 P1-1), the drainage layer being installed directly on the insulation boards.

A drainage system (drainage layer and filter layer according to *§ 8.251*) can be installed between the insulation boards and the planted soil; the drainage system shall be installed in compliance with its Technical Application Document.

In the case of the JACKODUR WA solution described in *§ 4.2* above, the JACKODUR WA non-woven material is placed directly on top of the insulation boards, underneath the drainage layer.

6.14 Protection by planted soil on garden terrace roofs

The material is supplied progressively using small heavy equipment rolling on load distribution planks; the drainage layer and the soil are spread manually; this safeguards the extruded polystyrene insulation boards from puncturing and deterioration.

6.15 Specific elements: raised surfaces, expansion joints, rainwater drains

The roof details are implemented in compliance with the requirements of standard NF P 84-204-1-1 (reference DTU 43.1 P1-1), § 9.3 et annex B "Arrangement of garden terrace roofs", and of specific Technical Application Documents.

6.2 Planted terraces and roofs

cf. *table 1d.*

The JACKODUR terrace roof method can be used up to the extreme wind depression or height limit of the building as listed in the Technical Appraisal of the planting method favourable for use in inverted roof applications with a maximum depression of no more than 4,712 Pa according to the amended NV 65 snow and wind regulations.

Weight of Maximum Water Capacity (*Capacité Maximale en Eau*, or C.M.E.) of the components of the JACKODUR terrace roof method and of the JACKODUR WA non-woven material: cf. *table 5* at the end of the Technical File.

6.21 Waterproof covering

Permissible waterproof coverings comply with:

- Either the standard NF P 84-204-1-1 (reference DTU 43.1 P1-1) for traditional garden-type asphalt;
- or a Technical Appraisal in the case of non-traditional or mixed asphalt under asphalt favourable to use in planted terraces and roofs;
- or a Technical Application Document based on bitumen sheets, or with a synthetic membrane, or with a liquid waterproofing solution, specific to planted terraces and roofs.

6.22 Installation of the insulation boards

It is carried out according to *§ 4.1 et 4.2*, and according to the Technical Appraisal of the planting method favourable to use in inverted roof applications.

6.23 Drainage layer and filter layer

They are as specified in the Technical Appraisal of the planting method favourable to use in inverted roof applications.

According to the Technical Appraisal of the planting method, the drainage layer can comprise, in whole or in part, the movable protection specified in *§ 4.41*.

6.24 Protective ballast on top of inverted insulation of planted terraces and roofs

The movable protection helps to hold the insulation boards in place against forces generated by extreme wind depression in terms of the amended NV 65 snow and wind regulations and against the pressure of water, independently of the planting method situated above the movable protection.

That movable protection is specified in *§ 4.41*.

As required by the Technical Appraisal of the planting method, a non-woven separation layer covers the movable protection.

6.25 Planting of green terraces and roofs

It is carried out according to the Technical Appraisal of the planting method favourable to use in inverted roof applications.

6.26 Specific elements: raised surfaces, sterile zones, rainwater drains

The roof details are carried out in compliance with the Technical Appraisal of the planting method favourable to use in inverted roof applications.

6.3 Terrace roofs in mountain climates

cf. *tables 1, 1b, 1c and 1d*.

This method can be used under the conditions specified in NF DTU 43.11 (Avril 2014) on load-bearing masonry elements:

- inaccessible [roofs], including passageways, except temporary rainwater retention, of minimum slope 1 % to 5 %;
- technical [roofs] or [roofs] with technical zones, including platform tracks, of minimum slope 1 % to 5 %;
- [roofs] accessible to pedestrian traffic and to residence with protective ballast (slope 1 % to 5 %): prefabricated pavers on a gravel bed; cast-in-situ and partitioned slabs;
- Gardens, of minimum slope 1 % to 5 %.

The permissible waterproof coverings shall comply either with the standard NF P 84-204 (DTU 43.1) including protection for asphalt, or with that standard Technical Application Document, or with a Technical Appraisal specific to garden terrace applications.

The JACKODUR WA solution is mandatory.

7. Materials

7.1 JACKODUR insulation boards

7.11 Definition of the materials

a) JACKODUR KF 300 Standard SF: rigid polystyrene extruded with CO2 gas, produced by extrusion and characterised by a skin with a densified surface. The innovative multi-layer technology makes it possible to produce very thick JACKODUR KF 300 Standard SF boards;

b) JACKODUR Plus 300 Standard SF: rigid polystyrene extruded with HFO gas, produced by extrusion and characterised by a skin with a densified surface. The innovative multi-layer technology makes it possible to produce very thick JACKODUR Plus 300 Standard SF boards;

7.12 Specifications

cf. *table 3.*

7.13 Production and checks

7.131 Production

JACKODUR boards are manufactured by JACKON Insulation GmbH at its factories in Arendsee, Germany, and Olen, Belgium. They are produced in a continuous process that basically comprises the following steps:

- Mixing of polystyrene and additives;
- Fusion and homogenisation of the mixture;
- Extrusion of the compound;
- Assembly of the boards of the thick range using multi-layer technology;
- Trimming, packaging;
- Stabilisation of the products.

7.132 Production control

Quality checks are carried out by the laboratory in the factories by complying at least with the requirements of the standard EN 13164.

a) On raw materials

Quality checks are carried out by the suppliers, who guarantee those checks.

b) During production

The products are subject to frequent checks to guarantee their quality. Specifically, the following checks are performed:

- Verification at two-hour intervals of: length, width, flatness, perpendicularity, thickness and density;
- Following each change of product, setting or team, compressive strength is checked directly as the product comes off the production line.

c) On finished products

The quality checks are the ones imposed by the ACERMI certification and table B.1 of annex B of the standard EN 13164. They are applied for all thicknesses.

The curvature check is carried out twice per year for each product.

The values of R_{CS} and d_S are recorded each time compressive strength is measured.

7.133 Checks carried out by external bodies

The factories in Arendsee and Olen are certified and audited by ACERMI (France). Those two sites are also audited by DQS GmbH (Germany) and certified according to ISO 9001 and ISO 14001.

7.14 Packaging - Identification - Labelling - Storage

7.141 Packaging

This is made by wrapping heat-shrink polyethylene film around 4 and 6 faces of the package at the Arendsee and Olen factories, respectively.

7.142 Identification and labelling

The commercial name of the product is marked on the boards in a continuous process. A code is applied to each board to ensure product traceability.

The labelling complies with CE marking requirements and with the ACERMI certification.

7.143 Storage

The products are stored in the factory, protected from water and weather,
or outside for short periods (depending on the climatic conditions and on the storage method).

7.2 Other materials

7.21 Waterproofing materials

- Traditional waterproofing materials using traditional asphalt shall comply with the standard NF P 84-204 (reference DTU 43.1);
- Waterproofing materials based on non-traditional asphalt, and those mixed with asphalt, subject to Technical Appraisals where favourable to use in inverted insulation applications;
- Waterproof coverings based on bitumen sheets specified by their Technical Application Documents where favourable to use in inverted insulation applications;
- Waterproof coverings based on a synthetic membrane in compliance with their Technical Application Documents where favourable to use in inverted insulation applications;

- Flashing material according to the standard NF P 84-204 (reference DTU 43.1) for traditional asphalt coverings or according to the Technical Application Documents of the waterproof coverings;
- Liquid waterproofing systems (LWS) in compliance with the requirements of their Technical Application Document which specify the conditions of use for inverted insulation applications.

7.22 Dissociation layer under insulation boards

- Synthetic non-woven of at least 170 g/m^2 made of polyester or polypropylene;
- Dissociation layer mentioned in the Technical Application Document of the waterproof covering.

7.23 Dissociation layer on insulation boards

a) Non-woven:

- Fleece permeable to water vapour (Sd ≤ 0.1m) of at least 170 g/m² made of polyester or polypropylene,
- the one mentioned in the Technical Application Document of the waterproof covering for use in inverted insulation applications,
- the one mentioned in the Technical Appraisal of the planting method.

b) Film:

- synthetic film with a thickness of at least 100 µm,
- the one mentioned in the Technical Application Document of the drainage system (cf. *§ 7.262*).

c) For reinforced concrete slabs under platform tracks:

- non-woven (cf. *§ 7.23a*),
- covered by a film (cf. *§ 7.23b*),
- drainage system (cf. *§ 7.262*).

d) Under dry-laid pavers made of concrete or natural stone:

- Either:
  - non-woven (cf. *§ 7.23a*),
  - covered by a flowing aggregate bed of thickness ≥ 3 cm, rolled or crushed, of grain size 3/15.
- Or:
  - a drainage system (cf. *§ 7.262*).

e) Under reinforced mortar slabs and reinforced concrete paving to covered with a floor covering (frost-proof tiles):

- Case of private-use areas < 100 m²:
  - non-woven (cf. *§ 7.23a*),
  - covered either by a bed of flowing aggregate ≥ 3 cm, rolled or crushed, of grain size 3/15 and a layer of non-woven fabric (cf. *§ 7.23a*), or of a film (cf. *§ 7.23b*).
- Case of other terrace roofs:
  - drainage system (cf. § 7.262),
  - possibly covered by a film specified in the Technical Application Document of the drainage system.

f) Under concrete pavers:

- non-woven (cf. § 7.23a),
- covered by a bed of sand with an average thickness of 6 cm and of grain size d ≥ 2 cm and D ≤ 5 cm according to the standard NF EN 13043.

7.24 JACKODUR WA specific filter layer

- Non-woven material permeable to water vapour (Sd = 0.04 m);
- Roll with 3 m width and 100 m length;
- Weight of roll: 30 kg;
- Area density: 100 g/m²;
- Longitudinal tensile strength: 210 N/5cm (EN 29073-3);
- Lateral tensile strength: 145 N/5cm (EN 29073-3);
- Water penetration resistance: >150 cm (EN 20 811);
- Flexibility at low temperature: no tearing at -40 °C (EN 13859-1).

7.25 Polyurethane glue

Single-component assembly glue based on polyurethane without solvent, e.g. JACKODUR glue:

- Working time (23 °C, 50 % relative humidity): 5-10 min;
- Frost-free storage: ≤ 30 °C.

7.26 Drainage layer and filter layer

7.261 Drainage layer for garden terrace roofs

- Drainage layers the meet the requirements of the standard NF P 84-204 (reference DTU 43.1) and of the shared technical specifications (*CPT Commun*) "Waterproofing by means of single-layer synthetic membranes made of bitumen-incompatible PVP-P covered under a Technical Appraisal or a Technical Application Document" (*CSTB leaflet* 3502, Avril 2004) :
  - cast expanded polystyrene slabs mentioned in the Technical Application Document of the waterproof covering.
  - stones and aggregate of grain size 15/40 or 20/40 of thickness ≥ 0.10 m,
  - aerated mineral aggregate (shales, clays, pozzolans, etc.) of grain size 10/30 of thickness ≥ 0.10 m;
- Drainage system specified in the Technical Application Document (cf. *§ 7.262*).

7.262 Other drainage systems

Drainage system having a Technical Application Document for use in inverted roof applications, or mentioned in the Technical Appraisal of the planting method.

7.263 Filter layers

- Synthetic non-woven material of at least 170 g/m2 that complies with the requirements of the standard NF P 84-204-1-1 (reference DTU 43.1 P1-1);
- Filter layer mentioned in the Technical Application Document of the waterproof covering;
- Filter layer mentioned in the Technical Appraisal of the planting method.

7.27 Protections

cf. *table 1.*

7.271 Inaccessible roofs

7.2711 Inaccessible roofs

Aggregate with grain size ranging from 5 mm to 2/3 in protection thickness. The minimum average grain size is 16 mm (for example: 10/22, 12/20, 15/30 to 16/32).

7.2712 Passageways

Prefabricated concrete pavers complying with the requirements of standard NF EN 1339 and of the minimum class (bending fracture) 1-45 (marking S-4), for installation on gravel bed or non-woven material, and of at least 40 mm thickness.

7.272 Roofs accessible to pedestrians and to residence

- Prefabricated pavers in compliance with the requirements of standard NF EN 1339 of the minimum class (bending fracture): 1-45 (marking S-4), for installation on gravel bed;
- Prefabricated pavers in compliance with the requirements of standard NF EN 1339, NF-certified, of the minimum class (bending fracture): 2-70 or 2-110 (markings T-7 and T-11), for installation on pedestals, in lowland climates;
- Pedestals in compliance with the requirements of the standard NF P 84-204 (DTU 43.1) or of the Technical Appraisals of the coverings, in lowland climates;
- Frost-proof hard floor coverings for sealed or glued installation on partitioned slab (cf. *Standard NF P 84-204 - DTU 43.1*). Limited to private use, approximate area < 100 m², in lowland climates.

  In the specific case of heavy protection to be covered with sealed floor coverings according to DTU 52.1, the minimum slope is 1.5 % (2 % for solution B) in compliance with the regulations of standard NF P 84-204 (DTU 43.1);
- Cast-in-situ and partitioned concrete pavers (cf. *§ 4.435);*
- Interlocking or non-interlocking concrete paving stones, NF-certified, for installation on a sand bed (cf. *Standard NF P 84-204 - DTU 43.1*) and its separation layer (cf. *§ 8.23*).

7.273 Garden terrace roofs

- Planting soil for garden terrace roofs in compliance with the specifications of the standard NF P 84-204 (reference DTU 43.1).

7.274 Planted terraces and roofs

- Planting of green terraces and roofs by means specified in the Technical Appraisal of the planting method.

8. Determination of the thermal resistance of the system

8.1 Principle

The heat losses through a roof with inverted insulation are equal to the sum of all losses of a conventional roof of the same construction and the additional losses caused by the run-off and evaporation of the water between the insulation and the covering. The latter are largely compensated over the course of the heating period by an increase in the inverted insulation thickness, reducing the losses during dry periods.

8.2 Determination of JACKODUR board thickness

Refer to *thermal annex A* for the standard solutions [used on uninterrupted areas of roof] and to *thermal annex B* for the JACKODUR WA solution.

It is the responsibility of the user to refer to the ACERMI certificate currently in force (www.acermi.com).

In the absence of a valid certificate, the effective thermal resistances of the JACKODUR boards are calculated taking into account the thermal conductivity of section 2/5 of the Th-U rules (version 2004), either the tabular default value of thermal conductivity (λ_{DTU}), or by multiplying the stated thermal resistance (R_D) by 0.85.

B. Test results

Tests of identification, suitability for use and durability have been documented in the following reports:

- CSTB test reports:
  - No. RSET 07-005 of 18 October 2007, determination of behaviour under continuous load (floating pavers on pedestals);
  - No. RSET 07-26007934 of 30 August 2007, determination of the curvature under thermal gradient and behaviour under continuous load (floating pavers on pedestals);
  - No. CLC-ETA-14-26050412-2 of 01 October 2014, test of behaviour under distributed static loads and elevated temperatures;
  - No. CLC-ETA-14-26050412-2 of 01 October 2014, test of continuous load in temperature;
  - No. CLC-ETA-14-26050412-2 of 01 October 2014, determination of curvature under the effect of a thermal gradient;
- Reports of the European classification of reaction to fire, issued by the MPA NRW, amended by the letter of the MPA NRW of 29 November 2007:
  - No. 420001510 04-1.2 issued on 22 February 2005, valid for boards produced in Mechau, with thickness from 20 to 60 mm and density 33 to 45 kg/m^3;
  - No. 420001085 02-155 issued on 06 November 2003, valid for boards produced in Mechau, with thickness from 80 to 200 mm and density 33 to 43 kg/m^3;
  - No. 230003407-1 issued on 16 June 2004, valid for boards produced in Olen, with thickness from 20 to 80 mm and density 33 to 43 kg/m^3;
- Monitoring report of the MPA NRW Dortmund No. 42 0001164 – 2007-3 of 28 September 2007.
- Internal test reports:
  - No. TTI3-01-V01 of 16 May 2014, test verifying the influence of temperature on Rcs and ds.

C. References

C1. Environment and health data (1)

Jackodur KF 300 Standard SF boards are the subject of an Environmental Product Declaration (EPD), in compliance with the standard ISO 14025.

The applicant declares that this sheet is generally applicable. It was issued in 2010 by PE international at the request of EXIBA and underwent verification by a third party.

The data supplied by the EPD are intended for use in the calculation of the environmental impacts of the works in which the respective products (or processes) are likely to be incorporated.

C2. Other references

Since 2007, the method has been in use at multiple sites totalling more than 50,000 m² of terrace roofs with the JACKODUR terrace roof method.

(1) The Specialised Group did not examine them within the framework of this APPRAISAL.

Thermal annex A: Standard solution [for uninterrupted roof areas]

The heat transfer coefficient for the uninterrupted area of roofs with inverted insulation is calculated according to the Technical Rules validated by the Technical Appraisal Thermal Committee (*Comité Thermique de l'Avis Technique*, or *CTAT*) on 12 November 2009, i.e. in the following manner:

The heat transfer coefficient must be corrected to account for:

- air spaces in the thermal insulation,
- any mechanical fasteners that penetrate the insulation layer,
- precipitation in the case of inverted roofs.

The correction to be applied to the heat transfer coefficient – designated by ΔU – is given by the expression:

$$\Delta U = \Delta U_g + \Delta U_f + \Delta U_r$$

where:

- ΔU_g: is the correction for air gaps, $\Delta U_g = 0$ for JACKODUR boards;
- ΔU_f: is the correction for mechanical fasteners, $\Delta U_F = 0$ for independent JACKODUR boards;
- ΔU_r: is the correction for inverted roofs due to rainwater that circulates between the insulation and the waterproof covering.

Method for calculating the correction due to rainwater that circulates between the insulation and the waterproof covering

The calculation method is based on the standard NF EN ISO 6946 and can be described as follows:

The formula for the coefficient Up of thermal transmittance in the standard [uninterrupted] area of roofs with inverted insulation is given by the expression:

$$Up = U_0 + \Delta U \qquad \text{Up in W/(m².K)}$$

Notes:

- The coefficient Up is presented in its final result with two significant digits,
- U0 is calculated to ± 0.01,
- ΔU is calculated to ± 0.01 (ΔU < 0.01 is considered as equal to zero).

in which:

- U_0: is the average coefficient Up of thermal transmittance of the roof lining, without accounting for additional losses due to the circulation of water between the waterproof covering and the applied insulation:

$$\frac{1}{U_0} = 0.14 + R_0 + R_1 = R_T \quad U_0 \text{ in W/(m².K)}$$

Note: Thermal resistances are calculated with at least three significant digits.

with:

- R_T: is the total thermal resistance, rounded off to two digits after the comma when it represents a final result, in (m².K)/W,
- R_0: is the thermal resistance between the inner face of the roof and the surface of the waterproof covering, in (m².K)/W,
- R_1: is the thermal resistance of the insulation layer over the waterproof covering, taking into account the variation $\Delta\lambda_h$ due to the infiltration of water between the waterproof covering and the applied insulation:

$$R_1 = \frac{e_1}{(\lambda_{EFFECTIVE} + \Delta\lambda_h)} \qquad R_1 \text{ in (m².K) /W}$$

- e_1: is the thickness of the insulation, in m;
- $\lambda_{EFFECTIVE} + \Delta\lambda_h$: is the thermal conductivity of the JACKODUR insulation under the conditions of use as inverted insulation, taking into account the volumetric moisture content in the product, the value of $\Delta\lambda_h$ being listed in *table A2.*

Note:

- $\lambda_{EFFECTIVE}$: basic effective conductivity, stated value (λ_D) with a 15 % safety factor applied to the thermal conductivity, or value certified by ACERMI, or default value of Th-U (λ_{DTU}),
- $\lambda_{EFFECTIVE} + \Delta\lambda_h$: effective conductivity with inverted insulation for hard masonry protection, supplemental amount according to *table* A2.

- ΔUr: is the correction to apply to the average coefficient Up of thermal transmittance of the roof for a method. ΔUr represents the additional heat losses due to the flow of rainwater through the insulation joints as far as the waterproof covering:

$$\Delta U_r = p \,.\, f.x \,.\, \left(\frac{R_1}{R_T}\right)^2 \quad \text{in W/(m².K) with:}$$

- p: in mm/day, average intensity of precipitation during the heating season, in mm/day. For buildings located in lowland climates in European France, the parameter p is specified for each *département* and listed in *table A1* below,
- *f*: drainage factor, depending on the share of *p* that reaches the waterproof covering,
- *x*: in (W.days)/(m².K.mm), factor accounting for the increase in heat loss due to drainage,
- *f.x* = 0.04: for a single-layer insulation on top of the waterproof covering, dry-laid and with heavy protection exposed to the exterior, such as aggregate.

Table A1 – Average precipitation "p" in mm/day (1), in lowland climates

No.	Département	p	No.	Département	p	No.	Département	p
01	Ain	2.12	**32**	Gers	1.99	**64**	Pyrénées-Atlantiques	3.42
02	Aisne	1.89	**33**	Gironde	2.90	**65**	Hautes-Pyrénées	3.33
03	Allier	1.84	**34**	Hérault	2.31	**66**	Pyrénées-Orientales	1.87
04	Alpes-Haute-Provence	2.03	**35**	Ille-et-Vilaine	1.93	**67**	Bas-Rhin	1.33
05	Hautes-Alpes	2.03	**36**	Indre	2.06	**68**	Haut-Rhin	1.31
06	Alpes Maritimes	2.74	**37**	Indre-et-Loire	1.98	**69**	Rhône	2.12
07	Ardèche	2.62	**38**	Isère	2.58	**70**	Haute-Saône	2.86
08	Ardennes	1.89	**39**	Jura	2.21	**71**	Saône-et-Loire	2.21
09	Ariège	2.85	**40**	Landes	2.87	**72**	Sarthe	1.99
10	Aube	1.81	**41**	Loir-et-Cher	1.99	**73**	Savoie	2.91
11	Aude	2.22	**42**	Loire	1.56	**74**	Haute-Savoie	2.91
12	Aveyron	2.19	**43**	Haute-Loire	1.56	**75**	Paris	1.69
13	Bouches-du-Rhône	1.81	**44**	Loire-Atlantique	2.48	**76**	Seine-Maritime	2.24
14	Calvados	2.09	**45**	Loiret	1.78	**77**	Seine-et-Marne	1.81
15	Cantal	1.93	**46**	Lot	2.50	**78**	Yvelines	1.69
16	Charente	2.40	**47**	Lot-et-Garonne	1.99	**79**	Deux-Sèvres	1.86
17	Charente-Maritime	2.42	**48**	Lozère	1.56	**80**	Somme	2.04
18	Cher	1.94	**49**	Maine-et-Loire	1.86	**81**	Tarn	1.83
19	Corrèze	1.93	**50**	Manche	1.84	**82**	Tarn-et-Garonne	1.99
2A	Corse-du-Sud	2.41	**51**	Marne	1.58	**83**	Var	2.42
2B	Haute-Corse	2.41	**52**	Haute-Marne	2.25	**84**	Vaucluse	2.01
21	Côte-d'Or	1.89	**53**	Mayenne	1.93	**85**	Vendée	2.32
22	Côtes-d'Armor	2.37	**54**	Meurthe-et-Moselle	2.00	**86**	Vienne	2.07
23	Creuse	1.93	**55**	Meuse	2.25	**87**	Haute-Vienne	3.01
24	Dordogne	1.99	**56**	Morbihan	2.90	**88**	Vosges	2.00
25	Doubs	3.00	**57**	Moselle	2.08	**89**	Yonne	1.72
26	Drôme	2.62	**58**	Nièvre	2.20	**90**	Territoire-de-Belfort	3.06
27	Eure	1.59	**59**	Nord	1.84	**91**	Essonne	1.69
28	Eure-et-Loir	1.59	**60**	Oise	1.83	**92**	Hauts-de-Seine	1.69
29	Finistère	2.89	**61**	Orne	2.24	**93**	Seine-Saint-Denis	1.69
30	Gard	2.44	**62**	Pas-de-Calais	1.67	**94**	Val-de-Marne	1.69
31	Haute-Garonne	1.83	**63**	Puy-de-Dôme	1.19	**95**	Val-d'Oise	1.69

Key:

p: average precipitation during the heating season (October to April, 1961 - 1990), in mm/day, valid for lowland climates.

(1) The data presented here are from the stations of the synoptic network of Météo France, which carried out measurements during the period from 1961 to 1990 and were not subjected to major displacements during that period. Those data were supplemented by data from six stations, which were subjected to major displacements during that period and for which the thirty-year series was not homogeneous: Gourdon (Lot), Grenoble (Isère), Limoges (Haute-Vienne), Millau (Aveyron), Rouen (Seine-Maritime) and Tours (Indre-et-Loire). We chose to calculate the averages for those stations on the longest homogeneous period between 1961 and 1990, to have the best possible distribution (source: Météo France).

Useful calculation parameter values – Standard solution [for uninterrupted roof areas]

The parameters used to calculate the coefficient ΔU, supplement $\Delta\lambda_h$ and parameters *f.x* are listed in table A.2 below:

Table A2 – Values of coefficient $\Delta\lambda_h$ and of the parameter f.x of the standard solution

	Inaccessible terrace roofs			**Terrace roofs accessible to pedestrians and residence**				**Green roofs**	
	Inaccessible roofs	Technical terraces or technical zone terraces	Technical roofs with platform tracks	Dry-laid prefabricated pavers	Floating pavers on pedestals	Private-use tiles, surface ≤ 100 m²	Cement concrete pavers Concrete slab	Garden terrace roofs	Planted terraces and roofs
Supplement of λ ($\Delta\lambda$) in mW/m.K	2 (1)	2 (1)	2	2 (1)	2 (1)	4	4	4	4
Value of the parameter f.x of the standard solution	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
(1) Case of underfloor heating with waterproof covering temperature < 30 °C: Δλh = 4 mW/(m.K).									

Example of thermal calculation for a specific project – standard solution

Table A3 – Example of thermal calculation – standard solution

Hypothetical construction of a terrace roof accessible to pedestrians: enclosed and heated building, situated in Saint-Denis (Seine-Saint-Denis) (climate zone H1)		**Thermal resistances:**
- reinforced concrete load-bearing element, non-heating, thickness 0.20 m ($\lambda_{EFFECTIVE}$ = 2 W/m.K) - asphalt waterproof covering 5 + 20 ($\lambda_{EFFECTIVE}$ = 0.70 and 1.15 W/m.K)	}	R_0 = 0.125 m².K/W
- Bed made of JACKODUR KF 300 Standard SF board, thickness 320 mm: • e_2 = 320 mm • $\lambda_{EFFECTIVE}$ = 0.036 W/m.K • $\Delta\lambda_h$ = 4 mW/m.K	}	R_1 = 8.000 m².K/W
Total thermal resistance: $R_T = 0.14 + R_0 + R_1$	}	R_T = 8.265 m².K/W
		so coefficient U_0 = 0.12 W/(m².K)
Correction ΔU to be applied to the average coefficient Up of thermal transmittance of the roof, with $\Delta U = \Delta U_f + \Delta U_g + \Delta U_r$: - ΔU_g = 0 et ΔU_f = 0 - correction ΔU_r due to rainwater that circulates between the insulation and the covering: • parameter *p* = 1.69 mm/day according to *table A1* • value *f.x* = 0.04 in the standard solution		/
		so correction ΔU = 0.06 W/(m².K)
The overall coefficient of [thermal] transmittance of the roof: **Up = U_0 + ΔU = 0.18 W/(m².K)**		

Thermal annex B JACKODUR WA solution

The basic approach to calculating the JACKODUR WA solution is the same as the one specified in *Thermal annex A*, but with a correction: ΔUr modified of the coefficient Up of thermal transmittance in the standard [uninterrupted] part of the roof.

Basically, the use of a specific filter layer makes it possible to reduce the quantity of rainwater run-off flowing between the JACKODUR boards, thereby improving the thermal performance of the terrace roof.

The installation of the intermediate specific filter layer and the factors of drainage and of heat loss increase due to drainage make it possible to have values of *f.x* lower than those of the standard solution (recall: *f.x* = 0.04) in the following formula:

$$\Delta U_r = p \,.\, f.x \,.\, \left(\frac{R_1}{R_T}\right)^2 \quad \text{in W/(m}^2\text{.K)}$$

The value f.x determined from watering tests is: 0.0015. This makes it possible to ignore the correction factor ΔU_r.

Useful calculation parameter values – JACKODUR WA solution

The parameters used to calculate the coefficient ΔU, supplement $\Delta\lambda_h$ and parameters *f.x* are listed in table B1 below:

Table B1 – Values of coefficient $\Delta\lambda_h$ of the JACKODUR WA solution

	Inaccessible terrace roofs			**Terrace roofs accessible to pedestrians and residence**				**Green roofs**	
	Inaccessible roofs	Technical terraces or technical zone terraces	Technical roofs with platform tracks	Dry-laid prefabricated pavers	Floating pavers on pedestals	Private-use tiles, surface ≤ 100 m²	Cement concrete pavers Concrete slab	Garden terrace roofs	Planted terraces and roofs
Supplement of λ ($\Delta\lambda$) in mW/m.K	2 (1)	2 (1)	2	2 (1)	2 (1)	4	4	4	4
Value of the parameter f.x of the JACKODUR WA solution (2)	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015

(1) Case of underfloor heating with waterproof covering temperature < 30 °C: Δλh = 4 mW/(m.K).
(2) CTAT decision of 15 October 2012 valid for JACKODUR KF 300 Standard SF and JACKODUR Plus 300 Standard SF boards

Example of thermal calculation for a specific project – JACKODUR WA solution

Table B2 – Example of thermal calculation – JACKODUR WA solution

Hypothetical construction of a terrace roof accessible to pedestrians: enclosed and heated building, situated in Saint-Denis (Seine-Saint-Denis) (climate zone H1)		**Thermal resistances:**
- reinforced concrete load-bearing element, non-heating, thickness 0.20 m ($\lambda_{EFFECTIVE}$ = 2 W/m.K) - asphalt waterproof covering 5 + 20 ($\lambda_{EFFECTIVE}$ = 0.70 and 1.15 W/m.K)	}	R_0 = 0.125 m².K/W
- Bed made of JACKODUR KF 300 Standard SF board, thickness 320 mm: • e_2 = 320 mm • $\lambda_{EFFECTIVE}$ = 0.036 mW/m.K • $\Delta\lambda_h$ = 4 mW/m.K	}	R_1 = 8.000 m².K/W
Total thermal resistance: $R_T = 0.14 + R_0 + R_1$	}	R_T = 8.265 m².K/W
		so coefficient U_0 = 0.12 W/(m².K)
Correction ΔU to be applied to the average coefficient Up of thermal transmittance of the roof, with $\Delta U = \Delta U_f + \Delta U_g + \Delta U_r$: - ΔU_g = 0 et ΔU_f = 0 - correction ΔU_r due to rainwater that circulates between the insulation and the covering: • parameter *p* = 1.69 mm/day according to *table A1* • value *f.x* = 0.0015 with the use of JACKODUR WA specific filter layer according to the CTAT decision of 15 October 2012		negligible
		so correction ΔU = 0.00 W/(m².K)
The overall coefficient of [thermal] transmittance of the roof: **Up = U_0 + ΔU = 0.12 W/(m².K)**		
(1) ΔU = 0.00 car ΔU < 0.01 is considered equal to zero.		

Tables and figures of the Technical File

Table 1 – Method for JACKODUR terrace roofs as inaccessible roofs

	Inaccessible terrace roofs (1) (5)	**Technical terraces or technical zone terraces (5)**	
		without platform tracks	with platform tracks
Supplement of λ ($\Delta\lambda$)	2 mW/m.K (2)	2 mW/m.K (2)	2 mW/m.K
Utilisation pressure			(3)
Separation layer	Either non-woven, or JACKODUR WA non-woven (6), or drainage layer (4)	or aggregate of the standard part, or JACKODUR WA non-woven (6), or drainage layer (4)	Either non-woven + synthetic film 100 µm or JACKODUR WA non-woven + 100 µm synthetic film; or drainage layer (4)
Protective layer	Aggregate, thickness of ballast specified in *§ 4.41*	Class S4 pavers according to the standard NF EN 1339, laid dry	Cast-in-situ reinforced concrete paving over a width limited to approx. 2 m Partitioning in compliance with the standard NF P 84-204 (DTU 43.1)

The grey fields correspond to impermissible usage

(1) The passageways are made with pavers on a separation layer (cf. *§ 4.421 of the Technical File*).

(2) Case of underfloor heating with waterproof covering temperature < 30 °C: $\Delta\lambda h$ = 4 mW/(m.K).

(3) With the values Rcs_{min}- $ds_{max}ds_{min}$ from *table 3*.

(4) Drainage system covered under Technical Application Document for use in inverted terrace roofs (cf. *§ 7.262* of the Technical File). It can be installed after placement of the intermediate JACKODUR WA non-woven.

(5) In mountain climates, the JACKODUR WA non-woven is mandatory. Slopes according to § 6.3.

(6) Mandatory in mountain climates.

Table 1b – Method for JACKODUR terrace roofs as accessible roofs

	Terrace roofs accessible to pedestrians and to residence (1)				
	Dry-laid pavers (2) (10)	**Floating pavers on pedestals** (3)	**Hard floor coverings**		**Paving stones** (5)
			Private-use tiles, surface < 100 m² (4)	Tiles for all terrace roofs (4)	
Supplement of λ ($\Delta\lambda$)	2 mW/m.K (6)	2 mW/m.K (6)	4 mW/m.K	4 mW/m.K	4 mW/m.K
Utilisation pressure	60 kPa (8)	40 kPa (9)	60 kPa (8)	60 kPa (8)	60 kPa (8)
Separation layer	Either JACKODUR WA non-woven / non-woven + aggregate 3/15 thickness ≥ 3 cm or JACKODUR non-woven / drainage layer (7)	Possible JACKODUR non-woven + pedestals according to DTU 43.1 or the TAD of the covering	JACKODUR non-woven / non-woven + aggregate 3/8 thickness 3 cm + synthetic film 100 µm or non-woven	Possible JACKODUR non-woven + drainage system (7) + possible film according to the TAD of the drainage system	JACKODUR non-woven / non-woven + bed of sand of average thickness 6 cm
Protective layer	Pavers in compliance with standard NF EN 1339 and of class S4 or higher dry-laid	Pavers in compliance with standard NF EN 1339 and of class T7 or T11	Reinforced mortar slab or reinforced concrete slab according to the standard – DTU 43.1 + sealed or glued tiles)	Reinforced mortar slab or reinforced concrete slab according to the standard – DTU 43.1 + sealed or glued tiles)	Concrete pavers according to - DTU 43.1

(1) In new construction, in compliance with NF P 84-204 (DTU 43.1): minimum slope 1.5 % or the slope specified in the Technical Application Document of the drainage system (2 % or greater, according to the TADs); slope zero (0 %) with floating pavers on pedestals only. In renovation work, the minimum slope complies with the standard NF P 84-208 (reference DTU 43.5). In mountain climates, slope according to § 6.3.

(2) cf. *§ 4.431 of the Technical File.*

(3) cf. *§ 4.432 of the Technical File.*

(4) cf. *§ 4.433 of the Technical File.*

(5) cf. *§ 4.434 of the Technical File.*

(6) Case of underfloor heating with waterproof covering temperature < 30 °C: $\Delta\lambda h$ = 4 mW/(m.K).

(7) Drainage system covered under Technical Application Document for use in inverted terrace roofs (cf. *§ 7.262* of the Technical File).

(8) Value of creep rupture test with a safety factor of 2.

(9) Value of constant load test with a safety factor of 2.

(10) Only permissible protection in mountain climates and JACKODUR WA mandatory.

Table 1c – Method for JACKODUR terrace roofs as accessible roofs (continued)

	Terrace roofs accessible to pedestrians and to residence (1)	
	Cast-in-situ concrete (4)	
	Area > 500 m^2 / Thermal resistance > 2 (m^2.K)/W (cf. *§ 4.4352*)	Area < 500 m^2 or thermal resistance < 2 (m^2.K)/W (cf. *§ 4.4351*)
Supplement of λ (Δλ)	4 mW/m.K	
Utilisation pressure	(2)	60 kPa
Separation layer	JACKODUR WA non-woven/non-woven + aggregate 3/15 thickness ≥ 3 cm + Non-woven/drainage layer (3)	
Protective layer	Reinforced concrete slab according to DTU 13-3 P2, partitioned according to § 4.352	Reinforced concrete slab according to DTU 43.1

(1) In new construction, in compliance with NF P 84-204 (DTU 43.1) and NF DTU 43.11: minimum slope 1.5 % or the slope specified in the Technical Application Document of the drainage system (2 % or greater, according to the TADs). In renovation work, the minimum slope complies with the standard NF P 84-208 (reference DTU 43.5). In mountain climates, slope according to § 6.3.

(2) With the values Rcs_{min}- $ds_{max}ds_{min}$ from table 3 (cf. § 4.4352)

(3) Drainage system covered under Technical Application Document for use in inverted terrace roofs (cf. § 7.262 of the Technical File).

(4) Permissible in mountain climates.

Table 1d – Method for JACKODUR terrace roof as garden terrace roofs or planted terraces and roofs (1)

	Garden terrace roofs (5)	**Planted terraces and roofs**
Supplement of λ (Δλ)	4 mW/m.K	4 mW/m.K
Utilisation pressure	60 kPa (4)	60 kPa (4)
Separation layer - Drainage layer	• Either JACKODUR non-woven + drainage layer according to DTU 43.1 or NF DTU 43.11 or according to the TAD of the waterproof coverings • or JACKODUR non-woven + drainage system (drainage layer and filter layer) (2)	• JACKODUR non-woven + movable protection (3)
- Filter layer	• Either filter layer according to DTU 43.1 or NF DTU 43.11 or according to the TAD of the waterproof coverings • or drainage system (drainage layer and filter layer) (2)	Filter layer specified in the TA of the greening method
Protective layer	Planting soil according to DTU 43.1 or NF DTU 43.11	Planting substrate according to the TA of the greening method

(1) Slope zero (0 %), or the slope specified in the Technical Application Document of the drainage system (2 % or greater, according to the TADs), or the slope mentioned in the Technical Appraisal of the planting method. In mountain climates, slope according to *§ 6.3*.

(2) Drainage systems covered under Technical Application Document for use in garden terrace roofs with inverted insulation.

(3) According to the requirements of the Technical Appraisal of the planting method, the drainage layer can comprise, in whole or in part, the movable protection of insulation boards by means of aggregate.

(4) Value of creep rupture test with a safety factor of 2.

(5) Only permissible case in mountain climates and JACKODUR WA mandatory.

Table 2a – Minimum thicknesses of concrete pavers on non-woven

Thickness of insulation layer	**Thickness of concrete pavers on separation layer**
50 mm	40 mm
60 mm	50 mm
80 mm	60(1) mm
90 mm ≤ thickness ≤ 120 mm	70(1) mm
130 mm ≤ thickness ≤ 180 mm	80(1) mm
190 mm ≤ thickness ≤ 250 mm	90(1) mm
250 mm ≤ thickness ≤ 320 mm	100(1) mm
(1) The pavers can be laid in two beds.	

Table 2b – Minimum thicknesses of concrete pavers on pedestals

Thickness of insulation layer	**Thickness of concrete pavers on pedestals**
≤ 90 mm	50 mm
≤ 100 mm	
100 mm ≤ thickness ≤ 120 mm	
130 mm ≤ thickness ≤ 180 mm	50 mm + supplemental ballast between pedestals of 16 kg/m^2 per cm of insulation > 12 cm
190 mm ≤ thickness ≤ 320 mm	Case not foreseen

Table 3 - Specified characteristics of JACKODUR KF 300 Standard SF and JACKODUR Plus 300 Standard SF boards

Characteristics			Specified values	Units	Observations
Geometry	Length		1,250 (±6)	mm	EN 822
	Width		600 (±6)	mm	EN 822
	Thicknesses (in 10-mm increments)	KF 300 Standard SF	50 to 320 (-2 /+3) (Belgium) 50 to 160 (-2 /+3) (Germany)	mm	EN 823
		Plus 300 Standard SF	50 to 200 (-2 /+3) (Germany)		
	Defect tolerances:				
	squareness		5	mm/m	EN 824
	surface flatness		6	mm	EN 825
	appearance		The surface of the board must exhibit an extrusion skin without cracking of depth > 3 mm.		
Presentation		**Edge machining**	the boards have shiplap profiles along the four edges: width 15 mm x 1/2 nominal thickness counting from the lower face.		
		Colour	purple throughout, the intensity of the hue possibly varying from one board to another.		
Weight	Density		38 ± 6	kg/m³	EN 1602
Mechanical properties	Settlement under distributed load of 40 kPa at 60 °C		Class C		UEAtc guide (cf. *§ 4.51*)
	Compressive strength at 10% deformation		≥ 300	kPa	EN 826, CS(10/Y)300
	Operating compressive strength Rcs_{min} *(1)* KF 300 Standard SF (50-320 mm) Plus 300 Standard SF (50-200 mm)		0.14	MPa	*CSTB* specifications 3230_V2 November 2007
	Operating deformation (1) KF 300 Standard SF (50-320 mm)		ds_{min} = 0.7 ds_{max} = 2.0	%	
	Plus 300 Standard SF (50-200 mm)		ds_{min} = 0.6 ds_{max} = 1.8	%	
	Behaviour under continuous load in temperature (3) KF 300 Standard SF (50-120 mm) Plus 300 Standard SF (50-180 mm)		40	kPa	CSTB "e-cahier" specifications 3669 of January 2010
Dimensional stability	Dimensional variations in free state of deformation		≤ 0.5 and ≤ 5	% mm	UEAtc guide (cf. *§ 4.51*)
	Curvature under the effect of a thermal gradient (60 °C / 23 °C)		≤10	mm	UEAtc guide (cf. *§ 4.32*)
Hygrometry	Long-term water absorption by total immersion WL(T)		≤ 0.7	%	EN 12087 method 2A
	Long-term water absorption by diffusion WD(V)		≤ 3	%	EN 12088
	Additional due to freeze-thaw effects		FTCD1	-	EN 12091
Thermal properties	*Rated thermal conductivity* λ_D *(2)* JACKODUR KF 300 Standard SF - from 50 to 60 mm		0.036	W/m.K	ACERMI certificate no. 03/074/261
	- from 70 to 190 mm		0.035	W/m.K	
	- from 200 to 320 mm		0.036	W/m.K	
	JACKODUR Plus 300 Standard SF - from 50 to 200 mm		0.027	W/m.K	ACERMI certificate no. 03/074/805
Reaction to fire (Euro class)			E	Euro class	

(1) Knowledge of the critical operating strength and operating deformation enables the project manager to size the concrete works to accommodate the facade cleaning platform tracks, taking into account the waterproof covering and the board thickness.

(2) These values of thermal conductivity rated and certified by ACERMI cannot be used alone, but must be corrected by correction factors according to § 8 of the Technical File and to annex B, in order to obtain $\lambda_{EFFECTIVE}$.

(3) In the case of protection by floating pavers on pedestals.

Table 4 – Weight of maximum water capacity of the components of the JACKODUR terrace roof method

Elements	Description	Weight of max. water capacity
JACKODUR boards	Inverted insulation board	50 kg / m³
JACKODUR WA non-woven	Specific filter layer (non-woven)	100 g / m²
Aggregate	Movable protection	18 daN / cm of height / m²

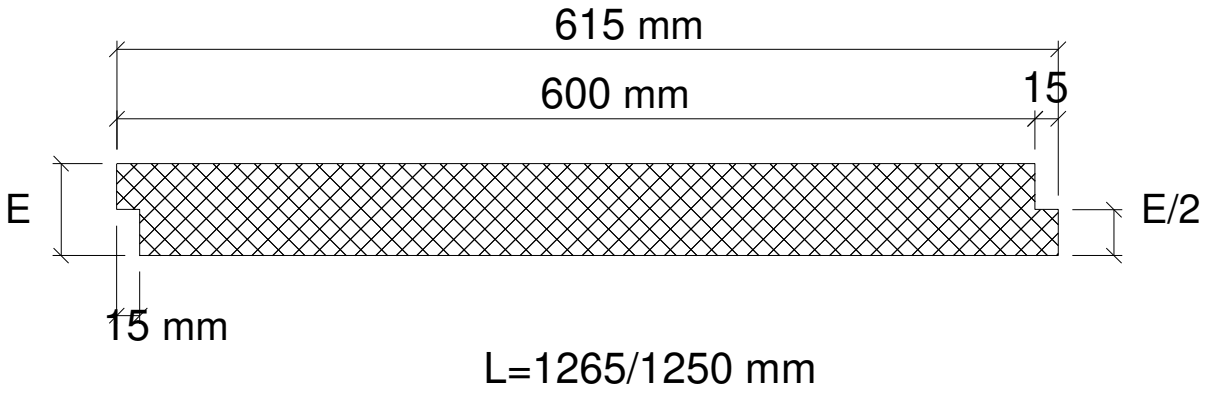


Figure 1 - Sectional view of JACKODUR boards E = 50 to 210 mm

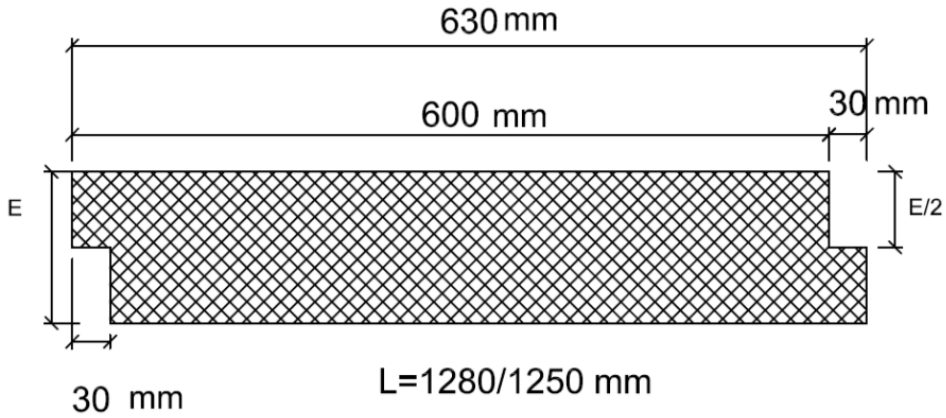
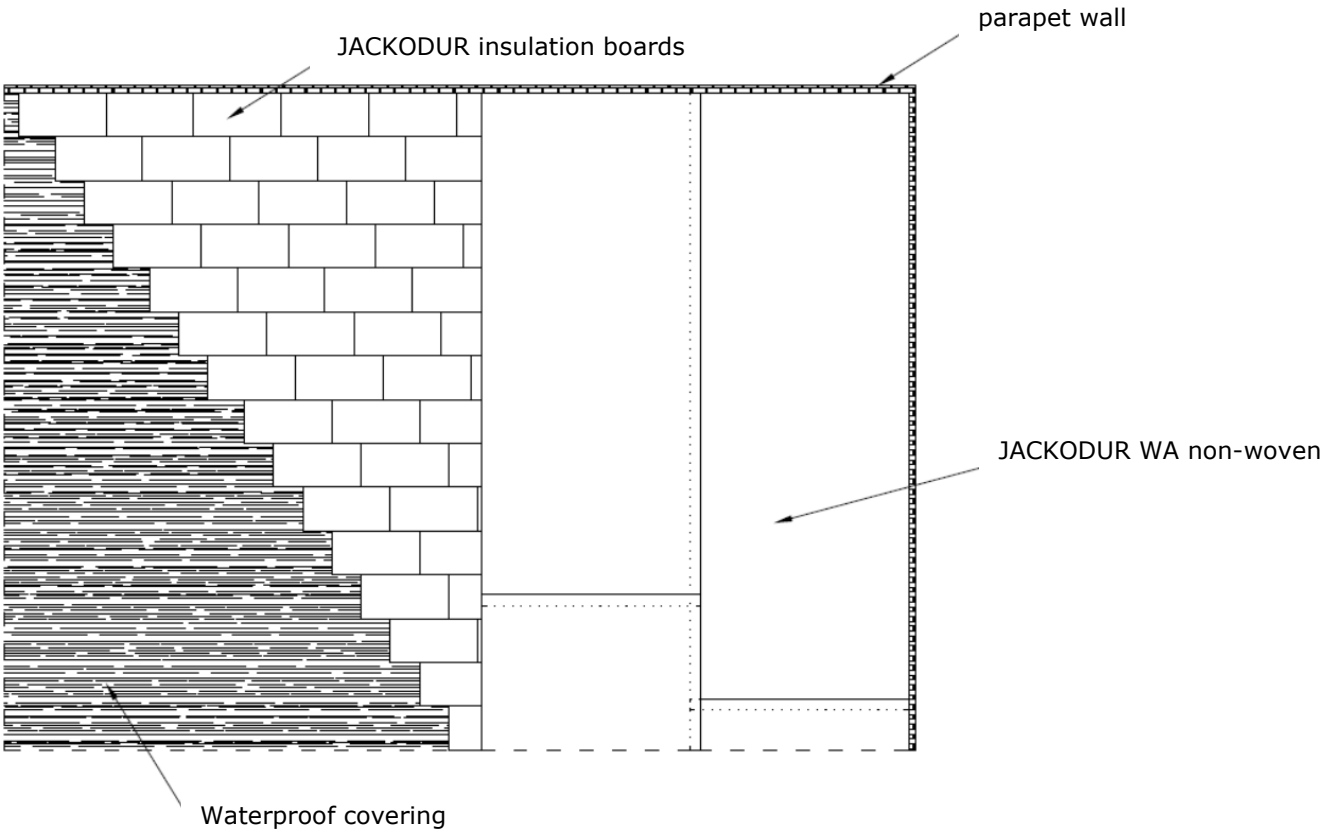
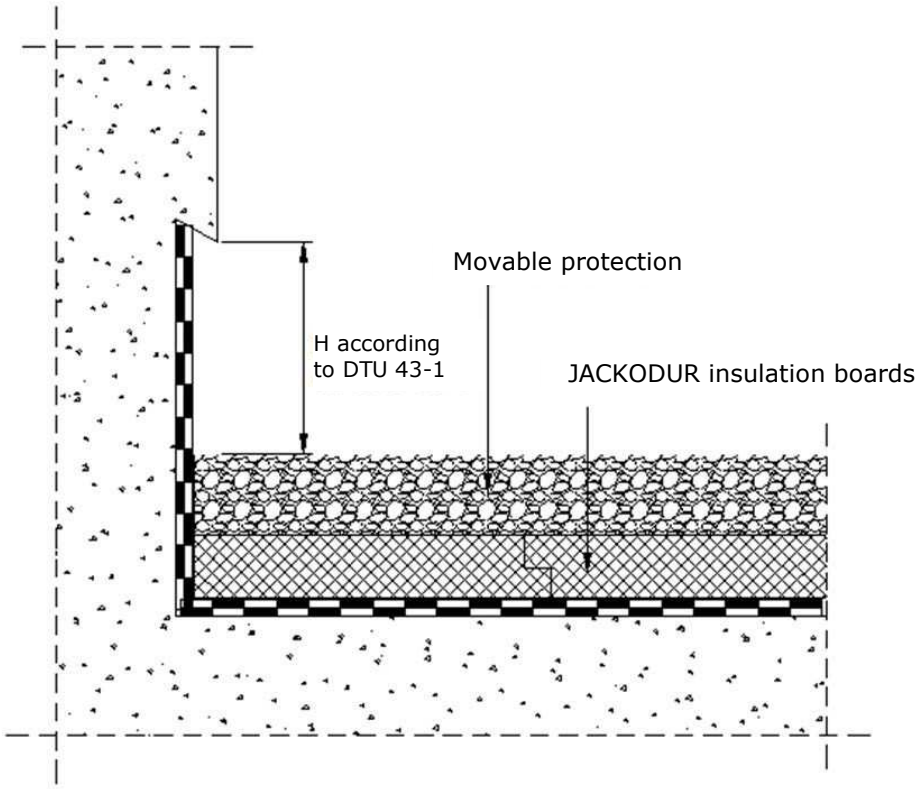


Figure 1b - Sectional view of JACKODUR boards E = 220 to 320 mm



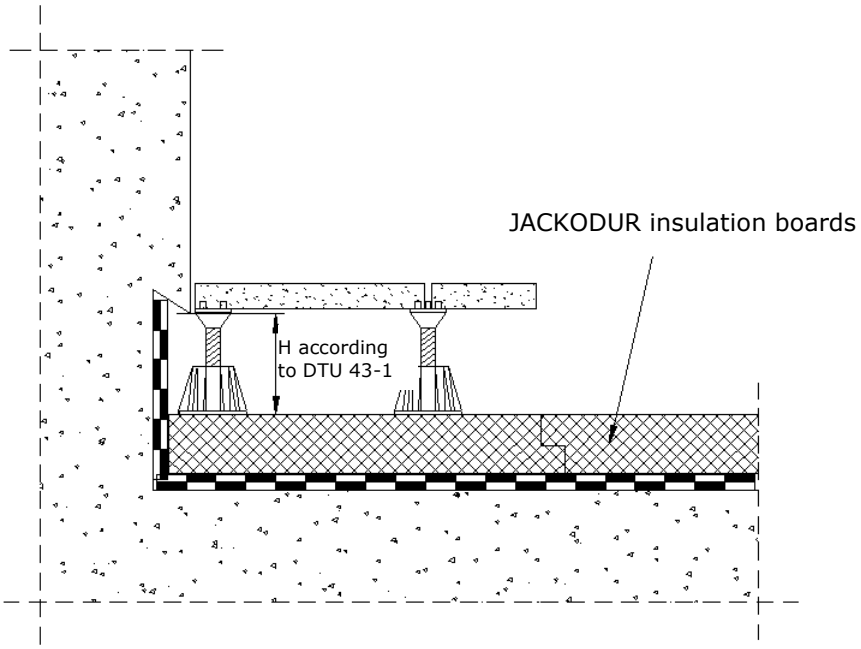
The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF.

Figure 2 - Installation of WA non-woven



The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF

Figure 3 - Inaccessible terrace arrangement



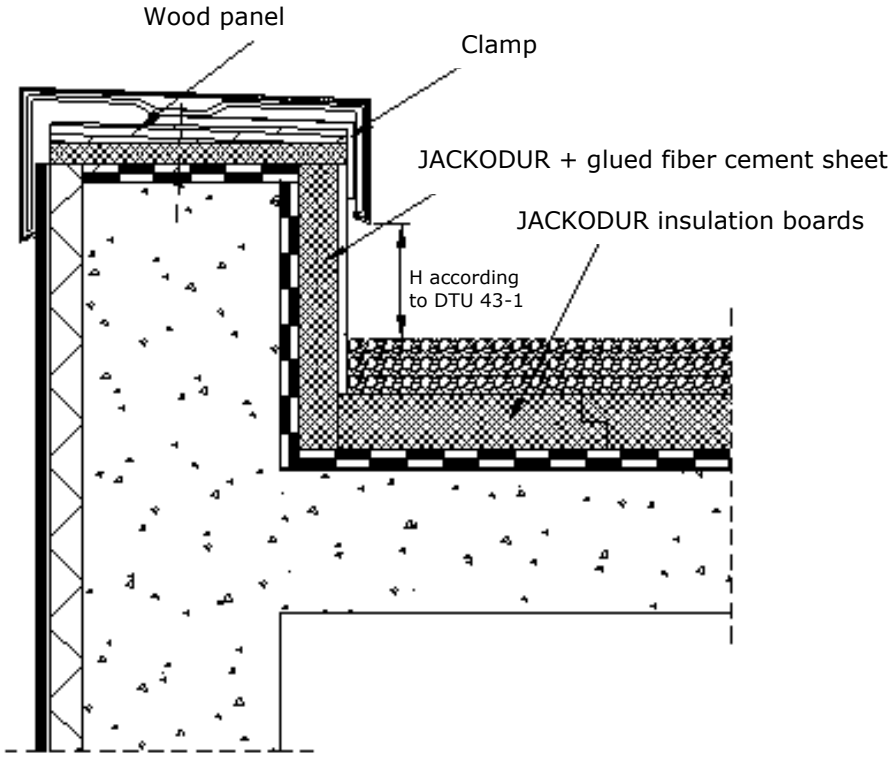
The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF.

Thickness of JACKODUR KF 300 Standard SF insulation boards: from 50 to 120 mm.

Thickness of JACKODUR PLUS 300 Standard SF insulation boards: from 50 to 180 mm.

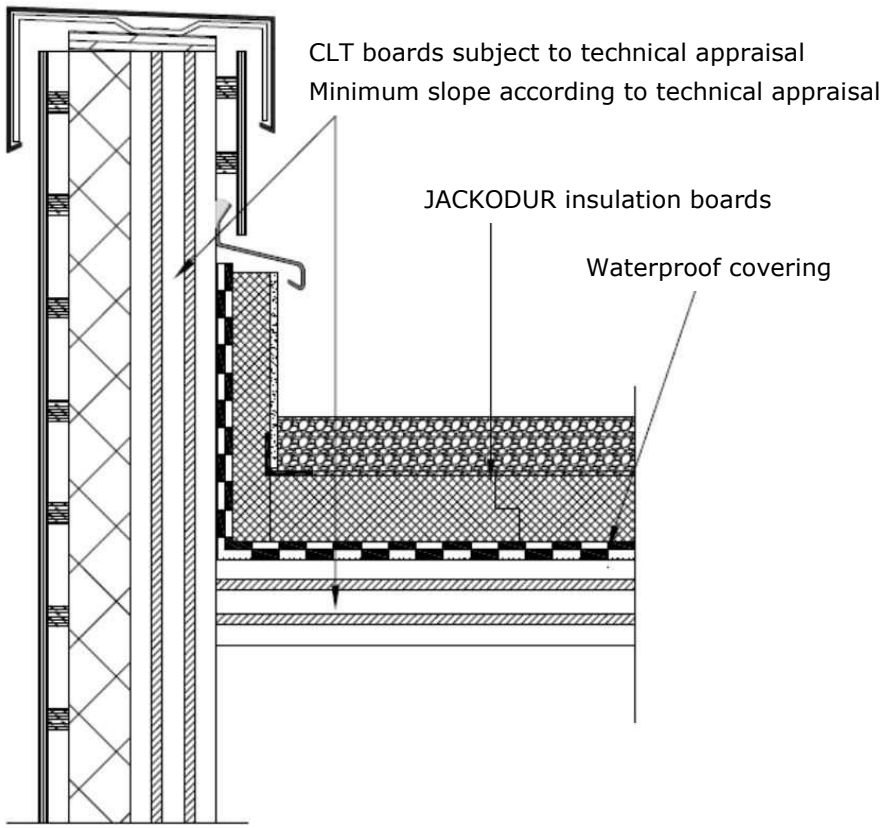
Maximum pressure under each pedestal: 40 kPa.

Figure 4 - Accessible terrace, floating pavers on pedestals



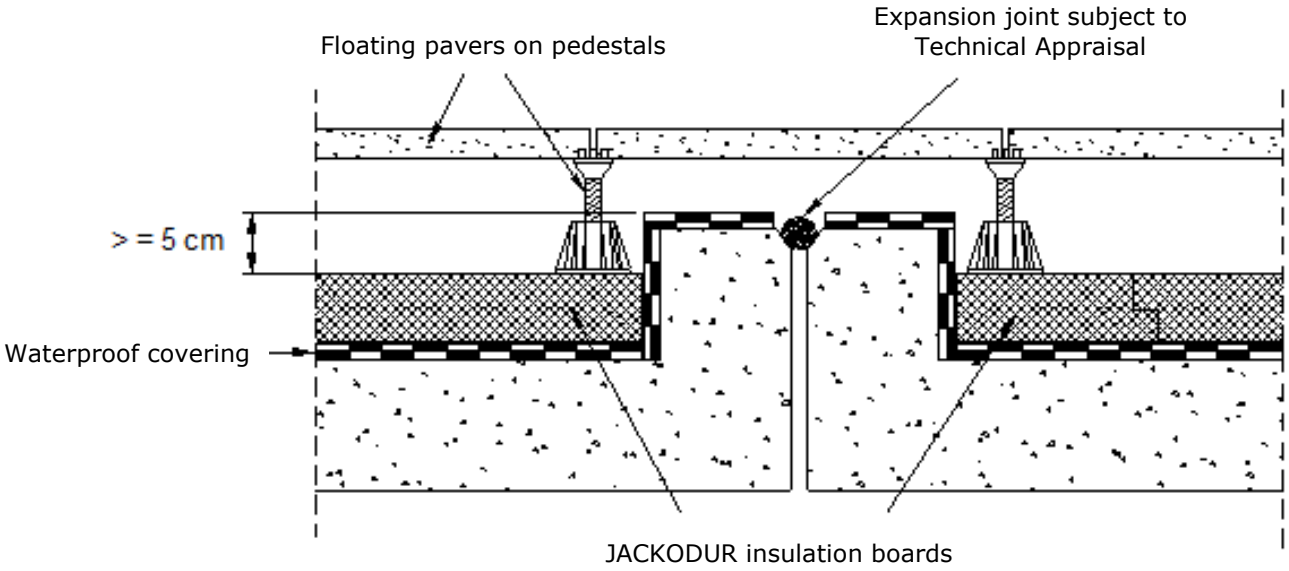
The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF.

Figure 5 – Example of protection of flashings on load-bearing masonry element



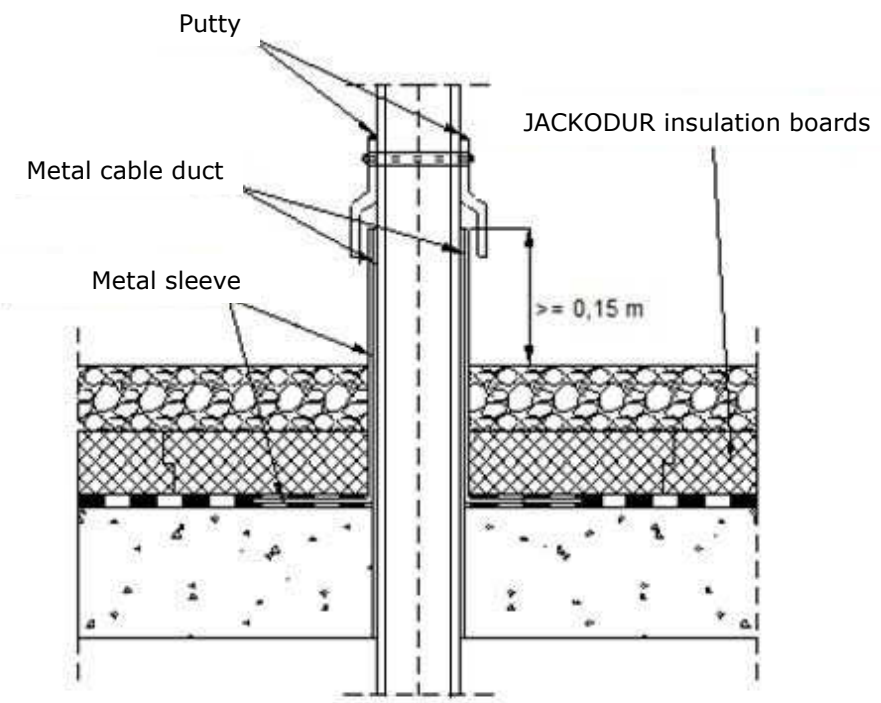
The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF.

Figure 5b – Example of protection of flashings on load-bearing CLT board element subject to Technical Appraisal



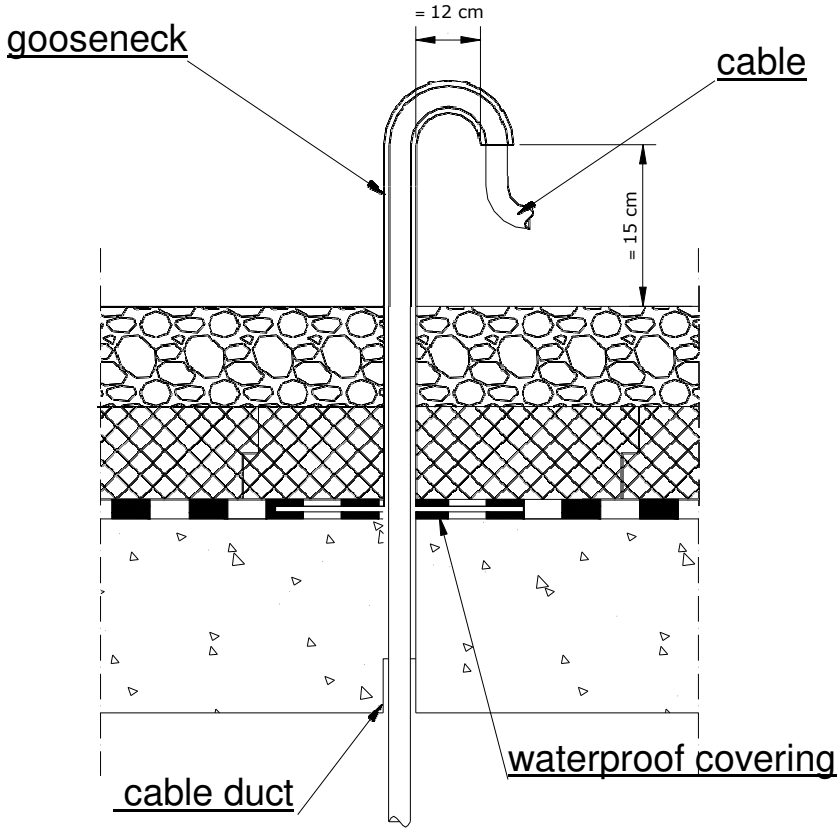
The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF.

Figure 6 - Raised flat joint and floating pavers on pedestals



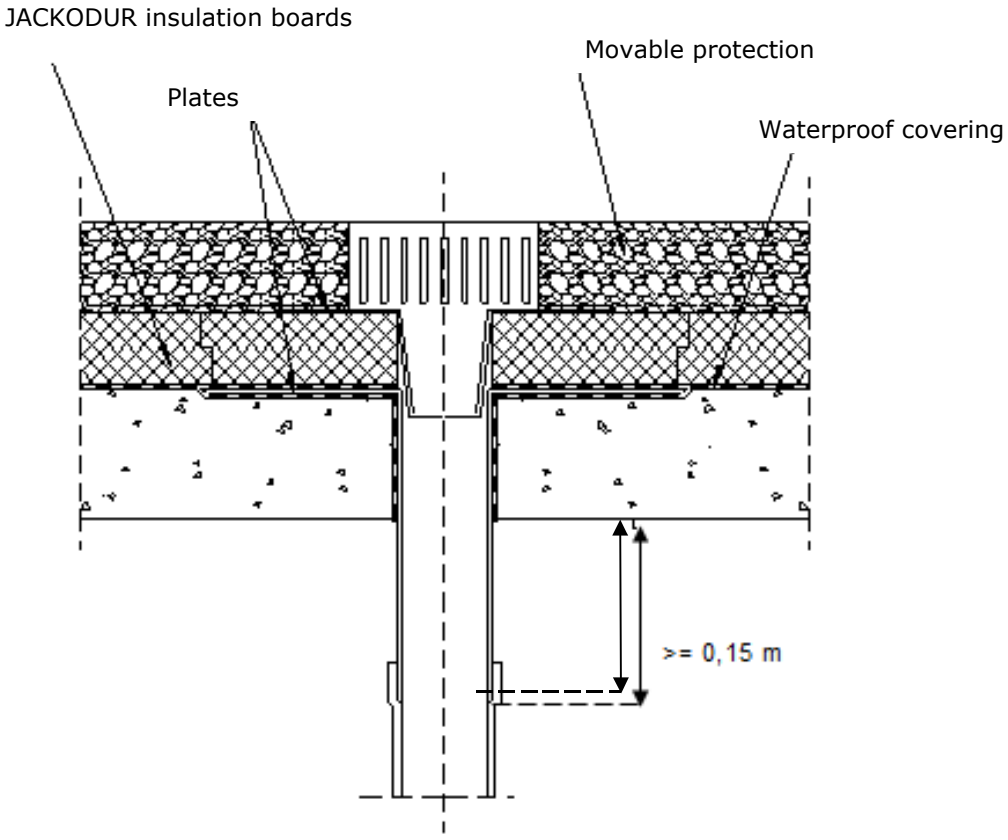
The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF.

Figure 7 - Ventilation, example solution



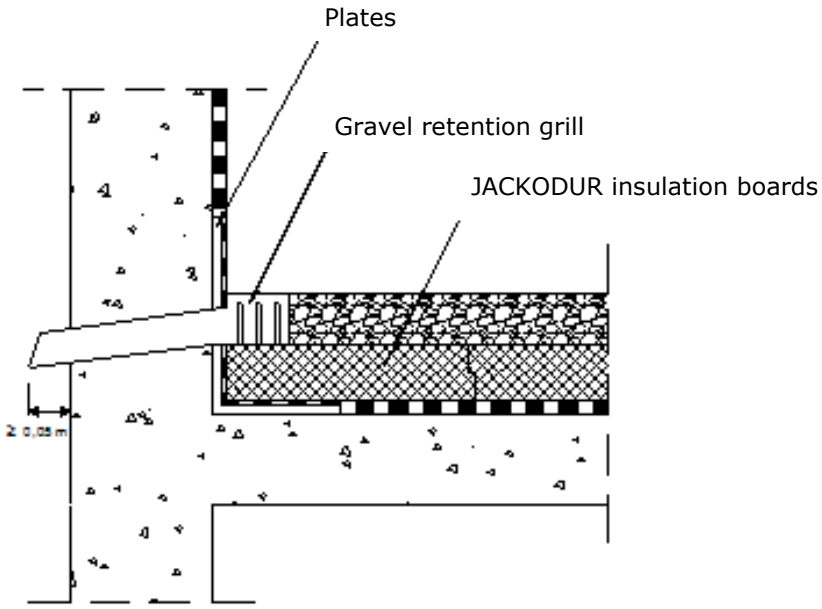
The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF.

Figure 8 - Passage of supply cables, example solution



The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF.

Figure 9 - Rainwater drain



The product name "JACKODUR insulation boards" refers to the following insulation boards: JACKODUR Plus 300 Standard SF and JACKODUR KF 300 Standard SF.

Figure 10 - Example of overflow/scupper