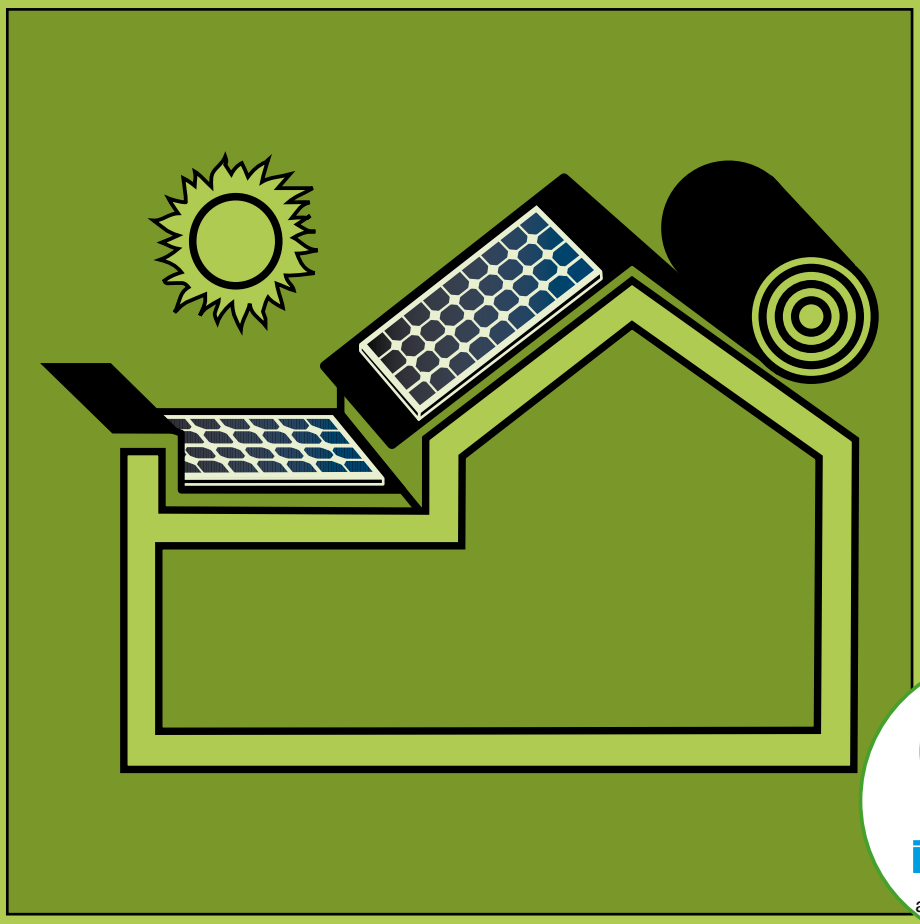
Technical specification 14 bis

B_{roof} (t2) classified ROOFS WITH PHOTOVOLTAIC SYSTEMS*



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Choice of layer structure and systems to connect photovoltaic systems not built into the waterproofing of old and new roofs

Roofs are particularly suitable for use for the production of electrical energy from the sun, primarily flat roofs, since it is easier to orient the system in the most favourable position for the highest coverage from the photovoltaic panel. A photovoltaic system must last at least 20 years, and subsequent renovation of the photovoltaic system may be limited to only the replacement of the photovoltaic module, leaving the metal frame to which it is hooked in place. The frame itself may be fixed to the roof through the layers of waterproofing. For this reason, it is important, for new roofs, to adopt a two-layer system, suing a long lasting membrane certified with Agrement/DVT of the I.T.C-CNR as first layer, such as: PROTEADUO TRIARMATO, HELASTA POLIESTERE or FLEXTER FLEX TESTUDO SPUNBOND POLIESTERE protected from fire of external origin by a FIRESTOP POLIESTERE membrane that complies with the provisions of the "**Guide for the installation of photovoltaic systems – 2012 edition**" by the Fire Brigade Department of the Italian Ministry of the Interior. The same applies to old coverings to be used for this purpose, after careful analysis of the existing covering, which may be in poor condition, or close to expiry in terms of its guarantee. Complete renewal of the covering may be an option, or, in the case of bituminous coverings, simple renovation by "complete overlay" on top of the existing waterproofing. After an overview of the different types of photovoltaic panels, for those panels that are fixed through the waterproofing, suitable techniques to connect the waterproof covering to the panels supports are suggested below, with the best strategies for implementing the yield of the photovoltaic modules. The same applies to sloping roofs with undertile MINERAL FLEXTER FLEX TESTUDO SPUNBOND POLIESTERE membrane, and sloping roofs with DOFAR series breathing undertile sheets.
Thin film photovoltaic panels built into the waterproof covering are not considered in this discussion, and in accordance with the suggestions of ENEA (the Italian body for new energy and environmental technologies), it is preferable that, as far as possible, roof-mounted photovoltaic systems do not interfere with the waterproofing and insulation.

* **Case 3a – photovoltaic panels with FV panels of class 2 or equivalent fire reaction on B_{roof} (t2)** classified roofs, in the light of the circular on the fire prevention requisites of photovoltaic systems installed on the roofs of buildings in which activities subject to fire prevention control take place, issued by the Fire Brigade Department of the Italian Ministry of the Interior on 07/02/2012 and subsequent clarification notes issued on 04/05/2012.

INTRODUCTION

Architecture for sustainable building is not limited to the design of a "conservative" envelope from an energy point of view, but current design research intends to make the building envelope perform an "active" energy role, designing buildings that include systems for the capture of thermal and photovoltaic solar energy to produce energy from the sun.

The European directive to promote the use of energy from renewable sources (Directive 2001/77/EC), incorporated into Italian law with legislative decree 387/2003 and following by subsequent implementing decrees, introduced the incentive programme called Conto Energia (Energy Account), this is an incentive in the form of a grant to produce electricity from the sub using photovoltaic systems that are permanently connected to the electricity grid. Italy is one of the sunniest countries in Europe, particularly in the south, but the photovoltaic sector in Italy is one of the least developed in the world.

It is estimated that, using current technologies, a photovoltaic system in Italy is able to generate approximately 1150 kWh per year for every kWp of photovoltaic modules installed, which rises to 1500 kWh going further south. Germany, although disadvantaged by its geographical position, is a country where the production of electrical energy from the sun is highly advanced, but produces only 600 kWp per year for each kWp of photovoltaic modules installed. The favourable climate of Italy allows the beneficiary to recoup the costs incurred within 10 years, and to generate approximately the same sum in the next 10 years. In the south the situation is even better, because the investment tends to pay for itself within about 8 years. The roofs of building, especially those that are flat, non-terraces with bare waterproof covering, are unused surfaces that can easily be used to produce electric energy from the sun using a photovoltaic solar panel system that meets the criteria of sustainable building.

GBC ITALIA (Green Building Council) AND *LEED* CERTIFICATION

socio del GBC Italia

GBC Italia, which INDEX belongs to, has the task of using the common guidelines to everyone in the ***LEED*** international community to develop the characteristics of the ***LEED Italia*** system, which must take into consideration the specific climatic, building and legislative conditions in Italy.

LEED opts for a view of sustainability by making the most of all possibilities to reduce the various kinds of environmental impacts and harmful emissions of the buildings being built.

The ***LEED*** standards are parameters for ***sustainable building*** developed in the USA and applied in 40 countries throughout the world. They indicate the requirements for eco-compatible buildings, able to "work" sustainably and self-sufficiently energy-wise. It is essentially a rating system for the development of "green" buildings. ***LEED*** is a certification, which may be obtained on a voluntary basis, where the actual designer deals with collecting the data for the assessment. The system is based on the award of credits for each of the requirements that characterise the sustainability of the building.

The certification level obtained comes from the sum of the credits.

The assessment criteria used by ***LEED*** (2009 version) are grouped into six categories (+1 only valid in the USA), which envisage one or more compulsory prerequisites and a number of environmental performances that attribute the building's final score:

- Sustainable sites (1 prerequisite, 26 points)
- Efficient water consumption (1 prerequisite, 10 points)
- Energy and atmosphere (3 prerequisites, 35 points)
- Materials and resources (1 prerequisite, 14 points)
- Indoor environmental quality (2 prerequisites, 15 points)
- Innovation and design process (6 points)
- Regional priority (4 points) only applicable in the USA

There are 4 rating levels:

- basic certification between 40 and 49 points
- Silver: between 50 and 59 points
- Gold: between 60 and 79 points
- Platinum: more than 80 points

The following point in the ***LEED*** regulations includes the solar reflectance index:

- ***SS Credit 7.2: Heat Island Effect - Roof***

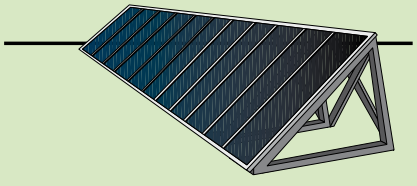
SRI (solar reflectance index) limits of the roofing materials.

What is it useful to know about photovoltaic panels installed on a roof

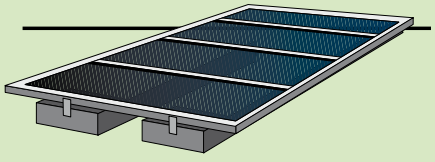
Orientation and slops

The ideal orientation and inclination for photovoltaic panels is approximately 30°, facing South. However satisfactory yields are also obtained with orientation to the South East and South West, and with inclindations of 20° and 40°. If flat instead of the ideal inclination, the loss of yield can be around 10%.

System with leaning interlocking modules



System with flat rigid modules



Yield and surface area

Different photovoltaic panels based on differing technologies, and with different yields, are available on the market. Using high yield modules, a smaller surface area is neeed to obtain a given power level, installation space is reduced, and the panels can be oriented more easily in the sunnier areas of the roof, avoiding areas of shade.

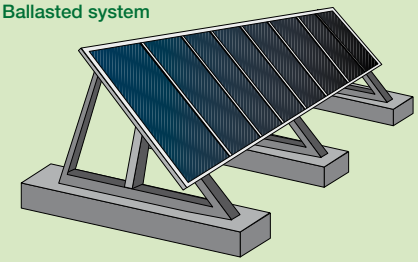
The mass-to-air ratio of the photovoltaic system

The weight per square metre of the photovoltaic installation assumes special importance on roofs. It must be compatible with the additional load that the roof is able to support. The load does not only depend on the unit weight of the panel, but also on the way in which it is installed on the roof.

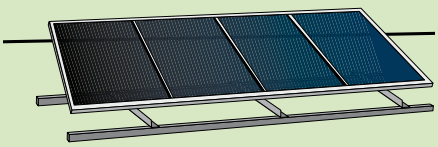
Panels simply attached by ballasting, to avoid piercing the waterproof covering, make a greater contribution to the load linked to the windiness of the climate zone and the geometry of the roof than systems that are mechanically anchored to the support (the average weight is 40-50 kg/m^2).

However, there are innovative tubular photovoltaic modules that are neither ballasted nor anchored, that resist winds of up t0 208 km/h and weigh 16 kg/m^2.

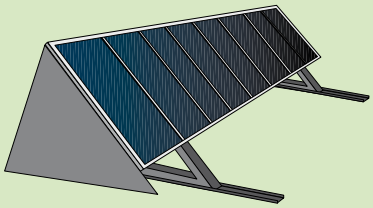
Ballasted system



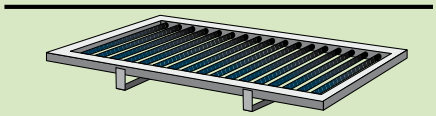
Mechanically fixed system



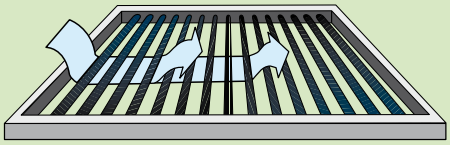
System with leaning interlocking modules



Leaning tubular system



Wind and air do not affect the tubes

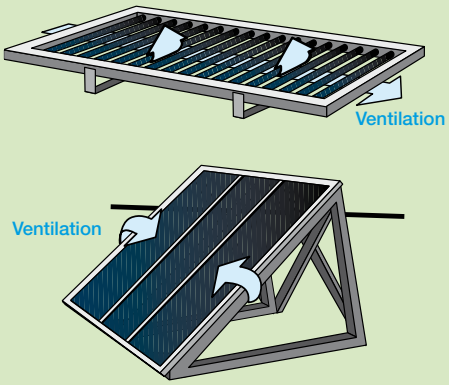


Temperature

The yield of photovoltaic panels is declared for a temperature of 25°C, but it must be born in mind that for crystalline silicon panels this falls as the temperature rises by 0.3 – 0.4 % for every °C and a black surface on the roof can reach a temperature of over 70°C.

The ventilation on the back of the panel, and lowering the temperature of the roof surface on which the system is installed are therefore of great importance in improving its yield.

Tubular modules and inclined panels are ventilated at the rear.



The cleanliness of the panel

The efficiency of a panel is closely linked to the periodic cleaning of its surface. Only panels covered with glass are easy to clean, but the deposits left by standing water must be removed, or the panel does not produce energy.

This is of such importance that nowadays panels are built without an aluminium outer frame, to prevent even the smallest accumulation of water on the panel.

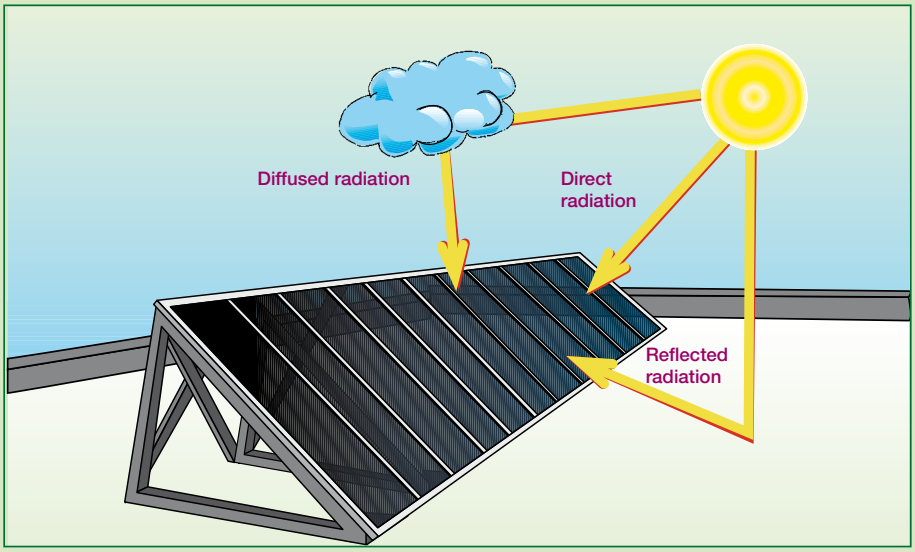
Solar radiation

The total solar radiation that reaches the photovoltaic module has three components: **direct radiation**, **diffuse radiation** and **reflected radiation**.

Direct radiation is that part of solar radiation that reaches the photovoltaic module directly, on a day with clear skies, for example.

Diffuse radiation is a portion of direct radiation that diffuses through the clouds and particles dispersed in the atmosphere, and so the panel also produces energy on a cloudy day, although less of it.

Finally, **reflected radiation** is that part of solar radiation that is reflected by the surrounding environment onto the panel, such as when the roof is covered in snow. SWo reflected radiation depends on the materials that surround the photovoltaic field, and appropriate adaptations can be made to increase the yield of traditional panels. This can be especially important for those panels that produce energy not only from the side facing the sun, such as tubular panels.



Influence of the waterproof roof finish on the yield of a photovoltaic system on the roof

In the previous section we saw how temperature and reflected radiation can influence the yield of a photovoltaic system. Both are determined by the colour of the surface of the waterproof covering on which the panel is installed.

Over 90% roofs are dark-coloured, and the surface of the roof exposed to solar radiation reaches temperatures of around 80°C, which also has negative effects on the yield of the photovoltaic panels, which decreases as the temperature risesi

The increase in the solar reflectance of the roof service with specific surface treatments of the waterproof covering provides a two-fold benefit – reducing the temperature to as low as approximately 40°C while increasing the albedo, the fraction of incident radiation that is reflected from the roof surface, increasing the yield of the photovoltaic system

INDEX systems to increase the solar reflectance of the roof.

The choice of colour of the top layer of the waterproof covering, which should be a covering with mineral self-protection of slate granules (MINERAL), the most durable, and unaffected by the problems experienced with membranes with metal self-protection, is the first strategy that may be applied to increase the reflection of solar radiation. As the table of temperatures reached in summer by various finishes of the waterproof covering below clearly shows, a white slate-covered membrane clearly reduces the temperature of the roof.

Membranes that are self-protected with metal foil to produce a shiny surface have a high solar reflectance, but low emissivity in infrared, and once oxidised the IR emissivity increases, while the solar reflectance reduces as the same time, while aluminium-based paints are not very durable.

Levels of temperature reached by the waterproof covering with different surface finishes exposed in the same conditions to summer solar radiation

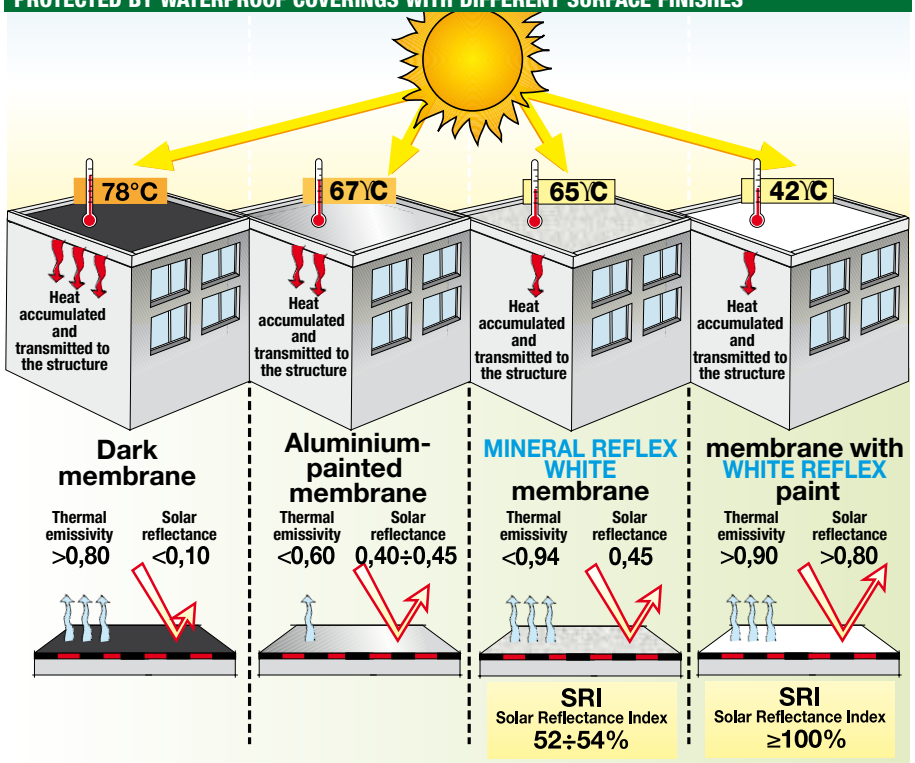
Surface finishing	Max Temp.
Black bituminous membrane	78°C
Grey slate membrane	74°C
White slate membrane	70°C
Painted aluminium bituminous membrane	67°C
Membrane with copper foil	60°C
Membrane with aluminium foil	55°C

THE NEW INDEX SOLUTIONS

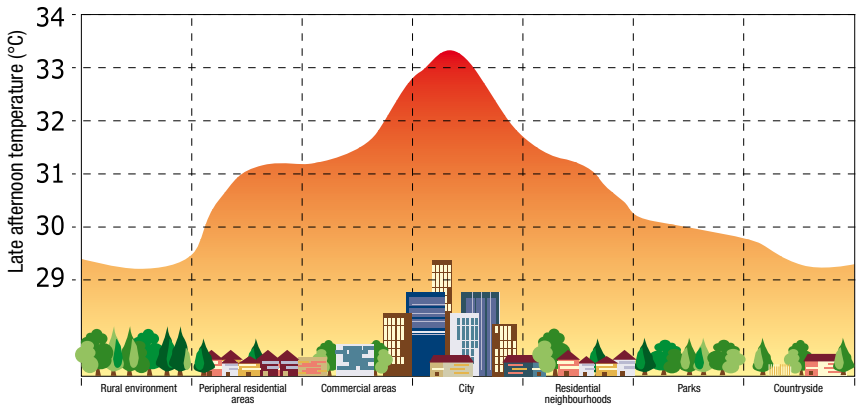
Slated membranes with MINERAL REFLEX WHITE

MINERAL REFLEX WHITE treatment of MINERAL series membranes is based on the use of a special white mineral self-protection with high saturation and luminosity, which allows roofs to be created with high solar reflectance together with very high thermal emissivity.
A dark coloured covering has very low solar reflection, and during the day absorbs a lot of heat which is insufficiently disposed of during the night, even though the roof has high emissivity in infrared.
A covering with aluminium paint has good solar reflection which reduces the absorption of heat during the day, but at night heat loss is small because it has low IR emissivity.
A **MINERAL REFLEX WHITE** white covering has both good daytime reflection and high night time emission, which results in low heat absorption, which also has beneficial effects on energy consumption for conditioning in summer of the building.

TEMPERATURES, REFLECTANCE, EMISSIVITY REACHED BY ROOFS EXPOSED TO THE SUN PROTECTED BY WATERPROOF COVERINGS WITH DIFFERENT SURFACE FINISHES



PHENOMENON OF URBAN HEAT ISLANDS



The increase in the solar reflectance and thermal emissivity provided by the MINERAL WHITE REFLEX paint applied to the slated membrane

Surface	Reflectance	Emissivity
Black bituminous membrane	<10% (<0,1)	>80% (>0,8)
Aluminium-painted bituminous membrane	40÷45% (0,40÷0,45)	<60% (<0,6)
Membranes with a slated finish MINERAL REFLEX WHITE	45% (0,45)	<94% (<0,94)

The **MINERAL REFLEX WHITE** treatment produces a further environmental benefit, because it reduces urban over-heating.

So in accordance with the criteria of The Green Building Council, the membrane can amply satisfy the SRI>29 requirement for the following *LEED* Credits:
- *SS Credit 7.1: Heat Island Effect: Roofs of underground carparks*
- *SS Credit 7.2: Heat Island Effect: Roofs*

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The covering painted with **MINERAL REFLEX WHITE** in compliance with the requirements of the Green Building Council responds to the *LEED-SS Credit 7.1 and 7.2- Carpark Roofs and Heat Island Effect for sloping roofs*

SRI (Solar Reflectance Index)	*LEED* Standard	SRI≥29
	Waterproofing membrane MINERAL REFLEX WHITE	SRI> 52÷54%

Levels of temperature reached by the waterproof covering with different surface finishes exposed in the same conditions to summer solar radiation

Surface finishing	Max Temp.
Black bituminous membrane	78°C
Grey slate membrane	74°C
White slate membrane	70°C
Painted aluminium bituminous membrane	67°C
Waterproofing membrane MINERAL REFLEX WHITE	65°C
Membrane with copper foil	60°C
Membrane with aluminium foil	55°C
Bituminous membrane with WHITE REFLEX paint	42°C

WHITE REFLEX PAINT

The INDEX Research and Development Department has developed **WHITE REFLEX**, a new water-based paint that, applied to the waterproof membranes of roofs with bare waterproofing, reduces the daytime temperature and permits fast cooling at night reducing heat transmission into inhabited environments, energy consumption for conditioning in summer, and urban overheating.
WHITE REFLEX increases both the solar reflectance and the thermal emissivity of the surfaces to which it is applied.
WHITE REFLEX paint, with a special white pigment, reduces temperature more than membranes self-protected with metal, and as the table above shows, is even more efficacious than **MINERAL REFLEX WHITE** treatment.

In conformity with the criteria of the Green Building Council painting the slated membrane with **WHITE REFLEX** paint contributes to meet the following *LEED* criteria:

LEED- EA Credit 1: Optimisation of Energy Performances

Cold roofs with **WHITE REFLEX** can be modelled in the proposed design to show its impact in reducing gratuitous heat intakes. If the proposed roof initially has a solar reflectance of at least 0.70, and a thermal emissivity of at least 0.75, the proposed design can use a modelled solar reflectance of 0.45, which takes account of the reduction in reflectance, against the default value of 0.30 which will be modelled for the reference building.

The increase in the solar reflectance and thermal emissivity provided by the WHITE REFLEX paint applied to the waterproof covering

Surface	Reflectance	Emissivity
Black bituminous membrane	<10% (<0,1)	>80% (>0,8)
Aluminium-painted bituminous membrane	40÷45% (0,40÷0,45)	<60% (<0,6)
Bituminous membrane with **WHITE REFLEX** paint	**>80% (>0,80)**	**>90% (>0,90)**

LEED- SS Credit 7.2: Heat Island Effect - Roofs

Roofs painted with **WHITE REFLEX** reduce the effects of "heat islands") differences in thermal gradient between urbanised areas and green areas) and minimise their impact on the micro-climate and on the human and animal habitat.

Option 1: roofing materials with a Solar Reflectance Index (SRI) equal to or greater than the values indicated in the table below for a minimum of 75% of the roof surface must be used.

The covering painted with WHITE REFLEX in compliance with the requirements of the Green Building Council responds to the *LEED-SS Credit 7.2-Heat Island Effect: Roof, 1 Point* for *Options 1* e *3* for flat roofs

SRI (Solar Reflectance Index)	*LEED* Standard	SRI≥78
	Bituminous membrane with WHITE REFLEX paint	**SRI ≥100**

Option 3: Install high albedo surfaces and green roofs that, in combination, meet the following criteria: (Area roof meeting minimum SRI/0.75) + (Area of vegetated roof/0.5) ≥ Total roof area

LEED- EA Credit 2: Renewable Energies on Site

WHITE REFLEX increases the yield of photovoltaic solar panels, one of the systems to produce energy from renewable sources on site, permitted in point EA2, used to offset the energy consumption of the building (the increase is estimated at between 4 and 10%, systems installed on roofs are being tested).

Note. Note that the use of reflective paints, such as WHITE REFLEX, on FIRESTOP POLIESTERE could invalidate the fire certification, because the tests should be repeated with the paint, so for a white reflective covering choose FIRESTOP POLIESTERE with Mineral Reflex White ultrawhite slate, which does not affect the validity of the certification since the slate is still non-combustible.

The use of **WHITE REFLEX** paint, which can maintain the waterproof covering at around 40°C, translates into a reduction of 10 - 20°C in the temperature of rigid photovoltaic panels in crystalline silicon, increasing their yield by 3 – 8%. The yield of the photovoltaic panels increases with the increase in environmental luminosity.

WHITE REFLEX reflective paint increases the albedo, improving the yield of photovoltaic panels.

The estimated increase in the yield of traditional concentration photovoltaic panels (composed of crystalline or polycrystalline cells) of the two effects together is of the order of 4 – 10%.

To demonstrate and validate this assertion,

INDEX authorised a series of site tests and laboratory trials in collaboration with the University of Modena and Reggio Emilia in July 2007.

As well as adhesion tests on a range of application surfaces, specific tests were carried out to evaluate the possible increases in energy production that could be attributable to the presence of a reflectivesupport treated with **WHITE REFLEX**.

The energy production of a photovoltaic system with crystalline silicon cells was monitored from April (the month in which **WHITE REFLEX** was applied).

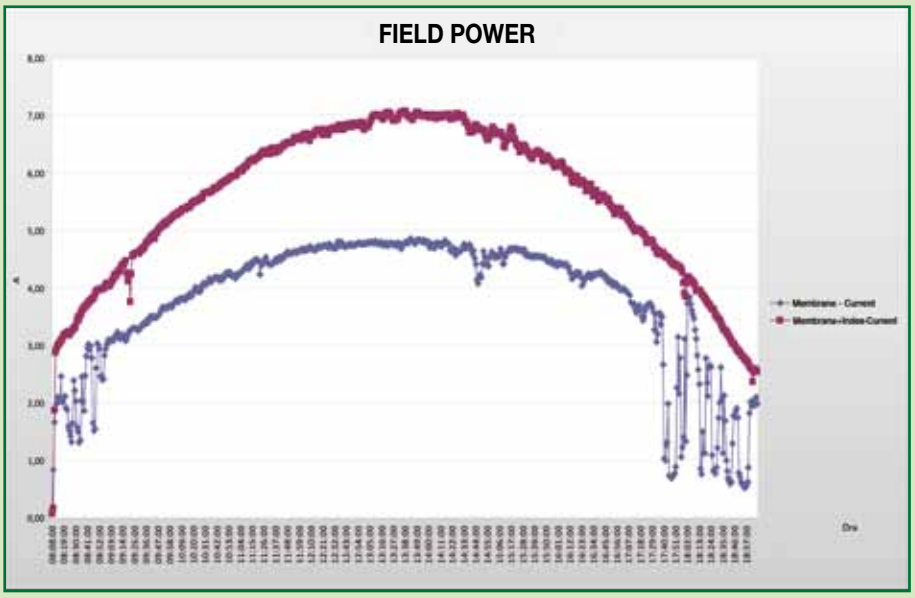
The system was installed on a roof of approximately 700 m² in order to compare the performance before and after the reflectiveand cooling treatment carried out with **WHITE REFLEX**.

2009	ELECTRICITY PRODUCED (watts)	SUN (days)	RAIN (days)	ENERGY/days SUN (watts/days SUN)
MAY	19341,5	24,5	6,5	789,45
JUNE	18709,7	22	8	850,44
JULY	25294,7	28,5	2,5	887,53
AUGUST	21496,3	27,5	3,5	781,68
SEPTEMBER	15953,1	26	4	613,58
Total	100795,3	128,5	24,5	784,40

2010	ELECTRICITY PRODUCED (watts)	SUN (days)	RAIN (days)	ENERGY/days SUN (watts/days SUN)
MAGGIO	17655,6	16,5	14,5	1070,04
GIUGNO	22727,5	25,5	4,5	891,27
LUGLIO	25065,8	28,5	2,5	879,50
AGOSTO	20814,4	25,5	5,5	816,25
SETTEMBRE	14076,8	22	8	639,85
Total	100340,1	118	35	850,34

The performance comparison described above analysed an interval of 5 months (from May to September) in 2009 (untreated roof with bare black bituminous covering) and in 2010 (after the treatment).
To obtain a rough but indicative assessment the data were compared considering the presence of the sun, consulting the meteorological tables for the San Giovanni in Marignano (RN) area.

Eliminating the days of persistent rain from the counts, and considering production to be have been halved on those days on which there was stormy weather, it was immediately evident that despite a notable increase in rain (in the month of May 2010) the system maintained constant energy production over the 5 months. The last column shows the figures that are of greatest interest for the objective set at the start of this test, the production of energy (in the form of energy proposed for sunny days), increased noticeably, by around 8%.
In conclusion, a commercial assessment could also be carried out, by quantifying the economic benefit of the presence of **WHITE REFLEX** very high solar reflectance paint.
After due consideration of the approximate nature of the sample data (the periods and intensity of sunshine are not known with precision), and evaluating the deterioration and loss of yield of the system itself (the manufacturers indicate that the reduction in performance is concentrated in the first period of operation), and so considering the energy produced as the sum of the energy that could potentially be sold, and the energy not requested by the grid, it was calculated that the system produced 8,400 watts of extra energy, a quantity that is almost sufficient to cover the costs incurred for the supply and application of the paint.
Very briefly, we could say that the operation covered its costs within one year, and generates "wealth" in subsequent years.



Alongside the systems with crystalline silicon cells (which at present account for 85% of installations) other types of photovoltaic panels are starting to be used in Italy.
One of the most interesting proposals is a type produced in the U.S. which is revolutionary in terms of ease of installation and maintenance, which does not require mechanical fixings or ballast on the roof. These systems, with cylindrical elements in CIGS (copper, indium, gallium, diselenide), able to capture both direct solar radiation and radiation reflected from a roof treated with **WHITE REFLEX**,
the increase in energy production should be even more consistent than those recorded in the previous test.
In the summer of 2009 (application on 29 June) we were able to carry out a test that had particularly interesting outcomes.
On the date of the first inspection the cylindrical cell system placed on a small roof (about 100 m^2) with a bituminous surface finish self-protected with green slate granules, less than 30% of the nominal energy expected was being produced.

The system dysfunction was caused by the very poor solar reflectance values of the covering, and the subsequent application of **WHITE REFLEX** paint would demonstrate this.

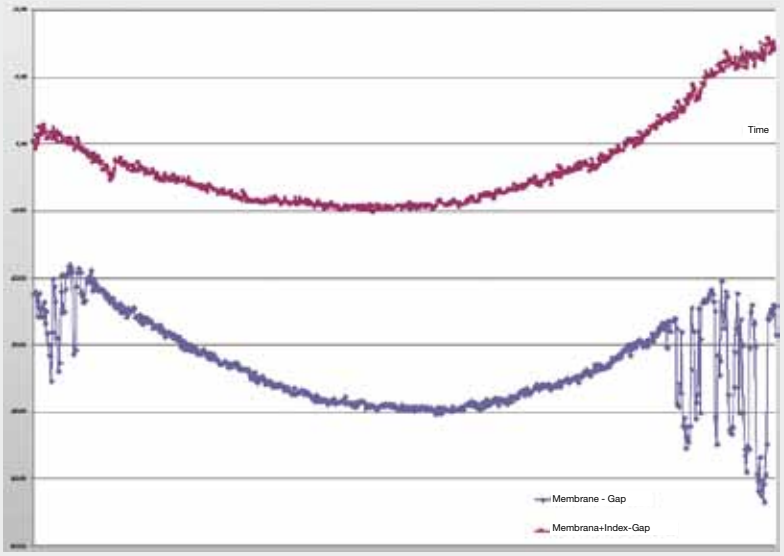
One month after the application the energy production data could be downloaded, and as shown by the graph on the previous page, a 30% increase in the field current (and hence the field power) produced had been recorded.
The other graph reproduced here, shows the energy produced by the system over a day of sunshine before and after the treatment with **WHITE REFLEX**. This shows a clear improvement, particularly at the times of the worst albedo (early morning and dusk).

BEFORE

After application, the effect of the paint could be seen immediately, albeit in an approximate way, using a solarimeter to measure solar radiation. An approximately 7-fold increase in solar reflection could be observed.

AFTER

DIFFERENCE BETWEEN EXPECTED POWER AND REAL POWER



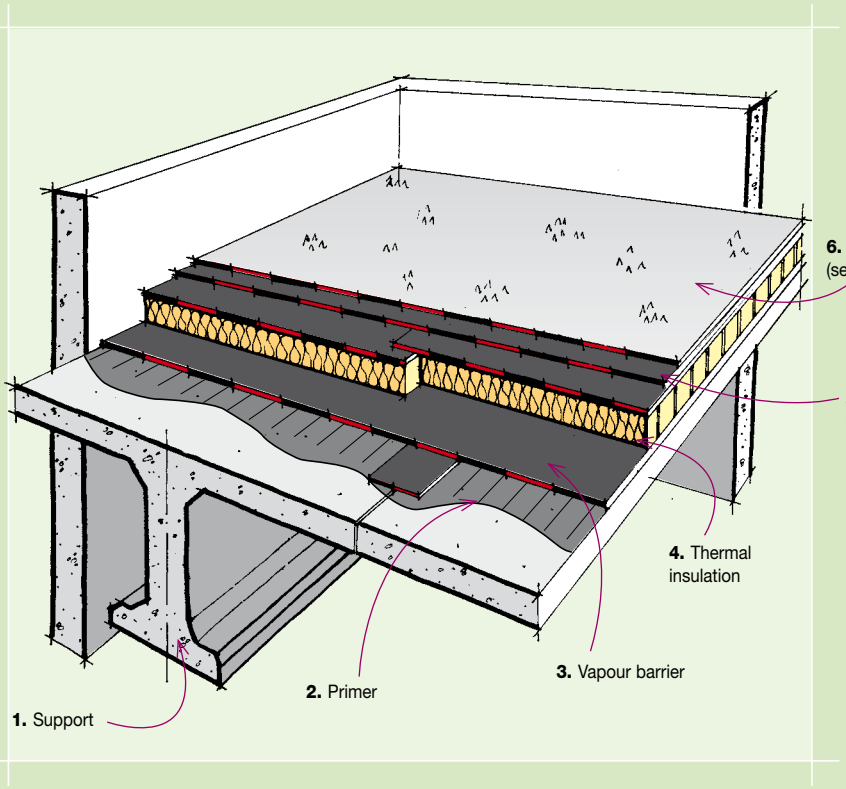
In conclusion, although testing cannot be considered finished yet, the presence of a high solar reflection roof may be considered absolutely necessary for this type of cylindrical cell system, and **WHITE REFLEX** paint, given its great flexibility in use (it adapts to almost any support) must be considered one of the most interesting solutions.

SOME ADVICE
from the ENEA publication "L'ENERGIA FOTOVOLTAICA" ("PHOTOVOLTAIC ENERGY").

Creating a photovoltaic system is not too complex, but is a job that should be left to specialists. However, it is useful to know some of the rules that must be respected in the design and subsequent installation phases.
The support structures must be built in such a way as to last at least as long as the system, i.e. 25-30 years, and must be erected in such a way as to allow easy access to the modules for replacement and cleaning, and to the electric junction box, for inspection and maintenance. They must also guarantee resistance to corrosion and wind.
The photovoltaic generators placed on roofs must not interfere with the waterproofing and insulation of the surfaces, and in some case fixed or mobile walkways may be needed.
An empty space, minimum 5 mm, must be provided between modules for generators fitted in parallel and and a short distance, up to 5 cm, from other fixed surfaces, for those generators on which wind pressure can reach high values.
If assembling modules on walls or facades, it is vital that a space (4-6 cm) is left between the modules and the surface to ensure good air circulation, and hence good cooling of the surface of the module.
The electrical cables and connecting and interconnection boxes must be of suitable size, meet electrical standards, and ensure the prescribed degree of insulation, protection and waterproofing required.

WATERPROOFING AND THERMAIL INSULATION OF

NEW OR COMPLETE RENOVATIONS OF FLAT ROOFS



LAYERS
1. Support
2. Primer
3. Vapour barrier
4. Thermal insulation
5. Waterproofing membrane (first layer)
6. Waterproofing membrane (second layer)

PRIMER

The primer penetrates into the pores of concrete surfaces, prevents dust and has the function of promoting adhesion on the surfaces to which the membranes must be bonded. INDEVER is a traditional solvent-based bituminous primer; the ECOVER water-based primer is more innovative and lower environmental impact. The whole surface to be covered and the vertical parts onto which the waterproof layer must be stuck, are painted with a coat of about 300 g/m^2 INDEVER adhesion bituminous primer, a solution based on oxidised bitumen, additives and solvents, with solid content (UNI EN ISO 3251) of 40% and viscosity (UNI EN ISO 2431) of 12-17 s, or ECOVER, with a water-based bituminous emulsion and solid content (UNI EN ISO 3251) of 37% using 250-400 g/m^2.

VAPOUR BARRIER

For a roof with a covering exposed to the external environment without ballast, the connection of the vapour barrier to the concrete support is of particular importance.
To oppose the force of the wind and to guarantee the dimensional stability of the stratified elements subject to heat variations, except for in special cases, the connection must be made with full adhesion.
To prevent the formation of bubbles on the vapour barrier generated by concrete supports that are still damp, it is appropriate for the vapour barrier + insulation + 1 layer of the covering all to be laid at the same time.
According to the different situations and requirements different technological solutions are identified for the vapour barrier.

	Traditional	**Innovative cold-bonded double-sided adhesive** (with cold bonding of the incorporated insulation)	**Innovative torch-bonded** (with torch bonding of the incorporated insulation)
On roofs of rooms with low humidity (relative humidity <80% at 20°C)	*case* **A** **DEFEND - 3 mm** heat-bonded adhesive under stuck insulation (1)	*case* **C** **SELFTENE BV BIADESIVO POL. SELFTENE BV BIADESIVO/V** cold-bonded adhesive under stuck insulation (*) (2)	*case* **E** **TECTENE BV STRIP/V PROMINENT/V** heat-bonded adhesive under stuck insulation (3)
Vapour barrier on roofs of rooms with high humidity (relative humidity > 80% at 20°C)	*case* **B** **DEFEND ALU POL. -3 mm** heat-bonded adhesive under stuck insulation (1)	*case* **D** **SELFTENE BV BIADESIVO ALU POLYESTER** cold-bonded adhesive under stuck insulation (*) (2)	*case* **F** **TECTENE BV STRIP ALU POL. PROMINENT ALU POL.** heat-bonded adhesive under stuck insulation (3)
Special case of draining vapour barrier on roofs of rooms with very high humidity			*case* **G** **DIFFUSER ALU POL.** heat-bonded semi-adhesive + "***case A***" or "***case E***"

(*) *System to be used for surface areas of ≤500 m^2*
(1) *Insulation stuck with molten oxidised bitumen*
(2) *Insulation cold-bonded onto the upper self-adhesive face of the vapour barrier*
(3) *Insulation stuck by heat bonding of the strips or the heat-adhesive embossings on the upper face of the vapour barrier*

A; B. *On DEFEND and DEFEND ALU POLYESTER heat-resistant insulating panels and THERMOBASE PUR and THERMOBASE FR are chosen.*
C; D. *On SELFTENE BV BIADESIVO polystyrene or polyurethane panels can be stuck, and THERMOBASE PSE, THERMOBASE PSE/EX and THERMOBASE PUR*
E; F. *Heat bonding on PROMINENT is reserved for heat-resistant thermal insulation and THERMOBASE PUR whereas on TECTENE BV STRIP polystyrene and polyurethane panels can be stuck, and THERMOBASE PSE, THERMOBASE PSE/EX and THERMOBASE PUR using suitably trained labour.*

THERMAL INSULATION

This is required for containing energy consumption and limiting any dilations of the load-bearing structure; it also prevents internal condensation of water vapour on cold walls. Either fibrous or cellular, the most common insulators are: glass-fibre or rock mineral fibre panels, expanded polyurethane or polystyrene panels, perlite and cellulose fibre agglomerates, cork, etc. INDEX produces the THERMOBASE insulation in rolls, made up of strips of insulating material already bonded to a bitumen-polymer membrane, a product that meets the specifications of *sustainable building* because membrane/insulation bonding in the factory reduces the laying operations on the roof and the consequent emission of fumes, smells and noise in the environment. For flat roofs that are not walkable, with bare covering under the photovoltaic system, types that are more resistant to the compression and foot traffic necessary for maintenance of the system are preferred. The insulating materials are produced in different types, densities and dimensions, according to their intended use. It is important to choose materials of the type expressly declared by the manufacturer as being suitable for roof insulation and to be bonded and coated with bitumen-polymer membranes and bituminous materials in general. Cellular insulating materials are preferable because, in the event of leaks in the waterproof layer, they absorb less water. Heat-resistant insulating panels (perlite, expanded polyurethane, cork, mineral wools), such as THERMOBASE PUR can be bonded with molten oxidised bitumen. For safer laying, reducing the risk of burns and the emission of fumes and smells, the expanded polyurethane panels and THERMOBASE PUR can also be heat-bonded onto the PROMINENT and TECTENE BV STRIP EP membranes and can be heat-bonded directly to the waterproof covering suggested below. Expanded polystyrene insulating panels can be heat-bonded onto TECTENE BV STRIP EP or cold-bonded onto SELFTENE BV BIADESIVO and then before laying the waterproof layer they must be protected with the self-thermoadhesive membrane in the AUTOTENE BASE series, which is bonded onto the polystyrene panel on its own, using the heat transmitted from the heat bonding of the waterproof layer above; alternatively rolls of insulation pre-bonded to a membrane of the THERMOBASE PSE/120 or THERMOBASE PSE/EX type can be used.

The thickness of the insulation must be sufficiently high to prevent the dew point dropping below the vapour barrier and must comply with legislation in force on energy containment in buildings.

THERMOBASE PSE/120-V3											
Thickness	20	30	40	50	60	70	80	90	100	110	120
Thermal resistance R_D (m^2K/W)	0.58	0.87	1.16	1.44	1.73	2.01	2.30	2.58	2.87	3.16	3.44

THERMOBASE PSE/EX-V3							
Thickness	30	40	50	60	80	100	120
Thermal resistance R_D (m^2K/W)	0.92	1.22	1.48	1.78	2.23	2.79	3.35

THERMOBASE PUR-V3					
Thickness	30	40	50	60	80
Thermal resistance R_D (m^2K/W)	1.08	1.44	1.80	2.16	3.09

WATERPROOF COVERING

Roofs with exposed covering are the most common and widely used solution for industrial and commercial buildings, which are often large. Exposed roof coverings are more stressed, because they are directly exposed to the weather, and if it is fitted under a photovoltaic system that must last more than 20 years it is important to choose long lasting membranes. It must be considered that the waterproof covering is a continuous element that almost always covers discontinuous element; therefore the mechanical resistance and elasticity of the covering also play an important role as a good grip must be guaranteed on concrete substructures where there may be cracks or where the joining lines of prefabricated concrete panels or insulating panels undergo opening and closing cycles generated by temperature differences and can cause fatigue of the covering above causing the waterproofing to crack. The completely bonded covering is more stable and more resistant to impact and static load, wind and hail stones and in the event of accidental tearing, not much water passes through.

The recommended connection to the substructure for the exposed covering is in full adhesion which, as well as the benefits already stated, fights the phenomenon of reptation which can occur in colder climates on exposed coverings without heavy protection.

Only in the case of bare coverings laid directly on concrete supports, and in the case of renovations of coverings that might retain damp is the laying of a semi-independent covering advisable, as an alternative to full adhesion, to avoid the formation of bubbles generated by damp trapped in damp supports that is transformed into damp when the covering is exposed to the sun. The PROTEADUO, HELASTA and FLEXTER FLEX TESTUDO membranes proposed in this publication are all covered by the Agrément ITC-CNR (former ICITE), which certifies their durability and related constant periodic inspections. Although the proposed membranes can be laid in a single layer 4 mm thick in compliance with their CE marking, it has become common practice to lay a double layer to achieve a higher degree of safety and in relation to the fact that repair work in the event of defect in the covering.

A further reason for laying a double layer is the greater resistance to fire from sources external to the waterproof covering, required by the Guide for the installation of photovoltaic systems annexed to the circular on the fire prevention requisites of photovoltaic systems installed on the roofs of buildings in which activities subject to fire prevention control take place, issued by the Fire Brigade Department of the Italian Ministry of the Interior on 07/02/2012 and subsequent updated issued on 04/05/2012 – case 3a. In this case a **membrane with Broof classification in accordance with UNI EN 13501-5:2009 based on the results of tests of exposure of roofs to an external fire in conformity with UNI ENV 1187:2007 should be laid as the overlay of the new waterproofing system.** FIRESTOP POLIESTERE membrane is classified Broof (t2) in conformity with UNI EN 13501-5:2009 on either a combustible or a non-combustible substrate.

The Broof(t2) classification is the only one that envisages more articulated broad rules for the field of application of the membrane tested on different substructures.

FIRESTOP POLIESTERE is the fire resistant membrane with the broadest field of application, in fact its certification makes it suitable for laying on both flat and sloping roofs, and on combustible or non-combustible substrates, provided their density is > 16 kg/m^3, in which case it is applicable: **on any kind of thermal insulation of density > 16 kg/m^3; on wood substructures, concrete substructures, metal substructures, bituminous substructures** etc, since, used as finishing layer of a new or old bituminous waterproof covering it satisfies the requirements of the Guide for the installation of photovoltaic systems, 2012 edition.

The systems recommended in this publication are as follows:

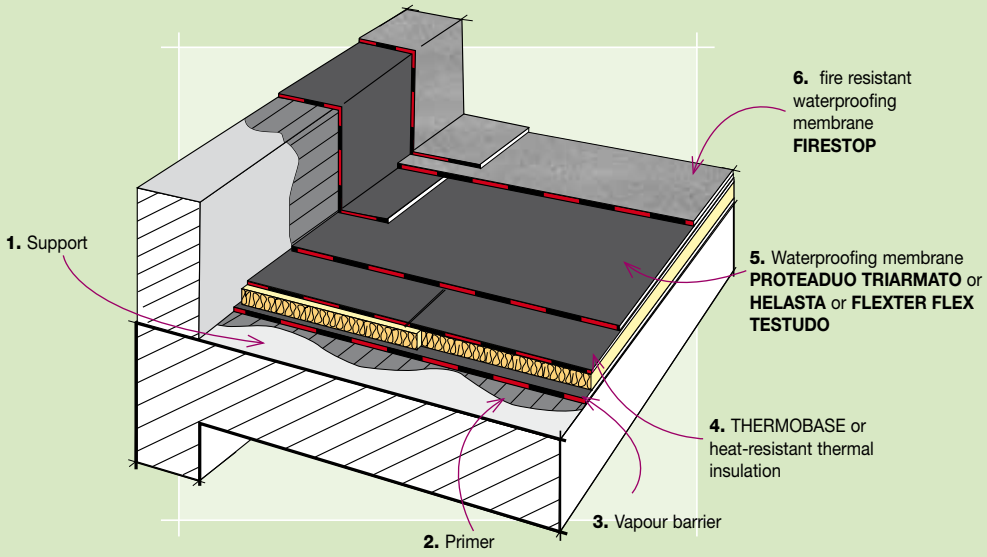
- **Double layer with exposed covering on heat-resistant thermal insulation and THERMOBASE (also valid for roofs with pitch < 40%)** – page 10.
- **Double layer with exposed covering on heat-resistant thermal insulation and THERMOBASE (also valid for roofs with pitch < 15%)** – page 11.
- **Double layer with exposed covering on heat-resistant thermal insulation and THERMOBASE (also valid for roofs with pitch < 15%)** – page 12.

Preparation of the substructure, other technical solutions and technical details are illustrated in

TECHNICAL SPECIFICATIONS 2 "Non-walkable flat roof"

WATERPROOF COVERING

TWO-LAYER WATERPROOF COVERING TORCH-BONDED IN FULL ADHESION ON HEAT-RESISTANT THERMAL INSULATION AND ON THERMOBASE (valid for roofs with pitch(*) ≤40%)



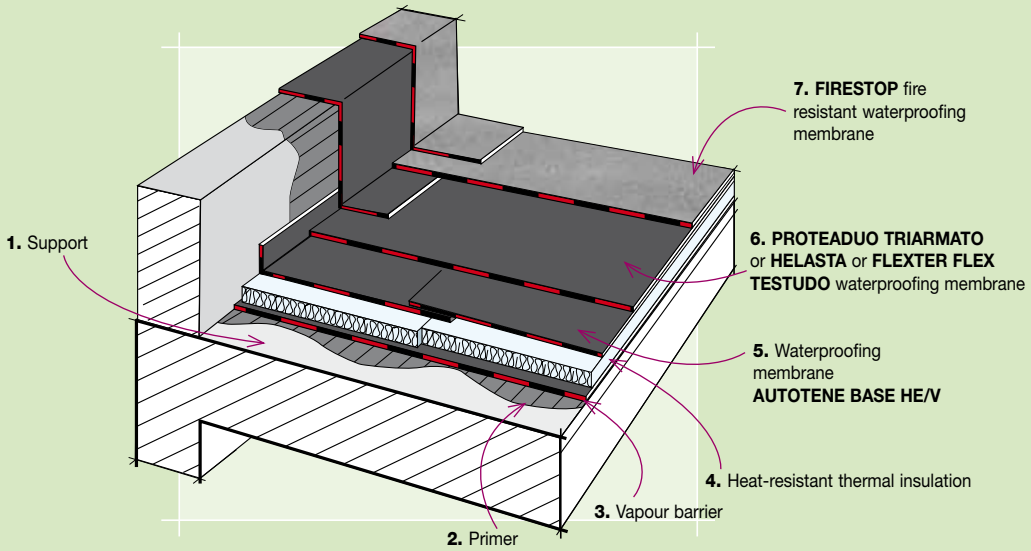
LAYERS
1. Support
2. Primer
3. Vapour barrier
4. THERMOBASE or heat-resistant thermal insulation
5. **PROTEADUO TRIARMATO** or **HELASTA** or **FLEXTER FLEX TESTUDO** waterproofing membrane
6. **FIRESTOP** fire resistant waterproofing membrane

• Laying method
Underlay membrane: The distilled 4 mm thick bitumen-polymer waterproofing under membrane Agrement/DVT ITC-CNR certified will be torch bonded in full adhesion to the layer of THERMOBASE or heat resistant thermal insulation.
The sheets of membrane unrolled along in parallel the line of maximum pitch, should be overlapped 10 cm longitudinally and 15 cm at the top, and continuously torch-bonded to the substructure and along the overlaps. They will also be turned up and torch bonded to the vertical parts.
Alternatively, the following membranes may be used:
• PROTEADUO TRIARMATO multi-layer composite distilled bitumen polymer membrane;
Alternatively:
• HELASTA POLIESTERE distilled bitumen elastomeric polymer membrane;
Alternatively:
• FLEXTER FLEX SPUNBOND POLIESTERE distilled bitumen elastoplastomeric polymer membrane.
Overlay membrane: The overlay of the waterproofing covering will be composed of a **FIRESTOP POLIESTERE** fire-resistant distilled bitumen-elastoplastomeric polymer waterproofing membrane, self-protected with slate granules, with mass-to-air ratio (EN 1849-1) of 4.5 kg/m^2, based on distilled bitumen, plastomers and elastomers, and harmless inorganic flame retardant additives with reinforcement consisting of spunbond non-woven polyester fabric. The membrane will have Euroclass E reaction to fire (EN 13501-1), with **Broof (t2) classification of resistance to external roof fires on both combustible and non-combustible laying surfaces (according to UNI EN 13501-5:2009 fire classification of construction elements and products - part 5: classification based on the results of tests exposing roofs to external fire according to UNI ENV 1187:2007)**.
The sheets on the second layer will be laid overlapping by 10 cm longitudinally and 15 cm transversally, across the overlaps of the first layer, and torch-bonded onto the whole surface and the overlaps. The waterproof covering will be turned up on the vertical parts to at least 20 cm above the water runoff plane.

(*) **For pitches of 40 to 100%**, the bonding of the waterproof membrane should be supplemented by mechanical fixing using nails with 50 mm diameter washers every 20 cm, under the overlaps at the top of the last sheet.

WATERPROOF COVERING

TWO-LAYER WATERPROOF COVERING TORCH-BONDED IN FULL ADHESION ON NON-HEAT-RESISTANT THERMAL INSULATION PROTECTED BY A SELF-THERMOADHESIVE MEMBRANE (valid for roofs with pitch ≤15%)



LAYERS
1. Support
2. Primer
3. Vapour barrier
4. Heat-resistant thermal insulation
5. **AUTOTENE BASE HE/V** self-thermoadhesive waterproofing membrane
6. **PROTEADUO TRIARMATO** or **HELASTA** or **FLEXTER FLEX TESTUDO** waterproofing membrane
7. **FIRESTOP** fire resistant waterproofing membrane

• Laying method

Protection layer. An AUTOTENE BASE HE/V distilled bitumen polymer membrane reinforced with glass-fibre, with the underside and the overlap of the upper side coated with an adhesive mix activatable by the indirect heat generated by the torching of the next layer will be used to protect the heat-sensitive thermal insulation. The sheets of membrane will be loose laid on the insulating panels with 6 cm longitudinal overlaps and 10 cm transversal overlaps. Both self-thermoadhesive surfaces are protected by a silicone-coated film which is removed as the rolls used to cover the whole flat surface are unrolled to cover the whole flat surface and turned up 5 cm onto the vertical parts. The angle between the flat and vertical parts will be reinforced by torch-bonding across the corner a 20 cm wide 4 mm thick strip of membrane of the same type as the membrane to be used to cover the flat areas.

Underlay membrane: The next layer of the waterproof coating will be composed of a 4 mm thick distilled bitumen polymer waterproof membrane, reinforced with non-woven polyester fabric, certified with Agrement/DVT of the ITC-CNR.

The sheets on the second layer will be laid overlapping by 10 cm longitudinally and 15 cm transversally, across the overlaps of the first layer, and torch-bonded onto the whole surface and the overlaps. The waterproof covering will be anchored at the foot of the vertical parts.

Alternatively, the following membranes may be used:

• PROTEADUO TRIARMATO multi-layer composite distilled bitumen polymer membrane;

Alternatively:

• HELASTA POLIESTERE distilled bitumen elastomeric polymer membrane;

Alternatively:

• FLEXTER FLEX SPUNBOND POLIESTERE distilled bitumen elastoplastomeric polymer membrane.

Overlay membrane: The overlay of the waterproofing covering will be composed of a **FIRESTOP POLIESTERE** fire-resistant distilled bitumen-elastoplastomeric polymer waterproofing membrane, self-protected with slate granules, with mass-to-air ratio (EN 1849-1) of 4.5 kg/m^2, based on distilled bitumen, plastomers and elastomers, and harmless inorganic flame retardant additives with reinforcement consisting of spunbond non-woven polyester fabric. The membrane will have Euroclass E reaction to fire (EN 13501-1), with **Broof (t2) classification of resistance to external roof fires on both combustible and non-combustible laying surfaces (according to UNI EN 13501-5:2009 fire classification of construction elements and products - part 5: classification based on the results of tests exposing roofs to external fire according to UNI ENV 1187:2007)**.

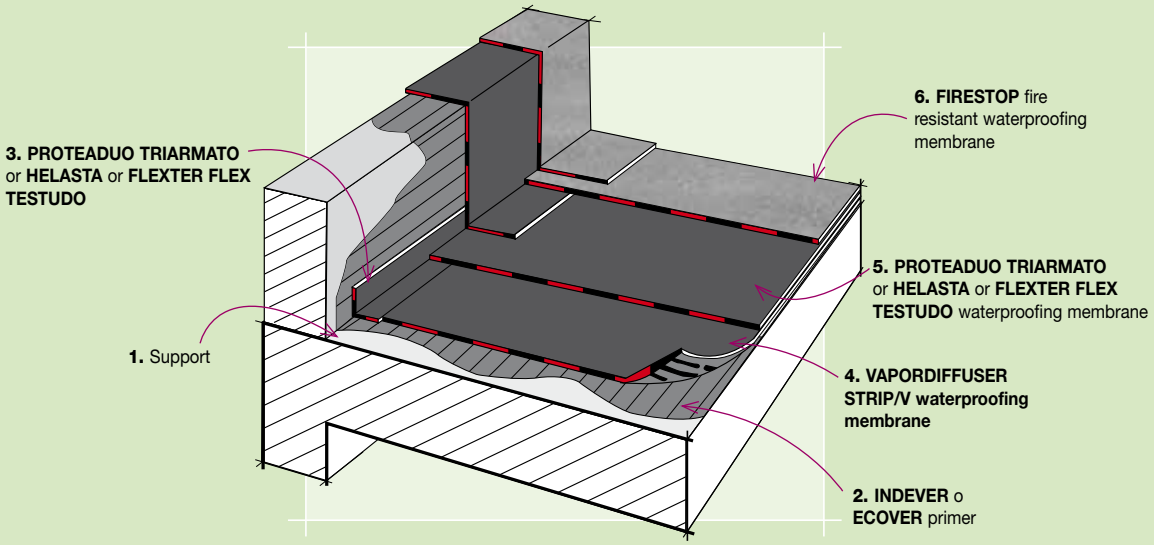
The sheets on the second layer will be laid overlapping by 10 cm longitudinally and 15 cm transversally, across the overlaps of the first layer, and torch-bonded onto the whole surface and the overlaps. The waterproof covering will be turned up on the vertical parts to at least 20 cm above the water runoff plane.

(*) **For pitches of 15 - 40%**, the bonding of the waterproof membrane should be supplemented by mechanical fixing using nails with 50 mm diameter washers every 20 cm, under the overlaps at the top of the last sheet.

NEW OR COMPLETE RENOVATIONS OF FLAT ROOFS

WATERPROOF COVERING

TWO-LAYER WATERPROOF COVERING TORCH-BONDED IN FULL ADHESION ON THERMOADHESIVE UNDERLAY IN PARTIAL ADHESION OF THE BANDS TO THE CONCRETE SURFACES (valid for roofs with pitch(*) ≤ 15%)



LAYERS
1. Support
2. **INDEVER** or **ECOVER** Primer
3. **PROTEADUO TRIARMATO** or **HELASTA** or **FLEXTER FLEX TESTUDO**
3. **VAPORDIFFUSER STRIP/V** waterproofing membrane
4. **PROTEADUO TRIARMATO** or **HELASTA** or **FLEXTER FLEX TESTUDO** waterproofing membrane
5. **FIRESTOP** fire resistant waterproofing membrane

• Laying method

Primer. Firstly, a coat of INDEVER bituminous primer will be applied to the clean and dry substructure, at 0,3 - 0,5 kg/m², or, alternatively, water-based ECOVER primer, applied at 0,25 - 0,40 kg/m². The angle between the flat and vertical part will be reinforced by torch-bonding across the corner a 20 cm wide 4 mm thick strip of smooth membrane of the same type as the membrane to be used as the upper layer, to be applied before the vertical parts are covered.

Vapour diffusion layer. The VAPORDIFFUSER STRIP/V, thermoadhesive waterproofing membrane in distilled bitumen elastoplastomeric polymer based on distilled bitumen, plastomers and elastomers, reinforced with glass-fibre, with 40% of the lower face coated with bands of elastomer thermoadhesive which, with 40% of the lower face coated with bands of special elastomer thermoadhesive, and, adhering only partially by torch-bonding, will allow the damp trapped in the concrete support to diffuse, avoiding bubbles and condensation, will be torch-bonded to the clean and dry substructure without a prior application of primer.

The sheets will be unrolled on the flay part until the connect with the reinforcement strip previously arranged on the corner between the flat and vertical surfaces, and will be turned and overlapped 10 cm longitudinally with a 15% overlap transversally at the top.

After aligning and rearranging the sheets, they will be bonded by heating the lower face of the sheet with a propane gas torch, activating the adhesive properties of the bands of thermoadhesive. The overlaps of the sheets will be torch-bonded at the same time.

Underlay membrane: The next layer of the waterproof coating will be composed of a 4 mm thick distilled bitumen polymer waterproof membrane, reinforced with non-woven polyester fabric, certified with Agrement/DVT of the ITC-CNR.

The sheets on the second layer will be laid overlapping by 10 cm longitudinally and 15 cm transversally, across the overlaps of the first layer, and torch-bonded onto the whole surface and the overlaps. The waterproof covering will be anchored at the foot of the vertical parts.

Alternatively, the following membranes may be used:

• PROTEADUO TRIARMATO multi-layer composite distilled bitumen polymer membrane;

Alternatively:

• HELASTA POLIESTERE distilled bitumen elastomeric polymer membrane;

Alternatively:

• FLEXTER FLEX SPUNBOND POLIESTERE distilled bitumen elastoplastomeric polymer membrane.

Overlay membrane: The overlay of the waterproofing covering will be composed of a **FIRESTOP POLIESTERE** fire-resistant distilled bitumen-elastoplastomeric polymer waterproofing membrane, self-protected with slate granules, with mass-to-air ratio (EN 1849-1) of 4.5 kg/m², based on distilled bitumen, plastomers and elastomers, and harmless inorganic flame retardant additives with reinforcement consisting of spunbond non-woven polyester fabric. The membrane will have Euroclass E reaction to fire (EN 13501-1), with **Broof (t2) classification of resistance to external roof fires on both combustible and non-combustible laying surfaces (according to UNI EN 13501-5:2009 fire classification of construction elements and products - part 5: classification based on the results of tests exposing roofs to external fire according to UNI ENV 1187:2007)**.

The sheets on the second layer will be laid overlapping by 10 cm longitudinally and 15 cm transversally, across the overlaps of the first layer, and torch-bonded onto the whole surface and the overlaps. The waterproof covering will be turned up on the vertical parts to at least 20 cm above the water runoff plane.

(*) **For pitches of 15 - 40%**, the bonding of the waterproof membrane should be supplemented by mechanical fixing using nails with 50 mm diameter washers every 20 cm, under the overlaps at the top of the last sheet.

CONSERVATIVE RENOVATIONS

This technical note applies to cases of renovation without demolition, when the old layer structure can be maintained in place.
Demolition of the existing layer structure, should, for both economic and environmental reasons, be the last solution to be considered!!
Full demolition should only be considered in the presence of a layer structure that includes fibrous thermal insulation which is disintegrating and heavily impregnated with water.
Deferring demolition works and the consequent reduction in waste over time that results from this is a fundamental criterion of sustainable building.
The disposal of waste, and the costs of this, are increasingly problematic, and so it makes sense to avoid the full demolition of the old layer structure.

In conformity with the criteria of the Green Building Council, renovation that avoids demolition of the existing covering contributes to meet the following *LEED* criteria:

LEED- EA Credit 1.1: : Building Reuse Maintain Existing Walls, Floors and Roof

The technical/economic/environmental advantages of avoiding demolition of the existing covering:

- **INDEX polymer bituminous membranes allow the life of old bituminous coverings to be extended (TLE) by "complete overlay" of the new membrane without demolition and consequent accreditation of *LEED* credits in accordance with the Green Building Council criteria.**
- **The great advantage of bituminous coverings is that they can be regenerated with membranes of the same nature, increasing their "useful life" 2 or 3 wrinkle, reducing the costs of demolition and waste disposal, over time .**
- **With a renewal layer that adheres to the old covering, the waterproof function of the existing roof is recovered, and the covering is more resistant.**
- **The layer structures described below all roofs to be renovated, eliminating the environmental impact of waste in accordance with the criteria of sustainable building.**

Preliminary works to renovate the old waterproof covering

Before proceeding with the renovation works, it is necessary to distinguish between:

- bituminous covering that has reached the end of its life, but is still flat, waterproof and stuck to the support, with a few defects limited to some bubbles and a few small wrinkles with no trapped damp.
- poorly adhering covering on which there are signs of leaks and major corrugation, which is thought to retain damp between the layers.

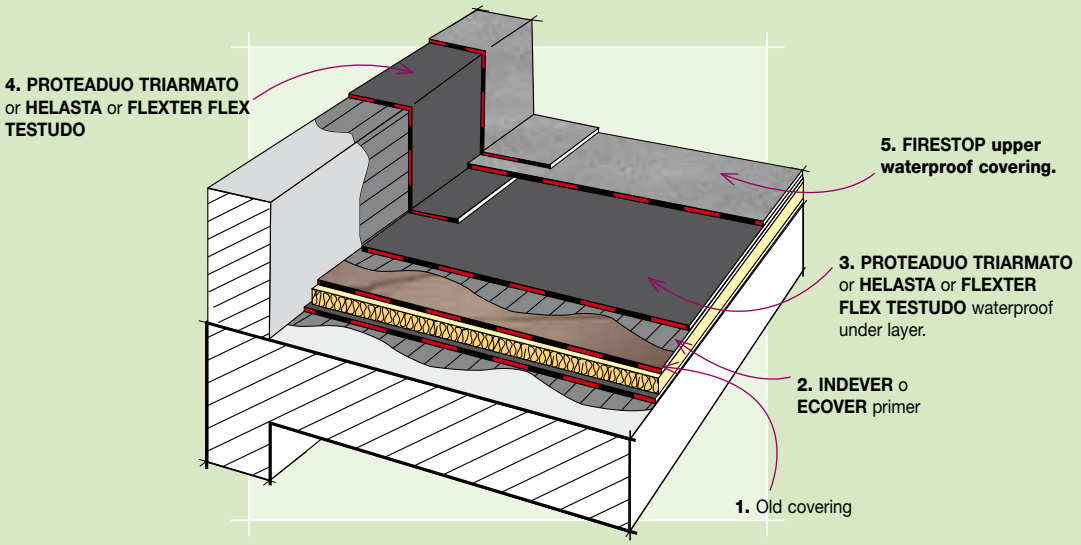
In the first case, after repairing the cracks with a torch-bonded strip of membrane, and flattening the bubbles with crossed slashes covered with a patch of membrane bonded in the same way, the covering can be torch-bonded with **full adhesion**.

In the second case, however, for example, in the ase of a covering that is wrinkled because it is not well bonded, it is likely that water has penetrated between the layers, through the opening of an overlap with wrinkles, and that water remains trapped that can generate bubbles of steam in the sun, if the new covering is bonded with full adhesion. The same thing can happen when the finishing layer of the old covering is a slated membrane reinforced with glass-fibre and bonded to a membrane reinforced with non-woven polyester fabric.
The old covering may well not leak, but the top slated later is cracked, and water has penetrated between the layers. In this case, too, a new covering bonded in full adhesion may generate vapour bubbles.
In the cases mentioned above, the new covering must be bonded **in semi adhesion**, so that the water vapour that develops can diffuse without creating bubbles.
At the same time, the bond, even though partial, must be able to resist the action of the wind, and for this Index has developed specific membranes that are bonded in semi adhesion to the old covering even without the use of primer, and which are wind resistant.
These are membranes whose lower surfaces are coated with a special thermoadhesive elastomer mixture that guarantees strong and elastic adhesion for 40 % of the surface.
The strip bonding of a membrane to a nailed insulation panel **has successfully resisted the maximum level of 10kPa of the wind resistance test specified in standard EN 16002**.
The test is transferable to all the types produced with the same strip configuration of the lower face, and the exceeding of the maximum level of the new covering means that, to obtain a renovation with the maximum wind resistance, all the attention should be focussed on the safe and effective stabilisation of the old covering. Briefly, the wind resistance of the renovation work is entirely dependent on how the old covering is attached.

Bonding in bands creates a microgap between the old and the new covering in which water vapour can diffuse without forming bubbles.
Adhesion in bands will have a further advantage, because it distributes the movements of the insulating panels of the underlying support over a wider area of new covering, reducing considerably the mechanical stresses on it.

WATERPROOF COVERING

TWO-LATER RENOVATION TORCH BONDED IN FULL ADHESION ON A COAT OF PRIMER (valid for roof pitches (*) ≤40%)



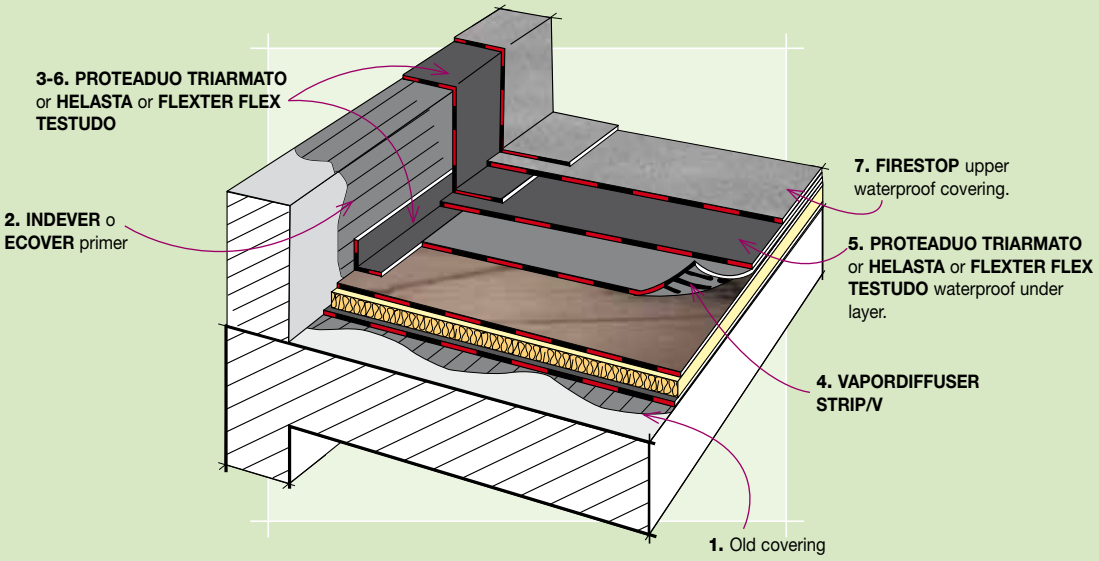
LAYERS
1. Old covering
2. **INDEVER** o **ECOVER** primer
3. **PROTEADUO TRIARMATO** or **HELASTA** or **FLEXTER FLEX TESTUDO** waterproof under layer.
4. **PROTEADUO TRIARMATO** or **HELASTA** or **FLEXTER FLEX TESTUDO**
5. **FIRESTOP upper waterproof covering.**

• Laying method
Primer. After repairing the old covering, a coat of INDEVER bituminous primer will be applied to the clean and dry substructure, at 0.3 – 0.5 kg/m², or, alternatively, water-based ECOVER primer, applied at 0.25 – 0.40 kg/m².
Underlay membrane: The 4 mm thick distilled bitumen polymer waterproof membrane, reinforced with non-woven polyester fabric , certified with Agrement/DVT of the ITC-CNR will then be torch bonded in full adhesion.
The sheets of membrane unrolled along in parallel the line of maximum pitch, should be overlapped 10 cm longitudinally and 15 cm at the top, and continuously torch-bonded to the substructure and along the overlaps. They will also be turned up and torch bonded to the vertical parts.
Alternatively, the following membranes may be used:
• PROTEADUO TRIARMATO multi-layer composite distilled bitumen polymer membrane;
Alternatively:
• HELASTA POLIESTERE distilled bitumen elastomeric polymer membrane;
Alternatively:
• FLEXTER FLEX SPUNBOND POLIESTERE distilled bitumen elastoplastomeric polymer membrane.
Overlay membrane: The overlay of the waterproofing covering will be composed of a **FIRESTOP POLIESTERE** fire-resistant distilled bitumen-elastoplastomeric polymer waterproofing membrane, self-protected with slate granules, with mass-to-air ratio (EN 1849-1) of 4.5 kg/m², based on distilled bitumen, plastomers and elastomers, and harmless inorganic flame retardant additives with reinforcement consisting of spunbond non-woven polyester fabric. The membrane will have Euroclass E reaction to fire (EN 13501-1), with **Broof (t2) classification of resistance to external roof fires on both combustible and non-combustible laying surfaces (according to UNI EN 13501-5:2009 fire classification of construction elements and products - part 5: classification based on the results of tests exposing roofs to external fire according to UNI ENV 1187:2007)**.
The sheets on the second layer will be laid overlapping by 10 cm longitudinally and 15 cm transversally, across the overlaps of the first layer, and torch-bonded onto the whole surface and the overlaps. The waterproof covering will be turned up on the vertical parts to at least 20 cm above the water runoff plane.

(*) **For pitches of 40 to 100%**, the bonding of the waterproof membrane should be supplemented by mechanical fixing using nails with 50 mm diameter washers every 20 cm, under the overlaps at the top of the last sheet.

WATERPROOF COVERING

TWO-LATER RENOVATION TORCH BONDED IN FULL ADHESION ON A COAT OF PRIMER (valid for roof pitches (*) ≤15%)



LAYERS
1. Old covering
2. **INDEVER** o **ECOVER** primer
3. **PROTEADUO TRIARMATO** or **HELASTA** or **FLEXTER FLEX TESTUDO**
4. **VAPORDIFFUSER STRIP/V**
5. **PROTEADUO TRIARMATO** or **HELASTA** or **FLEXTER FLEX TESTUDO** waterproof under layer.
6. **PROTEADUO TRIARMATO** or **HELASTA** or **FLEXTER FLEX TESTUDO**
7. **FIRESTOP upper waterproof covering.**

• Laying method

Vapour diffusion layer. After cutting the parts of the old covering stretched at the base of the protruding parts, remove the covering that does not adhere to the vertical parts, cut and flatten all creases in the covering, re-attaching them to the support and, after stabilising the old waterproofing with mechanical fixing. The angle between the flat and vertical part will be reinforced by torch-bonding across the corner a 20 cm wide 4 mm strip of smooth membrane of the same type to be used as the next layer which will be applied before the flat area is covered.

The VAPORDIFFUSER STRIP/V, thermoadhesive waterproofing membrane in distilled bitumen elastoplastomeric polymer based on distilled bitumen, plastomers and elastomers, reinforced with glass-fibre, with 40% of the lower face coated with bands of elastomer thermoadhesive which, adhering only partially by torch-bonding, will allow the damp trapped in the concrete support to diffuse, avoiding bubbles and condensation, will be torch-bonded to the clean and dry laying surface without a prior application of primer.

The sheets will be unrolled on the flay part until the connect with the reinforcement strip previously arranged on the corner between the flat and vertical surfaces, and will be turned and overlapped 10 cm longitudinally with a 15% overlap transversally at the top.

After aligning and rearranging the sheets, they will be bonded by heating the lower face of the sheet with a propane gas torch, activating the adhesive properties of the bands of thermoadhesive. The overlaps of the sheets will be torch-bonded at the same time.

Underlay membrane: The next layer of the waterproof coating will be composed of a 4 mm thick distilled bitumen polymer waterproof membrane, reinforced with non-woven polyester fabric, certified with Agrement/DVT of the ITC-CNR (former ICITE).

The sheets on the second layer will be laid overlapping by 10 cm longitudinally and 15 cm transversally, across the overlaps of the first layer, and torch-bonded onto the whole surface and the overlaps. The waterproof covering will be anchored at the foot of the vertical parts.

Alternatively, the following membranes may be used:

• PROTEADUO TRIARMATO multi-layer composite distilled bitumen polymer membrane;

Alternatively:

• HELASTA POLIESTERE distilled bitumen elastomeric polymer membrane;

Alternatively:

• FLEXTER FLEX SPUNBOND POLIESTERE distilled bitumen elastoplastomeric polymer membrane.

Overlay membrane: The overlay of the waterproofing covering will be composed of a **FIRESTOP POLIESTERE** fire-resistant distilled bitumen-elastoplastomeric polymer waterproofing membrane, self-protected with slate granules, with mass-to-air ratio (EN 1849-1) of 4.5 kg/m^2, based on distilled bitumen, plastomers and elastomers, and harmless inorganic flame retardant additives with reinforcement consisting of spunbond non-woven polyester fabric. The membrane will have Euroclass E reaction to fire (EN 13501-1), with **Broof (t2) classification of resistance to external roof fires on both combustible and non-combustible laying surfaces (according to UNI EN 13501-5:2009 fire classification of construction elements and products - part 5: classification based on the results of tests exposing roofs to external fire according to UNI ENV 1187:2007)**.

The sheets on the second layer will be laid overlapping by 10 cm longitudinally and 15 cm transversally, across the overlaps of the first layer, and torch-bonded onto the whole surface and the overlaps. The waterproof covering will be turned up on the vertical parts to at least 20 cm above the water runoff plane.

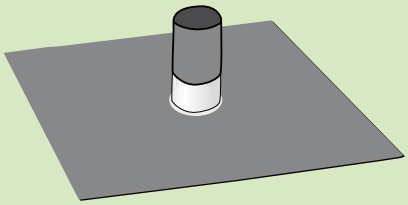
(*) **For pitches of 15 - 40%**, the bonding of the waterproof membrane should be supplemented by mechanical fixing using nails with 50 mm diameter washers every 20 cm, under the overlaps at the top of the last sheet.

Preparation of the substructure, other technical solutions and technical details are illustrated in

TECHNICAL SPECIFICATIONS 2 "Non-walkable flat roof"

LAYING DETAILS

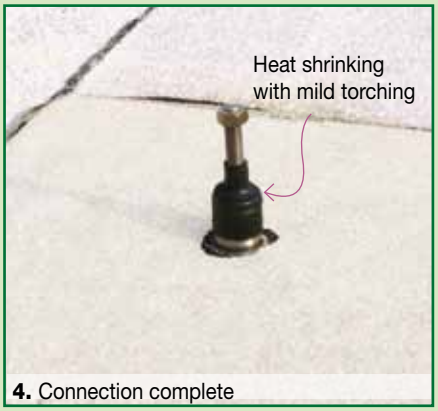
Vertical connectors



VERTICONNECT is a vertical connector with adjustable collars for the passage of cables into waterproofed coverings with bitumen polymer membrane.
It is a safe, flexible, waterproof solution for vertical connectors, pipes, sections, consoles, threaded rods, etc. which pierce the horizontal plane of a flat roof waterproofed with bitumen polymer membrane.

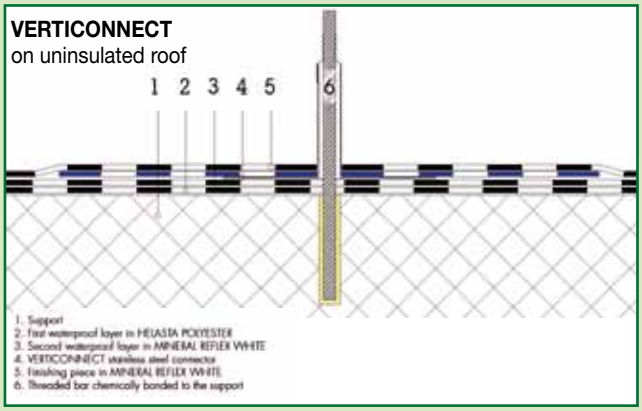
1. Application of VERTICONNECT

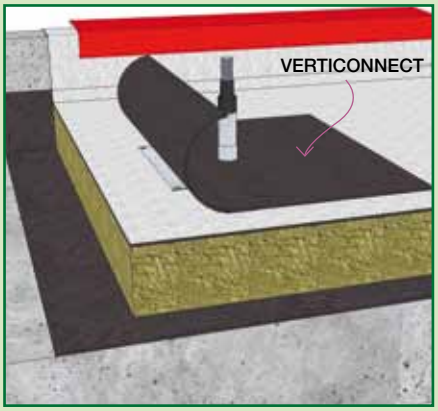
2. Application of finishing patch on VERTICONNECT



4. Connection complete

3. VERTICONNECT fixed to roof





Preparation of the substructure, other technical solutions and technical details are illustrated in

TECHNICAL SPECIFICATIONS 2
"Non-walkable flat roof"

TECHNICAL SPECIFICATIONS

PRIMER

INDEVER

Quick drying adhesion bituminous primer suitable for preparing surfaces for the heat bonding of polymer bitumen membranes, such as INDEVER, with a base of oxidised bitumen, additives and solvents with solid content (UNI EN ISO 3251) of 40% and cup viscosity of DIN/4 at 23°C (UNI EN ISO 2431) of 12 - 17 s.

ECOVER

Adhesion bituminous primer, suitable for preparing surfaces for the heat bonding of bitumen polymer membranes, such as ECOVER, with a water bituminous emulsion base, with solid content (UNI EN ISO 3251) of 37%.

VAPOUR BARRIER

INNOVATIVE VAPOUR BARRIERS WITH INCORPORATED ADHESIVE FOR COLD-BONDING OF THE THERMAL INSULATION

SELFTENE BV HE BIADESIVO ALU POLIESTERE

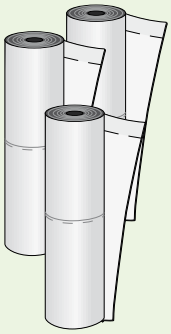
Bitumen elastomeric polymer vapour barrier membrane, 3 kg/m² (EN1849-1), reinforced with aluminium foil bonded to a non-woven composite polyester fabric stabilised with glass-fibre, with Euroclass E reaction to fire (EN 13501-1), water vapour permeability (EN 1931) μ=1,500,000, tensile strength (EN 12311-1) L/T of 250/120 N/50 mm and elongation at rupture(EN 12311-1) L/T of 15/20%.

SELFTENE BV HE BIADESIVO POLIESTERE

Bitumen elastomeric polymer vapour barrier membrane, 3 kg/m² (EN1849-1), reinforced with aluminium foil bonded to a non-woven composite polyester fabric stabilised with glass-fibre, with Euroclass E reaction to fire (EN 13501-1), water vapour permeability (EN 1931) μ=100,000, tensile strength (EN 12311-1) L/T of 400/300 N/50 mm and elongation at rupture(EN 12311-1) L/T of 40/40%.

SELFTENE BV HE BIADESIVO/V

Bitumen elastomeric polymer vapour barrier membrane, 3 kg/m² (EN1849-1), reinforced with glass-fibre mat, with Euroclass E reaction to fire (EN 13501-1), water vapour permeability (EN 1931) μ=100,000, tensile strength (EN 12311-1) L/T of 300/200 N/50 mm and elongation at rupture(EN 12311-1) L/T of 2/2%.



INNOVATIVE VAPOUR BARRIER MEMBRANES WITH INCORPORATED HEAT ACTIVATED ADHESIVE FOR STICKING HEAT-RESISTANT THERMAL INSULATION

TECTENE BV STRIP EP ALU POLIESTERE

Bitumen-elastomeric polymer vapour barrier membrane of 4 kg/m2 (EN1849-1), with incorporated adhesive for bonding insulating panels, made up of thermoadhesive bands distributed across 40% of the upper face of the sheet, reinforced with aluminium foil bonded to a composite non-woven polyester fabric stabilised with glass-fibre, with water vapour permeability (EN 1931) μ=1,500,000, tensile strength (EN 12311-1) L/T of 250/120 N/50 mm and elongation at rupture (EN 12311-1) L/T of 15/20%.

TECTENE BV STRIP EP/V

Bitumen-elastomeric polymer vapour barrier membrane 3 mm thick (EN1849-1), with incorporated adhesive for bonding insulating panels, with thick thermoadhesive strips distributed across 40% of the upper face of the sheet, reinforced with glass-fibre mat, with Euroclass E reaction to fire (EN 13501-1), water vapour permeability (EN 1931) μ=100,000, tensile strength (EN 12311-1) L/T of 300/200 N/50 mm and elongation at rupture (EN 12311-1) L/T of 2/2%.

INNOVATIVE VAPOUR BARRIER MEMBRANES WITH INCORPORATED HEAT ACTIVATED ADHESIVE FOR STICKING HEAT-RESISTANT THERMAL INSULATION

PROMINENT ALU POLIESTERE

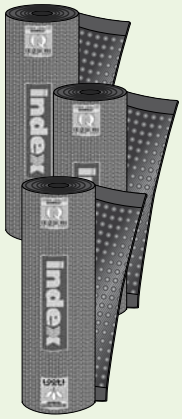
Elastoplastomeric bitumen polymer vapour barrier membrane of 4 kg/m² (EN1849-1), with incorporated adhesive for bonding insulating panels, made up of thermoadhesive embossings, 5 mm thick, distributed across 40% of the upper face of the sheet, reinforced with aluminium foil bonded to a non-woven composite polyester fabric stabilised with glass-fibre, with water vapour permeability (EN 1931) μ=1,500,000, tensile strength (EN 12311-1) L/T of 250/120 N/50 mm and elongation at rupture (EN 12311-1) L/T of 15/20%.

PROMINENT POLIESTERE

Bitumen-elastomeric polymer vapour barrier membrane of 4 kg/m² (EN1849-1), with incorporated adhesive for bonding insulating panels, made up of thermoadhesive bosses, 5 mm thick, distributed across 40% of the upper face of the sheet, reinforced with composite non-woven polyester fabric stabilised with glass-fibre, with Euroclass E reaction to fire (EN 13501-1), water vapour permeability (EN 1931) μ=100,000, tensile strength (EN 12311-1) L/T of 450/400 N/50 mm and elongation at rupture (EN 12311-1) L/T of 40/40%.

PROMINENT/V

Bitumen-elastomeric polymer vapour barrier membrane of 4 kg/m² (EN1849-1), with incorporated adhesive for bonding insulating panels, made up of thermoadhesive bosses, 5 mm thick, distributed across 40% of the upper face of the sheet, reinforced with glass-fibre mat, with Euroclass E reaction to fire (EN 13501-1), water vapour permeability (EN 1931) μ=100,000, tensile strength (EN 12311-1) L/T of 300/200 N/50 mm and elongation at rupture (EN 12311-1) L/T of 2/2%.



VAPOUR BARRIER

STANDARD VAPOUR BARRIER MEMBRANES

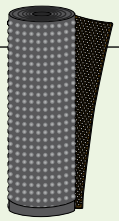
DEFEND ALU POLIESTERE

Bitumen elastomeric polymer vapour barrier membrane, 3-mm thick (EN1849-1), reinforced with aluminium foil bonded to a non-woven composite polyester fabric stabilised with glass-fibre, with Euroclass E reaction to fire (EN 13501-1), water vapour permeability (EN 1931) μ=1,500,000, tensile strength (EN 12311-1) L/T of 250/120 N/50 mm and elongation at rupture(EN 12311-1) L/T of 15/20%.

DEFEND/V

Bitumen elastoplastomeric polymer vapour barrier membrane, 3-mm thick (EN1849-1), reinforced with glass-fibre mat, with water vapour permeability (EN 1931) μ=100,000, tensile strength (EN 12311-1) L/T of 300/200 N/50 mm and elongation at rupture(EN 12311-1) L/T of 2/2%.

INNOVATIVE DRAINING VAPOUR BARRIERS FOR THE DIFFUSION OF CONDENSATION AND THE CONNECTION TO THE SUPPORT WITH PARTIAL ADHESION



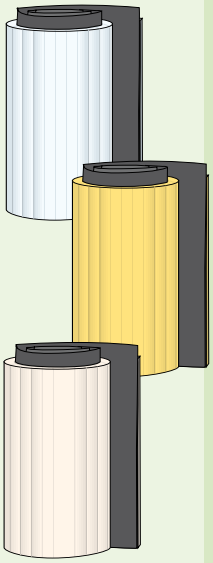
DIFFUSER ALU POLIESTERE

Bitumen elastoplastomeric polymer vapour barrier membrane, of 4 kg/m^2 (EN1849-1), able to create a micro air space on the surface to which it is bonded to drain water vapour and connection in partial-adhesion with “bitumen nails” onto about 40% of the surface, obtained by torching the thermoadhesive bosses that protrude by about 3.5 mm from its lower face.

The membrane reinforced with aluminium foil, bonded to a non-woven composite polyester fabric stabilised with glass-fibre, has water vapour permeability (EN 1931) μ=1,500,000, tensile strength (EN 12311-1) L/T of 250/120 N/50 mm and elongation at rupture(EN 12311-1) L/T of -1/20%.

THERMAL INSULATION

INSULATORS PRE-COUPLED WITH MEMBRANES



THERMOBASE PSE/120

Thermal insulation supplied in rolls with overlapping selvedge such as THERMOBASE PSE/120 made up of insulating strips 5 cm wide and 100 cm long in sintered expanded polystyrene with a compression resistance of 10% (EN 826) ≥120 KPa [CS(10)120] heat-bonded continuously to a distilled bitumen polymer membrane P4 110 cm wide to allow the elements to be overlapped longitudinally. The membrane is reinforced with non-woven composite polyester fabric stabilised with glass-fibre and has a hot stability (EN 1110) of 120°C, flexibility (EN 1109) of -15°C, ultimate tensile strength (EN 12311-1) L/T of 600/400 N/5 cm and ultimate elongation (EN 12311-1) L/T of 40/40%.

THERMOBASE PSE/EX

Thermal insulation supplied in rolls with overlapping selvedge such as THERMOBASE PSE/EX made up of insulating strips 5 cm wide and 100 cm long in extruded expanded polystyrene with a 10% compression resistance (EN 826) ≥200 KPa [CS(10/Y)200] heat-bonded continuously to a distilled bitumen polymer membrane P4 110 cm wide to allow the elements to be overlapped longitudinally. The membrane is reinforced with non-woven composite polyester fabric stabilised with glass-fibre and has a hot stability (EN 1110) of 120°C, flexibility (EN 1109) of -15°C, ultimate tensile strength (EN 12311-1) L/T of 600/400 N/5 cm and ultimate elongation (EN 12311-1) L/T of 40/40%.

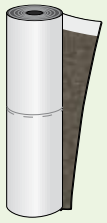
THERMOBASE PSE/PUR

Thermal insulation supplied in rolls with overlapping selvedge such as THERMOBASE PUR made up of 5 cm wide and 100 cm long insulating strips of expanded polyurethane rolled continuously between two glass-fibre mats or two bituminised foam boards which are continuously heat-bonded to a distilled bitumen-polymer membrane P4 110 cm wide to allow the longitudinal overlap of the elements, with a 10% compression resistance (EN 826) =100 KPa [CS(10/Y)100]. The membrane is reinforced with non-woven composite polyester fabric stabilised with glass-fibre and has a hot stability (EN 1110) of 120°C, flexibility (EN 1109) of -15°C, ultimate tensile strength (EN 12311-1) L/T of 600/400 N/5 cm and ultimate elongation (EN 12311-1) L/T of 40/40%.

WATERPROOF COVERING

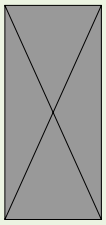
AUTOTENE BASE HE/V

Self-heat-adhesive waterproofing base membrane, such as AUTOTENE BASE HE/V, in distilled bitumen elastomeric polymer, air-to-mass ratio 2 kg/m^2 (EN 1849-1), with the underside and the overlapping strip of the upper coated with an adhesive mix, which is activated by the indirect heat generated by the torch bonding the next layer, both protected by a silicone-coated film which is removed as the roll is unrolled. The membrane, strengthened with a reinforced glass-fibre mat has maximum tensile strength (EN 12311-1) L/T of 300/200 N/50 mm, elongation at max. tensile strength L/T (EN 12311/1) of 300/200 N/50 mm, elongation at rupture (EN 12311-1) L/T of 2/2% and cold bend (EN 1109) of -25°C.



VAPORDIFFUSER STRIP/V

VAPORDIFFUSER STRIP/V distilled bitumen elastoplastomeric polymer waterproofing membrane for laying the waterproof coating in partial adhesion, damp diffusion and distribution of movements on the laying surface, with 40% of the lower face coated with bands of elastomer thermoadhesive. The membrane will have Euroclass E reaction to fire (EN 13501-1), with a mass-to-area ratio (EN 1849-1) of 2 Kg/m^2, L/T maximum tensile force (EN12311-1) of 300/200 N/50 mm, L/T elongation at max. tensile force (EN 12311-1) of 2/2%, and cold bend (EN 1109) of -15°C.



PROTEADUO TRIARMATO

PROTEADUO TRIARMATO multi-layer composite bitumen polymer waterproofing membrane, 4 mm thick (EN 1849-1), certified with the Agrément/DVT of I.T.C-CNR (former I.C.I.T.E.), made up of an upper layer in elastoplastomeric polymer distilled bitumen with ring and ball softening point (EN 1427) of 150°C, a lower layer in elastoplastomeric polymer distilled bitumen with elastic recovery (NF XP 84-360) of 300% and a stabilised three-layer composite reinforcement with glass-fibre between two spunbond polyester “non-woven fabrics”, impregnated with elastoplastomeric polymer distilled bitumen. The membrane will have Euroclass E reaction to fire (EN 13501-1), have a maximum tensile force (EN 12311-1) L/T of 750/650 N/50 mm, elongation at max. tensile force (EN 12311-1) L/T of 50/50 %, resistance to tearing (EN 12310-1) L/T of 250/250 N, resistance to impact (EN 12691 - method A) of 1,000 mm, resistance to static load (EN 12730) of 15 kg, heat dimensional stability (EN 1107-1), L/T of -0.3/+-0.3%, cold bend (EN 1109) of -15°C for the upper layer and -25°C for the lower layer.

HELASTA POLIESTERE

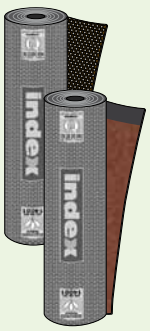
HELASTA POLIESTERE distilled bitumen elastomeric polymer waterproofing membrane, 4 mm thick (EN 18491), certified with the Agrément/DVT of I.T.C-CNR, with a radial butadiene-styrene thermoplastic rubber base and distilled bitumen base, with elongation at max. tensile force of 2000% and elastic recovery (NF-XP 84-360) of 300%, reinforced with spunbond non-woven polyester fabric stabilised with glass-fibre. The membrane will be Euroclass E fire resistant (EN 13501-1), with maximum tensile force (EN 12311-1) L/T of 850/700 N/50 mm, elongation at max. tensile force (EN 12311-1) L/T of 50/50 %, resistance to tearing (EN 12310-1) L/T of 200/200 N, fatigue resistance (UEAtc) of over 1,000 cycles on new material and over 500 cycles on artificially aged material, resistance to impact (EN 12691 - method A) of 1,250 mm, resistance to static load (EN 12730) of 20 kg, heat dimensional stability (EN 1107-1) L/T of –0.3%/+0.3%, cold bend (EN 1109) of -25°C and shape stability to heat (EN 1110) of 100°C.

FLEXTER FLEX TESTUDO SPUNBOND POLIESTERE

FLEXTER TESTUDO SPUNBOND POLIESTERE elastoplastomeric bitumen polymer waterproofing membrane, 4-mm thick (EN 1849-1), based on distilled bitumen, plastomers and elastomers, with composite reinforcement consisting of spunbond non-woven polyester fabric stabilised with glass-fibre, certified with the Agrément ITC-CNR (former ICITE), Euroclass E reaction to fire classification (EN 13501-1). The membrane has a tensile strength (EN 12311-1) L/T of 850/700 N/50mm, elongation at rupture(EN 12311-1) L/T of 50/50 %, resistance to tearing (EN 12310-1) L/T of 200/200 N, resistance to impact (EN 12691 - method A) of 1,250 mm, resistance to static load (EN 12730) of 20 kg, hot dimensional stability (EN 1107-1), L/T of ±0,3/±-0.3%, cold flexibility (EN1109) of -25°C and heat resistance (EN1110) of 140°C.

MINERAL FLEXTER FLEX TESTUDO SPUNBOND POLIESTERE

MINERAL FLEXTER TESTUDO SPUNBOND POLIESTERE elastoplastomeric bitumen polymer waterproofing membrane, 4-mm thick (EN 1849-1), measured on the selvedge self-protected with slate granules, certified with the Agrément ITC-CNR (former ICITE), based on distilled bitumen, plastomers and elastomers, with composite reinforcement consisting of spunbond non-woven polyester fabric stabilised with glass-fibre. The membrane will have Euroclass E reaction to fire (EN 13501-1), have a maximum tensile force (EN 12311-1) L/T of 850/750 N/50 mm, elongation at max. tensile force (EN 12311-1) L/T of 50/50 %, resistance to tearing (EN 12310-1) L/T of 200/200 N, resistance to impact (EN 12691 - method A) of 1,250 mm, resistance to static load (EN 12730) of 20 kg, heat dimensional stability (EN 1107-1), L/T of -0.3/+-0.3%, cold bend (EN 1109) of -25°C and heat resistance (EN 1110) of 140°C.



FIRESTOP POLIESTERE

Fire resistant FIRESTOP POLIESTERE elastoplastomeric polymer-bitumen waterproofing membrane, self-protected with slate granules, with mass-to-air ratio of 4.5 kg/m^2, based on distilled bitumen, plastomers and elastomers, and harmless inorganic flame retardant additives with reinforcement consisting of spunbond non-woven polyester fabric. The membrane will have Euroclass E reaction to fire (EN 13501-1), with Broof (t2) classification of resistance to external roof fires on both combustible and non-combustible laying surfaces (according to UNI EN 13501-5:2009 fire classification of construction elements and products - part 5: classification based on the results of tests exposing roofs to external fire according to UNI ENV 1187:2007). The membrane will have L/T tensile strength (EN12311-1) of 750/600 N/50 mm, elongation at rupture (EN 12311-1) of 50/50%, nail tear strength (EN12310-1) of 150/150 N, dimensional stability when hot (EN1107-1) - 0.5+.5%, cold bend (EN1109) of -10°C and heat resistance (EN1110) of 120°C.

MINERAL REFLEX WHITE TREATMENT

To reduce energy consumption and limit the effects of “urban heat islands”, the membrane will have high solar reflectance of R = 45%, and a very high thermal emissivity of E = 94%, which results in a Solar Reflectance Index SRI of 52 – 54%, obtained with a MINERAL REFLEX WHITE special white mineral protection with high saturation and luminosity.

Technical specifications

14 bis

index
Construction Systems and Products

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