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GUIDE TO WOODEN BUILDINGS

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After years of stagnation in design and fruitless conventionalism, the result of an exclusive concentration on the use of brick in mass-produced buildings, employing the traditional system of reinforced concrete framing and mostly brick walls, since 2010 the has been a definite growth in interest among professionals in wooden structures and hybrid constructions which marry the prerequisites and technical characteristics of diverse materials such as wood, steel, stone and reinforced concrete itself.

More recently, wood has regained its rightful position as a structural element for designing and constructing single- and multi-family homes, multi-storey buildings and increasingly complex structures, ever more distant from the conventional wooden bungalow structures which dominated the market until just a few years ago.

From 2008 onwards, with the enactment of the Building Regulations, there has been a renewed interest in wood throughout Europe; the recession in the construction industry and the resulting need to diversify the production of real estate has opened up the potential for the new structural potential of innovative wooden components such as X-LAM, with their unique characteristics:

- exceptional flexibility and ductility;
- greater speed of modular wood systems;
- far better anti-seismic qualities;
- improved energy saving characteristics;
- very low environmental impact;
- as well as the undeniable charm of one of the oldest construction materials in existence.

Taken all together, these characteristics have promoted a renaissance in the use of wood in buildings for a vast range of uses.

**Wood, from the past to the future**

Since the very earliest days, wood has played a major role and has always been deemed a basic resource for humankind. Carpentry for buildings and furnishings, the production of paper, ships, musical instruments - these are just the most common activities in which wood has always been considered the best possible material. Thanks to its wide availability and ready supply, especially in certain northern European countries with their fully-fledged culture of wood, its cost effectiveness and flexibility and speed of use, wood has played a major role in the development of human civilisation.

Wood has played a leading role in a revolutionary change in construction techniques, since the early 1800’s (with wood framed buildings, which we will consider below). It has been the driving power in the settlement of North America and Northern Europe, and even today is still one of the most widely used techniques in these regions. In Italy too, in the last ten years, the culture of wood has undergone a long period in which brick, concrete and steel had usurped its rightful place, relegating it to a secondary, decorative function.

The increasing awareness of purchasers and designers in relation to low environmental impact housing and the earthquakes of recent years (in particular, L’Aquila in 2009 and Emilia in 2012), has given rise to a new interest in wood, thanks to its significant resistance to seismic shock and very short construction times compared to masonry buildings. Wood has a series of benefits which makes it perfectly suited to use in areas at high risk of earthquake - light weight, elasticity and outstanding physical and mechanical characteristics - so that, together with steel, it is the ideal material for partially prefabricated constructions. As regards environmental impact, wood is one of the best available solutions thanks to its renewability and total recyclability.

However, despite these numerous benefits, wood also has some downsides.

Wood is an isotropic material, i.e. its physical and mechanical characteristics vary in relation to the direction of the force to which it is subjected and designers must therefore make sure to make best use of its characteristics; it is hygroscopic, absorbing humidity if not properly treated, which may be a critical consideration for a wooden building; and finally, wood is subject to attack by mould, fungus and insects, and its characteristics can be compromised by knots and cracks which affect its density and integrity, thus potentially causing unexpected collapse.

The introduction of new ways of using wood as a structural element has largely resolved the above problems, and the new ways in which solid wood is used and new gluing technologies (using polyurethane adhesives which comply with precise regulations governing formaldehyde emissions, such as EN 15425) used in cross-slat systems, generally known as X-LAM or CROSS-LAM, have led to considerable innovations in wooden buildings and contributed to expanding the use of wood from single and two family homes of one or at most two storeys, to a new vision which has led to the acceptance, even in Italy, of wood as a material suited to multi-storey buildings and large corporate office buildings.

As regards the legal and regulatory aspects, new local legislation has been introduced in Italy; the new update to the regulations mean that today it is possible to build completely in wood without the restriction of 4 storeys and without the design having to be validated by the Superior Council of Public Works, as used to be the case; Ministerial Decree 14 January 2008, “Technical Regulations for Construction”, Presidential Decree n. 380 2001 and the requirement for CE marking (per EN 14080 for laminated timber), have finally established and identified the professional positions and responsibilities for wooden construction work, and governing the entire process of production, design and construction with a series of directives and obligations.

As regards its production capacity, Italy, at present only theoretically, is able to produce the raw material at the same level as the major producers like Austria and Germany, and can offer wood of qualities suited to construction, furnishings and semi-finished components; white and red spruce, chestnut, oak and larch, poplar and beech are all woods which, if introduced into the market as raw materials, have the capacity to create a turnover almost com-parable to that of Austria, currently, despite its smaller surface area, close to 5 billion euro with just two woods, white and red spruce - around 5 times greater than Italian turnover.
Physical and mechanical characteristics

Humidity content
Wood is a porous, capillary material; its internal structure with its large surface area thus enables it to quickly exchange both the humidity in the air and fluids with the exterior. The humidity content of wood is the most important of its mechanical, physical and technological parameters and wood may deform permanently as a function of its internal humidity (one need only recall the forming processes used in boat building and the making of making of barrels for wine and other fluids).

Since the material is hygroscopic, the wood establishes an equilibrium with its environment by absorbing or releasing water vapour as external conditions vary.

The humidity content and, even more, wood’s ability to absorb water, must thus be assessed and controlled carefully by the producers and users of wooden construction components.

An incorrect assessment can cause deformations (swelling, deformation or cracking) or cause the wood to degrade after it has been installed if the necessary precautions are not taken. For instance, wooden coverings installed on supports which have not been seasoned properly or wooden roofing or components of buildings which have not been treated and which, after a few years, display evident signs of deterioration and require immediate refurbishing.

Density
At the microscopic level, wood may be considered to be composed of a ligneous component, the air enclosed by its pores, and the water in its veins, which is reflected in its density (specific mass) where, although the density of the ligneous component is effectively identical for all woods (the anhydric density), the specific mass is strongly affected by the water content which results in woods of very different overall densities.

The ratio of the surface area occupied by the cell walls and pores various considerably between varieties of wood, and the specific mass thus depends on the variety. For physiological reasons, there is a lower limit to the density (volume occupied by the walls = 6%) of around 100 kg/m³ (for the lightest wood used in industrially, balsa, this is \( \rho_0 \approx 130 \text{ kg/m}^3 \)), as well as an upper limit (volume occupied by the walls = 93%) which equals around 1200 - 1400 kg/m³.

The woods seasonal growth, and the position and width of the rings also significantly modify the density of the varieties of wood, from 250 - 300 kg/m³ for spring growth woods to 850 - 1000 kg/m³ for late growth woods.

Thermal characteristics
Due to its porous and capillary structure, wood may be considered to be a poor conductor of heat. Since its thermal conductivity \( \lambda \) depends on the air and water it contains, it is strongly dependent on the variety of wood in question and, for a humidity content of 20%, will vary from 0.10 - 0.20 W/mK.

Acoustic characteristics
Historically, wood has often been used in acoustic settings, first and foremost in the construction of musical instruments and absorbing panels used to correct the acoustics of a hall, and is widely prized for its combination of flexibility in application with excellent acoustic response and good aesthetics. The speed of sound depends on the direction of the sound waves relative to the wood’s grain; along the grain it can reach 4000 - 6000 m/s, perpendicular to the grain this drops to 400 - 2000 m/s.

Mechanical characteristics
Wood is an orthotropic material, and thus its mechanical characteristics are not specified in relation to the direction of the stress (isotropic) but it rather has unique, independent mechanical properties along each of its three axes. The longitudinal axis (L) is parallel to its fibres, the radial direction (R) is perpendicular to the growth rings (and to the fibres in the radial direction), while the tangential axis (T) is also perpendicular to the fibres, but tangential to the growth rings. The humidity content is another variable to be considered in relation to the elastic behaviour of wood: the greater the humidity content, the less elastic the material, while the modulus of elasticity remains constant up to a humidity of 7 - 8%, after which it drops to its lowest values at a humidity of around 30%.

The tensile strength of wood depends, like many other of its characteristics, on the variety of wood in question, any defects, deviations and discontinuities of the fibrous structure, insect and fungal aggression, cracks and so on, all of which decrease its mechanical strength; the amount of this reduction must be evaluated case by case on the basis of experience. One must therefore be very cautious in using tensile strength specifications when designing wooden structures. Experimental values cannot be exhaustive, since the tests are run for short periods of time, the standard humidity conditions are constant, the samples employed are small and often defect free. To avoid underestimating a design and running the risk of failing to consider the real conditions of use, coefficients must be used to account for such factors.

The various countries which use wood as a common construction material have specific local standards relating to the various uses of the material; Italy also has a system of legislation and standards which govern the use of wood in construction.

Ministerial Decree 14.09.2005 “Technical Regulations for Construction” was the first national decree to specify the minimum characteristics for using wood as a construction material (the corresponding international regulations are SIA 164 (Switzerland), DIN 1052 (Germany) and Regles C.B. 71 (France)); the other local references are EN 1995 Eurocode 5 and the Instructions of CNR-DT 206/2006.

There are also specific standards, listed below, which govern the various types of wood and their applications, for example, solid wood, laminar timber beams and panels, OSB construction panels and so on.

- solid wood, UNI EN 14081-1;
- glued laminar timber (GLULAM), UNI EN 14080;
- finger jointed structural timber, UNI EN 385;
- plywood panels, UNI EN 636;
- oriented strand boards, UNI EN 300;
- particleboard, UNI EN 312;
- high density fibre board, UNI EN 622-2;
- medium density fibre board, UNI EN 622-3;
- laminated veneer lumber (LVL), UNI EN 14374, UNI EN 14279

UNI EN 11035-2, on the other hand, applies a classification per the strength and national variety of the wood, coniferous or deciduous, with a division into three categories for coniferous woods (S1, S2 and S3) and a single class for deciduous woods (S).

Standards which classify wood by strength are divided into visual classification standards, such as UNI EN 518 (one assesses the size and distribution of knots, the angle of the fibrous structure, the thickness of the growth rings, deviations and deformations) and machine classification standards, such as UNI EN 519 (one assesses physical characteristics such as specific mass and modulus of elasticity). Note that there is also a standard relating to the type of mounting (mechanical with employing nails, adhesion with a variety of adhesives of which the most common is certainly polyurethane based, and mechanical with wooden dowels).

Durability
Wood can keep its mechanical and aesthetic qualities for a long time in favourable environmental conditions, as shown by certain Northern European structures built solely of wood many centuries ago. If exposed to the weather and inadequately protected, its colour changes to a greyish tone. Applying a protective layer (varnish, paint) increases the resistance of the wood to its environment, but does not completely waterproof it. Paints and varnishes may also be effective barriers to organic aggression. The principal enemies of wood are fungi, and certain types of insects which eat the cellulose, thus destroying the wood’s structure. Fungi only grow in certain conditions, when the water content of the wood is around 20% and the temperature is 15 to 20°C; construction timber is thus usually attacked in the area where the wood is attached to the masonry, where it comes into greater contact with humidity. The only defence is to treat the wood in advance of installation.

The most dangerous insects in this regard are termites which appeared in some areas of Italy a few decades ago and present a genuine threat. They are particularly insidious since their activity is not evident: there are no holes and no issue of dust as happens with woodworm and house longhorn beetles. The latter two are also extremely dangerous and very widespread in our latitudes. In the Mediterranean one finds the so-called shipworm, a small crab which digs out tunnels in wooden objects immersed in sea water. The only protection against insects, as for fungi,
Products and solutions for wooden structures

Construction techniques for wooden structures

Since the earliest times, wood has been one of the most widely used materials for satisfying mankind’s basic needs for warmth, shelter, food, self-defence and moving on the water - all requirements solved by primitive man with wood.

Its availability, ductility in use, good thermal insulation, workability and good mechanical characteristics have all ensured that wood has been prized as the construction material par excellence.

We can immediately order the panorama of types of construction using wood by making a rough distinction between light and heavy structures, which can in turn be further divided into:

**HEAVY STRUCTURES**
- Blockbau
- X-LAM (cross-laminated board)

**LIGHTWEIGHT STRUCTURES**
- Fachwerk
- Framed structures
- Framed wall structures

**BLOCKBAU type structures**

This is probably the oldest construction technique, the first used by man, and consists in using circular sections of trees (boles from which the bark has been removed) to build heavy walls by overlapping the boles and joining them at the corners using interlocking or cut joints; the walls provide both static strength and structural rigidity.

Such buildings, due to their special characteristics and primitive look, are mostly associated with alpine regions, where they have been widely used to build high altitude houses and hay barns, and have never been more generally used for the construction of other types of building.

With the advent of new technologies in the wood industry (NC machinery which can cut and slot components quickly and to a very high precision) this technique has undergone further development and the round boles can now be substituted by squared off beams which have a much less picturesque look, while maintaining the robustness and rigidity of the original “blockbau” technology.

Like every wooden construction, in which the elements are not protected against the weather, “blockbau” buildings must be properly programmed both during construction and throughout the life of the building. During the construction phase, the elements must be impregnated with water-based protective agents and subjected to saturation of their relative humidity (in autoclaves) whereas during the life of the completed building routine maintenance is required to prevent disease of the wood itself or other issues which may compromise its structural and aesthetic qualities.

is treatment prior to installation. Impregnating substances capable of protecting wood against organic aggression can be divided into two categories. The first is composed of creosote, pentachlorophenol, metalorganic compounds, etc. soluble in an oily medium; the second category includes aqueous solutions of the salts of chrome, zinc, arsenic etc. A vast range of such products is commercially available, some of which are mixtures of several active ingredients. These products must be applied under pressure in an autoclave.

This treatment completely protects the wood, but it is costly and hard to apply to large objects, so that protective agents are generally brushed or sprayed on or simply added to the varnishes and adhesives, which only affords a partial protection. It is well known that wood is flammable: above 200°C combustion phenomena are produced, wood forms a layer of carbonised material while pyrolysis releases combustible gases. The low thermal conductivity of wood quickly reduces its temperature just beyond the combustion zone, so that structures which have not been completely burnt may maintain good structural characteristics once the fire has been put out.

Wood can be treated with fire proofing or retardant agents which reduce the speed of combustion.
Buildings made with cross-laminated panels (X-LAM technology)

In contrast with the “blockbau” technology, X-LAM structures have experienced a real explosion of popularity over the last ten years and are currently the most widely used technique in Europe, due to their flexibility, speed of construction and cost-effectiveness.

X-LAM panels are created by bonding using a variety of technologies, of which the most common is polyurethane-based adhesive, of an odd number of layers (usually 3, 5 or 7) of relatively thin wooden boards (usually 15 to 40 mm) in a perpendicular grain pattern, the panels themselves then being connected by finger joints.

The potential for making prefabricated X-LAM panels to size and their modularity (the same panels can be used to make floor slabs, outer walls and dividing walls) makes this a highly flexible technology, with predictable scheduling of construction on site.

When properly constructed in terms of its static connections, X-LAM is currently one of the few wood construction techniques suited to multi-storey buildings, thus overturning the conventional, restricted view of wood as suited only to the construction of single-storey buildings.

The foundations are built in the normal way, followed by a foundation layer in reinforced concrete and a beam in reinforced concrete, to which are then fixed, using special “hold down” brackets and angled screws, larch kerbs to which the X-LAM walls themselves are attached; each panel, of finite size, is nailed or bolted to the adjacent panel, using strips of plywood to bridge them.

The doors and windows are cut out from the wall panels and the transoms are composed of panels with a horizontal direction and fibre to better resist the stresses to which the walls may be subjected, whether vertical loads, their own weight, wind force etc.

The floor slabs are made in the same way, with horizontal X-LAM panels connected to the walls with special right-angle brackets of suitable size and area for the static and structural loads (using “double hold down” and/or perforated band mountings).

The structural elements of X-LAM buildings are generally conceived as a natural replacement for the concrete framing of conventional constructions, and are then covered with coverings which not only cover utility ducts but also play an important role in thermal and acoustic insulation.

The outer walls may be constructed in a variety of ways in relation to the materials and performance required, but they seldom differ much, in terms of the layers involved, from the following diagram, where the X-LAM panel structure is covered internally with a false wall in slabs of plasterboard or wooden panels, with an insulated air gap, and externally with the all-over insulation technique and protective finish with a thin layer of plastic decoration or curtain wall (especially in service industry and office buildings).

The intermediate floors and dividing walls between adjacent lodgings are treated in a similar way: ceilings generally have a plastered, plaster/silicate board or wooden panelling false ceiling which may be in contact with the raw ceiling or suspended, depending on the available space and thermal and acoustic insulation requirements.

While the dividing walls are generally equipped with two false walls (one on each side), also in plastered, plaster/silicate board or wooden panelling boards, which house the utility ducting and provide thermal and acoustic insulation.

Framed buildings

Although less familiar than the cross-laminated panel technique described above, the framing technique is tried and tested, as reflected in its wide use in the more developed Northern European countries, where it has been used successfully for many years, and is increasing finding adherents in other countries.

The system consists in the construction of a bearing frame in spruce beams and pillars, the walls no longer provide the static strength but are exclusively employed as insulating and enclosing panels.

From the purely architectonic point of view, the framing approach can satisfy the widest aesthetic and design needs, and the spacing of the structural elements can be very wide, thus enabling very free construction of the internal spaces and large windows and other openings.

The perimeter walls are covered internally with panels of wooden derivate (OSB or plywood) or plasterboard panels, while externally the all-over insulation techniques is employed as in X-LAM constructions; as regards dividing walls, they are covered in the same way but with plasterboard panels, thanks to its better aesthetic qualities, while the air gap (or double air gap, depending on the requirements of the construction) generally houses the utility ducting and is then filled with fibrous, easily worked materials to provide the thermal and acoustic insulation.

Products and solutions for wooden structures
The foundation structures of wooden buildings are waterproofed to protect the interior from infiltrations of water and prevent the wood itself deteriorating due to the capillary action of groundwater. Wood is a natural material and absorbs water naturally; if not adequately waterproofed it quickly deteriorates, with predictable consequences.

It is important that the foundation/wall connection be protected and isolated to prevent humidity rising and direct contact between the wood and its concrete base.

Waterproofing works in contact with the ground should be planned and carried out with great care, bearing in mind that the life of the coating must be the same as that of the structure, and that it is most unlikely that any remedial work will be possible, so a lack of waterproofing or defective waterproofing could be very costly indeed.

So the selection of materials should focus on products that maintain their characteristics - impermeable to water and water vapour, rot resistance and mechanical resistance over time, even when subject to site traffic. Nor should it be forgotten that the problem if damp in structures that are underground or in contact with the ground is often related to thermal insulation, and that very frequently damp is attributed to the non-impermeability of the structure, rather than to condensation of damp air due to the inadequate thermal resistance of floors and walls in contact with the ground.

**WATERPROOFING SYSTEMS WITH DISTILLED POLYMER-BITUMEN MEMBRANES**

**IN THE PRESENCE OF AQUIFER WATER**

1. Weak mix
2. Waterproofing with double-layer of HELASTA
3. Foundation
4. ECOVER primer
5. Damp Proof Course
6. Waterproofing with double-layer of HELASTA
7. PROTEFON protective sheet
8. Flashing

**STRATIFIED ELEMENTS**

1. Weak mix
2. HELASTA waterproofing membrane
3. Foundation
4. ECOVER primer
5. Damp Proof Course
6. HELASTA waterproofing membrane
7. PROTEFON protective sheet
8. Flashing
The designer must therefore check:
• the water that rises from the ground through capillary action, from an unconfined aquifer or by rainwater washout.
• the water contained as vapour in the telluric area that migrates with changes in barometric pressure and temperature, and that can condense on cold surfaces.
• the water produced and contained in the form of vapour in air of basement spaces that can condense on cold surfaces.
• the protection of the interior from radon gas.

To resolve all these problems, INDEX offers a wide range of solutions including HELASTA high elastomeric performance traditional bitumen polymer membranes and INDEXTENE HDPE SUPER or SELFTENE BASE HE adhesive membranes which do not require the use of propane burners to adhere to clean and dry surfaces. The sheets are rotproof and resistant to traction and perforation. They have good resistance to vapour diffusion, and may therefore be successfully used in waterproofing systems in underground closures both against rising damp due to capillary action and in the presence of an unconfined aquifer. In addition, ARMODILLO is the most recent waterproofing membrane for underground masonry work. This is an armoured draining membrane which combines the functions of waterproofing, draining and protection in a single product.

If radon gas is present, it is essential that the foundation layer be of the "igloo" crawlspace type, with adequate aspiration/ventilation to prevent the gas accumulating and disperse it outside the building. INDEX produces the RADON BARRIER certified waterproofing membrane which provides outstanding protection against radon as well as excellent waterproofing.
Depending on the various types of construction, the internal and outer walls of wooden buildings may be designed and built with solid wood beams (blockhaus system), with framing structures or with solid cross-laminated wood panels (X-LAM).

To obtain a statically solid structure able to satisfy the requirements for thermal and acoustic insulation as well as any other specification, the internal and outer walls must be specified with different thicknesses of the bearing section and, if necessary, fitted with false walls in plasterboard or composed of OSB compressed wood panels (interior) while the outer walls are fitted with all-over insulation if built with X-LAM panels, and internal and external coverings for blockhaus constructions and framed structures (which may however also be left with the wood itself exposed).
These pages list a number of technical solutions supplied by INDEX for the thermal and acoustic insulation of internal and outer walls, in relation to the various types of construction technique. As regards the evaluation of the performance of the systems proposed below, we indicate the calculated thermal specifications, whereas for the acoustic performance, since there is no archive of tested installations nor a standard method for calculating the apparent acoustic insulation, we simply give some information drawn from the literature; the authors will update this listing following the campaign of on-site tests being run at the time of writing.

**CERTIFICATIONS**

The all-over thermal insulation system
**CAPTHERM**
is certified
**ETA 13/0134**

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**THERMAL AND ACOUSTIC INSULATION**

**OUTER WALLS**

1. X-LAM wall
2. THERMOSILENTRock thermo-acoustic insulation
3. COATBOND FINE FIBER adhesive/render
4. RETINVETRO FOR SMOOTHING RENDERS reinforcement
5. DECORFINE SIL coloured finish

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**CERTIFICATIONS**

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**ETA 13/0134**

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**THERMAL AND ACOUSTIC INSULATION**

**OUTER WALLS**

1. Plasterboard panel
2. Wood bearing frame and SILENTRock fibrous thermal and acoustic insulation
3. Plasterboard panel
4. Wood bearing frame and SILENTRock fibrous thermal and acoustic insulation
5. Plasterboard panel
6. THERMOSILENTRock thermo-acoustic insulation
7. COATBOND FINE FIBER adhesive/render
8. RETINVETRO FOR SMOOTHING RENDERS reinforcement
9. DECORFINE SIL coloured finish
10. RETINVETRO PER RASANTI (FIBREGLASS MESH FOR RENDER) reinforcement
11. DECORFINE SIL coloured finish

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**STRATIFIED ELEMENTS**

1. X-LAM wall
2. THERMOSILENTRock thermo-acoustic insulation
3. COATBOND FINE FIBER adhesive/render
4. RETINVETRO SMOOTHING RENDER reinforcement
5. DECORFINE SIL coloured finish

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**STRATIFIED ELEMENTS**

1. Plasterboard panel
2. Wood bearing frame and SILENTRock fibrous thermal and acoustic insulation
3. Plasterboard panel
4. Wood bearing frame and SILENTRock fibrous thermal and acoustic insulation
5. Plasterboard panel
6. THERMOSILENTRock thermo-acoustic insulation
7. COATBOND FINE FIBER adhesive/render
8. RETINVETRO PER RASANTI (FIBREGLASS MESH FOR RENDER) reinforcement
9. DECORFINE SIL coloured finish

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**THERMAL AND ACOUSTIC INSULATION**

**OUTER WALLS**

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8. RETINVETRO PER RASANTI (FIBREGLASS MESH FOR RENDER) reinforcement
9. DECORFINE SIL coloured finish

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**STRATIFIED ELEMENTS**

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7. COATBOND FINE FIBER adhesive/render
8. RETINVETRO PER RASANTI (FIBREGLASS MESH FOR RENDER) reinforcement
9. DECORFINE SIL coloured finish

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**CERTIFICATIONS**

The all-over thermal insulation system
**CAPTHERM**
is certified
**ETA 13/0134**
The same considerations as for the walls apply to the floors, where, depending on the type of construction we may find floors made of X-LAM resting against the walls and mechanically secured with steel brackets and fasteners, floors with framing structures supported by square beams or round beams (parallel beams or blockhaus).

The various types of wooden floor can be left exposed as the underlying ceiling or be covered by a plasterboard false ceiling or OSB compressed wood boards, as almost always is the case for X-LAM structures.

As regards their acoustic and thermal insulation, the possible solutions are many and various, from floors designed completely dry, i.e. with a structure without any cement in it, to traditional floors with structural screed and floating screed composed of sand and cement, or hybrid solutions to satisfy the economic and static conditions of the installation in question.

As regards the evaluation of the performance of the systems proposed below, we indicate the calculated thermal specifications, whereas for the acoustic performance, since there is no archive of tested installations nor a standard method for calculating the apparent acoustic insulation and the index of walkover noise for the floor above, we simply give some information drawn from the literature; the authors will update this listing following the campaign of on-site tests being run at the time of writing.

Acoustic insulation with double layer of FONOSTOPDuo

Certified solution
Measurements on site

\[ L'_{n,w} = 58 \text{ dB} \]
SLABS

ACOUSTIC INSULATION

SLABS WITH FLOATING FLOOR WITH RADIATOR FLOOR HEATING SYSTEM

Acoustic insulation with FONOSTOPTrio

Certified solution
Measurements on site

\[ L'_{n,w} = 59 \text{ dB} \]

Acoustic insulation with FONOSTOPDuo

STRATIFIED ELEMENTS

1. Board
2. Polyethylene protective sheeting
3. Structural screed
4. Filler layer
5. Acoustic insulation for foot traffic noise FONOSTOPTrio
6. Panels and pipes for the radiator heating system
7. DRYCEM or QUICKCEM armoured concrete screed
8. Flooring laid with FLEXBOND adhesive and grouted with FUGOCOLOR
Acoustic insulation with FONOSTOPDuo

1. X-LAM floor slab
2. THERMOSILENTRock thermo-acoustic insulation
3. OSB panel
4. Acoustic insulation for foot traffic noise FONOSTOPDuo
5. DRYCEM or QUICKCEM armoured concrete screed
6a. Flooring laid on FONOSTOPTile biadhesive and grouted with FUGOPOX COLOR AB
6b. Parquet flooring laid on FONOSTOPLegno

Acoustic insulation with double layer of FONOSTOPDuo

1. X-LAM floor slab
2. THERMOSILENTRock thermo-acoustic insulation
3. OSB panel
4. Acoustic insulation for foot traffic noise FONOSTOPDuo
5. DRYCEM or QUICKCEM armoured concrete screed
6a. Flooring laid on FONOSTOPTile biadhesive and grouted with FUGOPOX COLOR AB
6b. Parquet flooring laid on FONOSTOPLegno

Certified solution
Measurements on site

\[ L'_{n,w} = 53 \text{ dB} \]
Depending on the various types of construction, the internal and outer walls of wooden buildings may be designed and built with solid wood beams (blockhaus), framing structures or solid cross-laminated wood panels (X-LAM) and even plasterboard panels supported by steel frames, or composed of OSB compressed wood panels.

INDEX solutions for waterproofing and laying ceramic and stone coverings are simple and versatile, since the products we supply adhere to all the above surfaces.

### Waterproofing with UNOLASTIC

1. **X-LAM floor slab**
2. Adhesive waterproofing membrane **INDEXTENE HDPE SUPER**
3. **Filler layer**
4. Acoustic insulation for foot traffic noise **FONOSTOPDuo** (FONOCELL in the perimeter joints)
5. **DRYCEM** or **QUICKCEM** armoured concrete screed
6. **UNOLASTIC** and **COVERBAND ADHESIVE** waterproofing in the perimeter joints
7. Flooring and wall tiles laid with **FLEXBOND** adhesive and grouted with **FUGOPOX COLOR AB**
The same considerations as for the walls apply to the floors, where, depending on the type of construction we may find floors made of X-LAM resting against the walls and mechanically secured with steel brackets and fasteners, floors with framing structures supported by square beams or round beams (parallel beams or blockhaus).

The various types of wooden floor can be left exposed as the underlying ceiling or be covered by a plasterboard false ceiling or OSB compressed wood boards, as almost always is the case for X-LAM structures. INDEX solutions for waterproofing and laying ceramic and stone on floors are simple and versatile, since the products we supply adhere to all the above surfaces.
Balcony with flooring laid over concrete screed

1. X-LAM floor slab
2. INDEXTENE HDPE
3. INDEXTENE HDPE SUPER adhesive waterproofing membrane
4. MINERAL SELFTENE HE
5. Flooring laid over reinforced concrete screed
6. Metal profile member

STRATIFIED ELEMENTS
1. X-LAM slab
2. INDEXTENE HDPE
3. INDEXTENE HDPE SUPER adhesive waterproofing membrane
4. MINERAL SELFTENE HE
5. Flooring laid over reinforced concrete screed
6. Metal profile member
The design of a wooden roof must take into consideration of a number of very different factors, mostly concerned with seasonal conditions and the location of the building itself: roofs made in mountain areas or Northern European countries will be very different from those made in the Mediterranean area or flatlands. The technical solutions aim to create a roof which provides outstanding thermal and acoustic insulation and comfort for the occupants throughout the life of the installation.

**THE INSULATION, VENTILATION AND PERMEABILITY OF A WOODEN ROOF**

Timber roofs are valued for their lightness, which is an advantage in terms of construction, but a disadvantage in terms of thermal insulation.

The absence of thermal inertia means that the insulating depth must be increased, but often this is not enough to guarantee comfort and limit the energy consumption of air conditioning during the summer, and increasing the thermal insulation should be combined with the introduction of a ventilation space which will often be of constant depth, in the case of a habitable roof-space, or of a depth that varies with the pitch of the roof surfaces, in the case of a non-habitable roof-space. Installed between the outer layer of tiles and the insulating layer, this assures both “thermal washing” of the heat transmitted to the layers lying under the outer layer of tiles that have been heated by the sun and damp control in winter, caused by gaseous vapour migrating from the inhabited area towards the outside, through the layers of the roof.

The ventilation space is used to evacuate warm water vapour from inhabited rooms before it reaches a concentration such as to condense inside the layers directly underneath it, the temperatures of which decrease towards the outside.

Condensation of steam, in quantities that exceed the re-evaporation capacity of the layer structure in the summer, not only inhibits the insulating properties of the thermal insulation, causing the phenomenon to worsen, it also constitutes a hazard for timber roofs, since it creates an environment that favours the formation of degenerative processes in the timber roof itself. So ventilation is particularly important for timber roofs, since it affects the life of the load-bearing structure. While in old roofs the non-inhabited space under the roof could guarantee total or partial ventilation, through the joins in the various kinds of tiles or slates laid on rafters and not on continuous boards, these days, with the use of the roof-space as a living space, this is no longer possible, given the development of regulatory requirements for energy saving, together with the progressive reduction in the air permeability of the outer shell of the building and the introduction of the use of undertile sheets to protect against wind and powdery snow.

The use of continuous board and undertile sheets also means that the ventilation space now consists of two chambers, which may be defined as the primary ventilation space, which is the space between the thermal insulation and the continuous board or undertile sheet, and the secondary ventilation, or microventilation space, which is the space between the continuous board or undertile sheet and the tile covering.

This means that specific air intakes must be incorporated to guarantee the necessary ventilation and supply both the primary and the secondary spaces.

For further considerations on the sizing of the ventilation space, we refer to INDEX’s “Guide to under-tile protection with breathable sheets”.

Whereas, if there is no primary ventilation space and the undertile sheet is resting directly on the thermal insulation or a prefabricated wood panel containing a thermal insulator without ventilation space, then it must be highly transpiring, which means membranes with vapour permeability SD of less than 0.09m, a characteristic which only bitumen-free synthetic sheets possess.

INDEX can supply a variety of solutions for waterproofing ventilated and unventilated wooden roofs which can satisfy any design requirement.
The following pages consider three different waterproofing methods:

- Ultra-breathable synthetic undertile sheet, breathable bituminous undertile sheet and heavyweight bituminous undertile sheet (undertile sheet with breathable sheets).
- Adhesive systems and membranes (undertile sheet).
- Traditional flame-bonded membranes (roofs with exposed covering).

INDEX’s technical department is available to support the designer in selecting and specifying the best products and systems in terms of waterproofing and thermal and acoustic insulation.
**Orientation of the main exposed beams**

Undertile sheet laid over thermal insulation, microventilation under the tiles

---

<table>
<thead>
<tr>
<th>Vapour barrier layer (2)</th>
<th>Thermal/acoustic insulation (3)</th>
<th>Waterproofing undertile sheet (4)</th>
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</thead>
<tbody>
<tr>
<td>DIFOBAR SINT F.V. 140</td>
<td>THERMOSILENTRock</td>
<td>Synthetic ultra-breathable undertile sheets</td>
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<td>DIFOBAR SINT 90</td>
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<td>ALUSTOP SINT B.V. 105</td>
<td>THERMOSILENTRock EXPANDED PERLITE EXPANDED SINTERED POLYSTYRENE EXPANDED EXTRUDED POLYSTYRENE POLYURETHANE PIR</td>
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<td>DIFOBAR SINT 90</td>
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</tbody>
</table>

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**STRATIFIED ELEMENTS**

1. Board
2. Vapour control sheets: DIFOBAR SINT F.V. 140 or ALUSTOP SINT B.V. 105 vapour barrier
3. Thermal insulation
4. DIFOBAR SINT ultra-breathable waterproofing undertile sheet
5. Tiles on slats
**ROOFS - BREATHABLE UNDERTILE SHEETS**

**WATERPROOFING AND THERMAL INSULATION OF WOODEN ROOFS WITH SYNTHETIC WATERPROOF AND BREATHABLE SHEETS**

**INHABITED ROOF SPACE - DOUBLE BOARD**

Orientation of the main exposed beams

Undertile sheet laid on continuous board, microventilation under the tiles

---

**Vapour barrier layer (2)**

- ALUSTOP SINT B.V. 105

**Thermal/acoustic insulation (3-4)**

- THERMOSILEN Rock
- EXPANDED PRLITE
- EXPANDED SINTERED POLYSTYRENE
- EXPANDED EXTRUDED POLYSTYRENE
- POLYURETHANE
- PIR

**Waterproofing undertile sheet (6)**

- Synthetic ultra-breathable undertile sheets
  - DIFOBAR SINT 160
  - DIFOBAR SINT 150
  - DIFOBAR SINT 90

---

**STRATIFIED ELEMENTS**

- 1. Board
- 2. Vapour control sheets: ALUSTOP SINT B.V. 105 vapour barrier
- 3-4. Thermal insulation
- 5. Second board
- 6. DIFOBAR SINT ultra-breathable waterproofing undertile sheet
- 7. Tiles on slats
WATERPROOFING AND THERMAL INSULATION OF WOODEN ROOFS
WITH WATERPROOF, BREATHABLE SHEETS
VENTILATED INHABITED ROOF SPACE - DOUBLE BOARD

Orientation of the main exposed beams
Undertile sheet laid on continuous board, microventilation under the tiles

<table>
<thead>
<tr>
<th>Vapour barrier layer (2)</th>
<th>Thermal/acoustic insulation (3)</th>
<th>Waterproofing undertile sheet (4)</th>
<th>Waterproofing undertile sheet (6)</th>
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Orientation of primary concealed beams
Undertile sheet laid on continuous board, microventilation under the tiles

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WATERPROOFING AND THERMAL INSULATION OF WOODEN ROOFS
WITH WATERPROOF, BREATHABLE SHEETS
INHABITED VENTILATED ROOF SPACE - SINGLE BOARD

Orientation of primary concealed beams
Undertile sheet nailed under tension to the beams, microventilation under the tiles
Orientation of primary concealed beams
Undertile sheet laid over thermal insulation, microventilation under the tiles

<table>
<thead>
<tr>
<th>Vapour barrier layer (2)</th>
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INDEX’s BEST-ADHESIVE adhesive membranes, composed of professional quality polymer bitumen membranes, tried and tested over decades of experience, which bond to one or both of their faces with special elastomer bonding agents, are attached by simply pressing them onto the surface at ambient temperature - no flame is required.

Among our BEST-ADHESIVE products, the SELFTENE range stands out with its specific series of membranes and accessories, along with user instructions, selected for ease of installation without the use of professional equipment and a reduced range of products, thus allowing simple resolution of the most common waterproofing requirements for wooden roofs.

**ADVANTAGES**

- **Easy installation without the need for flame**: avoids the risk of setting fire to the wooden roof.
- **Low environmental impact installation**: no fumes, noise or odours, plus energy savings.
- **Direct installation without barriers, strong adhesion**: even on heat-sensitive surfaces.
- **Easy installation**: no professional equipment required.

The elastomer adhesive facings have a high level of adhesion to the surface and the thermal insulation. Enables installation without barriers on flame-sensitive surfaces (expanded polystyrene, wood, etc.)

- **Savings of 100 to 140 kg of gas per 1000 m² (plus transport costs)**
  - Avoids welding fume emissions
  - Avoids exposure to heat of the fitter’s feet and hence the risk of scalding

**NO**

**SELFTENE**

**SELFTENE BV**

**BIADESIVO (BIADHESIVE)**

High adhesion to overlaps
Orientation of the main exposed beams
Single layer adhesive waterproofing layer on continuous boards

**Inhabited ventilated roof space - double board**

1. Board
2. SELFTENE BV BIADESIVO adhesive vapour barrier
3. Compression resistant thermal insulation, adhesive
4. Second board
5. MINERAL SELFTENE TEGOLA EP adhesive waterproofing membrane
6. Curved tiles

**Inhabited roof space**

**PITCH ≤35%**

Not suited for mountain climates

---

**Stratified elements**

1. Board
2. SELFTENE BASE EP adhesive vapour barrier
3. Thermal insulation
4. Second board
5. MINERAL SELFTENE TEGOLA EP adhesive waterproofing membrane
6. Curved tiles

**Inhabited roof space**

**PITCH ≤35%**

Not suited for mountain climates

---

**Stratified elements**

1. Board
2. SELFTENE BASE EP adhesive vapour barrier
3. Thermal insulation
4. Second board
5. MINERAL SELFTENE TEGOLA EP adhesive waterproofing membrane
6. Curved tiles

**Inhabited roof space**

**PITCH ≤35%**

Not suited for mountain climates

---

**Stratified elements**

1. Board
2. SELFTENE BASE EP adhesive vapour barrier
3. Thermal insulation
4. Second board
5. MINERAL SELFTENE TEGOLA EP adhesive waterproofing membrane
6. Curved tiles

**Inhabited roof space**

**PITCH ≤35%**

Not suited for mountain climates
Orientation of the main exposed beams
Single adhesive waterproofing layer on thermal insulation

1. Board
2. SELFTENE BY BIADESIVO adhesive vapour barrier
3. Compression resistant thermal insulation, adhesive
4. Transverse strips (spacing 60 cm)
5. Adhesive waterproofing membrane
   MINERAL SELFTENE TEGOLA EP
   nailed under the head laps
   (max shet length 2.5 m)
6. Curved tiles

 Orientation of the main exposed beams
Adhesive single waterproofing layer over undertile microventilated insulating layer

1. Board
2. SELFTENE BASE EP adhesive vapour barrier
3. Compression resistant thermal insulation
4. Transverse strips (spacing 60 cm)
5. MINERAL SELFTENE TEGOLA EP adhesive waterproofing membrane
6. Curved tiles

STRATIFIED ELEMENTS
1. Board
2. SELFTENE BY BIADESIVO adhesive vapour barrier
3. Compression resistant thermal insulation, adhesive
4. Transverse strips (spacing 60 cm)
5. MINERAL SELFTENE TEGOLA EP adhesive waterproofing membrane
6. Curved tiles

STRATIFIED ELEMENTS
1. Board
2. SELFTENE BASE EP adhesive vapour barrier
3. Compression resistant thermal insulation
4. MINERAL SELFTENE TEGOLA EP adhesive waterproofing membrane
5. Tiles on slats

Inhabited roof space
Pitch ≤35% Not suited for mountain climates

Mountainous climate included
Max 900 m
WATERPROOFING OF WOODEN ROOFS WITH ADHESIVE DISTILLED POLYMER-BITUMEN MEMBRANES

UNINHABITED ROOF SPACE - SINGLE BOARD

Orientation of the main exposed beams
Single layer adhesive waterproofing layer on continuous boards

1. Board
2. Adhesive waterproofing membrane MINERAL SELFTENE TEGOLA EP nailed under the head laps (max sheet length 4.0 m)
3. Curved tiles

Uninhabited roof space

Not suited for mountain climates

PITCH ≤35%

UNINHABITED

Orientation of the main exposed beams
Adhesive single waterproofing layer under Canadian shingles

1. Board
2. Heat-bonded waterproofing membrane TECTENE TEGOLA EP nailed under the overlaps
3. COVERTILE Canadian shingles

Uninhabited roof space

Mountainous climate included

PITCH ≤35%

UNINHABITED

STRATIFIED ELEMENTS
1. Board
2. MINERAL SELFTENE TEGOLA EP adhesive waterproofing membrane
3. Curved tiles

STRATIFIED ELEMENTS
1. Board
2. TECTENE TEGOLA EP thermo-adhesive waterproofing membrane
3. COVERTILE Canadian shingles
ROOFS - UNDERTILE

**Slope**

- **LOW SLOPED ROOF**
  - Nails under overlap every 20 cm
  - MINERAL SELFTENE TEGOLA EP

- **HIGH SLOPED ROOF**
  - Nails under overlap every 20 cm
  - MINERAL SELFTENE TEGOLA EP

**Skylights and protruding structures**

- Metal system provided by skylight supplier
- Skylight
- SELFTENE BV BIADESIVO (BIADHESIVE)

**Side edges of roof**

- SELFTENE BV BIADESIVO (BIADHESIVE)

**Installation of MINERAL SELFTENE TEGOLA EP POLIESTERE over thermal insulation laid between transverse slats (page 7)**

- Nails under overlap every 10 cm
- Thermal insulation
- Nailed to slat
- Slat

**MINERAL SELFTENE TEGOLA EP**
LAYING THE TILES
The roof tile installation systems covered by this publication include:
• direct laying to mortar kerbs over a mineral-coated undertile waterproofing layer
• laying to slats fixed mechanically
In the first case it is the climatic conditions, geometry of the roof and local customs combined with the manufacturer’s recommendations which lead to the selection of this type of application (roof angle generally ≤35%), and INDEX offers a range of products composed both of the resistant and elastic MINERAL membranes (plastomeric and elasto-plastomeric, we do not recommend elastomeric MINERAL membranes) with the upper face covered with scales of slate bonded at high temperature which allows for long-term holding of the mortar kerbs used to mount the tiles as well as the same pre-assembled to various types of THERMOBASE TEGOLA compression-resistant thermal insulation which reduce installation times.

If installing to slats, which guarantees the long life of the tiles even in less favourable climatic conditions, an undertile ventilation space must be provided to allow the latter and the slats themselves to dry quickly, implemented with an air gap with intakes at the bottom and top of the roof between the undertile membrane and the overlying discontinuous layer.

Here too, INDEX proposes the same materials with mineral coated upper face, in this case to prevent slippage, installed as indicated below, primarily to ensure waterproofing even in the vicinity of the mechanical mountings of the slats which perforate the membrane itself.

One must take care that the nails fixing the counterslats which perforate the undertile waterproofing membrane do not also penetrate the thermal insulation layer, generally composed of porous, absorbent materials which do not ensure a seal around the nail.

The nails must be driven directly into the support or a slat forming part of the thickness of the insulation layer to render any infiltration of humidity insignificant.

DIRECT INSTALLATION OF ROOF TILES TO MINERAL COATED MEMBRANE ON MORTAR KERBS
(max roof angle ≤35%)
When permitted by the tile manufacturer and local custom, the layer of tiles may be laid on mortar kerbs, themselves supported directly by the membrane in rows parallel to the guttering, making sure to interrupt them every 2 m or so with a short slit to provide ventilation under the tiles and draining of any infiltration of water.

TILES INSTALLED OVER WOODEN SLATS
If the tiles are laid onto wooden slats, they are nailed in parallel with the guttering on 20 mm thick and 40 mm wide slats previously mechanically secured to the concrete layer under the membrane and oriented along the maximum slope of the roof perpendicular to the guttering to ensure good ventilation under the tiles.

• Under slat sealing layer
In order to ensure optimum waterproofing, before the first row of slats is laid perpendicular to the guttering, under each of the latter one must flame bond to the undertile membrane a layer of membrane of at least 4 mm thickness and 100 mm width to which the slat is then secured, thus raising the waterproofing of the nails relative to the surface over which any water infiltration drains by the thickness of the membrane employed for the purpose.

• Over slat sealing layer
To ensure an effective seal of the slat nails even in areas with high snowfall during thaws, where water may collect under the tiles, it is best to encapsulate the counterslats which set the ventilation gap with a layer of armoured membrane with unwoven polyester fabric of width 25 cm flame bonded to them and turned down and glued to the undertile membrane.

In this case, to enable optimal coverage of the slats, the slats themselves should have a trapezoidal section.

We give below the measurements of the slat cross sections recommended by CSTB for roofs in mountain areas:
- minimum thickness: 2.7 cm
- width at base: 8 cm
- width at top: 5 cm
Adhesive single waterproofing layer with roof tile and Shingle decoration

It may be convenient to cover a wooden roof without previously mechanically securing the underlying sheet and use adhesive membranes. INDEX produces a vast range of extra-adhesion membranes (super-adhesion membranes), the use of which is described in their technical specifications. The risk of fire when installing membranes to wood is resolved with this system, since the membranes are installed without the use of flame bonding. Even if, on the general part of the roof, mechanical fastening is not employed, the mounting of the layers to the foot of the roof’s border, skylights, chimneys and any volumes protruding from the roof is imperative for the stability of the covering. The same is true of the covering of vertical sections, which must be prepared by first installing the SELFTENE BASE EP adhesive membrane, cold-bonding to which is supplemented with nails which prevent the covering slipping or being torn off by the wind.

Covering slopes
The system described below is applicable to both flat roofs and roofs with a slope of up to 15%. For greater slopes, the adhesive should be supplemented with mechanical fasteners under the head kerbs of the last mineral coated membrane layer, using fasteners and 50 mm washers or equivalent every 20 cm under the overlaps, which must be at least 15 cm wide. Furthermore, the length of the waterproofing layer must be less than 4 m. The system does not provide for covering roofs with a slope of more than 40%.

CAUTION
Since the layer is completely adhering to the boards, the use of this system in non-insulated warm roofs must be carefully assessed in terms of the thermo-hygrometric conditions of the roofed in areas to prevent humidity accumulating in the wooden structures.
### Table of MINERAL DESIGN AUTOADESIVO EP OVERLAPS POLIESTERE patterns

<table>
<thead>
<tr>
<th>Three dimensional</th>
<th>Conventional patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decoration:</strong></td>
<td><strong>Decoration:</strong></td>
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### Installation details

**Slopes greater than 15%**

- Mechanical fixing every 20 cm with nail or screw with large washer

**Slopes between 15% and 100%**

- Maximum length 5 metres

**Slopes over 100%**

- Maximum length 2.5 metres

### Head laps

- **Straight cut**
- **Overlap zone of the membrane designed with a straight cut**
- **Overlap zone of the membrane designed with the profile**
- **Cut following the curve of the tile and overlap on the membrane below**

### Ridges and rain guides

- **Solution A**
  - Cut the single slates
- **Solution B**
  - Cut a strip as illustrated
- **Solution C**
  - Cut a strip as illustrated
- **Solution D**
  - Cut following the curve of the tile and overlap on the membrane below
TERRACES AND NON-WALKABLE FLAT ROOFS

Flat roofs are used as terraces to make urban buildings more habitable, at the present time solutions such as terraced buildings on multiple levels combined with roof gardens are in common use. Not very commonly used in the past, flat roofs have developed in recent years with the arrival of concrete and the new architectural trends developed by Rationalism in the early 20th century, whose best known exponent was Le Corbusier. Even in wooden buildings, this type of design is of great importance, especially in very tall apartment buildings in wood in which exposure to sunlight actively contributes to the habitability of outdoor spaces, especially in combination with roof gardens. The technical solutions aim to create a roof which provides outstanding thermal and acoustic insulation and comfort for the occupants throughout the life of the installation.

Flat wooden roofs in general, whether walkover or not, require proper drainage of rainwater, since infiltrations of water can cause serious damage over time. The selection of waterproofing systems and products must assure good protection over the long term; this is why materials must be chosen which have good mechanical strength and, in the context of non-walkover flat roofs, good UVA resistance (exposed waterproof roofs).

FLAT ROOFS AND BIO-ARCHITECTURE

Naturally, respecting the thermal transmittance limits during the design and building stages makes no sense if the design solution does not last over time, and the durability of the insulation does not only depend on the quality of the insulating material. Therefore, as well as energy containment, the design principles of bio-architecture also consider urban/landscape integration, the use of renewable sources of energy, the environmental impact of building products through the LCA (Life Cycle Assessment), the impact of the building process, as well as a forecast of the environmental impact during the management and maintenance/repair stages, partial or total modification of the intended use for parts/all of the building, during its partial or total demolition and, at the end of its lifetime, recycling of the building materials.

One of the main requirements for sustainable building is the durability of the technical solutions provided by the design and the fact that they are easy to dismantle, which both lead to a lower consumption of resources, therefore INDEX has not stopped at just producing high performance insulating materials but, in order to maintain the thermal insulation performance over time, it has produced specific technical publications suggesting the best protection systems that are safe and easy to maintain and repair.

An example of this is the flat “inverted roof” made up of a floating floor in squares of concrete laid dry on plastic HELASTORING supports, which rest on a layer of thermal insulation in extruded polystyrene panels laid without any constraints on a waterproof covering without adhesion. An alternative to this is the configuration of multifunctional roofs illustrated in the following picture, made up of areas set up for different functions with prefabricated separating elements laid dry on a single waterproof covering, also applied without adhesion, almost always with a root inhibitor additive to allow the possible expansion of green areas without having to do any work on the waterproofing.

INDEX’s technical department is available to support the designer in selecting and specifying the best products and systems in terms of waterproofing and thermal and acoustic insulation.
TERRACES - WALKABLE FLAT ROOFS

WATERPROOFING OF WOODEN ROOFS WITH TRADITIONAL SINGLE-LAYER DISTILLED POLYMER-BITUMEN MEMBRANES

SINGLE LAYER

Terrace with thermal insulation
Inverted roof system

1. X-LAM floor slab
2. PROTEADUO TRIARMATO or HELASTA waterproofing membrane fully flame bonded
3. PROTEADUO TRIARMATO or HELASTA independently laid waterproofing membrane
4. Waterproofing membrane MINERAL HELASTA fully flame bonded
5. Extruded expanded polystyrene thermal insulation
6. Pavers on HELASTORING supports
7. Metal profile member

Terrace without thermal insulation

1. X-LAM floor slab
2. PROTEADUO TRIARMATO or HELASTA waterproofing membrane fully flame bonded
3. PROTEADUO TRIARMATO or HELASTA independently laid waterproofing membrane
4. Waterproofing membrane MINERAL HELASTA fully flame bonded
5A. Paving on reinforced concrete screed
5B. Pavers on HELASTORING supports
6. Metal profile member

STRATIFIED ELEMENTS

1. X-LAM slab
2. PROTEADUO TRIARMATO or HELASTA independently laid waterproofing membrane
3. PROTEADUO TRIARMATO or HELASTA waterproofing membrane, flame bonded, full coverage adhesion
4. MINERAL HELASTA membrane, flame bonded, full coverage adhesion
5. Extruded expanded polystyrene thermal insulation
6. Squares on HELASTORING supports
7. Metal profile member
TERRACES - WALKABLE FLAT ROOFS

WATERPROOFING OF WOODEN ROOFS
WITH DOUBLE LAYER DISTILLED POLYMER-BITUMEN MEMBRANES

DOUBLE LAYER

With self-thermo-adhesive and traditional distilled bitumen membranes

1. X-LAM floor slab
2. PROTEADUO TRIARMATO or HELASTA waterproofing membrane fully flame bonded
3. AUTOTENE BASE HE/V self-thermo-adhesive waterproofing membrane
4. PROTEADUO TRIARMATO or HELASTA waterproofing membrane, flame bonded, full coverage adhesion
5. MINERAL HELASTA membrane, flame bonded, full coverage adhesion
6A. Paving on reinforced concrete screed
6B. Pavers on HELASTORING supports
7. Metal profile member

With adhesive distilled bitumen membranes

1. X-LAM slab
2. SELFTENE BASE HE adhesive waterproofing membrane
3. SELFTENE BASE HE adhesive waterproofing membrane
4. MINERAL SELFTENE HE OVERLAPS adhesive waterproofing membrane
5A. Paving on reinforced concrete screed
5B. Squares on HELASTORING supports
6. Metal profile member

STRATIFIED ELEMENTS
1. X-LAM slab
2. PROTEADUO TRIARMATO or HELASTA waterproofing membrane, flame bonded, full coverage adhesion
3. AUTOTENE BASE HE/V self-thermo-adhesive waterproofing membrane
4. PROTEADUO TRIARMATO or HELASTA waterproofing membrane, flame bonded, full coverage adhesion
5. MINERAL HELASTA membrane, flame bonded, full coverage adhesion
6A. Paving on reinforced concrete screed
6B. Squares on HELASTORING supports
7. Metal profile member
**Products and solutions for wooden structures**

**TERRACES - WALKABLE FLAT ROOFS**

**WATERPROOFING OF WOODEN ROOFS WITH DOUBLE LAYER SELF-THermo-ADHESIVE AND TRADITIONAL POLYMER DISTILLED BITUMEN MEMBRANES**

**DOUBLE-LAYER**

**TERRACES**

1. X-LAM floor slab
2. Vapour barrier and thermal insulation
3. AUTOTENE BASE HE/V self-thermo-adhesive waterproofing membrane
4. PROTEADUO TRIARMATO or HELASTA waterproofing membrane, fully flame bonded, full coverage adhesion
5. MINERAL HELASTA membrane, flame bonded, full coverage adhesion
6A. Paving on reinforced concrete screed
6B. Squares on HELASTORING supports
7. Metal profile member

**STANDARD VAPOUR BARRIER AND COLD-BONDED INSULATING PANELS IN:**
- EXTRUDED EXPANDED POLYSTYRENE
- POLYURETHANE
- MINERAL FIBRE

2. Waterproofing membrane DEFEND
3. DEFEND/V or DEFEND ALU vapour barrier, dry laid
4. Bituminous adhesive MASTICOLL
5. Thermal insulation

**ADHESIVE VAPOUR BARRIER AND BONDED INSULATING PANELS IN:**
- EXPANDED POLYSTYRENE
- EXTRUDED EXPANDED POLYSTYRENE
- POLYURETHANE

1. X-LAM floor slab
2. Adhesive waterproofing membrane SELFTENE BASE HE
3. SELFTENE BV HE BIADESIVO adhesive vapour barrier
4. Thermal insulation
5. MINERAL HELASTA membrane, flame bonded, full coverage adhesion
6A. Paving on reinforced concrete screed
6B. Squares on HELASTORING supports
7. Metal profile member

**LAYING THE VAPOUR BARRIER**

1. X-LAM floor slab
2. Waterproofing membrane DEFEND
3. DEFEND/V or DEFEND ALU vapour barrier, dry laid
4. Bituminous adhesive MASTICOLL
5. Thermal insulation

**STANDARD VAPOUR BARRIER AND COLD-BONDED INSULATING PANELS IN:**
- POLYURETHANE

2. Waterproofing membrane DEFEND
3. DEFEND/V or DEFEND ALU vapour barrier, dry laid
4. Bituminous adhesive MASTICOLL
5. Thermal insulation

**ADHESIVE VAPOUR BARRIER AND BONDED INSULATING PANELS IN:**
- EXPANDED POLYSTYRENE
- EXTRUDED EXPANDED POLYSTYRENE
- POLYURETHANE

1. X-LAM floor slab
2. Adhesive waterproofing membrane SELFTENE BASE HE
3. SELFTENE BV HE BIADESIVO adhesive vapour barrier
4. Thermal insulation
5. MINERAL HELASTA membrane, flame bonded, full coverage adhesion
6A. Paving on reinforced concrete screed
6B. Squares on HELASTORING supports
7. Metal profile member

**STRAITIFIED ELEMENTS**
1. X-LAM slab
2. Vapour barrier and thermal insulation
3. AUTOTENE BASE HE/V self-thermo-adhesive waterproofing membrane
4. PROTEADUO TRIARMATO or HELASTA waterproofing membrane, fully flame bonded, full coverage adhesion
5. MINERAL HELASTA membrane, flame bonded, full coverage adhesion
6A. Paving on reinforced concrete screed
6B. Squares on HELASTORING supports
7. Metal profile member
Roof without thermal insulation
With self-thermo-adhesive and traditional distilled bitumen membranes

2. Adhesive waterproofing membrane
   SELFTENE BASE HE
   (nailed)

4. Waterproofing membrane
   MINERAL PROTEADUO HP 25
   (certified RG5 for resistance to hail)
or MINERAL HELASTA

1. X-LAM floor slab

3. AUTOTENE BASE HE/V
   self-thermo-adhesive
   waterproofing membrane

---

Roof without thermal insulation
Roof with adhesive distilled bitumen membranes

2. Adhesive waterproofing membrane
   SELFTENE BASE HE
   (nailed)

4. Adhesive waterproofing membrane
   MINERAL SELFTENE HE OVERLAPS

1. X-LAM floor slab

3. Adhesive waterproofing membrane
   SELFTENE BASE HE

---

STRATIFIED ELEMENTS
1. X-LAM slab
2. SELFTENE BASE HE adhesive waterproofing membrane (nailed)
3. AUTOTENE BASE HE/V thermo-adhesive waterproofing membrane
4. MINERAL PROTEADUO HP 25 waterproofing membrane (hail resistance RG5)
or MINERAL HELASTA

STRATIFIED ELEMENTS
1. X-LAM slab
2. SELFTENE BASE HE adhesive waterproofing membrane (nailed)
3. SELFTENE BASE HE adhesive waterproofing membrane
4. MINERAL SELFTENE HE OVERLAPS adhesive waterproofing membrane
NON-WALKABLE FLAT ROOFS

WATERPROOFING OF WOODEN ROOFS WITH DOUBLE LAYER DISTILLED POLYMER-BITUMEN MEMBRANES

DOUBLE LAYER

Roof with thermal insulation
With self-thermo-adhesive and traditional distilled bitumen membranes

<table>
<thead>
<tr>
<th>Thermal insulation (4)</th>
<th>Waterproofing membrane (5) First layer</th>
<th>Waterproofing membrane (7) Second layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPANDED SINTERED POLYSTYRENE</td>
<td>AUTOTENE BASE EP</td>
<td>MINERAL PROTEADUO HP 25 (hail resistance RG5)</td>
</tr>
<tr>
<td>EXPANDED EXTRUDED POLYSTYRENE</td>
<td></td>
<td>MINERAL HELASTA</td>
</tr>
<tr>
<td>EXPANDED SINTERED POLYSTYRENE</td>
<td>SELFTENE BASE HE</td>
<td>MINERAL DESIGN TRIARMATO</td>
</tr>
<tr>
<td>EXPANDED EXTRUDED POLYSTYRENE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISOBASE PSE</td>
<td>The membrane is already included in the ISOBASE insulating layer</td>
<td>MINERAL PROTEADUO HP 25 (hail resistance RG5)</td>
</tr>
<tr>
<td>ISOBASE PSE/EX</td>
<td></td>
<td>MINERAL HELASTA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MINERAL DESIGN TRIARMATO</td>
</tr>
</tbody>
</table>

STRATIFIED ELEMENTS
1. X-LAM slab
2. SELFTENE BASE HE adhesive waterproofing membrane
3. SELFTENE BV HE BIADESIVO adhesive vapour barrier
4. Thermal insulation
5. Waterproofing membrane First layer
6. SELFTENE BASE HE adhesive waterproofing membrane
7. Waterproofing membrane Second layer
Recovering vital areas within cities is a trend that has constantly become more firmly established over recent years and that is dictated not only by the requirement to recover areas that would otherwise be infertile, but also by the need to improve the environmental quality of building complexes. The green area function of a roof garden fulfils a fundamental urban task since, as well as its private use, it can also bring back collective gathering places and transform the appearance of districts not only aesthetically but also in terms of living quality. As for the implementation of new works, green roofs are an excellent way of solving many problems associated with garage and basement roofs. They can also perform the important function of regulating stormwater flow. The on-going development of the territory is reducing the drainage capacity of areas undergoing urbanisation, so that sewer networks are becoming obsolete too fast. Using the roofs of new buildings as roof gardens, which act as hydraulic accumulators during heavy rainstorms, prevents the sewer network’s capacity being overloaded. Green roofs also have the role of reducing the phenomenon of urban “heat islands” and their use provides a significant economic advantage in the energy management of the building and the overall management of urban areas. In the city of Chicago alone a Weston Design Consultant study estimates the annual energy saving due to the transformation of the city’s roofs to green roofs to be $100,000,000. Furthermore, roof gardens: filter out urban pollutants and reduce carbon dioxide, filter polluting rainwater, cool the air by evapo-transpiration of water vapour, promote the development of animal ecosystems, reduce the transmission of noise within the building, reduce the effects of urban heat islands, increase the heat storage capacity of roofs and their thermal resistance, protect the waterproof layer and increase its lifetime - to sum up, they are a powerful instrument in new architectural languages.

As well as the tried and tested waterproofing materials, INDEX can also provide laying systems for them, along with the correct application methods of the different products. The cultivation of plants on flat surfaces therefore only remains a problem in terms of the choice of materials and careful use of the laying techniques.

For the sizing of green roofs please refer to the UNI 11235 legislation.

The use of the roofs of buildings as green roofs is one of the main strategies used in bio-architecture to limit the environmental impact of the construction. Roof gardens, which have a long history - the hanging gardens of Babylon built by King Nebuchadnezzar are the most famous example - are recommended by all sustainable architecture associations both because they reduce the building’s energy consumption and hence its CO₂ emissions, and because they have numerous other economic benefits: they absorb rainwater and release it slowly, which prevents overloading the sewer networks and hence flooding, and also prevent existing sewers from being overloaded by new buildings.

**Intensive and extensive green roofs**

There are two different types of green roofs: “intensive green roofs” (roof gardens) and “extensive green roofs”.

In “extensive green roofs” small plants are grown, which retain the soil; they are not accessible but the amount of maintenance required is lower and the irrigation system simpler. The waterproofing cover suggested below is suited to both types, while in roof gardens the thickness of the soil and its drainage almost always impose the use of a thermal insulating layer, in extensive green roofs the thermal insulation is always included.
Double-layer systems with adhesive distilled bitumen membrane

1. X-LAM floor slab
2. ECOTENE HDPE ANTIRADICE adhesive waterproofing membrane
3. Waterproofing membrane ECOTENE HDPE ANTIRADICE
4. ECOTENE HDPE ANTIRADICE adhesive waterproofing membrane
5. Adhesive waterproofing membrane MINERAL SELFTENE HE OVERLAPS
6. Extensive green roof

Single-layer systems with traditional distilled bitumen membrane

1. X-LAM floor slab
2. HELASTA ANTIRADICE waterproofing membrane
3. HELASTA ANTIRADICE waterproofing membrane nailed under the overlaps
4. HELASTA ANTIRADICE waterproofing membrane
5. MINERAL HELASTA waterproofing membrane
6. Extensive green roof

STRATIFIED ELEMENTS
1. X-LAM slab
2. ECOTENE HDPE ANTIRADICE adhesive waterproofing membrane
3. INDEXTENE HDPE ANTIRADICE adhesive waterproofing membrane
4. INDEXTENE HDPE ANTIRADICE adhesive waterproofing membrane
5. MINERAL SELFTE HE OVERLAPS adhesive waterproofing membrane
6. Extensive green roof
WOODEN HOUSE BUILT IN OUR TRAINING AND USING INDEX SYSTEMS

1. FOUNDATIONS
2. OUTER WALLS
3. INNER WALLS
4. SLOPED ROOFS
5. FLAT ROOF GARDENS
6. TERRACES
7. BALCONIES
8. FLOOR SLABS
9. FLOORS
10. BATHROOMS AND SHOWERS
WOODEN HOUSE BUILT IN OUR TRAINING AND TECHNICAL REFRESHER COURSE CENTRE USING INDEX SYSTEMS AND PRODUCTS

1. FOUNDATIONS
2. OUTER WALLS
3. INNER WALLS
4. SLOPED ROOFS
5. FLAT ROOF GARDENS
6. TERRACES
7. BALCONIES
8. FLOOR SLABS
9. FLOORS
10. BATHROOMS AND SHOWERS
Waterproofing works in contact with the ground should be planned and carried out with great care, bearing in mind that the life of the coating must be the same as that of the structure, and that it is most unlikely that any remedial work will be possible, so a lack of waterproofing or defective waterproofing could be very costly indeed.

So the selection of materials should focus on products that maintain their characteristics - impermeable to water and water vapour, rot resistance and mechanical resistance over time, even when subject to site traffic.

**STRATIFIED ELEMENTS - SOLUTION A**

- **Reinforced concrete foundation**
  - 1. **ECOVER.** Water-based bituminous primer
  - 2. **SELTENE BASE EP.** Adhesive elastomeric polymer-bitumen membrane
  - 3. **HELASTA POLIESTERE.** Elastomeric polymer-bitumen membrane
  - 4. **PROTEFON.** Plastic drainage sheet with tapered profiles.

**STRATIFIED ELEMENTS - SOLUTION B**

- **Reinforced concrete foundation**
  - 1. **INDEVER PRIMER E.** Solvent-based, fast drying bituminous primer
  - 2. **INDEXTENE HDPE SUPER.** Adhesive membrane self-protected with polyethylene film

**STRATIFIED ELEMENTS - SOLUTION C**

- **Reinforced concrete foundation**
  - 1. **INDEVER.** Solvent-based bituminous primer
  - 2. **ARMODILLO POLIESTERE.** Armoured multi-functional polymer-bitumen membrane, protective and draining
  - 3. Panel in sintered expanded polystyrene or extruded expanded polystyrene
The thermal insulation of wooden walls not only protects against heat and cold, but must protect the wood against rainwater while providing good breathability for vapour and fire resistance. For this reason, it is essential to use a fibrous material like rockwool with its excellent breathability, thermal insulation, fire resistance and acoustic insulation. The system is completed with high quality render with excellent mechanical and breathability qualities. It is then finished with highly breathable and water repellent coat of siloxane. INDEX systems also allow the creation of all-over insulation with synthetic stone coverings, which offer very good aesthetics and excellent thermal insulation properties.

**STRATIFIED ELEMENTS - SOLUTION A**

1. **THERMOSILENTROCK.** Rigid water-repellent rockwool panels for thermal and acoustic insulation, secured with anchor bolts.
2. Anchor bolts.
3. **COATBOND FINE FIBER e RETINVETRO PER RASANTI.** Fibre-reinforced single-component render for gluing and rendering the all-over insulation systems and for no-crack rendering of a variety of surfaces. The **RETINVETRO PER RASANTI** glass fibre mesh is sunk into the freshly applied layer.
4. **COATBOND.** Fibre-reinforced single-component render for gluing and rendering the all-over insulation systems and for no-crack rendering of a variety of surfaces.
5. **PRIMER FIX.** Water-based primer for concrete, paint and crumbling masonry.
6. **DECORPLAST 1,2.** Acrylic-siloxane water emulsion protective, decorative, breathable, water repellent and algae-resistant coverings for interiors and exteriors.

**STRATIFIED ELEMENTS - SOLUTION B**

1. **POLICAPHERM.** Self-extinguishing sintered expanded polystyrene rigid panels, with low water absorption and high thermal insulation, mounted with anchor bolts.
2. **COATBOND e RETINVETRO PER RASANTI.** Fibre-reinforced single-component render for gluing and rendering the all-over insulation systems and for no-crack rendering of a variety of surfaces. The **RETINVETRO PER RASANTI** glass fibre mesh is sunk into the freshly applied layer.
3. **COATBOND.** Fibre-reinforced single-component render for gluing and rendering the all-over insulation systems and for no-crack rendering of a variety of surfaces.
4. Anchor bolts.
5. **COATBOND e RETINVETRO PER RASANTI.**
6. **COATBOND.**
7. Exposed stone covering applied with **PETRABOND** and grouted with **MUROSTUK.**
INTERNAL WALLS

Depending on the various types of construction, the internal and outer walls of wooden buildings may be designed and built with solid wood beams (blockhaus system), with framing structures or with solid cross-laminated wood panels (X-LAM). To obtain a statically solid structure able to satisfy the requirements for thermal and acoustic insulation as well as any other specification, the internal and outer walls must be specified with different thicknesses of the bearing section and, if necessary, fitted with false walls in plasterboard or composed of OSB compressed wood panels (interior) while the outer walls are fitted with all-over insulation if built with X-LAM panels, and internal and external coverings for blockhaus constructions and framed structures (which may however also be left with the wood itself exposed). These pages list a number of technical solutions.

**STRATIFIED ELEMENTS - SOLUTION A**

1. **SILENTRock.** Thermal and acoustic insulation in self-bearing rockwool panels for use in the airgap of traditional cavity walls and plasterboard walls and false walls on metal frames.
2. **DIFOBAR SINT F.V. 140.** 3-layer synthetic polypropylene sheet as a vapour barrier for ventilated wooden roofs.
3. **OSB panel.**
4. **PRIMER U.** Adhesion promoting primer for non-absorbent surfaces.
5. **RASOPLAN FLEX.** Cement-based medium flexibility render for regularising inner outer masonry, paint and plastering surface porosity.
6. **SILICOLOR.** Acrylic-siloxane water emulsion based waterpaint, hydro-repellent, algae resistant and highly breathable, for interiors and exteriors.

**STRATIFIED ELEMENTS - SOLUTION B**

1. **SILENTEcoEster.** Self-bearing thermal and acoustic insulation panels made of heat bonded polyester fibre, without adhesive, non-toxic, precoupled on one side with a transparent film of polyester impermeable to the air and water vapour for thermal and acoustic insulation of perimeter walls.
2. **OSB panel.**
3. **PRIMER U.** Adhesion promoting primer for non-absorbent surfaces.
4. **RASOPLAN FLEX.** Cement-based medium flexibility render for regularising inner outer masonry, paint and plastering surface porosity.
5. **SILICOLOR.** Acrylic-siloxane water emulsion based waterpaint, hydro-repellent, algae resistant and highly breathable, for interiors and exteriors.
supplied by INDEX for the thermal and acoustic insulation of internal and outer walls, in relation to the various types of construction technique. As regards the evaluation of the performance of the systems proposed below, we indicate the calculated thermal specifications, whereas for the acoustic performance, since there is no archive of tested installations nor a standard method for calculating the apparent acoustic insulation, we simply give some information drawn from the literature; the authors will update this listing following the campaign of on-site tests being run at the time of writing.

**STRATIFIED ELEMENTS - SOLUTION C**
1. Wood bearing frame and SILENT\textit{Eco Ester} thermal and acoustic insulation
2. Plasterboard panel
3. PRIMER FIX. Water-based primer
4. SILICOLOR. Acrylic-siloxane water emulsion based waterpaint, hydro-repellent, algae resistant and highly breathable, for interiors and exteriors.

**STRATIFIED ELEMENTS - SOLUTION D**
1. Wood bearing frame and SILENT\textit{Rock} fibrous thermal and acoustic insulation
2. ALUSTOP BV 105. Reflectant vapour barrier sheet
3. Plasterboard panel
4. PRIMER FIX. Water-based primer
5. SILICOLOR. Acrylic-siloxane water emulsion based waterpaint, hydro-repellent, algae resistant and highly breathable, for interiors and exteriors.

**STRATIFIED ELEMENTS - SOLUTION E**
1. Wood bearing frame and SILENT\textit{Rock} fibrous thermal and acoustic insulation
2. Plasterboard panel
3. PRIMER FIX. Water-based primer
4. SILICOLOR. Acrylic-siloxane water emulsion based waterpaint, hydro-repellent, algae resistant and highly breathable, for interiors and exteriors.
The design of a wooden roof must account for a variety of diverse factors, mostly related to climate and location. The technical solutions aim to create a roof which provides outstanding thermal and acoustic insulation and comfort for the occupants throughout the life of the installation. INDEX can supply a variety of solutions for waterproofing ventilated and unventilated wooden roofs which can satisfy any design requirement. We give below three examples of ventilated and micro-ventilated roofs which can be implemented using INDEX products.

**STRATIFIED ELEMENTS - SOLUTION A**
1. **DIFOBAR SINT F.V. 140**. 3-layer synthetic polypropylene sheet as a vapour barrier for ventilated wooden roofs.
2. **THERMOSILENTROCK**. Rigid water-repellent rockwool panels for thermal and acoustic insulation.
3. **DIFOBAR SINT 160**. Ultra-breathable waterproofing synthetic undertile sheet, 160 g/m², for ventilated and unventilated wooden roofs, laid directly onto the insulation.
4. Slat to support the tiles and provide microventilation.

**STRATIFIED ELEMENTS - SOLUTION B**
1. **DIFOBAR SINT F.V. 140**. 3-layer synthetic polypropylene sheet as a vapour barrier for ventilated wooden roofs.
2. **THERMOSILENTROCK**. Rigid water-repellent rockwool panels for thermal and acoustic insulation.
3. **DIFOBAR SINT 90**. Ultra-breathable waterproofing synthetic undertile sheet, 90 g/m², for ventilated and unventilated wooden roofs, laid directly onto the insulation.
4. Primary ventilation provided by slats resting directly on the insulation plus boards.
5. **DIFOBAR PLUS**. Polymer-bitumen waterproofing and breathable undertile sheet, with high mechanical resistance and long life for ventilated wooden roofs. Sheet laid directly onto boards.
6. Slat to support the tiles and provide microventilation.

**STRATIFIED ELEMENTS - SOLUTION C**
1. **SELFTENE B.V. HE BIADESIVO/V**. Vapour barrier membrane in polymer-bitumen with adhesive facing on both sides for cold-bonding to the laying surface and insulating panels. Version with reinforced glass felt mesh.
2. **POLISTIRENE ESTRUSO** (EXTRUDED POLYSTYRENE). Extruded expanded polystyrene panels with high compression resistance.
3. Primary ventilation provided by slats resting directly on the insulation plus boards.
4. **MINERAL DESIGN AUTOADESIVO EP SELFFLAPS POLIESTERE**. Adhesive waterproofing membrane for decorating and extending the design of exposed roofs. Bonds directly onto the boards.
There are two different types of green roofs: “intensive green roofs” (roof gardens) and “extensive green roofs”. The extensive green roof features small plants in special systems designed to retain the soil but which are not walkover except in case of maintenance, which is generally very limited in scope. Roof gardens, on the other hand, have a layer of soil deep enough to permit the cultivation of larger plants (up to small trees, depending on the amount of ground): this makes the use of more massive supports necessary (which also cost considerably more), due to the much greater loading. Maintaining such systems is much more costly and time-consuming. The waterproofing cover proposed by INDEX in the following page is suitable for both types of green roof, following application of a high performance elastomeric membrane to protect against roots.

**STRATIFIED ELEMENTS**

1. **HELASTA POLIESTERE ANTIRADICE.** High performance polymer-bitumen waterproofing membrane with root prevention additive; the cover is made of a single-layer with mechanical stabilisation under the overlaps and heat welded side and head overlaps.

2. **MINERAL HELASTA POLIESTERE.** High performance elastomeric polymer-bitumen waterproofing membrane laid vertically in full contact adhesion over the first layer.

3. System for making extensive green roofs composed of EPS insulation tubes and vegetable layer.
The use of roofs as terraces is intended to make urban buildings more habitable. Even in wooden buildings, this type of design is of great importance, especially in very tall condominial buildings in wood in which exposure to sunlight actively contributes to the habitability of outdoor spaces, especially in combination with roof gardens. The technical solutions aim to create a roof which provides outstanding thermal and acoustic insulation and comfort for the occupants throughout the life of the installation.

**STRATIFIED ELEMENTS**

*Single-layer system with micro-mineral coated undertile adhesive membrane laid directly on wooden roof*

1. **SELFTESTile.** Elastomeric adhesive polymer-bitumen waterproofing membrane reinforced with unwoven polyester fabric, with mineral coated upper face and lower surface coated with adhesive mix.

2. **UNOlastic.** High adhesion water-based bituminous elastomer single-component waterproofing, easy to apply, takes cement mortar for sealing the joints between sheets of SELFTESTile. The seal is composed of two layers with a layer of **RINFOTEX PLUS** or **RINFOTEX EXTRA** reinforcement between them.

3. Tiles laid with **Geniustrong**: High adhesion/elasticity cement-based super-adhesive, designed specifically for porcelain tiles, mosaic, natural and composite stone.

4. **Fugopox Color AB.** Ceramic grouting with high cleanability, anti-bacterial, waterproof, stain resistant, for high chemical resistant grouted joints from 2 to 20 mm.

In vertical:

5. **PRIMER U.** Adhesion promoting primer for non-absorbent surfaces.

6. **Rasoplan Flex.** Medium flexibility cement render for regularising masonry, paint and plastering surface porosity.

7. **SILICOLOR.** Breathable siloxane waterpaint for interiors and exteriors.
STRATIFIED ELEMENTS
Single-layer system with micro-mineral coated undertile adhesive membrane laid directly on wooden roof

2. PURLASTIC FLASHING. Thixotropic single-component polyurethane bitumen waterproofing, ready for use, high adhesion, quick and easy application, takes cement mortar to seal the joints between the sheets of SELFTENETile. The seal is composed of two layers with a layer of RINFOTEX EXTRA reinforcement between them.
3. Tiles laid with GENIUSTONG: High adhesion/elasticity cement-based super-adhesive, designed specifically for porcelain tiles, mosaic, natural and composite stone.
4. FUGOPOX COLOR AB. Ceramic grouting with high cleanability, anti-bacterial, waterproof, stain resistant, for high chemical resistant grouted joints from 2 to 20 mm.
Depending on the type of construction, we may encounter traditional framed floors, with supporting beams and boards, framed floors with filled airgap (only very occasionally) or heavy duty cross-laminated X-LAM board floors.

Depending on your needs for thermal and acoustic comfort, we give below a series of explanatory sections, which summarise INDEX’s research in recent years into wooden structures, starting from traditional layering.
structures, with utility levelling screed and cement screed for the floors (whether ceramic or wooden), followed by more recent types of structure, all or partially dry laid, which are very suited to refurbishing projects due to their low weight.

### STRATIFIED ELEMENTS - SOLUTION E

1. Wooden frame bearing structure with air gap filled with rigid panels of THERMOSILENTROCK high density water-repellent rockwool, for thermal and acoustic insulation.
2. INDEXTENE HDPE SUPER. Adhesive waterproofing membrane reinforced with glass fibre felt and protected by a layer of high density polyethylene for cold waterproofing foundations, balconies, bathrooms and walls set into the ground.
3. Lightweight utility levelling screed.
4. FONOSTOP Duo double layer. Two layer walkover noise insulation with high phono-resilience for internal and external floors, with floating paving.
5. Heating system pipe and tubing panels
6. DRYCEM or QUICKCEM. Shrinkage compensating hydraulic binder for fast drying screeds.
8. FUGOPOX COLOR AB. Ceramic grouting with high cleanability, anti-bacterial, waterproof, stain resistant, for high chemical resistant grouted joints from 2 to 20 mm.

### STRATIFIED ELEMENTS - SOLUTION F

1. Bearing structure in wood with bearing beams and boards, consolidated with reinforced concrete structural screed.
2. Lightweight utility levelling screed.
3. FONOSTOPTrio. Three layer walkover noise insulation with high phono-resilience for internal and external floors, with floating paving.
4. Heating system pipe and tubing panels
5. DRYCEM or QUICKCEM. Shrinkage compensating hydraulic binder for fast drying screeds.
7. FUGOPOX COLOR AB. Ceramic grouting with high cleanability, anti-bacterial, waterproof, stain resistant, for high chemical resistant grouted joints from 2 to 20 mm.
Ceramic floors

STRATIFIED ELEMENTS
1. Tiles self-bonded to FONOSTOPTile Biadhesive: Acoustic insulation for walkover noise, biadhesive, multifunction for underfloors, for direct laying with adhesive of ceramics, wood and natural stone, with waterproofing and fracture prevention function for internal floors.
2. FUGOPOX COLOR AB. Ceramic grouting with high cleanability, anti-bacterial, waterproof, stain resistant, for high chemical resistant grouted joints from 2 to 20 mm.

Wooden floors

STRATIFIED ELEMENTS
1. FONOSTOPLegno. Two layer walkover noise acoustic insulation for floating interlocking wooden floors.
2. Interlocking wooden parquet.
Waterproofing interiors like bathrooms and showers or wellness areas must be done with products able to adhere to the various materials employed, including wood, metal, insulation, etc. Furthermore, these products must be versatile enough to handle any geometry of the installation and above unchanged performance and durability over the long term. For this reason, one must use elastomeric materials which adhere to all materials and can be covered, such as UNOLASTIC or SELFTENETILE.
The data provided are indicative average data for current production and may be changed and updated by INDEX S.p.A. at any time, without prior notice. The technical information and suggestions provided represent our best knowledge of the properties of the product in use. Considering the many possible uses of the product, and the possible interference of elements not in our control, we take no responsibility for the results. The Purchaser is responsible for establishing the suitability of the product for the use envisaged.

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