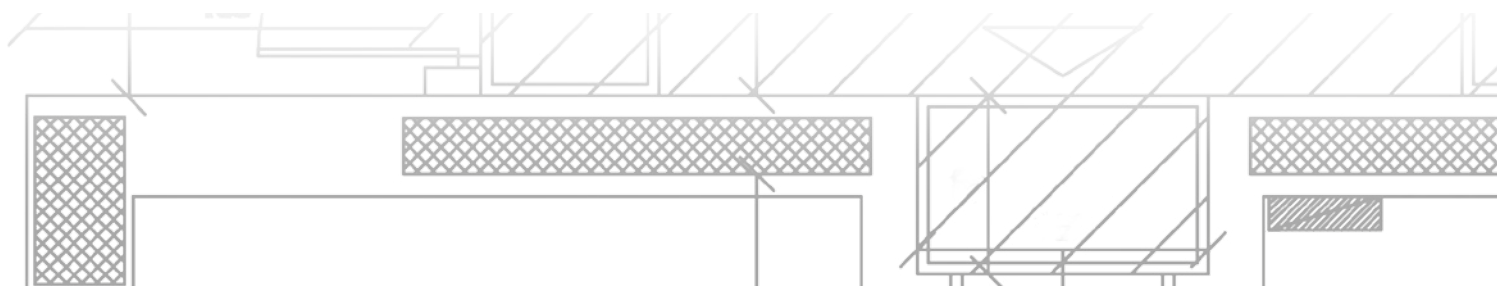




Technical Manual

MAPETHERM



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1. THERMAL INSULATION

This Technical Manual is an integral part of the certification system covered by current European Guidelines. Its aim is to increase the level of knowledge regarding external thermal insulation systems (ETICS – External Thermal Insulation Composite System) and to provide clear information on their technical aspects such as performance characteristics, the materials used in the system, how to choose and design a thermal insulation system, critical areas in the system and the current reference norms and standards applicable to this area, as well as to try and simplify some of the physical concepts regarding such systems.

Some of the general notions are provided in order to offer more complete information and, in all cases, the guidelines must be verified against current applicable local and national norms and standards.

The energy performance of a building is primarily determined by the insulating capacity of its shell.

The aim of an efficient insulating system for buildings is to guarantee that not only the air, but also walls, floors and ceilings, reach the correct temperature. In fact, a cold sensation comes from both a low air temperature and a low temperature of the horizontal and vertical protective elements.

To have a feeling of comfort the walls of a home must also be nice and warm and, to prevent them cooling down, they must be insulated with a “warm blanket” of insulation.

The exact opposite must take place in the summer; the walls must heat up as little as possible, which is achieved by protecting them externally with a “shield” of insulation.

The aim of a thermal insulation system is to prevent heat flowing from the inside towards the outside and from the outside towards the inside; that is, it is highly effective in all seasons and in all climates.

A thermal insulation system is essential for structures built according to the principles of environmental sustainability, energy savings and living comfort.





1.1 WHAT IS THERMAL INSULATION?

Thermal insulation allows you to create ideal living conditions all year round. However, you cannot cut corners when installing a system and certain requirements must be met to get satisfactory results.

In the case of new builds, and when upgrading the energy efficiency of old buildings, current norms and standards specify a maximum value for **Transmittance U** ($\text{W/m}^2\text{K}$); this value expresses the rate of heat transfer through one square metre of a designed or built wall, in one hour, for a difference in temperature of one degree between the internal and external faces of a building. To put it more simply, the Transmittance (U) value represents the amount of heat transmitted (lost) from the inside towards the outside of a building in winter.

The lower the value of U, the lower the amount of heat transmitted, that is, the higher the performance properties of the new or upgraded wall.

Every building material (bricks, insulating materials, etc.) is characterised by its thermal transmittance properties, known as **Thermal conductivity** (λ), which is obtained experimentally and is expressed in W/mK .

The lower the value of λ , the lower its thermal transmittance capacity, that is, the higher its insulating capacity.

Apart from thermal conductivity, another important characteristic to be considered is the **Inertia** (or Thermal capacity) of a material, that is, its capacity to accumulate heat and then release it, which is expressed in J/K .

For example, in winter, the higher the inertia of an internal wall, the higher the capacity of the structure to accumulate heat when it is available (central heating system running, for example), and then to release it when the set temperature is reached, thereby resulting in a considerable reduction in fuel consumption.

In the summer, on the other hand, the higher its inertia, the higher the capacity of the structure to accumulate heat in the hottest hours and

prevent heat entering the rooms, which it then releases during the night when it is possible to ventilate the rooms.

External insulation maximises both these effects.

The efficiency of an external shell during the summer months is measured according to the level of comfort reached in the internal rooms and, to have a better understanding of this concept, the two parameters affecting this condition must be considered:

- Thermal wave **Phase shift (ϕ)**: this value represents the time that elapses (in hours) between the maximum temperature on the external face and on the internal face of a structure: the higher the phase shift factor, the higher the capacity of the structure to delay the thermal wave, that is, better performance.
- Thermal wave **Attenuation factor (f_a)**: this value represents the reduction in size (attenuation) of the thermal wave as it passes through the structure: the lower the attenuation factor, the higher the capacity of the structure to reduce the thermal wave.

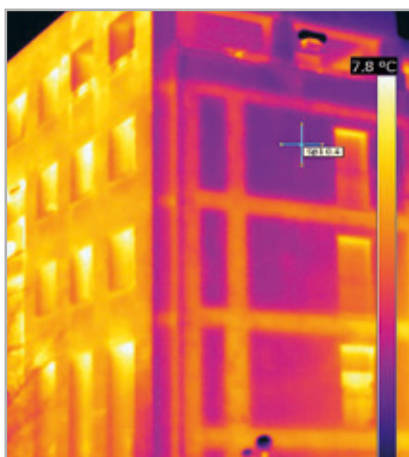
It is immediately clear that thermal insulation for walls may be optimised by considering just two parameters: the nature of the material used (which means their inertia and insulating capacity) and their thickness.

Therefore, to design an insulating shell correctly, various parameters and the area in which the building is located must be taken into consideration: a shell with high performance properties in cold weather is not necessarily the most suitable during hot weather.

Also, the sequence in which the materials are applied must also be considered: the same materials applied in a different sequence may have a considerable impact on the entire system in terms of protection during cold and hot weather, inertia, dew-point, etc.



A building without external insulation highlighting thermal bridges in the structure (beams and pillars). Masonry buffer walls damaged by microorganisms due to them being colder



An image of the same building taken with an infra-red camera: the surface temperature of the areas around the thermal bridges is considerably higher, an indication of heat loss

1.2 THERMAL BRIDGES

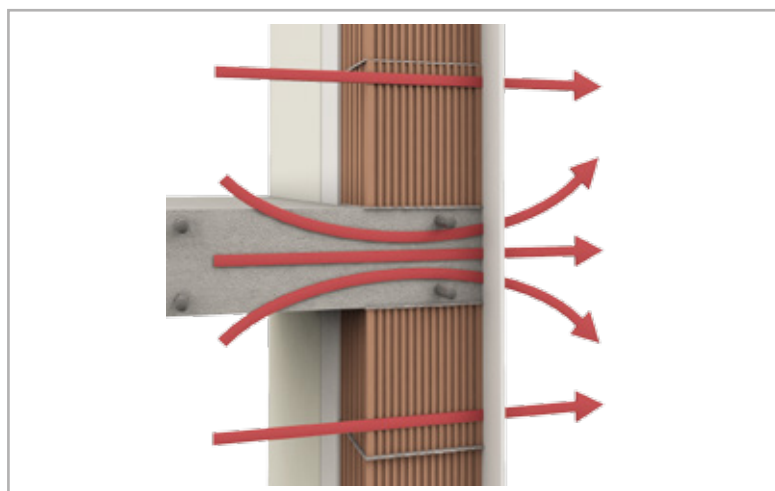
Thermal bridges are gaps or breaks in the insulating system and represent preferential routes for the transmission of heat.

They are the cause of heat dispersion, illnesses and discomfort:

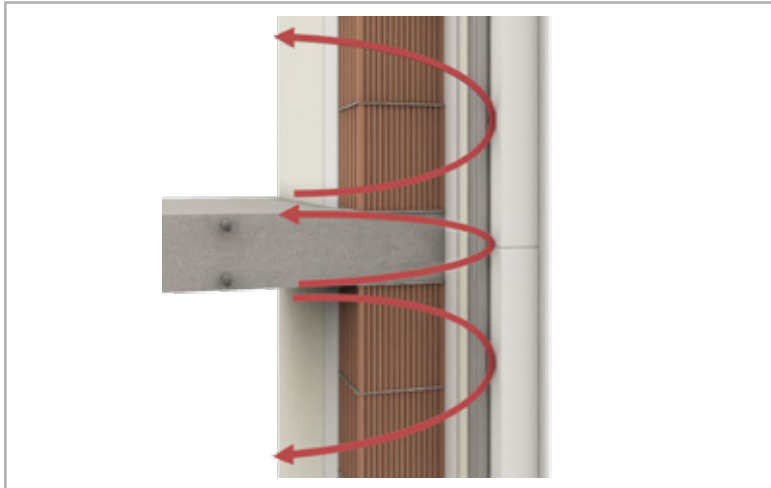
- dispersion of heat towards the outside during the winter, resulting in colder rooms and higher fuel consumption for heating systems;
- transmission of heat towards the inside during the summer, resulting in rooms becoming overheated and higher fuel consumption for air-conditioning systems;
- internal surfaces in correspondence with thermal bridges and around thermal bridges are colder during the winter, resulting in the formation of condensation and the premature growth of mould and bacteria.

If we exclude occasional thermal bridges, they may be sub-divided into two main categories:

- construction-related: due to the high conductivity (λ) of certain materials, such as reinforced concrete (beams and pillars);

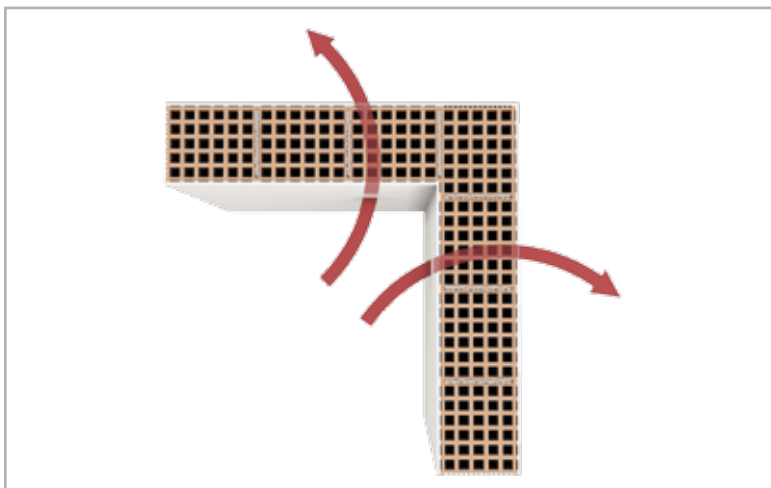


Construction-related thermal bridges

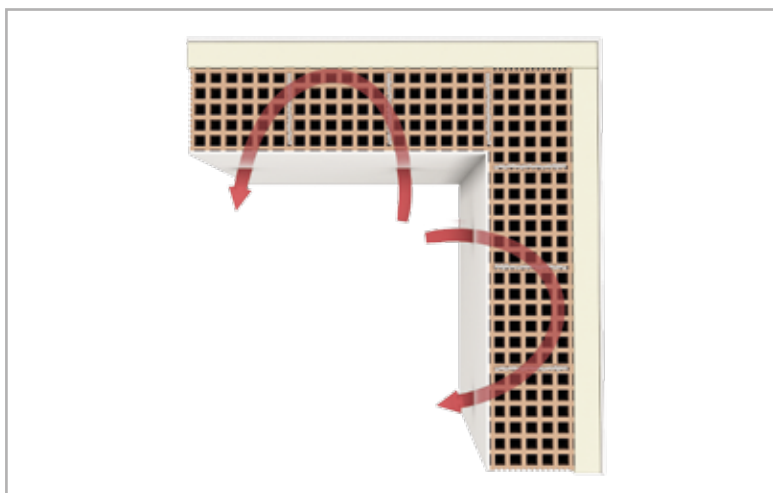


Construction-related thermal bridges eliminated by applying the Mapetherm System

- geometry-related: areas in which the internal surface is smaller than the external surface results in higher heat dispersion, such as the corners of buildings.



Geometry-related thermal bridges



Geometry-related thermal bridges eliminated by applying the Mapetherm System

In fig. 1.4 you can see a temperature of 8.4°C in correspondence with a thermal bridge and the inevitable formation of condensation and mould. An external thermal insulation system is an effective way of eliminating thermal bridges, whether they are construction-related or geometry-related.



1.3 CONDENSATION AND MOULD

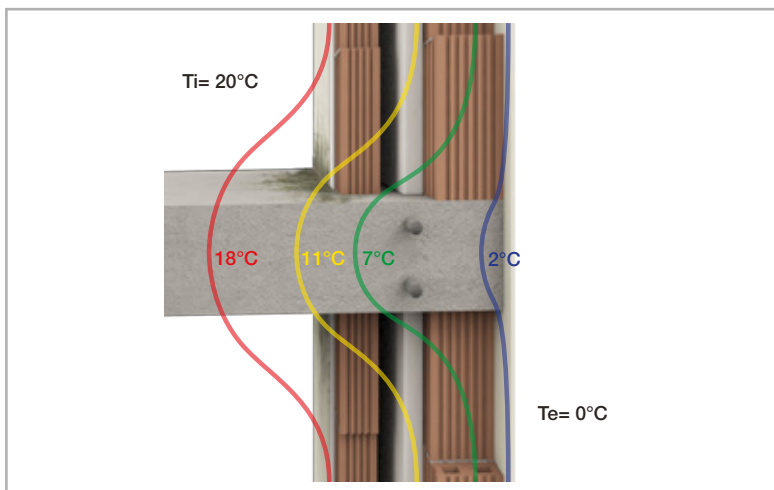
Our routine daily activities generate water vapour inside our homes: cooking, taking a shower, drying the laundry, or even just breathing and talking. Contrary to certain false information in circulation, only 1-3% of the vapour that forms inside our homes passes through the walls (see volume 4, “Mould, condensation and thermal bridges”, of the “Thermal and acoustic insulation” series of publications by ANIT – the Italian National Thermal and Acoustic Insulation Association).

The water vapour that forms condenses when it meets surfaces that are sufficiently cold (with a temperature lower than dew-point). If the amount of water vapour is high, condensation can also form when it meets surfaces that are not particularly cold. For example, in a room at +20°C with 80% relative humidity, condensation forms on any surface that has a temperature equal to or less than 18°C.

It is clear, therefore, how easy it is for condensation to form on internal walls, particularly in correspondence with thermal bridges where the surface temperature is considerably lower. Note also that condensation can form when relative humidity is at what is considered to be a more healthy level, that is, lower than 60%.

Any area with condensation is potentially fertile growing ground for bacteria and mould, thereby creating unhealthy surroundings (refer to the “*aggressive microorganisms*” section on page 62).

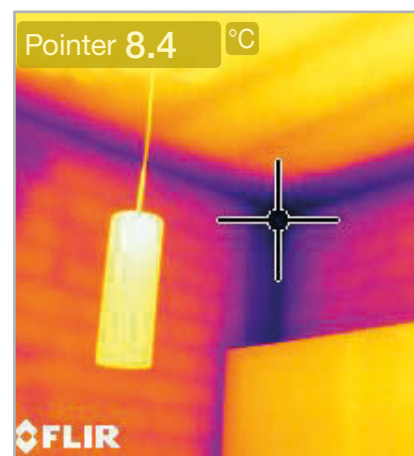
To make it more difficult for condensation to form and reduce the risk of illnesses, the temperature of the internal surfaces must be as high as possible. The only way of achieving this condition is by installing adequate external insulation and by controlling the level of humidity in rooms by ensuring they are adequately ventilated.



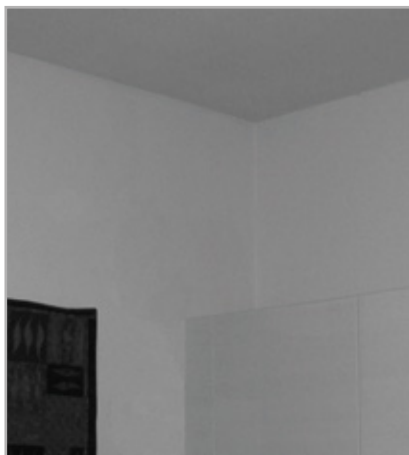
Temperature profile in correspondence with thermal bridges



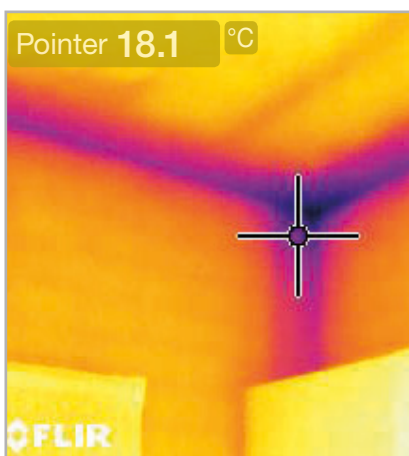
A room in a building without external insulation



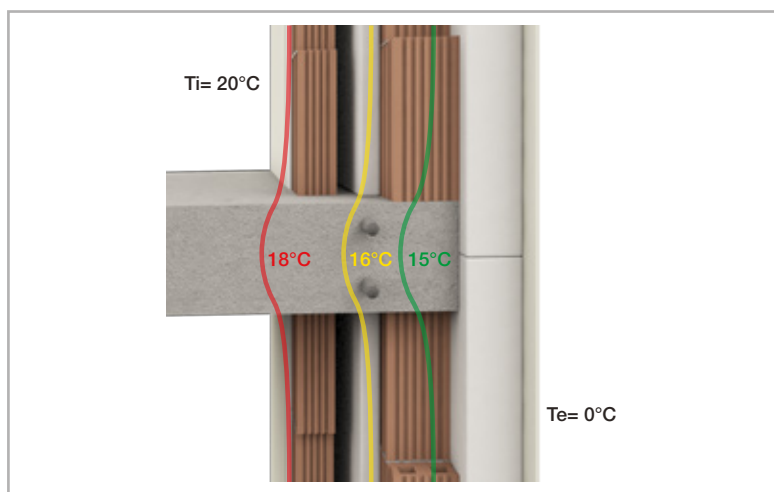
The same room viewed through an infra-red camera: the temperature in correspondence with the thermal bridges is 8.4°C



A room inside a building insulated with the Mapetherm System



The same room viewed through an infra-red camera: the temperature in correspondence with the thermal bridges eliminated by installing the Mapetherm System is 18.1°C



Temperature profile in correspondence with the thermal bridges eliminated by installing the Mapetherm System

1.4 BREATHABILITY

Breathability, or more correctly, permeability to water vapour, indicates how much water vapour manages to pass through a surface.

When we refer to external walls, high breathability is very useful to eliminate residual moisture in building materials or small amounts of condensation inside the structure. Very often, however, breathability is mistakenly used to refer to the water vapour produced inside a home that manages to pass through the walls towards the outside. The amount of vapour that manages to pass through the walls, however, is actually very low compared with the amount generated in our homes during our normal daily activities. Numerous calculation models confirm that walls do not breathe and that it is not the breathability of walls that eliminates the water vapour generated inside our homes; what is essential to eliminate water vapour is adequate ventilation.

To sum up, installing the MAPETHERM system improves the level of comfort because it is the most effective way of creating thermal balance in a building, correcting thermal bridges, significantly increasing the temperature of internal surfaces and, as a result, reducing the formation of

condensation, and the illnesses it provokes, to a minimum.

Although it does not condition the permeability of a structure, installation of the MAPETHERM system is often carried out in combination with other building work aimed at improving the energy efficiency of buildings. This means other opportune measures need to be taken to take good care of rooms, such as airing them by opening the windows, using a hood over kitchen hobs while cooking or, as in modern energy efficient homes, installing an automatic air-conditioning system.

2. REFERENCE NORMS AND STANDARDS

The energy performance of a building, which was not considered to be particularly significant in the past, is becoming more and more important due to environmental restraints, which impose a reduction in gas emissions, and the growing cost of fuel and energy. This theme has increased the need to limit heat losses from homes, which in turn has led to the creation of a new, fast-growing sector in the modern building industry which is dedicated to the development of suitable solutions.

1997 marked the signing of the Kyoto Protocol, an international agreement aimed at reducing emissions into the environment. It was undersigned by almost 190 countries and came into force in 2005, setting governments the task of passing laws on energy efficiency and making the subject one of the main and most widely discussed issues amongst the general public.

For their part, the European Union gave each member state the freedom to pass laws to meet the requirements of Directive 2002/91/CE, known also as the EPBD (Energy Performance Buildings Directive), later replaced by Directive 2010/31/UE published in the Official Gazette of the European Union on the 18th of June, 2010.

The document imposes minimum performance limits for buildings and the obligation to officially certify these limits. This led to a revolution in the building industry which is now geared up to the construction or





upgrading of buildings with high energy performance characteristics, that is, lower harmful emissions and running costs (for both central heating and air conditioning systems) with very low levels of heat loss for all the elements that form the external shell, a drastic reduction in Primary Energy Requirements (PER), no condensation in cavity walls, the elimination of thermal bridges, etc.

To reach such performance levels, external thermal insulation has become one of the main technologies adopted thanks to its simplicity, cost-effectiveness, practicality and very high efficiency in any climate, whether it is hot or cold. Upgrading the energy efficiency of buildings (walls, windows, floors, etc.) is often incentivised by governments through tax relief, which can sometimes be quite significant with returns of up to more than half the cost of the investment.

It is worth pointing out that implementation of the European Directive is the sole responsibility of each individual state, and each state must pass legislation and define the minimum requirement in terms of energy efficiency of buildings, which has led to numerous provisions and amendments being issued that have created a state of confusion for those operating in this sector.

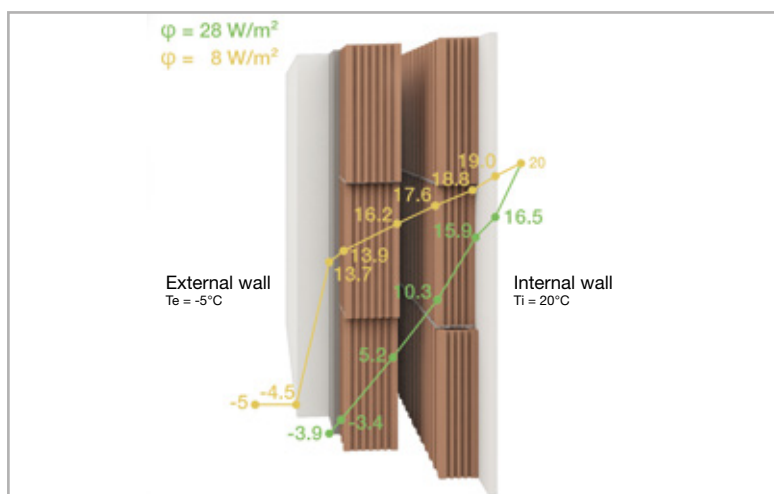
3. EFFECTIVENESS OF EXTERNAL THERMAL INSULATION SYSTEMS

External thermal insulation systems are the ideal insulating solution (and not only) for the rather bland, vertical surfaces of buildings. They are just as effective on new buildings as they are on upgraded buildings and, with this simple system, it is possible to optimise their performance and characteristics: living comfort, protection for the structure, compliance with current legislation and standards, energy savings, lower running costs for central heating and air-conditioning systems, a reduction in the emission of pollutants, solving or preventing potential thermal-hygrometric problems and healthier rooms.

Note: the graphs in sections 3.1 and 3.2 show a cavity-wall structure (8 + 12 cm) with a 6 cm cavity, internal plaster and external render.

3.1 BUILDINGS WITH AND WITHOUT EXTERNAL INSULATION

By analysing the temperature profiles across the section of a wall, you can immediately see how external insulation balances the thermal load of the entire structure and significantly reduces thermal-hygrometric stresses and loads. These advantages are present all year round, in any climate and at any temperature.

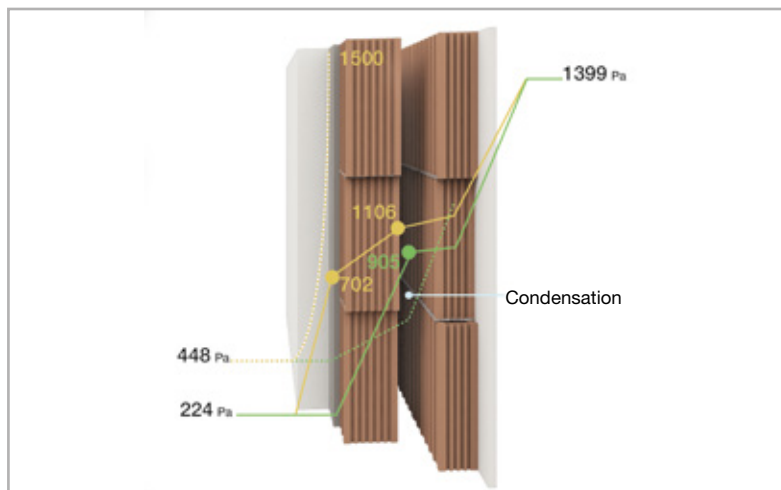


Graph 1

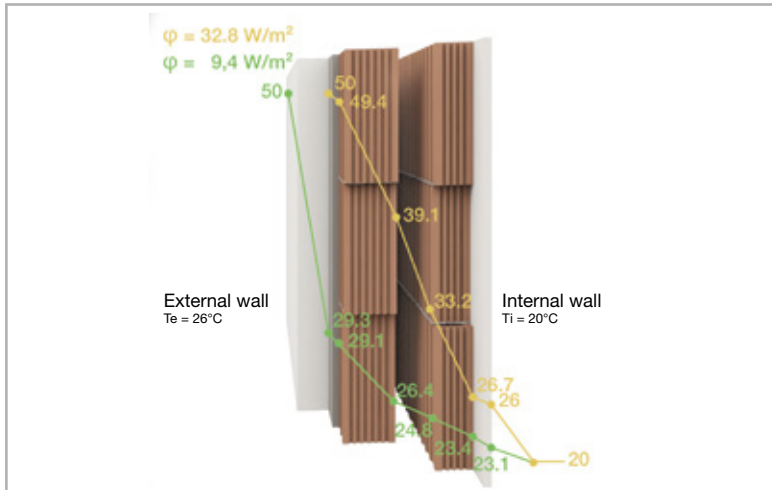
If we compare the green and yellow lines in graph 1, it is clear that installation

of the MAPETHERM system increases the temperature for every section and keeps it constant, which leads to a number of advantages:

- the surface temperature of the internal wall is very close to ambient temperature (+16.5°C to +19°C), it is more difficult for condensation and mould to form, which means more comfortable surroundings, there are considerable savings in heating costs and a reduction in the emission of pollutants;
- the internal surface temperature in correspondence with thermal bridges is higher, which offers a number of advantages (see previous point);
- a reduction in heat flow through the structure (from 28 W/m² to 8 W/m²), resulting in energy savings and a reduction in the emission of pollutants;
- a reduction in heat flow through thermal bridges, resulting in energy savings and a reduction in the emission of pollutants;
- mitigated temperature in correspondence with the surface of the external wall with a variation of more than +18°C on the surface of the brickwork (from -3.4°C to +13.9°C) resulting in an elimination of typical fracture phenomenon (e.g. cracks between brick buffer walls and the load-bearing reinforced concrete structure);
- limited temperature variation within the wall structure and thermal stresses and loads all but eliminated;
- elimination of the dew-point (the area where condensation forms) from the internal sections of the structure.



Graph 2



Graph 3

If we compare the green line and yellow lines in graph 3, even in the summer installation of the MAPETHERM system lowers the temperature for every section and keeps it constant, which leads to a number of advantages:

- the surface temperature of the internal wall is very close to ambient temperature (+26°C to +23.1°C), which means more comfortable surroundings, considerable savings in air-conditioning costs and a reduction in the emission of pollutants;
- the internal surface temperature in correspondence with thermal bridges is lower which offers a number of advantages (see previous point);
- a reduction in heat flow through the structure (from 32.8 W/m² to 9.4 W/m²), resulting in energy savings and a reduction in the emission of pollutants;
- a reduction in heat flow through thermal bridges, resulting in energy savings and a reduction in the emission of pollutants, as well as more comfortable surroundings;
- mitigated temperature in correspondence with the surface of the external wall with a variation of more than +20°C on the surface of the brickwork (from +49.4°C to +29.1°C), resulting in an elimination of typical fracture phenomenon (e.g. cracks between brick buffer walls and the load-bearing reinforced concrete structure);

- limited temperature variation within the wall structure and thermal stresses and loads all but eliminated.

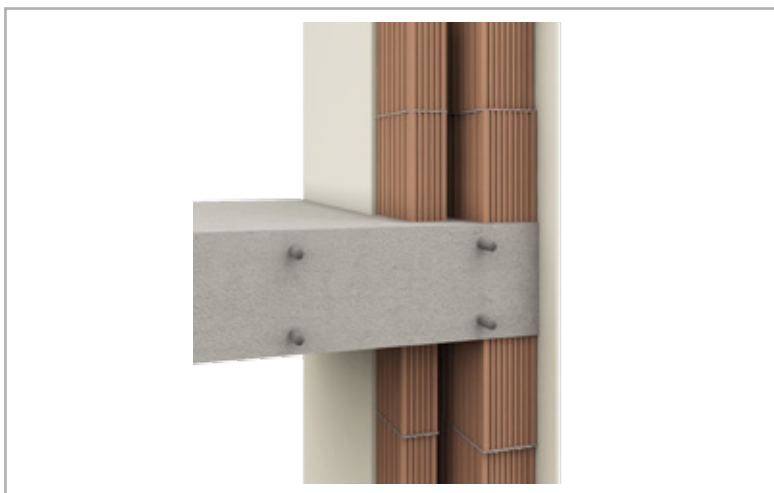
In conclusion, the reasons for which the MAPETHERM system leads to exceptional living, environmental and economic advantages and increases the durability of a building by protecting the entire structure on which it is installed from various problems are quite clear. The concept of durability is just as important as that of environmental sustainability; this is one of the reasons why external insulation is the most sustainable solution to adopt, whatever material is used.

In the following sections we will highlight how, starting from a specific type of structure, insulation can have an effect on all the parameters in play, depending on the type of insulating material chosen and where it is applied.

3.1.1 EXAMPLE OF AN EXISTING BUILDING WITHOUT INSULATION

A structure typically used in the building industry is a double-skin cavity wall made from bricks.

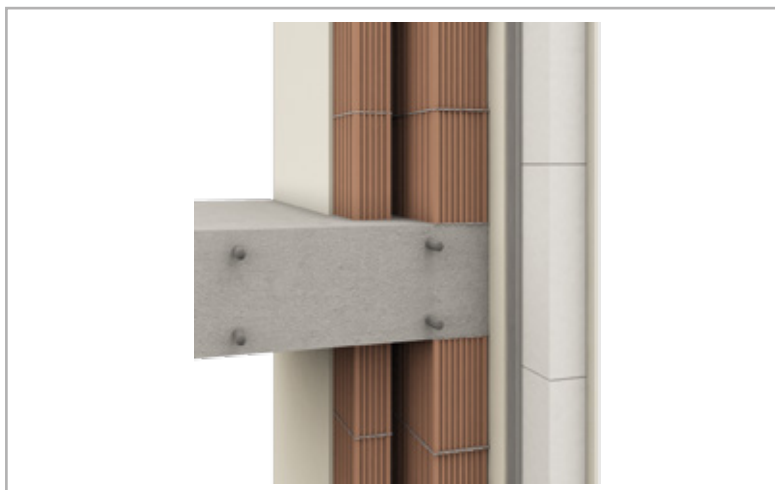
The examples only show the calculations carried out in correspondence with the brick walls without taking into consideration the thermal bridge formed by the load-bearing reinforced concrete structure (beams and pillars) where heat dispersion is even greater.



Stratigraphic lay-out of the structure without insulation

3.1.2 EXAMPLE OF A REFURBISHED EXISTING BUILDING WITH ETICS

The previous structure was insulated with the MAPETHERM external insulating system using EPS panels, which improves the performance characteristics of the walls all year round, creates thermal balance in the structures and eliminates thermal bridges.



Stratigraphic layout of the structure insulated with the Mapetherm System

Parameter	Existing building: original condition	Refurbished existing building with external insulation	Improvement
Transmittance (W/m ² K)	1.115	0.261	more than 4 times
Attenuation factor	0.633	0.208	3 times
Phase shift	6 hours 6 minutes	9 hours 15 minutes	1.5 times

By insulating walls from the outside, all the cold points are eliminated in winter and the thermal storage capacity (inertia) of the building is increased. The walls warm up, accumulate heat and then return it back into the rooms. This means that the heating system needs to be running for fewer hours, which means considerably lower fuel consumption and a reduction in the emission of pollutants.

One sure advantage of external insulation is that thermal bridges are completely eliminated, that is, in all those critical areas inside the structure

(such as around window and door fittings, edges, floors, pillars in the masonry, etc.) where mould is more likely to form. Also, external insulation may be installed without creating too much disturbance to those who live or work in the building and the rooms do not need to be emptied (work is carried out from the outside and the insulating material is only applied on the outside of the building). It is an ideal solution when renovation work is carried out on facades because creating thermal balance within a structure also prevents physical stresses and impedes the formation of new cracks.

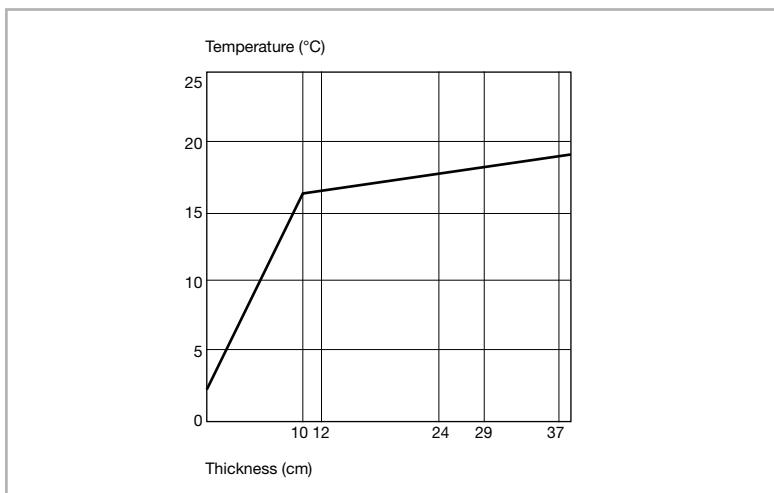


3.2 EFFECTIVENESS DURING WINTER AND SUMMER

If we analyse the figures in the previous table and consider an existing building that has been refurbished to improve its energy efficiency, we can see how an external insulation system performs extremely well all year round.

Winter:

- the amount of heat dissipated towards the outside in correspondence with the brick buffer walls is four times lower: transmittance drops from 1.115 W/m²K to 0.261 W/m²K;
- thermal bridges are completely eliminated and the drop in the amount of heat dispersed in correspondence with the thermal bridges is even greater than with the brick buffer walls;
- heat flow is three times lower in correspondence with the buffer walls;
- heat flow is reduced by even more in correspondence with the thermal bridges;
- the walls are kept warm which stops condensation forming inside the structure of the walls;
- the heat storage capacity (inertia) of the walls is maximised;
- the walls are in a state of thermal balance which considerably reduces the levels of hygrometric-thermal stresses acting on the entire structure of the building.



Temperature profile during the winter of a structure with an external insulation system

Summer:

- the amount of heat entering the rooms is three times lower: the attenuation factor drops from 0.633 to 0.208;
- heat entering the rooms is delayed by around 50%: the phase shift increases from 6 hours and 6 minutes to 9 hours and 15 minutes;
- the amount of heat transmitted towards the inside of the building in correspondence with the thermal bridges is reduced, the delay is even higher and the thermal bridges are completely eliminated;
- heat flow is almost four times lower in correspondence with the buffer walls;
- heat flow is reduced by even more in correspondence with the thermal bridges;
- the walls are prevented from overheating;
- the walls are in a state of thermal balance which considerably reduces the levels of hygrometric-thermal stresses acting on the entire structure of the building.

These figures clearly demonstrate the improvement in the performance characteristics of the wall structure in all seasons, the resulting

savings in running costs and a net reduction in energy consumption and harmful emissions. The rooms are also more comfortable thanks to the elimination of excessive temperature variations and the entire wall structure is safeguarded by putting it in a state of thermal balance.

The performance of an external insulation system may be even further improved by simply using thicker insulating material or using insulating material with better performance characteristics for the specific parameters you wish to improve.

Other performance characteristics may be improved (such as mechanical strength, durability, crack-resistance, resistance to bad weather, etc.) without changing the type of insulating material used, but by using specific materials and installation techniques.

Thanks to Mapei technology, you can install any type of material suitable for external insulating systems.

The following sections compare the effectiveness of alternative insulating systems.



3.2.1 EXAMPLE OF A REFURBISHED EXISTING BUILDING WITH CAVITY INSULATION

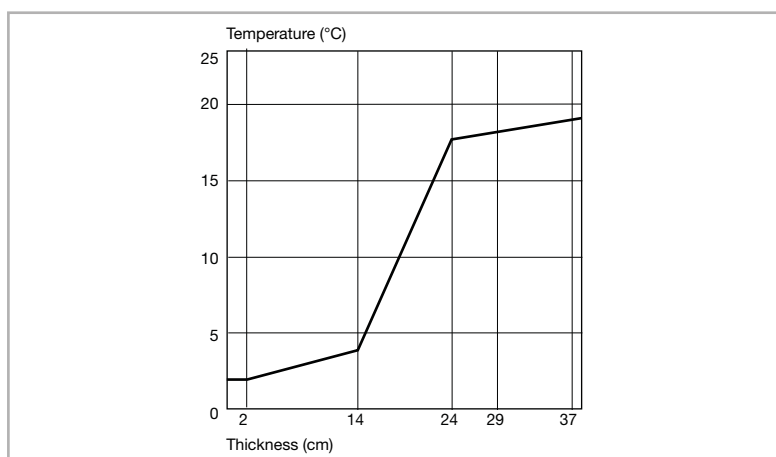


Stratigraphic lay-out of a structure with cavity-wall insulation

Parameter	Existing building: original condition	Refurbished existing building with external insulation	Refurbished existing building with cavity-wall insulation
Transmittance (W/m^2K)	1.115	0.261	0.261
Attenuation factor	0.633	0.208	0.497
Phase shift	6 hours 6 minutes	9 hours 15 minutes	8 hours 7 minutes

If we consider a refurbished building with insulating material inserted in the cavity between the two walls, the following results will be achieved compared with external insulation:

- the same performance in correspondence with the brick buffer walls during winter: transmittance is reduced by the same amount;
- better performance in correspondence with the brick buffer walls during the summer compared with the same structure without insulation, but not as effective as external insulation;
- no effect on performance characteristics in correspondence with thermal bridges: transmittance, attenuation and phase shift remain the same as in the original condition;
- the heat storage capacity (inertia) of the walls is partially exploited;
- only the internal walls are in a state of thermal balance;
- there is a medium level of risk for the formation of condensation in the cavity;



Temperature profile during the winter of a structure with cavity-wall insulation

- cracks could develop at the interface between the load-bearing reinforced concrete structure and the brick buffer walls because it would amplify the difference in temperature between the two structures and, therefore, their levels of thermal expansion;
- only a partial saving in running costs for central heating in the winter and air-conditioning in the summer.

This solution, therefore, is far from ideal from almost all points of view and could cause serious damage to the entire structure.



3.2.2 EXAMPLE OF A REFURBISHED EXISTING BUILDING WITH INTERNAL INSULATION

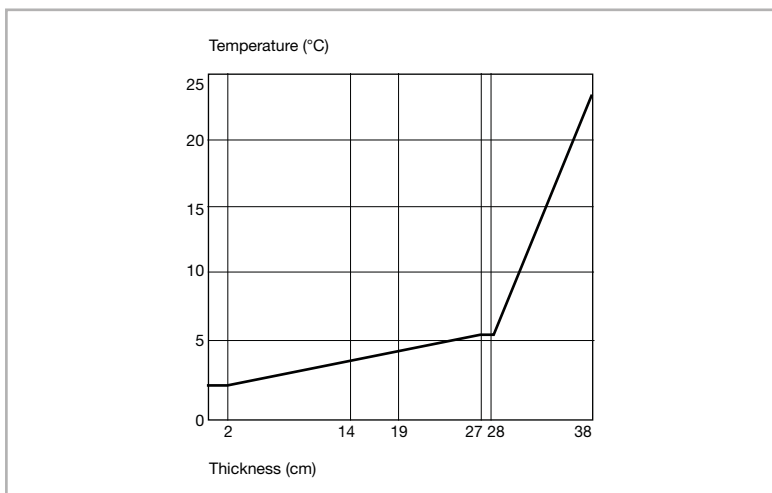


Stratigraphic lay-out of the structure with internal insulation

Parameter	Existing building: original condition	Refurbished existing building with external insulation	Refurbished existing building with internal insulation
Transmittance (W/m ² K)	1.115	0.261	0.261
Attenuation factor	0.633	0.208	0.240
Phase shift	6 hours 6 minutes	9 hours 15 minutes	8 hours 53 minutes

If we consider a refurbished building with internal insulation, the following results will be achieved compared with external insulation:

- the same performance in correspondence with the buffer walls during winter: transmittance is reduced by the same amount;
- better performance in correspondence with the brick buffer walls during the summer compared with the same structure without insulation, but slightly worse than with external insulation;
- has no effect on performance characteristics in correspondence with thermal bridges: transmittance, attenuation and phase shift remain the same as in the original condition;
- does not optimise thermal inertia: the mass of the internal walls is too low to accumulate heat;
- in cold seasons there is a high risk of condensation forming in the cavity because all the wall is cold;



Temperature profile during the winter of a structure with internal insulation

- high risk of the spread of mould hidden inside the structure that cannot be eliminated (in correspondence with condensation that forms in the cavity);





- only a partial saving in running costs for central heating in the winter and air-conditioning in the summer.

To summarise, this type of solution is also unsuitable and could even lead to other serious problems.

It is quite clear that, in order to design an insulating system correctly, you can never overlook any of the various parameters that come into play, and you must also take into consideration other less important parameters, even though they are not directly connected to thermal performance, such as soundproofing, fire reaction class, resistance to impacts, durability, etc.

3.3 EXAMPLES OF ESTIMATED SAVINGS: ENERGY, EMISSIONS AND COSTS

Energy consumption and the amount of harmful substances given off by heating systems during the combustion of methane gas or heating oil can vary significantly, depending on the effectiveness of the insulation around the external shell of the building (mass vertical surfaces, doors and windows, roof, etc.) and the heating system.

The same considerations can be made regarding the consumption of electrical energy consumed by air-conditioning systems during the summer. Following an intervention on the external walls of a building to upgrade its energy efficiency, it is possible to estimate by how much the emission of harmful substances and the consumption of fuel and energy has been reduced and to calculate the amount of money saved.

The estimates are calculated by comparing the different performance characteristics of the shell of the building before and after the upgrading work, the area where the building is located, the daily temperature of that particular climatic zone, the calorific power of the fuel used and the efficiency of the heating system.

It is now evident that upgrading the energy efficiency of the external walls of a building is a positive operation which has a significant economic and environmental impact.

As an example, if we consider the energy upgrading of a building by installing the MAPETHERM external insulation system on a house in Bologna with 250 m² of external surfaces, with the same parameters as used in section 3.2.1, there would be the following savings:

- *Energy for heating: 16535 kWh*
- *Methane gas: 1733 m³*
- *Carbon dioxide (CO₂) emissions: 2963 kg*
- **Total savings in winter: € 1039**
- *Energy for air-conditioning: 5750 kWh*
- *Total savings in summer: € 690*

Total annual savings: € 1729

3.4 ADVANTAGES OF THE MAPETHERM EXTERNAL INSULATION SYSTEM

Lower energy consumption

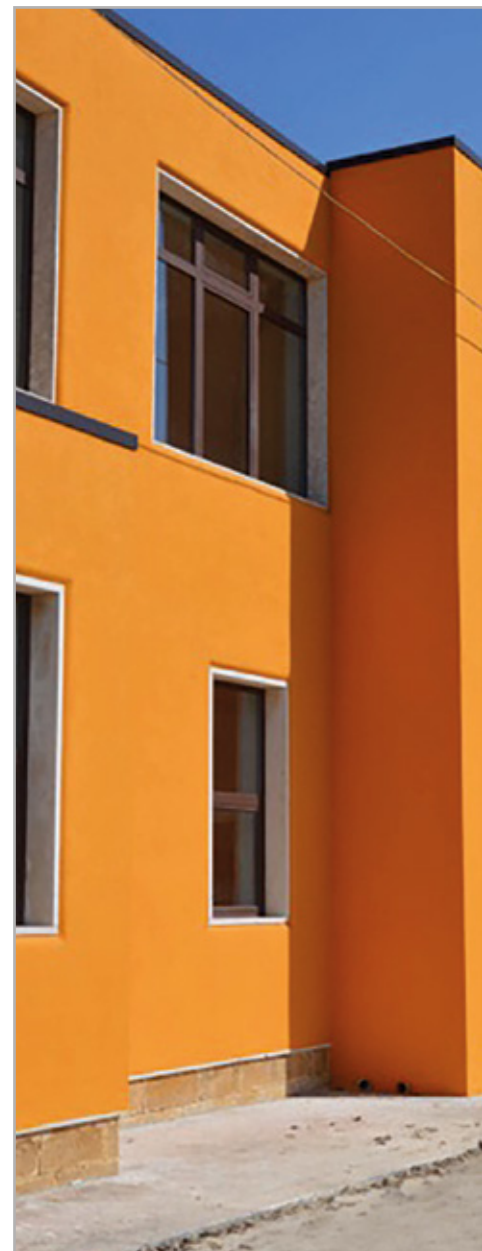
The amount of energy (methane, gas, electricity) required to heat and cool our homes is considerably lower thanks to the MAPETHERM system, leading to considerably lower monthly bills. These savings will cover the cost of the initial investment in just a few years.

Reduction of harmful emissions

MAPETHERM is undoubtedly one of the most technological systems available and it can be used to create solutions with the maximum environmental sustainability. In fact, using this system leads to constant, long-lasting savings and its true sustainability lies in its capacity to contain the emission of pollutants and substances that damage the environment, and in particular to drastically reduce the amount of energy wasted in every season of the year.

Cost-effective energy upgrading

The MAPETHERM system allows existing buildings to be upgraded with the





maximum effectiveness and to improve their performance characteristics and durability. In fact, thanks to the unrivalled cost/benefits ratio of this system, it is not so much a cost but an investment.

Insulation with continuity

MAPETHERM allows designers to insulate all vertical wall surfaces with a single, continuous system and to eliminate areas of the structure with localised and often harmful partial insulation (for example, in correspondence with reinforced concrete load-bearing structures).

Safeguarding wall structures on a long-term basis

MAPETHERM puts buildings into a state of thermal balance by insulating them completely without breaks or interruptions. The system eliminates thermal-hygrometric stresses acting on structures and increases their durability. In so doing, it prevents the formation of cracks and any resulting water infiltrations, which would otherwise lead to the development of unsightly stains and mould, as well as the exponential development of crumbling phenomenon and a considerable reduction in the insulation capacity of structures.

Correct and total elimination of thermal bridges

MAPETHERM corrects every type of thermal bridge by eliminating the main heat dispersion channels and sources of condensation and mould on internal surfaces and by balancing the areas with a higher risk of cracking (such as the interface between brick buffer walls and reinforced concrete beams and pillars). We must also point out that all other systems used to correct thermal bridges are not really what they seem and can often lead to serious illnesses.

Exploiting the inertia of walls

During cold weather, MAPETHERM keeps walls warm and then uses the heat stored in their mass. In hot weather, on the other hand, it prevents them overheating.

This occurs thanks to the correct positioning of the insulating panels.

Thinner wall structure

MAPETHERM is installed on the external surfaces and, when upgrading a building, there is no disturbance to those using the building and the internal areas are not restricted or reduced in any way. This means that walls may be thinner, lighter and cheaper to build and the floor area within the walls can be increased.

Correct and balanced vapour diffusion

MAPETHERM allows water vapour to be released from inside buildings and the widely held belief that external insulating systems form a barrier to water vapour is completely false.

Elimination of condensation in cavity walls

MAPETHERM transfers the dew-point to the external part of the structure, thereby impeding the formation of damaging, unhealthy condensation inside cavity walls.

Health and living comfort

MAPETHERM reduces the risk of the formation of condensation, and therefore mould, on internal surfaces and allows heat flow to be exploited more efficiently (lower heat flow in all seasons).

Simple, reliable and correct solutions for construction problems

MAPETHERM provides a reliable, simple and economic answer to criticalities that inevitably arise during construction work and that very often lead to premature problems for which it is difficult to find an effective solution.

Buildings have a higher value

Upgrading the energy efficiency of a building with the MAPETHERM system improves the external appearance of the building and places it in a much better energy class, which increases its value when it comes to selling or renting the building.

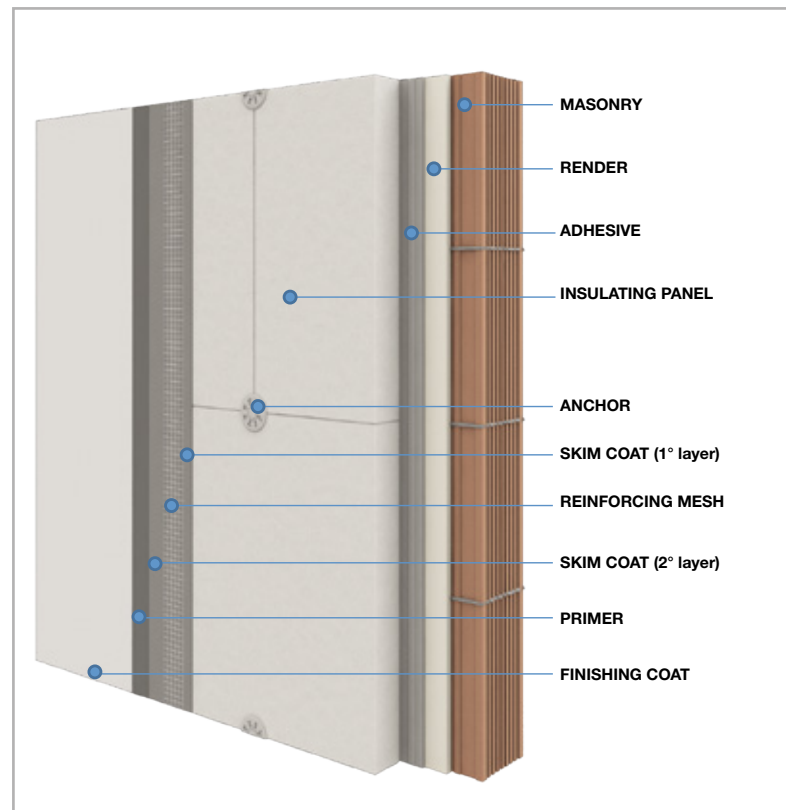
Sustainability

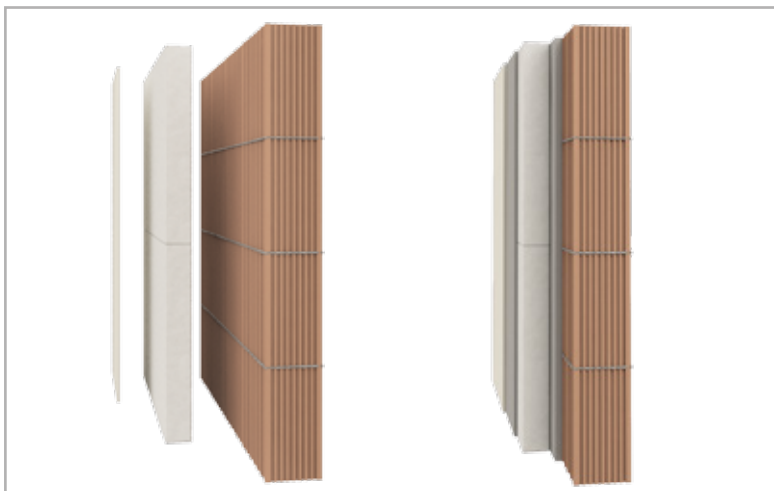
Upgrading the energy efficiency of a building with the MAPETHERM system, and the resulting lower energy consumption and lower amount of harmful emissions, is one of the most durable and sustainable interventions you can carry out.

Sustainability must always take into consideration the entire life cycle of a material or system and the concept of durability is of primary importance when carrying out this type of evaluation. It is completely wrong and too simplistic, therefore, to think that natural = sustainable.

4. EXTERNAL INSULATION SYSTEM

4.1 COMPONENTS





Interfaces in an external insulation system: adhesive and skim coat

4.2 CHARACTERISTICS AND PERFORMANCE EXPECTED FROM EACH COMPONENT

Since an external insulation system is made up of various components, it must obviously be considered in its entirety and each single element must be compatible with all the other elements. This concept is fundamental to ensure the performance and multi-decade life expectancy an external insulation system must guarantee and every single component in the system must have specific performance characteristics.

Also, from the figures shown above, the interfaces between the components in the system, that is the adhesive and the skimming products, are obviously the strategic features.

These two elements have the task of keeping the system locked together and counteracting the various stresses acting on the system.

4.2.1 SUBSTRATE

It is worthwhile considering the masonry substrate to be part of the MAPETHERM system, even if from a technical point of view it isn't. In fact, an external insulation system can be installed on practically any type of substrate, as long as it has been adequately prepared.

The external insulation system is a supported element and, as a result, the substrate (whether it is the masonry itself or render) must guarantee sufficient support; it must be able to withstand its own weight, the action of wind, any other loads and, above all, the thermal-hygrometric stresses acting on it.

It is necessary, therefore, to make sure the substrate is flat so that the external insulation system can be installed using the best performing technique possible. It has been demonstrated that the bonding system is more effective and durable over the years if the adhesive has been applied in a continuous layer.

4.2.2 ADHESIVE

The adhesive is the first important interfacing element of the system. It must guarantee that its adhesion properties remain stable over the years, resist high sheer and peel loads and counteract thermal expansion in the insulating panels. A good bond may only be formed if the characteristics of the adhesive are specified correctly, if only selected raw materials are used, if the manufacturer uses a certified quality production cycle and if the adhesive is used correctly on site with the recommended mixing ratios and the correct application techniques and methods are adopted.

4.2.3 INSULATING PANEL

The design engineer who calculates the dimensions for the system is also responsible for choosing the most suitable type and thickness of insulating panel. These are chosen and calculated by taking into consideration the type of building (new or old), the stratigraphic layout of the walls, the load-bearing system (concrete, bricks, poroton, stone, etc.), the area where the building is located and current norms and regulations (and by also taking into consideration, where required, possible tax relief for upgrading a building's energy performance).

The insulating panels are chosen according to specific requirements. In fact, it is possible to combine their insulating capacity with other properties, depending on which aspect of the system you wish to favour: soundproofing capacity, maximum reaction to fire, maximum permeability to water vapour,

very low water absorption, bio-building criteria, overall cost, simplicity of installation, etc.

There are many types of panels available on the market and they are available in different sizes and materials. It is impossible to say which is the best and they must be selected according to the main aims of each specific project. There is no single type of panel available on the market at the moment which offers all the performance characteristics required, so for each project the most important characteristics must be identified to help choose a panel which most closely meets these requirements. Only panels with the CE logo and which have been declared as suitable for the intended use by the manufacturer must be used.

4.2.4 ANCHOR

Even though it is the adhesive that has the task of binding the system together, fastening the insulating panels in place mechanically with special anchors is an important safety feature and is essential under certain circumstances.

The pitch and number of anchors required depend on the type of wall, the insulating panels and the bonding technique used. There are many types of anchors available on the market but, as with reinforcing mesh, their cost is often the only parameter taken into consideration and more important factors, such as the type of insulating material they will be used for, the length of the anchor, the type of substrate, their correct use, their performance characteristics (diameter, stiffness and load-bearing capacity of the washer, tensile strength, heat conductivity rates, etc.) are often overlooked.

It is certainly advisable to use anchors that meet the requirements of ETAG 014 guidelines, which classifies them with a letter (A, B, C, D and E) according to their suitability for various types of substrate.

4.2.5 SKIM COAT (BASE RENDER)

This is the second most important interfacing element of the system and must guarantee that the elements remain bonded to it over the years, it must help counteract tensions in the system caused by temperature

variations (expansion and contraction of the insulating panels in particular) and it must give the whole system a high level of mechanical strength.

In fact, it is reinforced render that gives the system its mechanical strength, not the density of the insulating panels, as many people wrongly believe.

The mechanical strength of the system must be guaranteed in both its dry and wet state. The chemical composition of the skimming product, therefore, is extremely important, particularly the quality of the binder in the product. The thickness applied is also extremely important, which in some cases may be more than 5 mm.

4.2.6 REINFORCING MESH

Glass fibre mesh, generally weighing 140-160 g/m², is embedded in the skim coat to distribute the stresses from the substrate and to increase the system's resistance to impact loads.

It must be treated with an anti-alkali primer to protect it against the basic pH levels of the skimming product it is embedded in and must be woven in such a way that it distributes loads correctly.

Heavier mesh (300-360 g/m²) is stronger which is why, in certain cases, it is used around the footings of buildings in combination with specific skimming products (e.g. MAPETHERM AR 1 LIGHT or MAPETHERM FLEX RP), which are much stronger than the skimming products normally used for external insulation systems.

4.2.7 PRIMER

Primer is used to prepare and even out surfaces to be covered with the final dressing coat and avoids prevents colours becoming uneven due to the different reactions between materials and/or different absorption levels in the substrate. If a coloured primer is used (base coat) the finish is more even and its covering capacity is improved. Apart from being unnecessary, solvent-based primers should never be used because they may react with the panels and modify their characteristics, causing them to detach from the skim coat or even completely disintegrate (in the case of synthetic panels).

4.2.8 FINISHING COAT

An external insulation system must be protected against thermal-hygrometric stresses and the surrounding environment with specific finishing products: they are generally quite thick or are applied using systems to guarantee specific performance characteristics (see section 5.4 “Choosing the right finishing product”).

A finishing product must have the following characteristics: plastic enough to prevent generating cracks, balanced permeability to water vapour, low water absorption to prevent extracting salts or carbonates from the skimming product and to prevent salts and pollutants from the outside being carried into the system, stable colour (if we consider it is applied on a heat barrier), the capacity to resist aggression from mould and algae and a light colour to protect the system from very high surface temperatures caused by exposure to direct sunlight, which in turn generates additional stresses in the entire system (solar reflectance index of more than 20%).

4.3 MAPETHERM SYSTEMS

Mapei systems allow you to design and install solutions that are the most functionally suitable for the structural characteristics of a building and its substrates, or according to the specifications and/or requirements of the client. In fact, the quality of the materials developed for the system and the theoretical and practical knowledge of their specialist engineers allow you to create an external insulation system using any type of Insulating panel, to analyse and overcome all critical points and any design or construction issue, apply finishes with very high aesthetic value, adopt particular technical performance characteristics, etc.

MAPETHERM systems are solutions, because they allow you to:

1. Optimise their insulating properties during winter by using insulating materials with low thermal conductivity, thanks to which the thickness of the system is as low as possible.
2. Maximise their insulating properties during winter by using specific insulating materials with high inertia, enabling their performance in terms of thermal wave phase shift and attenuation to be finely tuned.





3. Add soundproofing properties to walls by using insulating materials with low dynamic rigidity with the capacity to dampen sound waves.
4. Obtain the best reaction to fire classes with mineral insulating materials, ideal for surfaces potentially exposed to flames (such as ceilings in underground car-parks).
5. Employ materials certified for green building protocols.
6. Privilege the overall cost of an intervention by employing lightweight synthetic insulating materials combined with Fast Track Ready technology to make installation quicker and more cost-effective.
7. Enhance their water vapour permeability by employing insulating materials and finishing products with a low resistance to water vapour diffusion with the capacity to eliminate, where required, the problem of condensation inside the structure.
8. Privilege ease of installation by employing lightweight skimming compounds such as MAPETHERM AR1 LIGHT.
9. Impede absorption of water from the ground by employing insulating materials with low water absorption properties combined with waterproof skimming compounds such as MAPELASTIC.
10. Maintain their performance properties and guarantee their maximum durability over the years by employing only high quality adhesives, skimming compounds and finishing products.
11. Increase the overall strength of walls by employing specially developed skimming products such as MAPETHERM AR1 LIGHT or MAPETHERM FLEX RP for sections particularly exposed to impact damage, such as the walls of schools, open galleries, areas overlooking the street, etc.
12. Minimise water absorption and increase water vapour permeability by employing siloxane-based finishing products such as SILANCOLOR TONACHINO, with proven properties of water-repellence and long-lasting durability.
13. Increase resistance to the growth of mould and algae on external surfaces by employing products with proven effectiveness, recognisable by the "Plus" suffix, such as QUARZOLITE TONACHINO PLUS).

14. Apply highly attractive finishes, even by applying just a thin coat, by employing special solutions such as MAPETHERM FLEX RP 0.5 mm.
15. Repair existing or deteriorated external insulation systems with mould, algae or cracks (MAPETHERM FLEX RP).

Mapei technology allows you to employ any type of insulating material suitable for external insulation systems, provides extra properties that the insulating material alone could never guarantee and allows you to create systems with the maximum performance, durability and sustainability.

Here are just some of the solutions mentioned above:

- The MAPETHERM XPS system uses an extruded foam polystyrene insulating panel with no outer skin and with a rough surface to improve the bonding properties of the adhesive. It is characterised by its low water absorption, good compressive strength and excellent insulating properties.

Thermal conductivity λ : 0.032-0.036 W/mK

Water vapour diffusion resistance μ : 80-100

Covered by the European Technical Approval ETA 04/0061, issued by the ITC Institute of San Giuliano Milanese (see certification section).

- The MAPETHERM EPS system uses a sintered foam polystyrene insulating panel. This type of panel has a very competitive price, is easy to apply and has excellent insulating properties.

Thermal conductivity λ : 0.033-0.040 W/mK

Water vapour diffusion resistance μ : 30-70

Covered by the European Technical Approval ETA 104/0025, issued by the OIB Institute of Vienna (see certification section).

- The MAPETHERM M.WOOL system uses an insulating panel in mineral wool treated with moisture-hardening primer which is highly water-repellent. It is characterised by its excellent resistance to fire, extremely high permeability to vapour and excellent soundproofing properties.

Thermal conductivity λ : 0.032-0.048 W/mK

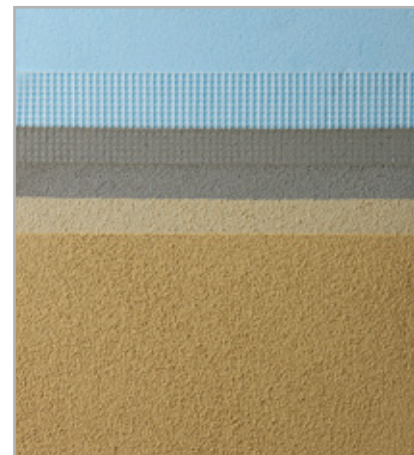


Fig. 4.1 - MAPETHERM XPS

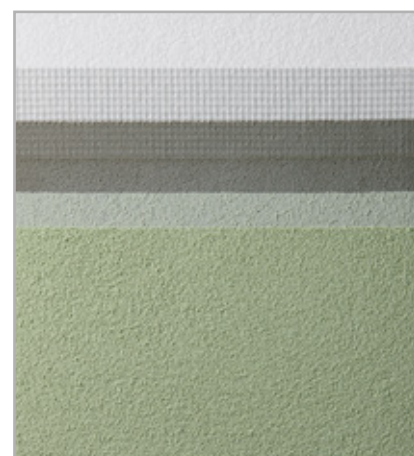


Fig. 4.2 - MAPETHERM EPS



Fig. 4.3 - MAPETHERM M.WOOL



Fig. 4.4 - MAPETHERM CORK

Water vapour diffusion resistance μ : 1.1-1.4

Covered by the European Technical Approval ETA 104/0024, issued by the OIB Institute of Vienna (see certification section).

- The MAPETHERM CORK system uses an insulating panel in natural, brown foam cork with no chemical adhesives. It is characterised by its excellent permeability to vapour and excellent stability and resistance to ageing. It is also made from recyclable, eco-sustainable raw materials.

Thermal conductivity λ : 0.040-0.048 W/mK

Water vapour diffusion resistance μ : 5-30

The technical specifications for the MAPETHERM system are available from the company website www.mapei.it



5. DESIGNING AND CHOOSING THE SYSTEM

The analysis of a building must always include an analysis of its actual surroundings and take into consideration its exposure to sunlight and the micro-climate of its surroundings. It must also evaluate the most appropriate insulating and finishing products to be employed to prevent the occurrence of future problems, such as condensation and aggressive microorganisms, which could appear, even after a short period of time, and cause discomfort or even unhealthy surroundings inside the rooms in the building.

Any insulation system must be correctly dimensioned in order to function effectively. New builds must be constructed according to the latest building regulations and standards and in compliance with geographic parameters which take the climatic zone in which the building is located into consideration. Similarly, thermal upgrading of an old building should not be carried out without the assistance of a specialist who, with the use of special software, will calculate the correct dimensions of the external insulating system according to the customer's specific requirements (natural products, budget, etc.), while respecting the thermal transmittance levels imposed by current norms and regulations. Under no circumstances

should the type and thickness of an insulating panel be defined without expert assistance and, although a DIY intervention may seem cheaper, in the long run it may provoke problems which would be difficult to solve at a later date (such as mould, condensation, detachment, etc.).

By working in conjunction with a specialised design engineer, energy certification may be obtained for a new build or for a building undergoing energy upgrading. If the values required are calculated during the design phase, the building may be classified according to its energy performance and the real energy consumption of the heating system during the winter and conditioning system during the summer may be certified. Also, apart from a more comfortable living environment and the benefits obtained by installing an external insulation system, the building will also increase in value.

Every component used in an external insulation system must be formulated correctly and must be manufactured according to appropriate quality standards in order to guarantee reliable properties in terms of performance and durability.

With the MAPETHERM systems it is possible to create a specialised solution for any building

In the following sections, we will highlight the importance of correct, precise design procedures for insulating panels, as well as for other components or features which are often overlooked or taken for granted, such as adhesives, skimming/smoothing compounds, anchors and studs and finishing products.

Section 6 will discuss **How to Install the Mapetherm System Correctly**, which is just as important as **designing the system correctly** and **choosing quality materials** specifically designed for external insulation systems.

The quality of the design work, the materials and the installation techniques leads to an effective, successful external insulation system, that is, one that has the correct functional performance properties and that remains durable over the years, characteristics which make this one of the most sustainable systems you can install.





5.1 CHOOSING THE RIGHT ADHESIVE AND SKIMMING PRODUCT

What are their main characteristics and installation requirements?

MAPEI entered the insulation sector after carrying out an in-depth analysis of what happens to an external insulation system while exposed to the typical aggressive elements which act on a facade, taking into consideration that the system is composed of completely different materials which must act together in synergy to offer their best performance. They found that an external insulation system is highly complex and must be considered as a whole, from the substrate to the final finish, but within the system there are two main components (the adhesive and skimming product) which have the strategic task of connecting all the layers and materials used in the system.

The system's capacity to withstand shear stresses and peel stresses is guaranteed exclusively by the adhesive and the skim coat.

The weight of the system and the depression induced by winds normally generate low stresses, which is easy to verify by carrying out a simple load balance analysis. By far the highest stresses are generated by the contrast in deformations induced by the high temperature differences between the two faces of the insulating panel.

In fact, 250 km/h winds induce a depressive force of 0.013 kg/cm^2 and the load due to the weight of the system is around 0.001 kg/cm^2 , which are negligible compared with the values of 2 kg/cm^2 and 6.5 kg/cm^2 (calculated according to the conditions in the following figures) that the adhesive needs to withstand, respectively, in terms of peel loads (distributed over the whole surface) and shear loads (concentrated in correspondence with the edges of the panel) induced by temperature changes.

The following images are a graphic illustration of the "work" an adhesive has to carry out.

Taken from research work carried out by Prof. Collina in collaboration with the Department of Structural Engineering of the Federico II University of Naples.

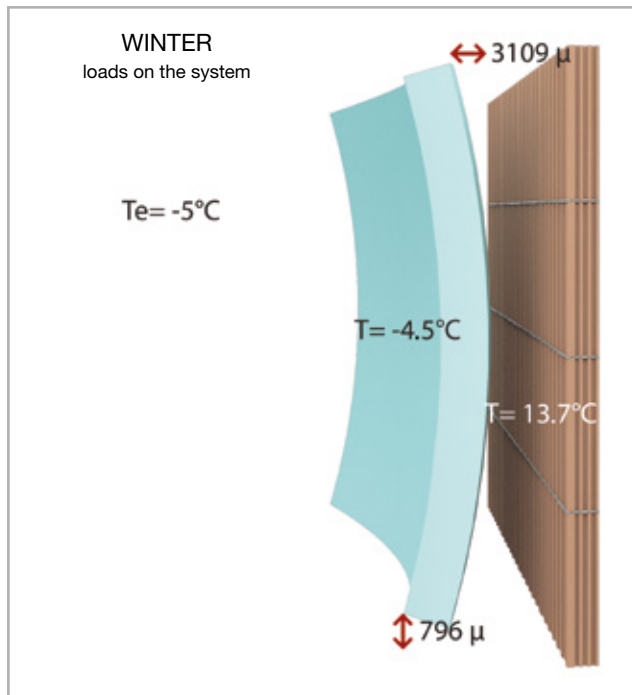


Fig. 5.1

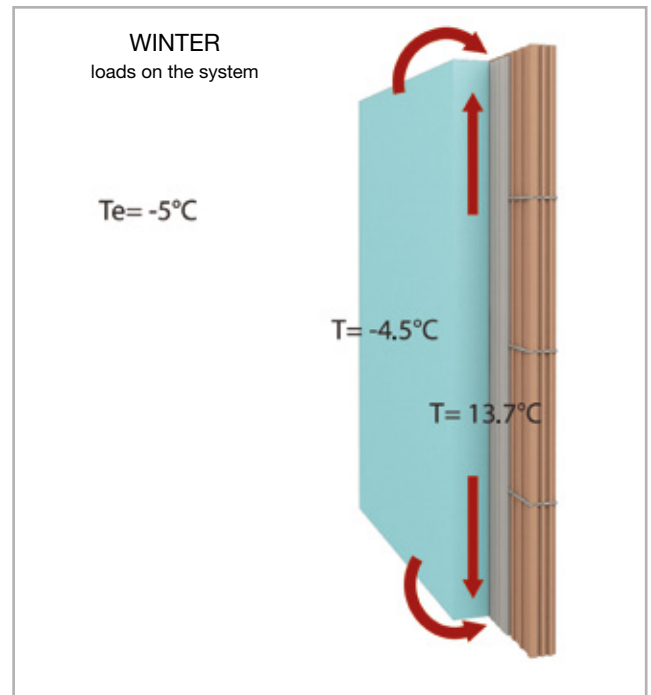


Fig. 5.2

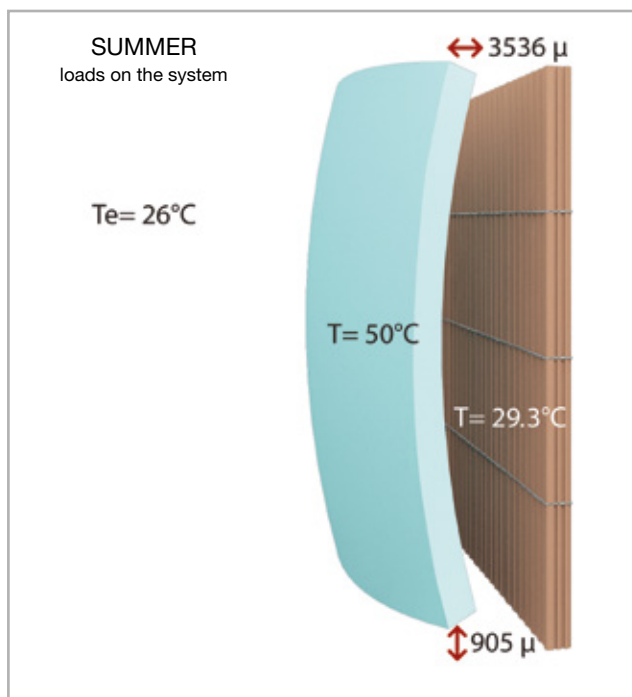


Fig. 5.3

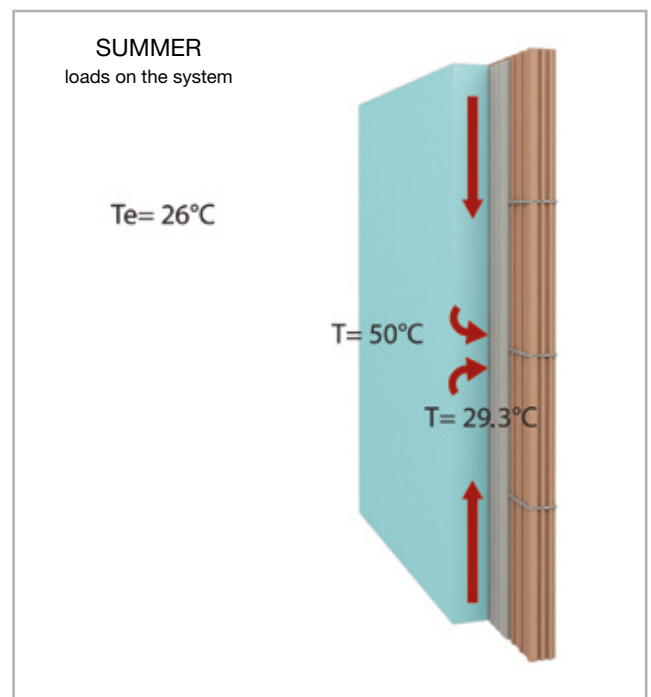


Fig. 5.4

Calculations carried out indicate that, during the winter, with an external temperature of -5°C and a room temperature of around $+20^{\circ}\text{C}$, the difference in temperature between the two sides of the panel (8 cm) is more than 18°C - Fig 5.1. In such conditions shrinkage loads are generated which, if not contrasted by the adhesive, would provoke almost $800\text{ }\mu\text{m}$ of deformation and shrinkage and more than 3 mm of flexural deformation. These loads must only be contrasted by the adhesive on which opposing loads and twisting moments are acting - the red arrows in Fig 5.2 - and only high quality adhesives are able to provide such a guarantee.

Similar considerations may be made by considering the conditions in the summer, when even heavier loads are measured, as shown in figures 5.3 and 5.4, even though the air temperature was not particularly high at $+26^{\circ}\text{C}$.

The deformations generated, therefore, are extremely high in all seasons, and the thicker the insulating material, then the heavier the loads acting on it. Only high quality adhesives, designed and manufactured for this specific area of use, are able to guarantee such high performance properties. From an analysis of the stresses, the following rule for correct application may also be established: only a seamless layer of adhesive, applied carefully to ensure it is regular and flat, can prevent serious defects developing, such as those shown in Figs. 5.1 and 5.3. The widespread practice of applying adhesive in beads and spots, or even worse applying only spots of adhesive, is not in line with the concept of distributing peel loads over the whole of the layer of adhesive. This application technique will lead to peel loads being concentrated unevenly, and only where the adhesive is present, and it is inevitable that the surface adhesion and expansion of the panel will not be perfectly contrasted and their limits will be exceeded, as shown in Fig. 5.3. The flatness of the substrate is important because high deviations can create the ideal conditions for the generation of high eccentric bending moments, which then lead to an increase in the loads acting on the adhesive and cause the surface adhesion limit at the adhesive-panel interface to be exceeded.

Another important point which should never be overlooked, in order to effectively contrast the thermal expansion and shrinkage of the insulating panels as described above, is the quality and thickness of the skim coat, that is, the second important connection component of the system. In fact, applying a layer that is both plastic and, at the same time, monolithic, allows hygro-thermal strains to be contrasted even more effectively, especially when the seamless bonding approach is not adopted. To this end, it is recommended to use a skimming product with tried and tested quality criteria and to apply the skimming product in two coats to form a reinforced layer around 4 mm thick (and never less than 3 mm).

Mapei, which has always been considered a reference company in the adhesives sector thanks to their constant commitment into the research and development of innovative products and systems, has created the MAPETHERM System which guarantees an additional important feature: the MAPEI guarantee based on their undisputed leadership in the adhesives sector.

5.2 CHOOSING THE RIGHT INSULATING PANEL

Which is the best panel?

Thermal conductivity (λ) is all too often considered the only significant criteria when choosing an insulating panel, without considering that other very important characteristics may also be associated. All too often, the same type of panel is used out of pure habit or because of its price, thus generalising site conditions. The best way of deciding which is the most suitable panel is to clearly define its objectives and check the various performance levels on offer:

- thermal insulation;
- soundproofing capacity;
- reaction to fire;
- strength;
- stability;



- water absorption;
- permeability to water vapour;
- natural composition;
- price.

The insulating properties of the wall and possible architectural features must also be taken into consideration.

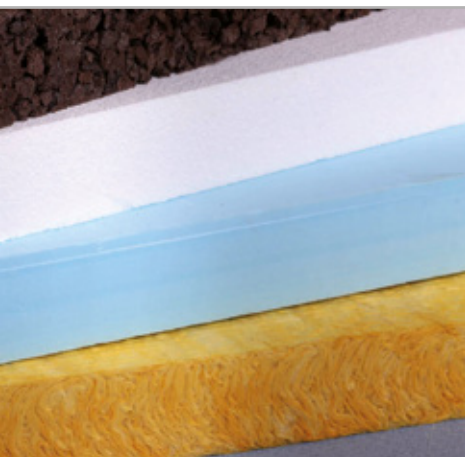


5.2.1 THERMAL INSULATION

The best insulator is stationary, dry air which, with a lambda value (λ) equal to 0.026 W/m²K (see UNI 7357) is bettered only by special panels (such as silica aerogel under vacuum at a pressure of 1.7×10^{-5} atmospheres) and certain heavy gases. It is important that this concept is clear because, in order to achieve higher values, air must be entrapped, held stationary and dry in the form of bubbles as small and waterproof as possible and the amount of material used, which is the source of heat conduction, must be reduced as much as possible. High performance values can be obtained from panels in aerogel, polyurethane, polyphenol or EPS with graphite, which allow high rates of thermal insulation to be achieved with thin panels. The issue of thermal insulation is slightly different during the summer, when better performance characteristics are obtained from denser panels that improve the attenuation factor and the thermal wave phase shift - see section 3.2. In this sense, higher performance properties can be obtained from glass fibres, cork and Rockwool, for example.

Also to be taken into consideration is the fact that certain materials are more sensitive to moisture and their insulating capacity tends to diminish quite considerably when they absorb moisture.

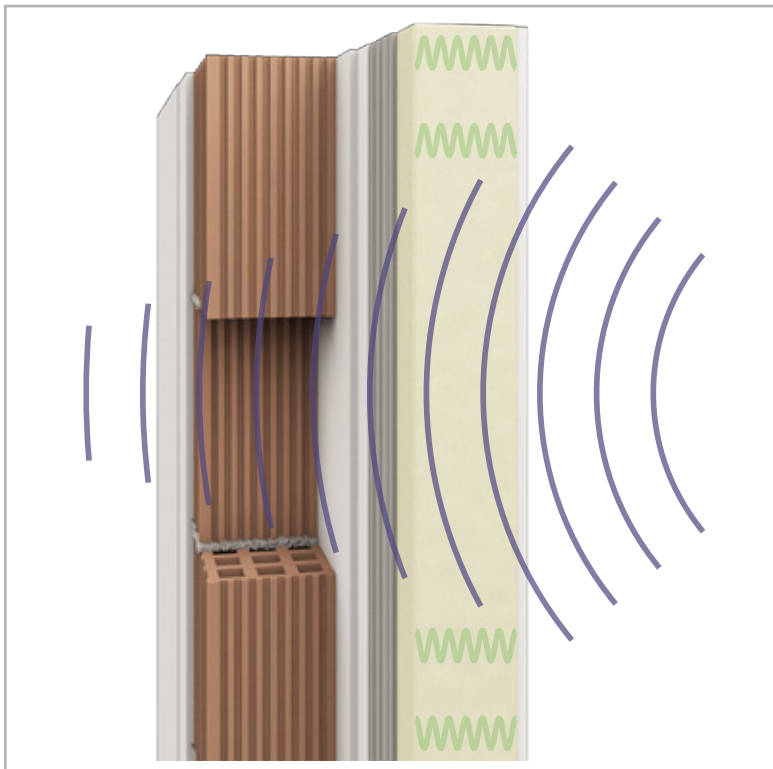
The parameter used in thermal calculations for materials carrying CE marking is the lambda value declared by the manufacturer (λ_D) calculated at 10°C in the centre of a sample cured at +23°C and 50% humidity. If we wish to perfect this calculation, the λ_D value may be changed for the



design conductivity value λ in compliance with EN ISO 10456 standards. This is not such a simple step because the design engineer must assess the temperature and humidity values of the insulating panel applied for the design calculations, and on this basis determine the value for λ , which could either improve or worsen according to the surrounding conditions adopted for the calculation.

5.2.2 SOUNDPROOFING

A building which also has good soundproofing is undoubtedly more comfortable and, when renovating old buildings, it is not possible to improve this property of the vertical structures without intervening on the external Insulation system. Sound waves are cushioned according to the mass-cushion-mass principle, where the elasticity of the panel acts as a cushion for the sound energy acting on it (the less rigid the panel, the higher its soundproofing capacity).



The mass-cushion-mass principle

High soundproofing capacity can be obtained from panels made from fibres, Rockwool and panels in EPS-S, that is, polystyrene with low dynamic rigidity (flexibilised panels).

The only other factor it is possible to intervene on to increase the soundproofing capacity is to increase the surface mass of the external layer (reinforced skim coat + finishing coat). In such cases, it is recommended to form an external layer with a mass of at least 10 kg/m² (around 8 mm in total).

The increase in the soundproofing capacity of walls may be calculated according to EN 12354-1 (Estimation of acoustic performance in buildings from the performance of elements) and UNI/TR 11175 (Guide to EN 12354 standards for estimating the acoustic performance of buildings).

5.2.3 REACTION TO FIRE

Every type of material has its own reaction to fire which is defined on the basis of tests carried out according to current norms and standards (ISO 13501) which establish a specific classification system which goes from A (non-flammable product) to F (highly flammable product). The reference parameters mainly taken into consideration are combustibility level, fire propagation velocity and the development of heat per unit of time. Flammable materials (vegetable and synthetic insulators) are made fire-proof by applying special paint on the surface or by adding fire-proof substances to the material during production.

In the case of external insulation systems, we have to take into consideration the performance characteristics of the entire system as a whole, so it is not necessary to take into consideration those of the single materials in the system.

5.2.4 STRENGTH

The strength of almost all insulating panels is reduced due to the low density or inherent fibrous consistency of the panel itself. Sometimes, however, higher performance levels are required, which are difficult to obtain because of the very nature of the materials from which they are made.

The most common example is skirting-boards at the base of walls which are subject to accidental impact by pedestrians or vehicles (motorcycles and bicycles). Manufacturers often refer to compressive strength at 10% of crushing, which basically indicates temporary compression, while in rare cases they declare compressive strength at 2% of crushing, which indicates the maximum, permanent deformation which a panel may support.

Very important in obtaining surfaces with high resistance to impact loads is not so much the panels themselves, but rather the quality, type and thickness of the reinforced layer applied on the panels. In fact, specific cementitious skimming products are available which greatly increase their performance properties (such as MAPETHERM AR 1 LIGHT), or cement-free skimming pastes are applied (such as MAPETHERM FLEX RP), which have resistance to impact values of more than 15 Joules, that is, 50% higher than conventional skimming products.

5.2.5 STABILITY

Thermal stability means mainly dimensional stability in terms of dimensional variations of the panel due to poor curing before being put on the market and the change in temperature and variation in the level of humidity to which it is exposed. One of the parameters to be evaluated is the coefficient of linear thermal expansion, which must not be too high. Fibre-based panels, such as those made from glass fibre or Rockwool, are more or less stable, whereas synthetic panels, such as those in EPS, XPS and polyurethane, have a higher coefficient but their movements are perfectly contrasted by using a high quality adhesive applied in the correct position (ideally over the entire surface of the panel).

Their chemical-physical stability also affects how they interact with UV rays and react to solvents (only use water-based products).

Other problems with certain types of material is their thermal-physical stability, that is, their capacity to maintain the same conductivity over the years, and their hygrometric stability, that is, their capacity to maintain the

same conductivity in the presence of moisture (certain materials are highly hygroscopic and, as a result, highly influenced by this factor).

5.2.6 WATER ABSORPTION

This parameter indicates a material's predisposition to entrap and hold water. Some types of material are considered to have almost zero absorption (0.5-1.5%), even when immersed, but water must always be prevented from infiltrating into an external insulation system. Any material which can have a variable moisture content has the potential to drastically reduce its insulating capacity and trigger off premature deterioration.

It is very important, therefore, to take special care with materials, from the way they are stored to the way they are installed (for fibrous materials in particular it is a good idea to protect them with sheets), to the way the system is waterproofed and sealed, especially around the critical areas - see section 9.

5.2.7 PERMEABILITY TO VAPOUR (BREATHABILITY)

The correct definition is water vapour diffusion resistance (μ), which is the capacity of a material to offer the least resistance possible to the passage of vapour. A more important indication is the value S_d (equivalent thickness of dry air) which considers the resistance to vapour in relation to the thickness of the material. It is very important that the entire stratigraphic layout of the wall is designed so that condensation does not form in the gaps. A correct permeability to vapour value maintains a correct hygrometric balance in the wall structure, but do not fall into the trap of believing that moisture created inside the rooms of typical a family home is released through the walls - see section 1.4. During the design phase, by using special software, it is possible to control the formation of condensation on surfaces and in the cavities (Glaser method) so that structures can be designed in which such conditions are never encountered. This problem is rarely encountered with external insulation systems. In fact, one of its main functions is precisely that of transferring the condensation point from the internal surfaces to the

external surfaces. If condensation does form, it can be tackled by increasing the thickness of the insulating material or using insulating material with a higher rate of permeability to vapour, although very often the application of a siloxane-based finishing product is sufficient (such as SILANCOLOR TONACHINO PLUS).

5.2.8 NATURAL COMPOSITION

The demand for natural materials for manufacturing insulating panels is mainly met by using materials such as cork, wood fibres, Kenaf and other vegetable or animal fibres, or even minerals such as calcium silicate hydrate or recycled cellular glass.

5.2.9 CONCLUSIONS

As a conclusion to this section dedicated to design, it is clear that choosing the right system depends mainly on the characteristics of the adhesive and the type of insulating panel. The experience matured in the adhesives sector allows Mapei to offer adhesives and skimming products that can be used as a part of any system because they can be used with any type of panel that meets the criteria for its intended use within an external insulation system. It is clear, therefore, that by using Mapei systems during the design phase, it really is possible to comply with any client's specification and requirements, such as the need to have high thermal insulating capacity (during the winter and summer), insulate buildings by applying relatively thin layers, provide soundproofing properties, obtain the maximum reaction to fire class, optimise its permeability to vapour, create surfaces with very high resistance to impact loads, minimise water absorption, use natural, certified materials for green-building projects or favour the ease of installation or the cost-effectiveness of the intervention.

5.3 CHOOSING THE RIGHT ANCHOR

When should they be specified and how many and which type should you use?

According to the considerations made in section 5.1, if high quality adhesive is used and applied according to certain criteria, it would be sufficient to guarantee a good hold of the system and mechanical anchors shouldn't be required. Anchors, however, are an added safety feature that should never be undervalued, because they are able to compensate for failures in the underlying substrate and, therefore, should be specified for systems installed on substrates whose mechanical characteristics are uncertain, on rendered substrates, on old substrates, for systems weighing more than 30 kg/m², for systems installed on particularly tall buildings and for systems with insulating panels thicker than 10 cm.

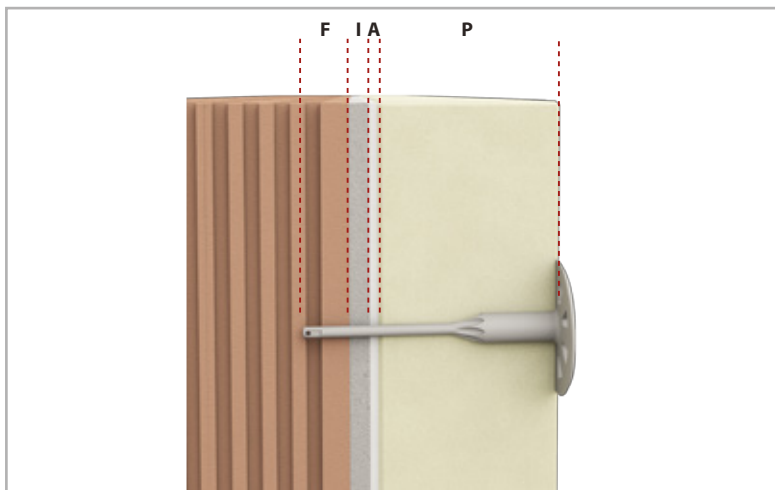
The type of anchors should be chosen according to the substrate they will be fastened to and the categories of use specified in ETAG 014. It is also recommended to use anchors whose efficiency has been certified according to the aforementioned guidelines and that have a tensile (pull-out) strength of at least 0.60 kN.

THE CATEGORIES OF USE SPECIFIED BY ETAG 014 DEFINE THE AREAS OF USE OF AN ANCHOR ACCORDING TO THE VARIOUS TYPES OF SUBSTRATE				
A	B	C	D	E
Normal concrete	Solid blocks	Hollow or perforated blocks	Lightweight concrete	Cellular concrete

When calculating the number of anchors required you must take into consideration the quality of the anchor (tensile strength), the type and weight of the insulating panels used in the system and the height of the building; 6 anchors per m² are usually sufficient, except in certain cases. The layout of the anchors and the way they are inserted into the substrate are also important in making sure they function correctly.

How long should they be?

There is no single answer to this question, even if the same thickness of insulating panel is anchored to the same type of substrate. In fact, the most important parameter when deciding on the length of the anchors is their anchoring depth, which is nominal and specific for each type of anchor. In order to avoid making simple mistakes this parameter must be known (it is written in the technical specifications and, often, on the packaging of the actual anchors).



The size of the anchor takes into account the thickness of the panel (P), the thickness of the adhesive (A), whether there is render on the substrate (I) and the correct anchoring depth (F)

5.4 CHOOSING THE RIGHT FINISHING PRODUCT

Can I use any finishing product on an external insulation system?

The finishing layer in an external insulation system sits against a thermal barrier formed by the insulating panel and reaches high temperatures that can vary very quickly as weather conditions change, which means it must have specific, well defined characteristics.

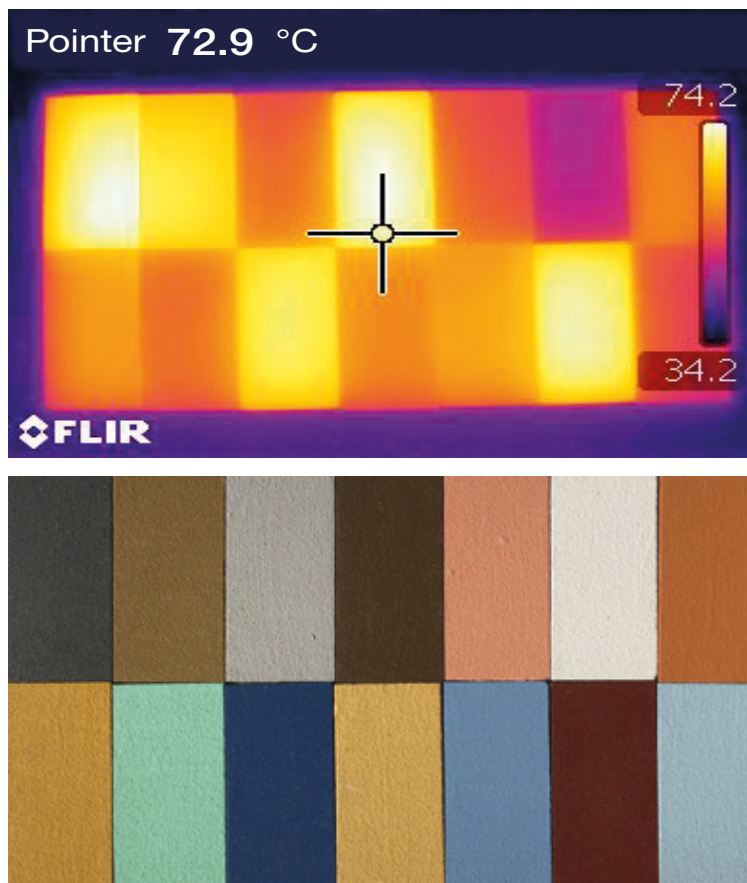
- it must provide protection against thermal-hygrometric stresses and atmospheric agents;
- it must be able to contrast stresses generated in the substrate without cracking. To achieve this characteristic, it is very important that either

the finishing product is sufficiently flexible or specially designed elastic systems are employed so that thin finishing products which guarantee good protection and durability may be applied;

- it must have low water absorption and balanced permeability to water vapour:
 - to impede salts inside the system travelling which, when crystallised, increase in volume and cause cracks or fractures;
 - to inhibit salts and carbonates contained inside cementitious skimming compounds being extracted and appearing on the surface of the finishing layer and forming unsightly white efflorescence or, even worse, collecting under the finishing layer and generating dangerous sub-efflorescence that could cause detachment of the finishing layer;
 - to prevent harmful internal freezing phenomenon;
 - to prevent the insulating panels swelling if they are absorbent;
 - to prevent reducing the insulating capacity of the system.
- it must maintain its original colour. Since it sits against a thermal barrier, the surface will certainly be exposed to the direct action of UV rays and high temperatures, so it must be formulated with special pigments with the highest resistance possible and must have a high content of quality resin binder to prevent the pigments being discoloured by UV rays and high temperatures;
- it must not generate stresses and/or strains in the system. As discussed above, since it must not overheat excessively, it is recommended to choose a colour that is not too dark and which, in all cases, has a solar reflectance index of more than 20% (this value must be higher if the system is installed in climatic zones with very strong, direct sunlight). This measure is tied to the temperatures the facade

of the building is exposed to due in direct sunlight, with temperatures during the summer that can quite often exceed +50°C.

- reflectance index (I.R.) is the unit of measure used for the reflectance level of sunlight, in which white has an I.R. value of 100% (radiation is completely reflected) and black has an I.R. of 0% (radiation is completely absorbed). The images below illustrate surfaces with finishing layers in different colours and the different temperatures that the surfaces reach when they are exposed to the same levels of radiation.



- it must be effective in contrasting the growth and spread of mould, algae and bacteria. A well designed external insulation system eliminates the dew point temperature inside the walls and leaves the external surfaces of the system cold. This means it is very important

to use materials with low water absorption that are certified to be effective for a wide spectrum of actions against the strains of bacteria, mould and algae most commonly found in nature.

In order to meet all the requirements listed above, Mapei proposes a range of highly flexible fine-textured rendering products with a high content of quality resin binders. They are available in various textures and range from products with a high level of strength and resistance to chemicals, to those with low water absorption and high permeability to water vapour and coloured products containing particularly resistant pigments that maintain their colour over the years, which have all proven to be effective in preventing the growth of mould, algae and bacteria.

These types of product are generally applied in layers at least 1.2 mm thick, which means those with particles smaller than 1.2 mm need to be applied in more than one coat to achieve the specified minimum thickness.

If you prefer a smooth finish, a layer of “reinforced” render at least 3-4 mm thick must be applied using MAPETHERM FLEX RP cement-free, fibre-filled, colourable, lightweight skimming paste, which is resistant to the aggressive action of mould and algae. By using MAPETHERM FLEX RP, the final finishing coat may be applied after just 24 hours without having to wait for a cementitious skimming product to cure fully and without having to apply a coat of primer, making this finishing cycle much quicker; in this case, it may be completed by applying two coats of paint (excluding mineral paint) or higher performing fine-textured render.

The only way of guaranteeing the quality, durability and, as a result, the sustainability of an external insulation system is by using systems consisting of compatible materials that have been developed, tested and certified to be used in combination, thereby avoiding the installation of an assembled or improvised external insulation system with the sole aim of reducing costs, but compromising on quality and durability.

Only by starting from these sound principles, together with the professionalism of the design engineer and work team, will it be possible to achieve the enormous performance, economic, living and environmental advantages that the MAPETHERM system guarantees.

BIOLOGICAL AGGRESSION

Aggression from biological agents is very common in the building industry and also very easy to identify. Mould on the facades of buildings, or even worse inside the building itself, is not a particularly healthy sign and may lead to finishing coats deteriorating rapidly or, even worse, a higher health risk for those users and residents of the buildings who are sensitive to the spores and toxins released into the environment.

The micro-organisms which make up mould and algae often find ideal conditions for breeding, and quickly infest the facades of buildings and damage walls inside homes, leading quickly to severe deterioration.

When a surface deteriorates there is visible damage to the walls, with the formation of unsightly black and green stains (Figs. 5.5 and 5.6), followed by the microorganisms penetrating into the walls and releasing acidic metabolites that cause a progressive decay of the coating and the formation of cracks and decay deep down into the substrate.

ALGAE AND MOULD

Algae and mould are biological vegetable organisms which reproduce by releasing large quantities and varieties of spores into the air. Algae (Fig. 5.7 seen through an electron microscope) is made up of photosynthetic organisms which contain chlorophyll: they need light to live, a high level of humidity and mineral salts, elements which are normally present on the surface of walls. Because of their special nature, they almost always form externally. Mould (Fig. 5.8 seen through an electron microscope) is a vegetable organism which is part of the fungi group. It is unable to photosynthesise and, apart from a certain level of humidity, it requires organic nutrition. Suitable substrates for such



Fig. 5.5

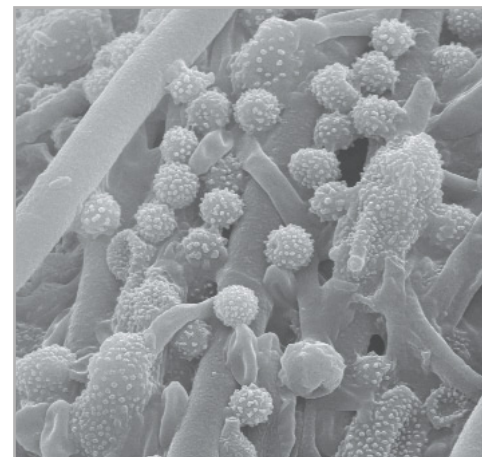
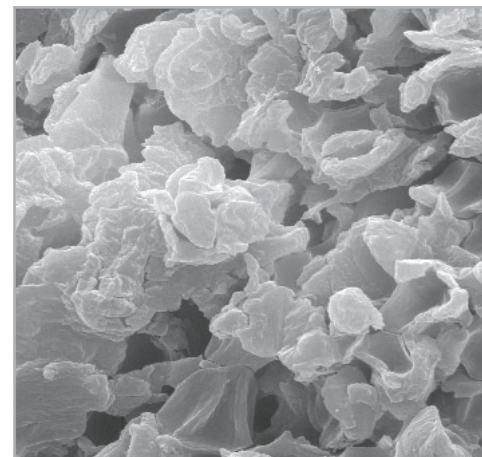




Fig. 5.6

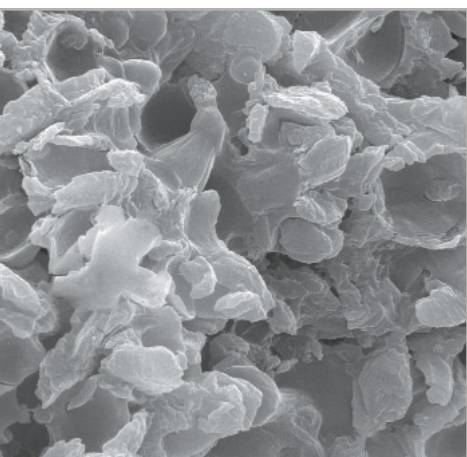


Fig. 5.7

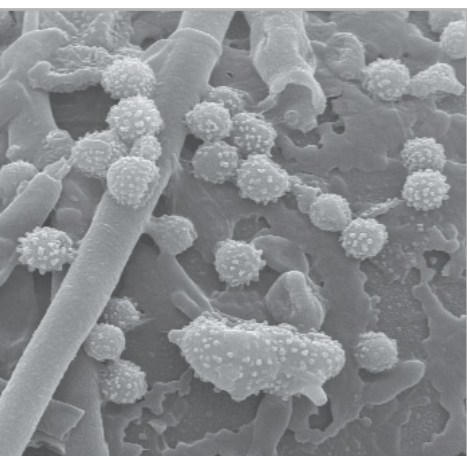


Fig. 5.8

organisms are wall surfaces which contain the “nutrients” required, such as dirt (a mixture of dust and organic particles) deposited on the coating or which derive from the cellulose contained in wall paints. They reproduce both internally and externally. In the latter case, they form mainly on old colonies of algae (in symbiosis) which guarantee water retention and a supply of metabolites for nutrition. Special attention must be paid to mould, in that it develops filaments which may penetrate deep down into the top coating and cause considerable damage. The biological activity of algae and mould also produces various acidic metabolites which also attack the coating.

MOISTURE: AN ESSENTIAL CONDITION FOR THE DEVELOPMENT OF ALGAE AND MOULD

The main condition for biological deterioration of an internal or external surface is the presence of moisture in the substrate. The difference in temperature may also be a determining factor, while the alkaline environment may inhibit their formation.

On external walls, absorption and water retention are mainly due to:

- micro-climatic and atmospheric conditions, such as their vicinity to damp ground and water courses, the presence of fog and the lack of sunlight (north-facing walls);
- a high level of water absorption and low breathability of the coating;
- the presence of thermal bridges (cold spots) due to the incorrect use of materials with different thermal conductivity and, as a result, the formation of condensation;
- exposure to atmospheric agents without protective architectonic elements (such as flat roofs and guttering);
- these conditions are made worse if the building is close to farm crops, thick vegetation, etc.

Condensation forms inside buildings mainly in cold spots on walls, and is mainly due to:

- poor thermal insulation;
- the presence of thermal bridges;
- poor air circulation and, therefore, poor discharge of the moisture produced in rooms;
- these conditions are made worse if poor quality paints and coating products are employed.

The problems mentioned above are quite common and occur frequently in almost all buildings. It is quite safe to say, therefore, that all buildings and wall systems have a substrate which is suitable to promote the growth of these biological organisms. Coating products and paint used to protect and decorate facades do not cause the development of algae and fungi, unless they are used incorrectly. It is very difficult to predict if or when algae and mould will develop. However, if there are favourable climatic conditions for their development, the use of materials developed to slow down their formation must be considered during the design phase and regular maintenance work must be carried out, because the effectiveness of such products tends to reduce over the years. If possible, suitable methods and materials should be adopted for new buildings to reduce the risk of their formation, although such countermeasures are not always sufficient due to the complexity of the factors involved and the wide variety of biological species present in different areas. With repair jobs, on the other hand, the modifications which may be carried out on buildings are quite limited, even in those cases where the background of the building itself often supplies important information regarding the presence or absence of risk factors. The only really effective method to counteract biological deterioration is to use, in both cases, coating products that are resistant to the growth of algae and mould, which in the case of walls already damaged, include





a thorough hygienising and cleaning operation of the areas affected. With these types of coating products, resistance to biological organisms is given by their content of special additives which remain inside the coating, even after they have dried, and protect against the proliferation of algae and mould.

These additives have to be correctly balanced and they must also have low solubility so they are not removed by the leaching action of rainwater and damp, thereby providing long-lasting protection while, at the same time, guaranteeing their effect on the surface of the coating and on layers of dirt.

With the aforementioned problems in mind, MAPEI has developed and proposes a series of products which are resistant to the aggressive action, growth and proliferation of these micro-organisms. These products are easily recognisable by their “PLUS” suffix and are: SILANCOLOR CLEANER PLUS, SILANCOLOR PRIMER PLUS, SILANCOLOR TONACHINO PLUS, SILANCOLOR PAINT PLUS, QUARZOLITE TONACHINO PLUS, QUARZOLITE HF PLUS, ELASTOCOLOR TONACHINO PLUS and DURSILITE PLUS.



6. HOW TO INSTALL THE MAPETHERM SYSTEM

A correct external insulation system must always include a phase in which the complete kit comprising the system is chosen carefully. Apart from the insulating layer, this also includes all the materials used to prepare the substrate, bond the insulating panels and skim and finish the facade to give it the mechanical characteristics and final pattern and colour required. Similarly, correct installation on site and the correct design of all the construction details in more critical and problematic areas of the building are also essential to guarantee the required level of living comfort and obtain the reduction in energy consumption and environmental

sustainability expected. The following paragraphs contain a full description of how to use the materials and how to install a complete MAPETHERM system.

6.1 SUBSTRATE PREPARATION

Before installing an external insulation system, the surfaces must be mechanically strong, free of any areas at risk of detachment, perfectly clean and free of all traces of dust, dirt, grease, form-release agents and any other material or substance which could affect adhesion of the panels to the substrate.

6.1.1 BUILDINGS IN STONE OR BRICK MASONRY

On buildings with a natural brick or stone finish (not rendered), the consistency of the stone blocks and the condition of the surface of the bricks must be checked and all flaky or loose parts must be eliminated. In the case of particularly porous stone blocks with a powdery or dusty surface, you may opt for a primer (such as MALECH, a micronized acrylic resin-based product in water dispersion used to prepare the surface of masonry in general), which is applied on the surface of the masonry with a brush, roller or by spray.

If the mortar between the stone or bricks has been worn away by rainwater, it will need to be pointed using mortar with suitable elastic-mechanical properties (such as MAPE-ANTIQUE MC ready-mixed de-humidifying mortar for renovating damp stone, brick and tuff masonry or POROMAP INTONACO grey ready-mixed, de-humidifying, salt-resistant mortar, which is applied by hand or with a rendering machine and is used for renovating stone, brick and tuff masonry).

If the wall is particularly out of plumb or uneven due to the type of construction materials used (such as out-of-square, rough-cut or rounded stone blocks), the surface will have to be levelled off and/or made vertical by rendering the surface with mortar that adheres really strongly to the substrate and has a low modulus of elasticity and high tensile and



Fig. 6.1 - Masonry building with rising damp



Fig. 6.2 - The areas of detached render must be removed before bonding the insulating panel

flexural strength (such as NIVOPLAN levelling mortar for walls mixed with PLANICRETE synthetic latex rubber for cementitious mortar, or with INTOMAP 1R base render, which may also be applied with a rendering machine).

An external insulation system must never be installed on masonry with a high level of capillary rising damp.

In fact, if such a system were to be installed, the damp in the wall would increase due to a lower evaporation rate from the walls after bonding the insulating panels.

Paradoxically, because of the effect of running the heating system in the building during the winter, the increased level of damp in the walls would cause a critical situation and provoke the formation of surface efflorescence and blistering of the paintwork inside the building. In the summer, on the other hand, the migration of salts towards the external face of the wall and their crystallisation, combined with an increase in vapour tension, could cause portions of the adhesive to become detached and compromise the entire insulation system.

Therefore, if there is rising damp in the walls, an external insulation system may only be installed after protecting the walls with a chemical barrier (by injecting waterproofing or water-repellent mixes into the wall such as MAPESTOP, an agent injected into the wall made from concentrated silicon micro-emulsion which forms a chemical barrier against rising damp in masonry).

Alternatively, the outside wall must be protected with macro-porous de-humidifying render (such as MAPE-ANTIQUE or POROMAP) up to the level of the first floor slab, followed by installing the external insulation system from that level up.

6.1.2 BUILDINGS IN RENDERED REINFORCED CONCRETE OR MASONRY

In the case of old buildings in either masonry or with a reinforced concrete frame which are already rendered, before bonding the insulating panels, the

render must be checked to make sure it is well attached to the substrate; any detached portions must be demolished.

Areas where the render has been demolished may then be repaired using PLANITOP FAST 330 or cementitious mortar with added latex (such as NIVOPLAN + PLANICRETE).

Also, before bonding the panels, the consistency of the surface of the render must be checked by carrying out a series of pull-off tests, for example. If the values measured are particularly low, it is generally good practice to brush the render with a stiff brush to remove the poorly attached areas and then treat these areas with a high-penetration consolidating primer (such as MALECH). In the case of render that has been painted or coated with a plastic material, make sure they are well bonded to the substrate. After removing any areas which are either loose or flaky, brush down well and wash the entire surface with high-pressure water jets.

Similarly, in the case of facades dressed with ceramic, glass mosaic or clinker tiles, make sure they are well bonded to the substrate. Any areas which are detached must be removed and integrated with NIVOPLAN + PLANICRETE or PLANITOP FAST 330.

6.1.3 WALLS AND/OR STRUCTURES WITH CRACKED CONCRETE

In the case of cracked walls, the first step is to ascertain the cause of the cracks to check if they are stable or due to movements in the building which are still under way. In the latter case, before installing an external insulation system, work will have to be carried out on the building to impede any further movements to stop the cracks propagating into the panels, the skim coat and the finishing coat of the external insulation system.

If the cracks are stable, on the other hand, and their movement is only influenced by the inevitable thermo-hygrometric gradients, the facing walls of buildings in stone or brick may be rebuilt using the patching and tacking technique or, if there is only slight cracking, they may be repaired

by grouting them with the same adhesive used to bond the panels (MAPETHERM AR1 one-component cementitious adhesive and skimming compound for external insulation systems, MAPETHERM AR1 GG one-component cementitious adhesive and skimming compound with larger particles for external insulation systems or MAPETHERM AR1 LIGHT one-component lightweight cementitious adhesive and skimming compound with larger particles for external insulation systems).

The same technique may be used to grout cracks in render caused by hygroscopic shrinkage and/or high absorption of water by the substrate when the render was applied. Grouting with mortar may also be used to seal localised cracks in buildings with reinforced concrete frames, in buffer wall-beam joints and buffer wall-pillar joints. In new buildings, where the external insulation system may be installed as soon as construction work has been completed, there is a high risk of cracks forming at the reinforced concrete frame/buffer-wall interface after installing the external insulation system and provoking cracks and localised detachment in the skimming and finishing layers. To minimise this risk, when applying the render, embed a strip of mesh to hold the render and protect these areas.



6.1.4 STRUCTURES AND/OR ELEMENTS IN CONCRETE

On new concrete walls, use high-pressure water (120 atm) to clean them down. Special additives may also be included to remove all traces of form-release agents from the surface.

Clean the surface of existing structures thoroughly to remove all loose parts, surface laitance and all traces of dust, oil, grease and dirt in general.

If the concrete is deteriorated and there is corroded rebar showing through, or if there are areas of delaminated and/or detached concrete, repair these areas as follows:

- remove the deteriorated concrete;

- clean the rebar with a stiff brush or by sand-blasting or hydro-blasting;
- protect the rebar by applying a cementitious passivating mortar (such as MAPEFER 1K one-component, anti-corrosion cementitious mortar for rebar);
- reintegrate the area with shrinkage-compensated mortar (such as MAPEGROUT T40 medium-strength, fibre-reinforced thixotropic mortar for repairing concrete, MAPEGROUT BM two-component thixotropic mortar with a low modulus of elasticity or PLANITOP SMOOTH & REPAIR controlled-shrinkage, rapid-setting, thixotropic cementitious mortar used for repairing the cortex and for finishing reinforced concrete). After reconstructing the area, wait until the substrate is fully cured before installing the external insulation system.

6.2 HOW TO APPLY PROFILES FOR EXTRA SUPPORT AND PROTECTION

Before installing the insulating panels, attach MAPETHERM BA support profiles to the wall with MAPETHERM FIX B anchors every 40 cm and, if required, MAPETHERM PROFIL BA anti-crack profiles and any other required containment and protection profiles, such as side guards, guards below the windowsills, flashing, etc.

6.3 INSTALLING THE INSULATING PANELS

The insulating panels are bonded to the substrate with special ready-mixed adhesive (such as MAPETHERM AR1, MAPETHERM AR1 GG or MAPETHERM LIGHT) mixed with water.

Whichever type of adhesive is used, make sure the surface of the panels is not too smooth (surface “skin”) before bonding them in place, otherwise they will not adhere strongly to the substrate.

If the substrate is flat, spread an even layer of adhesive over the entire back face of the insulating panel. If the surface is not flat, apply a series



of spots and beads so that at least 40% of the surface is covered with adhesive. If the substrate is particularly out of flat (more than 15mm with a 4 metre straight-edge), skim the surface where required with MAPETHERM AR1 LIGHT.

When installing the panels, make sure the adhesive doesn't seep into the joints between adjacent panels and forms a thermal bridge due to the higher thermal conductivity of the adhesive or, even worse, the formation of cracks around the joints.

The thickness of the layer of adhesive should be sufficient to cover the surface of the panel evenly and/or eliminate differences in flatness in the substrate of up to 5 mm. To form the thickness required, we suggest using a N° 10 notched spreader.

If the substrates are not perfectly flat, spread beads of adhesive around the edges of the panels and spots of adhesive in the middle of the panels. Make sure the adhesive is not used to compensate for uneven areas of more than 15 mm, otherwise stresses could be generated and the panels could become detached while the adhesive is shrinking. Also, if the adhesive is no longer in contact, it will not be able to counteract the thermal shrinkage that takes place in the panels.

Make sure the adhesive used to install the system does not allow air to pass between the insulating panel and the substrate, otherwise this could result in a chimney effect that detaches the insulating panel, thereby provoking a dangerous sail effect.

Install the insulating panels starting from the lower part of the wall and work upwards, with the longest side placed horizontally and the vertical joints staggered by at least 25 cm. Stagger the ends of the panels in correspondence with the edges of the wall.



Fig. 6.3 - Positioning the support profiles: make sure they are horizontal using a spirit level



Fig. 6.4 - Fasten the support profiles in place with expansion anchors



In order to get the maximum adhesion strength, install the panels immediately after spreading the adhesive on the back of the panels, especially in hot or windy weather.

In order to form the maximum contact area between the substrate, adhesive and panel, press down lightly on the panel immediately after application with a float and then check the flatness constantly as work progresses with a straight edge; if they are out of flat, press them down into the correct position.

Once the adhesive has dried, it will be possible to make the surface perfectly flat and get a much better finish by planing the surface (synthetic panels) or by skimming the surface to compensate for the areas out of flat (fibre-based panels).

It is very important to install the insulating layer carefully and correctly in order to form an insulation system of the highest quality with the most attractive appearance.

If there are gaps wider than 2 mm between the panels once they have been bonded, inserts made from insulating material must be placed in the gaps or, if the gaps are less than 5 mm wide, low density insulating foam may be used. Whichever of these two solutions is used, make sure



Fig. 6.5 - Adhesive spread evenly on the back of an insulating panel



Fig. 6.6 - The back of a panel with beads of adhesive around the edges and spots of adhesive in the middle



Fig. 6.7 - Panels bonded in place with staggered joints



Fig. 6.8 - Pressing down the panel with a float

the filler material goes right through the whole thickness of the insulating panels.

When bonding panels around openings in the wall for doors and windows, the joints between adjacent panels must not be in line with the parapets, architraves or edges of the openings.



The correct way to position panels around openings

The position of structural expansion joints must be respected and the joints must be protected with special straight or angular jointing profiles, such as MAPETHERM PROFIL E or MAPETHERM PROFIL V. If openings in the wall need to be insulated (parapets and hangers for doors and windows), the panels bonded to the facade must overlap the edges of the openings so that they also cover the edges of the insulating panels inside the openings.

If EPS or XPS panels are exposed to direct sunlight for long periods of time an uneven glaze will form on the surface. This may be removed with a brush before applying the skim coat.

It is also good practice to protect the panels from damp and rain, particularly fibre-based panels.

6.4 ANCHORS

Apart from adhesive (but not instead of adhesive), mechanical anchors in the form of wall anchors may be used to fasten the panels in place. To assess whether extra anchors are required, what type you should use and how long they should be, refer to Section 5.3.

The anchors are added once the adhesive has hardened, in correspondence with the adhesive, and are inserted into the load-bearing part of the substrate (and not into the render, for example).

When installing particularly heavy insulating panels, it may be useful to insert an anchor in the centre of the panel while you are installing it to help support its weight while the adhesive is setting. More anchors can then be inserted once the adhesive has hardened.

If, however, the substrate shows poor cohesion and/or is not flat, or if the adhesive has been applied in beads and spots, it is good practice to increase the number of anchors and position them along the top and middle of the panel until they reach a more solid part of the substrate; make sure they are inserted to the correct depth (the depth specified for that particular type of anchor).

For panels made from synthetic material, it is recommended to use a “T” layout for the anchors so they can help the adhesive and skimming compound contrast thermal expansion in the panels.

For fibre-based panels, it is recommended to use a “W” layout for the anchors to prevent the risk of perforating the panels (pull-through) around the corners of the panels.



Fig. 6.9 - Drilling a hole to insert the anchor

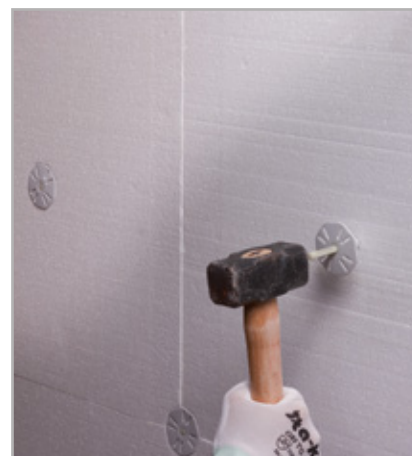
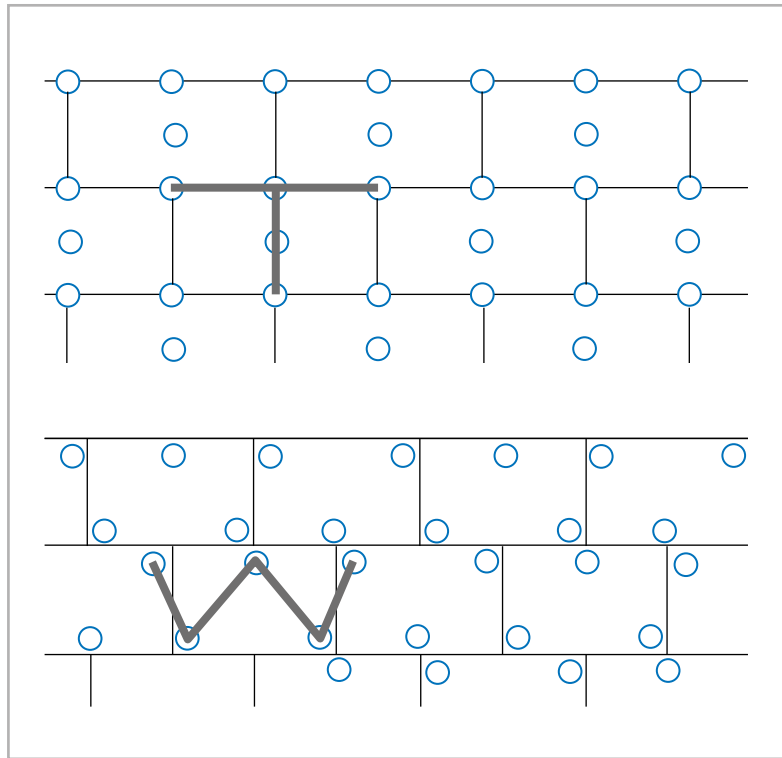


Fig. 6.10 - Inserting the anchor



Layout of the anchors

The holes for the anchors must be drilled after the adhesive has hardened (at least 2-3 days) to prevent affecting the flatness of the bonded panels. The drill-bit used to make the holes must be the same diameter as the stem of the anchor. A hammer-drill should only be used to drill holes in concrete or solid bricks.

The anchor is then inserted so that the head of the anchor sits against the surface of the insulating panel (MAPETHERM FIX type anchors) or, in the case of embedded anchors, by using the special anchor cap.

Every anchor inserted into the substrate must form a perfect grip, otherwise it must be removed, the hole must be filled with special insulating foam and a new anchor must be inserted nearby.



6.5 ELEMENTS FOR ADDED STRENGTH AND PROTECTION

Once the panels have been installed and the adhesive has hardened, special reinforcement elements need to be applied. These elements are fastened to the panel with the same adhesive/skimming product. Apply a strip of adhesive or skimming compound the same width as the strip of mesh attached to the profile and press the reinforcement profile into the adhesive or skimming compound so that the profile and strip of mesh are embedded.

The reinforcement elements must be made from PVC or aluminium alloy (never use galvanized or painted steel) and are as follows:

- MAPETHERM PROFIL guards placed around edges to keep them plumb and provide mechanical protection;
- MAPETHERM PROFIL E and MAPETHERM PROFIL V linear and angular profiles for expansion joints;
- MAPETHERM ROMPIGOCCIA profiles with drip channels for horizontal edges which must be positioned in a perfectly flat position using a spirit level;
- MAPETHERM PROFIL W profiles positioned on the inside of openings for windows to seal the system and compensate for the different expansion rates of the materials they are in contact with;
- diagonal reinforcement placed around the edges of openings measuring around 30x40 cm (off-cuts of mesh such as MAPETHERM NET). They are placed at an angle of 45° and in perfect contact with the corners to contrast stresses that concentrate in such areas and prevent the appearance of diagonal cracks typical in such areas.



Fig. 6.11 - Application of the first coat of skimming compound



Fig. 6.12 - Application of MAPETHERM NET



Fig. 6.13 - The edges of the mesh must overlap by at least 10 cm

6.6 HOW TO APPLY A REINFORCED SKIM COAT (REINFORCED BASE RENDER)

The insulating panels are skimmed with special adhesive paste (such as ADESILEX FIS 13) mixed with cement (CEM II/A-LL 42.5R in compliance with EN 197/1) at a ratio of 1/0.7, or with a ready-mixed product (such as MAPETHERM AR1, MAPETHERM AR1 GG or MAPETHERM LIGHT) mixed with water.

It is possible to obtain a particularly smooth finish by applying MAPETHERM FLEX RP cement-free, fibre-filled, flexible, colourable, lightweight skimming paste which is resistant to the aggressive action of mould and algae. Using MAPETHERM FLEX RP makes it possible to apply a finishing product without priming the surface beforehand and to create an external insulation system with very high resistance to impact loads.

Before applying this type of skimming product, check the panels to make sure their surface is not dusty, otherwise the skimming product may not adhere correctly to the panel.

The skimming mortar must only be applied once the adhesive is hard enough (the time required depends on the weather conditions and normally takes at least 24 hours). Apply the skimming mortar in two coats with a steel spreader to form a 4 mm thick layer.

When installing fibre-based panels, it may be better to apply a preliminary coat of skimming mortar to obtain a better finish.

Apply a first coat of skimming mortar around 2.5-3 mm thick and, while it is still wet, place MAPETHERM NET alkali-resistant glass fibre mesh on the mortar starting from the top working downwards; make sure the sheets of mesh overlap each other by at least 10 cm. Be very careful when positioning the mesh to avoid forming bubbles or creases in the mesh; never cut the mesh to remove creases or bubbles if they do form. The mesh should be placed at around the mid-point of the layer of skimming mortar (or in the outer third of the layer if it is thicker than 4 mm, as normally occurs when applied on fibre-based panels). In correspondence with the

edges (of buildings, openings, etc.) the reinforcement mesh must overlap the mesh on the edge and corner guards.

After around 24 hours, and only when the first coat has hardened, apply a second coat of mortar around 1-1.5 mm thick. Spread it on evenly so that it completely covers the mesh with a coat at least 1 mm thick.



6.7 PROTECTING THE SYSTEM

To prevent any part of the insulating panels coming into contact with the outside, and prevent water, air or dust entering the joints between the external insulation system or any other parts or elements of the building, critical areas must be further protected, as specified for the various construction features in section 7, to compensate for the thermal contraction/expansion that occurs between the different types of material in the system by taking necessary measures: extruded foam polyethylene cord such as MAPEFOAM, one-component, paintable acrylic sealant in water dispersion such as MAPEFLEX AC4 and accessory items suitable for this type of use such as MAPETHERM PROFIL BA, MAPETHERM PROFIL W, etc.



6.8 HOW TO APPLY THE FINISHING COAT (FINISHING RENDER)

Wait until the skimming mortar is perfectly dry and cured (at least 14 days in good weather) to prevent drawing salts or carbonates from the skimming mortar, or the “burning” of any organic resin and pigments contained in the finishing product by the residual alkalinity on the skimming mortar.

The next step is to apply primer compatible with the finishing product to be applied (such as MALECH or QUARZOLITE BASE COAT followed by a finishing coat of QUARZOLITE TONACHINO, for example).

After at least twelve hours, apply a finishing coat of textured coating paste with a stainless steel or plastic spreader, starting from the top

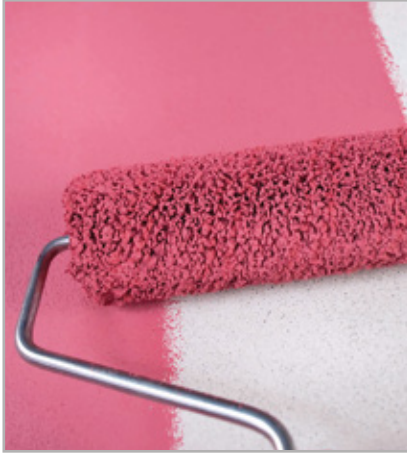


Fig 6.14 - Application of coloured primer



Fig 6.15 - Application of finishing render



Fig 6.16 - Finishing off the surface of the finishing render with a plastic float

working downwards, and finish the surface with a sponge or plastic float, depending on the type of product applied.

Textured coating products must be used for this operation to counteract the formation of cracks. Textured coating products with a particle size of 1.2 mm or more may be applied in a single coat, while finer textured products must be applied in several coats until they form a layer at least 1.2 mm thick.

Work should only be interrupted when an entire surface has been coated and we recommend using appropriate application methods and sufficient manpower to prevent joints being visible. Horizontal and/or vertical strips may also be applied if work is to be interrupted to prevent defects due to re-starting application of the coating product.

It is recommended to use finishing products that are known to be effective in contrasting the formation and growth of algae and mould.

The protective finishing cycle must take into consideration the type of insulating panel installed, the architectural features of the building, the area in which it has been built, the local climate and the instructions given by the designer engineer and Works Director.

7. THE COMPONENTS IN THE SYSTEM

7.1 ADHESIVES AND SMOOTHING/SKIMMING PRODUCTS

• ADESILEX FIS13

Adhesive and smoothing/skimming compound in water dispersion mixed with cement for external insulation systems.

- Consistency: thick paste.
- Colour: white.
- Density (g/cm³): 1.5.
- Application temperature: +5°C to +35°C.
- Mixing ratio: 1 part of ADESILEX FIS 13 with 0.7 parts of 42.5 cement (in weight).
- Cleaning: water.
- Storage: 24 months.
- Application: spreader.
- Consumption: 1.8-3.2 kg/m² depending on the bonding technique used; 1-1.2 kg/m² per mm of thickness for smoothing/skimming.
- Packaging: 25 kg drums.

• MAPETHERM AR1

One-component cementitious mortar for bonding and smoothing/skimming insulating panels and for external insulation systems.

- Consistency: powder.
- Colour: grey.
- Density of mix (kg/m³): 1,450.
- Application temperature: +5°C to +35°C.
- Mixing ratio: 21-24% with water (in weight).
- Cleaning: water.
- Storage: 12 months.
- Application: spreader.
- Consumption: 4.0-6.0 kg/m² depending on the bonding technique used; 1.3-1.5 kg/m² per mm of thickness for smoothing/skimming (recommended: 4 mm in 2 layers).
- Packaging: 25 kg bags.





• MAPETHERM AR1 GG

One-component coarse-textured cementitious mortar for bonding and smoothing/skimming insulating panels and for external insulation systems.

- Consistency: powder.
- Colours: white or grey
- Density of mix (kg/m³): 1,400.
- Application temperature: +5°C to +35°C.
- Mixing ratio: 21-24% with water (in weight).
- Cleaning: water.
- Storage: 12 months.
- Application: spreader.
- Consumption: 4.0-6.0 kg/m² depending on the bonding technique used; 1.35-1.55 kg/m² per mm of thickness for smoothing/skimming (recommended: 4 mm in 2 layers).
- Packaging: 25 kg bags.



• MAPETHERM AR1 LIGHT

One-component lightweight cementitious mortar for bonding and smoothing/skimming insulating panels and for external insulation systems.

- Consistency: powder.
- Colour: white.
- Density of mix (kg/m³): 1,300.
- Application temperature: +5°C to +35°C.
- Mixing ratio: 29-31% with water (in weight).
- Cleaning: water.
- Storage: 12 months.
- Application: spreader.
- Consumption: 3.0-5.0 kg/m² depending on the bonding technique used; 1.20-1.40 kg/m² per mm of thickness for smoothing/skimming (recommended: approx. 4 mm).
- Packaging: 23 kg bags.



• MAPETHERM FLEX RP

Cement-free fibre-filled lightweight elastic smoothing/skimming paste resistant to microorganisms for internal and external use.

Available in the following particle sizes: 0.5 mm and 1.5 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (g/cm³): approx. 1.45-1.50 (depending on particle size).
- Application temperature (of substrate and air): +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: spreader.
- Consumption: 0.5 mm: 1.9-2.1 kg/m²; 1.5 mm: 4.0-5.0 kg/m².
- Packaging: 20 kg drums.

7.2 INSULATING PANELS

• MAPETHERM CORK

Cork insulating panel for external insulation systems.

- Composition: expanded cork.
- Colour: brown.
- Thickness available mm: 40, 50, 60, 80, 100.
- Dimensions of panel mm: 1000 x 500.
- Packaging: packs from 1.5 to 4 m² (depending on thickness).

• MAPETHERM EPS

Sintered expanded polystyrene insulating panel for external insulation systems.

- Composition: sintered expanded polystyrene.
- Colour: white.
- Thickness available mm: 40, 50, 60, 80, 100.
- Dimensions of panel mm: 1000 x 500.
- Packaging: packs from 3 to 7.5 m² (depending on thickness).

• MAPETHERM M. WOOL

High-density glass wool insulating panel for external insulation systems.

- Composition: high density glass wool.
- Colour: yellow.

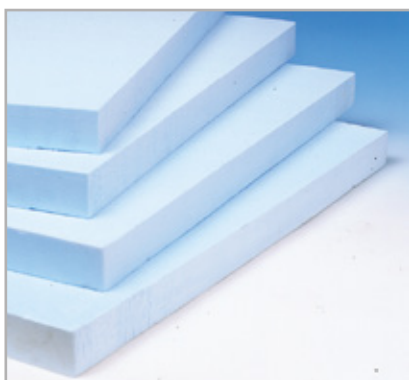


- Thickness available mm: 40, 50, 60, 80, 100.
- Dimensions of panel mm: 1200 x 600.
- Packaging: packs from 2.88 to 7.2 m² (depending on thickness).

• MAPETHERM XPS

Extruded polystyrene insulating panel for external insulation systems.

- Composition: extruded expanded polystyrene.
- Colour: blue.
- Thickness available mm: 40, 50, 60, 80, 100.
- Dimensions of panel mm: 1200 x 600.
- Packaging: packs from 2.88 to 6.48 m² (depending on thickness).



7.3 ACCESSORY ITEMS

• ELASTOCOLOR NET

Alkali-resistant glass fibre mesh for reinforcing fine-textured smoothing/skimming paste.

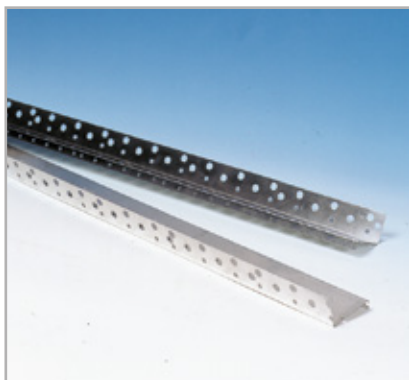
- Composition: 100% glass fibre.
- Colour: white.
- Mesh size (mm): 2.7 x 2.7.
- Weight of primed mesh (g/m²): approx. 61.
- Packaging: 50 m x 1 m rolls.



• MAPETHERM BA

Aluminium starting profiles with drip channels.

- Composition: aluminium:
- Colour: grey.
- Sizes available: 40, 50, 60, 80 and 100 mm.
- Length m: 2.50.
- Packaging: packs of 20 profiles.



• **MAPETHERM FIX**

Anchors for fixing insulating panels and composite insulating systems in place, comprising a metal/nylon nail and polypropylene expansion anchor.

- Composition: synthetic material with zinc-plated steel nail.
- Colour: grey.
- Sizes available mm: 108, 128 and 148.
- Packaging: box of 100 studs.



• **MAPETHERM FIX 9**

Polypropylene anchors.

- Composition: polypropylene.
- Colour: grey.
- Sizes available mm: 83.
- Packaging: box of 500 studs.



• **MAPETHERM FIX B**

Nylon self-tapping fixing studs with zinc/chrome-plated steel screws.

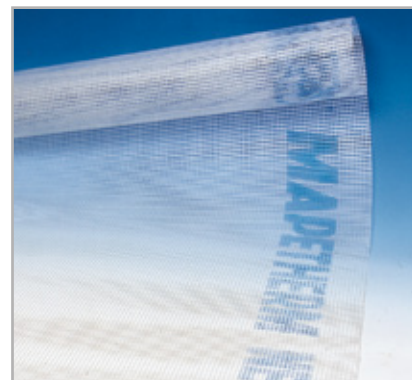
- Composition: nylon and zinc/chrome-plated steel.
- Colour: grey.
- Sizes available mm: 45.
- Packaging: box of 100 studs.

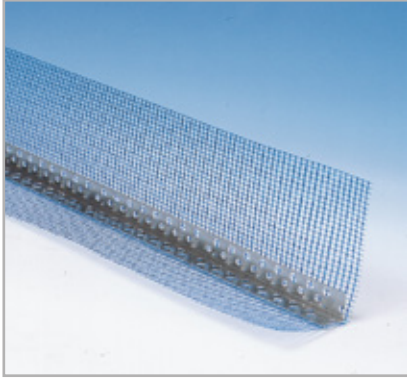


• **MAPETHERM NET**

Alkali-resistant glass fibre mesh for reinforced smoothing/skim coats, repairing façades and for external insulation systems.

- Composition: 100% glass fibre.
- Colour: white.
- Mesh size (mm): 4.15 x 3.8.
- Weight of primed mesh (g/m²): approx. 150.
- Packaging: 50 m x 1 m rolls.

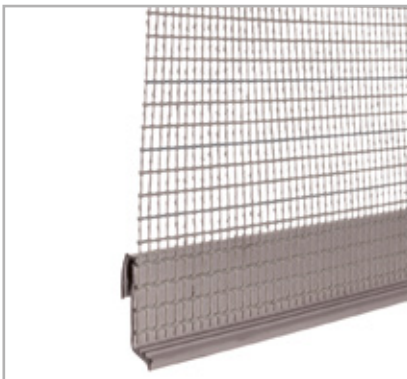




• MAPETHERM PROFIL

Aluminium corner profile with pre-assembled alkali-resistant glass fibre mesh.

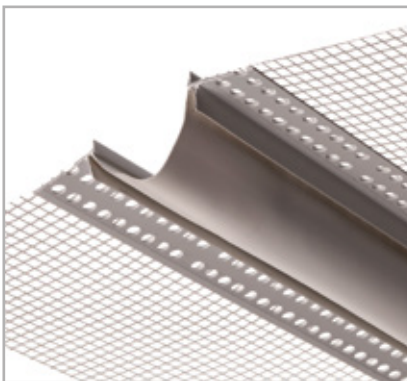
- Composition: aluminium:
- Colour: grey.
- Length m: 2.50.
- Packaging: box of 100 profiles.



• MAPETHERM PROFIL BA

PVC profile with drip channel incorporated with 10 cm wide alkali-resistant glass fibre mesh for MAPETHERM BA starting profiles.

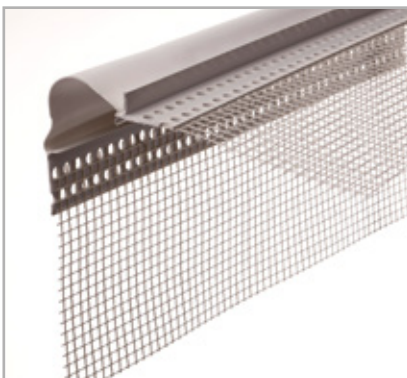
- Composition: PVC.
- Colour: white.
- Length m: 2.50.
- Packaging: packs of 25 profiles.



• MAPETHERM PROFIL E

PVC profile incorporated with 10 cm wide alkali-resistant glass fibre mesh and a flexible membrane for flat expansion joints.

- Composition: PVC.
- Colour: white.
- Length m: 2.50.
- Packaging: packs of 25 profiles.



• MAPETHERM PROFIL V

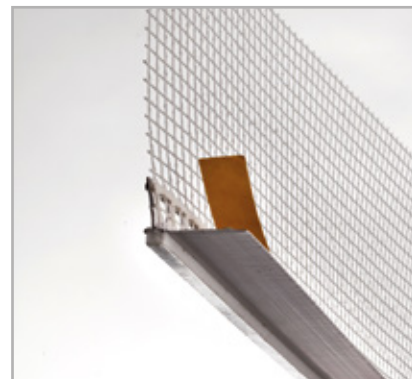
PVC profile incorporated with 10 cm wide alkali-resistant glass fibre mesh and a flexible membrane for corner expansion joints.

- Composition: PVC.
- Colour: white.
- Length m: 2.50.
- Packaging: packs of 25 profiles.

• MAPETHERM PROFIL W

Adhesive PVC profile incorporated with 10 cm wide alkali-resistant glass fibre mesh and a flexible membrane for the inside edge of windows.

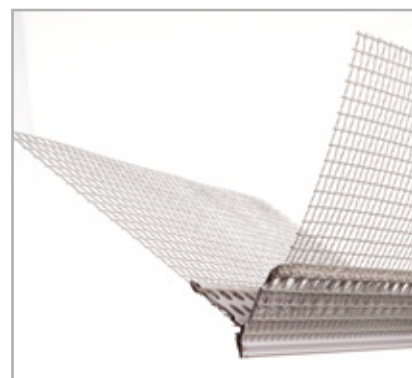
- Composition: PVC.
- Colour: white.
- Length m: 2.40.
- Packaging: packs of 30 profiles.



• MAPETHERM ROMPIGOCCIA

PVC corner profile with drip channel incorporated with 10 cm wide alkali-resistant glass fibre mesh for door and window openings. May be used as a drip channel for balconies and jutting features.

- Composition: PVC.
- Colour: white.
- Length m: 2.50.
- Packaging: packs of 20 profiles.



7.4 PRIMERS AND FINISHING PRODUCTS

• ELASTOCOLOR TONACHINO PLUS

Elastic, water-repellent, anti-algae and anti-mould, elastomeric hygienising coating for internal and external use.

Available in the following particle sizes: 1.2 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.70.
- Dry solids content (EN ISO 3251) (%): approx. 83.
- Dilution rate: ready-mixed (may be diluted with 1-2% of water if required).
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: trowel.





- Consumption: 1.2 mm; 1.9-2.3 kg/m².
- Packaging: 20 kg drum.

• MALECH

Water-based acrylic undercoat to even out surfaces and promote bonding.

- Consistency: fluid liquid.
- Colour: transparent.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.01.
- Dry solids content (EN ISO 3251) (%): approx. 15.
- Dilution rate: ready-mixed; dilute with 30-50% water for surfaces with low absorbency.
- Re-coat time: 12-24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: brush, roller or spray.
- Consumption: 0.10-0.15 kg/m².
- Packaging: 2 and 10 kg cans.



• QUARZOLITE BASE COAT

Coloured acrylic undercoat with good filling and adhesion promoting properties for internal and external use.

- Consistency: thick liquid.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.58.
- Dry solids content (EN ISO 3251) (%): approx. 67.
- Dilution rate: as is or diluted with 5-10% water.
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: brush, roller or spray.
- Consumption: 0.3-0.5 kg/m² per coat.
- Packaging: 20 kg drum.

• QUARZOLITE GRAFFIATO

Highly protective acrylic scratch-effect coating for covering surface defects on internal and external use.

Available in the following particle sizes: 1.2 mm and 1.8 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.7-1.8 (depending on particle size).
- Dry solids content (EN ISO 3251) (%): approx. 85.
- Dilution rate: ready-mixed (may be diluted with 1-2% of water if required).
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: trowel.
- Consumption: 1.2 mm: 1.9-2.3 kg/m²; 1.8 mm: 2.4-2.8 kg/m².
- Packaging: 20 kg drum.

• QUARZOLITE HF PLUS

Durable, anti-mould and anti-algae, quartz-filled, acrylic hygienising paint with good filling properties for internal and external use.

- Consistency: thick liquid.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.58.
- Dry solids content (EN ISO 3251) (%): 70.
- Dilution rate: 10-15% water.
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: brush, roller or spray.
- Consumption: 0.35-0.45 kg/m² (for two coats of product).
- Packaging: 20 kg drum.





• QUARZOLITE TONACHINO

Highly-protective textured acrylic coating with good filling properties for internal and external use.

Available in the following particle sizes: 0.7 mm, 1.2 mm, 1.5 mm and 2.0 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.65-1.95 (depending on particle size).
- Dry solids content (EN ISO 3251) (%): approx. 85.
- Dilution rate: ready-mixed (may be diluted with 1-2% of water if required).
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: trowel.
- Consumption: 0.7 mm: 1.7-2.0 kg/m²; 1.2 mm: 1.9-2.3 kg/m²; 1.5 mm: 2.2-2.6 kg/m²; 2.0 mm: 2.6-3.0 kg/m².
- Packaging: 20 kg drum.



• QUARZOLITE TONACHINO PLUS

Highly-protective, anti-mould and anti-algae, acrylic hygienising coating for internal and external use.

Available in the following particle sizes: 1.2 mm and 1.5 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.55-1.85 (depending on particle size).
- Dry solids content (EN ISO 3251) (%): approx. 85.
- Dilution rate: ready-mixed (may be diluted with 1-2% of water if required).
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.

- Application: trowel.
- Consumption: 1.2 mm: 1.9-2.3 kg/m²; 1.5 mm: 2.2-2.6 kg/m².
- Packaging: 20 kg drum.

• **SILANCOLOR AC TONACHINO**

Water-repellent, textured acrylic-siloxane coating with good filling properties for internal and external use.

Available in the following particle sizes: 1.2 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.70.
- Dry solids content (EN ISO 3251-1) (%): approx. 80.
- Dilution rate: ready-mixed (may be diluted with 1-2% of water if required).
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: trowel.
- Consumption: 1.2 mm: 1.9-2.3 kg/m².
- Packaging: 20 kg drum.

• **SILANCOLOR BASE COAT**

Water-repellent, coloured siloxane undercoat with good filling properties for internal and external use.

- Consistency: thick liquid.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.58.
- Dry solids content (EN ISO 3251) (%): approx. 67.
- Dilution rate: ready-mixed or diluted with 5-10% water.
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.





- Storage: 24 months.
- Application: brush, roller or spray.
- Consumption: 0.3-0.5 kg/m² per coat.
- Packaging: 20 kg drum.

• SILANCOLOR CLEANER PLUS

Anti-mould and anti-algae hygienising detergent in water solution to even out surfaces.

- Consistency: fluid liquid.
- Colour: transparent.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.01.
- Dilution rate: dilute up to 300% with water.
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: low pressure manual spray or brush.
- Consumption: 0.2-1 kg/m² of ready-mixed solution.
- Packaging: 1 kg and 5 kg cans.



• SILANCOLOR GRAFFIATO

Breathable, water-repellent, scratch-effect siloxane coating with good defect covering properties for internal and external use.

Available in the following particle sizes: 1.2 mm and 1.8 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.7-1.8 (depending on particle size).
- Dry solids content (EN ISO 3251) (%): approx. 80.
- Dilution rate: ready-mixed (may be diluted with 1-2% of water if required).
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.

- Storage: 24 months.
- Application: trowel.
- Consumption: 1.2 mm: 1.9-2.3 kg/m²; 1.8 mm: 2.4-2.8 kg/m².
- Packaging: 20 kg drum.

• **SILANCOLOR PAINT PLUS**

Breathable, water-repellent, anti-algae and anti-mould siloxane hygienising paint for internal and external use.

- Consistency: thick liquid.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.55.
- Dry solids content (EN ISO 3251) (%): approx. 65.
- Dilution rate: 15-20% water.
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: brush, roller or spray.
- Consumption: 0.3-0.4 kg/m² (for two coats of product).
- Packaging: 5 kg and 20 kg cans.

• **SILANCOLOR PRIMER**

Breathable siloxane undercoat.

- Consistency: fluid liquid.
- Colour: milky white.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.01.
- Dry solids content (EN ISO 3251) (%): approx. 12.
- Dilution rate: ready-mixed.
- Re-coat time: 12-24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: brush, roller or spray.
- Consumption: 0.10-0.15 kg/m².
- Packaging: 10 kg can.





• SILANCOLOR PRIMER PLUS

Anti-mould and anti-algae siloxane hygienising undercoat.

- Consistency: fluid liquid.
- Colour: milky white.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.01.
- Dry solids content (EN ISO 3251) (%): approx. 5.
- Dilution rate: ready-mixed.
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: brush, roller or spray.
- Consumption: 0.1-0.3 kg/m².
- Packaging: 2 kg and 10 kg cans.

• SILANCOLOR TONACHINO

Breathable, water-repellent, textured siloxane coating with good filling properties for internal and external use.

Available in the following particle sizes: 0.7 mm, 1.2 mm, 1.5 mm and 2.0 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap[®] automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.65-1.95 (depending on particle size).
- Dry solids content (EN ISO 3251) (%): approx. 80.
- Dilution rate: ready-mixed (may be diluted with 1-2% water if required).
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: trowel.
- Consumption: 0.7 mm: 1.7-2.0 kg/m²; 1.2 mm: 1.9-2.3 kg/m²; 1.5 mm: 2.2-2.6 kg/m²; 2.0 mm: 2.6-3.0 kg/m².
- Packaging: 20 kg drum.



• SILANCOLOR TONACHINO PLUS

Breathable, water-repellent, anti-mould and anti-algae siloxane hygienising coating for internal and external use.

Available in the following particle sizes: 0.7 mm and 1.2 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.65-1.90 (depending on particle size).
- Dry solids content (EN ISO 3251) (%): approx. 80.
- Dilution rate: ready-mixed (may be diluted with 1-2% water if required).
- Re-coat time: 24 hours.
- Application temperature: +5°C to +35°C.
- Cleaning: water.
- Storage: 24 months.
- Application: trowel.
- Consumption: 0.7 mm: 1.7-2.0 kg/m²; 1.2 mm: 1.9-2.3 kg/m².
- Packaging: 20 kg drum.



• SILEXCOLOR BASE COAT

Highly breathable, coloured silicate undercoat with good filling properties for internal and external use in compliance with DIN 18363 Standards.

- Consistency: thick liquid.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.60.
- Dry solids content (EN ISO 3251) (%): approx. 67.
- Dilution rate: as is or with 5-10% of SILEXCOLOR PRIMER.
- Re-coat time: 24 hours.
- Application temperature: +8°C to +35°C.
- Cleaning: water.
- Storage: 12 months.
- Application: brush, roller or spray.
- Consumption: 0.3-0.5 kg/m² per coat.
- Packaging: 20 kg drum.





• SILEXCOLOR GRAFFIATO

Highly breathable, scratch-effect silicate coating with good defect-covering properties for internal and external use in compliance with DIN 18363 Standards.

Available in the following particle sizes: 1.2 mm and 1.8 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.7-1.8 (depending on particle size).
- Dry solids content (EN ISO 3251) (%): approx. 80.
- Dilution rate: ready-mixed (may be diluted with 1-2% of SILEXCOLOR PRIMER if required).
- Re-coat time: 24 hours.
- Application temperature: +8°C to +35°C.
- Cleaning: water.
- Storage: 12 months.
- Application: trowel.
- Consumption: 1.2 mm: 1.9-2.3 kg/m²; 1.8 mm: 2.4-2.8 kg/m².
- Packaging: 20 kg drum.



• SILEXCOLOR PRIMER

Highly breathable silicate undercoat in compliance with DIN 18363 Standards.

- Consistency: fluid liquid.
- Colour: transparent.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.1.
- Dry solids content (EN ISO 3251) (%): approx. 14.
- Dilution rate: ready-mixed.
- Re-coat time: 24 hours.
- Application temperature: +8°C to +35°C.
- Cleaning: water.
- Storage: 12 months.
- Application: brush, roller or spray.
- Consumption: 0.1-0.15 kg/m².
- Packaging: 10 kg can.

• **SILEXCOLOR TONACHINO**

Breathable, textured silicate coating with good filling properties for internal and external use in compliance with DIN 18363 Standards.

Available in the following particle sizes: 0.7 mm, 1.2 mm, 1.5 mm and 2.0 mm.

- Consistency: paste.
- Colour: white or various colours using the ColorMap® automatic colouring system.
- Density (EN ISO 2811-1) (g/cm³): approx. 1.65-1.95 (depending on particle size).
- Dry solids content (EN ISO 3251) (%): approx. 80.
- Dilution rate: ready-mixed (may be diluted with 3-5% of SILEXCOLOR PRIMER if required).
- Re-coat time: 24 hours.
- Application temperature: +8°C to +35°C.
- Cleaning: water.
- Storage: 12 months.
- Application: trowel.
- Consumption: 0.7 mm: 1.7-2.0 kg/m²; 1.2 mm: 1.9-2.3 kg/m²; 1.5 mm: 2.2-2.6 kg/m²; 2.0 mm: 2.6-3.0 kg/m².
- Packaging: 20 kg drum.





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e-mail: iticc@iticc.it

Valutazione Tecnica Europea

ETA 04/0061 of 28/07/16

PARTE GENERALE

Nome commerciale
Famiglia di prodotto a cui il prodotto appartiene

Produttore

Impianti di produzione

Questa Valutazione Tecnica Europea contiene

Questa Valutazione Tecnica Europea è rilasciata in accordo con il Regolamento (EU) N° 305/2011, sulla base della Linea Guida

Questo ETA sostituisce il

"MAPETHERM XPS"

Sistema Composito di Isolamento Termico Esterno di facciata con intonaco destinato all'isolamento termico esterno delle murature degli edifici

Mapei S.p.A.
Via Caffaro, 22 - I-20158 Milano (MI) - Italia

Mapei S.p.A.
St. Provinciale, 159
I-20060 Robbiano di Mediglia (MI) - Italia

14 pagine

ETAG 004 Edizione 2013, utilizzata come EAD (European Assessment Document - Documento di Valutazione Europea)

Bonestare Tecnico Europeo 04/0061 rilasciato in data 03.06.2013

Le istituzioni della presente Valutazione Tecnica Europea in altre lingue devono corrispondere pienamente all'originale rilasciato e devono essere indicate come tali. La comunicazione della presente Valutazione Tecnica Europea, inclusa la trasmissione elettronica, deve avvenire in formato integrale (ad eccezione degli eventuali allegati confidenziali). In ogni caso, una riproduzione parziale può essere fatta con il consenso scritto. L'Organismo di Valutazione Tecnica che rilascia l'ETA. Ogni riproduzione parziale deve essere indicata come tale.

8. SERVICES PROVIDED BY MAPEI

CERTIFIED QUALITY

Mapei guarantees that all materials supplied for external insulation systems are of the highest quality and that they have been specifically developed and tested for use with external insulation systems to maintain their durability over the years.

Their reliability is guaranteed by certificates of conformity which cover each single product and the complete insulation systems. ETA (European Technical Assessment) technical approval, issued according to the guidelines contained in ETAG 004, is recognition at European level to certify the quality and repeatability of the products, the cornerstones of the functionality and durability of MAPETHERM systems.

Mapei's cutting-edge technology, combined with their experience matured over the years in the adhesives sector, has led to the development of effective, long-lasting external insulation systems with any type of insulating panel considered suitable for this specific area of use, with finishes and patterns with a high aesthetic value.

Mapei guarantees the quality of their products through constant, programmed quality control procedures along the entire production chain in order to verify their compliance with the characteristics required in terms of reliability and durability of the system.

Mapei's has always paid the utmost attention to research and, every year, 5% of annual turnover is invested into research and development programmes.

TECHNICAL SALES SERVICE

In order to manage and support the complex, heterogeneous nature of external insulation systems, Mapei has a specialised team dedicated to this specific sector, with Product Line Specialists (experienced engineers from the technical sales division) located in various areas to provide



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OiB
Mitglied der EOTA

European technical approval

ETA-10/0024

(English language translation, the original version is in German language)

Handelsbezeichnung

Mapetherm M. Wool

Zulassungsinhaber

Mapei S.p.A.
Via Caffaro, 22
20158 Milano (MI)
Italy

Zulassungsgegenstand

Außenseitiges Wärmedämm-Verbundsystem mit Putzschiicht zur Wärmedämmung von Gebäuden

Generic type and use of construction product

External Thermal Insulation Composite System with rendering for the use as external insulation of building walls

Geltungsdauer vom

28.06.2013

Validity

27.06.2016

Herstellwerk

Mapei S.p.A.
Stade Provinciale 159
20060 Robbiano di Mediglia (MI)
Italy

Diese Europäische technische Zulassung umfasst

15 Seiten einschließlich 6 Anhängen
15 pages including 6 Annexes

Diese Europäische technische Zulassung ersetzt

ETA-10/0024 mit Geltungsdauer vom 20.01.2010 bis 19.01.2015
ETA-10/0024 with validity from 20.01.2010 to 19.01.2015



European Organisation for Technical Approvals
Europäische Organisation für Technische Zulassungen
Organisation Européenne pour l'Agrement Technique



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OiB
Member of EOTA

European technical approval

ETA-10/0025

(English language translation, the original version is in German language)

Handelsbezeichnung

Mapetherm EPS

Zulassungsinhaber

Mapei S.p.A.
Via Caffaro, 22
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Italy

Zulassungsgegenstand

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European Organisation for Technical Approvals
Europäische Organisation für Technische Zulassungen
Organisation Européenne pour l'Agrement Technique

support for all those involved along the chain (design engineers, retailers, installers and clients). Our Product Line Specialists, who are constantly updated on the most important application criteria and current norms and standards, provide pre and post-sales technical support, check the all-important diagnostic and finishing phases, suggest the most appropriate technical solutions and provide answers to all specific requests with accurate information and recommendations.



9. CONSTRUCTION DETAILS AND CRITICAL AREAS

This section contains examples of construction feature layouts and critical areas typically encountered in external insulation systems to illustrate how an insulation system may be tied-in and connected to masonry structures or particular areas in such structures, such as doors, windows, balconies, etc.

All these layouts are available in DWG format from the company website www.mapei.it

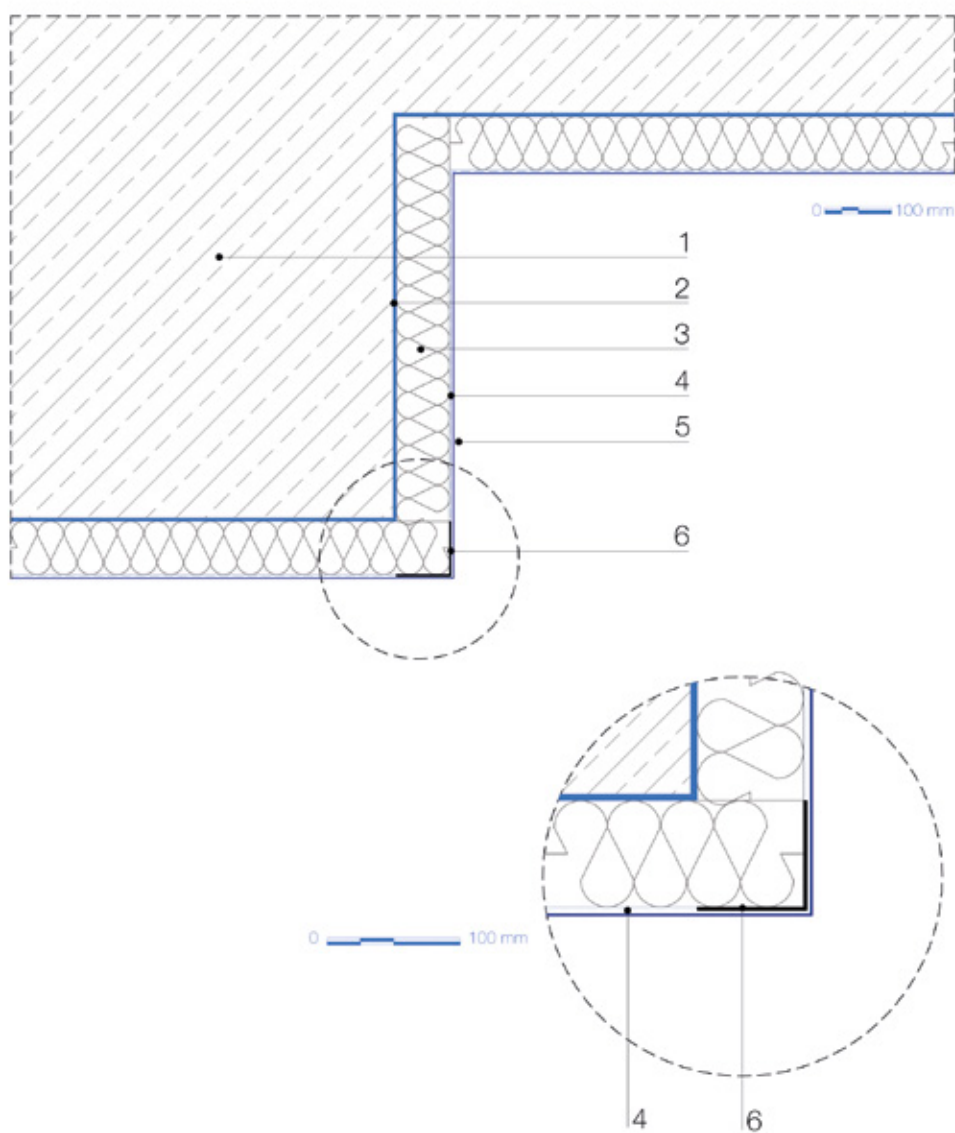
Note: the following layouts are for illustration purposes only. The technical details shown are examples of layouts to help with design procedures. The use of these layouts, and the completeness and technical characteristics of each layout, must be verified by the design engineer/client during the executive design phase. The layouts shown above, therefore, do not replace executive designs or installation details for actual site use. All dimensions must be verified and defined according to the actual executive project specifications for site use.

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of an edge and a corner - Horizontal section (scale 1:10 - 1:5 approx.)

Detail No. 01

Rev. 1 date 12.04.2016



KEY

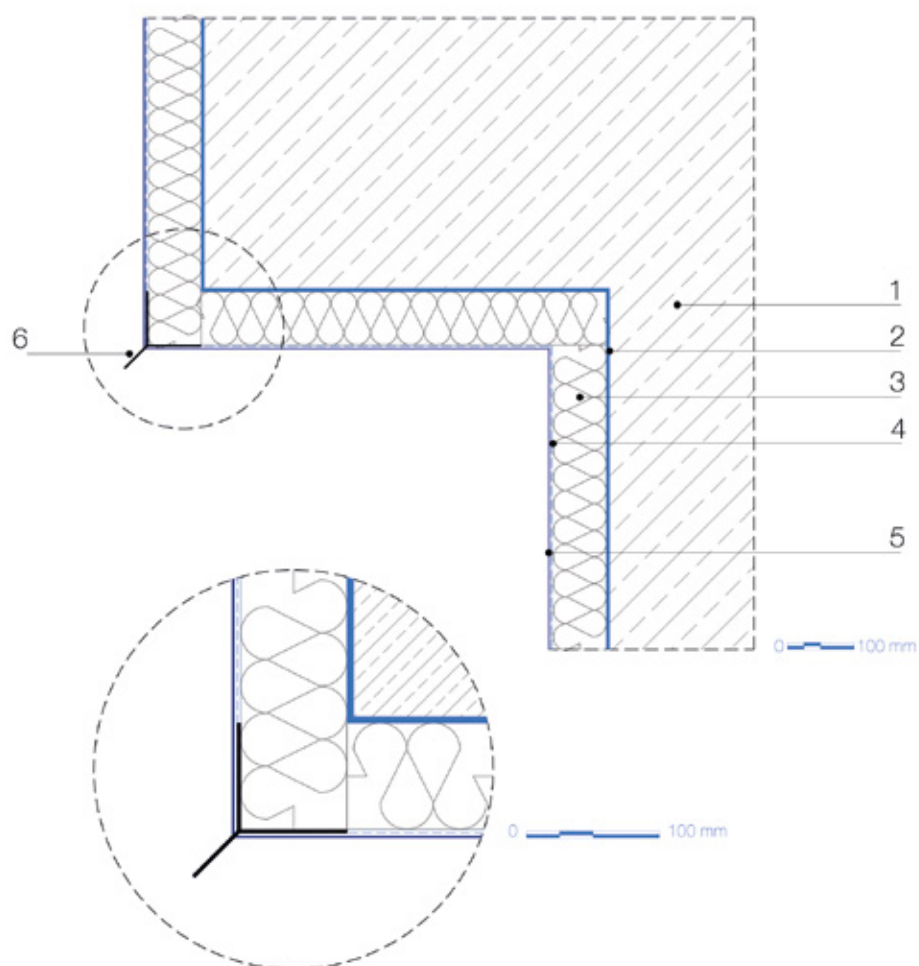
1. Masonry
2. Mapetherm adhesive
3. Insulating panel
4. Skim coat Mapetherm + Mapetherm Net
5. Primer + Tonachino
6. Mapetherm Profil

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of a piloties-type structure - Vertical section (scale 1:10 - 1:5 approx.)

Detail No. 02

Rev. 1 date 12.04.2016

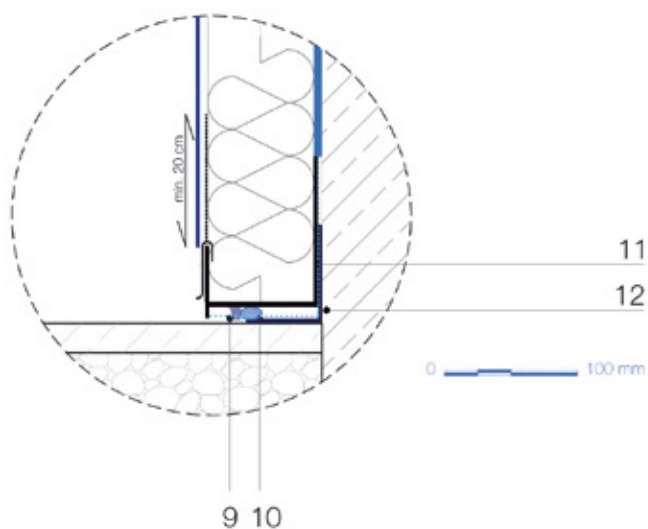
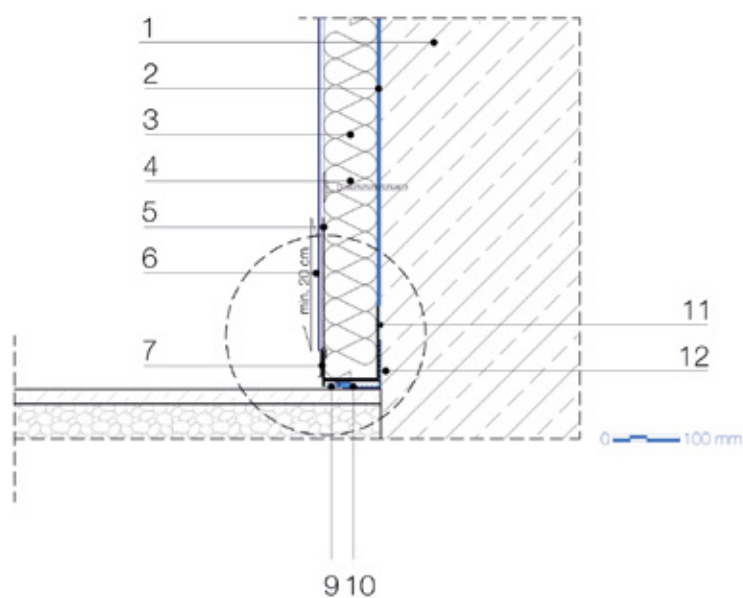


EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around an existing floor with starting profile - Vertical section (scale 1:10 - 1:5 approx.)

Detail No. 03

Rev. 1 date 12.04.2016



KEY

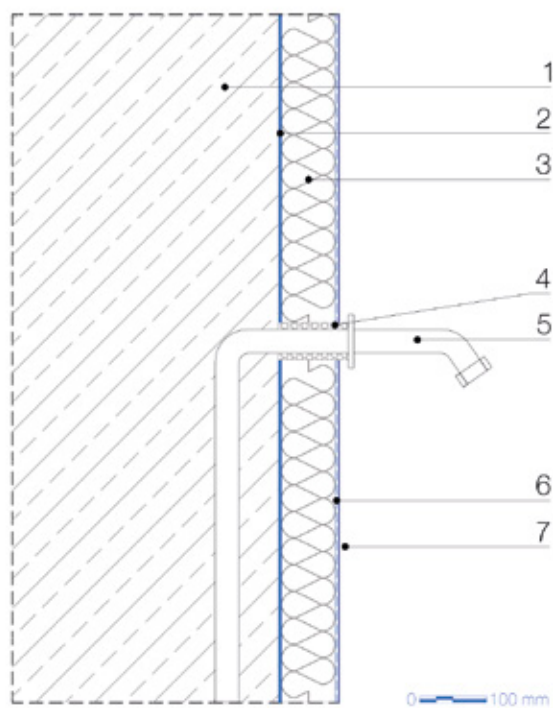
1. Masonry
2. Mapetherm adhesive
3. Insulating panel
4. Mapetherm Fix
5. Skim coat Mapetherm + Mapetherm Net
6. Primer + Fine-textured render
7. Mapetherm Ba + Mapetherm Profil BA
8. Overlap the edges of the net
9. Mapeflex AC4 sealant
10. Mapefoam
11. Waterproofing with Mapelastich Foundation
12. Mapeband SA

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around an external tap - Vertical section
(scale 1:10 sapprox.)

Detail No. 04

Rev. 1 date 12.04.2016



KEY

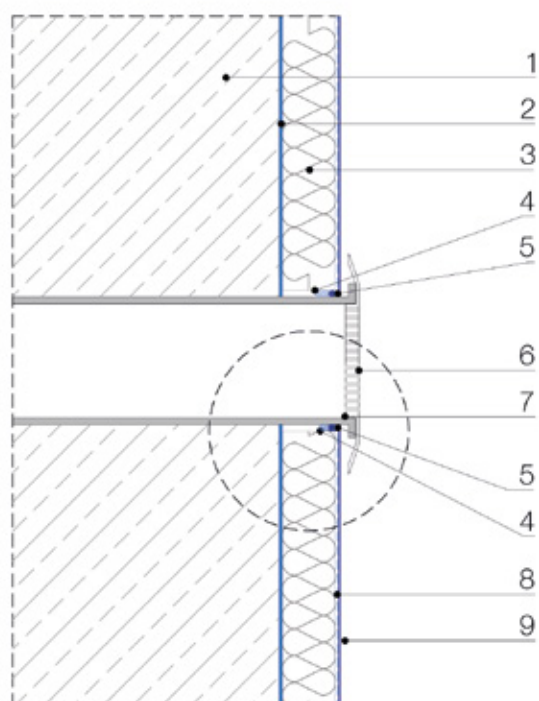
1. Masonry
2. Mapetherm adhesive
3. Insulating panel
4. Insulating fixing element
5. Pipe
6. Skim coat Mapetherm + Mapetherm Net
7. Primer + Fine-textured render

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a ventilation channel - Vertical section
(scale 1:10 - 1:5 approx.)

Detail No. 05

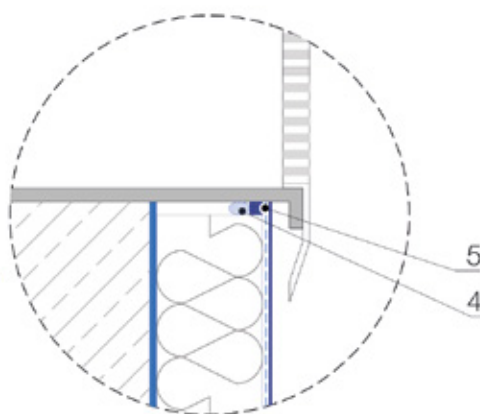
Rev. 1 date 12.04.2016



KEY

1. Masonry
2. Mapetherm adhesive
3. Insulating panel
4. Mapefoam seal
5. Mapeflex AC4 sealant
6. Shut-off grate
7. Plastic tube
8. Skim coat Mapetherm + Mapetherm Net
9. Primer + Fine-textured render

0 100 mm

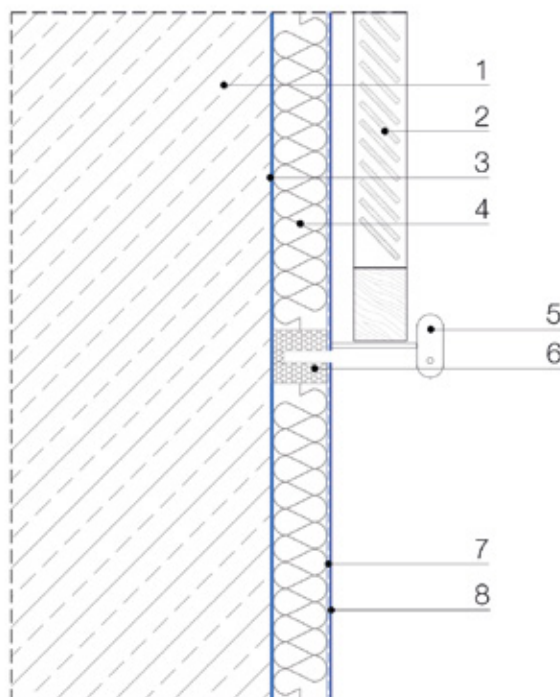


EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a shutter holdback - Vertical section
(scale 1:10 approx.)

Detail No. 06

Rev. 1 date 12.04.2016



KEY

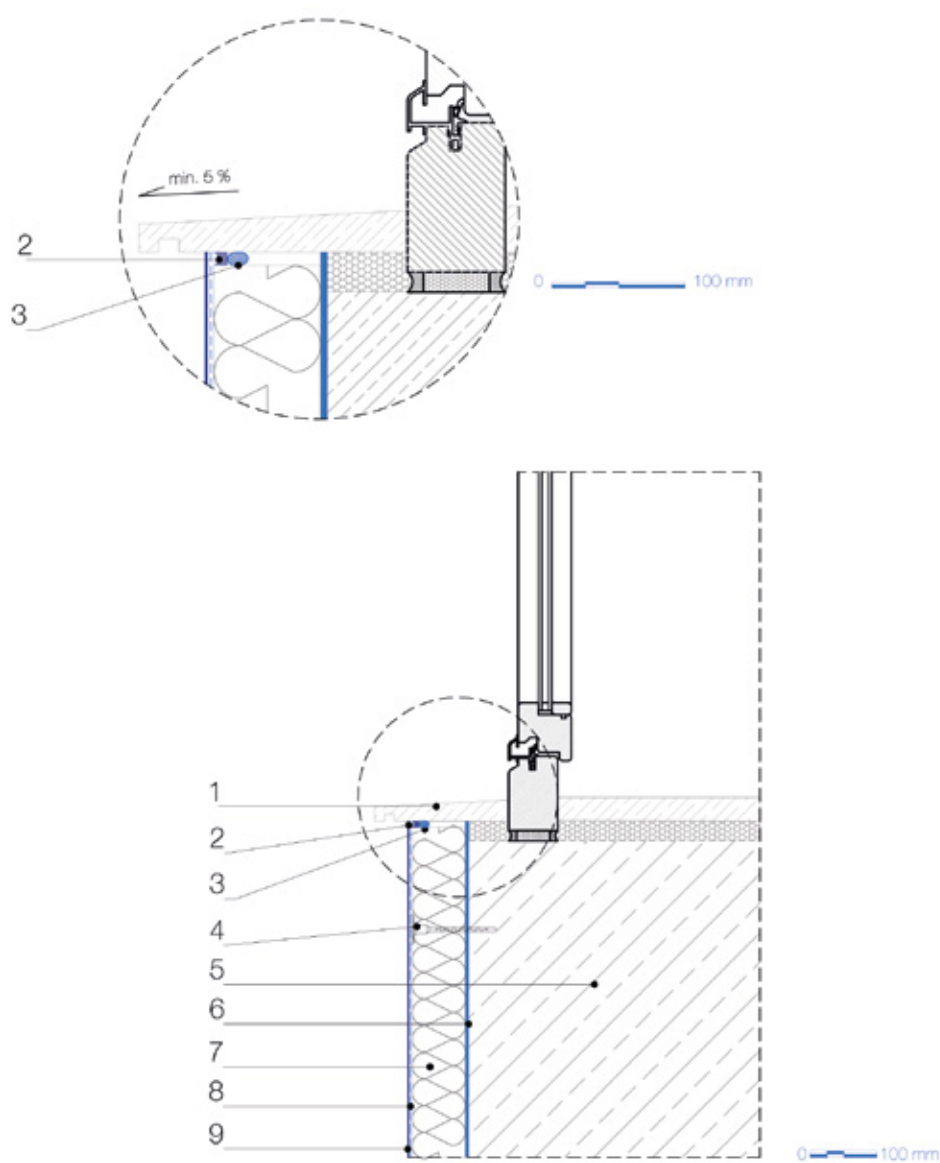
1. Masonry
2. Shutter
3. Mapetherm adhesive
4. Insulating panel
5. Shutter holdback
6. Insulating fixing element
7. Skim coat Mapetherm + Mapetherm Net
8. Primer + Fine-textured render

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around window ledge - Vertical section
(scale 1:10 approx.)

Detail No. 07

Rev. 1 date 12.04.2016



KEY

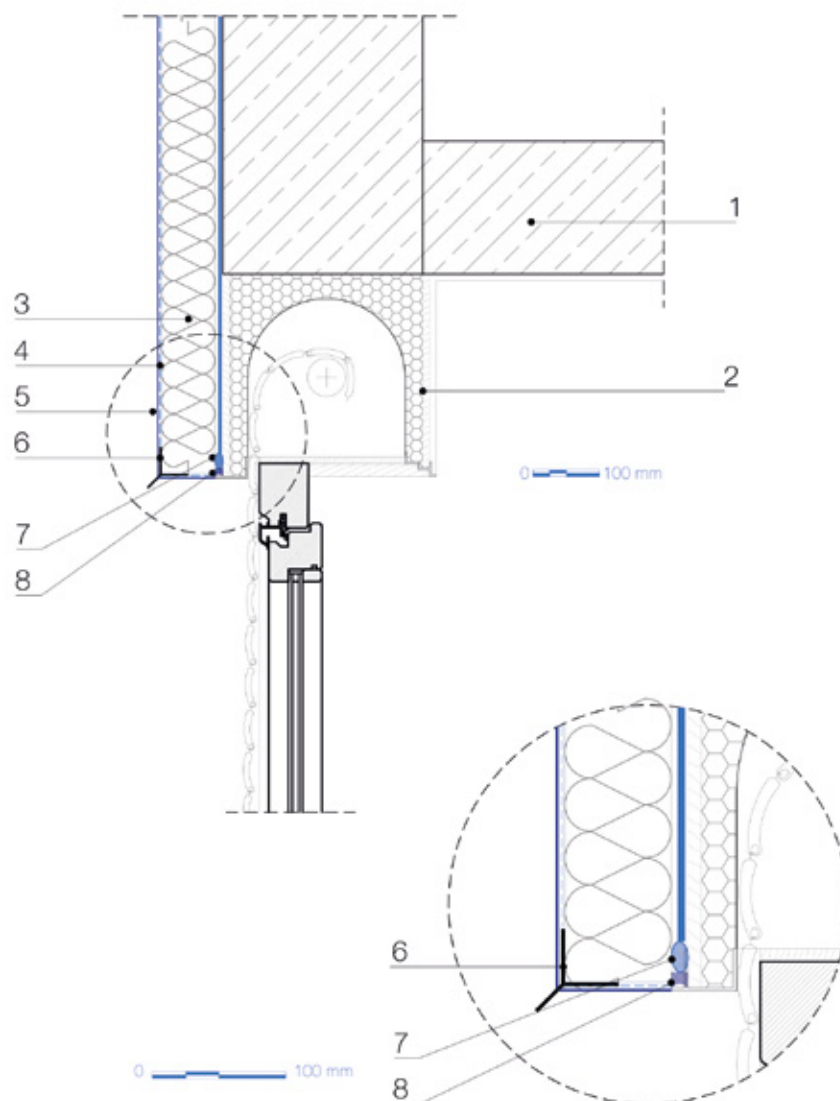
1. Window ledge
2. Mapeflex AC4 sealant
3. Mapefoam seal
4. Mapetherm Fix
5. Masonry
6. Mapetherm adhesive
7. Insulating panel
8. Skim coat Mapetherm + Mapetherm Net
9. Primer + Fine-textured render

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a shutter housing mounted flush with the external wall - Vertical section (scale 1:10 - 1:5 approx.)

Detail No. 08

Rev. 1 date 12.04.2016



KEY

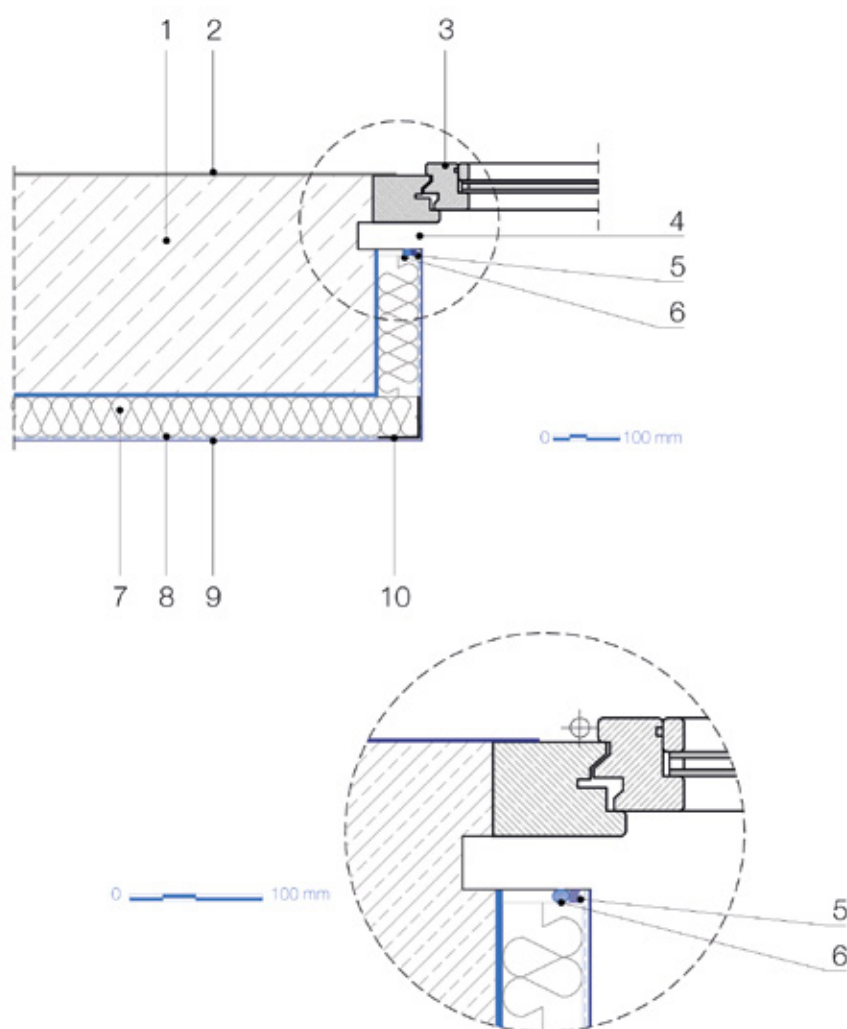
1. Masonry
2. Roller shutter housing
3. Insulating panel
4. Skim coat [Mapetherm](#) + [Mapetherm Net](#)
5. [Primer](#) + Fine-textured render
6. [Mapetherm Rompigoccia](#)
7. [Mapefoam](#) seal
8. [Mapeflex AC4](#) sealant

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a roller-blind runner - Horizontal section
(scale 1:10 - 1:5 approx.)

Detail No. 09

Rev. 1 date 12.04.2016



KEY

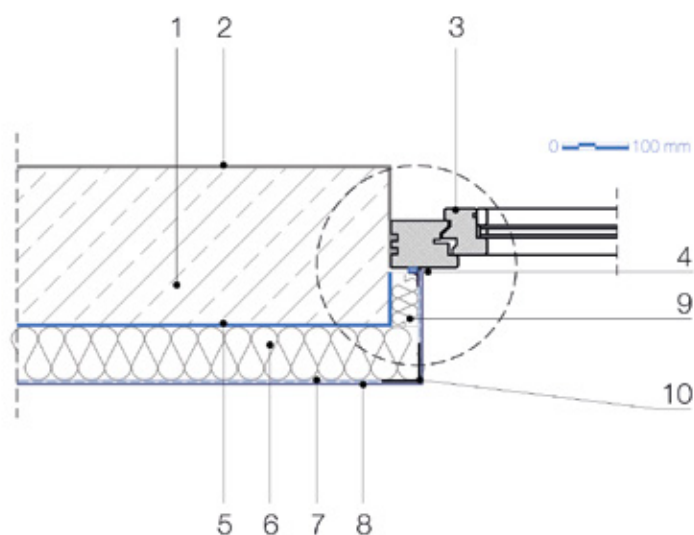
1. Masonry
2. Internal render
3. Window frame
4. Blind runner
5. Mapeflex AC4 sealant
6. Mapefoam seal
7. Insulating panel
8. Skim coat Mapetherm + Mapetherm Net
9. Primer + Fine-textured render
10. Mapetherm Profil

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a door or window frame recessed inside the opening - Horizontal section (scale 1:10 - 1:5 approx.)

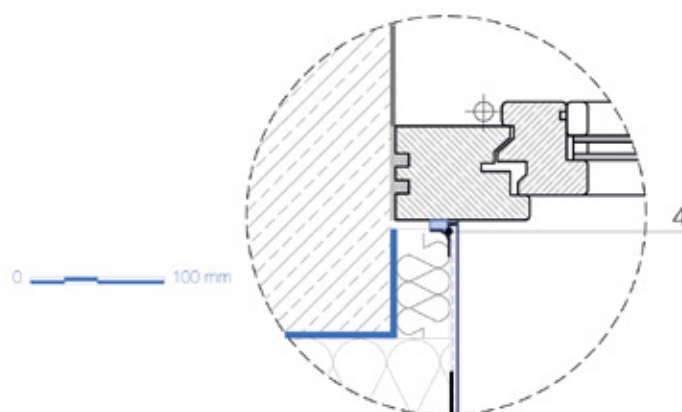
Detail No. 10

Rev. 1 date 12.04.2016



KEY

1. Masonry
2. Internal render
3. Window frame
4. [Mapetherm Profil W](#)
5. [Mapetherm adhesive](#)
6. Insulating panel
7. Skim coat [Mapetherm](#) + [Mapetherm Net](#)
8. [Primer](#) + Fine-textured render
9. Hemmed insulating panel
10. [Mapetherm Profil](#)

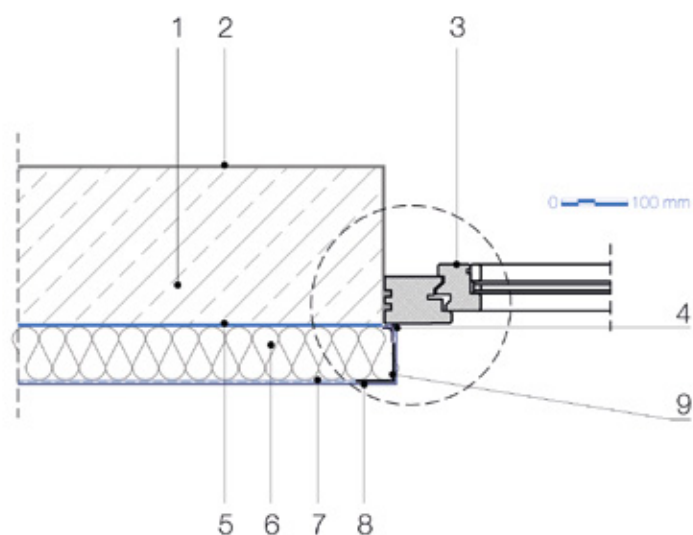


EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a door or window frame mounted flush with the external wall - Horizontal section (scale 1:10 - 1:5 approx.)

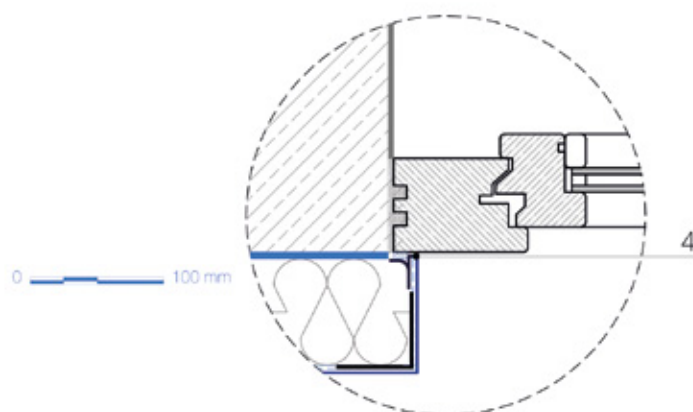
Detail No. 11

Rev. 1 date 12.04.2016



KEY

1. Masonry
2. Internal render
3. Window frame
4. Mapetherm Profil W
5. Mapetherm adhesive
6. Insulating panel
7. Skim coat Mapetherm + Mapetherm Net
8. Primer + Fine-textured render
9. Mapetherm Profil

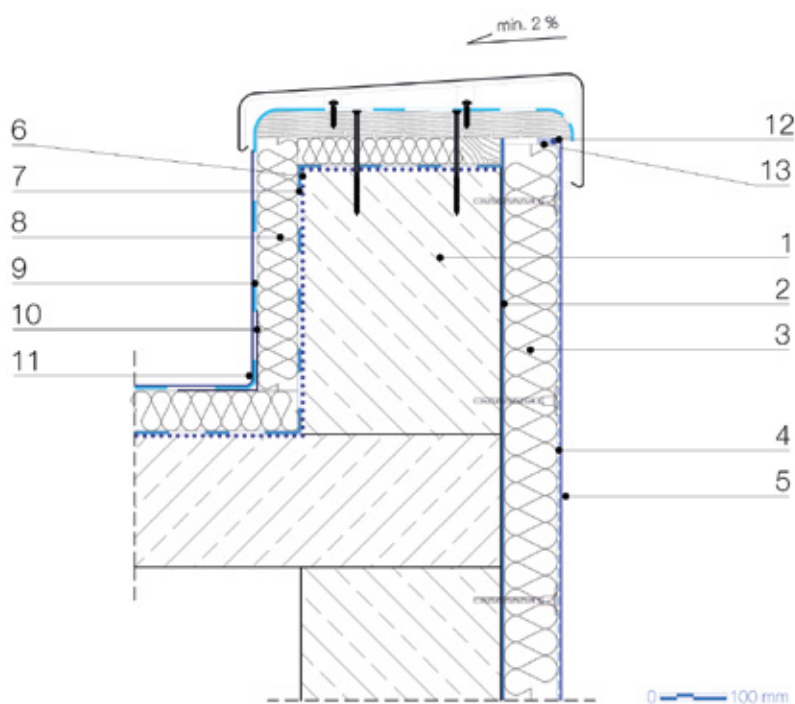


EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a flat roof and top of parapets - Vertical section
(scale 1:10 approx.)

Detail No. 12

Rev. 1 date 12.04.2016



KEY

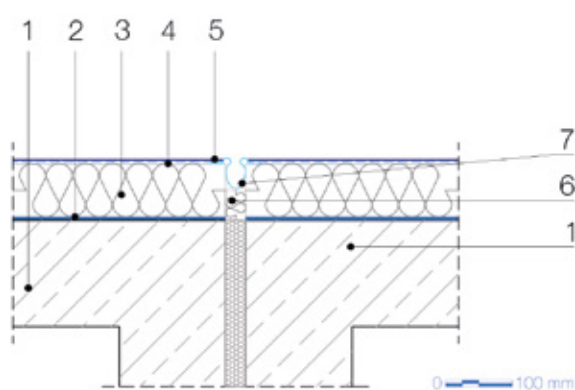
1. Masonry
2. Mapetherm adhesive
3. Insulating panel
4. Skim coat Mapetherm + Mapetherm Net
5. Primer + Fine-textured render
6. Polyprimer Primer
7. Barrier to water vapour Polyvap SA
8. Insulating panel
9. Waterproofing with Mapelastic Foundation
10. Mapeband SA
11. Primer + Fine-textured render
12. Mapeflex AC4 sealant
13. Mapefoam seal

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around expansion joints - Horizontal section
(scale 1:10 approx.)

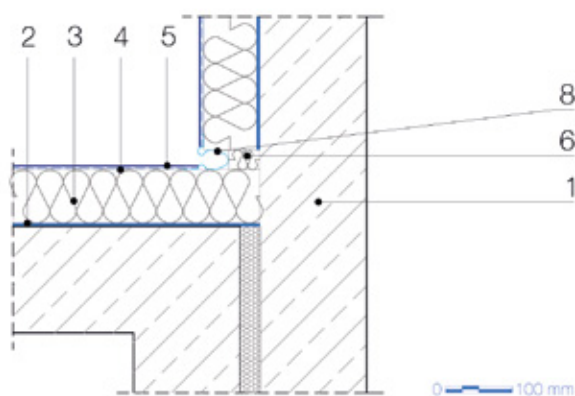
Detail No. 13

Rev. 1 date 12.04.2016



KEY

1. Masonry
2. Mapetherm adhesive
3. Insulating panel
4. Skim coat Mapetherm + Mapetherm Net
5. Primer + Fine-textured render
6. Mineral wool insulating panel
7. Mapetherm Profil E
8. Mapetherm Profil V

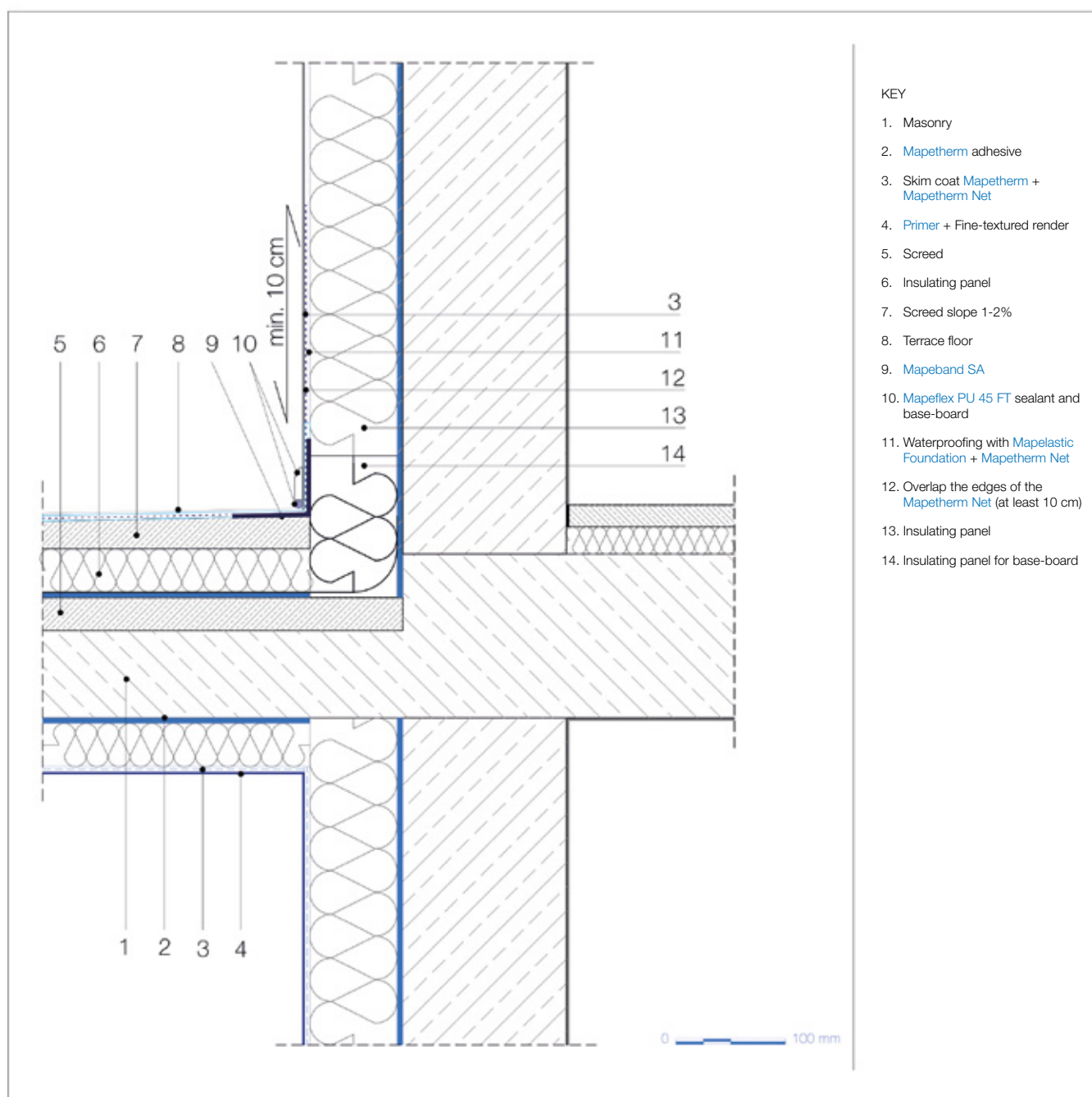


EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around terraces and balconies with insulation system connection - Vertical section (scale 1:5 approx.)

Detail No. 14

Rev. 1 date 12.04.2016

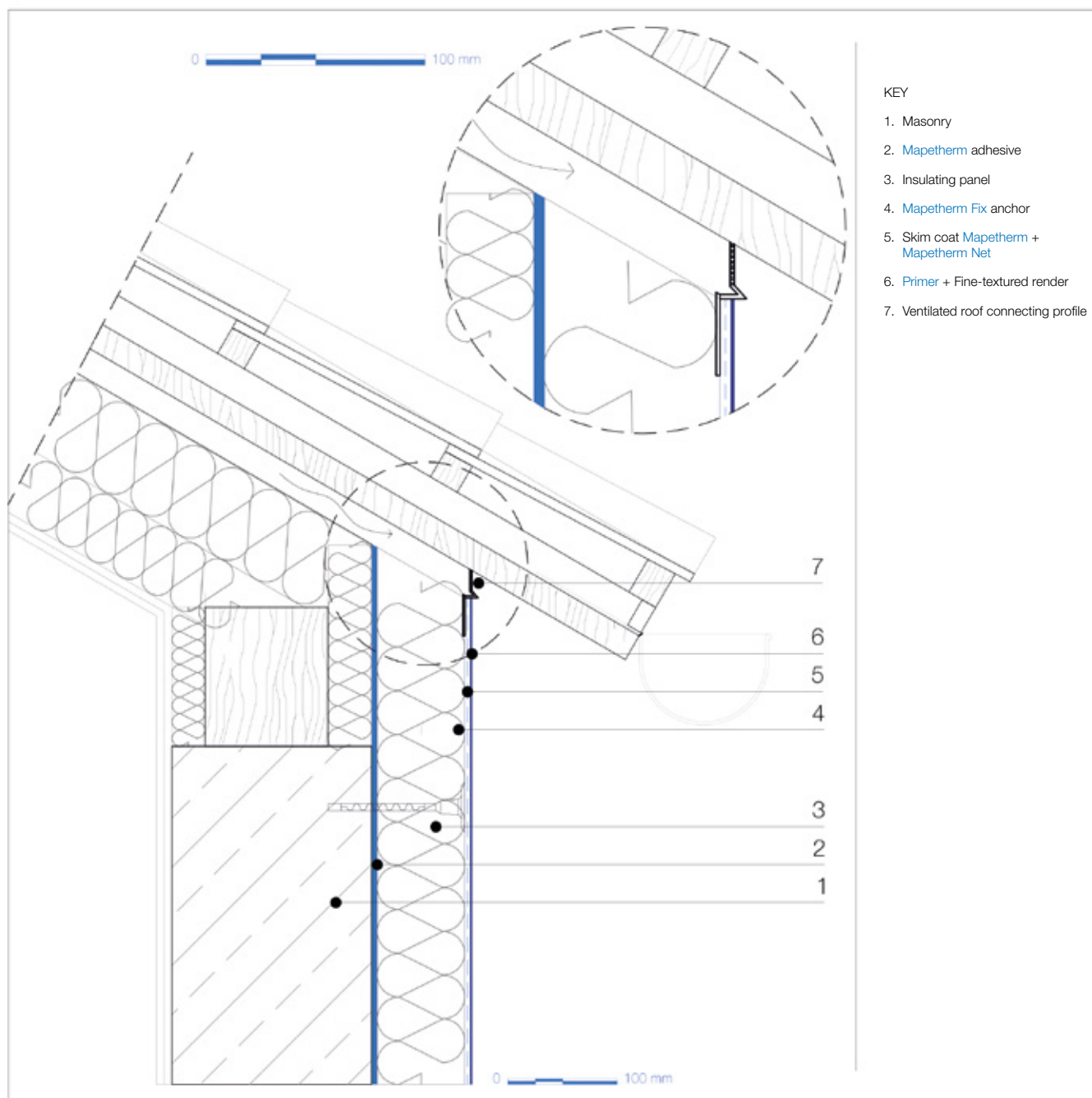


EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a ventilated roof - Vertical section
(scale 1:5 approx.)

Detail No. 15

Rev. 1 date 12.04.2016

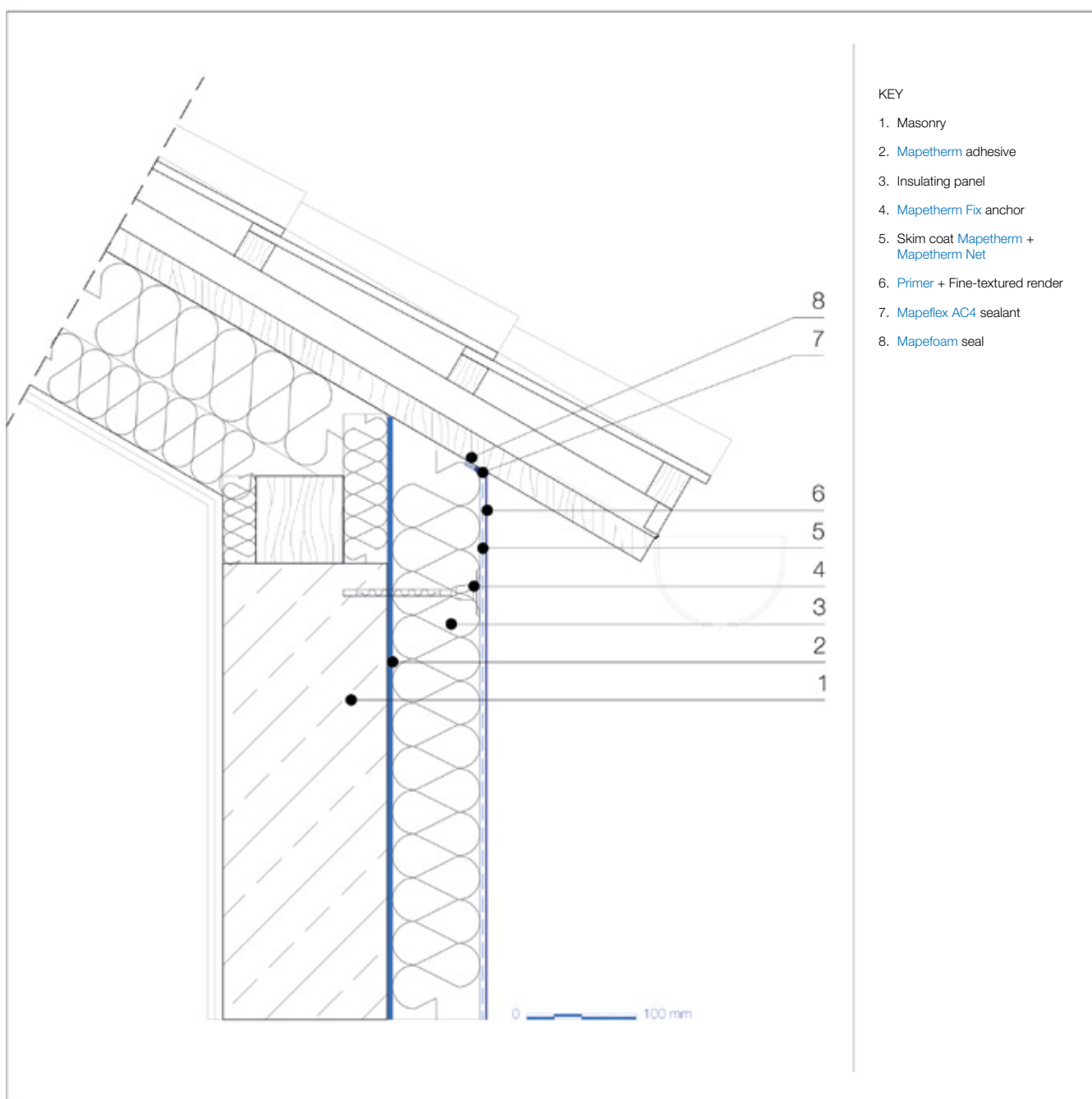


EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a warm roof - Vertical section (scale 1:5 approx.)

Detail No. 16

Rev. 1 date 12.04.2016

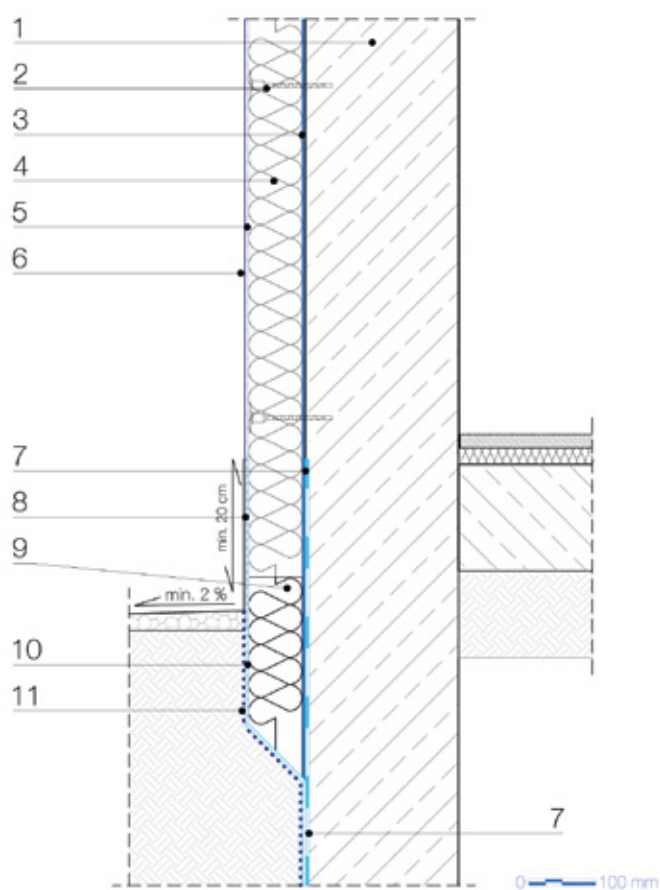


EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of an underground support profile detail - Vertical section (scale 1:10 approx.)

Detail No. 17

Rev. 1 date 12.04.2016



KEY

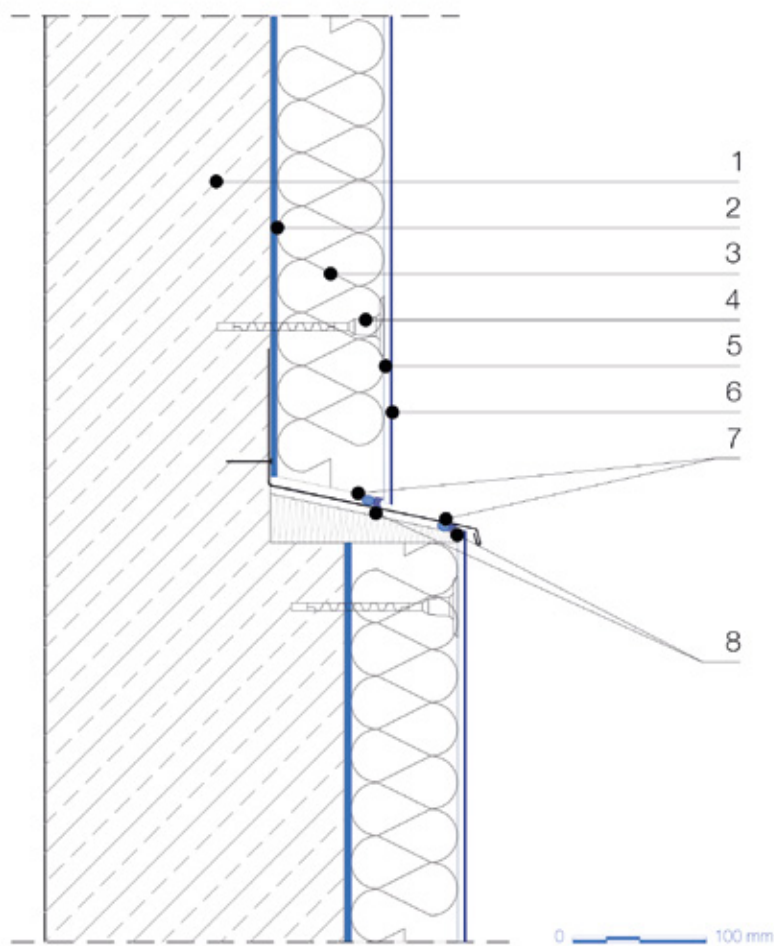
1. Masonry
2. Mapetherm Fix anchor
3. Mapetherm adhesive
4. Insulating panel
5. Skim coat Mapetherm + Mapetherm Net
6. Primer + Fine-textured render
7. Mapelast Foundation
8. Overlap the edges of the Mapetherm Net (at least 20 cm)
9. Insulating panel for base-board
10. Mapelast Foundation + Mapetherm Net
11. Waterproofing with Polyfond Kit Drain

EXTERNAL THERMAL INSULATION SYSTEMS - Mapetherm System

Layout of insulation system around a protruding element - Vertical section
(scale 1:5 approx.)

Detail No. 18

Rev. 1 date 12.04.2016



KEY

1. Masonry
2. Mapetherm adhesive
3. Insulating panel
4. Mapetherm Fix anchor
5. Skim coat Mapetherm + Mapetherm Net
6. Primer + Fine-textured render
7. Mapefoam seal
8. Mapeflex AC4 sealant

[illegible]

Note: _____

Note: _____

Technical Manual

MAPETHERM

HEADQUARTERS

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