Suber ™ Explained

Technical information of Cork & Suber™

– Extracted from technical whitepaper authored by inventor Vittorio Bonacini, D. Eng.

ABSTRACT

This document details the history and technical details of Cork in general and Suber™. The original document was authored in Italian and translated into English. Many of the formula references remain in the original metric standard.

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ALL ABOUT CORK & SUBER

Before entering into the subject of SÚBERTRES and its properties and characteristics, I think it would be a good idea to say a few words about cork, the primary component of Suber (96% by volume), given that Suber stems from the idea of transferring the extraordinary properties and characteristics of cork to a product which can be used industrially in all sectors of industry, and in construction in particular, while preserving its ecological nature and possibly enhancing its properties.

Cork is the light and porous bark covering the wood of cork oaks (Quercus Súber). It gradually becomes thicker and thicker as the tree grows and can reach a thickness of 25 cm. It protects the tree from the extreme conditions of the Mediterranean climate, such as drought, high summer temperatures, cold and fires. Its purpose is to protect and insulate the tree. This latter function, as an insulator, enables it to resist the passage of heat 30 times better than concrete.

Cork is the bark of the cork oak, which protects the most delicate part of the tree against external agents, like armor providing a highly specialized level of protection, acquired over a gradual natural evolutionary process of millions of years. It provides the tree with layer upon layer of elastic protection, which insulates the tree from the cold and the heat, and allows it to breathe (exchange of gases with the environment).

It is made up of dead cells, the inside of which becomes filled with an air-like gas. This gas accounts for almost 90% of cork, which is why it is so light, so elastic, and so compressible. The walls of the cells, which are like tiny airtight compartments, are mainly made of suberine and cerine, substances which make it highly resistant to fire, flexible, and practically rot-proof.
Thus cork is an extraordinary material, with unique physical and chemical properties. It is a completely natural, noble, renewable, and biodegradable product. Its production causes no pollution and the ecosystem from which it is harvested remains undamaged, since cork is obtained by debarking cork oak every 9 to 12 years, without cutting down the tree. Cork extraction is a very environment-friendly and low impact process.

Cork is harvested for the first time when the tree has a circumference of 70 cm and a height of 1.30 m (age of tree: 25 – 30 years). Cork oaks can live for around 170 to 200 years and so can yield cork between 15 and 20 times.

Few materials can boast so many useful characteristics at the same time. To cite just a few of its properties, cork is:

- Odorless
- Resistant to chemical agents
- Impermeable to liquids
- Practically rot-proof
- Highly resistant to insect attacks

- Compressible and elastic, with an extraordinary dimension recovery capacity
- Very low thermal conductivity
- Excellent acoustic and vibration insulation
- Very light with high mechanical strength.
- The low residual humidity in cork after the woody impurities have been removed makes it impossible for microorganisms to proliferate, which gives it an **unlimited life span**.

Given its extraordinary characteristics, harmonized in a single material, it is unsurprising that cork has a great many applications. Some of its uses date from the distant past. In many cases, synthetic materials have partially replaced it. But, the fact is that for most of its uses **it has no rivals**.

Among other applications, cork is used in boat and ship building, where it is used as thermal insulation and for anti-vibration purposes, as well as anti-slip flooring, life belts, buoys, etc. In the manufacture of machinery, it is used to provide anti-vibration mounts, gaskets for engines and transformers, etc. The glass and ceramics industries also use cork granules and dust, and cork discs for polishing, while cork is used in the manufacture of refractory bricks.

Cork is commonly used in construction, in the cooling industry, in the manufacture of automotive and aeronautical accessories, in the chemical and pharmaceutical industries, in the footwear industry, in printing, and in the manufacture of sports equipment.

The use of cork gives rise to very significant and demonstrable environmental and social benefits. The cork industry engenders a sustainable, non-polluting, economic activity, which places an ecological, natural, renewable and recyclable product on the market. The economy and the livelihoods that depend on cork are among the most important reasons for conserving and protecting cork oaks. These forests and woodlands are only to be found in seven Western Mediterranean countries and they are home to great biodiversity.

Like other woodlands, cork oak woods conserve the soil, recharge aquifers, control surface run-off, and capture carbon dioxide, the main greenhouse gas blamed for global warming. In this latter respect, cork plays a particularly significant role, since it is a very long-lasting material and is therefore ideal for sequestering CO2 for very long periods of time. A cork oak exploited for cork production produces nearly 5 times more cork than an unharvested tree, so commercial exploitation increases the amount of sequestered CO2. In a quite singular way, and thanks to other unique characteristics of cork, cork oak woods act as a brake on desertification and a buffer against forest fires.

The most classical and economically important use of cork is in the manufacture of cork stoppers that represents about 85% of worldwide turnover in the cork sector.
To manufacture wine corks, the bark is boiled in water and allowed to

dry. The cork planks are then cut into strips slightly wider than the length of the cork stoppers to be produced, and finally, the corks are punched out by special cylindrical cutters.

In order to make use of the large amount of natural cork left over from the stopper manufacturing process (off-cuts from the perforated strips) this “waste cork” is shredded to make various diameters of cork granules (between 0.5 mm/over 3 mm).

Cork granulate is used to make various types of agglomerates:

Black agglomerates

Also called —ecological cork. The granules (significantly larger than 3 mm) are put in molds and submitted to pressure at a temperature of 320ºC. The cork releases a natural resin, which binds the granules together. The black color is the result of toasting the cork at a high temperature. These sheets are used for acoustic and thermal insulation.

White or composite agglomerates

The granulate is mixed with artificial adhesive bonding agents. After homogenization, it is poured into molds to form blocks which are dried under pressure and heat. The blocks are then sanded, varnished and waxed before being used to make wall and floor tiles.

Agglomerates for stoppers

The granulate is mixed with thickening and lubricating agents and then poured into cylinders where it dries and binds together, emerging from the other part of the cylinder in the form of a rod. These rods are left to dry for a fortnight, after which they are cut and sanded to the size of the stoppers.

Agglomerates for Suber™

Cork granulate is mixed in rotary machines with natural fats, vinyl, acrylic resins, and other natural ingredients suitable for maintaining and enhancing the properties and characteristics of cork. These ingredients endow the resulting cork paste with durability, malleability and its industrial application as a material to be sprayed onto any kind of surface, such as ceramics, tiles, cement, glass, iron, wood, concrete, plastic, methacrylate, asbestos cement, dry wall, glass in general, etc. It can be manufactured in its natural color but may also be pigmented in

any color addition to being applicable to any surface, once sprayed and dry, Suber will accept render, plaster, paint, tiling, paving, etc.

ABOUT SUBER

Creation and development

1998 saw the beginning of research to find a different use for cork granulates. The objective of the new product was to maintain and enhance the characteristics and properties of natural cork and to conserve its **ecological nature by using non-toxic, natural, and non-polluting components.**

During 1998- 2000, we concentrated our efforts on developing, testing, and certifying Suber, using the essential laboratory tests. After these initial years of research and proving, the compound was patented as a multi- purpose product and registered under the trademark Suber with protection until 2020.

In 2006 a fire resistant version, Suber Fireproof, was developed and patented. It was intended for the protection of metal structures, roofs, and perimeter and dividing walls of industrial workshops and warehouses. Fire certification provided by official laboratories classifies Suber Fireproof as Class 1 (formerly M1 – new European standard: A1).

After the initial years during which Suber was perfected, sales have been doubling year after year since 2004 with thousands of applications. This growth appears to have no limits; **sectors where it is used include construction, maritime, transport (trains, cars, aircraft), industry, etc.**

Properties

Suber, the Latin name for cork, and Tres (Spanish for ‗Three') for the three pillars on which our product is based, which are:

a) Technological goodness, originating from the constitution and structure of cork.

b) Sustainability of this goodness over time due to the composition of cork.

c) Possibility of using Suber in a very broad range of applications due to the co-existence of a number of different properties within the same product.

We shall analyze the properties of Suber based on the list set out above. As we do, so we should remember that everything we describe is certified by homologations and dozens of tests

conducted by official laboratories, as well as our own experience and verification of those properties over the last ten years.

> Aristotle said that:
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> *It is ignorance not to know how to tell the difference between what needs proving and what doesn't. Therefore let us trust in the intelligence of our collaborators and customers and concentrate on the really important points, which require explanation. We shall therefore only look further into those properties and characteristics, which require more precise technical explanations, giving other matters a brief explanation. Instead we would encourage our readers to refer to resources such as technical and safety specifications, laboratory tests and homologations, user and applications manual, color chart, application video, catalogues and to this report, together with other reference sources such as samples of Suber in various colors and granule size, photos of work done in the last ten years and, finally, some more in-depth descriptions of some of the properties pertaining to each particular product.*

Suber is an optimal product with properties and characteristics that complement and enhance one another, making it a unique product in the market, one without any competition. It boasts a multitude of features such as:

- Proven **durability** over time.
- A single product for multiple applications and uses.
- No waste of material.
- Jobs require no/minimum construction work or demolition.
- Energy saving.
- Produces Healthier habitats.
- A single product solving multiple problems.
- Decorative & can be supplied in any color.
- It is light.
- It has a proven track record for over ten years & thousands of referenceable jobs.
- It is guaranteed.
- It is a sealant/waterproofing agent.
- It is anti-humidity.
- It is anti-saltpeter (efflorescence).
- It is anti-capillarity.
- It is anti-condensation.
- It is a thermal insulator.
- It is an excellent adhesive.
- It is an acoustic insulator and corrector.
- It is elastic.
- It is ecological.
- It is anti-vibration.

- It is ideal for encapsulating materials.
- It is transpireable (breaths).
- It is fireproof.
- ISO 9001/200032 quality certification & is certified by over a hundred laboratory tests.
- Adheres to any type of surface.

The above features exist because nature developed cork mainly for the purpose of providing insulation. But cork also meets a number of different and complex vegetal needs as befits a living organism (the tree). They are not shared by any other insulating material.

Cork, and its derivative Suber, present an ideal set of properties that complement each other, without any single property conflicting with any other. With cork and Suber, we see the work of nature, having achieved an integrated and balanced range of technological virtues. As an example, If cork were less dense in order to have better thermal conductivity it would have much less strength and would be less elastic.

Studies carried out in various research centers demonstrate that, in comparison with other materials, cork agglomerates are remarkable for the harmony that exists between their various properties.

A naturally "perfect" insulating material

There are many materials which have properties that, in some cases, are highly desirable for the purpose for which they are intended, but none of them compare to Suber in terms of **harmoniously combining so many complementary properties**, which remain unchanged over its useful life, and which can serve so many different purposes.

This is because cork is radically different from other important insulating materials, a difference that resides in its origin. Cork is a natural product. This is the main reason behind why cork is the best insulator. The reason is simple: the cork which is shredded to make Suber preserves the same original properties as natural cork without any substantial change.

We strive to produce the best insulating material. The different products we manufacture will be the best in terms of the priority characteristic (for example, low thermal conductivity in the case of thermal insulators). But an insulating material is a physical entity in which **insulating capacity cannot be the sole criterion**; there are a number of other complementary properties that are essential if the product is to serve the purpose for which it is intended.

Technology is incapable of achieving optimal performance in all the characteristics of the product at the same time, because many of the various criteria conflict with one another. For example, the more impermeable to damp an insulator is, the better insulator it will be, but in this case it will be more prone to contraction or expansion due to changes in temperature. The lower the mechanical strength of a insulator, the better insulator it will be, (because the

thermal conductivity of a material is higher the greater its density and the greater its mechanical strength).

Artificial insulating materials may have some very good properties but other essential complementary properties will have to be sacrificed or will conflict with one another. What use is a good thermal insulator if it has low mechanical strength, or if it absorbs excessive humidity, or crumbles and cracks, or gives off toxic vapors if burnt, or if after a few years of use it turns to dust?

In the field of construction it is important to note that agglomerates remain in perfect condition and retain all their properties for dozens of years. This is not the case with other types of chemical insulating materials, which in the course of a few years will have practically disappeared or will have lost a large percentage of their insulating capacity.

Durability over time

For hundreds of years cork is naturally exposed to all the climatological stresses, which the cork oak tree that it protects has to withstand, without suffering any damage.

If a branch of a cork oak is left on the ground, after a number of years all that will remain will be the sleeve of cork that used to protect the branch. Can there be a better demonstration of its durability?

Cork and all its derivative products, and especially Suber, share virtues, which have practically no equal among artificial products. For demonstration, pieces of cork found in woodlands, which have been at the mercy of the elements for a hundred years, retain the same histological and technical characteristics as when they were attached to the tree.

Wine has been kept in perfect condition for over twenty centuries in amphorae sealed with cork.

- A countless number of ancient objects made of cork have been found in a usable condition.

- Cold vaults over eighty years old, which have been demolished as obsolete, have been found with the cork agglomerates used in their construction still intact.

While it is important for a material to be good, just as or even more important is that its goodness is preserved without impairment throughout its useful life.

Cork agglomerates (and, of course, Suber) are the products which best withstand the passage of time, a claim which is fully substantiated. We should not confuse this with what is referred to as the —accelerated aging of materials, a concept that refers to standard laboratory tests,

which attempt to simulate a product's performance and suitability under normal conditions by subjecting it to extreme conditions for a shorter time.

These tests, which agglomerates in general and Suber in particular, pass with flying colors, are good because no better ones exist, and to a certain extent they may provide a guarantee of future performance, but the real test is actual experience, and here only cork, its derivatives, and Suber, can demonstrate their worth.

Accelerated aging laboratory tests carried out in the year 2000 (Laboratory IOCESA in accordance with standard UNE 104.281), jobs performed over the years have provided a practical demonstration of the reliability and durability of Suber, even in complicated jobs. Jobs performed ten years ago show very similar or the same results in terms of aesthetic finish and properties as jobs carried out just weeks ago. This practically demonstrates that Suber is a product, which stands the test of time without losing any of its properties or characteristics.

Some examples:

Suber against rust:

- Application of Suber on the surfce of rusted sheet metal. The job was performed in 2002; today the facades show no sign of defect or rust.

Suber against damp:

- Application of Suber in the basements of the Italian Foreign Ministry building, (La Farnesina – Rome) with a serious damp problem. The job was performed in 2000; there is now no damp at all and the basements are currently being used for the storage of documents.

Suber for energy saving:

- Application of Suber on roofs and facades of an industrial building and offices in Seville. The job was performed in the year 2000. Now the surfaces show no sign of defect and the owners are very satisfied since in only three years the cost of applying Suber has been amortized by the energy savings in heating and air-conditioning.

Suber against problems of damp due to capillarity:

- A gated community in the province of Seville comprising 32 terraced houses with problems of damp due to capillarity. The product was first applied in the year 2000 and last applied in 2008. There is no noticeable difference between the first and last applications in spite of the nine years' interval between them.

A single product for more applications and uses

Suber is used in:

- Waterproofing, protection, and thermal insulation of roofs
- Encapsulation of asbestos and cement
- Facade coating
- Anti- damp, anti-saltpeter (efflorescence), and anti-condensation agent
- Acoustic and thermal insulation under paving or beneath rendered, tiled or coated finishes in general.

By adding pigments and titanium dioxide to Suber, either at the manufacturing stage or on-site, we offer over 50 different colors however any color can be manufactured (for specific requirements and in large amounts) except for white.

By adding approximately 10% fine grain silicon to Suber, we obtain Suber Trafficable. It has lower waterproofing and elasticity properties but is tougher and more resistant. It is used on trafficable terraces and parking spaces. It has to be treated with polyurethane paint in order to increase its strength and make it still tougher and more rigid.

By adding a thickening and adhesive component to Suber, we get Suber Filler. This product is used for sealing cracks, filling expansion joints, and making sundry other repairs before finishing the application of sprayed Suber.

Fireproof SUBER

Another Suber product we manufacture is Fireproof Suber. This was patented in 2006 and in 2008 it was certified as FR 55 (fire resistant for 55 minutes) by the AIDICO CTF laboratory of Valencia.

An M1 rating was awarded by the laboratory of the Italian Ministry of the Interior (Fire Service) and confirmed by the official laboratories of the French railway system and the Italian railway system (LAPI).

We have supplied several metric tons of the product to Lithuania, France, Romania, Russia, Italy and Spain to be applied in jobs requiring an M1 rating.

ADDITIONAL ADVANTAGES

No wasted material

Whatever is left over in a container after using part of the product may be reused for other jobs at another time, provided that the container is well closed and resealed.

Save time and money

- The case of a seeping terrace or trafficable roof: There is no need to tear up the paving, re-lay it and waterproof it. Spray Suber Trafficable and a coat of polyurethane sealant or, alternatively, two coats of Suber, and replace the paving.

- The case of a problem due to capillarity: There are no products on the market that can provide a definitive solution to this problem. There are other alternatives but they are destructive and costly; for example, cutting the affected walls and inserting an impermeable layer; making holes in the walls to insert porous ceramic elements; electrolysis; holes for inserting special resins as a barrier; total covering of the affected walls with an impermeable coating, etc. Simply cleaning up the wall and spraying it with Suber solves the problem since it absorbs the damp and transfers it to the outside where it evaporates.

- The case of damaged or oxidized asphalt roofing felt: One solution would be to tear up all the waterproofing and re-lay it, knowing that in a few years' time the problem will return. Instead you can repair the cracks and imperfections in the waterproofing with Suber Filler and apply two layers of Suber Trafficable or normal Suber.

Energy saving

The thermal insulation properties of Suber allow a saving of up to 50% of the energy needed to heat or cool an area. This is demonstrated in practically all jobs using Suber involving exterior and/or interior coatings of houses, hotels, etc.

Example:

- After the application of Suber sprayed cork on over 65,000 sq/ft of facades of a hotel in Perugia (Italy), savings in air- conditioning and heating bills represented over 40%. In the hotel's recent extension and upgrade with the addition of new facilities, beauty salons, spa, indoor pools, and prestigious suites, the owners have once again used Suber projected cork for facades, roofs, waterproofing, underfloor insulation, and interior decor.

Healthier habitats

Living in a damp and saturated atmosphere, with stains and mildew due to condensation problems at heat bridges, being too cold or too hot, with degraded walls and peeling paint,

makes you vulnerable to illnesses and is also psychologically diminished from living in a well-decorated habitat free of these problems, problems which can be easily remedied by spraying Suber on interior walls.

DETAILED PROPERTIES AND CHARACTERISTICS

Only with the appearance of cork agglomerates were we able to have such a broad range of materials with sufficient homogeneity and with specific and defined dimensions, allowing us to make widespread use of them. Their technological characteristics are largely the result of the fundamental and intrinsic technological characteristics of the raw material – cork - which, in turn, are the result of cork's own cellular constitution, which is so original and unrivalled.

Suber enjoys these same properties, which we have further enhanced, and in which each component has its function **without** (and this is most important) **compromising the other basic properties of cork agglomerates.**

We shall be examining these properties step by step.

High coefficient of friction

The millions of tiny sucker-like openings that form on the surface of any cork, which has been cut or shredded, give it a surprisingly high coefficient of friction and higher still in Suber.
If we measure the coefficient of friction on an inclined plane, we will see that cork will begin to slide at 42 degrees, whereas rubber only manages 28 degrees and leather 18 degrees.

This property may be put to practical use. For example, roofs made of sheet steel and polyurethane sandwich panels on which we wish to lay roof tiles: without Suber the tiles would slide. Another example: to prevent people from slipping on swimming pool surrounds.

Resistant to rodents, insects and microorganisms

Suber is resistant to attack by rodents, insects and microorganisms. With regard to rodents and insects, the resistance of cork has been proven since time immemorial. As for microorganisms, various laboratory tests have demonstrated conclusively that cork agglomerates do not provide a suitable substrate for microorganisms (Standard MIL-T- 12664).

It is true that mildew may appear on natural cork under certain totally ideal environmental conditions, but only on the surface, without penetrating inside, and so it can be very easily removed. Suber does not suffer from any kind of invasion of this nature. It is also important to understand that materials Suber protects are also protected from attack.

Suber is not vulnerable to such organisms, doubtless due to the suberine, a substance we mentioned earlier, which in this respect acts as a strong repellent.

References

The files of photos and customer references support our claims: video, web page, news channel, distributor channel, CD of photos, etc.

Decorative

The possibility of supplying Suber in three different cork grain sized (between 0.5 and 1 mm = fine, between 1 and 2 mm = medium, between 2 and 3 mm = coarse), the possibility of sanding down the product once applied, the possibility of combining different colors in the application phases, all contribute to providing a very pleasing finish and aesthetic result.

Lightweight

The large amount of air (or a gas similar to air) contained in cork (89.70%) and the lightness of its cell walls results in a specific weight of between 0.12 and 0.25 KG/dm3.

On facades, an average of 10 oz of Suber is required per ft2 of surface to be coated at a thickness of less then 1/8th". Given that, when totally dry, Suber weighs approximately 2.4 oz/ft2 (at a thickness of less than 1/8th"), its use is ideal in special situations where it is vital not to put too much weight on the structure; this is also an important property.

Sealant

The various tests conducted in different laboratories and the jobs carried out on terraces, roofs, tanks, swimming pools, etc. are proof that Suber is totally impermeable. (Laboratory Vorsevi - Laboratory IOCESA – Laboratory LAPI).

It is impermeable due to its chemical structure with an abundant presence of suberine and cerine, and due to its physical structure of closed cells, which enclose the spaces within, with no discontinuity or gaps that would allow capillarity. This property, in conjunction with other characteristics, is of great importance in most applications of cork, of its agglomerates, and of Suber. In the field of construction, it enables the insulating properties of cork agglomerates to remain unaltered.

Anti-humidity

The various tests conducted in different laboratories and the jobs carried out on facades, roofs, basements, interiors of houses, schools, etc. are proof that two coats of Suber will eliminate any type of dampness.

Anti-saltpetre (efflorescence)

The various tests conducted in different laboratories (see CD in PDF format with all the evidence) and the jobs carried out on facades with this symptom, are proof that Suber prevents the outbreak of saltpetre efflorescence.

Anti-capillarity

The various tests conducted in different laboratories (see CD in PDF format with all the evidence) and the jobs carried out on facades and walls with this symptom are proof that Suber prevents rising damp due to capillary action.

Anti-condensation

Condensation is a symptom, which emerges whenever there is defective thermal insulation, substantially due to the problem of thermal bridges in buildings. The presence of thermal bridges is one of the most important problems in modern building. The main causes of thermal bridges can be summed up as:

- The combination of different building materials (for example: bricks attached to reinforced concrete).
- Geometric discontinuity in the structure (example: corners, balconies, etc.).
- Breaks in the thermal insulation (example: columns, inter-floor beams, windows, etc.).

The negative impact of the presence of thermal bridges may be:

- **Heat loss**- As a result of poor insulation, thermal bridges and heat dissipation can account for up to 40% of total heat losses in a building. Thermal bridges can triple the transfer of heat from a section of the building, even though it may represent only a small part of the surface area.

- **Condensation**- Condensation is a typical phenomenon caused by thermal bridges. It appears when the normal levels of relative humidity of indoor atmospheres in conditions of thermal comfort combine with a surface temperature of the building‘s envelope which is below dew point.

- **Formation of mildew**- Mildew forms when there is a particular combination of temperature, vapor and a favorable substrate. Thermal bridges caused by the simultaneous presence of high relative humidity and low surface temperature (0/15ºC) are the main cause of the formation of mildew and fungus.

- **Damage**- Cyclical variations of surface temperatures often cause building materials to pulverize. Also these problems are often sources of litigation for builders and technicians in the sector.

- **Decrease in thermal comfort**- When the temperature of the interior surface of a part of the structure is more than 4ºF lower than the ambient temperature, it is typical to experience a sensation of not feeling well. This can be remedied only by increasing the ambient temperature, leading to a greater waste of energy.

Thermal insulation (Lambda & Technical calculations)

This physical property of cork is the basis for what is historically one of the most widespread uses of cork, one that is of vital importance in the field of construction. In fact, it is well known that the best insulator is a vacuum; followed by dry, still air. Cork and its agglomerates, thanks to the enormous number of cells filled with a gas (very similar to air), which is trapped without any possibility of moving or being renewed, together with its low humidity absorption capacity, precisely meets the requirements of an insulator of the highest order.

The technical characteristics of Suber, which has a thermal conductivity, lambda, of 0.038 Kcal./h mºC, and its peculiar property of never falling below 32 ºF and never rising above 86ºF, as well as its characteristic of being transpireable, enable it to reduce considerably or eliminate completely and definitively a building‘s thermal bridges.

In practical terms, it is a thermal coating which eliminates the risk of condensation and mildew forming, by reducing thermal differences and so allowing heat to accumulate in walls, leaving them always dry because they are protected from outside influences.

Pure cork agglomerates, a basic component of Suber, have a very high insulating capacity with a coefficient of thermal conductivity λ (lambda) = 0.034 Kcal m/h m2ºC.

The lambda (λ) coefficient indicates the amount of heat (in kilocalories), which passes through a square meter of the material in question in the space of an hour, when the material is a meter thick and there is a temperature difference of 1.2 degrees Fahrenheit between the two faces.

The material is considered to be uniform and to have two parallel surfaces. A number of important considerations need to be taken into account with regard to the coefficient λ. The lambda of a material must always be referenced to a specific average temperature. If this is not the case, it is impossible to compare the lambdas of different materials.

The lambda of a material depends on the circumstances prevailing at the time it is measured.

For cork it is:

λ = 0.034 Kcal m/h m2ºC T = 20ºC at a density of 105 Kg/m3 λ = 0.030 Kcal m/h m2ºC T = 0ºC at a density of 105 Kg/m3
λ = 0.018 Kcal m/h m2ºC T = 150ºC at a density of 105 Kg/m3

The behavior of other, much more modern materials, present excessively optimistic lambda values **compared with their practical performance**.

It is not the same to obtain a lambda value in the laboratory using recently manufactured, clean specimens as it is to test the same material in use, even without suffering from the effects of humidity.

While lambda is perhaps the most representative measure of the insulating capacity of a material, **it is not the only one**. A material's insulating capacity should be considered with the material in use. It is here where all its other characteristics, whether beneficial or otherwise, exert their influence. If that influence is not good, the impairment of the material's insulating capacity is twofold:

1. Because the lambda coefficient itself increases (for example, due to the humidity absorption effect).

2. Because the material deteriorates in detriment to its action (for example, dimensional instability in response to temperature changes).

Cork agglomerates are the most rational thermal insulators, and Suber is still more rational, because all its qualities help to preserve its fundamental properties in space and time, properties that were determined at a certain point in time (its lambda in this case).

There are other insulating materials which in fact present a lower lambda than Suber but doubtless only **by sacrificing other characteristics**, which over time will have an inopportune effect on the material's worth as an insulator. Thus we should treat lambda, used on its own, with some considerable caution.

After these observations it is easy to see how hard it is to answer the main question:

What would be the equivalent thermal insulation of a coat of Suber compared with the most commonly used insulation - expanded polystyrene or another insulator, for example polyurethane?

The answer is more complex than it would appear at first sight**.**

Applying the superficial theory used by construction technicians, who take as their sole reference for calculation the coefficient of thermal conductivity, lambda, we can put forward the following theory.

If we are talking about another insulator, the natural comparison is with expanded polystyrene. All we need to do is to assess the coefficient of thermal conductivity of the insulator in question in a back-to-back comparison with expanded polystyrene (0.038 Kcal. m /H m2ºC.).

If, for example, the insulator in question were polyurethane, which has a lambda of 1.20 Kcal. /h mºC, we could say that 38 millimetres of expanded polystyrene can be replaced by 20 millimetres of polyurethane.

Coefficients of thermal conductivity (lambda) are established for each type of material, (insulating or non-insulating). Below we have listed a number of materials by way of example. It should be remembered that the lower the lambda, the better the material acts as a thermal insulator:

Compact rock:	3.00 Kcal. /h mºC
Porous rock:	2.00 —
Cement render:	1.20 —
Plaster render:	0.26 —
Solid brick:	0.75 —
Lined brick:	0.65 —
Drywall:	0.16 —
Plaster panel:	0.26 —
Glass plate:	0.82 —
Steel plate:	50.0 —
Copper:	330.0 —
Aluminium:	175.0 —
Pine or fir wood:	0.12 —
Agglomerate:	0.07 —
Carpet:	0.04 —
Asphalt roofing roof:	0.16 —
Expanded clay:	0.09 —
Glass wool:	0.032 —
Rock wool:	0.034 —
Expanded polystyrene:	0.038 —
Sheet polyurethane:	0.020 —
Sprayed polyurethane:	0.020 —
Cork:	0.034 —
Suber:	0.038 —

The lambda coefficient depends on the material regardless of its thickness. With the tabulated value of the lambda, the coefficient of thermal transfer of heat —K (Kcal. /h m2ºC) can be calculated, using the following formula:

$$K = \frac{1}{\frac{1}{a} + \frac{Si}{lambda\ i}}$$

Where:

a = surface coefficient of heat transfer, this being a constant value equal to 5 (1/a = 0.2)
Si = thickness in metres of each component (example: render + bricks + insulator + bricks + render)
Lambda i = coefficient of thermal conductivity of each component

Once the coefficient of thermal transfer of heat K has been calculated, we can calculate the rate of heat flow "Q" (Fourier's Law) using the formula:

$$Q = K \times S \times (Ti - Te) \text{ in Kcal. /h}$$

Where:

K = Coefficient of thermal transfer S = Surface of the wall in m2
Ti = Interior temperature Te = Exterior temperature

Rate of heat flow Q tells us how much heat passes from the interior to the exterior of a surface S per unit of time (an hour).

By obtaining this value (which might be negative, in which case we will speak of Kilo Frigories/h), we can calculate the useful power output of an air-conditioning unit or a heater to achieve and maintain a healthy and comfortable indoor environment.

$$Pu = Q + 0.29\ V \times (Ti - Te)$$

Where V is the minimum air renewal rate to keep the environment healthy.

The actual power to install is the result of multiplying this useful power output by 1.2 in the case of constant heating (k calories) or cooling (k frigories) and by 1.5 in the case of intermittent heating or cooling.

The values of V are tabulated; below we list some of them (m3/hour per person)

Banks minimum	1.8	recommended 3.5
Bars	4.5	7
Schools	10	20
Factories	1.3	1.8
Hospitals	4.5	5.5
Restaurants	2	2.5
Theatres and cinemas	1	1.3
Apartments	1	1.3
Garages	1	1.3
Supermarkets	1	1.3

According to the theory, and generally speaking, we need:

- A material with a low coefficient of thermal conductivity (lambda) and an equally low coefficient of thermal transfer K
- A low heat flow Q to be able to save the energy used to heat or cool the environment; parity between surface and K would also give a small difference of temperature between indoor and outdoor temperatures.
- Transpiration of the various materials making up the whole (for example a wall) in order to have the necessary air exchange to keep the environment healthy, without damp or condensation, and generally comfortable.

All the above is valid for each type of material EXCEPT cork and Suber.

a. Suber is the only insulating material, which has a variable coefficient of thermal conductivity λ. For a normal temperature range (between 14 and 104ºF) certified laboratory tests give us a 28% lower lambda than its tabulated value.

b. Suber is the only insulating material which boasts a peculiar property: whatever the outdoor temperature, the —core of Suber will have a temperature which will never fall below 32ºF and will never rise above 86ºF. This means that heat flow Q, which is directly dependent on the temperature difference between the inner and outer surface, is considerably lower. For example: a temperature of 176ºC incident directly on a roof of made of sheet metal on an industrial building should be considered as a maximum of 86ºF, which will be the temperature of the core of Suber. In the case of an outdoor temperature of -13ºF and an indoor temperature of 71.6ºF, the temperature difference for calculating Q will not be 116.6ºF, it will be 71.6ºF, because the core of Suber will have a minimum temperature of 32ºF and not -13ºF.

c. Suber is 79% transpireable which allows sufficient exchange of air without opening the door to condensation or damp. Other insulating materials, mainly petroleum based ones, such as polyurethane, expanded polystyrene, asphalt roofing felt, and in part,

glass and rock wool, etc., are materials which do not allow the ventilation and transpiration of walls or roofs. This is why it is difficult to answer the original question that we considered, because you cannot make a superficial and ready comparison between other insulating materials and Suber. But, thanks to our experience, we can state that a 1/8" thickness of Suber is sufficient to achieve the same thermal insulation as ¾" of any other insulator. One thickness of 1/8" of Suber is capable of reducing the actual power required to achieve a healthy and comfortable indoor environment without condensation or damp by over 50% compared with the actual power calculated for other insulating materials by the traditional method (λ, K, Q, Pu, P).

Continuing with our explanation of the thermal properties, we also need to take a closer look at another very important aspect: the concept of thermal diffusion, which refers to the propagation of heat through the insulating material. On this front, Suber wins again over any other thermal insulator. This parameter is given by the expression:

$$D\ (\text{diffusivity}) = \frac{\lambda\ (\text{thermal conductivity})}{\rho\ (\text{density}) \cdot Cs\ (\text{specific heat})}$$

When an insulating material separates two environments, one cold and one warm, its thermal resistance to the flow of heat $r = 1/\lambda$ acts as a barrier against the flow of heat. This barrier is uniformly effective provided that the temperature conditions on either side of the material do not vary. If the heat ceases on the warm side, the existing heat on that side will persist for more or less time depending on the thermal diffusivity of the material.

It is very important for the material to prevent dissipation of the heat, since this will have a positive impact on the economy of the process. Thus, if the heating in the interior of a room is switched off, the longer the accumulated heat remains in the room the better.

In places which need to maintain very constant indoor temperatures (hospitals, schools, homes, etc.), the use of materials with low diffusivity is recommended, since even if the output of the heat source were maintained, variations in outdoor conditions (day and night temperatures) would cause indoor temperatures to vary if the insulating material used was not adequate.

In this respect, cork agglomerates are, without a doubt, the most suitable insulating materials since they have the lowest thermal diffusivity. The lambda of agglomerates varies relatively little from that of other insulating materials, but the density of cork derivates is much higher than that of any other material, with a density of around 100 Kg /m3, while Suber's density is even greater at 150-235 Kg/m3. It also has the highest specific heat of all insulating materials (0.40 Kcal/KgºC). Therefore if we apply the formula we saw above, Suber yields the lowest values, which makes Suber the best material at conserving heat.

Any other insulating material that was as dense as Suber would have to increase its density at the cost of its lambda in order to conserve heat better, which would make it a worse thermal insulator.

It could be argued that while Suber conserves heat very well, it also requires more time to raise the room temperature to the desired level. But this is not the case, because this circumstance relates directly to the concept of thermal storage Q, which depends solely on the specific heat of the material, which while it may be higher in Suber than in other insulating materials, the difference is a mere 10%.

Adhesive

Suber adheres to any kind of surface with a very high tensile strength. In the case of gypsum, plaster, agglomerates, sand renders, or dusty surfaces, we recommend using Suber Fixative before spraying.

Acoustic insulator and corrector

As is well known, good thermal insulators are, in general, good acoustic correctors but are bad sound insulators. With regard to protection against noise, we need to take three considerations into account:

- The first consideration concerns insulation from air to air sound (insulation of a room in a house from the noise from the street, for example) – noise by transmission.
- The second concerns the insulation from noises caused by percussion (noise caused by knocks, footsteps, or the clack of heels on paving, the sound of moving furniture, the drumming effect on tin roofs, or the sound of objects being dropped, which is transmitted from one floor to another, for example). – Noise by impact.
- The third consideration concerns the absorption of the sound produced in a certain place and how the reverberation time decreases; in other words, the echo (absorption of the sound produced by a meeting in a room, a sports centre with echo problems, a restaurant, etc. – thus if there is no echo we have acoustic comfort). – Resonance or reverberation noise.

Suber can be used successfully in all three cases described above. With regard to air to air sound insulation, neither cork nor any of the other thermal insulation materials is an acoustic insulator. Acoustic insulation in this case is inescapably determined by the law of mass (Berger's Law) which states that the sound transmitted will be greater, the greater the mass by m2 of the material (the greater its density). In this respect, the best insulator would be a sheet of lead.

In general, for any given material, the level of insulation increases as the frequency of the sound increases. That is to say, it is harder to insulate against low-pitched sounds than high-pitched ones.

Transmission noise (pink noise) is the most problematical and the new regulation is very demanding. As in the case of thermal insulation there is no answer to the direct question

How many decibels will a good coat of SUBER eliminate? Furthermore, there are no theoretical calculations to fall back on.

Only on-the-job experience enables us to evaluate the work required to achieve the levels required by regulations. Before starting a job, first we need to measure the current situation with regard to noise; sometimes it may be necessary to increase the weight of the structure, put in more glass wool with mats of different densities, a good layer of coarse grain cork applied to the walls and a second coat of finish. Sometimes the job might also call for vertical asphalt felt on top of glass wool to reflect the sound waves back onto the glass wool, etc.

As you can see, this type of insulation is complex and always requires a prior study which cannot be resolved by means of calculations. Sometimes just a good finishing coat of coarse grain cork may be enough to solve the problem. It is important to bear in mind that if we double the thickness of the insulating material we will not achieve double the acoustic insulation due to the fact that the ratio between the thickness of the insulator and the degree of insulation achieved is logarithmic.

By examining the graph of a sound wave over time and at the frequencies which the human ear can hear (between 125 Hz and a little over 4,000 Hz), we can deduce that high-pitched frequencies (the highest between 2,000 Hz and over 4,000 Hz) can be eliminated by means of insulation using fibrous materials (glass or rock wool). The fibres absorb the sound energy and transform it into friction (calorific energy). The low- pitched frequencies (between 125 Hz and 1,000 Hz) are eliminated by wall components having a good weight (law of mass).

Middle frequencies (between 1,000 Hz and 2,000 Hz) are eliminated by an absorbent material, for example, with Suber. Thus to insulate against transmission noises we need a package of solutions containing the three properties described above:

- Weight of the structure to be insulated (fundamental law of mass).
- Glass or rock wools (in resinated mats or panels).

Here at Suber, in our numerous wall insulation jobs, we have always used a product of the brand ISOVER, called Calibel, for the first and second elements. These are panels made up of a sheet of Pladur, 10, 12 or 15 mm thick, to which is bonded a resinated panel of glass wool, 25 or 40 mm thick. For the insulation of roofs we have also placed two layers of glass or rock wool at two different densities (for example 30 and 60 kg/m3) and sometimes we have had to add weight to the roof structure by hanging panels of Pladur, and even metal sheets when the weight of the roof is insignificant (for example, a roof made of Uralita and nothing else).

Finally a very important factor to be taken into account in acoustic insulation jobs is the matter of acoustic bridges. All the work done, the materials chosen, the studies prior to the work, the expense incurred having the initial measurements taken, the care taken in the performance of the work, all count for nothing if special attention is not paid to this factor.

In practice few acoustic bridges are capable of cancelling out all the good insulation work to reduce the result by more than 90%. For reverberation and resonance noise (for example when it is required to absorb part of the noise and prevent sound waves from reflecting on the walls and bouncing back with the same force) we need to increase the absorbent surface with a relatively soft product which reflects the sound waves in more directions, not only at 90 degrees to the angle of incidence.

The Suber to use is the coarse grain product (between 2 and 3 mm), applied to a thickness of 4 – 5 mm, or the combination of a coat of medium grain product with a coat of fine grain. In this way, on encountering a surface which is a poor reflector, rough, relatively soft, and much greater (at least 2.5 times the unsprayed surface), a large percentage of the sound waves are absorbed. They are reflected in all directions and the reverberation time is greatly reduced by eliminating the echo and sending back a greatly reduced level of sound energy compared with the source noise, since a large percentage of the noise has been trapped by the cork particles.

The alpha (α) level of acoustic absorption defines the fraction of the total energy of the sound incident on the material which is absorbed by it or passes through it. This coefficient varies according to the frequency of the sound. As an acoustic absorbent, Suber has an absorption curve which can be considered to be exceptional, for two reasons:

- The curve is good throughout the entire frequency range and best in the middle and high frequency zone. This is particularly interesting if we compare it with the absorption curve of other materials, which may present very good absorption for a single frequency or a small range of frequencies but will perform poorly at all other frequencies.

- The second reason relates to the fact that Suber is exposed on the surface. Otherwise sound would not incide directly on its surface and so would not be absorbed by it.

In this respect, the goodness of Suber compared with other materials is unquestionable, so we can add sound absorption to the host of qualities enjoyed by cork and Suber.

Good acoustic absorption means that the reverberation time is very low for the frequency in question.

Reverberation time is the time that elapses, measured in seconds, between the moment the sound source ceases and the moment that the sound is impossible to hear. In practice, we are talking about echo. The greater or lesser value of reverberation time will to a great extent determine the acoustic comfort or discomfort of a room in which, for example, there are several groups of people all speaking at once. Suber is used in this field as a coating for walls and ceilings.

Notes:

Reverberation time (TR60): is the time required, in seconds, for the average sound in a room to decrease by 60 decibels after a source stops.

- Echo: when the reflections of a sound arrive with a delay greater than 50 milliseconds after the original source.

- Transmission: happens when a sound wave strikes a surface and that surface transmits it (it passes through the surface) at a reduced energy level.

- Absorption: happens when the energy of the incident sound wave is absorbed by a surface.

- Reflection: happens when the energy of the incident sound wave is reflected by a surface at the same energy level. It acts like Snell's law: the law of mirrors.

- Diffusion: Property of surfaces by which acoustic energy is dispersed in space. It occurs when the energy of the incident sound wave is scattered by a surface; i.e. it is dispersed. Impact or percussion noises consist of the reduction of the noise level generated by impacts on slabs and transmitted to the floor immediately below. To obtain an effective reduction of this effect it is necessary to ensure total separation between the flooring and the structure of the building.

In this respect Suber is unbeatable, for a number of simple reasons: Suber is a material with low dynamic rigidity. It dampens sound waves produced by percussion. It has elastic properties without equal; it has the property of being able to be compressed without lateral extrusion while retaining its ability to regain its original thickness once the force or load producing the deformation has ceased.

Elasticity

On the basis of laboratory tests conducted in the year 2000 at two different facilities (the Vorsevi and IOCESA labs) we can guarantee that Suber Natural has an elasticity of about 30% of its thickness; Suber Facade (pigmented) has a lower elasticity due to the titanium dioxide and the pigment which strengthens Suber Facade; its elasticity is nearly 18% of the thickness applied. Thus at a normal sprayed thickness of 3 mm, the product is guaranteed to withstand without cracking a movement of between 0.9 and 0.18 mm.

The following describes an impressive demonstration of this:

A sample of cork measuring a cubic inch was submitted to the extraordinary load of 6,350 Kg without breaking and, once released from the pressure, immediately regained 90% of its original height, without any appreciable increase of its length or width. This test represents strength of close to 1,000 Kg/cm2. The term elasticity should not be confused with the ability to yield to pressure, which is compressibility. In the case of cork, there is a fundamental and distinctive characteristic: its capacity to be compressed without lateral dilation (Poisson module

= 0). This unique characteristic spawns a large number of industrial applications, and in the construction sector it is very useful in expansion joints.

It is ecological: Cork and its agglomerates is an absolutely natural product, free from any kind of toxic component. Being dead matter it is a totally inert product. Suber is made from pure cork agglomerate plus non-toxic and non-hazardous water-based thickeners, with absolutely no free formaldehyde.

The industrial production of Suber does not harm the environment. On the contrary, the use of cork (without cutting down any trees and thereby increasing the capture of CO2 in the atmosphere) makes it a sustainable product. It is biodegradable, with a total absence of any environmentally harmful substances, its packaging is recyclable, the various production stages use very little energy or water, and the wastewater from the manufacturing process or from the cleaning of machinery can be safely discharged into the sewage system without polluting or damaging aquifers.

None of its components is a risk to the health of staff involved in the manufacture of Suber, and it is fully compliant with all the ecological criteria that a product considered as ecological at a European level should comply with.

Vibration Dampening

Suber is used to make anti-vibration pads, where its toughness and capacity to regain its form after compression without any permanent deformation and be ready to perform the same task over again, gives it an advantage over other materials. For example, if we coat an iron plate subject to vibrations with Suber we can eliminate those vibrations. By spraying a coat of Suber under the feet of a piece of machinery subject to vibrations we can dampen those vibrations and not transmit them. By coating the inside of the bodywork of a car or motorhome with Suber we can eliminate vibrations, etc.

Encapsulating asbestos (fiber-cement “Uralita”)

(Certified in Europe only as of 2013)

EEC Directives No. 83/477/CEE of 19/9/83, 87/217/CEE of 19/3/87, 91/382/CEE of 25/7/91, EUR LEX 32003 LO018ES and subsequent directives, together with national legislation and regulations, all referring to the prohibition of the use of asbestos in construction (and more specifically the use of uncoated Uralita on roofs exposed to the weather) have outlawed the use of materials containing asbestos in Europe and have imposed the implementation of solutions to existing buildings using Uralita pre-dating the above mentioned legislation.

Today there are only two possible courses of action if you have a Uralita roof:

a) Leave the roofs as they are, waiting for a stricter regulation that will force compliance, meanwhile risking incurring large fines.

b) Comply with European legislation, which requires the adoption of one of these two measures:

i) - Demolition of the roofs using specialized firms (registered with the RERA - Registry of Companies with Asbestos Risk – at the Provincial Department of Employment and Social Security. Demolition materials have to be taken to authorized landfills, under payment of a fee and with a 5-year liability period) and subsequent installation of a new roof.

ii) Leave the existing roof and encapsulate it with appropriate materials certified for that purpose.

Roof Coating

Suber's many properties and characteristics makes it the best product on the market for solving many kinds of roofing problems.

Spraying a coat Suber of a thickness of approximately 1/8th" will provide:

1. Damping of impact noise due to rain (drum effect).
2. General sealing of fissures, cracks, anchor holes.
3. Overall waterproofing of the roof against seepage or leaks.
4. Uniformity of thermal insulation with the elimination of sources of condensation due to the elimination of thermal bridges.
5. Energy savings; up to 40% of the energy consumed in heating and air- conditioning.
6. Decrease of indoor temperatures in the summer of over 22ºF.
7. Durability of its properties and characteristics over time without their being affected by atmospheric agents.
8. Excellent aesthetic finish.

These properties make Suber® unique in the market. If we wish to compare it with sprayed polyurethane (a superior artificial thermal insulator), we see that **polyurethane has a number of negative characteristics:**

- Not transpireable,
- Not impermeable
- Degrades over time

- In the event of a fire it give offs toxic cyanide-based gases (on March 24, 1999 a fire in a refrigerated truck insulated with polyurethane in the Mont Blanc tunnel caused 39 people to die of intoxication).

Water Vapor Transmittable (Breathable)

Laboratory tests prove it. While Suber is 100% impermeable, it allows up to 79% of the air to pass. This is an important property that the most commonly used coatings can not claim.

Fire resistant and retardant

While cork cannot of course be considered to be non- combustible, it does have very good properties in terms of its reaction to fire. The current modern trend is towards standardized tests, which measure aspects that have a bearing on the saving of human lives in the event of a fire. In the light of this, the following basic aspects are considered:

a) - Reaction to fire: This concerns the capacity of a material to contribute to the development and propagation of fire. When rating reaction to fire, the following factors are evaluated:

- The calorific capacity of the material
- Its combustibility
- Flame spread

Thus, in accordance with the standard ISO–DIS/834, materials are classified as:

M0	=	Non-combustible.
M1	=	Combustible. Non-flammable.
M2	=	Combustible. Low flame spread.
M3	=	Combustible. Easy flame spread.
M4	=	Combustible. Very easy flame spread.
M5	=	Combustible. Very inflammable.

Cork products as a rule fall within class:

M2 = Combustible. Low flame spread.

However, there are surface and mass treatments which allow cork to obtain M1 classification, as is the case of Suber.

In its original formula, Suber does not allow fire to spread and once removed from the source of fire it is self-extinguishing.

Due to the fire resistant properties of cork, in some forest fires it has been found that cork trees with their bark still attached (i.e. those that have not been harvested) manage to survive the effects of the flames, even though the rest of the foliage has been burnt away.

This happens because, as it burns, the inside of the bark closes in reaction to the heat, which prevents the entry of oxygen and combustion, thereby protecting the tree, which by the next season will have fully recovered.

b) Fire resistance: This refers to the time during which the material or element tested is capable of maintaining its function while under attack from fire.

The following properties are evaluated:

- Mechanical stability
- Flame resistance
- Non-emission of flammable gases
- Thermal insulation

The time during which these 4 criteria are maintained is called fire endurance.
The time during which the first 3 criteria are maintained is the flame retardant time. The time during which the first criterion is maintained is called fire stability.

The fire resistance of cork products is very high, as a result of the surface carbonization it undergoes and its high thermal insulating capacity.

The flame does not spread, the integrity of the material is maintained, it does not give off burning drips or particles, nor does it give off toxic gases.

It should be borne in mind that reaction to fire is far more important for safety than actual fire resistance. Thus, for example, a metal structure with a very high fire resistance is much more dangerous than roof made of laminated wood as the latter has a much better reaction to fire (it will not collapse or will take longer to do so) allowing the building's occupants to be evacuated.

c) Smoke generation: Most fire victims suffer from smoke asphyxiation. Artificial products that attempt to replace cork and its agglomerates (expanded polystyrene, polyurethane, foam rubber, etc.) give off chlorhydric acid and cyanhydric gas.

Using a different formula, we have recently (2006) patented SUBER FIREPROOF. It has been certified by the laboratory of the Italian Ministry of the Interior – Fire Department, which has certified our product as Class 1 (formerly M1). In the case of jobs requiring fire resistance, we recommend applying a first coat of Suber natural and a second finishing coat of Suber Fireproof.

Fire resistance tests (FR) will be carried out in the months to come at the official laboratory AIDICO CTF on structures subject to load. The first tests certified a fire resistance of 55 minutes.