INFORMATION ABOUT THE MANUFACTURE OF JOINERY FOR EXTERIORS

WOOD

JOINERY DESIGN AND CONSTRUCTION

GLUING, FILLING, SEALING AND ACCESSORY MATERIALS

INSTALLATION

Coating joinery (windows, shutters, exterior doors, garage doors) is a multi-step process which, through the application of several different products, each having its own specific action, provides not just the desired look but above all the required performance (see table 1).

Table 1 - Goals of coating wood for exteriors.

PERFORMANCE	Protect the wood Long-lasting
AESTHETIC	Manufactured article decoration Meet market requirements
ECONOMIC	Easy to make Production advantages
ENVIRONMENTAL	Low impact Reduced solvent emissions

Amongst these, protection of the wood and the long life of the joinery are the most sought-after technical qualities and have always been studied by our R&D laboratory.

» INFORMATION ABOUT THE MANUFACTURE OF JOINERY FOR EXTERIORS

Which coating is most suitable for maximum joinery protection?

Which coating system is most suitable for maximum lifetime?

Which construction methods are most suitable for maximum lifetime?

To answer these questions and be able to define a quality standard, we first need an understanding of how the main agents attacking exterior wood act. Only then can we identify the factors affecting the lifetime of exterior joinery and so take action both at the design and the coating stages to improve wood protection.

Main causes of deterioration of exterior joinery:
- Solar radiation
- Water
- Fungi
- Insects

Whilst the first two act on the wood, the coating film and the wood-coating system, the others act only on the wood.
As a result, to ensure that coated exterior joinery is protected and long-lasting, the following requirements must be met:
- Reduction of moisture absorption
- Reduction of solar radiation absorption
- Protection from attack by fungi and insects

These requirements cannot come second to economic or production targets. They must be considered and fulfilled at every stage of manufactured article processing, by using suitable construction, coating system, application system and wood species solutions.
Aspects to be considered for guaranteeing that these requirements are satisfied:
- Wood
- Joinery design and construction
- Filling, sealing and accessory materials
- Installation

Each of these taken individually is necessary but not sufficient to guarantee that joinery is protected and long-lasting. Unfortunately, it is widely but incorrectly believed that a good coating can correct design or wood preservation errors (poor drying, wood unsuitable for exteriors, etc.) or that good design can make up for unsuitable coatings or coating systems.
The information we provide comes from our current best knowledge of problems relating to coating wood for exteriors.

WOOD

SELECTING WOOD SPECIES

When choosing the wood species, consider the following aspects:
- Natural durability
- Impregnability
- Extractives
- Knots
- Specific gravity and porosity

Natural durability

Wood has its own natural durability (see table 3). That is to say, its own natural capacity for withstanding attacks by fungi and insects. In most cases, heartwood already has natural resistance, whilst the sapwood is very vulnerable, since it is rich in substances that facilitate the growth of both fungi and insects.

Impregnability

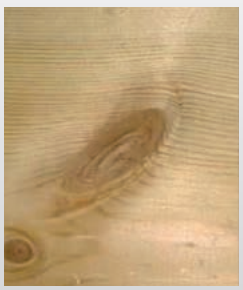
Impregnability (see table 2) refers to the capacity of the wood to absorb a liquid deep into its structure. In this case, the liquid is a protecting-preserving product. The sapwood is always more permeable than the heartwood due to the different structure of the wood tissue. Permeable wood is preferred, since, the protective wood stain application conditions being equal, more in-depth protection is achieved.

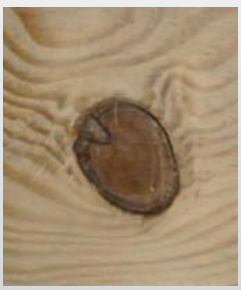
Extractives

In wood, as well as cellulose and lignin, there are minority compounds called extractives (including terpenes, phenols, tannins, etc.) whose chemical compositions and percentages differ in the various wood species. Extractives can cause a number of issues:
- During the coating step, they prevent the film from drying or do not allow the protective wood stain to flow.
- On the installed joinery, acting as a coating film depolymeriser, migrating to the surface when heated by the sun, or hampering moisture absorption (in the case of oils). In the latter case, water will stand in the wood-coating interface, with negative consequences for film adhesion.

Knots

Any knots present must be healthy (left-hand photo), adherent and have a maximum diameter no greater than 1/3 of the width of the workpiece. Non-adherent knots which are falling out (right-hand photo) are not permitted.
Woods with knots having a diameter of more than 30 mm must not be used for joinery because knots are more compact than the surrounding wood, so after the dimensional changes caused by the temperature, considerable tensions may arise, causing the knot to split. Resin may also seep out. Knot-free laminated pine with finger joints is also currently available.





» WOOD

Table 2 - Main characteristics of the various wood species

Wood species	Softwood Hardwood (1)	Specific gravity (Kg/m³)	Porosity (%) (2)	Pores	Resin	Sapwood (3)	Sapwood impregnability (4)	Heartwood impregnability (4)
WHITE FIR Abies alba	S	460	69			X	2v	2-3
RED FIR Picea albies	S	460	69		YES	X	3v	3-4
CHESTNUT Castanea sativa	H	590	61	YES		T	2	4
DOUGLAS Pseudotsuga menziesii	S	530	65		YES	T	3	4
HEMLOCK Tsuga heterophylla	S	490	67			X	2	3
DARK RED MERANTI Shorea curtisii	H	680	55	YES		T	2	4v
LIGHT RED MERANTI Shorea leprosula	H	520	65	YES		M	2	4v
NIANGON Heritiera utilis	H	680	55	YES		M	3	4
SCOTS PINE Pinus sylvestris	S	520	65		YES+	T-M	1	3-4
OAK Quercus robur	H	710	53	YES		T	1	4
TEAK Tectona grandis	H	680	55	YES		T	3	4

» WOOD

Table 3 - Natural durability of the various wood species

Wood species	Natural durability (5) WOOD-EATING FUNGI	Natural durability (6) WOODWORM (Anobium punctatum)	Natural durability (6) OLD-HOUSE BORER (Hylotrupes bajulus)	Natural durability (7) TERMITES	Natural durability (6) POWDER-POST BEETLES (Lyctus brunneus)	Natural durability (6) HARDWOOD BORER (Hesperophanes cinereus)
WHITE FIR Abies alba	4	NRH	NRH	NR	R	R
RED FIR Picea albies	4	NRH	NRH	NR	R	R
CASTAGNO Castanea sativa	2	NR	R	MR	R	NR
DOUGLAS Pseudotsuga menziesii	3	NR	NR	NR	R	R
HEMLOCK Tsuga heterophylla	4	NRH	NR	NR	R	R
DARK RED MERANTI Shorea curtisii	2-4	n/d	R	MR	R NR(8)	R
LIGHT RED MERANTI Shorea leprosula	3-4	n/d	R	NR	R NR(8)	R
NIANGON Heritiera utilis	3	n/d	R	MR	R	R
SCOTS PINE Pinus sylvestris	3-4	NR	NR	NR	R	R
OAK Quercus robur	2	NR	R	MR	NR	NR
TEAK Tectona grandis	1	n/d	R	MR	R	R

Notes to tables 2 and 3:

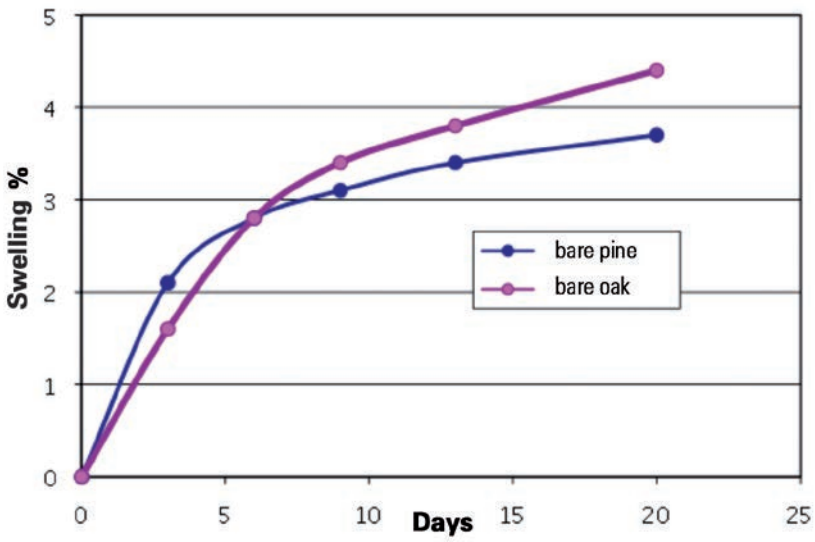
(1) H: Hardwood, S: Softwood
(2) The percentage ratio of volume of void spaces in the wood to total volume. The value shown was calculated using the theoretical formula: 100 - 66.7 x specific gravity (g/cm³)
(3) X: No clear distinction between sapwood and heartwood, T: thin (from 2 to 5 cm), M: medium (from 5 to 10 cm)
(4) 1: impregnable, 2: moderately impregnable, 3: not very impregnable, 4: not impregnable
(5) The information shown relates only to heartwood; the sapwood of all of the wood species is considered to belong in class 5. 1: very durable, 2: durable, 3: moderately durable, 4: not very durable, 5: not durable
(6) The information shown relates to the sapwood; the heartwood of all of the wood species is considered resistant, except for species with sapwood classed as X, that is to say, with heartwood which is not differentiated (e.g.: fir). In this case the heartwood is assigned the durability class of the sapwood. R: resistant; NR: Not resistant; NRH: heartwood known to be not resistant
(7) The resistance only relates to the heartwood; the sapwood of all of the wood species is not resistant. R: resistant; MR: moderately resistant; NR: not resistant
(8) Values obtained from tests carried out by CNR research centre, Florence
Note: n/d: Insufficient data available, v: species shows a very high level of variability

» WOOD

Specific gravity and porosity

The specific gravity and the porosity (percentage ratio of void volume to total volume), are two very important characteristics of wood, in relation to the movements caused by the variation in the relative humidity of the air (see table 1). In general, woods with a high specific gravity swell and shrink more than those with a lower specific gravity. However, very porous woods (that is to say, with low specific gravity, such as fir), have the disadvantage of a response speed to variations in ambient humidity in the first 3-5 days that is considerably faster than woods which are less porous (e.g.: Douglas) and therefore have a low hygroscopic inertia (Fig. 2).

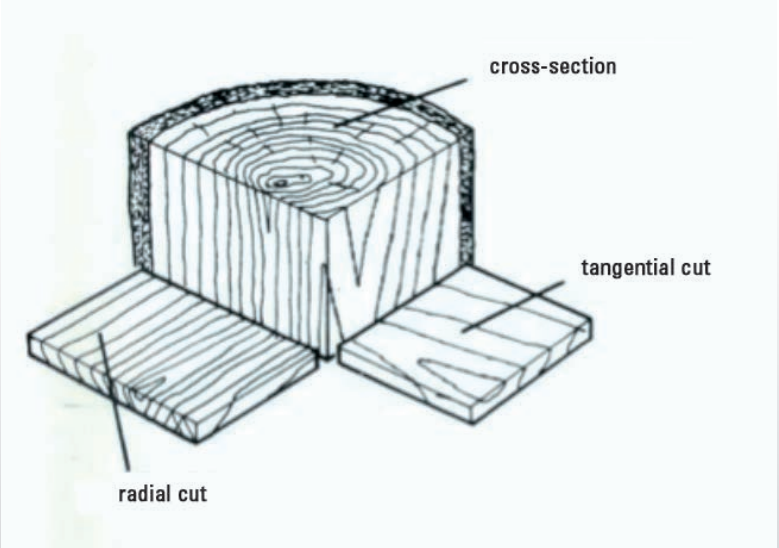
Fig. 2: tangential swelling of bare pine and oak in an environment with 23°C and 100% relative humidity.



Wood and ambient humidity

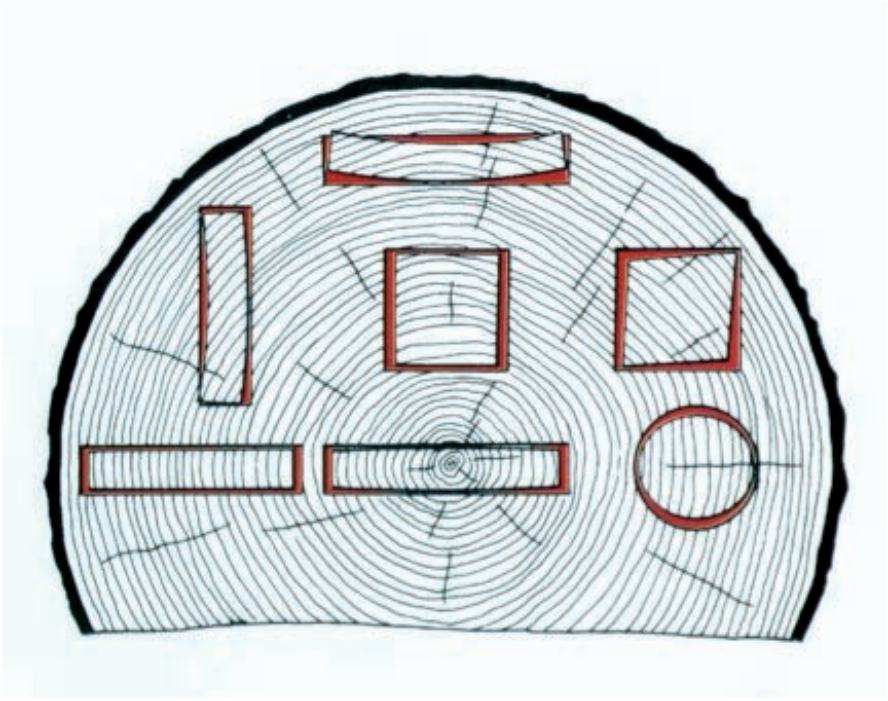
Wood is a hygroscopic material, that is to say, it tends to absorb and desorb moisture depending on the relative humidity and the temperature of the air. This property of wood results in internal movements, known as swelling and shrinkage. The greatest dimensional change is seen with a tangential cut. With radial or transversal cuts it is smaller or practically non-existent (Fig. 3 and Fig. 4).

Fig. 3: wood cuts



» WOOD

Fig. 4: shrinkage and distortion of elements obtained in various positions shown on a cross-section of the log



The various wood species swell and shrink differently, also depending on the time for which they are exposed to a particular environment. Woods with low specific gravity (e.g.: fir and pine), tend to swell after just 5 days of exposure in a humid environment. Woods with a high specific gravity (e.g.: oak), initially do not swell very much, but if the humidity conditions persist for longer than two weeks, tend to swell more than those with low specific gravity (Fig. 2).
Table 4 contains some information about the main wood species used for joinery, and their behaviour relative to ambient humidity. Some species have smaller dimensional changes, therefore they are more suitable for environments where humidity is more variable.

Table 4 - Wood species and ambient humidity: tangential and radial dimensional changes compared to the EMC.

Dimensional changes	Wood species	Wood equilibrium moisture content at 60/90% ambient relative humidity	Tangential % and Radial % movement between 60 and 90% ambient relative humidity
Medium	Oak	12/20	2,5/1,5
	Pine	12/20	2,2/1,0
	White fir	12/20	2,1/1,0
	Red fir	12/20	2,1/1,0
Small	Hemlock	13/21	1,9/0,9
	Douglas	12,5/19	1,5/1,2
	Chestnut	12,5/17,5	1,3/0,7
	Teak	10/15	1,2/0,7

» WOOD

SELECTING SOLID WOOD

The wood must be healthy and free of pith. It must also meet these requirements:

- **Fungi**: no fungal attacks; a limited presence of blue stain fungus is permitted.

- **Insects**: no insect attacks; isolated flight holes with a maximum diameter of 2 mm on fresh wood are permitted.

- **Splits**: there must not be any transversal splits. Longitudinal splits are allowed only if they are small and/or repaired with wood.

- **Sapwood**: may be present when its characteristics are similar to those of the heartwood (e.g.: pine). Not permitted for woods in which the sapwood and the heartwood have characteristics that are very different to each other.

- **Resin pockets**: may be present, with maximum width 5 mm, repaired with wood and provided that after coating they are not visible (when using pigmented coatings) or the same colour as the rest of the wood (when using transparent coatings).

Preliminary treatment of the wood
All wood processing is decisive and its true importance is never acknowledged. Such processing ranges from felling of the tree to production of the manufactured article ready to be primed and coated. Much of the success of joinery depends on the processing. The following steps can be identified: preservation, drying, storage and sanding of the bare wood.

From the time the tree is felled, the wood must be preserved so that, during transportation and storage, it is protected from bacteria, fungi and insects.

To minimise movements of the wood caused by ambient humidity, it must be correctly dried. Because, particularly during the first few months outside, waterborne coatings are permeable to water and so tend to absorb ambient moisture, the drying of the wood must aim to make it as stable as possible, so that it is much less sensitive to variations in humidity. Drying procedures which were once suitable for coating with solvent-based products (practically impermeable), are no longer usable for waterborne products. Drying the wood to 10% (for example in the case of pine), then working it is extremely dangerous with a waterborne coating. The correct procedure is to first dry it to 10%, then bring it to 12%, unload it from the kiln and then work it. This second drying cycle causes permanent deformations in the wood which make it more stable (wood hysteresis cycle). Increasingly fast production times are not compatible with best processing procedures, especially for wood, a living material.

When carried out properly, artificial drying (traditional in hot air, in a dehumidification kiln or in a vacuum kiln) is definitely positive and a preliminary step for good, lasting wood preservation. Wood dried using hot air allows more uniform moisture, but if done properly, drying in a vacuum kiln gives the same results. It allows the elimination of most resinous substances present in the wood. For exterior joinery, the relative moisture of the wood recommended for supplying in Italy (average air conditions: 20°C and 65% relative humidity) is between 11% and 15% depending on the wood species.

» WOOD

The wood must be stored in a controlled environment, since warehouses are often infested with insects or fungi.

Sanding of the bare wood must promote absorption of the protective wood stain without making the surface too rough. Sanding with paper that is too fine (more than 180 grit) or worn polishes the surface rather than smoothing it. That prevents penetration by the active ingredients of the protective wood stain, consequently reducing protection against fungi and insects.

JOINERY DESIGN AND CONSTRUCTION

Correct exterior joinery design is the essential prerequisite for a hard-wearing, lasting coating. As well as making the joinery attractive and practical, the design must favour technical solutions in line with the following general principles:

- Atmospheric water must be allowed to run off immediately, preventing it from standing on the surface.
- Moisture must not be allowed to remain within the wood.
- The shape of the frame members (or profiles) for wooden windows must allow easy application of the necessary layer of coating during the coating step.

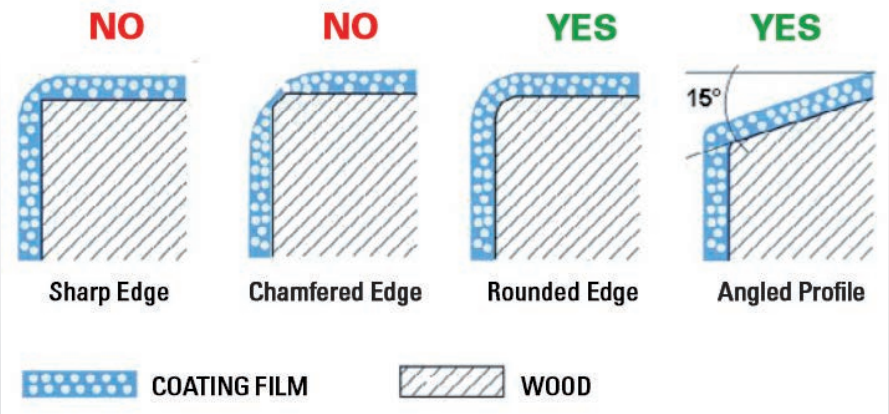
EDGES

Rounded edges (minimum radius of curvature 2 mm) must be used rather than sharp or 45° edges, so that the coating film is continuous and uninterrupted (Fig. 1). Close to a sharp edge, surface tension causes shrinkage of the moist coating film just applied, creating a thin area of the protective surface, through which water can then get in (only 20 microns of moist coating, compared with 200 microns of moist coating on the rest of the wood). It is important that the final part of the rounding connects perfectly with the flat walls on the sides, to avoid the creation of small sharp edges.

ANGLED SURFACES

Any flat parts must have an angle of inclination of at least 15°, both to promote atmospheric water run off (rain, snow, night-time condensation, etc.) and to reduce exposure to solar radiation (Fig. 5).

Fig. 5: examples of edges and angled surfaces. Notice how the coating lies with the different construction methods.



END GRAIN PROTECTION

If the cross-section, or "end grain" of a piece of wood is viewed under a microscope, you can see how, unlike with a radial or tangential cut, the in-depth structure of this part of the wood consists of a multitude of small open tubes (tracheids and vessels), similar to a sponge. This aspect results in two extremely dangerous situations.

» JOINERY DESIGN AND CONSTRUCTION

The wood in this region is more permeable to water: it acts like blotting paper, water and/or moisture travelling along the channels several centimetres into the wood. Consequently this wood, having a higher moisture content than the rest of the joinery structure, tends to deteriorate significantly faster. It is also easier for fungi to attack this area.

Instead of being deposited on the surface, the coating is absorbed by the wood. No visible finishing layer is left on the surface. This means reduced protection against UV radiation and water, with sudden deterioration of what little coating was left on the surface.

What tips relating to joinery design, construction and coating should be considered in order to minimise defects that arise with the presence of end grain?

In general, use cutters able to precisely cut the end grain, without leaving the surface too open or rough.
For sashes and fixed frames, use a special doser to apply to the end grain the water-based resin barrier with elastic properties XA 481 (Fig. 6), so as to close all of the open channels. That operation must be carried out before applying the top coat on the protective wood stain (Fig. 7).

Fig. 6: Sayerlack XA 481 single-component filler

Fig. 7: application of the XA 481 single-component filler on the ends. First use the special doser to apply the product on the end section, then remove any excess product with your finger.

Prevent the fixed frame vertical member, on the outside, from reaching the base of the frame (that is to say, resting on the windowsill), by using a horizontal member which is as long as the width of the window.
For shutters with vertical elements, use 150-180 grit sandpaper to sand the shutter end sections, so as to reduce surface roughness and the permeability of the end grain.
Opt for shutters with vertical elements in a protected position rather than completely outside or flush with the wall.

» JOINERY DESIGN AND CONSTRUCTION

Exterior shutters must be mounted raised off walls (by at least 6 mm), to prevent water from standing between the wood strips and the walls, especially if there is an exterior windowsill, where we usually see greater deterioration due to the fact that, if installation is incorrect, the end grain may be left to soak in water.
For exterior shutters with vertical elements, apply another coat on the ends (or apply a larger quantity of coating), because, as the wood there has a spongy structure, it needs extra sealing.

SHUTTERS

Special care must be taken when designing and constructing shutters. This is in addition to the aspects already covered in the previous sections concerning end grain.
Due to the methods used to make such shutters, during lengthy periods of high ambient humidity (e.g.: fog) or persistent rain or snow, there are problems with swelling towards the outer sides, bowing and/or breakage of the supporting frame and difficulty opening and closing. Such problems are due to the fact that the preferred materials for making shutters are strips of wood with pronounced U or V shapes in the grain, that is to say, from tangential cutting of the log. The tangential section of the wood is that which undergoes the greatest swelling and shrinkage when there are changes in moisture content. If a wood strip shutter has between 6 and 8 tangential cut strips of wood placed side by side, then swelling is greatly increased.

Fig. 8: examples of different cuts from a pine log. On the left is the tangential cut: the wood shows pronounced shapes in the grain. On the right is the radial cut: the wood has a striped grain.

Below are several tips for designing, constructing and coating wood strip shutters in a way that will minimise swelling.

Use well-seasoned wood: do not use wood with 10% moisture content. Wood which has undergone a hysteresis cycle should preferably be used (see Drying wood).

Where possible, use wood obtained with a radial cut or as close as possible to it: since this is much more stable.

Leave a space of at least 2-3 mm between the wood strips.

Apply a coating to the male and female sections of the strips before assembling the shutter, so as to reduce the infiltration of humidity into the wood (in this case a white or brown coating could be used, also to reduce the problem of visible bare wood following wood movements).

» JOINERY DESIGN AND CONSTRUCTION

These tips should be followed, together with others already mentioned, which also help to reduce issues with shutters:

Sand the ends of the strips with 150-180 grit sandpaper before coating.

Leave a gap of 6 mm rather than 4 mm between lateral walls and the shutter.

Apply a larger quantity of coating on the ends.

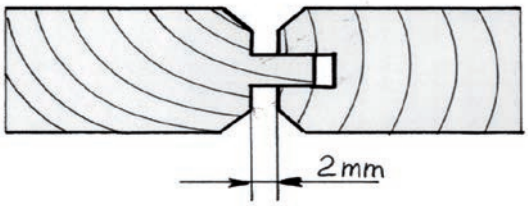


Fig. 9: example of joint between two strips with empty space, obtained by removing a plastic profile once the shutter had been assembled.

Concerning the 2 mm space between strips, a summary of the possible solutions is provided below:

Empty space (Fig. 9): this is by far the best, since there is 100% recovery of the empty space. Achieved using 2 mm plastic profiles, which are removed once the shutter has been assembled.

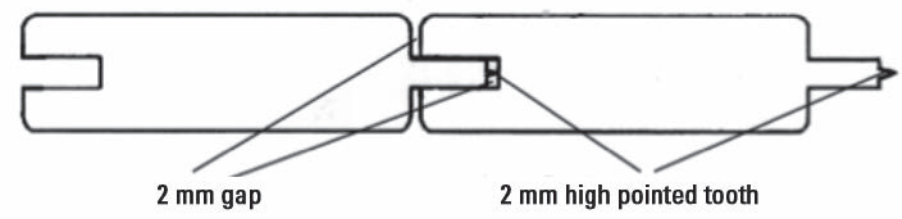


Fig. 10: example of joint between two strips with bead, having a small pointed tooth on the end of the male part.

Male end with small pointed tip (Fig. 10): gives good results. There is 50% recovery of the empty space left between the strips (Fig. 11). A similar result can be achieved by placing the pointed element in the female part rather than on the male part.

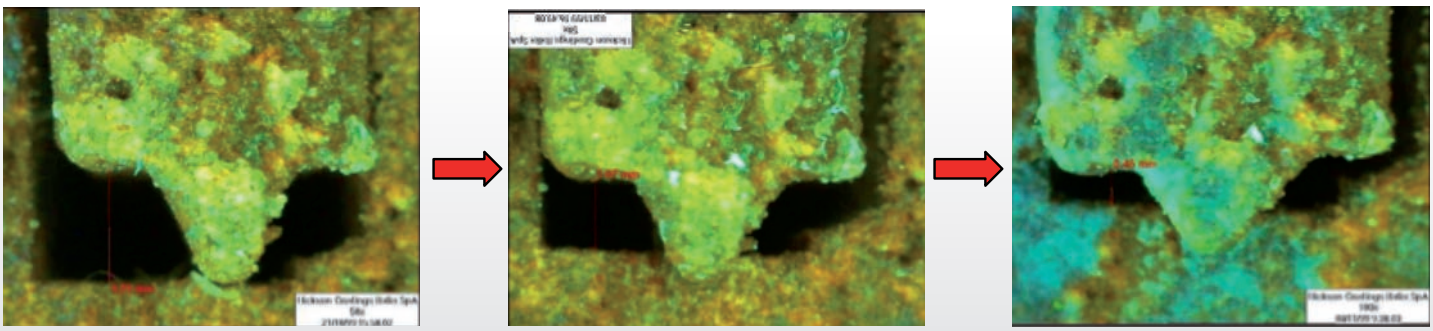


Fig. 11: microscope enlargement of a joint between two strips of the type with a male end having a small pointed tip: notice that from left to right, as the exposure time to a humid climate increases (two weeks of rain) the tooth is partly crushed and partly penetrates the female part.

Entire male end forming a pointed tip: gives no guarantee of recovery of the empty space since the pointed tip, being very wide, cannot be driven in or crushed, depending on normal changes in the moisture of the wood (that is to say, up to 20%).

GLUING, FILLING, SEALING AND ACCESSORY MATERIALS

GLUING THE WOOD

For windows, use adhesive which is classed as at least D3 in accordance with EN 204.

For gluing shutters and laminated wood, use adhesive which is classed as D4 in accordance with EN 204.

FILLING

Filing has always been a fundamental step in coating systems both for interiors and exteriors. Its main function is to correct and cover imperfections, splintering and cracking of wood.

The filler is usually applied during the coating step immediately after application of the protective wood stain and/or the basecoat.

Filling bare wood is preferably avoided, since all of the imperfections in it may not yet be apparent and so cannot be completely covered. They would become visible after application of the coating.

Basically, the choice of filler is greatly affected by application conditions. However, it is important to consider the most common problems linked to the use of fillers in coating systems with waterborne products.

The filler should ideally have the following characteristics:

It should not cause shrinkage or swelling after drying, due to application of the waterborne topcoat over it.

It should not cause haloing after sanding, due to application of the waterborne topcoat over it.

It must guarantee optimum hold for the subsequent waterborne topcoat.

It must have a good level of sandability.

It must not crack too much. If it does, it should then be "smoothed" before application of the waterborne topcoat.

There are many types of filler on the market with very different characteristics.

Do not use fillers containing wax. Use two-component fillers for rebuilding joinery parts. The best solution is always the wooden dowel. For small repairs (less than 1 mm) single-component fillers can be used.

Whatever the case, a preliminary test is always recommended to highlight any problems involved in the above-mentioned case.

» GLUING, FILLING, SEALING AND ACCESSORY MATERIALS

Filling should only be carried out if absolutely necessary and inevitable, since it is always a weak point in the wood-coating system.

SEALING GLAZING

The main function of silicone sealing is to form a seal between the glazing and the door or window frame which must be long-lasting and prevent any water or air from infiltrating. This reduces heat loss.

Silicone can be applied during the final step of the joinery coating system, either directly at the manufacturer's premises before installation, or on site following delivery of the frame without the glazing but with glazing beads in place (the glazier will then seal the door or window).

There are many types of silicone on the market with very different characteristics.

The choice of silicone is affected by application conditions. However, it is important to consider the most common problems linked to the use of silicones in coating systems with waterborne products.

The silicone must have the following characteristics:

Optimum adhesion on the waterborne topcoat, on the glazing and wood.

Optimum resistance to ageing, meaning the capacity for withstanding sunlight and weather.

Permanent elasticity without creating micro-cracks or chalking as time passes.

Good chemical resistance.

During polymerisation it must not generate acidic or alkaline substances which may corrode, attack or simply cause haloing of the waterborne coating.

Given the wide variety of materials available on the market, it is always a good idea to carry out a preliminary test, to highlight any problems involved in the above-mentioned case.

In general, neutral cure silicones (e.g.: with alkoxy or benzamide curing) in practice gave the best results on waterborne coatings for exteriors.

GASKETS

Gaskets are designed to guarantee closing and a hermetic seal between the parts of a door or window frame, so that it remains perfectly sealed against water and air, reducing heat loss.

» GLUING, FILLING, SEALING AND ACCESSORY MATERIALS

When using gaskets on articles coated with waterborne products it is important to consider the compatibility of the systems used: not all gaskets available on the market meet that requirement.
Ideal gaskets are of the thermoplastic type, which when joinery is treated with waterborne coatings for exteriors, are made of olefin rubber (derived from oil compounds). Unlike traditional PVC mixture-based gaskets, such gaskets do not normally contain additives for guaranteeing flexibility and elastic return (recovery from deformation when the test load ceases). This means that, even at high temperatures, since there are no volatile plasticising additives present, elasticity and dimensional stability characteristics remain unchanged. Also, the chemical affinity (due to polarity as a result of a charge imbalance at molecular level) between such plasticisers and the compounds used in waterborne coatings, may cause solid gluing of the gasket to the article, deteriorating into blocking problems. For these reasons PVC mixture-based gaskets are usually unsuitable for fitting on windows coated with water-dilutable acrylic coatings.
Vice versa, olefin rubber gaskets contain no plasticising additives, since the elastic characteristics are intrinsic in the basic material and so are more compatible with use with waterborne coatings. That property also allows gaskets with practically no shrinkage and a brittle point (temperature at which the gasket becomes rigid) shifted to lower temperatures, also favouring their use in extremely cold environments (not possible or extremely difficult with PVC mixture-based gaskets).

In any case, given the wide variety of materials available on the market, it is always a good idea to carry out a preliminary test to check the suitability of the gasket selected.
One gasket test procedure uses a criterion set by I.F.T. in Rosenheim, which may be summarised as follows:

Four pieces of gasket 60 mm long are placed between two coated wooden boards. The wooden boards (initially dried with moisture content at 12-15%) must be coated 24 hours before starting the test. The dimensions are approximately 150x50x15 mm. The gaskets are made to project by around 5 mm on each side.

The sample formed in that way is wrapped in a sheet of aluminium, pressed with a load of 500 g and put in a heater at a controlled temperature of 50°C for 14 days.

After 14 days the results are checked by considering the **gluing**, **degeneration** and **colour** of the samples. The result is a **pass** or **fail** in the following cases:

GASKET TEST RESULTS CLASSIFICATION

Assessment of	Pass if	Fail if
Gluing	The gasket can be removed without effort, even if apparently glued	The gasket appears firmly glued to the coated wood and removal is difficult
Degeneration	The gasket is intact, dry, free of defects (cracks, etc.)	The gasket has deteriorated, with the possibility of some parts remaining attached to the coated wood
Colour	No colour change, any colour halos can be removed using products classed according to DIN 68861/1^ (water, etc.)	Persistent, non-removable colour defects (marks, shading, etc.)

» GLUING, FILLING, SEALING AND ACCESSORY MATERIALS

These assessments apply for any type of gaskets and should be considered approximate, since actual operating conditions are different to experimental conditions.

PACKAGING MATERIALS

Expanded polystyrene, bubble wrap and PVC-based plastic materials are not suitable for packaging manufactured articles on which a waterborne coating has been applied. Expanded polyethylene has provided excellent results. Given the great variety of materials on the market, a preliminary test is always recommended. Positive results have been obtained with foams similar to those shown in this photograph.

INSTALLATION

Shutters must be mounted raised off walls by at least 6 mm, to prevent water from standing between the wood strips and the walls, especially if there is an exterior windowsill, where we usually see greater deterioration due to the fact that, if installation is incorrect (gap of less than 6 mm), the end grain may be left to soak in water.

For shutters with two leaves, the latter must be installed in such a way as to leave a gap of 6 millimetres between them.

Any external edge covers must be protected on the ends, for example with the application of a silicone or the **XA 481** barrier before fitting.