SUPER GROUP OF INDUSTRIES

TECHNICAL INFORMATION FOR THIN HPL

SUPER HYLAM (P) LIMITED

CONTENT

PREFACE

This document is intended to provide a general understanding of HPL, its manufacture, properties, types and relevant international standards.
It provides information on working methods with Thin HPL, as well as some good practice recommendations for its use. The advice and recommendations have an advisory nature only. If you need more information or have a specific question, please contact Super Hylam customer service.

1. AN INTRODUCTION TO HPL

1.1 **What is HPL**

Decorative High Pressure Laminates (HPL), as defined by the European and international standards for HPL – EN 438, ISO 4586 and BIS 2046 are high-density panels (≥1.35g/cm3), finished and ready for use, which have exceptional mechanical, physical strength and chemical resistance, are easy to work and simple to maintain. Super Hylam HPL panels are made of several layers of cellulose fibre material impregnated with thermosetting resins and then simultaneously subjected to both pressure (>7MPa)) and heat (140 / 150°C) in special presses, for a fixed time, which varies depending on the type of laminate. This process creates a stable, inert, homogeneous, nonporous and high density material, with physical and chemical properties that are totally different from those of its original ingredients. In addition to given its very low permeability, HPL acts as a barrier against the possible emission of formaldehyde and other volatile substances (VOCs) from any timber substrates it is applied to.

1.2 Composition

HPL panels are made exclusively of cellulose-based materials (60–70%) and thermosetting resins (30–40%). They can have decorative finishes on one or both sides.
These are the different layers:

- *Overlay*

A highly transparent paper, which makes the laminate surface abrasion and scratch resistant. Used only with printed patterns.

- *Decorative paper*

External paper, with no chlorides. These are coloured or patterned and give the laminate its aesthetic appearance.

- *Kraft paper*

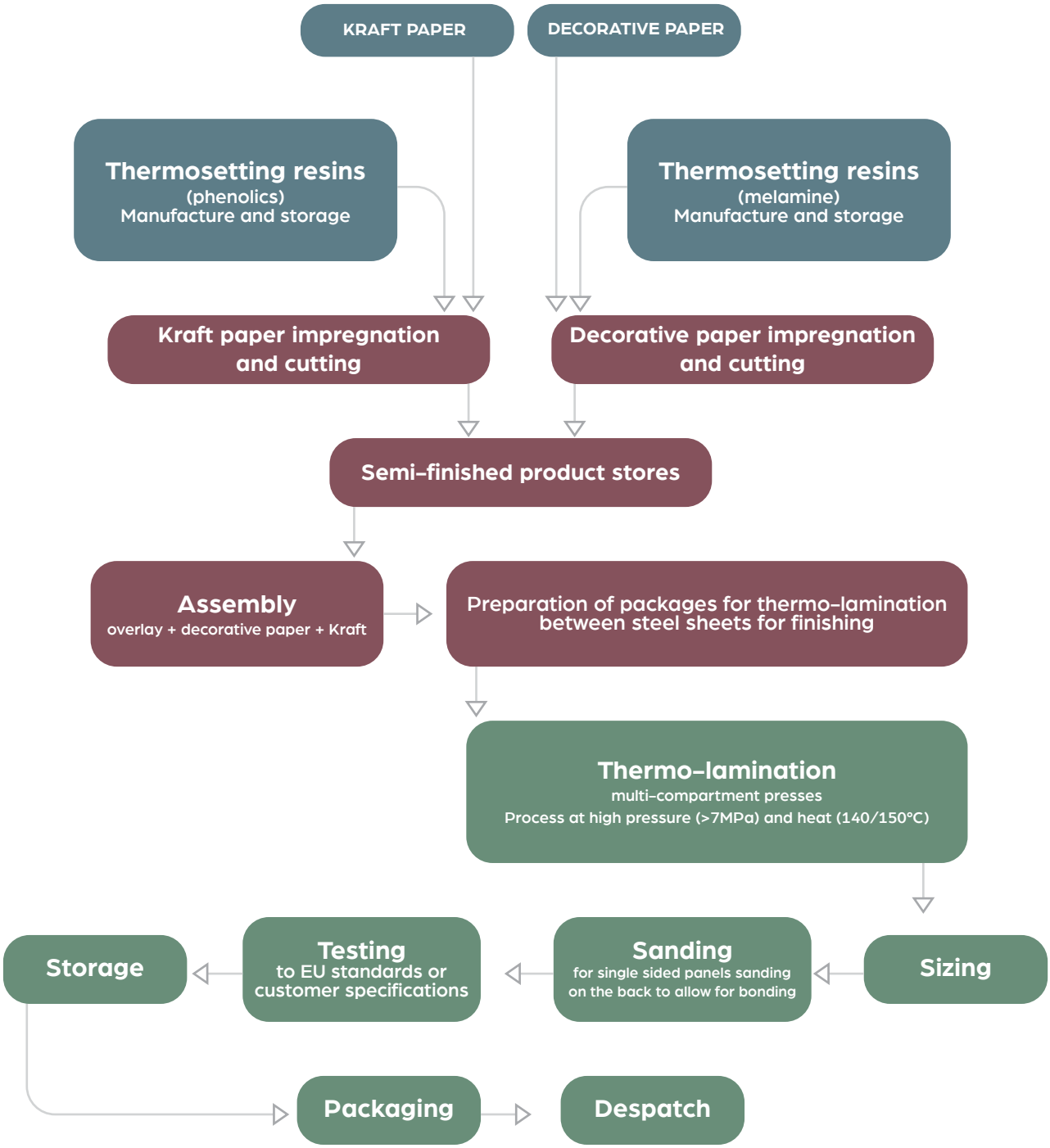
"The heart" of HPL. This is the, mostly brown, paper, which is the core of high-pressure laminate.

2. MANUFACTURE

2.1 **Manufacturing process**

Behind the apparent simplicity of high pressure laminates lies highly advanced technology that requires a powerful manufacturing plant and substantial investment in research and development.

The manufacturing process for HPL is governed by BIS 2046 and ISO 4586, which sets out specifications for the finished product. In Super Hylam specifically, the decorative and kraft papers are mainly purchased from paper mills, while the thermosetting resins are produced in-house. These are the different manufacturing stages:



2.2 **Most common grades**

Here are some examples, in accordance with this standard, of common grades of HPL for interior use and their principal applications.

Grade	Properties	Principal Applications
Single sided laminates up to 2mm thick		
HGS	Standard suitable for horizontal as well as vertical applications that require high performance.	Furniture, worktops, kitchens, catering, retail etc.
HGP	Postformable with properties similar to the category above but can be bent and formed at high temperature.	The same areas as HGS, where the project requires curved surfaces.
HGF	High-performance laminate, with specific fire resistance.	Premises that require compliance with fire regulations: schools, hospitals, laboratories, public transport, ships, airports, waiting rooms, railway carriage etc.
VGS	Standard Suitable for vertical as well as horizontal applications that require high performance.	Furniture veneer, cabinets, lifts, doors, offices, wall paneling, kitchens, bathrooms etc.
VGP	Postformable with properties simialr to the category above but can be bent and formed at high temperature.	The same as above, where the project requires curved surfaces.
Single sided laminates up to 4mm – double sided from 2mm to 30mm thick		
CGS	Thick, compact and integral material for both vertican and horizontal applications.	Furniture, benches, bookcases, transport and sports facilities, where strength ad / or self-supporting properties are required.
CGF	Thick, compact and integral with specific fire resistance requirements	The same as above, where there are fire regualtions.

3. GENERAL WORKING WITH HPL

3.1 **Maintenance**

HPL surface should be cleaned regularly but does not require any special maintenance, just a damp cloth with warm water or mild detergents. Almost all normal household cleaning products or disinfectants are tolerated perfectly well, as long as they are not abrasive or highly alkaline.

The table below shows the cleaning products and methods best suited to different types of dirt.

Recommendations for cleaning the surface of HPL for interior products

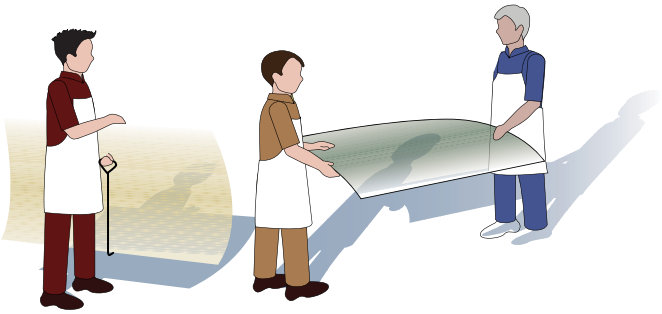
Type of dirt	Recommended cleaning product and method of application
Syrup, fruit juice, jam, spirits, milk, tea, coffee, wine, soap and ink	Water with a sponge
Animal and vegetable fats, sauces, dry blood, dry wine and spirits, eggs	Cold water with soap or household detergent with a sponge
Smoke, gelatine, vegetable and vinyl based glues, organic waste, gum arabic	Hot water with soap or household detergent with a sponge
Hair spray, vegetable oil, biro and felt tip pens, wax, foundations and greasy make-up, residual solvent marks	MEK, alcohol, acetone with a cotton cloth
Nail polish, spray lacquer, linseed oil	Acetone with a cotton cloth
Synthetic oil paints	Trilene nitre based solvent with a cotton cloth
Neoprene glues	Trichloroethane with a cotton cloth
Traces of silicone	Wooden or plastic scraper, taking care not to scratch the surface
Lime deposits	Detergents containing low percentage of citric or acetic acid (10% max)

3.2 **Transportation / Handling.**

• In order to avoid damage of surfaces and edges, sheets must be handled with extreme care. Always transport the panels on flat and stable pallets and secure the panels so that the do not slip.

• Make sure that the panels do not slide over each other during loading and unloading operations. Lift them by hand or, if compact laminate, by means of a suction cup hoisting device.

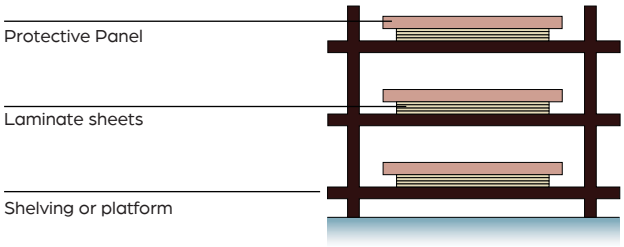
• Pay particular attention to dirt, foreign bodies and sharp edges that can cause damage in case of rubbing against the surfaces.



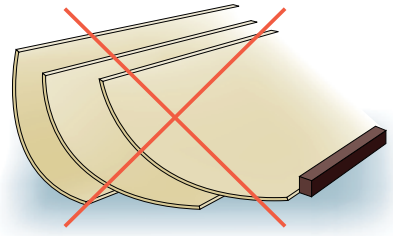
3.3 **How to strore HPL**

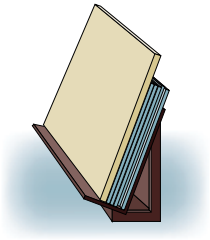
The sheets of HPL laminate are placed in pairs and with the decorative sides one against the other, on flat, horizontal shelves; the outer sheet will have the decorative side facing downwards to prevent the surface being damaged or distorted and it is a good idea to protect it with a polythene sheet or a larger sized hardboard panel. If horizontal storage is not possible, the sheets can be placed in piles at an angle of 60 – 70°, with the whole surface area resting against a rigid support and making use of any device that will help prevent them slipping. Decorative laminates should always be kept in an enclosed space at a temperature of between 10 and 36°C and humidity between 60 and 65%. It is also important to remember that the longer the HPL laminates are kept in stock, the greater the risk of warping, so if they have to be stored for an extended period, it is always better to secure them with straps

Correct horizontal storage.



The sheets that do not support the entire surface to a rigid support tend to slip and to bend.





3.4 **Cutting/Milling/Drilling**

3.4.1 Cutting

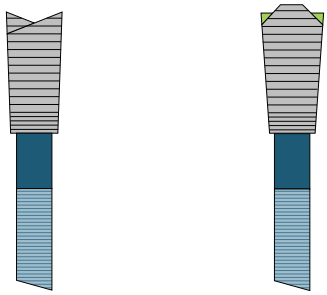
How to cut HPL

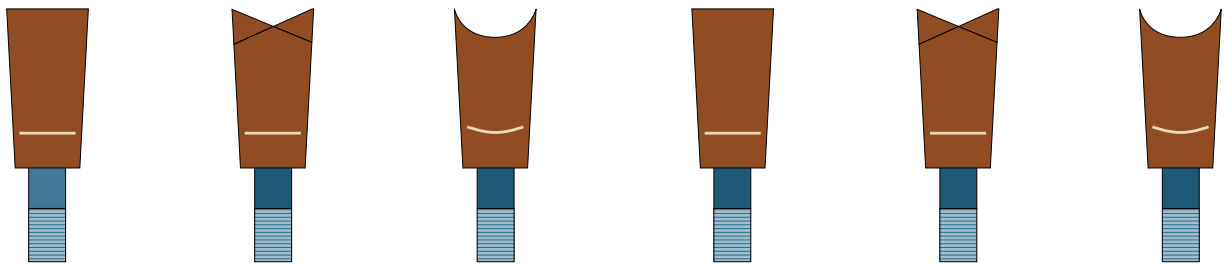
The decorative side of the HPL laminate sheet is impregnated with melamine resin, which makes the surface hard and uniform.
It should preferably be cut with saws using blades with tungsten carbide inserts; these are longlasting, but must be handled with care since they can easily be damaged if they come into contact with metal surfaces. They are especially recommended for cutting standard and com–pact laminates.
Please note: for the Flooring grade, blades with diamond inserts are recommended because they stay sharp for longer and are therefore longer lasting.

Cutting by hand

Portable circular saws are used only in certain circumstances, where onsite work is essential. The saw must be well sharpened so that great pressure is not required and this reduces the risk of the laminate chipping and / or cracking. The operation should always be carried out in com–pliance with codes of practice and safety regulations.

Profiles of the tungsten or diamond inserts fitted to the saw discs currently available.





Cutting with bench machinery

This essentially entails circular saws.

To get good results with bench circular saws it is essential:

• To place the laminate with the decorative face in the opposite direction to the rotation of the blade. In addition, the sheet must be well supported and heldin place with an adjustable height pressure tool to prevent movement and vibration.

• To use an accurate guide,

• To make sure that the saw blade is aligned with the worktop and projecting the right amount.

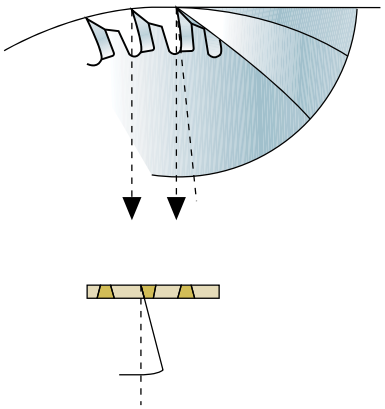
it is also possible to cut several sheets of laminate together. In the case of single sided sheets, all the sheets should be located with decorative sides facing upwards. In the case of double sided sheets, to avoid any chipping caused as the disc exits the lower face, machines fitted with a scribe should be used before the actual cutting. Alternatively, the stack of sheets should be placed on a "sacrificial panel" that is at least as hard and substantial as the laminates that are being cut to shape.

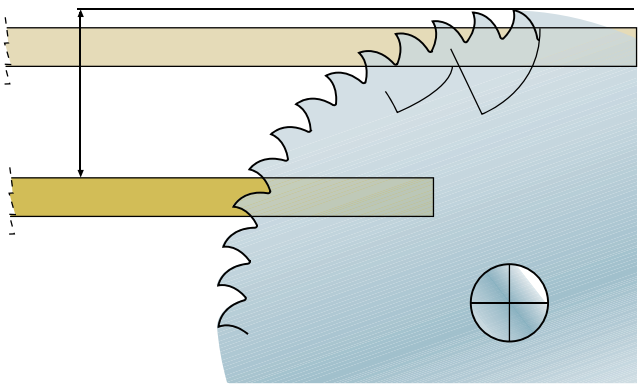
Recommended specification for circular saws:

- Tooth pitch, 10 to 15mm.
- Cutting speed, 3,000 to 4,000 rpm
- Tip speed, 60 to 100m/ s
- Forward speed, 15 to 30m / min.

The blades should not be too thin; if they are less than 2mm thick, they lose rigidity and then vibrate, making the cut less precise.

Blade advancement scheme.





Cutting Composite Panels

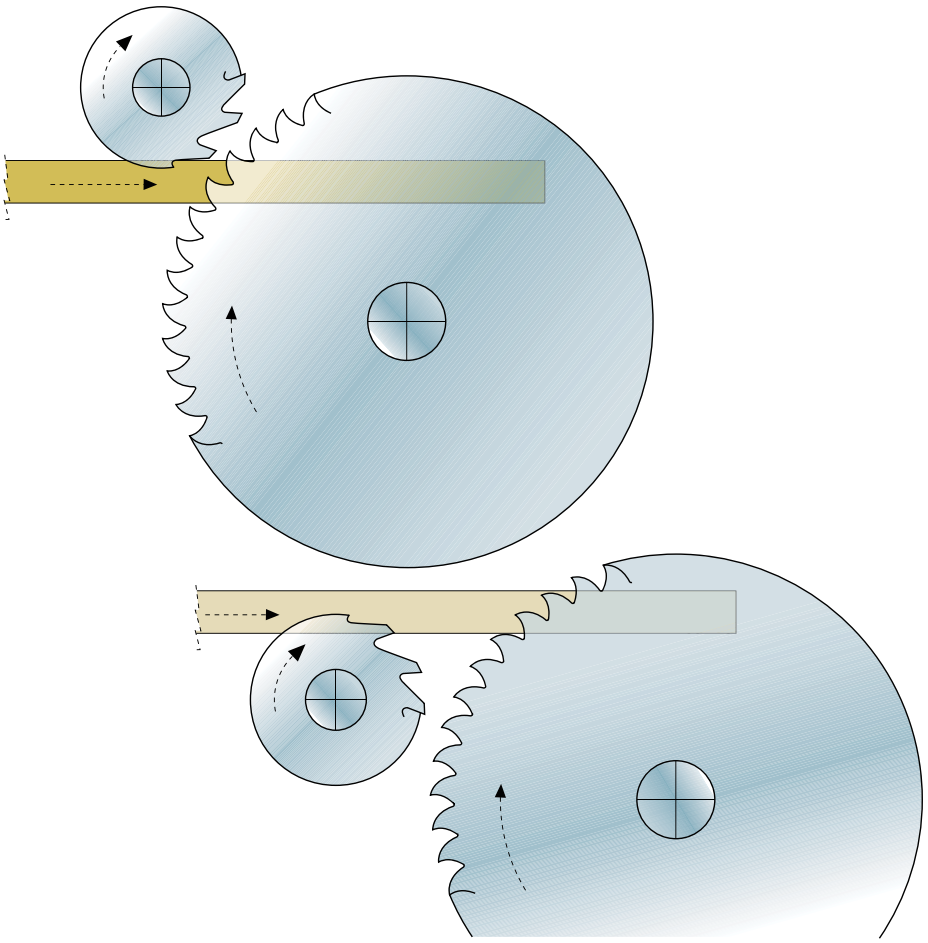
Everything mentioned so far also applies to the cutting of composite panels with decorative laminate glued onto one or both sides of the substrate. In this case too, band saws are not recommended. Best results are achieved with fixed circular saws fitted with scribes and by carefully adjusting the blade height. The quality of the cut also depends on the profile and the number of teeth, the tip speed, the forward speed and the blade's angle of entry and exit.

For cutting laminate and composite panels it is a good idea:

1. to choose the most suitable blade
2. to use a low forward speed and not "attack" the material;
3. to vacuum the dust during the work.

Operations should be carried out in compliance with codes of practice and safety regulations.

Circular saws



3.4.2 **Milling.**

How to mill HPL laminate

Depending on the circumstances, milling can be carried out in various ways, using portable tools or fixed equipment.

Milling with portable cutters

For an accurate job it is always essential to use machining centres. Portable cutters, as well as belt sanders or grinding wheels, are used especially to trim the projecting edges of panels already glued onto a substrate. In this case, the base of the cutter must be covered with felt to protect the decorative finish side during the work. The laminate surface should be cleaned of any dust and grit and it is essential to remove the chips during the operation, by vacuuming. For the machined part to be properly finished, a rotation speed of at least 20,000 rpm is required. Cutters with two blades, one straight and one angled, are suitable both for a square cut and for chamfering. To avoid damaging the tools, the section of laminate to be milled should not project beyond the backing by more than 2 to 3mm. For continuous operations or for major projects, the use of power tools with parallel blades is recommended.

Milling with fixed equipment

Milling machines or wood machining centres with chucks with interchangeable blades can be used. The recommended tool attachments are cutters, discs or drill bits in solid tungsten carbide or in steel with tungsten carbide or diamond inserts, with one or more vertical or angled teeth. In the case of curved edges, it is better to cut out the rough shape required first, leaving a 1mm surplus. The next step is milling to the finished shape required.

Smoothing by hand

To finish the edges or chamfer the corners by hand, various tools such as files or sandpaper can be used. To trim the edges or chamfer the sharp corners, square (rather than milled) files are used, making sure to use them in a direction away from the decorative side towards the core. It is also possible to use fine files or abrasive paper (100–150 grit sandpaper) and dual speed scrapers. To avoid scratching, it is important to proceed gently and possibly in two stages, first with a coarser and then with a finer sandpaper.

3.4.3 **Drilling.**

How to drill HPL

The techniques shown are valid both for drilling individual sheets of HPL laminate and for drilling those already glued to a substrate.
Naturally these operations should also be carried out in compliance with codes of practice and safety regulations. For best results and to avoid the risk of future splits or cracks, it is important to remember the following:

• Holes for screws should have a diameter at least 0.5mm greater than the diameter of the screw itself. This is because the screw must have some "play" in all directions without touching the edges of the hole, to allow for slight dimensional movements in the laminate caused by changes in environmental conditions and to avoid cracks appearing around the actual hole.

• The drill speed should never be such as to overheat the melamine surface of the decorative laminate and damage it.

• To avoid splintering the material around the drill bit's exit hole, it is a good idea to place the laminate on a hard wooden board.

•To prevent round head screws as well from "gripping" too tightly, plastic or rubber washers can be fitted.

• After drilling, it is advisable to check that the edge of the hole is clean and smooth. Should it not be, carefully rectify it because any micro-spalling can lead to cracking in the future.

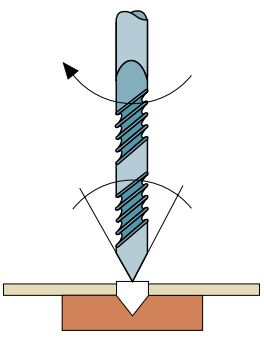
Drilling tools

The choice of tools depends on the size of the hole that has to be made. Basically it involves pillar tools, hand tools or a machining centre that can mill as well as drill.

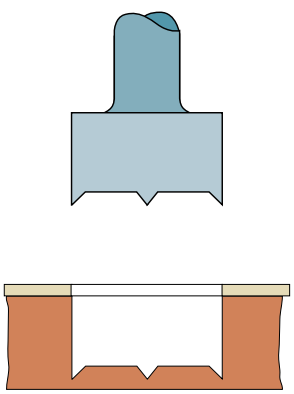
a) Twist drills

The most suitable bits for drilling decorative laminates are special steel twist drills for plastics, with a point angle of 60° to 80° (rather than the 120° of normal metal bits), a sharp helix angle and a wide flute for rapid chip removal. The recommended rake angle is 7° with an 8° angle of attack.

Drilling with helical wick



Drilling with milling cutter



b) Hole cutters

These are recommended for larger holes.

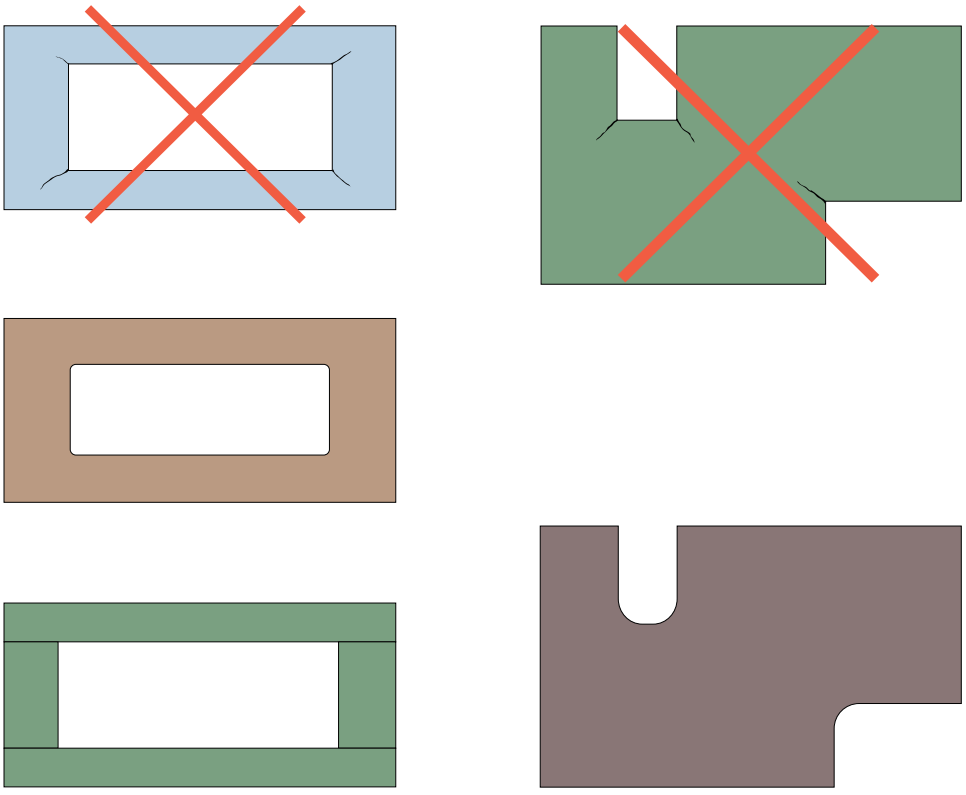
3.4.4 **Internal Cuts.**

How to make internal cuts

The following refers both to laminate sheets and to composite panels with HPL laminate applied to one or both sides. When carrying out internal fretwork, it is important to know that right angled cuts can cause breakage or cracking of the laminate. In order to avoid these, all the corners of the internal cut-outs should be evenly rounded, polished and brushed to remove any chips. The inner radius of the rounded corner must be as large as possible.

For internal cut-outs with side dimensions of up to 250mm, the rounding of the corners should create a radius of at least 5mm. If the length of the cut is greater, the radius of the corners should be greater too. Before cutting the side of the opening, it is better to form the interior angles directly with the milling machine or drill, rounded to the required radius. If the design requires interior right angles, this should be achieved by placing HPL laminate panels together at each corner with butt joints.

Cutouts-angle can cause cracking or fissuring of the laminate.



Interior trim corners should be rounded.

3.5 **Pre Conditioning.**

How to prepare hpl laminates and substrates

High-pressure decorative laminates are made of up to 60 / 70% cellulose fibres. These are very sensitive to changes in temperature and, especially, humidity and react with dimensional movements. The dimensional changes in HPL may be different from those of the backing and therefore cause distortions in the finished panel.

This can be avoided by:

- Preconditioning both the backing and the laminates prior to bonding
- Balancing the composite panel so that the two outer faces consist of laminates with identical properties
- Ventilation and humidity control in the room where the composite panel is installed
- Installation of the panel in such a way as to allow any dimensional changes

3.5.1 Pre-conditioning

In order for the decorative laminates and the substrate to achieve a balanced and stable humidity level, they must both be pre-conditioned at the same time before they are bonded together. This operation enables any differences between the materials to be minimized, especially in the event of changes in environmental conditions, which are the causes of stresses. There are "hot" and "cold" techniques to help achieve this.

3.5.2 Cold pre-conditioning

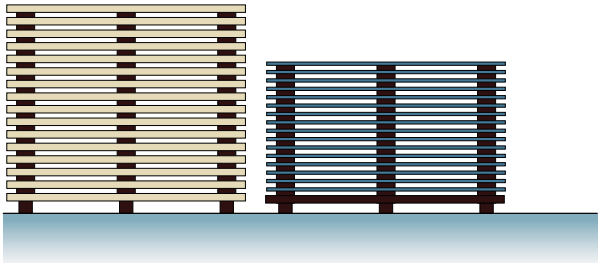
Method A.

The decorative laminates and substrates are stacked and shut away together for at least three days in a room with humidity and temperature levels similar to those where the finished panels are to be installed. If these are to be installed somewhere hot and with consistently low humidity, the components must be conditioned in a hot and dry atmosphere to avoid subsequent shrinkage

Method B.

Laminates, substrates and adhesives are placed in a room for ten days at a temperature of between 18 and 20°C, a humidity of 50% and with good air circulation.

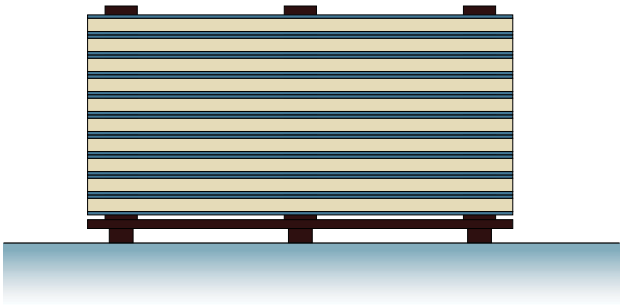
Method B



Method C.

The sheets of laminate that will form the opposite faces of the same panel are stacked in pairs in a dry room for at least three days, with the back sanded faces in contact, until they achieve an almost identical moisture content. After bonding, every movement caused by changes in humidity will be similar in magnitude and direction on each side of the panel, reducing the risk of distortion. With this method, there is no need to condition the substrate in the same place.

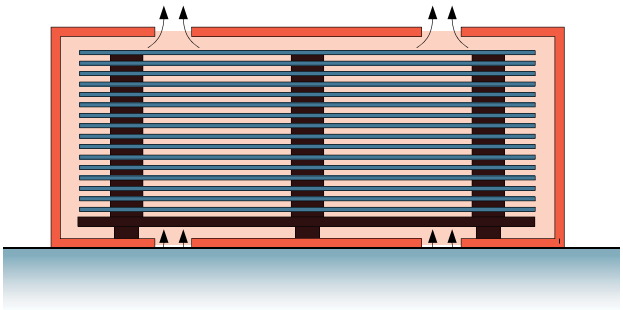
Method C



3.5.3 Hot pre-conditioning

The sheets of laminate are arranged in pairs, spaced apart, so as to allow hot air to circulate. Duration and temperature will vary depending on the type of glue used (for example, 10 hours at 40°C or 6 at 50°C). If it is necessary to speed up the operation, the laminates can undergo an accelerated partial drying process, placing them, separated by battens, in a small heated room, for about 3 hours at a temperature of 40°C or for 2 hours at a temperature of 50°C. A heat press can also be used to speed up the operation even further, with panels put in two at a time (face to face) for about ten minutes. The bonding should be carried out several hours later.

For pre-conditioning, the panels should be placed, backs together in pairs with spaced slats to allow air circulation.



Please note: These guidelines apply when environmental conditions at the panel's intended location are temperate. For extreme conditions, it is advisable to refer to Super Hylam Private Limited customer services. If the composite panel's final destination is one with low relative humidity, it is advisable to pre-condition both the substrate and the laminate at a similar relative humidity and at room temperature or at a higher temperature for a shorter period; e.g. 20 hours at 40°C or 10 hours at 50°C. It is never advisable to exceed 50°C. Bonding should be carried out immediately after pre-conditioning, strictly in accordance with the manufacturers' recommendations.

- ***Balancing the sheets***

Stresses may occur between two different materials bonded together. To avoid subsequent distortion in the resulting panel, it is therefore desirable to use materials with identical properties on both sides, subject to the same dimensional changes in relation to environmental variations. This is an essential strategy, especially if the panel is self-supporting or not directly supported by a rigid structure. The larger the area to be clad, the more essential it is to consider these factors: choice of the most appropriate sheets for balancing the panel, density, symmetry and the rigidity of the substrate. Ideally the laminates to be used for both sides of the finished composite panel should be taken from the same sheet of laminate or from laminates of the same type, thickness, pattern, finish and production batch and from the same manufacturer. It is important that the two laminate faces are cut in the same direction, i.e. in the fibre direction of the paper, which is the same as the direction of sanding. In this way, the dimensional movement of the laminate will, in fact, be minimal compared with what would occur if the faces were cut in the opposite direction. Although not recommended because the risk of warping cannot be totally ruled out, it is possible, in standard and non-critical applications, to use materials other than laminate on one side of a composite panel (metal sheets, wood veneer, coats of lacquer, impregnated papers etc.). Naturally, it is important to choose materials with physical properties more like those of the laminate, as the more these differ from those of the laminate, the more likely it is that stresses will be created due to the lack of symmetry.

- ***Ventilation and humidity control***

HPL sheets (both thin and thicker varieties) can be covered on both sides with a protective film. To store them properly, the protective film should never be removed from just one side. It is also important to remember that High-Pressure Laminates and wood fibre substrates are materials that are sensitive to humidity changes in the air. HPL, for example, expands by about 1.5mm per linear metre in both lengthwise and widthwise directions. So adequate space for expansion should be provided between one sheet and the next.

3.6 **Substrate.**

3.6.1 INTRODUCTION

Decorative laminate is a semi-finished product that, in almost all applications, is bonded to a substrate.

The substrate supports the laminate and must resist distortion. The material it is made of should therefore be selected according to the characteristics of the application, the intended use of the composite panel and the environment in which it is to be installed:

- Stability,
- Flatness,
- Rigidity,
- Mechanical properties,
- Uniformity of thickness,
- Water and humidity resistance,
- Fire performance properties.

For the surface of the laminate to appear perfectly smooth and uniform, the surface of the substrate must be too. Imperfections in the substrate, in fact, tend to be transferred to the laminate surface, especially if the sheet is very thin. With a smooth, shiny finish, the imperfection is very obvious. Chipboard and MDF panels are generally excellent substrates because they experience similar dimensional movements to those of decorative laminates, as they are themselves made of cellulose. In other cases, metal or mineral-based, kraft paper and foam plastic substrates are used instead

3.6.2 Adaptability of substrates

In the table below is a list of substrate materials that can be combined with decorative HPL laminates and their degree of adaptability.

Substrate	Degree of adaptability
Panel of particle board (Chipboard)	Fixing methods depend on the thickness of the composite panel. The structure of chipboard (chip shape, resin content, density etc.) greatly influences its surface quality and characteristics. The most appropriate chipboards for bonding to decorative laminates are multilayer chipboards. P3 EN 312–3 type chipboards are an ideal backing for decorative laminates in areas with a dry atmosphere and they can also be manufactured with fire–resisting properties. P5 EN 312–5 type panels are more resistant to moisture and can be installed in areas of greater humidity. To avoid damage due to shrinkage and distortion, the panels should be sanded evenly on both sides. Panels must meet the minimum requirements of the standards. The nominal density should be no less than 650kg/m3
Medium or high density fibreboard (MDF – HDF)	These should be sanded before bonding (usually carried out by the manufacturer). They are made using a dry process and use synthetic resins for bonding the wood fibres together; they have a uniform structure and a fine texture that enables well–shaped finishes to be achieved, with smooth edges. They can be treated to increase fire and moisture resistance. Their nominal density should be no less than 800kg/m3.
Plywood panels	Thin panels are not self–supporting. Fixing techniques depend on the thickness of the composite panel. Low–density plywoods in hardwoods such as poplar are particularly suitable for bonding to decorative laminate.
Laminboard panels	Laminboard panels are suitable only if formed of narrow enough strips. Otherwise, surface undulations may appear in low humidity conditions.
Honeycomb structure substrates	These can be used as internal components of a substrate or combined with a frame.They can be made of wood, metal, impregnated paper, cardboard (recycled or otherwise), polycarbonate or polypropylene. In aluminium, they are ideal for creating panels that are rigid but light, finished with decorative laminates on both sides. They come in different thicknesses and various cell sizes and are bonded with epoxy resin–based adhesives. In non–Impreganted Kraft paper–they are generally used as a core in plywood sandwich panels or panel doors; they are also used with direct lamination in applications where restrications or impact resistance are more important. Impregnated Kraft paper–resists moisture better when impreganted and is normally used in small cell formats. Plastics such as polycarbonate and polypropylene are durable, light and not sensitive to moisture.
Mineral–based substrates	Concrete, calcium silicate or vermiculite panels.There are several non–combustible substrates, mostly calcium silicate–based. Decorative laminates should be used only on substrates formed from a single block because these are more resistant to delamination.
Metal substrates	The dimensional movement of metals is different from that of decorative laminates.Aluminium and steel are suitable substrates if their surface is prepared carefully before bonding the laminate to it (with PUR or epoxy glue).
Foam plastics (polystyrene, PVC, polyurethane, phenol based etc.)	Rigid foams are self–supporting substrates, with good thermal insulation and are suitable for direct lamination. Phenolic foams have good fire resisting properties. They can also be found as the "core" in timber frames.

3.6.3 Substrates not recommended

In the table below is a list of substrate materials that can be combined with decorative HPL laminates and their degree of adaptability.

Substrate	Degree of adaptability
Plaster or concrete surfaces	The uneven surfaces of these substrates do not normally lend themselves to the direct application of laminates. In addition, the dimensional movements of the materials are well-nigh incompatible.
Simple plaster or wallpaper surfaces	The dimensional movement of the decorative laminate on the paper could result in breakage.
Solid wood	This is unsuitable. The irregular dimensional movements cause surface undulations. As a substrate for laminates, it can only be used in small areas.

3.6.4 How to bond laminates to substrates

Firstly, prior to bonding, the laminate surfaces and substrates should be thoroughly cleaned of any dust, grease or other particles that could cause defects or stains.

- ***Bonding temperature***

Normally, bonding is best carried out at room temperature, but never below 15°C. At higher temperatures the "grab" time of the glue is reduced. It is advisable to carry out tests to check how the glues react in the particular environmental conditions.

- ***Adhesives***

The choice of glue from among the many types available should be determined by the type of substrate and the purposes the finished product is to fulfil.

- ***Classification of adhesives***

Based on their reaction to heat:

i) Thermoplastic adhesives

These soften with heat. This group includes chloroprene and neoprene–based glues, those based on pvac (polyvinyl acetate), silicones, acrylics, thermo–melting (hot melt) and special glues.

ii) Thermosetting adhesives

These harden when heated, after initially softening. Belonging to this group are glues based on urea and formaldehyde, melamine and formaldehyde, resorcinol and formaldehyde, the phenolics, the polyurethanes (one or two–pack purs) and polyester and epoxy resins. Based on method of application:

iii) High–pressure adhesives

A) High pressure and long duration.

Pressure is exerted by a mechanical or hydraulic press on the laminate and substrate, which are in full contact and at a set temperature, e.g. 80 / 90°C for textured finishes and a maximum of 60°c for gloss and semigloss finishes. Belonging to this group are pvac, acrylic, urea resin, phenolic and resorcinol and formaldehyde–based glues.

B) High pressure and short duration.

Pressure is exerted for a short time (static pressure contact adhesive), but distributed evenly by hammering or using a rubber roller, in other words placing a load on the panel being manufactured. Belonging to this group are: neoprene – chloroprene – pvac b2–b2.

iv) Light pressure adhesives

A) light pressure and long durationPolyester–based glues Pur polyurethane glues Epoxy glues

B) pressure exerted and short duration Thermo–melting (hot melt) glues (Applied with special equipment).

Bonding with presses

There are two possible methods of bonding with presses:

• With cold presses. These can be used with steel sheets and limited pressure. The best results are obtained with gloss and semi–gloss finishes.

• With hot presses. These can be used with stainless steel sheets, placing a sheet of laminate in every empty compartment. As an indication, for gloss finishes the maximum temperature is 50°C and the pressure 0.200g; for textured finishes the maximum temperature is 70°C and the pressure 0.500g.

Hardeners

Neoprene–based adhesives are used with a hardening agent, which increases the glue's heat resistance. Thermosetting adhesives are used with accelerators and catalysts, which ensure a good "grab", reducing the temperature and the period of application.

Types of adhesives

Thermoplastic adhesives	**Neoprene/Chloroprene**	Polychloroprene-based Available in solvent or aqueous solution, with or without hardener.
	PVAc	Polyvinyl acetate-based emulsion. Available as one or two-pack; the latter shows greater resistance to heat and humidity. If the substrate is compact and uniform, this ensures a good bond, being easy to use and fast setting. Being liquid, it should be distributed carefully over the surface to prevent fibres or chips lifting at a later stage.
	Acrylic compounds	
	Silicones	
	Hot melt (Thermo-melting)	Almost exclusively used for bonding edges and assembling pieces. Not to be used in proximity to hot surfaces.
Thermosetting adhesives	**Urea glues(UF)**	Urea and formaldehyde-based. Durable and resistant to high temperatures but with poor water resistance. Applied with presses at high temperatures.
	Melamine glues	Synthetic resins obtained by polycondensation of formaldehyde with melamine. Water, abrasion and heat resistant with considerable transparency to light radiation.
	Resorcinol and formaldehyde-based glues	Use with hot or cold pressure for bonding the laminate to moisture-resistant and some fire-resistant substrates. Good weathering resistance.
	Phenolic glues	Resistant to water, weathering and high temperatures.They reduce considerably in volume while setting.
	Polyurethane glues	These are strong and flexible and adhere well to smooth or porous surfaces; they withstand low temperatures better than other glues, while not tolerating high temperatures well. They have good cavity-filling properties. One or two-pack, they are excellent for bonding laminates to difficult substrates such as polystyrene, metal, mixed materials etc.
	Polyster	This is more sensitive to heat than other adhesives.
	Epoxy resins	These bond well to many materials and require only light pressure. The wide range of hardeners available for epoxy glues allows setting times to be achieved ranging from a few seconds (if the temperature is high) to many minutes or hours (at room temperature). They are strong and durable, have good cavity-filling properties and reduce very little in volume after drying.

3.6.5 Glues and substrates

- **Can be used with that substrate**

Substrates	Thermosetting adhesives					
	Neoprene Chloroprene	PVAc	Silicones	Acrylic compounds	Hot melt (Thermo-melting)	Special glues
Wood-based	★ Cold Treatment	★ Hot Treatment			★	
Paper based honeycomb structure	★ Cold Treatment	★ Hot Treatment				
Plastic foam or honeycomb material-based: polystyrene				★		
Pvc[2]	★			★		
Phenol-formaldehyde	★	★				
Polyurethanes	★					
Metal-based, in sheets or honeycomb structures	★				★	
Mineral substrates in sheets or plaster-based foams		★				
Concrete	★	★				
Aerated concrete	★	★				
Glass foam	★	★				

- **Can be used with that substrate**

Substrates	Thermosetting adhesives						
	Urea glues (UF)	Melamine glues	Resorcinol and formaldehyde glues	Phenolic glues	Polyurethane glues	Polyester	Epoxies
Wood	★	★	★	★	★	★	★
Paper with honeycomb structure	★	★	★	★	★	★	★
Plastic foam or honeycomb materials: polystyrene					★		★
Pvc[2]					★		★
Phenol–formaldehyde	★	★	★	★	★	★	★
Polyurethanes					★	★	★
Metal, in the form of sheets or honeycomb structures			★		★	★	★
Mineral substrates in sheets or plaster–based foams	★						
Concrete					★	★	★
Aerated concrete					★	★	★
Glass foam					★	★	★

3.6.6 Bonding

For best results and to prevent the risk of undulations, surface distortions (or blisters) and cracking, certain strategies are helpful.

- Pre-condition the laminate in temperature and humidity conditions similar to those where it will be installed.
- Avoid the use of, especially hand-applied, contact adhesives if the panel is to be installed in rather humid areas.
- Use contact adhesives only if the panel is no more than 600mm wide, applying it evenly to both surfaces in not too thick a layer.
- Cut the long side of the composite panel in the lengthwise direction of the laminate sheet, parallel to the direction of sanding.

4. POSTFORMING

4.1 How to hot–form postforming laminates

The postforming type of laminate was created in response to both aesthetic and functional requirements. Curved surfaces may actually be more attractive than those with sharp corners and are more hygienic because they have no joints where water or dirt can accumulate. Post–forming laminates retain the properties of standard HPL but they can be bent to concave or convex curves. This process is called postforming and can only be applied to the type of laminate specifically called HPL Postforming. The postforming technique allows a panel of a certain thickness to be profiled in cross–section. Depending on the application, the resulting panel may be:

• Most commonly, a composite product made of thin laminate glued onto a substrate, usually wood–based.

• In postforming the laminate to be bent is heated to temperatures that vary depending on the thickness and degree of curvature required.

• The best results are achieved by heating the area to be bent quite quickly to the right temperature.

• For any given thickness, laminates made to have greater fire resistant properties are less easy to postform.

4.2 Postforming temperature

The temperature to which laminates are heated for postforming ranges from the lowest temperature at which they can be postformed without breaking or cracking to the highest temperature at which they can be postformed without forming blisters and delaminating. For their own laminates, Arpa recommends an appropriate combination of temperature (120°C to 130°C, normally not exceeding 135°C), forward speed and heating time (normally not more than 10 seconds) relative to the required radius of curvature. This is a general indication, as conditions depend on the technique chosen. Laminates with a white decorative finish should always be postformed at the highest temperature in this range. It is always essential to monitor the temperature carefully throughout the entire process. The heating may, in fact, not proceed uniformly, due to changes in ambient temperature, variations in the heater voltage or in the speed of the equipment. With insufficient heating, the laminate can break completely or partially crack while, with excessive heating, the layers that make up the laminate can separate and blisters can appear. To check the temperatures, simple solid indicators can be used to register the surface and, by melting at a set temperature, these indicate the precise moment when the laminate reaches the required temperature. Alternatively infrared detectors can be used.

Please note: if HPL laminate is stored for several months under imperfect temperature and humidity conditions, it is highly advisable to perform a test on a sample before starting the whole postforming process.

4.3 Machinery

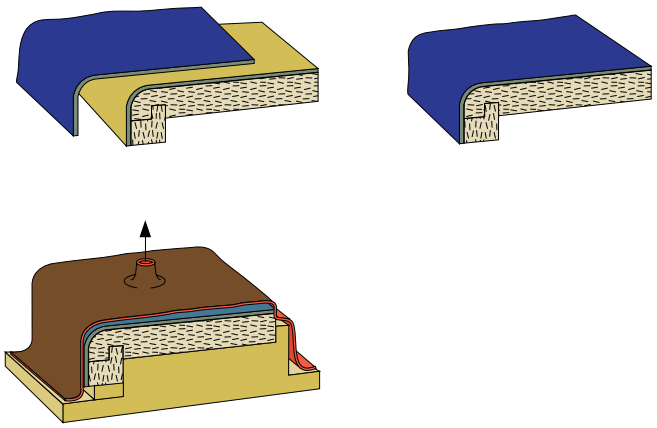
The postforming operation can be carried out with either static or continuous machines. With the former, the laminate remains stationary during the heating process and the bending operation makes the curved profile adhere to the substrate. With the latter, the laminate is taken on a conveyor belt, first into the heating and then into the forming zone. With static machines, bonding can be done with almost any type of adhesive. Among continuous machines, however, there are some that require the use of PVAc adhesives, while others use contact adhesives.
Heating can be carried out with infrared equipment, heated plates or bars or heated metal tubing. There are several factors that affect heating performance, including the heat source, its distance from the workpiece to be heated, the type of laminate and its thickness, the adhesive, the ambient temperature, the temperature of the laminate and the backing and the forming speed. It is therefore essential that each machine should be calibrated beforehand. The bending speed depends primarily on the thickness of the laminate, the radius of curvature, the type of curvature required, concave or convex, and whether the laminate is bent in a direction that is parallel to or across the cellulose fibres. The direction of the fibres is the same as the sanding direction of the reverse: lengthwise (L) is parallel and widthwise (T) is perpendicular to the direction of sanding. The normal postforming direction is lengthwise. Bear in mind that it is also possible to bend in a widthwise direction but, as this is relatively more difficult, with a greater risk of cracking than in a lengthwise direction, it is necessary to proceed under different conditions and to check them in advance.

4.4 Postforming technique

The technique of postforming generally entails shaping the substrate as a first step, according to the profile required. This can then be followed by two procedures:

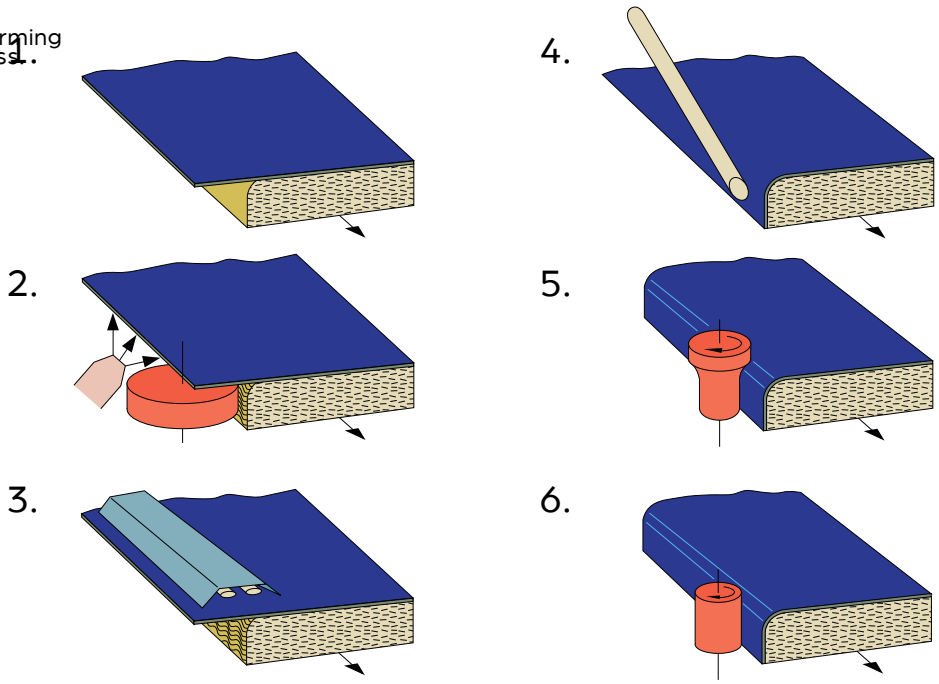
1. The sheet of laminate is postformed and then bonded to the substrate, ensuring that it adheres fully to the backing over both the flat section and the rounded profile, using a certain amount of pressure (2 separate operations);

Postforming and bonding in two phases.



2. The laminate is bonded to the substrate in the area that will remain flat and is then postformed along the profile of the backing, while at the same time making it adhere to the rounded edge using a certain amount of pressure (a continuous process is recommended for mass production).

Continuous postforming and glueing process.



The substrate requirements for PF laminates are the same as for standard laminates. For the laminate to adhere perfectly to the curved profile, it is a good idea to choose substrates with edges that can be easily shaped and neatly and cleanly trimmed.

Chipboard

It is essential that the chipboard is of good quality with a smooth and uniform surface that the chips do not come loose from while the edges are being shaped. It is then advisable to use a brush to remove the chips created when shaping the profile.

MDF

This is ideal for producing smooth–edged profiles

Plywood

Shaping the edge of plywood is difficult. The blades must be very sharp and very clean. After shaping the edges, a sanding operation is recommended followed by brushing.

Solid Wood

Solid wood may shrink and cause undulations to appear on the surface of the laminate, so it is preferable to use MDF or chipboard substrates.

5. TECHNICAL DATA SHEET

5.1 HGS

S.NO.	TEST	UNIT	PROTOCOL TEST	SPECIFIED LIMIT	RESULT OBTAINED
1.	**Dimensions**				
1.1	Average Length	mm	IS: 2046/1995	Shall be 2440+ 10/–0	2445.5
1.2	Average Width	mm	IS: 2046/1995	Shall be 1220 + 10/–0	1226
1.3	Normal Thickness	mm	IS: 2046/1995	Shall be 1.0 ± 0.10	1.03
1.4	Warping Flatness	mm	IS: 2046/1995	Not more than 120	45
2.	**Surface Defects**		IS: 2046/1995	Shall be Satisfactory	
2.1	Spots,Dirt & similar surface defect		IS: 2046/1995	Shall be Satisfactory	Satisfatory
2.2	Fibres, Hair & Scratches		IS: 2046/1995	Shall be Satisfactory	Satisfatory
2.2	Accumulated Surface Defects		IS: 2046/1995	Shall be Satisfactory	Satisfatory
3	Edge Defects		IS: 2046/1995	Shall be Satisfactory	Satisfatory
4	Broken Corners		IS: 2046/1995	Shall be Satisfactory	Satisfatory
5	Sanding Defects		IS: 2046/1995	Shall be Satisfactory	Satisfatory
6	Straigtness of Edges	mm/m	IS: 2046/1995	Not more than 1.5	1.3
7	Squareness	mm/m	IS: 2046/1995	Not more than 1.5	1.2
8	Resistance to surface wear, Index no.		IS: 2046/1995	Shall be 3	3
9.	**Resistance to immersion in Boiling Water**				
9.1	Mass increase	%	IS: 2046/1995	Not more than 10	5.5
9.2	Thickness increase	%	IS: 2046/1995	Not more than 12	4.7
9.3	Appearence	Degree	IS: 2046/1995	Not less than 4	5
10.	**Resistance to dry heat at 180 C, Appearence**	Degree	IS: 2046/1995		
10.1	Gloss	Degree	IS: 2046/1995	Not less than 3	5
10.2	Colour/others	Degree	IS: 2046/1995	Not less than 4	5

5.1 HGS

S.NO.	TEST	UNIT	PROTOCOL TEST	SPECIFIED LIMIT	RESULT OBTAINED
11	**Dimensional Stability at Deviated Temperature Cumulative Dimensional Change**	%			
11.1	Machine Direction-L		IS: 2046/1995	Not more than 0.55	0.37
11.2	Cross Machine Direction-T		IS: 2046/1995	Not more than 1.025	0.67
12	Resistance to Impact(by Small Dia-ball),Index no.		IS: 2046/1995	Not less than 3	3
13	Resistance to cracking	Degree	IS: 2046/1995	Not less than 4	5
14	Resistance to scratch	Index no.	IS: 2046/1995	Not less than 3	3
15	**Resistance to staining**	Rating			
15.1	Group 1 & 2	Rating	IS: 2046/1995	Not less than 5	5
15.2	Group 3 & 4	Rating	IS: 2046/1995	Not less than 4	5
16	Resistance to steam	Rating	IS: 2046/1995	Not less than 4	5
17	Resistance to cigarette burns	Rating	IS: 2046/1995	Not less than 3	5
18	Resistance to color change in Xenon-Arc Light		IS: 2046/1995	Greater than standard blue Wool No. 6	Satisfactory (Greator than Standard blue Wool No. 6

5.2 VGS

S.NO.	TEST	UNIT	PROTOCOL TEST	SPECIFIED LIMIT	RESULT OBTAINED
1.	**Dimensions**				
1.1	Average Length	mm	IS: 2046/1995	Shall be 2440+ 10/–0	2445
1.2	Average Width	mm	IS: 2046/1995	Shall be 1220 + 10/–0	1223.5
1.3	Normal Thickness	mm	IS: 2046/1995	Shall be 1.0 ± 0.10	1.01
1.4	Warping Flatness	mm	IS: 2046/1995	Not more than 120	50
2.	**Surface Defects**		IS: 2046/1995		
2.1	Spots,Dirt & similar surface defect		IS: 2046/1995	Shall be Satisfactory	Satisfatory
2.2	Fibres, Hair & Scratches		IS: 2046/1995	Shall be Satisfactory	Satisfatory
2.2	Accumulated Surface Defects		IS: 2046/1995	Shall be Satisfactory	Satisfatory
3	Edge Defects		IS: 2046/1995	Shall be Satisfactory	Satisfatory
4	Broken Corners		IS: 2046/1995	Shall be Satisfactory	Satisfatory
5	Sanding Defects		IS: 2046/1995	Shall be Satisfactory	Satisfatory
6	Straigtness of Edges	mm/m	IS: 2046/1995	Not more than 1.5	1.1
7	Squareness	mm/m	IS: 2046/1995	Not more than 1.5	1.0
8	Resistance to surface wear, Index no.		IS: 2046/1995	Shall be index no. 2	2
9.	**Resistance to immersion in Boiling Water**				
9.1	Mass increase	%	IS: 2046/1995	Not more than 10	6.2
9.2	Thickness increase	%	IS: 2046/1995	Not more than 12	5.6
9.3	Appearence	Degree	IS: 2046/1995	Not less than 4	5

5.2 VGS

S.NO.	TEST	UNIT	PROTOCOL TEST	SPECIFIED LIMIT	RESULT OBTAINED
10.	**Dimensional Stability at Deviated Temperature Cumulative Dimensional Change**	%	IS: 2046/1995		
10.1	Machine Direction–L		IS: 2046/1995	Not more than 0.55	0.43
10.2	Cross Machine Direction–T		IS: 2046/1995	Not more than 1.025	0.74
11	Resistance to Impact(by Small Dia–ball),Index no.		IS: 2046/1995	Not less than 3	3
12	Resistance to Scratch	Index no.	IS: 2046/1995	Not less than 2	2
13.1	Resistance to staining	Rating			
13.1	Group 1 & 2	Rating	IS: 2046/1995	Not less than 5	5
13.2	Group 3 & 4	Rating	IS: 2046/1995	Not less than 4	5
14	Resistance to steam	Rating	IS: 2046/1995	Not less than 4	5
15	Resistance to cracking	Rating	IS: 2046/1995	Not less than 4	5
16	Resistance to color change in Xenon–Arc Light		IS: 2046/1995	Greater than standard blue Wool No. 6	Satisfactory (Greator than Standard blue Wool No. 6

5.3 Anti-Bacterial Grade

S.NO.	TEST	UNIT	PROTOCOL TEST	SPECIFIED LIMIT	RESULT OBTAINED
1.	**Dimensions**				
1.1	Average Length	mm	IS: 2046/1995	Shall be 2440+ 10/-0	2445.5
1.2	Average Width	mm	IS: 2046/1995	Shall be 1220 + 10/-0	1226
1.3	Normal Thickness	mm	IS: 2046/1995	Shall be 1.0 ± 0.10	1.03
1.4	Warping Flatness	mm	IS: 2046/1995	Not more than 120	45
2.	**Surface Defects**		IS: 2046/1995	Shall be Satisfactory	
2.1	Spots,Dirt & similar surface defect		IS: 2046/1995	Shall be Satisfactory	Satisfatory
2.2	Fibres, Hair & Scratches		IS: 2046/1995	Shall be Satisfactory	Satisfatory
2.2	Accumulated Surface Defects		IS: 2046/1995	Shall be Satisfactory	Satisfatory
3	Edge Defects		IS: 2046/1995	Shall be Satisfactory	Satisfatory
4	Broken Corners		IS: 2046/1995	Shall be Satisfactory	Satisfatory
5	Sanding Defects		IS: 2046/1995	Shall be Satisfactory	Satisfatory
6	Straigtness of Edges	mm/m	IS: 2046/1995	Not more than 1.5	1.3
7	Squareness	mm/m	IS: 2046/1995	Not more than 1.5	1.2
8	Resistance to surface wear, Index no.		IS: 2046/1995	Shall be 3	3
9.	**Resistance to immersion in Boiling Water**				
9.1	Mass increase	%	IS: 2046/1995	Not more than 10	5.5
9.2	Thickness increase	%	IS: 2046/1995	Not more than 12	4.7
9.3	Appearence	Degree	IS: 2046/1995	Not less than 4	5
10.	**Resistance to dry heat at 180 C, Appearence**	Degree	IS: 2046/1995		
10.1	Gloss	Degree	IS: 2046/1995	Not less than 3	5
10.2	Colour/others	Degree	IS: 2046/1995	Not less than 4	5

5.3 Anti-Bacterial Grade

S.NO.	TEST	UNIT	PROTOCOL TEST	SPECIFIED LIMIT	RESULT OBTAINED
11	**Dimensional Stability at Deviated Temperature Cumulative Dimensional Change**	%			
11.1	Machine Direction-L		IS: 2046/1995	Not more than 0.55	0.37
11.2	Cross Machine Direction-T		IS: 2046/1995	Not more than 1.025	0.67
12	Resistance to Impact(by Small Dia-ball),Index no.		IS: 2046/1995	Not less than 3	3
13	Resistance to cracking	Degree	IS: 2046/1995	Not less than 4	5
14	Resistance to scratch	Index no.	IS: 2046/1995	Not less than 3	3
15	**Resistance to staining**	Rating			
15.1	Group 1 & 2	Rating	IS: 2046/1995	Not less than 5	5
15.2	Group 3 & 4	Rating	IS: 2046/1995	Not less than 4	5
16	Resistance to steam	Rating	IS: 2046/1995	Not less than 4	5
17	Resistance to cigarette burns	Rating	IS: 2046/1995	Not less than 3	5
18	Resistance to color change in Xenon-Arc Light		IS: 2046/1995	Greater than standard blue Wool No. 6	Satisfactory (Greator than Standard blue Wool No. 6
19	Anti-Bacterial Activity Test	% Reduction	ASTM D 2180	95.0(Min.)	99
20	Anti-Bacterial Efficacy & Activity Test as per JIS 2801-2012*	99.9 (4.5(Min.)	JIS Z 2801:2012	% Reduction 95.0(min.) Activity criteria 2.0(min)	99
21	*Bacteria Tested:	1. Pseudomonas Aeruginosa, 2. Enterococcus faecalis, 3. Candida Albicans, 4. Pseudomonas Aeruginosa, 5. Escherichia Coli, 6. Klebsiella Pneumoniae, 7. MRSA (Methicillin Resistant Staphylococcus Aureus), 8. Salmonella Enterica			

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SUPER GROUP OF INDUSTRIES

SUPER HYLAM PVT. LTD.
Narela Road, Kundli - 131028
Sonipat, Haryana
+91-97187797188
www.superhylam.com
support@superhylam.com