Stora Enso ThermoWood® Cladding

A Specifiers Guide

Stora Enso Timber

Stora Enso Timber is an international wood products company that provides customer-focused solutions to construction and joinery industries and the wood products trade worldwide. Its annual net sales are EUR 1.6 billion. Stora Enso Timber's total annual production capacity is 7.7 million cubic metres of sawn wood products, including 3.2 million cubic metres of value-added products. The company employs 4 900 people in 25 softwood sawmills and 23 further processing plants in ten European countries and its sales and distribution companies throughout the world. Stora Enso Timber belongs to Stora Enso's Forest Products product area together with Wood Supply Europe, Pulp Competence Centre and Pulp Marketing and Procurement. The other product areas of Stora Enso are Paper and Packaging.

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Document endorsement

Experts from the Building Research Establishment (BRE), UK Centre for Timber Technology and Construction reviewed the Stora Enso ThermoWood cladding – A Specifiers Guide and gave the following statement: "It is a comprehensive document related to the use of Stora Enso ThermoWood as cladding substrate and we consider it to be a major contribution to the best practice use of the substrate in cladding applications".

1. Introduction to Stora Enso ThermoWood

1.1 General facts about Stora Enso ThermoWood

ThermoWood is a product which is produced using a special high temperature kilning process which has been developed in Finland. Scientifically heat treatment of wood has been studied by Stamm and Hansen in the 1930's in Germany and by White in the 1940's in the United States. In the 1950's Germans Bavendam, Runkel & Buro continued research on the subject. Kollman & Schneider have published their findings in the 1960's and Rusche and Burmester in the 1970's. In the 1990's research work was carried out in France and the Netherlands, but one of the most intensive and comprehensive studies has been conducted by VTT in Finland.

This more recent research has shown that thermal modification and the ThermoWood process have a significant effect on the characteristics of wood. Details of these main property changes can be found in section 2 of this document.

As a pioneer in the early development of ThermoWood and a member of the Finnish ThermoWood association, Stora Enso Timber uses the patented process and markets the product under the registered name ThermoWood.

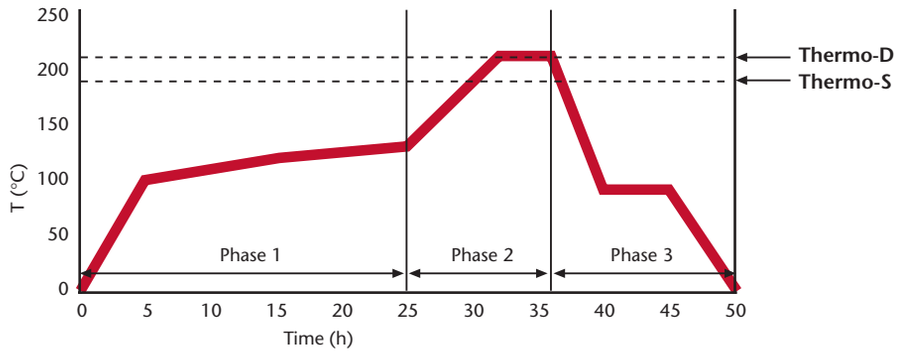
1.2 The ThermoWood process

The ThermoWood process can be divided into three main phases:

- **Phase 1.** ***Temperature increase and high temperature kilning***
  The kiln temperature is raised at a rapid speed using heat and steam to a level of around 100 °C. Thereafter the temperature is increased steadily to 130 °C during which time the high temperature drying takes place and the moisture content in the wood reduces to nearly zero.

- **Phase 2.** ***Intensive heat treatment***
  Once the high temperature kiln drying has taken place the temperature inside the kiln is increased to a level between 190 °C (Thermo-S) and 212 °C (Thermo-D) depending on the end-use application. Once the target level has been reached the temperature remains constant for 2–3 hours.

- **Phase 3.** ***Cooling and moisture conditioning***
  The final stage is to lower the temperature down using water spray systems and then once the temperature has reached 80–90 °C re-moisturising and conditioning takes place to bring the wood moisture content to a useable level over 4%.



The ThermoWood process

2. Key characteristics of ThermoWood for exterior cladding

Overview table of Key ThermoWood characteristics:

	Stability	Equilibrium 65% RH	Moisture content 95% RH	Durability (EN 113 test)
Thermo-S Spruce	Very good	6–7%	13–14%	Moderately durable (3)
Thermo-S Pine	Good	6–8%	14–16%	Moderately durable (3)
Thermo-D Spruce	Excellent	5–6%	11–12%	Durable (2)*
Thermo-D Pine	Good	6–7%	12–13%	Durable (2)*

General service situations and hazard classes given in EN 335-1: 1. Above ground, covered (dry), 2. Above ground, covered (risk of wetting), 3. Above ground, not covered.

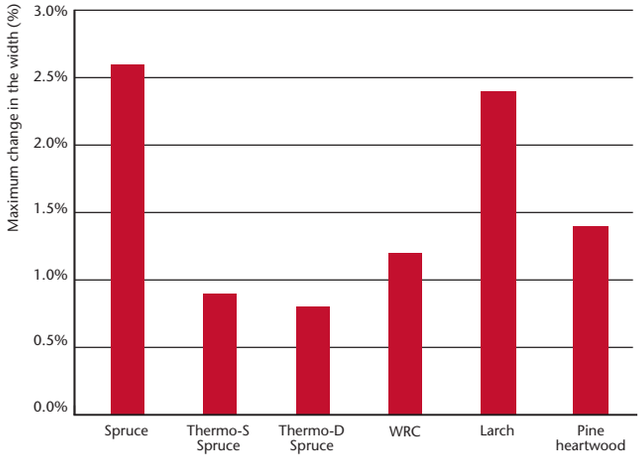
**See section 2.3*

2.1 Equilibrium moisture content

The ThermoWood process leads to a significant reduction in equilibrium moisture content. In higher relative humidity conditions the equilibrium moisture content of ThermoWood can be as much as 40% lower than untreated softwoods (VTT 2001).

2.2 Dimensional stability

As a result of the ThermoWood process the form stability of normal softwoods such as pine and spruce can be significantly improved. In addition the comparison with species such as Western Red Cedar (WRC) and Larch which are typical cladding materials prove to be very positive. The following chart indicates the maximum swelling in the width of the board between relative humidity of 35% to 85% and has been carried out in accordance with EN 1910 "Wood and parquet flooring and wood paneling and cladding – determination of dimensional stability".



Swelling test results: Maximum change in the width between relative humidity of 35% to 85%.

(Source: Helsinki University of Technology: Manninen, 2004)

ThermoWood has dramatically reduced swelling in the width when subjected to changes in relative humidity between 35% to 85%. The following table shows the expected maximum expansion in the width in terms of millimetres when the relative humidity increases from 35% to 85%.

Maximum change in width from 35% to 85% relative humidity

Cladding width (Rh35%)	Spruce (Rh85%)	**Thermo-D Spruce (Rh85%)**	Pine Heartwood (Rh85%)	Larch (Rh85%)	WRC (Rh85%)
120.0 mm	123.0 mm	**121.0 mm**	121.5 mm	123.0 mm	121.5 mm
142.0 mm	145.5 mm	**143.0 mm**	144.0 mm	145.5 mm	144.0 mm
190.0 mm	195.0 mm	**191.5 mm**	192.5 mm	195.0 mm	192.5 mm

2.3 Resistance to fungal attack

The biological durability of ThermoWood has been tested in accordance with EN 113 and has been found to obtain significantly improved levels of durability against attack by fungi (VTT 2001). When ThermoWood is used in above ground applications as defined in EN 335-1 and the design of the structure allows for good ventilation and water trapping is not allowed then ThermoWood spruce treated at temperatures of 190 °C (Thermo-S) should obtain a natural durability of class 3 (moderately durable) and at temperatures of around 212 °C (Thermo-D) up to durability class 2 (durable) according to EN 350-1 classification. If the structure is poorly designed in such a way that it is close to the ground, there is no ventilation and there are opportunities for water to trap then attack from more aggressive fungi such as Poria placenta could occur.

According to BS 8417:2003, the minimum requirements for use as cladding in the UK is that the material should be of a natural durability of at least class 3. With a durability rating of class 3, the material should be capable of satisfying performance requirements for 30 year service life as a cladding.

2.3.1 EN 335-2:1992 Hazard Class descriptions

Hazard Class 1 (e.g. internal joinery)
In this environment the moisture content of solid wood is such that the risk of attack by surface moulds or by staining or wood destroying fungi is insignificant (that is the wood shall have a moisture content of maximum 20% (m/m) in any part for practically the whole of its service life). However, attack by wood boring insects, including termites, is possible although the frequency and importance of the insect risk depends on the geographic region.

Hazard Class 2 (e.g. roof timbers, risk of wetting)
In this environment the moisture content of solid wood through accidental wetting or condensation occasionally exceeds 20% (m/m) either in the whole or only in part of the component and thus allows attack by wood destroying fungi. For timber whose use includes a decorative function, disfigurement can also occur as a result of the growth of surface moulds and staining fungi.

Hazard Class 3 (e.g. exterior cladding)
In this environment solid wood can be expected to have a moisture content above 20% (m/m) frequently, and thus it will often be liable to attack by wood destroying fungi. For timber whose use includes a decorative function, disfigurement can also occur as a result of the growth of surface moulds and staining fungi.

Hazard Class 4 (e.g. fence posts)
In this environment solid wood has a moisture content in excess of 20% (m/m) permanently and is liable to attack by wood destroying fungi.

2.4 Resistance to insect attack

Tests have been carried out to evaluate the resistance to attack from the three most common wood boring insects found in Europe. House Longhorn beetles (Hylotrupes bajulus) are found in the sapwood of softwood, the common furniture beetle (Anobium punctatum) preferentially attacks hardwoods and the Powderpost beetle (Lyctus brunneus) is found in some hardwood species. The results of the tests found that ThermoWood treated at both Thermo-S and Thermo-D was resistant to all three of the above insect species.

European Subterranean termites (Reticulitermes spp) are apparent in Southern Europe (Southern France, Spain, Portugal, Italy and Greece) and there are isolated cases in some North European countries. Termites found in Europe only attack buildings from the earth below, avoiding direct sunlight where possible. Termites will attack both wood and cement based materials in their quest for a strong food base. Various measures have been developed to control the problem these include polythene membranes being installed in the foundations of the building and various bituminous paint products are available to seal possible routes up the building. Detailed testing is currently ongoing as to the resistance of ThermoWood to attack by different types of termite. However it may be concluded that ThermoWood as a cladding material should not be at significant risk.

2.5 Appearance and weathering

ThermoWood has an attractive golden brown appearance. ThermoWood cladding if left without any surface coating will start to grey and weather in quite a short period of time, as can be expected with all natural wood products which are exposed to the weather effects (ultra violet radiation and rain). The greying effect can occur over one summer, especially on south facing walls, much the same as wood species such as Western Red Cedar or Larch. When left without surface protection small surface fissures will appear and also the juvenile wood grain will start to disappear – this again is a common weathering feature of all wood material over time.

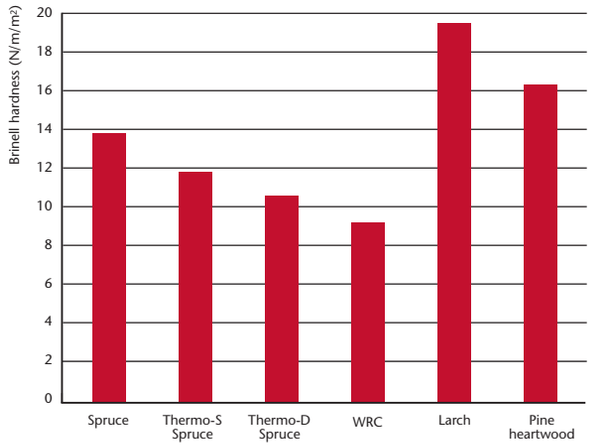
Due to the increased dimensional stability evident as a reduction in cupping, and other distortion, ThermoWood cladding is potentially an excellent substrate to support longer lasting surface coatings.

Two examples of ThermoWood cladding after three years weather exposure with and without surface coatings.

As with all natural based materials which are exposed to weathering ThermoWood can be affected by surface mould and staining fungi. This will not affect the integrity of the cladding and only has a negative aesthetic effect on the material if it occurs unevenly or particularly heavily.

2.6 Hardness

ThermoWood has been tested using a modified EN 1534 test (Wood and parquet flooring – Determination of resistance to indentation (BRINELL – test method)). An indentation force of 0,5 kN was used instead of 1 kN in the testing for all the tested species. The following chart presents the comparative results of different wood species most commonly used for exterior timber cladding.

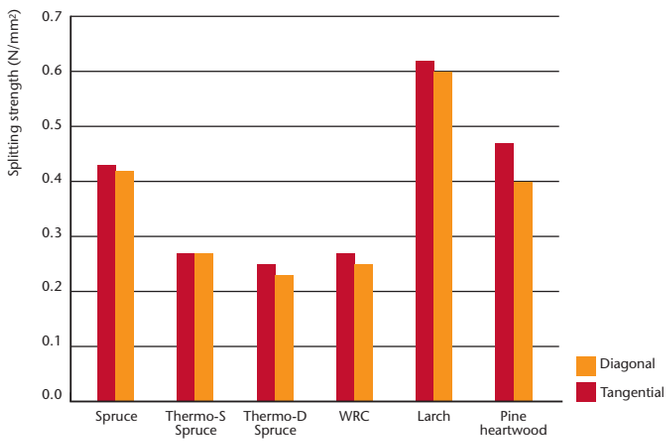


Brinell hardness test results using a modified version of EN 1534
(Source: Helsinki University of Technology: Manninen, 2004)

The thermal modification process does cause a small reduction in the Brinell hardness of the material. However the ThermoWood Spruce and Western Red Cedar results are quite comparable.

2.7 Splitting strength

As a result of the ThermoWood process there is a reduction in the splitting strength properties of ThermoWood material compared with the original timber. The following chart presents the comparative results of different wood species most commonly used for exterior wood cladding.



Splitting strength test results
(Source: Helsinki University of Technology: Manninen, 2004)

The thermal modification process does cause a reduction in splitting strength of the material. However ThermoWood Spruce and Western Red Cedar results are comparable.

2.8 Thermal properties

Tests have shown that the thermal conductivity of ThermoWood is reduced by 20–25% compared with normal kiln dried softwoods. As a result of this improvement, ThermoWood has good advantages when used in applications such as external and internal cladding & paneling. The results show that ThermoWood's thermal conductivity λ_{10} is in the region of 0.099 W/(m K). (VTT 2001)

2.9 Fire resistance

The effects of the ThermoWood process on softwoods does not greatly effect the fire resistance rating compared with normal kiln dried material. When testing the ThermoWood in accordance with the SBI (single burning item) test, the results found that it can reach fire class D. As with typical cladding materials such as Western Red Cedar or Larch it is possible to treat ThermoWood with commercially available fire retardant to obtain a fire rating of class 1 or class 0. Both WRC and the heartwood of larch have a treatability rating according to EN 350-2 of class of 4, ThermoWood falls into the same treatability class. (ThermoWood Handbook 2002)

2.10 Emissions

Testing of emissions from ThermoWood has been carried out. The results show that the TVOC (total volatile organic compounds) are dramatically lower than with normal kiln dried softwoods. The reduction in TVOC increases with higher temperature treatment levels. The characteristic smell which comes from the ThermoWood may be derived from furfural, but the levels are very low. (VTT 2001)

2.11 Leaching

As no substances are added during the ThermoWood process, no chemical leaching will occur. In addition as the resin is removed during the process, the problem of resin leakage through the knots or pitch pockets is removed.

3. The Stora Enso ThermoWood cladding products

3.1 Cladding product details

3.1.1 Product type

Describes the shape of the profiles.
- Tongue and grooved edges (T+G)
- Shiplap, rebated only
- Rebated bevel siding, sawn at an angle and measured at the thickest point

3.1.2 Surface type

Two alternative surface types are available:
- Planed, smooth factory finished surface
- Fine sawn, fine sawn surface which allows for excellent paint keying

3.1.3 Actual thickness and width

Describes the actual measurements at the thickest and widest point of the profile.

3.1.4 Actual surface cover

Describes the actual surface cover area once the cladding board is installed on the wall, it does not include any expansion gap that may be kept between the boards.

3.2 Standard product range

For examples of our standard product range please see the enclosed product specification sheet.

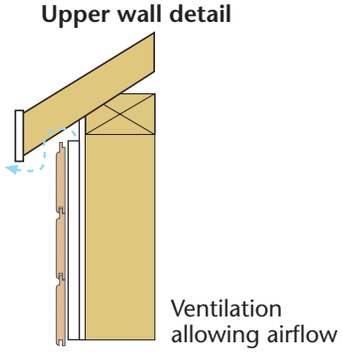
4. Design guidelines for timber cladding

4.1 General design issues

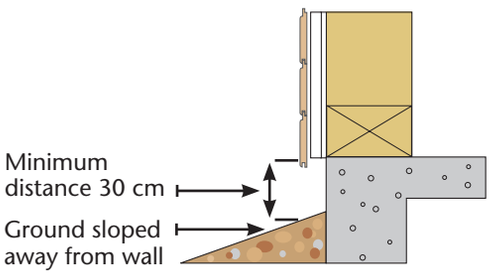
The following information can only be deemed as best practice recommendations and has been produced through consultation with various construction research institutes and organisation's such as TRADA, BRE, SKH, VTT.

4.2 Top and bottom of wall design

Upper wall detail

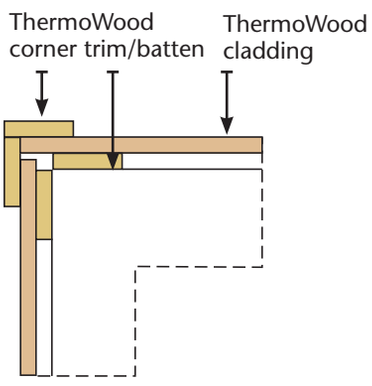


Lower wall detail

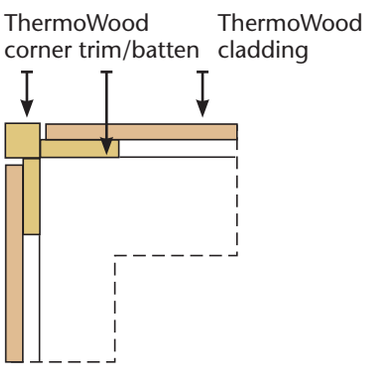


4.3 External corner design

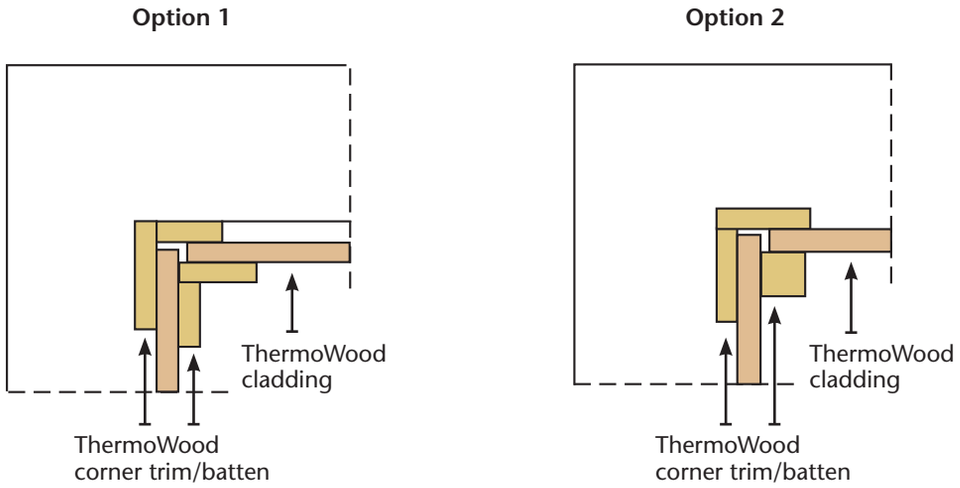
Option 1



Option 2



4.4 Internal corner design



5. Guide to installation of Stora Enso ThermoWood cladding

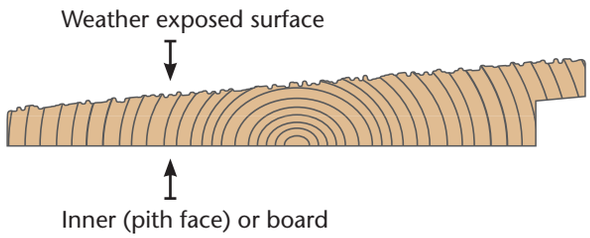
5.1 Working with the product

Sawing of ThermoWood can be carried out in the same way as working with other wood species such as Western Red Cedar. Sharp tools are recommended to give the best results. When using electric saws or planing equipment on site it is recommended to wear a dust mask as the dust particle size with ThermoWood is small, as might be expected with some hardwoods or MDF. Care should be taken when handling the ThermoWood cladding to avoid unnecessary impacts or damages when cutting or moving the material, heavy handling could lead to unwanted splits or other damage.

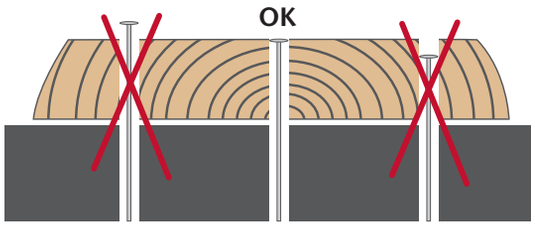
5.2 Fixing recommendations

The way in which the cladding is fixed is important. The use of the correct fixing materials, the space between fixings and the amount of fixings per board are all factors that need consideration.

The ThermoWood cladding should be produced so that the year ring positioning is such that the inner (pith face) of the board is orientated away from the weather exposed surface, this is to avoid the risk of year ring loosening, please see the drawing below:



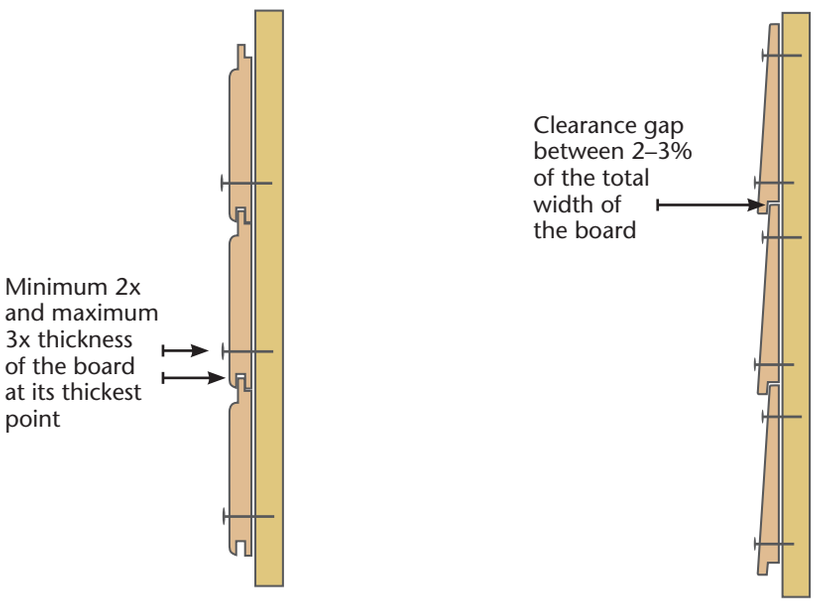
ThermoWood cladding can be fixed using traditional hammer and nail punch or with a compressed air nail gun. The latter has been found to bring excellent nailing results and leads to little or no splitting of the material due to the fact that there is no hard impact made to the cladding boards, where as traditional nailing has the risk of accidental impact. When setting the pressure for the air nail gun, set it so that the nail head finishes flush with the surface of the cladding or marginally (about 1 mm) below the surface (see the illustration below).



Recommended nail head penetration when fixing ThermoWood cladding

5.3 Recommended amount of fixings and positioning

The amount of fixings per board is heavily influenced by the width. While it is desirable to have one fixing per width of board especially when using secret nailing, it is generally recommended that for boards over 125 mm wide, two fixings are used over the width. However due to differences in national requirements this might vary from country to country and national requirements should be followed. The nail position from the bottom of the board must be a minimum 2 times and maximum 3 times the thickness of the board. When fixing also at the upper part of the board the nail should be positioned minimum 2 times and maximum 3 times the thickness of the board at its thickest point down from the top of the board. The importance of this is that there should be sufficient overlap between adjacent boards, but it is important not to have the fixing too close to the point where the overlap occurs. It is absolutely crucial that the fixings are not positioned through the two adjoining boards. A sufficient clearance gap between each board should be maintained to allow for tangential movement and also free space for drying when the material is wet. The recommended clearance gap is between 2–3% of the total width of the board. See illustrations below.



5.4 Fixing types

When fixing ThermoWood it is extremely important to use **stainless steel – rust free or fully galvanised nails**. Using normal wire nails or staples will lead to rust stains and overall deterioration in the fixing.

Below is a suggested fixing specification;

a) Stainless steel nails to comply with the International Stainless Steel Standard code AISI 304.

b) Nail head not too big and designed in such a way as not to damage the wood fibers on the surface, but not to compress them like a screw head.

c) The nails must not split the timber when nailed within 18 mm from the edge of the board.

d) To comply with recommendation (TRADA) regarding length of nail e.g. timber 20 mm thick requires a nail 3x the timber thickness giving a 40 mm penetration in to the timber batten. The nail shank to be annular ringed.

e) If the nails are to be hammer driven and because of the pliability of the stainless steel tests show that the nail needs to have 2.5 mm shank to avoid bending.

(Above specification supplied by Maestri-Kear (UK) Ltd)

6. Surface coating and maintenance of Stora Enso ThermoWood cladding

Various coating trials have been conducted with ThermoWood and the leading coatings manufacturers can provide recommendations on what coatings to use. In addition to the historical work that has been conducted the ThermoWood association have commissioned the BRE (UK) to carry out coatings trials with up to date systems from four major European coatings manufacturers. The results of these trials will be made available in due course.

The surface structure of ThermoWood is altered which makes moisture ingress more difficult than with untreated spruce or pine. For this reason many coating systems cannot be easily absorbed into the surface of the ThermoWood. ThermoWood is however still a more absorbent material than other building materials such as plastics and metals and adhesion of coatings still affords very good long term results. The lower movement characteristics are of benefit to the long term performance of coatings over other timber substrates that show more pronounced movement and hence stressing of surface coatings.

Cladding is often described as a semi stable timber substrate as defined by EN 927-1. Coatings manufacturers recommend that semi stable substrates receive in the region of 40 to 60 micrometres dry film thickness of surface coating. This film build is described as medium build by EN 927-1. Due to the increased dimensional stability of ThermoWood it may be possible to categorise this product as stable as defined by EN 927-1. In this event higher coating builds of 100 to 150 micrometres can be applied. These are likely to afford longer life spans in service.

Current coating recommendations are as follows;

- Coatings specifically designed for use on timber should be used. These can be water-borne, solvent-borne (sometimes referred to as oil based) or high solids solvent-borne in nature.

- Preferably all coatings should be applied in factory (or indoor conditions), but in any case outdoor coating should only be conducted in dry weather and not in conditions of extreme cold or high humidity.

- At least the first coat should be applied all round prior to fixing.

- For higher film builds it is more efficient to use spray application to deliver the coating.

Assuming that ThermoWood provides a stable substrate as described above and in accordance with EN 927-1:

Desired Maintenance Period	3–6 years*	6–12 years*
Coating film build required	Approximately 60 micrometres	Between 100 and 150 micrometres

** Maintenance period is highly dependent on design of cladding, on degree of weather exposure and on the type of coating used. Please consult coatings manufacturers for further information.*

7. Handling and storage

7.1 Factory environment

ThermoWood must be stored in a dry place, but there is no special need for controlled climate systems. An unheated warehouse is suitable.

The packages should be stored flat with sufficient supports between packs to avoid distortion. Packs should be stored off the ground.

Before use or further processing where gluing and/or surface treatment is taking place the material needs to be acclimatised to appropriate moisture content and temperature as per the manufacturer's recommendations.

7.2 Point of sale

When ThermoWood packages are lifted with a crane or forklift, the forks should be adjusted to maximum width to allow for better weight distribution. Before moving the packages, ensure that they are well strapped to avoid unnecessary damage or falling pieces.

ThermoWood should be carefully covered or stored inside a warehouse. The packages should be stored flat with sufficient supports between packs to avoid distortion. Packs should be stored off the ground.

7.3 Storage on the building site

ThermoWood must be stored in a dry place, but there is no special need for climate control. An unheated warehouse is suitable.

The packages should be stored flat with sufficient supports between packs to avoid distortion, and kept out of direct contact with the ground.

Before use or further processing where gluing and/or surface treatment is taking place the material needs to be acclimatised to the appropriate moisture content and temperature as per the manufacturer's recommendations.

8. General advice

8.1 Health & safety

There are no major differences in health and safety considerations for ThermoWood compared to other wood species. The two detectable differences are the odour of the material and the dust coming from processing of ThermoWood.

ThermoWood has a "smoke-like" smell, which is likely to be coming from chemical compounds called furfurals. Although the smell is easy to detect by human senses and seems stronger than of untreated wood, tests show the total volatile organic compound (TVOC) emissions from ThermoWood are substantially less than those from normal softwoods (VTT 2001).

No toxic or harmful components have been found in ThermoWood (VTT 2001). However if wood splinters penetrate the skin remove as soon as possible as with normal material.

ThermoWood dust has smaller particle size than normal softwoods. It is comparable to MDF (although lower density) or hardwood dust. Because of the reasons mentioned above one has to pay special attention to the dust removal system when machining, and the wearing of a mask is recommended.

When gluing or painting ThermoWood, always refer to the paint or glue manufacturers specific health and safety instructions.

8.2 End of life considerations

ThermoWood is a natural wood product without any chemicals added to it. When not glued or painted ThermoWood waste can be handled as any other untreated wood waste.

ThermoWood can be burned. It produces about 30% less energy than untreated wood, as the majority of the energy containing extractives have already been removed in the heat treatment process. ThermoWood burns with a smaller flame and produces less gases and smoke because of above mentioned reason. Inflammability is normally higher due to lower equilibrium moisture content of the wood i.e. dryness. There is no significant difference between the compounds of smoke from ThermoWood compared to those from normal wood.

Pelletizing and briquetting waste ThermoWood is possible, if mixed with normal saw dust. Due to the dryness and lack of resin normal softwood dust is needed to allow the pellets or bricks to bind together.

ThermoWood can be taken to the waste dump. It is non-toxic and not classified as hazardous waste.

Quality and environmental certification

Stora Enso ThermoWood is produced under strict quality control systems. It is certified with the Dutch Komo quality certification and included in the ISO 9001 quality system. Stora Enso ThermoWood rawmaterial is sourced from PEFC certified forests.

Disclaimer: This document has been produced as an informative guide based on best knowledge known at the time and should only be used accordingly. Stora Enso Timber accepts that the content is subject to change and reserves the right to amend the contents as new information becomes available.

For further information about Stora Enso ThermoWood® please visit our web site at www.storaenso.com/timber or contact your local Stora Enso sales office.

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