MAJOR FEATURES OF THERMO-TREATED WOOD

Parameter	Effect	Comments
Equilibrium moisture	Reduced 50% compared untreated wood. The difference is higher, the relative humidity is higher.	This difference remained after years of exposure. After thermo treatment the wood is dry - moisture content is 4-6%.
Dimensional stability	The swelling and shrinkage (both tangential and radial) reduces 3-5 times for softwoods and up to 15 times for hardwoods. This parameter is strongly depends on the relative humidity (at 100% reduces 2 times for softwoods and 3-5 times for hardwoods)	This because of the decrease in absorptive qualities, lower equilibrium moisture content and also due to lignin depolymerization the length of chains of cellulose decreases and this leads to the deformations decrease.
Color	Attractive golden brown appearance and even color at all depth.	The color is affected by the treatment temperature and time. It is possible to receive several gradations of color based on the process.
Appearance	Attractive golden brown appearance and even color at all depth. Color becomes more sated and homogeneous on all section; the structure of wood effectively comes to light.	The color is affected by the treatment temperature and time. It is possible to receive several gradations of color based on the process. The effect of valuable breeds of wood is reached.
Density	Lower density at 5-10%.	Due to the emissions during the thermo-treatment process and lower equilibrium moister content. This feature might improve the cost-efficiency of shipping of the treated material.
Cell structure	Changes as if after ageing for 120-250 years.	The color is affected by the treatment temperature and time. It is possible to receive several gradations of color based on the process. The effect of valuable breeds of wood is reached while the absorption of moisture is decreased.
Resin	Is almost fully removed.	
Brinell hardness	Increases as the treatment temperature increases. However, the relative change is very small, as the density decreases.	Certain kinds of timber change their place on the hardness scale, as some of them become harder, while others softer as a result of the treatment temperature and specie.
Permeability	The water uptake reduced up to 5 times depending on treatment temperature.	The surface of the thermo-treated wood is not porous but solid, also the chemical composition of the wood changes. Reduced water absorption has to be taken into account when working with water solvent glue or paint.
Thermal conductivity	Decreased by 10-30%.	Thanks to the lower water content and structural changes.
Fire resistance	The same as non-treated wood. Thermo--treated wood is in fire class D.	The time of ignition a little decreased, but better than the normally dried softwoods in terms of heat and smoke release.
Resistance to insect attack and termites	Significantly increased resistance to the hardwood and softwood insects, but only a little increased resistance to the termites (it is expected that termites will choose normal wood over thermo-treated).	Tests have been carried out in Europe 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 Thermo-treated wood was resistant to all three of the above insect species. Southern European Subterranean termites (Reticulitermes spp) found in Europe only attack buildings from the earth below, avoid-ing direct sunlight where possible. Termites will attack both wood and concrete based materials in their quest for a strong food base. Various measures have been developed to control the problem including polythene membranes being installed in the foundations and various bituminous paint products are available to seal possible routes up the building.
Rot resistance	Improved.	However it is not suitable for conditions where it would be saturated with water or in prolonged contact with damp ground.

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Biological durability	European tests on biological durability of Thermo-treated wood in EN 113, ENV 807 standards showed significantly improved level of resistance against fungi attack (15-25 times) depending on treatment temperature.	Thermo-treated wood does not require any chemical protection. Due to high heat of processing in wood decay hemi-cellulose and poly-sugars, that on a background of low equilibrium humidity eliminates conditions for occurrence and duplication of a fungus and microorganisms. Biodamaging agents (insects and those larvae, bacteria, fungi and their disputes) are destroyed. According to tests the wood, treated at 410F should obtain dura-bility class 2; upper 430F with 3 hours of treatment is class 1 (30 years service life outdoor). The best results can be achieved when the material is used in above ground applications with good ventilation and no water-trapping.
Weather resistance	Being a natural material exposed to weather effects (ultraviolet radiation and rain) it will start to grey without coating in approximately one summer. When left without surface protection small surface shakes can also appear.	As the thermo-treated wood has even brown color in depth, the original color can be easily restored by simply sanding the surface. Or recommended to apply a pigment based surface protection to prevent color changes and surface shakes. Strongly recommended apply of high-build stains and oils protected (the best are priming oil and solvent-based alkyd or water-based acrylic topcoat), otherwise the low-build coatings wore away and annual rings started to loosen just as in the panels without coating. The panels coated with the low-build stains showed a strong tendency to crack. Due to bacteria in the air or dirt carried in the rain, fungi can grow on the untreated surface. However, this is on the surface only and can be removed by wiping or scraping.
Ground contact	Not recommended to be used in deep ground applications where structural performance is required.	It is assumed that the indicated loss of strength is due to moisture and to any micro-organism. However practical experience has found that usage of highest temperature treated material in ground contact where structural performance is not critical and periodic drying of the surfaces is allowed does not cause any significant deterioration to the material. This is especially apparent when the ground has good drainage and is made up of sand or shingle.
Emissions	Total volatile organic compounds are significantly lower (250-800 mg/m2h) than with normal kiln dried material (1500 mg/m2h).	The most of thermo-treated wood emission is acetic acid (110 mg/ m2h). The smoke-like smell that comes out of thermo-treated wood (most likely comes from furfural) disappears almost totally with time or after coating.
Environmental purity	Absolutely.	The thermo-treatment is made without insertion of any chemicals. With guarantees at least the same class of durability as the chemically protected wood, thermo-treated wood holds no danger for the environment.
Utilization	Needs no additional conservation	Can be easily utilized at the end of its life cycle unlike the chemically treated lumber.
General strength	Reduced proportionally the density reduction.	Generally the strength of wood has strong correlation with density. Thermo-treated wood has slightly lower density and correlated lower strength values, but weight-strength-value can be practically unchanged.
Bending strength	Lower (1-30%) especially for lumber with knots and highly depends on treatment temperature.	It is recommended that deep Thermo-treated wood is NOT used for load bearing structural usage. On the other hand, it was found that the light treatment renders positive influence on elasticity of molecules of wood.
Dynamic bending strength	Lower (1-25%) especially for lumber with knots and highly depends on treatment temperature.	
Compression strength	The thermo-treatment process has no negative effect on the compression strength values.	This property depends mainly on density of wood. Moreover, in some cases results better, than for dried up wood.
Shear strength	Radial values reduced 1-25 percent and tangential values 1-40 percent.	Highly depends on treatment temperature.
Splitting strength	Reduces 20-40 percent depending on treatment temperature.	Hardwoods show better results than softwoods.
Screw holding strength	Bigger effect on screw holding strength comes from the general variance in wood density than thermo-treatment process.	It was found that the results were better when narrower pre-drill holes were used for material with lower density.

WORKING WITH THERMO-TREATED WOOD

The performance of Thermo-treated wood differs from normal wood. As the wood has becomes brittle, sharp blades have to be used to prevent the wood from ripping. The wood dust coming from the process is very finely divided and dry. Thermo-treated wood is suitable for jobs involving gluing with all glue and paint types. When water-based glue or paint is used, the longer drying time due to diminished absorption of water must be taken into consideration (mostly for softwoods). Normal painting and gluing processes present no problems with hardwoods. The darkened color created in the process is not durable in UV-light, unless the surface is treated with UV-resistant coating. This also enhances the product's performance against checking. Thermo-treated wood is more susceptible to mechanical damages compared to untreated wood. Thermo-treated wood can be sawn and worked in the same way as untreated lumber. It is easy to use all sorts of hand tools for cutting, drilling and planning.

Storage.

Thermo-treated wood can be stored for unlimited time in a dry place, including unheated warehouse. Avoid the direct sunlight exposure. The packages should be stored off the ground and flat with sufficient supports between packs to avoid distortion. Avoid to mill the "fresh" thermo-treated limber due to lumber need to restore MC to 4%. Keep treated lumber at least 2-3 weeks after treatment in warehouse.

Raw material.

Preliminary K/D must be soft and slow to avoid honeycombs and reduce tension. It is very important to select raw material without heart shakes, soft rot and dead knots, which are likely to drop out during thermo treatment. Sideboard material is less suitable for thermo treatment process. More vertical grained material leads to better end results.

Mechanical treatment.

All working techniques (sawing, planning, milling, drilling, turning and sanding) can be carried out with the regular tools and according to established working practices. To achieve the best results the use of well-sharpened hard metal blades is recommended. The following measures can lead to further improvements in quality:

- ✓ Increasing the cutting angle and also if possible, the clearance angle
- ✓ Increasing cutting speed
- ✓ Using tools with the highest possible number of blades
- ✓ Using parallel feed whenever possible

Due to the intensity of Thermo-treated wood is more brittle than untreated wood and therefore sharp edges (via chamfering or rounding) should be avoided.

Fixing.

Adhesive Fixing

Since the wood is entirely dried out, cases of insufficient adhesive strength may arise. It is important to carefully check if the required adhesive stability can be achieved when using water-based glues. Water -based glues, such as PVA requires longer compression and drying time when applied to softwoods. No significant difference for thermo-treated hardwoods when compared with non-treated wood. Due to brittleness of thermo-treated wood high compression pressures should be avoided. The glue used should also contain a high proportion of solid material. Chemically hardening glues (such as polyurethane, glue based on polyvinyl acetate + hardener, resorcinol phenol and melamine resin) can be used with thermo-treated wood in the same way as with non-treated wood. As levels of expansion and contraction in thermo-treated wood are 50% lower than ordinary wood, it cannot simply be attached to untreated wood. In these cases, careful preparation of both the thermo-treated and untreated wood is necessary. If raw plugs are to be used, then these should also be thermo-treated. Alternatively, plastic raw plugs could be used. Up to now, no guaranteed results have been obtained on the performance of thermo-treated wood when adhesives are applied for external use. It is recommended not to use glue for external use.
When gluing thermo-treated wood, the glue manufacturer's specific Instructions must always be referred to.

Screwing

Thermo-treatment reduces splitting strength of wood. The use of self-tapping or countersinking screws or pre-drilling of holes must be made to avoid cracking of the material. It is recommended to use less threaded screws compared with untreated wood. Stainless steel screws with coun-tersunk heads are most suitable in outdoor applications.

Nailing

When fixing thermo-treated wood it is extremely important to use stainless steel – rust free or fully galvanized nails. Using normal wire nails or staples will lead to rust stains and overall deterioration in the fixing. Small oval head nails reduce the risk of splitting. Nails should be sunk to a depth of about 1/16". Best results are gained when using a compressed air nail gun with adjustable nailing depth on the gun. Attention must be paid to the correct pressure and the nailer's drive length. Using a normal hammer increases risk of splitting due to accidental hammer contact with the wood. Due to the brittleness fixing with nails, nail plates (gang nails) and staples is only of limited use of the material. Recommended amount of fixings and positioning. 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.