



ThermoWood®

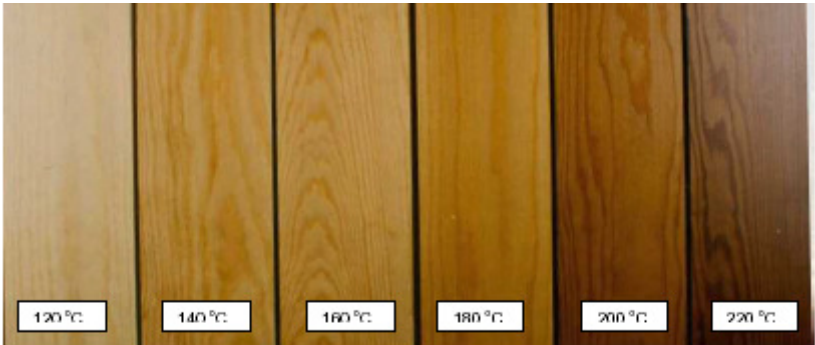
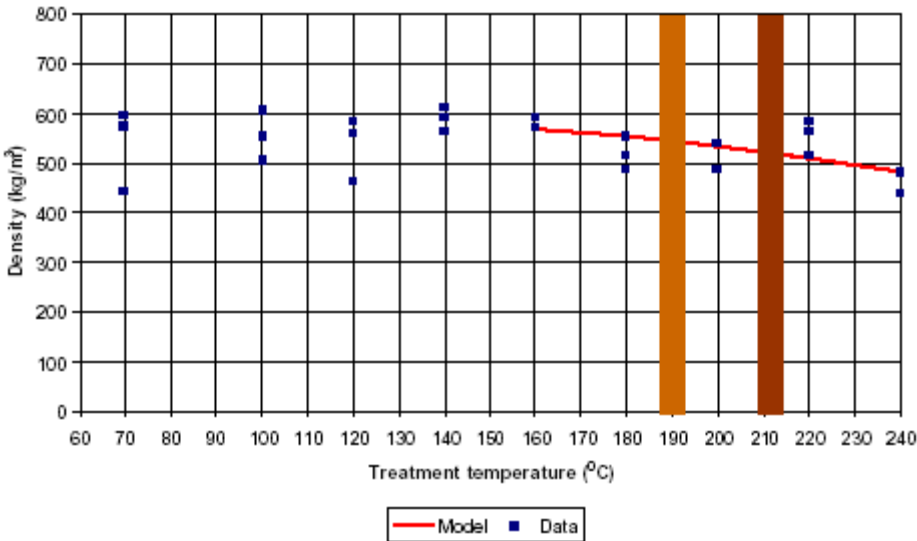
Main Properties

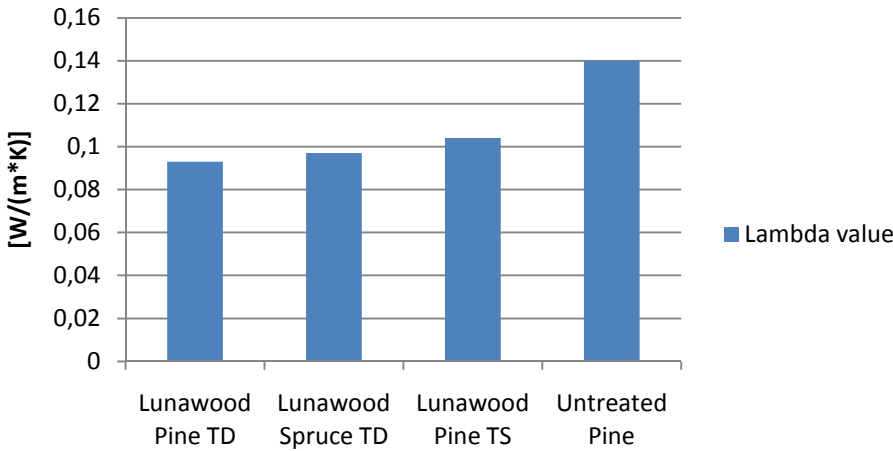
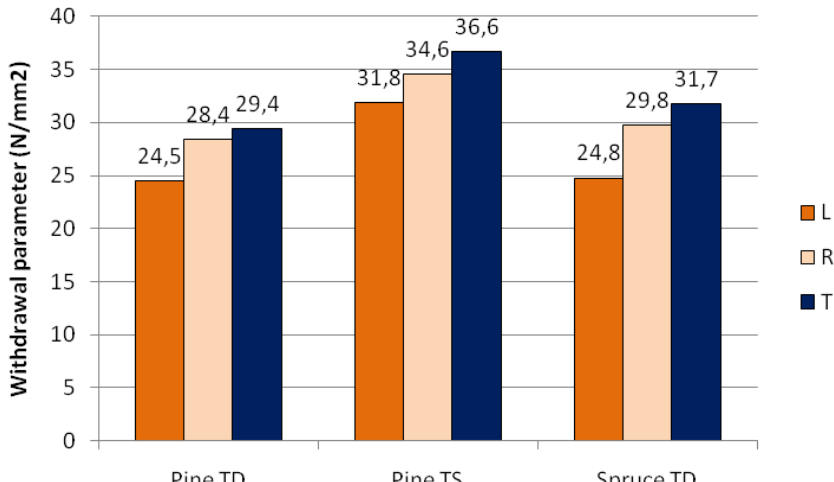
Updated 1.3.2011 / PVäät

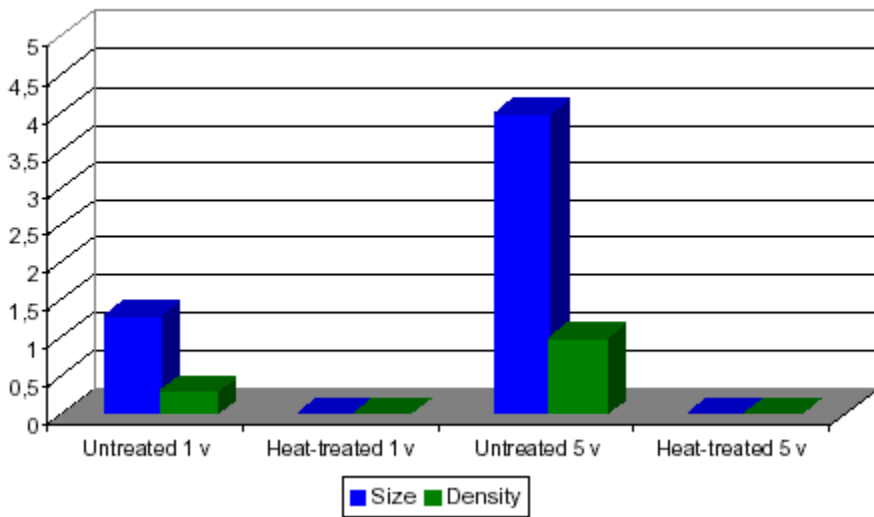
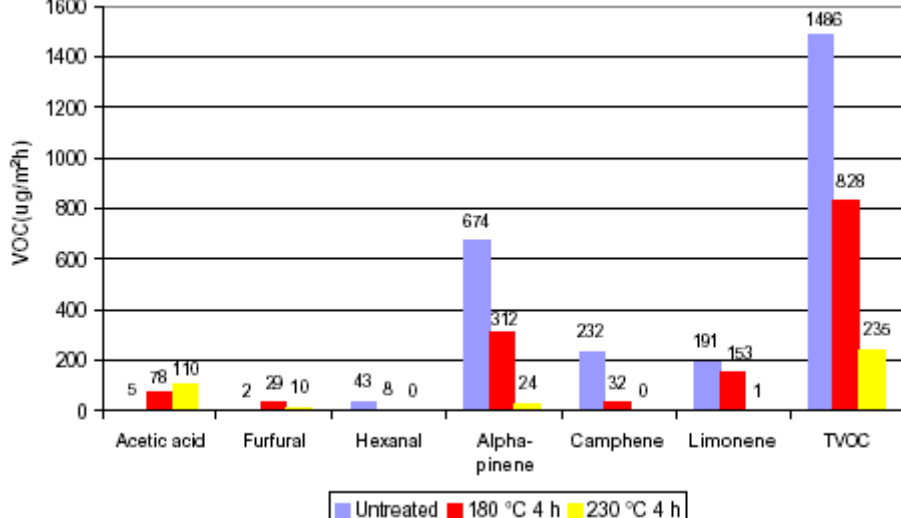


Property	Description																				
Equilibrium moisture content (EMC)	<p>Due to changes in cellular structure, wood's ability to absorb water from the surrounding air has decreased. The EMC of Finnish softwoods and hardwoods becomes 40-50 % lower, compared to untreated wood (depending on heat-treatment degree). As a result of the reduction in EMC, thermowood is more stable than normal wood in changeable climatic conditions. The moisture content does not change as much as untreated wood when stored at a work site.</p> <p>The wood is re-moisturized after treatment to moisture content between 6-9%, depending on end product.</p> <div><div>RH 85 % -> RH 30 % (EN 1910)</div><table><caption>Approximate data for RH 85 % -> RH 30 % (EN 1910)</caption><thead><tr><th>RH %</th><th>Lunawood - Pine TD</th><th>Lunawood - Pine TS</th><th>Lunawood - Spruce TD</th><th>Pine - untreated</th></tr></thead><tbody><tr><td>30</td><td>5.5</td><td>7.0</td><td>5.5</td><td>8.5</td></tr><tr><td>65</td><td>5.5</td><td>8.5</td><td>6.5</td><td>16.0</td></tr><tr><td>85</td><td>11.0</td><td>14.0</td><td>10.5</td><td>20.5</td></tr></tbody></table></div>	RH %	Lunawood - Pine TD	Lunawood - Pine TS	Lunawood - Spruce TD	Pine - untreated	30	5.5	7.0	5.5	8.5	65	5.5	8.5	6.5	16.0	85	11.0	14.0	10.5	20.5
RH %	Lunawood - Pine TD	Lunawood - Pine TS	Lunawood - Spruce TD	Pine - untreated																	
30	5.5	7.0	5.5	8.5																	
65	5.5	8.5	6.5	16.0																	
85	11.0	14.0	10.5	20.5																	
Strength	<p>The strength of the wood does not weaken considerably in lower treatment degrees.</p> <div><div>EFFECT OF TREATMENT TEMPERATURE ON THE MODULUS OF ELASTICITY, PINE</div><table><caption>Approximate data for Modulus of Elasticity vs Treatment Temperature</caption><thead><tr><th>Treatment temperature (°C)</th><th>Modulus of elasticity (N/mm²)</th></tr></thead><tbody><tr><td>60</td><td>13000</td></tr><tr><td>100</td><td>12000</td></tr><tr><td>120</td><td>13000</td></tr><tr><td>140</td><td>14000</td></tr><tr><td>160</td><td>15000</td></tr><tr><td>180</td><td>14000</td></tr><tr><td>200</td><td>12000</td></tr><tr><td>220</td><td>11000</td></tr><tr><td>240</td><td>10000</td></tr></tbody></table><div>Thermo-S Thermo-D</div></div> <p>The reference values for untreated spruce at 12% moisture content are: bending strength 40-50 N/mm2 and modulus of elasticity 9,700-12,000 N/mm2.</p> <p>According this it is recommended to use max 500 mm c/c with Lunawood decking and 600 mm c/c with cladding.</p>	Treatment temperature (°C)	Modulus of elasticity (N/mm²)	60	13000	100	12000	120	13000	140	14000	160	15000	180	14000	200	12000	220	11000	240	10000
Treatment temperature (°C)	Modulus of elasticity (N/mm²)																				
60	13000																				
100	12000																				
120	13000																				
140	14000																				
160	15000																				
180	14000																				
200	12000																				
220	11000																				
240	10000																				

Dimensional stability	<p>Compared to untreated wood the dimensional movement of wood decreases even 80-90 % (depending on heat-treatment degree). Shrinking and swelling is decreased as well. Cupping, twist and other distortion are significantly reduced compared to normally kiln-dried wood. Treatment significantly reduces the tangential and radial swelling.</p> <div><div>Dimension stability RH 85 % -> RH 30 % (EN 1910)</div><table><caption>Approximate data from Dimension Stability Chart</caption><thead><tr><th>Dimension</th><th>Lunawood Pine TD</th><th>Lunawood Pine TS</th><th>Lunawood Spruce TD</th><th>Pine untreated</th></tr></thead><tbody><tr><td>Length</td><td>0.10</td><td>0.10</td><td>0.10</td><td>0.10</td></tr><tr><td>Tangential</td><td>0.80</td><td>1.30</td><td>0.90</td><td>3.80</td></tr><tr><td>Radial</td><td>1.80</td><td>2.30</td><td>1.90</td><td>2.60</td></tr></tbody></table></div>	Dimension	Lunawood Pine TD	Lunawood Pine TS	Lunawood Spruce TD	Pine untreated	Length	0.10	0.10	0.10	0.10	Tangential	0.80	1.30	0.90	3.80	Radial	1.80	2.30	1.90	2.60																											
Dimension	Lunawood Pine TD	Lunawood Pine TS	Lunawood Spruce TD	Pine untreated																																												
Length	0.10	0.10	0.10	0.10																																												
Tangential	0.80	1.30	0.90	3.80																																												
Radial	1.80	2.30	1.90	2.60																																												
Biological durability	<p>The durability of Lunawood thermowood is based on the changes in chemical compounds in the wood. Wood's hemicellulose (sugar compound) is degraded, leaving no nutritive matter for fungi.</p> <p>High resistance to moisture and durability against decay-causing fungi makes it an excellent material for use in gardens, terraces as well as many other outdoor applications. Different process levels are used dependant on the required durability (Thermo-S and Thermo-D). As a consequence of heat treatment sugars of wood are in form, that decay funguses can't use them as nourishment.</p> <p>As decay resistance places it in decay resistance category 2, it is an alternative to AB-class impregnated wood (KOMO certificate). Lunawood thermowood is however not recommended to conditions where it would be saturated in water or come in contact with soil. According this information BRE concludes 30 years expected service life for Lunawood cladding and decking products.</p> <p>DURABILITY CLASSIFICATION OF DIFFERENT WOOD SPECIES</p> <table><tr><td></td><td>1 (highest)</td><td>2</td><td>3</td><td>4</td><td>5 (weakest)</td></tr><tr><td rowspan="8">WOOD SPECIE</td><td>Iroko</td><td>Iroko</td><td></td><td></td><td>pine spruce</td></tr><tr><td></td><td>WRC</td><td>WRC</td><td></td><td></td></tr><tr><td></td><td></td><td>Larch</td><td>Larch</td><td></td></tr><tr><td></td><td>Luna-Thermo-D</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>LunaThermo-S</td><td></td><td></td></tr><tr><td></td><td>European Oak</td><td></td><td></td><td></td></tr><tr><td>CCA imegrated</td><td></td><td>Douglas Fir</td><td>Douglas Fir</td><td></td></tr><tr><td></td><td>C imegrated</td><td></td><td></td><td></td></tr></table>		1 (highest)	2	3	4	5 (weakest)	WOOD SPECIE	Iroko	Iroko			pine spruce		WRC	WRC					Larch	Larch			Luna-Thermo-D						LunaThermo-S				European Oak				CCA imegrated		Douglas Fir	Douglas Fir			C imegrated			
	1 (highest)	2	3	4	5 (weakest)																																											
WOOD SPECIE	Iroko	Iroko			pine spruce																																											
		WRC	WRC																																													
			Larch	Larch																																												
		Luna-Thermo-D																																														
			LunaThermo-S																																													
		European Oak																																														
	CCA imegrated		Douglas Fir	Douglas Fir																																												
		C imegrated																																														

<p>Colour</p>	<p>The wood attains an even brown colouring throughout. The colour will fade over time due to the effects of both ultraviolet radiation from the sun and humidity.</p> <p>In outdoor applications, the lightening or greying in colour caused by the sun can be reduced by protecting it with a surface-treatment agent containing a pigment and UV-block.</p> <p>In indoor use changes are not strong, but lightening of colour on some level may be observed by time. Surface treatment for Lunawood thermowood in indoors is not necessary but recommended. Surface treatment such as varnishing, waxing or by using oil continues the life cycle of e.g. flooring materials and helps cleaning surfaces.</p>  <p>Figure 20-4. The colour of heat-treated pine. Treatment temperatures from 120 to 220 °C at 20 °C intervals. Treatment time (photo: VTT).</p>																				
<p>Weight (density)</p>	<p>The weight of wood decreases depending on treatment temperature and treatment time (by experiences 10-20%). Decreasing of weight is caused both by drying of wood and by degrading of compounds.</p> <p style="text-align: center;">EFFECT OF TREATMENT TEMPERATURE ON DENSITY, PINE</p> <p style="text-align: right;">Thermo-S Thermo-D</p>  <table border="1"> <caption>Approximate data points from the graph</caption> <thead> <tr> <th>Treatment temperature (°C)</th> <th>Density (kg/m³)</th> </tr> </thead> <tbody> <tr><td>70</td><td>580</td></tr> <tr><td>100</td><td>550</td></tr> <tr><td>120</td><td>520</td></tr> <tr><td>140</td><td>500</td></tr> <tr><td>160</td><td>480</td></tr> <tr><td>180</td><td>460</td></tr> <tr><td>200</td><td>440</td></tr> <tr><td>220</td><td>420</td></tr> <tr><td>240</td><td>400</td></tr> </tbody> </table>	Treatment temperature (°C)	Density (kg/m³)	70	580	100	550	120	520	140	500	160	480	180	460	200	440	220	420	240	400
Treatment temperature (°C)	Density (kg/m³)																				
70	580																				
100	550																				
120	520																				
140	500																				
160	480																				
180	460																				
200	440																				
220	420																				
240	400																				

Thermal conductivity and thermal insulation	<div><div>Lambda value [W/(m*K)] - EN 12667</div><table><thead><tr><th>Material</th><th>Lambda value [W/(m*K)]</th></tr></thead><tbody><tr><td>Lunawood Pine TD</td><td>0.092</td></tr><tr><td>Lunawood Spruce TD</td><td>0.095</td></tr><tr><td>Lunawood Pine TS</td><td>0.102</td></tr><tr><td>Untreated Pine</td><td>0.140</td></tr></tbody></table></div>	Material	Lambda value [W/(m*K)]	Lunawood Pine TD	0.092	Lunawood Spruce TD	0.095	Lunawood Pine TS	0.102	Untreated Pine	0.140						
Material	Lambda value [W/(m*K)]																
Lunawood Pine TD	0.092																
Lunawood Spruce TD	0.095																
Lunawood Pine TS	0.102																
Untreated Pine	0.140																
pH-value	Lunawood’s pH-value is slightly turned to acid. Value has varied between 4 - 6. Stainless and acid-proof fasteners are recommended to use in outdoor applications (humid conditions) to avoid corrosion of fasteners.																
Fastener use	<p>Fastener are recommended to place 70 mm from the product ends and 10 mm from sides. Also self drilling fasteners or pre drilling is recommended.</p> <p>The average values of withdrawal parameter of a wood screw (diameter = 2.7 mm and depth of penetration = 20 mm) in heat-treated pine and spruce in different directions (L = longitudinal, R = radial, T = tangential). Test is made according EN 1382.</p>  <table><thead><tr><th>Material</th><th>L</th><th>R</th><th>T</th></tr></thead><tbody><tr><td>Pine TD</td><td>24,5</td><td>28,4</td><td>29,4</td></tr><tr><td>Pine TS</td><td>31,8</td><td>34,6</td><td>36,6</td></tr><tr><td>Spruce TD</td><td>24,8</td><td>29,8</td><td>31,7</td></tr></tbody></table>	Material	L	R	T	Pine TD	24,5	28,4	29,4	Pine TS	31,8	34,6	36,6	Spruce TD	24,8	29,8	31,7
Material	L	R	T														
Pine TD	24,5	28,4	29,4														
Pine TS	31,8	34,6	36,6														
Spruce TD	24,8	29,8	31,7														
Chemical additives	Lunawood thermowood contains no additives. The process only uses vapour and heat, and no chemicals or agents are added to the material. The environmental benefit is that natural surroundings remain unaffected, and processing waste can be disposed e.g. by burning or by taking it to landfill without risk. Lunawood thermowood is easily recycleable.																
Fire properties	Tests has been carried out by Single Burning Item SBI test (EN 13823), by CTBA according to the NF B 52501 standard, and by British Standard BS 476 Part 7, and by VTT Finland according to ISO 5660. Tests indicate, that fire properties are almost the same as with untreated wood (D s1-d0).																
Smell	The smoke-like smell of heat-treated wood most likely comes from furfural. It has been found to disappear over time, and when surface treatments are applied the smell is removed.																

Other	<p>All resin is dispersed from the timber during the heat-treatment process. The benefit of dispersed resin means that there is no risk of resin seeping through surface paintwork. According to tests the best coating systems have consisted of the priming oil and solvent-based alkyd or water-based acrylic topcoat.</p> <p style="text-align: center;">EFFECT OF SUBSTRATE TO PAINT FLAKING</p>  <table><caption>Data for EFFECT OF SUBSTRATE TO PAINT FLAKING</caption><thead><tr><th>Substrate</th><th>Size (Blue)</th><th>Density (Green)</th></tr></thead><tbody><tr><td>Untreated 1 v</td><td>1.5</td><td>0.5</td></tr><tr><td>Heat-treated 1 v</td><td>0.2</td><td>0.2</td></tr><tr><td>Untreated 5 v</td><td>4.2</td><td>1.2</td></tr><tr><td>Heat-treated 5 v</td><td>0.2</td><td>0.2</td></tr></tbody></table>	Substrate	Size (Blue)	Density (Green)	Untreated 1 v	1.5	0.5	Heat-treated 1 v	0.2	0.2	Untreated 5 v	4.2	1.2	Heat-treated 5 v	0.2	0.2																	
Substrate	Size (Blue)	Density (Green)																															
Untreated 1 v	1.5	0.5																															
Heat-treated 1 v	0.2	0.2																															
Untreated 5 v	4.2	1.2																															
Heat-treated 5 v	0.2	0.2																															
Formaldehyde	<p>Formaldehyde contained by natural wood dissolves completely. Heat-treated wood is sterile and practically toxic-free.</p> <p>The total emission for heat-treated pine treated at 180 °C has been in tests 828 g/m²h, and the emission of heat-treated pine treated at 230 °C has been at the lowest 235 g/m²h (by the KET 3300495 test method), while untreated pine has showed the largest quantity of volatile organic compounds, 1486 g/m²h.</p> <p style="text-align: center;">VOLATILE ORGANIC COMPOUNDS FROM PINE SAMPLES</p>  <table><caption>Data for VOLATILE ORGANIC COMPOUNDS FROM PINE SAMPLES</caption><thead><tr><th>Compound</th><th>Untreated (Blue)</th><th>180 °C 4 h (Red)</th><th>230 °C 4 h (Yellow)</th></tr></thead><tbody><tr><td>Acetic acid</td><td>5</td><td>78</td><td>110</td></tr><tr><td>Furfural</td><td>2</td><td>29</td><td>10</td></tr><tr><td>Hexanal</td><td>43</td><td>8</td><td>0</td></tr><tr><td>Alpha-pinene</td><td>674</td><td>312</td><td>24</td></tr><tr><td>Camphene</td><td>232</td><td>32</td><td>0</td></tr><tr><td>Limonene</td><td>191</td><td>153</td><td>1</td></tr><tr><td>TVOC</td><td>1486</td><td>828</td><td>235</td></tr></tbody></table>	Compound	Untreated (Blue)	180 °C 4 h (Red)	230 °C 4 h (Yellow)	Acetic acid	5	78	110	Furfural	2	29	10	Hexanal	43	8	0	Alpha-pinene	674	312	24	Camphene	232	32	0	Limonene	191	153	1	TVOC	1486	828	235
Compound	Untreated (Blue)	180 °C 4 h (Red)	230 °C 4 h (Yellow)																														
Acetic acid	5	78	110																														
Furfural	2	29	10																														
Hexanal	43	8	0																														
Alpha-pinene	674	312	24																														
Camphene	232	32	0																														
Limonene	191	153	1																														
TVOC	1486	828	235																														

<p>Limitations</p>	<p>Based on the results of the field test (EN 252), it is recommended that Lunawood thermowood not be used in deep ground applications where structural strength is required.</p> <p>Lunawood thermowood is not recommended be used in continuous direct contact with moist soil. When constantly immersed in water or making soil contact, it loses its strength properties due to certain chemical reactions.</p> <p>Thermo-D 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.</p>
--------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

All the properties are based on the results of a range of tests, conducted over a period of several years, concerning Lunawood heat treated wood. These properties should be used as a guide only and are subject to variation due to the natural differences between timber pieces. The information is based on current knowledge. Further testing is constantly underway in order to verify previous test results and to accumulate a statistically significant database concerning the most important Lunawood ThermoWood properties. Information is based on research work done by Lunawood with its scientific partners and VTT in Finland.