



ThermoWood®

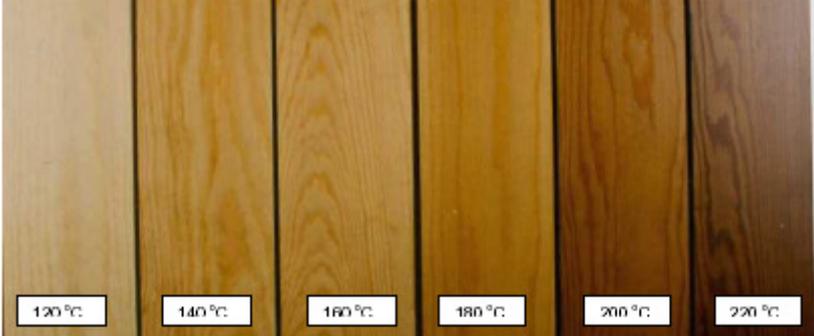
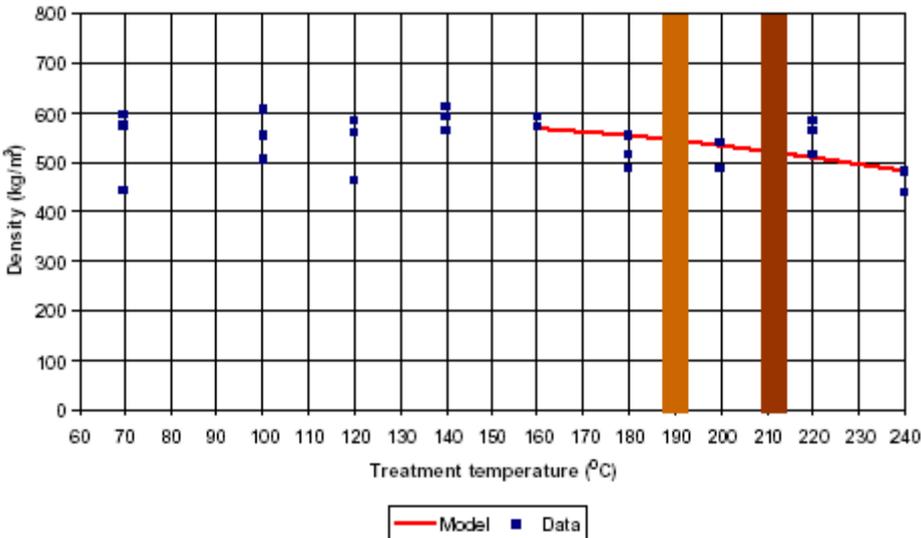
Main Properties

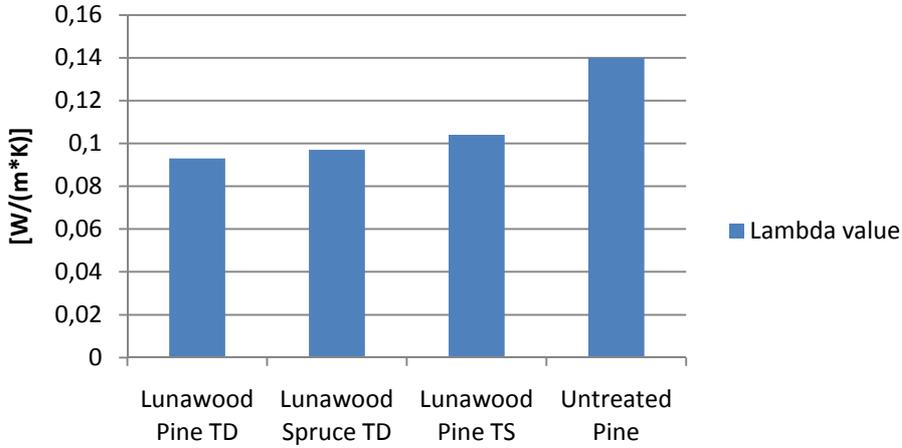
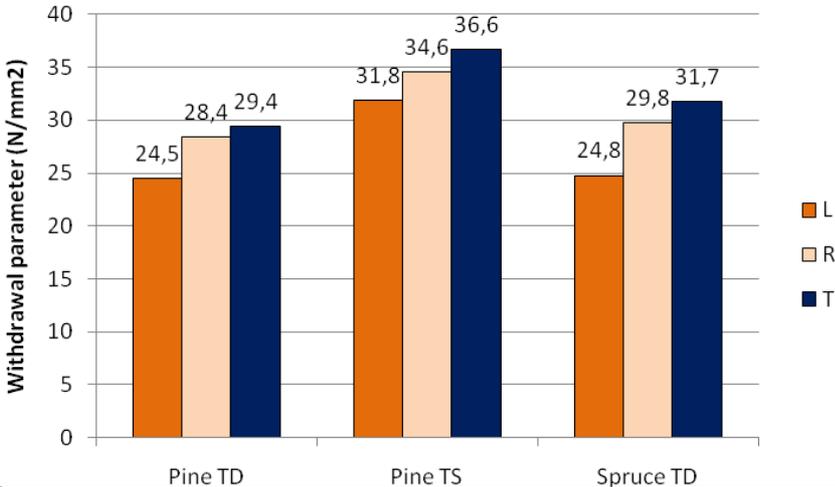
Updated 1.3.2011 / PVäät



Property	Description																																																
<p>Equilibrium moisture content (EMC)</p>	<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 data-bbox="347 600 1455 1272" style="border: 1px solid black; padding: 10px;"> <p style="text-align: center;">RH 85 % -> RH 30 % (EN 1910)</p> <table border="1"> <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>7.0</td> <td>16.0</td> </tr> <tr> <td>85</td> <td>11.0</td> <td>14.0</td> <td>11.0</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	7.0	16.0	85	11.0	14.0	11.0	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	7.0	16.0																																													
85	11.0	14.0	11.0	20.5																																													
<p>Strength</p>	<p>The strength of the wood does not weaken considerably in lower treatment degrees.</p> <div data-bbox="347 1317 1455 2027" style="border: 1px solid black; padding: 10px;"> <p style="text-align: center;">EFFECT OF TREATMENT TEMPERATURE ON THE MODULUS OF ELASTICITY, PINE</p> <table border="1"> <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>11000</td> </tr> <tr> <td>60</td> <td>12000</td> </tr> <tr> <td>60</td> <td>13000</td> </tr> <tr> <td>60</td> <td>14000</td> </tr> <tr> <td>100</td> <td>11500</td> </tr> <tr> <td>100</td> <td>12500</td> </tr> <tr> <td>100</td> <td>14500</td> </tr> <tr> <td>120</td> <td>10500</td> </tr> <tr> <td>120</td> <td>13000</td> </tr> <tr> <td>120</td> <td>14000</td> </tr> <tr> <td>140</td> <td>14000</td> </tr> <tr> <td>140</td> <td>16500</td> </tr> <tr> <td>140</td> <td>18000</td> </tr> <tr> <td>160</td> <td>16500</td> </tr> <tr> <td>180</td> <td>11500</td> </tr> <tr> <td>180</td> <td>14000</td> </tr> <tr> <td>180</td> <td>14500</td> </tr> <tr> <td>200</td> <td>11500</td> </tr> <tr> <td>200</td> <td>14000</td> </tr> <tr> <td>220</td> <td>11500</td> </tr> <tr> <td>220</td> <td>17500</td> </tr> <tr> <td>240</td> <td>11000</td> </tr> <tr> <td>240</td> <td>12000</td> </tr> </tbody> </table> </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	11000	60	12000	60	13000	60	14000	100	11500	100	12500	100	14500	120	10500	120	13000	120	14000	140	14000	140	16500	140	18000	160	16500	180	11500	180	14000	180	14500	200	11500	200	14000	220	11500	220	17500	240	11000	240	12000
Treatment temperature (°C)	Modulus of elasticity (N/mm²)																																																
60	11000																																																
60	12000																																																
60	13000																																																
60	14000																																																
100	11500																																																
100	12500																																																
100	14500																																																
120	10500																																																
120	13000																																																
120	14000																																																
140	14000																																																
140	16500																																																
140	18000																																																
160	16500																																																
180	11500																																																
180	14000																																																
180	14500																																																
200	11500																																																
200	14000																																																
220	11500																																																
220	17500																																																
240	11000																																																
240	12000																																																

<p>Dimensional stability</p>	<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 data-bbox="331 405 1299 976" style="border: 1px solid black; padding: 10px; text-align: center;"> <p>Dimension stability RH 85 % -> RH 30 % (EN 1910)</p> <table border="1" style="margin: 10px auto; border-collapse: collapse;"> <caption>Dimension Stability Data (RH 85% to RH 30%)</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>~0.1</td> <td>~0.1</td> <td>~0.1</td> <td>~0.1</td> </tr> <tr> <td>Tangential (%)</td> <td>~0.8</td> <td>~1.3</td> <td>~0.9</td> <td>~3.8</td> </tr> <tr> <td>Radial (%)</td> <td>~1.8</td> <td>~2.3</td> <td>~1.8</td> <td>~2.6</td> </tr> </tbody> </table> </div>	Dimension	Lunawood Pine TD	Lunawood Pine TS	Lunawood Spruce TD	Pine untreated	Length (%)	~0.1	~0.1	~0.1	~0.1	Tangential (%)	~0.8	~1.3	~0.9	~3.8	Radial (%)	~1.8	~2.3	~1.8	~2.6																											
Dimension	Lunawood Pine TD	Lunawood Pine TS	Lunawood Spruce TD	Pine untreated																																												
Length (%)	~0.1	~0.1	~0.1	~0.1																																												
Tangential (%)	~0.8	~1.3	~0.9	~3.8																																												
Radial (%)	~1.8	~2.3	~1.8	~2.6																																												
<p>Biological durability</p>	<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 style="text-align: center; color: green;">DURABILITY CLASSIFICATION OF DIFFERENT WOOD SPECIES</p> <table border="1" style="margin: 10px auto; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 5%;"></th> <th style="width: 20%;">1 (highest)</th> <th style="width: 20%;">2</th> <th style="width: 20%;">3</th> <th style="width: 20%;">4</th> <th style="width: 20%;">5 (weakest)</th> </tr> </thead> <tbody> <tr> <td rowspan="8" style="writing-mode: vertical-rl; transform: rotate(180deg);">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 imeprated</td> <td></td> <td>Douglas Fir</td> <td>Douglas Fir</td> <td></td> </tr> <tr> <td></td> <td>C imeprated</td> <td></td> <td></td> <td></td> </tr> </tbody> </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 imeprated		Douglas Fir	Douglas Fir			C imeprated			
	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 imeprated		Douglas Fir	Douglas Fir																																												
		C imeprated																																														

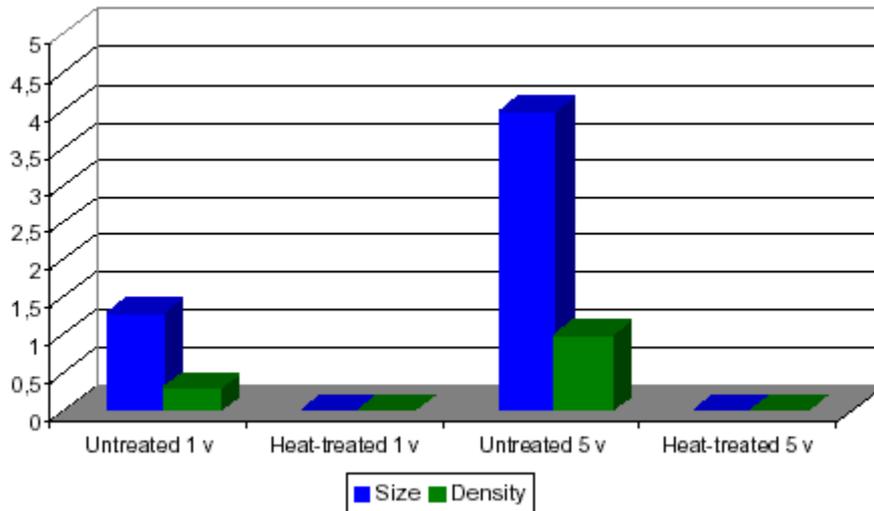
<p>Colour</p>	<p>The wood attains an even brown colouring throughout. The colour will fade over time due to the effects of both ultraviolet radiation from the sun and humidity.</p> <p>In outdoor applications, the lightening or greying in colour caused by the sun can be reduced by protecting it with a 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: center;">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>600</td></tr> <tr><td>100</td><td>550</td></tr> <tr><td>120</td><td>500</td></tr> <tr><td>140</td><td>580</td></tr> <tr><td>160</td><td>550</td></tr> <tr><td>180</td><td>500</td></tr> <tr><td>200</td><td>480</td></tr> <tr><td>220</td><td>450</td></tr> <tr><td>240</td><td>450</td></tr> </tbody> </table> <p style="text-align: center;">— Model ■ Data</p>	Treatment temperature (°C)	Density (kg/m³)	70	600	100	550	120	500	140	580	160	550	180	500	200	480	220	450	240	450
Treatment temperature (°C)	Density (kg/m³)																				
70	600																				
100	550																				
120	500																				
140	580																				
160	550																				
180	500																				
200	480																				
220	450																				
240	450																				

<p>Thermal conductivity and thermal insulation</p>	<p style="text-align: center;">Lambda value [W/(m*K)] - EN 12667</p>  <table border="1"> <caption>Lambda value [W/(m*K)] - EN 12667</caption> <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>	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																	
<p>pH-value</p>	<p>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.</p>																	
<p>Fastener use</p>	<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 border="1"> <caption>Withdrawal parameter (N/mm²)</caption> <thead> <tr> <th>Material</th> <th>L (N/mm²)</th> <th>R (N/mm²)</th> <th>T (N/mm²)</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 (N/mm ²)	R (N/mm ²)	T (N/mm ²)	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 (N/mm ²)	R (N/mm ²)	T (N/mm ²)															
Pine TD	24,5	28,4	29,4															
Pine TS	31,8	34,6	36,6															
Spruce TD	24,8	29,8	31,7															
<p>Chemical additives</p>	<p>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 recyclable.</p>																	
<p>Fire properties</p>	<p>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).</p>																	
<p>Smell</p>	<p>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.</p>																	

Other

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 alkyl or water-based acrylic topcoat.

EFFECT OF SUBSTRATE TO PAINT FLAKING

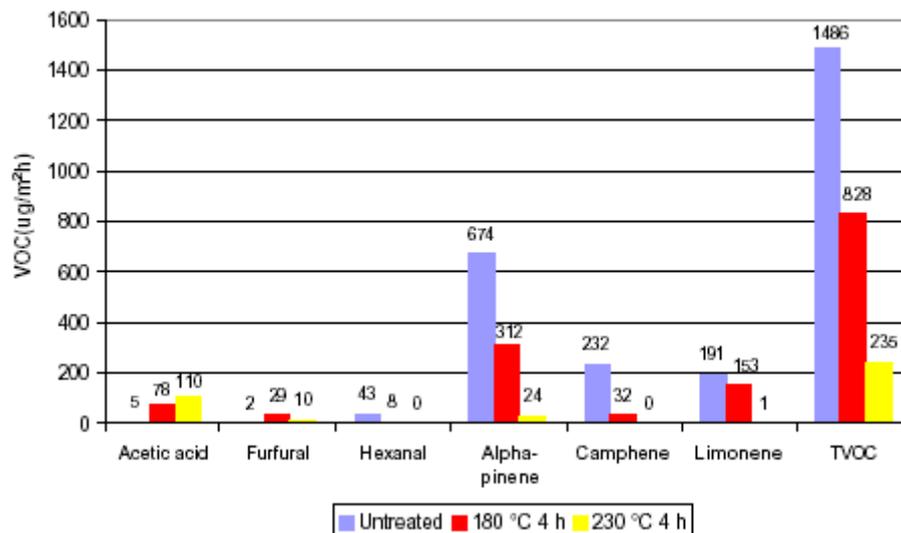


Formaldehyde

Formaldehyde contained by natural wood dissolves completely. Heat-treated wood is sterile and practically toxic-free.

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.

VOLATILE ORGANIC COMPOUNDS FROM PINE SAMPLES



<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.