

Product Properties of Belmadur Pine

Topic	Standard	Test Institute	Results & Recommendations
General			
Wood Species			
<p><i>Belmadur Scots Pine is listed as a suitable species on the "Wood Species List" (Holzartenliste) by the German quality association for windows and siding (VFF). Scots pine (Pinus sylvestris L.) was chosen for the Wood Species List because it is the most widely used species for windows in Germany. Radiata pine (Pinus radiata), Ponderosa pine (Pinus ponderosa), and Eastern white pine (Pinus strobus) have all been extensively tested and are also suitable for use in windows.</i></p>			
Wood Quality			
<p><i>All industry recommendations regarding wood quality for pine used in windows also apply to Belmadur wood.</i></p>			
Production Process for Belmadur Pine			
Wood Modification			
<p><i>In the textile industry, non-iron, wrinkle-free chemistry is used to cross-link and stabilize the cellulose molecules of cotton. Similarly, in the Belmadur wood modification process, wood is modified by cross-linking the Belmadur molecules with major wood components such as cellulose, hemicellulose and lignin.</i></p> <p><i>The Belmadur Technology is based on two process steps that are well-established in the wood industry. In the first stage, wood is impregnated with a water-based solution (the Belmadur solution) such that Belmadur cross-linking molecules fully penetrate the wood cross section. In the second stage, the fully impregnated wood is cured at temperatures above 100°C. At this point, the Belmadur molecules cross-link (react) with the components of the wood's cell walls.</i></p>			
Underlying Mode of Action			
<p><i>The Belmadur modification of wood is based on a non-biocidal mode of action. The Belmadur modification is a permanent, irreversible cross-linking of wood cell components. Given the changed wood cell structure, wood destroying fungi cannot use the Belmadur wood as a food source, because their enzymatic processes (digestion) no longer function as with regular wood.</i></p>			
Structure and Color Change			
<p><i>Wood permanently swells during Belmadur modification due to the permanent integration of the cross linker in the cell wall. This effect is called bulking. Bulking is characterized by the increased volume of the wood (in an absolute dry state) after the Belmadur modification. A measurable bulking is a clear indicator that the Belmadur cross-linker has penetrated the cell walls, while the cell lumen remain open. No damage to the structure of the wood should occur provided that the Belmadur process conditions and parameters are met. Belmadur pine is slightly darker after modification, with an appearance similar to larch. The slight color change is caused by hygrothermal discoloration, similar to that found when kiln-drying under high temperatures and steaming. Also "shading" or "spotting" can sometimes be observed, which is caused by the wood resins migrating to the surface during the process. After processing and/or profiling those color patterns are no longer visible.</i></p> <p><i>No effect on the color of the coating is observed when Belmadur pine is painted with dark colors. When painted white, unlike unmodified pine, discoloration caused by resin penetration of the coating does not occur with Belmadur pine. You get the best results by applying at least 100 µm dry film thickness.</i></p>			
Physical Properties of Belmadur Pine			
Biological Durability			
	CEN/TS 15083-1	Dr. Wolman GmbH, IfHH Göttingen	Durability Class 1
	ENV 807	IfHH Göttingen	Durability Class 1
<p><i>All tests were performed after an aging/leaching procedure according to DIN EN 84.</i></p>			
<p><i>Belmadur pine, classified in Durability Class 1, reaches the highest possible biological durability against wood destroying fungi. No domestic European wood species reaches this durability class. Even globally, only a few wood species such as teak can compete with Belmadur pine performance regarding biological durability.</i></p>			

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Bluestain			
	EN 152-1	Dr. Wolman GmbH, IfHH Göttingen	No bluestain protection
<i>After Belmadur modification, bluestain is significantly reduced. Full protection against bluestain cannot be guaranteed; therefore a treatment against bluestain is recommended.</i>			
Emissions			
	Formaldehyde: DIN EN 717-1	BASF AG IfHH Göttingen	< 0,1ppm
	VOC: ENV 13419 -Teile 1-3	BASF AG	TVOC after 72h: 440µg/m ³
<i>Formaldehyde emissions from uncoated Belmadur modified pine are significantly below the E1 emission limit of 0,1 ppm. The E1 limit applies to the class of engineered wood products (such as fibre boards and OSB). Emission of volatile organic compounds, VOCs, is significantly reduced versus natural pine. The Belmadur modification reduces VOC emissions by 90%, from 7120 to 440µg/m³, compared with natural pine.</i>			
Raw Density			
	DIN 52182	IfHH Göttingen	Dry density: 0,54g/cm ³ Raw Density 20%65%: 0,57g/cm ³
<i>The Belmadur modification of pine leads to a weight and volume increase, while simultaneously reducing equilibrium moisture content. The raw density is therefore increased by 5-8%.</i>			
Swelling and Shrinking Properties			
	DIN 52184	IfHH Göttingen	Maximum Swelling: radial 2,45 % tangential 4,42% longitudinal 0,131% Swelling Coefficient: radial 0,019 tangential 0,034 longitudinal 0,0009
<i>Swelling and shrinking of Belmadur pine compared to unmodified pine is reduced by 50-60%. Furthermore, the differences in swelling along the three grain directions (radial, tangential, longitudinal), the anisotropy, are greatly reduced.</i>			
Capillary Water Absorption			
	DIN EN ISO 15148	IfHH Göttingen	Coefficient of Water Absorption: WW radial 0,0333 kg/(m ² x h0,5) WW tan 0,0515 kg/(m ² x h0,5) WW long 2,208 kg/(m ² x h0,5)
<i>Belmadur modification of pine leads to a reduction in capillary water absorption.</i>			
Fire Behaviour			
	DIN 4102	BASF AG	Baustoffklasse B2
<i>Belmadur pine behaves as natural pine and therefore is classified as B2.</i>			
Equilibrium Moisture			
	DIN 52183	IfHH Göttingen	Ugl(20%65%) 7,8%
<i>The modification of pine with the Belmadur process causes a reduction in equilibrium moisture content of 30-40%. The moisture content of Belmadur pine can only be determined by oven drying or measurement of the dielectric constant. A measurement of conductivity is not possible with Belmadur modified wood.</i>			
Thermal conductivity (λ value)			
	DIN EN 12667	MPA Stuttgart	0,120 W/mK*
<i>The λ- value for Belmadur pine is lower than for natural pine due to the lower equilibrium moisture content. *Density570kg/m³</i>			

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Mechanical Properties of Belmadur Pine			
Bending Strength			
	DIN 52186	IfHH Göttingen	109,7 N/mm ²
<i>Bending strength of Belmadur pine is unchanged compared to unmodified pine. Belmadur pine is characterized by increased stiffness and less elasticity. The maximum bending is reduced by 50%.</i>			
Modulus of Elasticity			
	DIN 52186	IfHH Göttingen	13.375 /mm ²
<i>The static E-module is unchanged after the Belmadur modification.</i>			
Compression Strength (axial)			
	DIN 52185	IfHH Göttingen	76,5 N/mm ²
<i>The Belmadur modification of pine increases the compression strength parallel to the fibre by approximately 50% compared to unmodified pine.</i>			
Impact Resistance			
	DIN 52189	IfHH Göttingen	16 N/mm ²
<i>Belmadur pine is more brittle compared to unmodified pine due to cross-linking during the modification process. This leads to a reduced impact resistance.</i>			
Surface Hardness			
	Brinell Hardness	IfHH Göttingen	26 N/mm ²
<i>The Brinell surface hardness of Belmadur pine compared to unmodified pine is increased by 30-40%.</i>			
Suitability of Belmadur Pine for Window Production			
Corrosion			
		BASF SE	pH value of wood is unchanged
<i>All commercially available fittings and fasteners with various surface treatments recommended for pine wood can also be used on Belmadur pine.</i>			
Glue Adhesion			
	DIN 301/302 EN 391 B und C ASTM D 905	IfHH Göttingen Dynea Dynea	PVAc EPI PUR
<i>Generally, all commercially available adhesives and glues can be used. Adaptations based on the type of adhesive and the wood species may be needed, depending on the respective recommendation of the adhesive manufacturer and Münchinger.</i>			
Recommendations for Processing			
<i>Using the same rotation speed and feed rate, tool abrasion is reduced by 50% compared to unmodified pine. Force of infeed is decreased by the same amount. Dust generated when processing Belmadur pine should be handled under the same safety parameters as dust from the processing of hardwoods. If necessary increased brittleness requires adjustments in machine setting up and tool selection. In case of doubt one should contact respective supplier. It is strongly recommended to pre-drill all fittings in order to avoid splitting</i>			
Recycling and Disposal			
<i>Windows made of Belmadur pine can be recycled or disposed according to the same guidelines as windows from unmodified pine. Thermal disposal of Belmadur pine follows the same guidelines as laminated wood (according to Altholzverordnung, laminated wood belongs to Category A II). Belmadur pine shavings should not be used for animal bedding.</i>			
Quality of Belmadur Modification			
<i>Every batch of Belmadur modified pine is tested to ensure the highest quality. A highly reliable and traceable testing method was developed to verify the properties important to the application of Belmadur pine in windows and doors (biological durability and swelling/shrinking). This test method, the Nitrogen-method, determines the nitrogen level in Belmadur pine (unmodified pine wood does not contain nitrogen). The nitrogen level can then be correlated to the most important properties of Belmadur wood. With this method, the manufacturer as well as the customer can check that the proper modification level and quality of Belmadur pine was reached. Nitrogen testing can be performed after each production batch as well as on Belmadur pine in the final product (window, door) after many years in use.</i>			
Corner Fixing			
<i>For corner connections made up with dowels, we recommend to use plastic dowels. Beech e.g. is non durable, therefore please do not use Beech dowels at all!</i>			