Handbook

Thermo-Ash
Terrace deckings

brenstol

Contents

1. Preface

Thermally modified wood (so-called thermo-wood) shall show advantages over untreated wood in terms of dimensional stability, surface hardness, resistance to decay, and the appearance of cracks. If thermal modification is carried out with insufficient technology and/or lack of process know-how, these advantages will most likely not show, the wood will be deteriorated permanently instead.

Our manufacturer applies for the production of thermo-ash terrace deckings kiln technology of the Finnish mechanical engineering company Stellac Oy. Stellac is the manufacturer of thermo-kilns with the most advanced technology and the longest experience in the field. Stellac kilns are able to measure the humidity level of the wood at the beginning of the treatment process applying special sensors. The whole process is guided so that homogenous conditions with respect to humidity and temperature are created in all parts of the kiln. This forms the precondition to produce consistent quality from charge to charge, as well as within one charge. The measuring devices in the kiln support the kiln operator in controlling the process parameters of point in time, length of time, temperature and humidity level.

An essential step in the treatment process is the drying to 0% moisture level and the consecutive temperature increase and thermal treatment to up to 215 °C. Wrong decisions taken by the process operator concerning point in time and length of time of temperature increase or decrease respectively humidity level in form of steam may bring about irrevocable damage to the wood, which becomes obvious in the form of cracks, brittleness, or significant color differences.

One of the most important steps in manufacturing thermally modified ash his carried out towards the end of the process. Thermo-treatment causes the equilibrium moisture of wood to decrease. It is important to increase the moisture level of the wood at the end of the process to its new equilibrium moisture. This step requires profound know-how by the process operator. The operator decides when, how long, at which temperature level, which amount of steam will yield homogenous, not brittle thermo-ash. If this process of re-moisturizing is not or wrongly carried out, internal cracks will appear already in the kiln or at the storage site. Clearly visible become the cracks usually only after planing or even after installation of the deckings.

2. Processing guidelines

Color:
The color of thermally modified wood is not resistant to UV radiation. Wood that has fallen gray is not less resistant to decay. To maintain the color for a longer time, we recommend to oil the wood after installation at least once. Oil closes the wood's pores which inhibits dirt from sticking to the wood, which again facilitates the cleaning process. We can recommend our transparent thermo-ash oil (see pager 8), which we made good experiences with in terms of slower graying and new application after some time has passed.

Installation:
At installation one must take care that the support points (under construction) are nor further than 50 cm apart. At least 6-7 mm distance between single decking boards must be kept. Screwing must be done exclusively with fixation material made of stainless steel. Other metal materials may cause dark spots on the wood in exterior application. Screwing must always involve pre-drilling of a hole that is 1 mm bigger in diameter than the screw (for example a 4,0x40 mm screw requires a 5,0 mm bore hole). The screw head's conus must be counter-bored as well. We recommend the utilization of a depth stop. The size of the screw head must match the size of the counterbore. Any kind of screw must be pre-drilled. Fixation systems must allow the wood some sort of „working" or „moving" after installation.

Minimum distance side wise: 20mm Minimum distance front wise: 40mm

Storage:
Before installation it must be considered that the thermo-ash deckings are stored at the installation site or outside for about 48 hours (not at some inside place like for example a closed carport). The deckings gain the appropriate equilibrium moisture for installation thereby.

Cracks:
Also thermally modified wood can show small stress cracks. These are normally nor wider than 1-2 mm and can't be limited in length. Such cracks are indeed normal and no reason for a claim. If wider cracks occur, in 90% of all cases installation mistakes have been done (see above). Only about 10% of all cases are claims due to mistakes that were not detected during production or damage that occurred during transportation.

Color differences and shape distortion:
Color differences between single boards may occur and are due to different growth areas. These differences are no reason for a claim. Shape distortion of thermally modified wood is significantly less common than for untreated wood. Minor distortions can however occur, and are no reason for a claim.

Handling claims:
In case of a claim, damaged boards will be replaced by us. Replacement/Installation at site or free shipment of the material to the customer is to be discussed from case to case.

3. Static data

Due to its enormous toughness, the wood species of as his also after thermo-treatment in ideal form suited for the application as terrace decking (see physical test results of Technical University of Tallinn on page 9).

Statics differentiates between two basic terms :

- Load carrying capacity
  The load carrying capacity involves certain limit figures, which must be met in wood construction according to German norm DIN 1052. So far, there is only test results available and no valid norm for thermally modified wood. In terrace construction one will never be faced to the limit figures of load bearing capacity due to the relevant limit figures of service ability. Terrace construction has to respect the appropriate installation mode on a case-by-case basis. There is no single installation mode that has to be followed under all circumstances. The limit figures of load bearing capacity are more than met with thermo-ash deckings of 20 mm thickness.

- Service ability
  Service ability in terms of terrace construction describes the appropriate choice of the dimension between axes (under construction) to avoid objectionable bending of deckings. To achieve only minor bending and a save feeling for the user, one must take care that the dimension between axes with 20 mm deckings is not wider than 50 cm.

4. Modification of wood in exterior application

Wood in exterior applications underlies – simply spoken – two formative impacts:

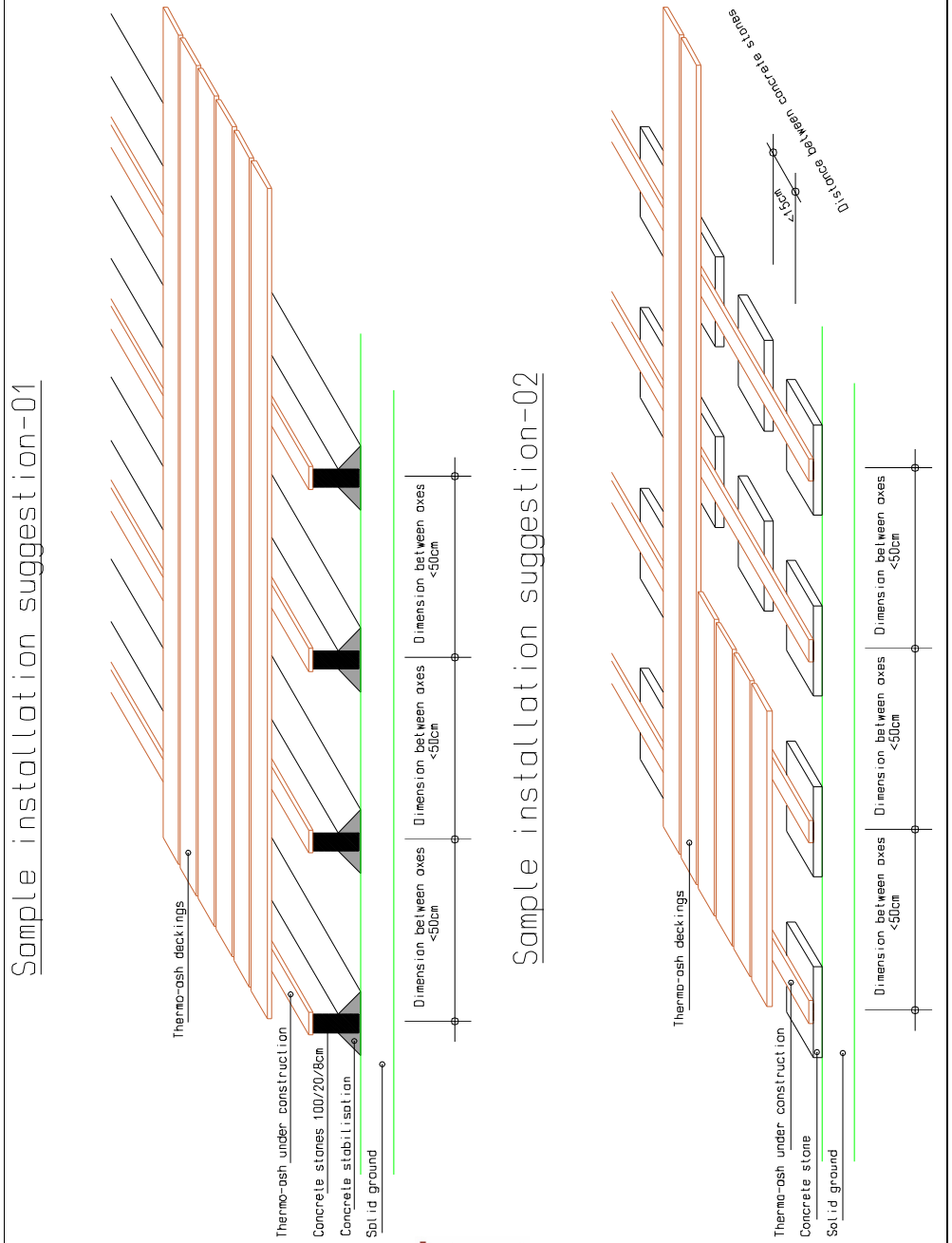
Ultraviolet light
and
water

General:
UV-light splits in a photolytic process a substance called lignin. The purpose of lignin is to bind the cellulose fibers in wood like a glue. Lignin becomes water soluble due to the splitting process. Humidity renders lignin therefore soft, driving rain may wash it out. Whitish cellulose fibers are left which are the ground for micro organisms that create a silver-gray patina onto the wood. Over time, the cellulose fibers start to erode since they are lacking the lignin glue. A relief-like surface is created that stresses the natural grain of the wood. In shady spots blue stain and mold may form, especially close to vegetation. This can also lead to color variations, but does not damage the wood in the application considered here. A significant impact is the constant shift between humidity penetration and drying-up. Driving rain and condensate is taken up by capillary action of untreated wood. The wood is swelling. The cross-section shrinks again with the drying-up process caused by sun and wind. This cycle repeats itself which leads to surface cracks and distortion, that can be depending on quality and condition very small or bigger.

Thermo-Ash (215°C / Thermo-D):
UV light and water impact thermo-ash like described above. The graying effect is present at similar extension, and can only be slowed down by applying surface oils with low surface tension. That respect the low absorptive capacity of thermo-ash. Dimensional stability and resistance to fungi, mold, insects etc. is better for thermo-ash than for untreated wood species.

Thermo-ash treated at 215 °C is supposed to be in resistance class 1-2, which is the same class predominant for all tropical hardwoods on the market. Thermo-ash is therefore an alternative to tropical hardwoods. The application of thermo-ash contributes to saving tropical forests, that are made accessible by forestry companies and thereby made vulnerable for following settlers and settlements, which cause long-lasting damage to the eco-system. Considering the physical test results of thermo-ash, one can position thermo-ash in front of all tropical hardwoods. Dimensional stability (swelling and shrinking) is better than for tropical hardwoods, however also with thermo-ash depending on growth, knots, and enclosures.

5. Installation suggestions

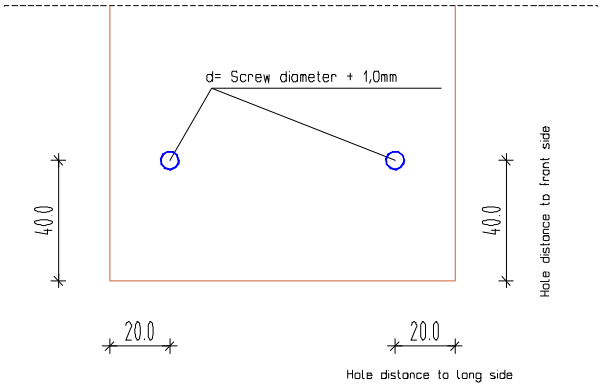


6. Fixation possibilities

Visible fixation possibility with thermo-ash stainless steel terrace screws

Cross section

Hole diameter d= (screw diameter + 1,0mm)
Adaptation screw head conus (countersink)

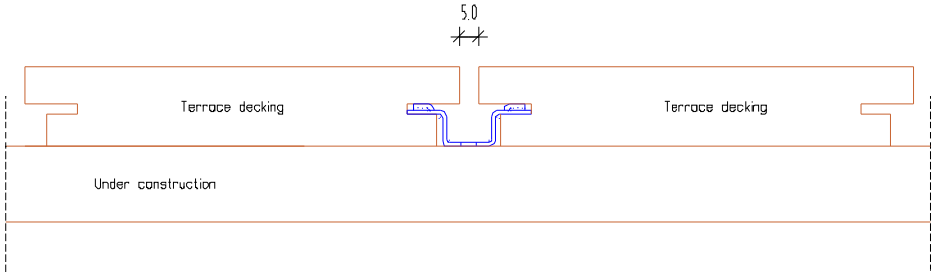


Top view

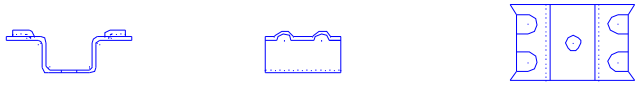
Bore hole table *	
Screw diameter	Screw hole
3,0mm 3,5mm 4,0mm 4,5mm 5,0mm	4,0mm 4,5mm 5,0mm 5,5mm 6,0mm

* Only for terrace decking not for the under construction

Invisibile fixation possibility with thermo-ash terrace clips



Thermo-ash terrace clip



Cross section Side view Top view

Pieces/sqm at a dimension between axes of 50,0cm	
Board width [mm]	Pieces [pcs.]
160 132 130 115 112 92 90	25 30 31 35 36 43 44

General calculation formula for determining the number of terrace clips required:

(1sqm / dimension between axes / board width) x 2

Example.:

(1,0sqm / 0,50m / 0,160m) x 2 = 25pcs.

7. Thermo-ash terrace oil

The appropriate oil for thermo-ash

After a long period of development, a terrace oil especially suited for thermo-ash can be presented. No wood is more exposed to weather than horizontally installed terrace deckings. Thermo-ash deckings shall keep the noble dark color obtained in the thermo-treatment process for at least one year after installation. This target was met with the thermo-ash terrace oil.

Due to its low surface tension, the oil can penetrate into thermo-ash although the absorption capacity of thermo-ash is poor. Oil and wood can bind and cause a rather lasting bonding. The oil hardens right after penetration and avoids thus to be washed out by the next driving rain – which is a standard problem with conventional oils. Moisture penetration is strongly reduced, which reduces the formation of surface cracks due to reduced swelling and shrinking. UV protection is sustainable since the oil is not washed out.

Advantages:
- Reduced surface cracks formation (reduced swelling and shrinking)
- Simple application with paint brush or soft cloth
- High UV protection
- Blue stain and fungi protection
- Accentuation of original wood color
- Aftercare possible

Dosage:
- 12 m²/liter per layer

Trading unit:
- 1,0 / 3,0 liter

8. Physical properties

TEST REPORT

No. 239 2007-07-05

Product description: Heat treated (215 ºC) ash wood 20x135x1000 mm
Reason for test: Test mandate of 2007-05-22
Test target: Determination of physical and mechanical properties of terrace deckings

Test methods.

The humidity of all samples was determined in a drying kiln at temperatures between 103 and 105 °C till a constant mass was achieved. Density, bending strength and surface hardness were measured at equilibrium moisture level of 4,6% in the laboratory. For obtaining the equilibrium moisture in exterior conditions the samples were exposed to a relative humidity of 85% till a constant mass was achieved.

The surface hardness was measured in accordance with EN 1534 by applying a certification stamp of 10 mm in diameter.

Test results.

Moisture level at (normal) laboratory conditions

Sample No.	1	2	3	4	5	6	**Average**
Moisture level, %	4,4	4,7	4,7	4,5	4,7	4,7	**4,6**

Density

Sample No.	1	2	3	4	5	6	**Average**
Density, kg/m^3	597	598	582	580	608	575	**590**

Equilibrium moisture at average exterior conditions

Sample No.	1	2	3	4	5	6	**Average**
Moisture level, %	7,7	8,0	7,9	7,8	7,9	8,1	**7,9**

Bending strength

Sample No.	1	2	3	4	5	**Average**
Bending strength, N/mm^2	110,0	102,3	89.2	100,4	83,5	
Sample No.	6	7	8	9	10	
Bending strength, N/mm^2	82,1	112,0	94,4	99,0	93,1	**96,6**

Surface hardness

No.	d1	d2	d	HB (N/mm^2)
1-20	4,9 – 7,3	5,1 – 7,6	5,00 – 7,45	19,1 – 47,5
Average				**29,4**

9. Resistance

RAPPORTO DI PROVA n°85963 / 1 del 17-03-2008

Date received:	08-10-07	BRENSTOL OU PETERBURI RD 44 11415 TALLINN ESTONIA Attn: Meelis Kajndu
Date of test:	09-11-07	
Date of issue:	17-03-08	
Sample name:	DECKING DI FRASSINO TERMOCOTTO 215°C	

Technical Report

Determination of the durability of solid wood against wood-destroying basidiomycetes.

Test method: according to CEN/TS 15083-1/2005, except for sampling and preparation of wood test specimens, which were provided by the customer.
Test material: heat treated ash (frassino termocotto)
Reference timber: Fagus sylvatica
Test fungi: Coniophora puteana DSM 3085; Coriolus versicolor DSM 3086
Ageing procedure: none
Sterilization: by gamma radiation
Date of exposure to fungi: 09/11/2007
Date removed from fungi, test duration: 10/03/2008, 4 **month**

Test results

Mean percentage mass loss of reference timber:
with Coniophora puteana: 33%
with Coriolus versicolor: 30%
test valid

Moisture content of test specimen after exposure to fungi
with Coniophora puteana: mean 18%, min 9%, max 24%
with Coriolus versicolor: mean 31%, min 16%, max 57%

Mean percentage mass loss of test specimens
with Coniophora puteana: 1%
with Coriolus versicolor: 1,4%

Median percentage mass loss of test specimens
with Coniophora puteana: 1%
with Coriolus versicolor: 1%

Provisional durability rating according to CEN/TS 15083-1/2005, Annex D:
Class 1 - very durable - median percentage mass loss ≤ 5

Note: the test method was applied to treated timber

Head of Department
Dott. Franco Bulian

Managing Director
Dott. Andrea Giavon

10. Energybalance terrace deckings

Rank	Wood Species	Cumulated Energy Demand Sawn Timber KD 15%	Transports till Arrival in EU Region		Energy Demand Transportation*)	Processing		Usage	ENERGY DEMAND PER YEAR
		kWh/kg	Ship (km)	Truck (km)	kWh/kg	Description	kWh/kg	Jahre	kWh/kg
1	Ipe South America	1,83	10.000	1.000	0,68	Planing	0,4	30	0,097
2	Robinia Central Europe	1,83	0	1.000	0,36	Planing	0,4	25	0,104
3	Thermo-Ash Central Europe	1,83	0	1.000	0,36	Thermo treatment, Planing	1,00	30	0,106
4	Thermo-Ash North America	1,83	6.000	1.000	0,55	Thermo treatment, Planing	1,00	30	0,113
5	Oak Central Europe	1,83	0	1.000	0,36	Planing	0,4	20	0,130
6	Thermo-Ash Eastern Europe	1,83	0	3.000	1,08	Thermo treatment, Planing	1,00	30	0,130
7	Oak North America	1,83	6.000	1.000	0,55	Planing	0,4	20	0,139
8	WPC Central Europe	2,50	0	1.000	0,36	Extrusion	1,7	30	0,152
9	Larch Central Europe	1,23	0	1.000	0,36	Planing	0,4	13	0,153
10	Douglas Fir Central Europe	1,23	0	1.000	0,36	Planing	0,4	13	0,153
11	Bangkirai Indonesia	1,83	15.000	1.000	0,84	Planing	0,4	20	0,154
12	WPC North America	2,50	6.000	1.000	0,55	Extrusion	1,7	30	0,158
13	Oak Eastern Europe	1,83	0	3.000	1,08	Planing	0,4	20	0,166
14	Douglas Fir North America	1,23	6.000	1.000	0,55	Planing	0,4	13	0,168
15	Pine impregnated Central Europe	1,23	0	1.000	0,36	Impregantion, Planing	1,00	13	0,199
16	Pine impregnated Eastern Europe	1,23	0	3.000	1,08	Impregantion, Planing	1,00	13	0,255
17	Larch Siberia	1,23	0	6.000	2,16	Planing	0,4	13	0,292

***) Ship 0,000032 kWh/kg*km; Truck 0,00036 kWh/kg*km**

ASSUMPTIONS:
1) The terrace deckings are not coated during usage. If coating would be considered, thermo-ash would perform better due to its reduced swelling & shrinking behavior. Coatings stay longer on surfaces that show low movement. Reduced consumption of paints reduces also the energy demand for the production of these paints and thereby contributes directly to the energy balance of terrace deckings.

2) It is assumed that 1 kg of each wood species covers about the same area. In most cases this is not true due to different densities of wood species. If different densities would be respected, the heavier species would perform worse due to the additional energy consumption from transportation.

3) As truck we assume a modern trailer truck corresponding to EU norms of the year 2010. One can assume that truck transports outside the EU area come with higher energy demands due to poor vehicle technology and road infrastructure. If this issue would be precisely accounted for, a species like Siberian Larch would perform worse.

4) For impregnated pine the energy demand for producing the impregnation agent hasn't been considered. If this aspect would be considered as well, impregnated pine would perform worse.

5) For WPC products the plastics content is assumed to be 50%. The wood content is not accounted for at all. Most WPC products bear a higher plastics content than 50%, which would lead to a worse energy balance than described here.

6) For all transports we assume the transport of finished products. In reality, most tropical hardwoods as well as most wood species from Eastern Europe and Russia are transported in fresh undried condition. North American and Central European wood species are shipped usually in dry state. If this aspect would be considered, fluctuations of up to 50% could occur for the energy demand for transportation.

DATA SOURCES:
Data are taken from the ProBas database maintained by German Federal Institute for the Environment (Umweltbundesamt) and the German Ökoinstitut. Other data is taken from the European Plastics Manufacturer's Association (APME), verified by Umweltbundesamt, respectively are calculated from these data sources.