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Dresden, 31 May 2016
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Test Report Order No. 2715422

Client: PURBANCHAL Laminates (P) Ltd
101, Goyal Avenue, Plot No. 318,
Ward 12B, Opp. LIC Block,
Gandhidham-370201, State: Gujarat
India

Date of order: 23 November 2015

Order: Performance of different tests of HPL according to EN 438-6:2005

Contractor: EPH - Laboratory Surface Testing

Engineer in charge: Dipl.-Ing. S. Wenk



Dr.-Ing. Rico Emmeler
Head of Laboratory Surface Testing

The Test Report contains 12 pages. Any duplication, even in part, requires written permission of EPH. These test results are exclusively related to the tested material.

1 Task

The authorized laboratory Entwicklungs- und Prueflabor Holztechnologie GmbH (EPH) was instructed by PURBANCHAL Laminates PVT Ltd in India to carry out testing of HPL according to EN 438-6.

2 Test material

For the test, the client sent the following HPL-material (receipt at EPH-laboratory on 20 January 2016).

Name of samples by the client	Test pieces / dimensions [mm]
Exterior Grade Compact Laminate decorative rough stone	17 pieces/ 120 x 15 x 6 16 pieces/ 15 x 120 x 6 5 pieces/ 300 x 200 x 6 5 pieces/ 200 x 300 x 6 13 pieces/ 50 x 50 x 6 13 pieces/ 230 x 230 x 6 13 pieces/ 250 x 50 x 6 13 pieces/ 50 x 250 x 6 4 pieces/ 150 x 77 x 6 3 pieces/ 145 x 65 x 6 3 pieces/ 2440 x 1220 x 6

3 Test performance

3.1 Determination of dimensional tolerances

The following tests were carried out according to EN 438-2:2005 p. 5 – 9: measurement of thickness, of length and of width, of edge straightness, of edge squareness and of flatness. The requirements are specified in standard EN 438-6:2005 Table 2.

3.2 Flexural modulus and strength according to ISO 178

The test for determination of bending strength and bending modulus of elasticity (MOE) was carried out according to ISO 178 “Plastics – Determination of flexural properties” at three-point bending test. The distance between supports, the width and the length of the specimens were chosen based on the thickness of the test material. 10 specimens parallel with production direction and 10 specimens perpendicular to the production direction were tested.

The test was carried out with the test machine TIRAtest 28100, a 5 kN load cell and a test speed of 2 mm/min.

The bending strength and the modulus of elasticity were calculated according to ISO 178.

3.3 Tensile strength according to EN ISO 527-2

The test for determination of tensile strength was carried out according to ISO 527-2 “Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics” at tensile test. The test specimens were prepared according to ISO 527-2, picture 1 (specimen type 1A). The length of the test specimens was 180 mm. The width in central section was 10 mm. 5 specimens parallel with production direction and 5 specimens perpendicular to the production direction were tested. The tensile strength was calculated according to ISO 527-2.

3.4 Determination of density

The density was determined according to EN 323 “Wood based panels – Determination of density”. 10 specimens of 50 mm x 50 mm x thickness were tested. The density was calculated by the use of measured values of length, width, thickness and mass of the specimens.

3.5 Determination of the impact resistance

The test was carried out according to according to EN 438-2:2005 part 21 with the big ball with equipment according to the standard.

3.6 Determination of the resistance to wet conditions

The test for determination of resistance to wet conditions was carried out according to EN 438-2:2005 part 15.

3.7 Determination of the dimensional stability at high temperature

The test for determination of dimensional stability at high temperature was carried out according to EN 438-2:2005 part 17.

3.8 Resistance to climatic shock

The resistance to climatic shock was determined according to DIN EN 438-2 part 19. The flexural strength and modulus of elasticity in flexure was determined according to EN ISO 178 before and after the 4-week storage. Also, a visual assessment concerning the appearance of the test specimens was done in accordance with EN 438-3, part 29. The variant was tested in transverse direction.

3.9 Resistance to UV-light

The UV-Light-Test was carried out on two exposed samples per variant with a QUV-weathering tester (test device KL 54) over 1500 h using the following parameters according to EN 438-2:2005 part 28. The specimens are cycled through periods of exposure to UV radiation followed by periods of no radiation, during which temperature changes occur.

In accordance with exposure mode 1 of EN ISO 4892-3 the cycle consists of 4 hours of dry UV exposure at a black-standard temperature of (60 ± 3) °C followed by 4 hours condensation exposure without radiation.

The following assessments were carried out to characterise the weathering resistance:

- Visual assessment of the colour change after exposure using the Grey scale according to EN ISO 105-A02 (contrast),
- Visual assessment according to in EN 438-2:2005 after 500 h, 1000 h and 1500 h (appearance).

3.10 Resistance to artificial weathering

The artificial weathering was carried out according to EN 438-2:2005 part 29, (EN ISO 4892-2) with Xenon tester Weather Ometer CI 3000 (test device KL 30). The overall weathering time was 3000 h (=650 MJ/m² radiant exposure).

The test was carried out with the following device parameters:

- Method A (full global radiation), Cycle 1
- 65 °C black standard temperature
- 65 % relative humidity
- Weathering cycle consisted of a spray cycle 18 min, 102 min drying phase

The following assessments were carried out to characterize the weathering resistance:

- Visual assessment of the colour change after exposure using the grey scale according to EN ISO 105-A02 after 500 h, 1000 h, 1500 h, 2000 h, 2500 h and 3000 h (contrast),
- Visual assessment according to in EN 438:2005, part 2, after 500 h, 1000 h, 1500 h, 2000 h, 2500 h and 3000 h (appearance).

4 Results

4.1 Dimensional tolerances according to EN 438-2:2005 p.5 - 9

Determination of thickness (t) - EN 438-2-2005 p.5

TP – No.	Value in mm (n = 4)				Value in mm		Requirements acc. to EN 438-6 Maximum variation (Δt) ± 0.40 mm
	t ₁	t ₂	t ₃	t ₄	t _{avg}	t _{nom}	
1	5.98	6.19	6.12	6.00	t _{avg}	6.03	fulfilled
2	6.01	6.01	5.95	5.95	t _{nom}	6.00	
3	5.95	6.07	6.07	6.14	Δt	0.03	

n = number of samples

Determination of width (w) - EN 438-2-2005 p.6

TP – No.	Value in mm (n = 2)		Value in mm		Requirements acc. to EN 438-6 Maximum deviation from the nominal size (Δw) + 10 mm / - 0 mm
	w ₁	w ₂	w _{avg}	w _{nom}	
1	1222.0	1222.0	w _{avg}	1222.0	fulfilled
2	1223.0	1221.0	w _{nom}	1220	
3	1222.0	1222.0	Δw	2.0	

n = number of samples

Determination of length (l) - EN 438-2-2005 p.6

TP – No.	Value in mm (n = 2)		Value in mm		Requirements acc. to EN 438-6 Maximum deviation from the nominal size (Δw): + 10 mm / - 0 mm
	l_1	l_2	$l_{avg.}$		
1	2440.0	2440.0	$l_{avg.}$	2440.8	<i>fulfilled</i>
2	2441.0	2442.0	l_{nomin}	2440	
3	2441.0	2441.0	Δl	0.8	

n = number of samples

*Determination of straightness (s) - EN 438-2-2005 p.7**long edges*

TP – No.	Maximum Value in mm/m (n = 4)		Largest single value in mm/m	Requirements acc. to EN 438-6 Maximum deviation: 1.5 mm/m
	edge ₁	edge ₂		
1	-0.20	-0.35	-0,35	<i>fulfilled</i>
2	-0.30	-0.30		
3	0.20	-0.20		

n = number of samples

short edges

TP – No.	Maximum Value in mm/m n = 4		Largest single value in mm/m	Requirements acc. to EN 438-6 Maximum deviation: 1.5 mm/m
	edge ₁	edge ₂		
1	0.30	-0.35	-0,35	<i>fulfilled</i>
2	-0.30	-0.30		
3	0.20	-0.20		

n = number of samples

Determination of squareness (q) - EN 438-2-2005 p.8

TP - No.	Measurement points in mm/m		Largest single value in mm/m	Requirement acc. to EN 438-6 Maximum deviation 1.5 mm/m
	Edge 1	Edge 2		
1	2.50	2.40	2.50	<i>not fulfilled</i>
2	1.50	1.80		
3	1.30	1.30		

Determination of flatness (q) - EN 438-2-2005 p.9

TP - No.	Measurement points in mm/m	Largest single value in mm/m	Requirement acc. to EN 438-6 Maximum deviation 5 mm/m
1	1.9	1.9	fulfilled
2	1.6		
3	1.8		

4.2 Flexural modulus (MOE) and strength (MOR) according to EN ISO 178

Orientation of test specimens	Modulus of Elasticity (MOE) in MPa (n = 10)	Mean value of MOE in MPa (n = 10)	Requirement (EN 438-6) ≥ 9000 MPa for type	
			EGS and EDS	EGF and EDF
longitudinal direction	14212	12649	fulfilled	fulfilled
transverse direction	11085		fulfilled	fulfilled

n = number of samples

Orientation of test specimens	Flexural strength (MOR) in MPa (n = 5)	Mean value of MOR in MPa (n = 10)	Requirement (EN 438-6) ≥ 80 MPa for type	
			EGS and EDS	EGF and EDF
longitudinal direction	148	135.9	fulfilled	fulfilled
transverse direction	121		fulfilled	fulfilled

n = number of samples

4.3 Tensile strength according to EN ISO 527-2

Orientation of test specimens	Tensile strength in MPa (n = 10)	Requirement (EN 438-6) ≥ 60 MPa for type	
		EGS and EDS	EGF and EDF
longitudinal direction	116,8	fulfilled	fulfilled
transverse direction	92,0	fulfilled	fulfilled

n = number of samples

4.4 Density according to EN 323

Mean value of density in g/cm ³ according to EN 438-2 (n = 10)	Requirement according to EN 438-6 ≥ 1.35 g/cm ³ for type	
	EGS and EDS	EGF and EDF
1.45	fulfilled	fulfilled

n = number of samples

4.5 Resistance to impact by large ball according to EN 438-2:2005 p. 21

Mean value of resistance of impact by large ball in mm according to EN 438-2 (n = 5)	Requirement according to EN 438-6 Drop height ≥ 1800 mm for type	
	EGS and EDS	EGF and EDF
1900	<i>fulfilled</i>	<i>fulfilled</i>

4.6 Resistance to wet conditions according to EN 438-2:2005 p.15

Test results for resistance to wet conditions according to EN 438-2 (n = 5)	mass increase appearance	Requirement according to EN 438-6 for type	
		EGS and EDS max. 5 % rating min. 4	EGF and EDF max. 8 % rating min. 4
mass increase	1.56 %	<i>fulfilled</i>	<i>fulfilled</i>
appearance	5	<i>fulfilled</i>	<i>fulfilled</i>

4.7 Dimensional stability at elevated temperature EN 438-2:2005 p.17

Orientation of test specimens	Dimensional stability at elevated temperature in % (n = 5)	cumulative dimensional change	Requirement according to EN 438-6 for type	
			EGS and EDS L: ≤ 0.3 % T: ≤ 0.6 %	EGF and EDF L: ≤ 0.3 % T: ≤ 0.6 %
L (longitudinal)	0.1		<i>fulfilled</i>	<i>fulfilled</i>
T (transversal)	0.2		<i>fulfilled</i>	<i>fulfilled</i>

4.8 Resistance to climatic shock according to EN 438-2, p.19

4.8.1 Visual assessment (appearance)

Visual assessment according to DIN EN 438 p. 2 after 4-weeks climate storage	Requirement according to EN 438-6 rating ≥ 4 for type	
	EGS and EDS	EGF and EDF
5	<i>fulfilled</i>	<i>fulfilled</i>

Assessment criteria according to EN 438-2 (2005), in ratings:

Rating 5: = no visible change

Rating 4: = change of gloss only

Rating 3: = Hairline surface cracks and/or erosion of surface

Rating 2: = Surface cracks

Rating 1: = Blistering and/or delamination

4.8.2 Flexural strength und Modulus of elasticity

Flexural strength		Flexural strength index D_s	Modulus of elasticity in flexure		Flexural modulus index D_m	Requirements for climatic shock according to EN 438-6 $D_s: \geq 0,95$ $D_m: \geq 0,95$ for type	
Arithmetical mean of 4 specimens			Arithmetical mean of 4 specimens			EGS and EDS	EGF and EDF
Control specimens	Cycled specimens		Control specimens	Cycled specimens			
[N/mm ²]	[N/mm ²]		[N/mm ²]	[N/mm ²]			
126,23	122,23	0,97	11341	10748	0,95	<i>fulfilled</i>	<i>fulfilled</i>

The test was performed alternately; which means two-way storage of the caps of the test specimens to the bending load.

The determination of flexural strength index D_s (change of flexural strength) and the flexural modulus index D_m (change of elasticity in flexure) in accordance with DIN EN 438-2:

$$D_s = \frac{\text{Arithmetical mean of the flexural strength of cycled specimens}}{\text{Arithmetical mean of the flexural strength of control specimens}}$$

$$D_m = \frac{\text{Arithmetical mean of the Modulus of elasticity in flexure of cycled specimens}}{\text{Arithmetical mean of the Modulus of elasticity in flexure of control specimens}}$$

4.9 Resistance to UV-light according to EN 438-2, p. 28**4.9.1 Contrast**

Recording of the change in colour using grey scale according to DIN EN 20105-A02:

Change of sample colour in grey scale due to colour change			Requirements for UV-light according to EN 438-6 for type	
500 h	1000 h	1500 h	EGS and EGF Grey scale rating: no requirement	EDS and EDF Grey scale rating not worse than 3*
5	5	5	<i>no requirement</i>	<i>fulfilled</i>

* after 1500 hours exposure

Rating scale for assessing change in colour using the grey scale

Grey scale N° 5	no change of colour
Grey scale N° 4,5	very small change of colour
Grey scale N° 4	small change of colour
Grey scale N° 3,5	recognisable change of colour
Grey scale N° 3	clearly recognisable change of colour
Grey scale N° 2,5	very clearly recognisable change of colour
Grey scale N° 2	strong change of colour
Grey scale N° 1	very strong change of colour

4.9.2 Appearance

Visual assessment according to in EN 438-2:2005

Visual assessment according after			Requirements for UV-light according to EN 438-6 for type	
500 h	1000 h	1500 h	EGS and EGF no requirement	EDS and EDF Rating $\geq 4^*$
5	5	5	<i>no requirement</i>	<i>fulfilled</i>

* after 1500 hours exposure

Assessment criteria according to EN 438-2 (2005), in ratings:

Rating 5:	= no visible change
Rating 4:	= change of gloss only
Rating 3:	= Hairline surface cracks and/or erosion of surface
Rating 2:	= Surface cracks
Rating 1:	= Blistering and/or delamination

4.10 Resistance to artificial weathering according to EN 438-2, p. 29**4.10.1 Contrast**

Recording of the change in colour using grey scale according to DIN EN 20105-A02:

Change of sample colour in grey scale due to colour change						Requirements for weathering (contrast) according to EN 438-6 Grey scale rating: ≥ 3 for type	
500 h	1000 h	1500 h	2000 h	2500 h	3000 h	EGS and EGF after 325 MJ/m ² radiant exposure (1500 h)	EDS and EDF after 650 MJ/m ² radiant exposure (3000 h)
5	5	4	3,5	3	3	<i>fulfilled</i>	<i>fulfilled</i>

Rating scale for assessing change in colour using the grey scale:

Grey scale No 5	no change of colour
Grey scale No 4,5	very small change of colour
Grey scale No 4	small change of colour
Grey scale No 3,5	recognisable change of colour
Grey scale No 3	clearly recognisable change of colour
Grey scale No 2,5	very clearly recognisable change of colour
Grey scale No 2	strong change of colour
Grey scale No 1	very strong change of colour

4.10.2 Appearance

Visual assessment according to in EN 438, p. 2:

Visual assessment according to in EN 438 part 2 (rating 1 - 5) after						Requirements for weathering (appearance) according to EN 438-6 Rating: ≥ 4 for type	
500 h	1000 h	1500 h	2000 h	2500 h	3000 h	EGS and EGF after 325 MJ/m ² radiant exposure (1500 h)	EDS and EDF after 650 MJ/m ² radiant exposure (3000 h)
5	5	5	5	5	5	<i>fulfilled</i>	<i>fulfilled</i>

Assessment criteria according to EN 438-2 (2005), in ratings:

Rating 5:	= no visible change
Rating 4:	= change of gloss only
Rating 3:	= Hairline surface cracks and/or erosion of surface
Rating 2:	= Surface cracks
Rating 1:	= Blistering and/or delamination



Figure: Test specimens 1 -3 after 3000 hours artificial weathering

5 Evaluation

The tested variant of a compact HPL can be evaluated for the several properties according to EN 438-6:2005, Table 2 (dimensional tolerances), Table 3 (physical property) and Table 4 (weather resistance) as following:

Dimensional tolerances – requirements table 2		
Property	Results	Requirements according to EN 438-6:2005
Thickness (EN 438-2, p.5)	0.03 mm	fulfilled
Flatness (EN 438-2, p.9)	1.9 mm/m	fulfilled
Length	0.8 mm	fulfilled
Width (EN 438-2, p.6)	2.0 mm	fulfilled
Straightness of edges (EN 438-2, p.7)	-0.35 mm/m	fulfilled
Squareness (EN 438-2, p. 8)	2.5 mm/m	not fulfilled

Property	Result	Requirements according to EN 438-6:2005 for type	
		EGS and EGF	EDS and EDF
Physical property – requirements table 3			
Flexural modulus (EN ISO 178)	12649 MPa	fulfilled	fulfilled
Flexural strength (EN ISO 178)	135.9 MPa	fulfilled	fulfilled
Tensile strength (EN ISO 527)	lengthwise: 116,8 crosswise: 92,0	fulfilled fulfilled	fulfilled fulfilled
Density (EN 323)	1.45 g/cm ³	fulfilled	fulfilled
Resistance to impact by large diameter ball (EN 438-25, p.21)	1900 mm	fulfilled	fulfilled
Resistance to wet conditions (EN 438-2, p.15)	appearance: 5 mass increase 1.56 %	fulfilled fulfilled	fulfilled fulfilled
Dimension stability at elevated temperature (EN 438-2, p.17)	L 0.10 % T 0.20 %	fulfilled fulfilled	fulfilled fulfilled
Weather resistance – requirements table 4			
Resistance to climatic shock (EN 438-2, p. 19)	appearance Flexural strength index D _s : 0,97 Flexural modulus index D _m : 0,95	fulfilled	fulfilled
Resistance to UV-Light (EN 438-2, p. 28)	contrast: grey scale appearance: rating > 6	no requirement	fulfilled
Resistance to artificial weathering (EN 438-2, p. 29)	contrast: grey scale appearance: rating > 6	fulfilled	fulfilled



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