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Laboratory for Polymers

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TRANSLATION OF THE TEST REPORT No. 884/18 – 460 – 1

on the testing of the Kerrock boards

108 UNI, 1099 GRANIT, 5055 TERACO

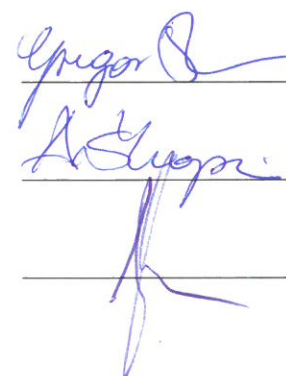
Orderer: **KOLPA, proizvodnja in predelava plastičnih mas d.d.,
Rosalnice 5, 8330 Metlika, Slovenija**

Order/contract: **1803549, dated 8. 5. 2018**

Responsible investigator: **Gregor Strmljan, MSc.**

Head of laboratory: **Assis. Prof. Andrijana Sever Škapin, PhD.**

Director: **Assoc. Prof. Andraž Legat, PhD.**



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Obr. P.S. 12-001-1/3

INTRODUCTION

Table 1: Data on the samples received for the testing.

Applicant	KOLPA, proizvodnja in predelava plastičnih mas d.d., Rosalnice 5, 8330 Metlika, Slovenija
Sample number. APPLICANT DESIGNATION (description) Quantity, dimensions	<p>1. KERROCK 108 UNI 8 boards: 86 cm x 76 cm x 12 mm</p> <p>2. KERROCK 1099 GRANIT 8 boards: 86 cm x 76 cm x 12 mm</p> <p>3. KERROCK 5055 TERACO 8 boards: 86 cm x 76 cm x 12 mm</p>
Manufacturer	KOLPA, proizvodnja in predelava plastičnih mas d.d., Rosalnice 5, 8330 Metlika, Slovenija
Internal (laboratory) sample designation	<p>D18-34-1 KERROCK 108 UNI</p> <p>D18-34-2 KERROCK 1099 GRANIT</p> <p>D18-34-3 KERROCK 5055 TERACO</p>
Date of sampling / mode of sampling	10. 5. 2018 / sampled and delivered by the applicant
Start of testing / end of testing:	
Density	14. 5. 2018 / 17. 5. 2018
Flexural properties (flexural strength and flexural modulus)	10. 5. 2018 / 6. 6. 2018
Tensile properties (tensile strength and elongation at break)	23. 5. 2018 / 6. 6. 2018
Charpy impact strength of unnotched specimens	10. 5. 2018 / 6. 6. 2018
Water absorption	10. 5. 2018 / 14. 9. 2018
Resistance to surface wear	10. 5. 2018 / 14. 6. 2018
Resistance to water vapour	9. 7. 2018 / 10. 7. 2018
Resistance to dry heat	11. 6. 2018 / 6. 7. 2018
Resistance to cigarette burns	10. 5. 2018 / 17. 7. 2018
Linear expansion coefficient	10. 5. 2018 / 9. 7. 2018
Barcol hardness	14. 6. 2018 / 21. 6. 2018
Mohs hardness	14. 6. 2018 / 21. 6. 2018
Compressive properties	10. 5. 2018 / 6. 6. 2018



In agreement with the applicant, the KERROCK boards were tested to determine the following properties:

1. DENSITY / *SIST EN ISO 1183-1: 2013*
2. FLEXURAL PROPERTIES (FLEXURAL STRENGTH AND FLEXURAL MODULUS) / *SIST EN ISO 178: 2011*
3. TENSILE PROPERTIES (TENSILE STRENGTH AND ELONGATION AT BREAK) / *SIST EN ISO 527-2: 2012*
4. CHARPY IMPACT STRENGTH OF UNNOTCHED SPECIMENS / *SIST EN ISO 179-1/1fU^c: 2010*
5. WATER ABSORPTION / *SIST EN ISO 62: 2009*
6. RESISTANCE TO SURFACE WEAR / *SIST EN 438-2: 2016, §10*
7. RESISTANCE TO WATER VAPOUR / *SIST EN 438-2: 2016, § 14*
8. RESISTANCE TO DRY HEAT / *SIST EN 438-2: 2016, §16*
9. RESISTANCE TO CIGARETTE BURNS / *SIST EN 438-2:2005, § 30*
10. LINEAR EXPANSION COEFFICIENT
11. BARCOL HARDNESS / *SIST EN 59:2016*
12. MOHS HARDNESS / *DIN EN 101:1985*
13. COMPRESSIVE PROPERTIES / *SIST EN ISO 604: 2003*

Note: The test methods listed above may, in some cases, deviate from the standards which specify them. The differences were agreed with the applicant prior to the testing.

COURSE OF MEASUREMENTS AND TEST METHODS DESCRIPTION

1. DENSITY

Method A was used to determine density of the samples tested. During the testing density was calculated gravimetrically using the Archimedes' principle. The test specimens were weighed dry (in air) as well as submerged in liquid water. Knowing the difference in mass, taking into account the density of water at known temperature at the time of the measurement density was then calculated. At least 3 specimens were tested per product type.

2. FLEXURAL PROPERTIES (FLEXURAL STRENGTH AND FLEXURAL MODULUS)

At least 5 test specimens with the dimensions of (240 x 20 x 12) mm were prepared using a CNC milling machine. Flexural properties were measured on the ZWICK Z100 tensile testing machine at standard laboratory conditions (23 °C and 50 % relative humidity). The span between specimen supports was 192 mm (16 x height of the test specimen) and the flexural strain rate was 2 mm/min.

3. TENSILE PROPERTIES (TENSILE STRENGTH AND ELONGATION AT BREAK)

Boards that were received for testing were machined using a CNC milling machine to produce test specimens with the following dimensions (length x end width x thickness): (200 x 20 x 12) mm. Width in the central (narrowest) part of the test specimen was 10 mm. Note that the specimens were machined without regard of orientation since the product is uniform in structure.

5 test specimens were prepared for each product type tested and the tensile properties were measured in the ZWICK Z100 tensile testing machine at standard laboratory conditions

(23 °C and 50 % relative humidity). Hydraulic jaws with the pressure set at 80 bars were used to hold the test specimens in place and the tensile strain rate was 1 mm/min.

4. CHARPY IMPACT STRENGTH

Boards that were received for testing were machined using a CNC milling machine to produce test specimens with the following dimensions (length x width x thickness): (80 x 10 x 12) mm. The samples prepared were unnotched.

At least 10 test specimens per product type tested were prepared for testing in the ZWICK D-7900 tester. The testing was done at standard laboratory conditions (23 °C and 50 % relative humidity). 1 J hammer with a speed of 1 m/s was used and the span between specimen supports was 62 mm. The hammer was carefully selected prior to the testing to ensure the specimen broke at the first blow.

5. WATER ABSORPTION

Boards that were received for testing were machined using a CNC milling machine to produce test specimens with the following dimensions (length x width x thickness): (60 x 60 x 12) mm.

Three test specimens were prepared for each product type tested. Prior to the testing the test specimens were dried for 10 days at 50 °C. When testing the test specimens were first weighed dry and then submerged in purified (deionised) water. The mass of the specimens was inspected at regular time intervals (24 hours). Before the weighing the specimens were wiped with a dry cloth. The testing of water absorbed by the test specimens lasted for 192 hours..

6. RESISTANCE TO SURFACE WEAR

Boards that were received for testing were machined using a CNC milling machine to produce test specimens with the following dimensions (length x width x thickness): (100 x 100 x 12) mm.

Three test specimens were prepared for each product type tested. During the testing the test specimens were placed in the ABRASER – MODEL 503 tester. Calibrated sand paper was used and the load exerted to the test specimen was defined. The test specimens were exposed to 100 revolutions after which surface wear was calculated and expressed gravimetrically as the difference in mass between the initial mass of the test specimen and the mass of the test specimen after the abrasion procedure with the unit (mg/1000 revolutions).

7. RESISTANCE TO WATER VAPOUR

Boards that were received for testing were machined using a CNC milling machine to produce test specimens with the following dimensions (length x width x thickness): (100 x 100 x 12) mm.

One test specimen for each product type tested was prepared. During the testing procedure the test specimen was exposed to boiling water vapour for one hour after. After 24 hours the surface of the test specimen was carefully inspected with a scale from 1 to 5 where 1 means worst and 5 means best grade. The scale used to evaluate the results was as follows:

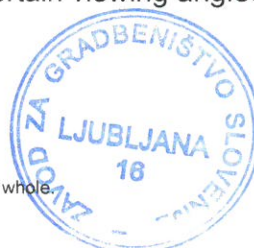
Rating 5: No visible change.

Rating 4: Slight change of gloss and/or colour, only visible at certain viewing angles.

Rating 3: Moderate change of gloss and/or colour.

Rating 2: Marked change of gloss and/or colour.

Rating 1: Blistering and/or delamination.



8. RESISTANCE TO DRY HEAT

Boards that were received for testing were machined using a CNC milling machine to produce test specimens with the following dimensions (length x width x thickness): (400 x 400 x 12) mm.

One specimen for each product type tested was prepared. During the testing the test specimen was exposed to silicone oil that was preheated to 160 °C. After the testing the test specimen was left to rest for one hour when it was visually assessed for discoloration, change in gloss and colour, blistering, swelling, cracking and other parameters. The scale used to evaluate the results was as follows:

Rating 5: No change. Test area indistinguishable from adjacent surrounding area.

Rating 4: Minor change. Test area distinguishable from adjacent surrounding area, only when the light source is mirrored on the test surface and is reflected towards the observers' eye, e.g. discoloration, change in gloss and colour.

Rating 3: Moderate change. Test area distinguishable from adjacent surrounding area, visible in several viewing directions, e.g. discoloration, change in gloss and colour, no change in the surface structure e.g. cracking, blistering.

Rating 2: Significant change. Test area clearly distinguishable from adjacent surrounding area, visible in all viewing directions, e.g. discoloration, change in gloss and colour, and/or structure of the surface slightly changed, e.g. slight cracking, slight blistering.

Rating 1: Strong change. The structure of the surface being distinctly changed, e.g. strong cracking, strong blistering and/or discoloration, change in gloss and colour, and/or the surface material being totally or partially delaminated.

9. RESISTANCE TO CIGARETTE BURNS

The test was performed on test specimens with the dimension of (230 x 230) mm, cut out of the samples supplied to us by the applicant. One test specimen per material type was tested. Marlboro Red cigarettes were used for the testing where a burning cigarette was placed onto the test specimens and was allowed to burn for 20 mm of its length. After the exposure to the cigarette burn the surface was cleaned with a soft cloth moistened with ethanol and examined with the naked eye.

The scale used to evaluate the results was as follows:

Rating 5: No visible change.

Rating 4: Slight change of gloss only visible at certain viewing angles and/or slight brown stain.

Rating 3: Moderate change of gloss and/or moderate brown stain.

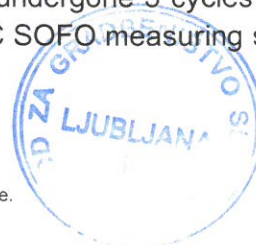
Rating 2: Severe brown mark, but no destruction of the surface.

Rating 1: Blistering and/or cracks.

10. LINEAR EXTENSION COEFFICIENT

Boards received for testing were machined using a CNC milling machine to produce test specimens with the following dimensions (length x width x thickness): (500 x 100 x 12) mm.

One specimen for each product type was prepared. During the testing the test specimens were put into a climatic chamber with temperature-relative humidity control to expose them to the temperatures ranging from -20 °C to +70 °C. The specimens undergone 3 cycles during which the extension-contraction was measured using a SMARTEC SOFO measuring system on the basis of optical fibres.



11. BARCOL HARDNESS

Hardness was measured with an apparatus supplied by the applicant. The presser foot was type GYZJ 934-1 and had an indenter with a diameter of the flat tip measuring 0.157 mm. Each test specimen was measured 10 times at standard laboratory conditions ((23 ± 2) °C and (50 ± 5) % relative humidity).

12. MOHS HARDNESS

Using a mineral of known hardness we tried to scratch and abrade the surface, the principle of the test being the material of a lesser hardness leaves no mark when scratching and the material of a higher hardness leaves marks when scratching. Minerals used to determine the hardness of the test specimens were as follows:

- Hardness 1:** Talc $Mg_3Si_4O_{10}(OH)_2$
- Hardness 2:** Gypsum $CaSO_4 \cdot 2H_2O$
- Hardness 3:** Calcite $CaCO_3$
- Hardness 4:** Fluorite CaF_2
- Hardness 5:** Apatite $Ca_5(PO_4)_3(OH-, Cl-, F-)$
- Hardness 6:** Orthoclase feldspar $KAlSi_3O_8$
- Hardness 7:** Quartz SiO_2
- Hardness 8:** Topaz $Al_2SiO_4(OH-, F-)_2$
- Hardness 9:** Corundum Al_2O_3
- Hardness 10:** Diamond C

Because of the relative imprecision of the method the result of the test is expressed as the interval between the highest hardness of the mineral used to scratch the test specimens that left no visible marks and scratches on the surface and the hardness of the material used to scratch the test specimen that first left visible marks and scratches.

13. COMPRESSIVE PROPERTIES

Boards received for testing were machined using a CNC milling machine to produce test specimens of the dimensions (10 x 10 x 4) mm At least 5 test specimens were prepared for the testing.

Measurements were made in the ZWICK Z100 tensile testing machine where the compression speed was 5 mm/min. All measurements were made in controlled laboratory conditions at 23 °C and 50 % relative humidity. Brushed steel plates were used as tool to compress the test specimens.

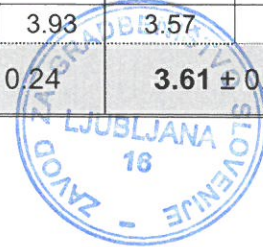
RESULTS

of the testing are gathered in Table 2 on the following pages.

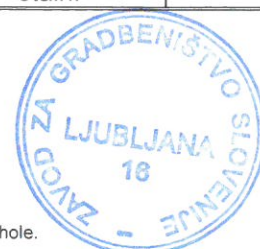


Table 2: Results of the testing.

Property tested (unit) / METHOD OF TESTING		Sample tested					
		108 UNI		1099 GRANIT		5055 TERACO	
Density / SIST EN ISO 1183- 1:2013 METODA A	Individual values (kg/m ³)	1706.7		1702.3		1698.2	
		1709.6		1703.5		1698.1	
		1707.8		1703.2		1696.9	
		1708.7		1702.2		1696.7	
	average value ± standard deviation	1708.2 ± 1.2		1702.8 ± 0.7		1697.5 ± 0.8	
Flexural properties – flexural strength, flexural modulus / SIST EN ISO 178: 2011 METHOD A	individual values (MPa)	flexural strength					
		72.5		68.3		51.2	
		73.0		68.7		50.1	
		75.3		71.7		49.7	
		79.7		67.5		55.5	
		76.9		71.3		56.0	
	average value ± standard deviation	75.5 ± 2.9		69.5 ± 1.8		52.5 ± 3.0	
	individual values (MPa)	flexural modulus					
		9340		9080		8870	
		8750		8990		8820	
		9010		9150		8870	
		9270		9190		8630	
		9090		9130		9130	
average value ± standard deviation	9090 ± 230		9110 ± 80		8860 ± 180		
Tensile properties – tensile strength, elongation at break / SIST EN ISO 527-2: 2012	individual values (MPa)	tensile strength					
		47.9		46.0		36.2	
		49.1		45.5		38.5	
		48.6		45.0		37.4	
		48.0		45.0		38.3	
		48.6		46.1		37.5	
	average value ± standard deviation	48.6 ± 0.6		45.5 ± 0.5		37.6 ± 0.9	
	individual values (%)	elongation at break					
		0.77		0.87		0.53	
		0.90		0.88		0.60	
		0.79		0.85		0.56	
0.80		0.84		0.60			
0.83		0.91		0.56			
average value ± standard deviation	0.82 ± 0.05		0.87 ± 0.03		0.57 ± 0.03		
Charpy impact strength of unnotched specimens / SIST EN ISO 179-1/fUc: 2010	individual values (kJ/m ²)	5.80	6.03	4.17	3.98	3.59	3.52
		5.81	5.61	3.83	4.64	3.58	3.47
		5.56	5.89	3.82	3.99	3.77	3.53
		5.67	5.93	4.04	3.90	3.58	3.80
		5.80	5.75	3.83	3.93	3.57	3.65
	average value ± standard deviation	5.76 ± 0.15		4.01 ± 0.24		3.61 ± 0.54	



Property tested (unit) / METHOD OF TESTING	Sample tested			
	108 UNI	1099 GRANIT	5055 TERACO	
Water absorption / SIST EN ISO 62:2009	water absorption after 24 h immersion			
	individual values (%)	0.033	0.052	0.037
		0.040	0.040	0.034
		0.040	0.036	0.036
		0.037	0.040	0.041
	average value ± standard deviation	0.037 ± 0.003	0.042 ± 0.007	0.037 ± 0.003
	water absorption at saturation c_s			
	individual values (%)	0.424	0.427	0.423
		0.422	0.422	0.422
		0.423	0.427	0.422
		0.420	0.424	0.425
	average value ± standard deviation	0.422 ± 0.002	0.425 ± 0.002	0.422 ± 0.001
	diffusion coefficient D			
individual values (mm ² /s)	7.71 x 10 ⁻⁷	8.54 x 10 ⁻⁷	9.07 x 10 ⁻⁷	
	8.06 x 10 ⁻⁷	8.54 x 10 ⁻⁷	6.07 x 10 ⁻⁷	
	8.06 x 10 ⁻⁷	7.57 x 10 ⁻⁷	8.17 x 10 ⁻⁷	
	7.71 x 10 ⁻⁷	8.54 x 10 ⁻⁷	6.98 x 10 ⁻⁷	
average value ± standard deviation	(7.89 ± 0.35) x 10⁻⁷	(8.30 ± 0.21) x 10⁻⁷	(7.57 ± 0.60) x 10⁻⁷	
Resistance to surface wear / SIST EN 438-2: 2016, § 10	individual values (mg/1000 revolutions)	1133	936	1010
		1031	1033	1138
		1117	1026	1195
	average value ± standard deviation	1094 ± 55	998 ± 54	1114 ± 95
Resistance to water vapour / SIST EN 438-2: 2016, tč. 14	result	Rating 5	Rating 5	Rating 5
	description	No visible change.	No visible change.	No visible change.
Resistance to dry heat / SIST EN 438-2: 2016, §16	result	Rating 5	Rating 5	Rating 5
	description	No change. Test area indistinguishable from adjacent surrounding area.	No change. Test area indistinguishable from adjacent surrounding area.	No change. Test area indistinguishable from adjacent surrounding area.
Resistance to cigarette burns / SIST EN 438-2:2005, § 30	rezultat	Rating 4	Rating 4	Rating 4
	description	Slight change of gloss only visible at certain viewing angles and/or slight brown stain.	Slight change of gloss only visible at certain viewing angles and/or slight brown stain.	Slight change of gloss only visible at certain viewing angles and/or slight brown stain.



Property tested (unit) / METHOD OF TESTING		Sample tested		
		108 UNI	1099 GRANIT	5055 TERACO
Linear coefficient of extension	α (-20 °C do 0 °C)	$(2.97 \pm 0.03) \times 10^{-5} \text{ K}^{-1}$	$(3.59 \pm 0.07) \times 10^{-5} \text{ K}^{-1}$	$(3.75 \pm 0.04) \times 10^{-5} \text{ K}^{-1}$
	α (0 °C do 20 °C)	$(3.32 \pm 0.06) \times 10^{-5} \text{ K}^{-1}$	$(3.84 \pm 0.24) \times 10^{-5} \text{ K}^{-1}$	$(4.04 \pm 0.05) \times 10^{-5} \text{ K}^{-1}$
	α (20 °C do 50 °C)	$(3.68 \pm 0.30) \times 10^{-5} \text{ K}^{-1}$	$(4.39 \pm 0.40) \times 10^{-5} \text{ K}^{-1}$	$(4.67 \pm 0.14) \times 10^{-5} \text{ K}^{-1}$
	α (-20 °C do 50 °C)	$3.32 \times 10^{-5} \text{ K}^{-1}$	$3.94 \times 10^{-5} \text{ K}^{-1}$	$4.15 \times 10^{-5} \text{ K}^{-1}$
Barcol hardness / SIST EN 59:2016	individual values (/)	64	64	61
		63	63	62
		63	63	61
		63	64	60
		62	62	62
	average value \pm standard deviation	63 ± 1	61 ± 1	61 ± 1
Mohs hardness / DIN EN 101:1985	result	2 - 3	2 - 3	2 - 3
Compressive properties – compressive strength / SIST EN ISO 604: 2003	individual values (MPa)	141	141	134
		146	136	134
		138	142	131
		148	146	136
		147	145	133
	average value \pm standard deviation	144 ± 4	142 ± 4	134 ± 2

Test report prepared by:

Gregor Strmljan, MSc.

