



**Instytut Techniki Budowlanej**  
**GROUP OF TESTING LABORATORIES**  
 accredited by Polish Center for Accreditation  
 accreditation certificate  
 N° AB 023



AB 023

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**CONSTRUCTION MATERIALS ENGINEERING DEPARTMENT**  
**BUILDING MATERIALS LABORATORY**

## TEST REPORT N° LZM00-06052/18/R54NZM/B

This test report presents the results of tests within the scope of accreditation and non-accredited results. Results outside the scope of accreditation have been marked "outside the scope of accreditation"

This report was issued in three copies, where the Client have received two copies and one remained in the ITB.

**Client (Manufacturer):** Selena Labs Sp. z o.o.  
**Client address:** 55-011 Siechnice; ul. Polna 14-18

### INFORMATION ABOUT PRODUCT

**Manufacturer (name and address):** Orion PU sp. z o.o.  
**Name and address of factory:** No data  
**Product name** Gypsum Cardboard Foam Adhesive / Pianoklej do płyt GK  
**Reference document for the product:** Tests for issuing National Technical Assessment  
**Information about product, intended use, and the number of the applicable system of assessment and verification of constancy of performance** Foam adhesive for fixing gypsum plasterboards, gypsum fiber boards, cement boards and wood-based panels to walls and building partitions made of concrete, ceramics, aerated concrete, silicates, wood, wood-based panels and insulating boards.  
 System 4  
**Identification code of the product-type:** The Client has not provided information about the identification code of the product-type

### Information about test item

**Test item:** Gypsum Cardboard Foam Adhesive (gun foam)  
**(name, description, condition, identification)** Detailed information about test item can be found on p. 2 of the test report „Test specimens”  
**Date of receipt test item:** 23/04/2018  
**N° of receipt protocol:** LZM00-06052/18/R54NZM  
**Receipt procedure:** N° 18

## Information about tests

**Test commencement date:** 17/07/2018

**Test completion date:** 27/07/2018

**Further information about tests:** *Personnel executing the work:*  
Iwona Komosa  
Jarosław Sówka

**TEST METHODS/PROCEDURES:**

Technical Report EOTA TR 46:2014

*Test methods for foam adhesives for External Thermal Insulation Composite Systems (ETICS).*

**1. Scope**

The scope of test covered determination of:

- density,
- tack free time,
- cutting time,
- shear strength and shear modulus,
- bond strength samples prepared at standard application conditions (*outside the scope of accreditation*),
- bond strength samples prepared with modification of processing time and temperature (*outside the scope of accreditation*).

**2. Test specimens**

The Client has delivered 9 cans of foam adhesive + applicator gun. Cans had replacement label with name: G.GC.PREM.SY.S.1000.865.Gr. No data about expiration date.

**3. Test methods and results**

NOTE: Uncertainty of measurement has been evaluated on the basis of available data including the accuracy of the measurement system used. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

**3.1. Density**

Determination of apparent density (with skin) was carried out in accordance with Technical Report EOTA TR 46:2014. Test was performed on samples of foam adhesive freely sprayed on a flat surface covered by PE-foil (without water spraying), at standard conditions (temp.  $23 \pm 2^\circ\text{C}$  and  $50 \pm 5\%$  RH), in form of cylindrically shaped „beads”, cut on both sides to the length of approx. 15 cm and diameter approx. 30 mm.

Test results are shown in table 1.

**Table 1.** Test results of apparent density of freely sprayed foam adhesive

No.	Density, $\text{kg/m}^3$ , after 24 hours curing
1	2
1	17,9
2	17,1
3	17,1
4	16,8
5	17,5
6	17,2
Mean value:	17,3

*Expanded uncertainty (related to the accuracy of the devices used) on a level of confidence of approximately 95% and coverage factor  $k = 2$ ,  $U_p = 1,7 \text{ kg/m}^3$*

### 3.2. Tack free time

Determination of tack free time was carried out in accordance with Technical Report EOTA TR 46, on samples of foam adhesive freely sprayed on a paper (without water spraying), at standard conditions (temp.  $23\pm 2^{\circ}\text{C}$  and  $50\pm 5\%$  RH), in form of cylindrically shaped „beads“ with approx. 30 cm length and with diameter of approx. 30 mm.

Test results are shown in table 2.

**Table 2.** Test results of tack free time of foam adhesive

No.	Time	Observations*		
		Sample 1	Sample 2	Sample 3
1	2	3	4	5
1	1min	—	—	—
2	1min 30sec	—	—	—
3	2min	—	—	—
4	2min 30sec	—	—	—
5	3min	—	—	—
6	3min 20sec	+	+	+
Tack free time:		3min 20sec	3min 20sec	3min 20sec
Mean value:		3min 20sec		
* Mark „—“ means negative result of test (foam adheres to the tube), mark „+“ positive result (tube is clear, no foam adheres to the tube)				

Expanded uncertainty (related to the accuracy of the devices used) on a level of confidence of approximately 95% and coverage factor  $k = 2$ ,  $U_p = 6 \text{ sec}$

### 3.3. Cutting time

Determination of cutting time was carried out in accordance with Technical Report EOTA TR 46, on samples of foam adhesive freely sprayed on a paper (without water spraying), at standard conditions (temp.  $23\pm 2^{\circ}\text{C}$  and  $50\pm 5\%$  RH), in form of cylindrically shaped „beads“ with approx. 30 cm length and with diameter of approx. 30 mm.

Test results are shown in table 3.

**Table 3.** Test results of cutting time of foam adhesive

No.	Time, min	Observations*		
		Sample 1	Sample 1	Sample 1
1	2	3	4	5
1	5	—	—	—
2	8	—	—	—
3	10	—	—	—
4	11	—	—	—
5	12	—	—	—
6	13	+	+	+
Cutting time, min		13	13	13
Mean value, min		13		
* Mark „—“ means negative result of test (foam cells are squeezed), mark „+“ positive result (knife is clear, foam cells are not squeezed)				
* Mark „—“ means negative result of test (foam adheres to the tube), mark „+“ positive result (tube is clear, no foam adheres to the tube)				

Expanded uncertainty (related to the accuracy of the devices used) on a level of confidence of approximately 95% and coverage factor  $k = 2$ ,  $U_p = 0,1 \text{ min}$

### 3.4. Shear strength and shear modulus

Determination of shear strength and shear modulus was carried out in accordance with Technical Report EOTA TR 46:2014, on samples which were prepared at standard conditions (temp.  $23\pm 2^{\circ}\text{C}$  and  $50\pm 5\%$  RH), in serpentine pattern.

Test was performed after 48 hours curing of sprayed samples at standard conditions, in testing machine, with constant speed 3 mm/min. Test results are shown in table 4.

**Table 4.** Test results of shear properties of adhesive foam 8 mm thick

No.	Shear strength, kPa	Shear modulus, kPa	Failure mode
1	2	3	4
1	146,5	920	20% in adhesive foam 80% unsticking from chipboard
2	147,0	897	
3	157,8	944	
4	166,5	824	40% in adhesive foam 60% unsticking from chipboard
5	112,3	919	10% in adhesive foam 90% unsticking from chipboard
6	143,6	954	20% in adhesive foam 80% unsticking from chipboard
Mean value:	<b>145,6</b>	<b>910</b>	—

Expanded uncertainty of shear strength (related to the accuracy of the devices used) on a level of confidence of approximately 95% and coverage factor  $k = 2$ ,  $U_p = 0,5\text{kPa}$

### 3.5. Bond strength at standard conditions (outside the scope of accreditation)

Determination of tensile bond strength of *cladding board – adhesive foam 8mm thick – substrate* was carried out according to Technical Report EOTA TR 46:2014, on samples which were prepared at standard conditions (temp.  $23\pm 2^{\circ}\text{C}$  and  $50\pm 5\%$  RH), in serpentine pattern.

As an EPS insulating material was used expanded polystyrene boards (on white raw material) with smooth surfaces and with level of tensile strengths TR150.

As cladding boards were used:

- gypsum plasterboards
- gypsum fiber boards
- cement boards
- magnesium boards
- wood-based panels (OSB/3).

As a substrate for above mentioned cladding boards was used concrete.

In other samples, as a cladding board was used gypsum plasterboard and other substrates, i.e.:

- aerated concrete
- silicates brick
- wood-based panels (OSB/3)
- white EPS raw material insulating boards
- graphite EPS raw material insulating boards.

Before bonding (24 h) cladding boards, substrates and cans with *Gypsum Cardboard Foam Adhesive* were stored at laboratory conditions (temp.  $23\pm 2^{\circ}\text{C}$  and  $50\pm 5\%$  RH).

Test of bond strength was carried out at testing machine, with constant speed 10 mm/min, 24 hours after curing samples.

Test results are shown in tables 5 and 6.

**Table 5.** Test results of tensile bond strength of adhesive joints prepared at laboratory conditions  
test set: cladding boards – concrete

No.	Bonding conditions	Tensile bond strength ⊥ to substrate, MPa	Failure mode
1	2	3	4
Test set: gypsum plasterboard – concrete			
1	<b>open time</b> – 1min 30sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,222	10% in foam adhesive, 90% getting unstuck from concrete
2		0,243	30% in foam adhesive, 70% getting unstuck from concrete
3		0,237	70% in foam adhesive, 30% getting unstuck from concrete
4		0,249	90% in foam adhesive, 10% getting unstuck from concrete
5		0,260	70% in foam adhesive, 30% getting unstuck from concrete
6		0,293	100% in the paper layer of gypsum plasterboards
Mean value:		<b>0,251</b>	–
Minimum single value:		<b>0,222</b>	–
Test set: gypsum fiber board – concrete			
7	<b>open time</b> – 1min 30sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,243	30% in foam adhesive, 70% getting unstuck from concrete
8		0,264	50% in foam adhesive, 50% getting unstuck from concrete
9		0,279	70% in foam adhesive, 30% getting unstuck from concrete
10		0,278	70% in foam adhesive, 30% getting unstuck from concrete
11		0,271	80% in foam adhesive, 20% getting unstuck from concrete
12		0,303	90% in foam adhesive, 10% getting unstuck from concrete
Mean value:		<b>0,273</b>	–
Minimum single value:		<b>0,243</b>	–
Test set: cement board – concrete			
13	<b>open time</b> – 1min 30sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,215	100% getting unstuck from concrete
14		0,274	20% in foam adhesive, 80% getting unstuck from concrete
15		0,268	70% in foam adhesive, 30% getting unstuck from concrete
16		0,313	60% in foam adhesive, 40% getting unstuck from concrete
17		0,274	70% in foam adhesive, 30% getting unstuck from concrete
18		0,318	80% in foam adhesive, 20% getting unstuck from concrete
Mean value:		<b>0,277</b>	–
Minimum single value:		<b>0,215</b>	–



Table 5 cont.

Table 3 cont.

No.	Bonding conditions	Tensile bond strength ⊥ to substrate, MPa	Failure mode
1	2	3	4
Test set: magnesium board – concrete			
19	<b>open time</b> – 1min 30sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,216	10% in foam adhesive, 90% getting unstuck from concrete
20		0,268	20% in foam adhesive, 80% getting unstuck from concrete
21		0,311	40% in foam adhesive, 60% getting unstuck from concrete
22		0,345	90% in foam adhesive, 10% getting unstuck from concrete
23		0,308	80% in foam adhesive, 20% getting unstuck from concrete
24		0,288	60% in foam adhesive, 40% getting unstuck from concrete
Mean value:		<b>0,289</b>	–
Minimum single value:		<b>0,216</b>	–
Test set: wood-based panel (OSB/3) – concrete			
25	<b>open time</b> – 1min 30sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,200	100% getting unstuck from concrete
26		0,271	40% in foam adhesive, 60% getting unstuck from concrete
27		0,257	50% in foam adhesive, 50% getting unstuck from concrete
28		0,297	30% in foam adhesive, 70% getting unstuck from concrete
29		0,285	70% in foam adhesive, 30% getting unstuck from concrete
30		0,272	80% in foam adhesive, 20% getting unstuck from OSB/3
Mean value:		<b>0,263</b>	–
Minimum single value:		<b>0,200</b>	–

Expanded uncertainty of shear strength (related to the accuracy of the devices used) on a level of confidence of approximately 95% and coverage factor  $k = 2$ ,  $U_p = 0,001\text{MPa}$

**Table 6.** Test results of tensile bond strength of adhesive joints prepared at laboratory conditions  
test set: gypsum plasterboard – other substrates

No.	Bonding conditions	Tensile bond strength ⊥ to substrate, MPa	Failure mode
1	2	3	4
Test set: gypsum plasterboard – aerated concrete			
1	<b>open time</b> – 30÷40sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,179	10% in foam adhesive, 90% getting unstuck from aerated concrete
2		0,180	100% getting unstuck from aerated concrete
3		0,161	10% in foam adhesive, 90% getting unstuck from aerated concrete
4		0,149	100% getting unstuck from aerated concrete
5		0,183	10% in foam adhesive, 90% getting unstuck from aerated concrete
6		0,139	100% getting unstuck from aerated concrete
Mean value:		<b>0,165</b>	–
Minimum single value:		<b>0,139</b>	–

Table 6 cont.

No.	Bonding conditions	Tensile bond strength ⊥ to substrate, MPa	Failure mode
1	2	3	4
Test set: gypsum plasterboard – silicate brick			
7	<b>open time</b> – 30+40sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,254	100% in foam adhesive
8		0,224	100% in foam adhesive
9		0,249	100% in foam adhesive
10		0,218	100% in foam adhesive
11		0,226	100% in foam adhesive
12		0,247	100% in foam adhesive
Mean value:		<b>0,236</b>	–
Minimum single value:		<b>0,218</b>	–
Test set: gypsum plasterboard – wood-based panel (OSB/3)			
13	<b>open time</b> – 30+40sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,231	100% in the paper layer of gypsum plasterboards
14		0,237	100% in the paper layer of gypsum plasterboards
15		0,228	100% in the paper layer of gypsum plasterboards
16		0,226	100% in foam adhesive
17		0,233	100% w in the paper layer of gypsum plasterboards
18		0,223	100% in the paper layer of gypsum plasterboards
Mean value:		<b>0,229</b>	–
Minimum single value:		<b>0,223</b>	–
Test set: gypsum plasterboard – white EPS raw material insulating board			
19	<b>open time</b> – 30+40sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,122	100% in EPS
20		0,148	100% in EPS
21		0,143	100% in EPS
22		0,151	100% in EPS
23		0,142	100% in EPS
24		0,138	100% in EPS
Mean value:		<b>0,141</b>	–
Minimum single value:		<b>0,122</b>	–
Test set: gypsum plasterboard – graphite EPS raw material insulating board			
25	<b>open time</b> – 30+40sec. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 23±2°C and 50±5% RH	0,101	70% in EPS 30% getting unstuck from EPS
26		0,149	100% in EPS
27		0,143	100% in EPS
28		0,160	100% in EPS
29		0,176	100% in EPS
30		0,170	100% in EPS
Mean value:		<b>0,150</b>	–
Minimum single value:		<b>0,101</b>	–

Expanded uncertainty of shear strength (related to the accuracy of the devices used) on a level of confidence of approximately 95% and coverage factor  $k = 2$ ,  $U_p = 0,001 \text{ MPa}$

### 3.6. Bond strength with modification of applications conditions (outside the scope of accreditation)

Determination of tensile bond strength of *cladding board – adhesive foam 8mm thick – substrate* was carried out based on Technical Report EOTA TR 46:2014, on samples which were prepared using serpentine pattern of application.

Samples were prepared with modification of applications conditions:

- open time (max 1min),
- temperature (min. 5°C and max 30°C).

Before bonding (24 h) any materials to above mentioned sets were stored:

- at application conditions – cladding board (gypsum plasterboard) and substrates (aerated concrete and white EPS board),
- at laboratory conditions – cans with adhesive.

Test of bond strength was carried out at testing machine, with constant speed 10 mm/min, 24 hours after curing samples at application conditions.

Test results are shown in table 7.

**Table 7.** Test results of tensile bond strength of test sets prepared with modification of applications conditions

No.	Bonding conditions	Tensile bond strength ⊥ to substrate, MPa	Failure mode
1	2	3	4
Test set: gypsum plasterboard – aerated concrete			
1	<b>open time – 1min</b> <b>foam adhesive thickness – 8 mm</b> <b>application – temp. 23±2°C and 50±5% RH</b>	0,098	100% getting unstuck from aerated concrete
2		0,105	100% getting unstuck from aerated concrete
3		0,115	100% getting unstuck from aerated concrete
4		0,115	100% getting unstuck from aerated concrete
5		0,137	100% getting unstuck from aerated concrete
6		0,125	100% getting unstuck from aerated concrete
Mean value:		<b>0,116</b>	–
Minimum single value:		<b>0,098</b>	–
Test set: gypsum plasterboard – white EPS raw material insulating board			
7	<b>open time – 1min</b> <b>foam adhesive thickness – 8 mm</b> <b>application – temp. 23±2°C and 50±5% RH</b>	0,112	100% in EPS
8		0,103	100% in EPS
9		0,118	100% in EPS
10		0,128	100% in EPS
11		0,138	100% in EPS
12		0,136	100% in EPS
Mean value:		<b>0,122</b>	–
Minimum single value:		<b>0,103</b>	–



Table 7 cont.

Table 7 cont.

No.	Bonding conditions	Tensile bond strength ⊥ to substrate, MPa	Failure mode
1	2	3	4
Test set: gypsum plasterboard – white EPS raw material insulating board			
13	<b>open time</b> – 30+40sek. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 5±2°C	0,143	100% in EPS
14		0,184	100% in EPS
15		0,170	100% in EPS
16		0,137	100% in EPS
17		0,149	100% in EPS
18		0,152	100% in EPS
Mean value:		<b>0,156</b>	–
Minimum single value:		<b>0,137</b>	–
Test set: gypsum plasterboard – white EPS raw material insulating board			
19	<b>open time</b> – 30+40sek. <b>foam adhesive thickness</b> – 8 mm <b>application</b> – temp. 30±2°C	0,120	100% in EPS
20		0,122	100% in EPS
21		0,114	100% in EPS
22		0,123	100% in EPS
23		0,126	100% in EPS
24		0,123	100% in EPS
Mean value:		<b>0,121</b>	–
Minimum single value:		<b>0,114</b>	–

Expanded uncertainty of shear strength (related to the accuracy of the devices used) on a level of confidence of approximately 95% and coverage factor  $k = 2$ ,  $U_p = 0,001 \text{ MPa}$

#### 4. TECHNICAL ASSESSMENT - outside the scope of accreditation

Test results (mean values) are summarized in table 8.

Test program of the Gypsum Cardboard Foam Adhesive has been established on the basis of the required scope for PU adhesives used in the ETICS system, in accordance with the methods specified in EOTA TR046. With regard to concrete and ceramic substrates, an analogous approach has been applied, which is used in adhesives in the ETICS systems, i.e. based on the results of bond strength tests made on the substrate indicated in EOTA TR046 (concrete) it is allowed to use other wall elements, such as building ceramics. Independently, the bond strength was determined on substrates not mentioned in ETAG 004 and EAD DP 14-04-0083-04.04 and those characterized by weaker adhesion in the case of polyurethane adhesives, i.e. aerated concrete and silicate brick.

**Table 8.** Summary of test results of Gypsum Cardboard Foam Adhesive

Item	Properties	Test results (mean values)
1	2	3
1	Density, $\text{kg/m}^3$ , after 24 hours curing (without water spraying)	17,3
2	Tack free time, min (without water spraying)	3 min 20 sec.
3	Cutting time, min (without water spraying)	13

Table 8 cont.

Item	Properties	Test results (mean values)
1	2	3
4	Tensile bond strength, MPa, after 24h curing at laboratory conditions (open time 1,5 min**, foam adhesive thickness 8 mm) – for test sets: <ul style="list-style-type: none"> <li>gypsum plasterboard – concrete</li> <li>gypsum fiber board – concrete</li> <li>cement board – concrete</li> <li>magnesium board – concrete</li> <li>wood-based panel (OSB/3) – concrete</li> </ul>	<b>0,251 (0,222*)</b> 0,273 (0,243*) 0,277 (0,215*) 0,289 (0,216*) 0,264 (0,200*)
5	Tensile bond strength, MPa, after 24h curing at laboratory conditions (open time 30-40 sek**, foam adhesive thickness 8 mm) – for test sets: <ul style="list-style-type: none"> <li>gypsum plasterboard *** – aerated concrete</li> <li>gypsum plasterboard *** – silicate brick</li> <li>gypsum plasterboard *** – wood-based panel (OSB/3)</li> <li>gypsum plasterboard *** – white EPS raw material insulating board</li> <li>gypsum plasterboard *** – graphite EPS raw material insulating board</li> </ul>	0,165 (0,139*) 0,236 (0,218*) 0,229 (0,223*) 0,146 (0,122*) 0,150 (0,101*)
6	Tensile bond strength, MPa, after 24h curing at laboratory conditions (foam adhesive thickness 8 mm) – with modification: <ul style="list-style-type: none"> <li>open time (max. 1,0 min) – for test sets: <ul style="list-style-type: none"> <li>gypsum plasterboard – aerated concrete</li> <li>gypsum plasterboard – white EPS raw material insulating board</li> </ul> </li> <li>application temperature: <ul style="list-style-type: none"> <li>low +5°C – for test set: gypsum plasterboard – white EPS raw material insulating board</li> <li>high +30°C – for test set: gypsum plasterboard – white EPS raw material insulating board</li> </ul> </li> </ul>	0,116 (0,098*) 0,122 (0,103*) 0,156 (0,137*) 0,121 (0,114*)
* Minimum single value of test results series ** Open time based on the manufacturer's declaration, reduced to 30-40 sec. at no. 5 test *** The cladding board, for which the weakest bond with concrete was obtained		

The analysis of the results presented in Table 8:

- A. The results of density, tack free time and cutting time of the *Gypsum Cardboard Foam Adhesive* (Table 8, items 1 to 3) obtained in the tests should correspond to the characteristics specified by the Manufacturer.
- B. Tensile bond strength was determined at 3 stages:
- stage 1 (tab. 8 item 4): adhesive bonds prepared in laboratory conditions in the set *all declared cladding boards - one type of substrate* (concrete). In this stage, the weakest bond with concrete was obtained for the gypsum plasterboard.
  - stage 2 (tab. 8 item 5): adhesive bonds prepared in laboratory conditions in the set *one type of cladding board* (gypsum plasterboard selected in stage 1) – *all declared substrates*. The weakest bonds with gypsum plasterboard was obtained for white EPS raw material insulating board and aerated concrete.
  - stage 3 (tab. 8 item 6): adhesive bonds prepared with modification:
    - open time for set *one type of cladding board* (gypsum plasterboard selected in stage 1) – two types of substrates (white EPS raw material insulating board and aerated concrete, selected in stage 2);

- temperature of application for set *one type of cladding board* (gypsum plasterboard selected in stage 1) – *one type of substrate* (white EPS raw material insulating board selected in stage 2).

In all tested bonds (tab. 8 items 4+6), tensile bond strength was not lower than 0,1 MPa. In the context of the intended use, this strength can be considered sufficient.

In evaluating of the test results simple acceptance rule was applied, according to which the product is considered as conforming specified requirements, if the test results without taking into account variability resulting from measurement uncertainty, meets the requirement. This is related to the risk of incorrect assessment resulting from the fact that uncertainty will not be taken into account in the assessment. The risk also arises from the fact that the laboratory does not have knowledge about the variability of the product population, but only about the sample tested.

This work, in scope of examined properties, can be basis for issuing National Technical Assessment.

Responsible for the test

**M. Sc. Eng. Iwona Komosa**



Signature

Authorizing person

**M. Sc. Eng. Magdalena Wasiak**



Signature

Laboratory Head LZM

**Dr Eng. Ewa Sudol**



Signature

**Warsaw, 23/10/2018**

**It replaces the test report of 02/08/2018**

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