Kiwa Polymer Institut GmbH
Quellenstraße 3
65439 Flörsheim-Wicker
Tel. +49 (0)61 45 - 5 97 10
Fax +49 (0)61 45 - 5 97 19
www.kiwa.de

Test report

P 5495-1-E

Testing order:	**Tests of the two-component casting resin mortar based on Epoxy resin cds-Giessbeton UW / rapid in accordance with:** **AC 150/5370-10C: Standards for specifying construction of airports** ITEM P-606 Adhesive compounds, two-component for sealing wire and lights in pavement
Customer:	**cds Polymere GmbH & Co. KG** **Gau-Bickelheimer Strasse 72** **D-55576 Sprendlingen/Rhh.**
Persons in charge:	**J. Magner** **Dipl.-Ing. (FH) N. Machill**
Date of the test report:	**2009-11-17**
This test report comprises:	**12 pages incl. annex 1**

kiwa
Partner for progress

C O N T E N T S

1 SUBJECT

Polymer Institut has been charged by the cds Polymere GmbH & Co. KG, Sprendlingen, to carry out tests in accordance with

AC 150/5370-10C: Standards for specifying construction of airports

ITEM P-606 Adhesive compounds, two-component for sealing wire and lights in pavement, **Stand 09/2007**

of the following material:

cds-Giessbeton UW / rapid

In detail the following tests should be carried out:

No.	Tests	Standard
1	Tensile strength and elongation	ASTM D 638
2	Volume expansion coefficient	ASTM D 1168
3	Linear expansion coefficient	ASTM D 1168
4	Tensile bond strength on steel and concrete	DIN EN 1542
5	Dielectric strength	ASTM D 149 - 97a
6	High voltage arc resistance	ASTM D 495 - 99

In addition to the testing scope of the FAA requirements the following tests should also be carried out:

No.	Tests	Standard
7	Tensile bond strength on - aluminium - asphalt	DIN EN 1542
8	Tensile bond strength on concrete after thermal shock and freeze-thaw stress (TWBM)	DIN EN 13687-1 DIN EN 13687-2

2 RECEIPT OF SAMPLES

On 2009-06-09 the following materials have been delivered from the customer to the Polymer Institut:

Table 1: Samples

No.	Description	Batch	Quantoity [kg]
1	cds-Giessbeton UW / rapid grey, comp. A	99650	1 x 7,25
2	Curing agent S for cds-Giessbeton UW rapid; comp. B	41323	1 x 0,75

3 PREPARATION OF SPECIMENS

3.1 Mixing proportion

For the preparation of specimens the delivered materials have been used in the mixing proportion component A: component B = 100 : 10.

The materials have been measured out in the above mixing proportion and mixed to homogeneity using a slowly-turning stirring machine with mixing paddle.

3.2 Preparation of the composite specimens / free films

The specimens for the tests with composite specimens have been prepared using the substrates below. Unless otherwise noted, this has taken place at standard temperature in accordance with DIN EN 23270.

Substrate:

Concrete of quality MC 0,40 in accordance with DIN EN 1766; dimensions 300 mm x 300 mm x 60 mm, with the following further characteristics:

Spreading measure	[cm]:	47,0
Apparent density of fresh concrete	[g/cm³]:	2,4
Compressive strength	[N/mm²]:	80,0
Tensile bond strength – Mean value	[N/mm²]:	3,5
Roughness	[mm]:	0,65

At the time of application the concrete slabs were older than 90 days. In the meantime, they have been stored at room climate.

Steel — of quality ST 37, surface preparation grade Sa $2^1/_2$, dimensions 300 mm x 300 mm x 5 mm

Aluminium — blast-cleaned using chromium ore slag, dimensions 200 x 200 x 5 mm³

Asphalt — mastic asphalt 0/11 mm, slightly ground, dimensions 300 x 300 x 60 mm³

The mixed material *cds-Giessbeton UW / rapid* has been applied immediately afterwards with a consumption of 3000 g/m² to the different substrates, using a smoothing trowel, and distributed evenly. Furthermore, free films of the material of thickness about 4 mm have been prepared.

4 TESTS

4.1 Tensile strength and elongation

Test specimens from *cds-Giessbeton UW / rapid* of type 1B in accordance with DIN EN ISO 527-2 with the stated mixing proportion have been used for the test after one day storage at room temperature and 7 days storage at 70 °C in a drying oven with recirculation of air.

The test has been carried out in accordance with DIN EN ISO 527 „*Plastics – Determination of tensile properties*“, using 5 test specimens and retaining the following test conditions:

Test conditions:

Test apparatus:	Universal testing machine 1445, company Zwick, in accordance with ISO 5893
Test temperature:	23 °C
Test speed:	20 mm/min
Elongation measurement device:	Cross-beam way
Clamping device:	mechanically

The test results are to be taken from table 2 as tensile stress at maximum force (tensile strength in MPa), as elongation (elongation at break in %) at break of the specimen, as single value and as mean value.

Table 2: Tensile properties of cds-Giessbeton UW / rapid

Sample	Tensile strength [MPa]		Elongation at break [%]	
	Single values	Mean value	Single value	Mean value
cds-Giessbeton UW / rapid	13,9 14,8 16,1	**14,9**	3,6 3,6 3,5	**3,6**

4.2 Volume expansion coefficient

The volume expansion coefficient γ_T has been determined following ASTM D 1168, using a number of pieces of *cds-Giessbeton UW / rapid* from the tensile test.

Test conditions:

Dilatometer:	Glass dilatometer V = 50 ml with riser tube (scale value accuracy 0,5 mm)
Liquid of known density:	Demineralised water
Temperature conditioning:	Water bath

The test has been carried out from room temperature up to 60 °C in steps of 5 K. The volume expansion has been read off each time after constant temperature was reached.

Result

The volume expansion coefficient γ_T has been calculated on the basis of the linear regression of the volume change from + 20 °C to + 60 °C.

$$\gamma_T = (93 \times 10^{-5})\ 1/K$$

4.3 Linear expansion coefficient

From a piece of specimens from the tensile test a prism of dimensions of about (47 x 4 x 4) mm has been cut out. The specimen has been dried and afterwards stored at standard temperature DIN EN 23270 prior to testing.

The thermal expansion coefficient α_t has been determined in accordance with DIN EN 1770 using a “Netzsch-Schubstangen-Dilatometer”

Parameters of measurement:

Length of specimen:	47,2 mm
Support of specimen:	Quartz
Sensor stamp:	Quartz
Pressing-on force:	50 cN
Measurement of length change:	Inductive path finder
Temperature measuring range:	-40 °C to +100 °C
Atmosphere:	Nitrogen

Result

The linear expansion coefficient has been determined for the temperature range from +2°C to +60 °C:

$$\alpha_T = (7{,}1 \times 10^{-5})\ 1/K$$

4.4 Tensile bond strength after application and storage at standard temperature

The tensile bond strength in accordance with DIN EN 1542 has been tested after a waiting time of 7 days at standard temperature in accordance with DIN EN 23270, using the test specimens coated in accordance with sub-clause 3.2.

The following test parameters apply:

Test apparatus:	Calibrated tensile test apparatus of company Freundl, type Easy
Load increase:	100 N/s (for cylinder Ø 50 mm this corresponds to 0,01 MPa/s)
Test cylinder:	Steel cylinder (Ø 50 mm, h = 35 mm)
Adhesive:	Solvent-free reactve resin adhesive based on epoxy resin

The results of the tests on concrete, asphalt, steel and aluminium as substrates are to be taken from the following tables:

Table 3a: Tensile bond strength of cds-Giessbeton UW / rapid on concrete

No.	Tensile bond strength [N/mm²]	Breaking area [%]
1	4,0	100 % cohesion failure in concrete
2	4,6	
3	4,2	
4	3,6	
5	4,9	
Mean value	**4,3**	

Table 3b: Tensile bond strength of cds-Giessbeton UW / rapid on steel

No.	Tensile bond strength [N/mm²]	Breaking area [%]
1	11,0	60 % cohesion failure in *cds-Giessbeton UW / rapid* 40 % cohesion failure in adhesive
2	11,8	
3	11,4	
4	10,7	
5	10,0	
Mean value	**11,0**	

Table 3c: Tensile bond strength of cds-Giessbeton UW / rapid on aluminium

No.	Tensile bond strength [N/mm²]	Breaking area [%]
1	6,0	60 % adhesion failure of *cds-Giessbeton UW / rapid* 40 % cohesion failure in *cds-Giessbeton UW / rapid*
2	5,6	
3	6,3	
Mean value	**6,0**	

Table 3d: Tensile bond strength of cds-Giessbeton UW / rapid on asphalt

No.	Tensile bond strength [N/mm²]	Breaking area [%]
1	2,4	100 % cohesion failure in asphalt
2	2,3	
3	2,4	
4	2,4	
5	2,4	
Mean value	**2,4**	

4.5 Tensile bond strength after thermal shock- / Freeze-thaw stress

Differing from sub-clause 3.2 the application of the coating system has taken place at the minimum application temperature (T_{MAT} of 8 °C) in horizontal position. After 2 days storage at T_{MAT} the test specimens have further been conditioned prior to testing at the standard temperature in accordance with DIN EN 23270.

The thunder-shower cycling took place in accordance with DIN EN 13687-2 *„Products and systems for the protection and repair of concrete structures – Test methods; Determination of thermal compatibility - Part 2: Thunder shower cycling (thermal shock)“ (May 2002),* and the subsequent thermal shock stress with influence of de-icing salt in accordance with DIN EN 13687-1 *„Products and systems for the protection and repair of concrete structures – Test methods; Determination of thermal compatibility - Part 1: Freeze thaw cycling with de-icing salt immersion“ (May 2002).* During interruptions of the thermal shock stress the test specimens have been stored in water.

By visual assessment after the end of the thermal shock stress no cracks, blisters or detachments could be established (cracks “0”, degree of blistering “0(S0)”).

Prior to the testing of the tensile bond strength the test specimens have been reconditioned for 7 days at the standard temperature in accordance with DIN EN 23270.

Table 4a: Tensile bond strength of cds-Giessbeton UW / rapid on concrete after thermal shock stress

Test specimen	No.	Tensile bond strength [N/mm²]	Breaking area [%]
1	1	2,8	80 % cohesion failure in concrete 20 % adhesion failure betweeen concrete and *cds-Giessbeton UW / rapid*
	2	3,0	
	3	3,0	
	4	2,8	
	5	3,1	
2	1	3,0	
	2	3,1	
	3	2,9	
	4	2,9	
	5	3,4	
	Mean value	**3,0**	

Table 4b: Tensile bond strength of cds-Giessbeton UW / rapid on concrete Reference: Coating at $T_{MAT,}$ testing at 23°C

Test specimen	No.	Tensile bond strength [N/mm²]	Breaking area [%]
1	1	4,4	100 % cohesion failure in concrete
	2	4,6	
	3	4,3	
	4	4,6	
	5	4,7	
	Mean value	**4,5**	

4.6 Dielectric strength

The dielectric strength has been measured following ASTM D 149-97a respectively DIN EN 60243-1 at the "Institut für Hochspannungstechnik of the RWTH Aachen", using specimens of the material of dimensions 100 mm x 100 mm x 1 mm.
The results are documented in the investigation report regarding the *Measurement of the dielectric strength* No. 0241/80 94909, dated 2009-09-14.

Result:

For the material *cds-Giessbeton UW / rapid* the dielectric strength has bee determined as

686 Volt/mil (17,15 kV/mm)

4.7 High voltage arc resistance

The measurement of the high voltage arc resistance in accordance with ASTM D 495 – 99 has been carried out at the "Lehrstuhl für Hochspannungstechnik und Blitzforschung der Universität der Bundeswehr München by Prof. Dr.-Ing. habil Klaus Stimper" at the testing laboratory in Erlangen. The results are documented in the test report (without number), dated 2009-10-03.

Result:

For the material *cds-Giessbeton UW / rapid* the high voltage arc resistance has been determined as

median value of the time until failure: **140 seconds**

5 SUMMARY

The Polymer Institut has been charged by the cds Polymere GmbH & Co. KG, Sprendlingen, to carry out tests in accordance with

AC 150/5370-10C: Standards for specifying construction of airports

ITEM P-606 Adhesive compounds, two-component for sealing wire and lights in pavement, **Stand 09/2007**

of the following material:

cds-Giessbeton UW / rapid

The results are to be taken from the previous sub-clauses. In annex 1 the results are compared to the FAA requirements for sealing compounds (ITEM P-606, state 2007-09).

Flörsheim-Wicker, 2009-11-17

The head of the institute

J. Magner

Kiwa Polymer Institut

The head of the laboratory

Dipl.-Ing. (FH) N. Machill

Annex 1

Summary of test results

Sub-clause of report	Test	Result	Requirement	Req. complied with?
1	2	3	4	5
4.1	Tensile strength [N/mm²] Elongation [%]	14,9 3,6	≥ 7,14 -	yes ----
4.2	Volume expansion coefficient [cm³/cm³/K]	93 * 10^{-5}	90 ... 120 *10^{-5}	yes
4.3	Linear expansion coefficient [m/m/K]	7,1 * 10^{-5}	30 ... 40 *10^{-5}	1)
4.4	Tensile bond strength Mean value [N/mm²] - on concrete - on steel - on aluminium - on asphalt	 4,3 11,0 6,0 2,4	 ≥ 1,4 ≥ 7,14 no req. no req.	 yes yes -- --
4.5	Tensile bond strength concrete on concrete after testing for thermal compatibility with de-icing salt - Mean value [N/mm²]	3,0	no req.	--
4.6	Dielectric strength [Volt/mil.]	686	≥ 350	yes
4.7	High voltage arc resistance [s]	140	≥ 125	yes

Key:

no req. No FAA requirement

1) The reference value for concrete of quality C50/60 is about 1,0 to 1,2 *10^{-5}