siebert+knipschild GmbH
Ingenieurbüro für Kunststofftechnik
Application technology
Materials testing
Quality assurance

Bergstücken 25
22113 Oststeinbek
phone: +49 (0)40-688 714 - 0
fax: +49 (0)40-688 714 - 99
e-mail: info@ibsiebert.de
Internet: www.ibsiebert.de

managing directors:
Kay Siebert
Andreas Haacker

company seat: Oststeinbek
Lübeck Municipal Court
Comm. Register HR B 3262 RE

tax no.: 30 293 30162
VAT ID no. DE216348565

Test report

Report no. 11-210-37921-PB

Material examination in accordance with ASTM F1216-09
Silicate Resin

manufacturer:	Trelleborg Pipe Seals Duisburg GmbH
sample designation:	pipe section DN 200: 85/15 Fiber Glass Material with W1
sample no.:	10.34724
substrate material ID:	85/15 Fiber Glass Material
resin ID:	silicate Resin "W1"
client:	Trelleborg Pipe Seals Duisburg GmbH Dr.-Alfred-Herrhausen-Allee 36 47228 Duisburg

SIEBERT + KNIPSCHILD GmbH · Ingenieurbüro für Kunststofftechnik · Bergstücken 25 · 22113 Oststeinbek · ☎ +49 (0)40 688 714 0 · 🖷 +49 (0)40 688 714 99

TABLE OF CONTENTS

SIEBERT + KNIPSCHILD GmbH · Ingenieurbüro für Kunststofftechnik · Bergstücken 25 · 22113 Oststeinbek · ☎ +49 (0)40 688 714 0 · 🖷 +49 (0)40 688 714 99

1 Determination of material properties according to ASTM F1216-09

1.1 Determination of tensile properties in accordance with ASTM D638-10

The specimens were taken from the cured CIPP in accordance with ASTM F1216-09, Section 8.1.1. The specimens were taken in the longitudinal direction.

Table: Summary of test results (mean values):

sample number	test date	wall thickness e_m [mm]	tensile strength σ_b [N/mm²]	elongation $\varepsilon_{Bnom.}$ [%]	Young's modulus E_f [N/mm²]
10.34724	31.08.2010	4.62 (0.182 in)	36.1 (5236 psi)	6.62	2523 (365930 psi)

The individual test log is enclosed as Annex.

1.2 Determination of bending stress and bending Young's modulus in accordance with ASTM D790-10

The specimens were taken from the cured CIPP in accordance with ASTM F1216-09, Section 8.1.1. The specimens were taken in the longitudinal direction.

Table: Summary of test results (mean values):

sample number	test date	wall thickness e_m [mm]	flexural strength σ_{fb} [N/mm²]	bending Young's modulus E_f [N/mm²]
10.34724	13.08.2010	4.75 (0.187 in)	79.5 (11531 psi)	2587 (375213 psi)

The individual test log is enclosed as Annex.

SIEBERT + KNIPSCHILD GmbH · Ingenieurbüro für Kunststofftechnik · Bergstücken 25 · 22113 Oststeinbek · ☎ +49 (0)40 688 714 0 · 🖷 +49 (0)40 688 714 99

1.3 Determination of the wall thickness of the CIPP in accordance with ASTM D5813-04, Section 8.1.2

The wall thickness was measured minus 0.20 mm (0.008 in) coating.

Table: Summary of test results

sample number	test date	Measuring point	wall thickness e_m [mm]	wall thickness e_m [in]
10.34274 (pipe section 1)	13.08.2010	1	5.44	0.214
		2	5.47	0.215
		3	5.04	0.198
		4	5.36	0.211
		5	5.03	0.198
		6	5.10	0.201
		7	5.27	0.207
		8	5.34	0.210
		9	5.44	0.214
		10	5.58	0.220
		11	5.32	0.209
		12	5.59	0.220
		Average	5.33	0.210
		Minimum	5.03	0.198
		Maximum	5.59	0.220
		Standard deviation	0.19	0.008

SIEBERT + KNIPSCHILD GmbH · Ingenieurbüro für Kunststofftechnik · Bergstücken 25 · 22113 Oststeinbek · ☎ +49 (0)40 688 714 0 · 🖷 +49 (0)40 688 714 99

1.4 Test of the resistance of the cured CIPP to chemical attack acc. to ASTM F1216, Table X2.1

For the test the resistance of the cured CIPP to chemical attack acc. to ASTM F1216, Table X2.1, the test specimens were stored in the test media for 28 days at 23°C. The test media included:

- 100% Tap water
- 5% Nitric acid
- 10% Phosphoric acid
- 10% Sulfuric acid
- 100% Gasoline
- 100% Vegetable oil
- 0.1% Detergent
- 0.1% Soap

After the storage time the flexural properties were determined acc. to ASTM D790 – 10.

1.4.1 Determination of the change of flexural properties

5 test specimens were used to determine the change of the flexural properties, i. e. flexural strength and flexural modulus, after 28 days of storage at 23°C in the test media listed in chapter 1.4.

The change of flexural strength and flexural modulus in per cent was determined after removal from the test media and conditioning (24 hours in standard climate conditions).

Table: Summary of test results (mean values):

test specimen designation	medium	test duration t [d]	change of flexural strength σ_{fb} [%]	change of flexural modulus E_f [%]
10.34724	100% Tap water	28	-13.7	-5.8
	5% Nitric acid	28	-11.1	-8.0
	10% Phosphoric acid	28	-19.3	+5.2
	10% Sulfuric acid	28	-17.9	+0.1
	100% Gasoline	28	-12.3	-11.5
	100% Vegetable oil	28	-10.8	+2.3
	0.1% Detergent	28	-8.9	-7.5
	0.1% Soap	28	-17.0	-8.6

The measurement and test logs are enclosed as Annexes.

SIEBERT + KNIPSCHILD GmbH · Ingenieurbüro für Kunststofftechnik · Bergstücken 25 · 22113 Oststeinbek · ☎ +49 (0)40 688 714 0 · 🖷 +49 (0)40 688 714 99

2 Other material properties of the component

2.1 Determination of Young's modulus, pipe stiffness and bending stress in accordance with ASTM D2412-10

Table: Summary of test results (mean values):

sample number	test date	wall thickness e_m [mm]	flexural strength σ_{fb} [N/mm²]	Young's modulus E_f [N/mm²]	Pipe stiffness S_R [N/mm²]
10.34274	20.08.2010	5.18 (0.204 in)	59.9 (8688 psi)	2767 (401319 psi)	0.038 (5.511 lbf/in²)

The individual test log is enclosed as Annex.

2.2 Determination of the compressive properties in accordance with ASTM D695-10

Table: Summary of test results (mean values):

sample number	test date	test direction	compressive strength σ_{-max} [N/mm²]	compressive Young`s modulus [N/mm²]
10.34274	27.08.2010	axial	50.2 (7281 psi)	1936 (280793 psi)

The individual test log is enclosed as Annex.

2.3 Determination of specific density in accordance with ASTM D792-08

Table: Summary of test results (mean values):

sample number	test date	Density [g/cm³]
10.34274	23.08.2010	1.2565

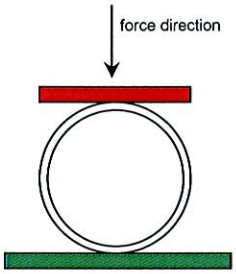
The individual test log is enclosed as Annex.

SIEBERT + KNIPSCHILD GmbH · Ingenieurbüro für Kunststofftechnik · Bergstücken 25 · 22113 Oststeinbek · ☎ +49 (0)40 688 714 0 · 🖷 +49 (0)40 688 714 99

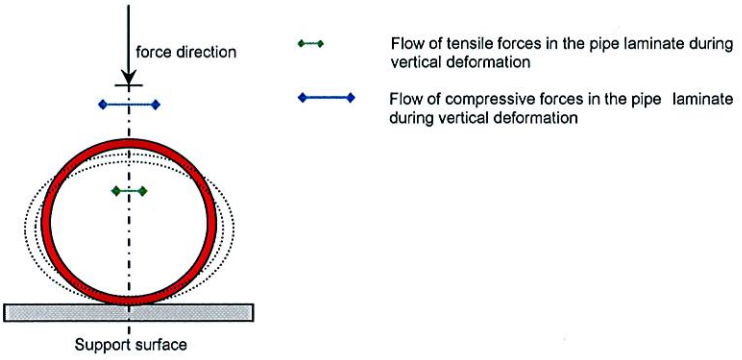
2.4 Determination of long-term values in the long-term vertical crushing strength test in accordance with ASTM D2990-09

Deviating from the standard, the long-term properties were measured on the pipe section.

For the long-term test the pipe section under test (length l = 300 mm) was exposed to a constant load. Based on the rupture load and component parameters from the short-term tests the sections under test we exposed to partial loads with an initial vertical deformation of 1.5 - 2 %, with the following setup:



Illus. 1: Test setup for the long-term vertical crushing strength test



Illus. 2: Flow of tensile and compressive forces in the pipe laminate during vertical deformation

The resulting deformation was documented.

2.4.1 Determination of the 24h Young's modulus and test of creep tendency in accordance with ASTM D2990-09

Deviating from the standard, the creep tendency was measured on the pipe section.

Table: Summary of test results (mean values):

sample number	test date	Young's modulus E_{1h} [N/mm²]	Young's modulus E_{24h} [N/mm²]	creep tendency K_{N24h} [%]
10.34274	14.08.2010	2577 (373762 psi)	2205 (319808 psi)	14.4

The individual test log is enclosed as Annex.

SIEBERT + KNIPSCHILD GmbH · Ingenieurbüro für Kunststofftechnik · Bergstücken 25 · 22113 Oststeinbek · ☎ +49 (0)40 688 714 0 · 🖷 +49 (0)40 688 714 99

2.4.2 Determination of the long-term creep factor α and reduction factor A1 in accordance with ASTM D2990-09

Test results of Trelleborg Pipe Seals "Silicate Resin – Glassliner" DN 200 (mean values):

long-term test 10,000^h with 1.5 - 2 % pre-deformation

	number of sample / sample designation		
Long-term test 10,000^h	10.34724 pipe section 1	10.34724 pipe section 2	10.34724 pipe section 3
creep factor $\alpha_{10,000h,\ dry}$	0.55	0.57	0.53
reduction factor $A1_{10,000h}$	1.83	1.76	1.90
	Extrapolation		
creep factor $\alpha_{ex50years,\ dry}$	0.41	0.45	0.41
reduction factor $A1_{ex50years}$	2.42	2.20	2.47
	mean values		
creep factor $\alpha_{ex50years,\ dry}$	**0.42**		
reduction factor $A1_{ex50years}$	**2.36**		

The test log is enclosed as Annex.

In the long-term test conducted acc. to ASTM D2990-09 the reduction factor A1 of the Trelleborg Pipe Seals "Silicate Resin – 85/15 Fiber Glass Material" (DN 200) after a measured duration of 10,000h is **$A1_{ex50years}$ = 2.36**. The creep factor of the Trelleborg Pipe Seals "Silicate Resin – 85/15 Fiber Glass Material" (DN 200) after a measured duration of 10,000h is **$\alpha_{ex50years,\ dry}$ = 0.42**.

The calculation for the 50-year extrapolation based on the measured value for 10,000h is described in the Annex.

Oststeinbek, October 21, 2011

SIEBERT + KNIPSCHILD GmbH
Materialprüfung
Qualitätssicherung

DAP-PL-3329.00
DAP-IS-4055.00

Technical Director
Dipl.-Ing. A. Haacker

Tester in charge
Dipl.-Ing. (FH) M. Lechner

Annex:
individual test logs