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Application-specific tests

Mechanical and environment-related performance of inflatable joint-sealing systems from Wolf Kabeltechnik GmbH

Extract from

Test Report No.

FO7 Part 27 PB 92/2016

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Application-specific tests for the mechanical and environment-related performance of inflatable joint-sealing systems from Wolf Kabeltechnik GmbH

1.	Resistance of the joint-sealing systems to (overhead) railway-track ballast stones	
1.1	(Overhead) railway-track ballast stones, to a depth of ~50 cm	-to follow-
1.2	Resistance to non-spherical shaped penetrating objects (hardness test) based on E DIN 60794-1-21/ E3	
1.3	Resistance to dry sliding abrasion from (overhead) railway-track ballast stones based on E DIN 60794-1-21/ E2	
1.4	Resistance to impact from (overhead) railway-track ballast stones based on DIN EN 60794-1-21 / E4	
1.5	Resistance to damage from shot pellets or sharp-edged stones from overhead based on E DIN EN 60794-1-21 / E13	
1.6	Resistance to damage from shot pellets or sharp-edged stones from overhead during and after temperature cycling based on E DIN EN 60794-1-21 /	E4 Impact, E13 Shot pellets F1 Temperature cycling

2.1	Movement in the direction of the x-axis, test of "Lateral crush expansion" based on DIN EN 60794-1-21/ E3	
2.2	Dynamic-elastic performance under oscillation stress	
2.3	Shear strength (t_B) wedge-shaped in the direction of the z-axis based on DIN EN 60794-1-21/ E22	
2.4	Shear strength (t_B) parallel in the direction of the z-axis based on DIN EN 60794-1-21/ E22 Sealing cushion QADK/V L	For joint width 3 cm 6 cm

3.1	Stability of joint seal with temperature cycling
3.2	Ageing performance of cable or joint sealing with long-term open-air exposure
3.3	Overpressure resistance of joint sealing elements

4.1	Tightness of aluminium laminate with thermolaminated swelling material after damage (e.g. as a result of dry sliding abrasion caused by penetrating ballast stones or attachment with screws)
4.2	Tightness of joint sealing cushions where two cushions are installed directly on top of each other

The full test report will be available on request from January 2017!
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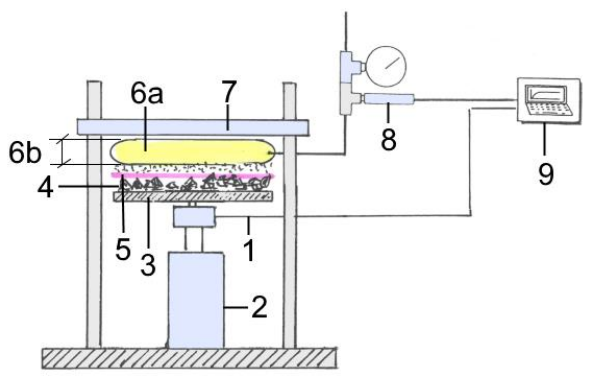
Test

Mechanical and environment-related performance of movement-joint sealing systems

Test sample:	**21.4 SVS Ballast stone protection tape** or equivalent **13.1 VF-QV-DF Surface protection** or **13.2 VF-QV-DES Liquid and diffusion blocking layer** (The above products are all Wolf trade names)

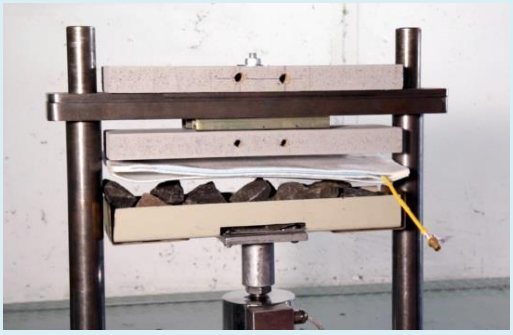
1. Test setup based on DIN EN 60794-1-21 Method E3

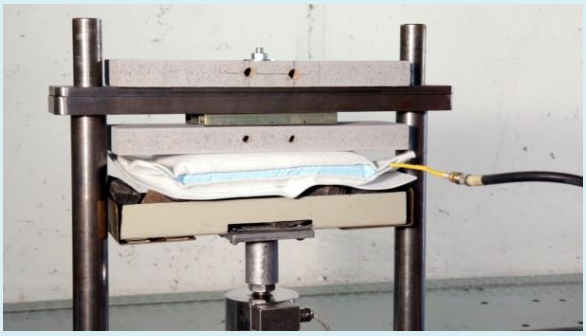
Indentation test (hardness measurement) for non-spherical penetrators based on DIN EN 794-1-21 Method E3.
Railway track ballast stones (basalt)



1 DMS load cell for transverse pressure 20 kN
2 Pressure cylinder
3 Movable slab
4 Track ballast stones (DB-Netz AG)
5 SVS ballast stone protection tape or equivalent thermolaminated aluminium composite film (the composite film is laid directly on the ballast stones over an area corresponding to that of the SVS ballast protection tape)
6a Joint-sealing cushion (valve)
6b Joint width
7 Base slab
8 Pressure transmitter
9 Measuring PC

2. Test procedure





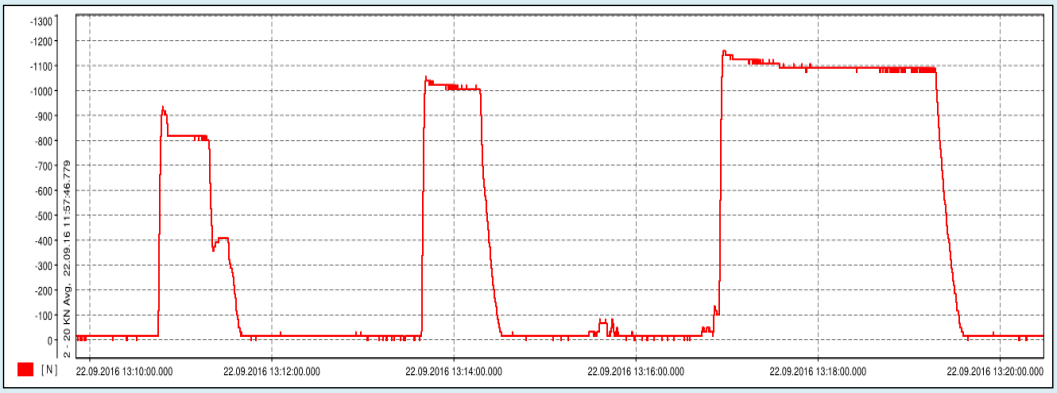
5 The SVS tape is positioned with the aluminium film side in direct contact with the ballast stones
6a The joint-sealing cushion is placed between the SVS tape and the steel base slab, and inflated to ~ 0.5 bar overpressure.
6b Joint width 4 cm

3 Movable slab for joint widths 3, 5 and 3 cm

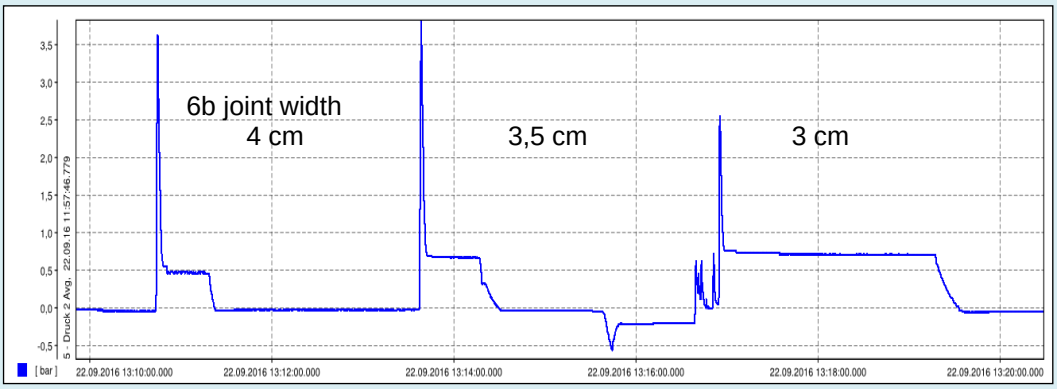
…/ Test procedure

Protocol 086/2016

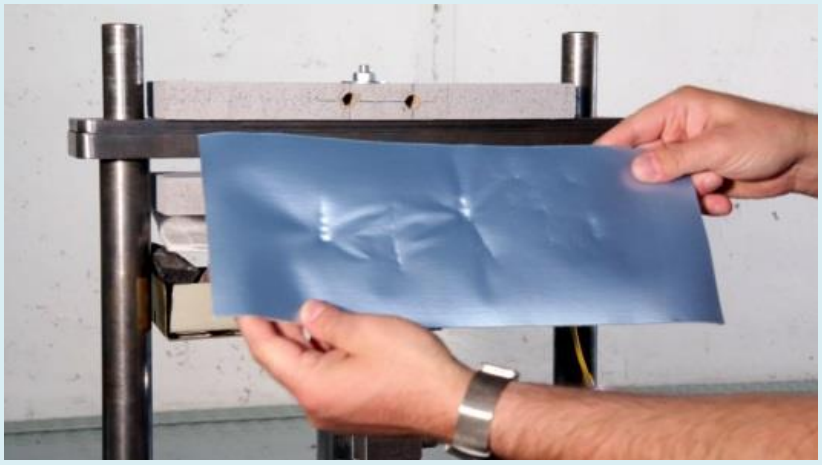
Transverse pressure [N]



Overpressure [bar]



3. Test result



Pressure marks are visible from the ballast stones, but no damage is done to the aluminium film.

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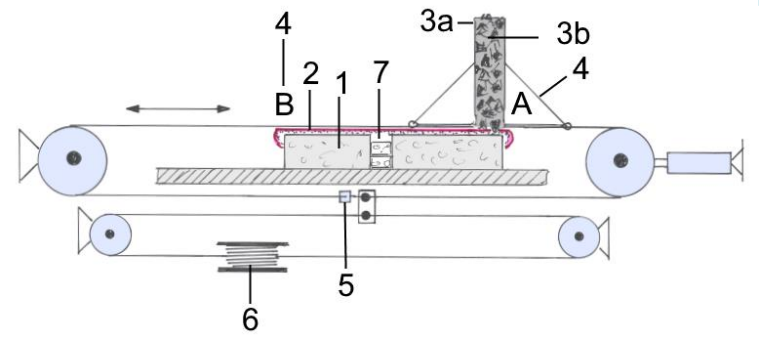
Test

Mechanical and environment-related performance of movement-joint sealing systems

Test sample of:	**21.4 SVS Ballast stone protection** or equivalent **13.1 VF-QV-DF Surface protection** or **13.2 VF-QV-DES Liquid and diffusion blocking layer** **14.1 VF-QVL-ADK Leakage protection device** (The above products are all Wolf trade names)

1. Test setup based on DIN EN 60794-1-2 Method E2

Dry sliding abrasion caused by overhead track ballast stones
Resistance to overhead ballast stones (basalt) with dynamic movement



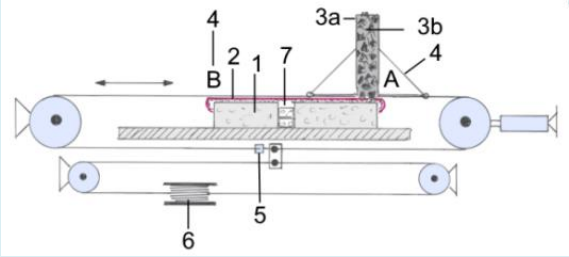
1 Support slab:
Concrete trough 27 x 80 (30+10+40) cm
2 Test sample:
21.4 SVS ballast stone protection
3a Overhead ballast stones (basalt 31,5/63)
height 50 cm = 5.1 kg
3b Metal grid
4 Pulling direction from A to B and back
5 DMS load cell 5 KN
6 Rope winch
7 Joint cavity width 27 x 10 cm

2. Test procedure

The metal grid is filled with ballast stones
Total weight 7.85 kg

Pulling direction from A to B and back

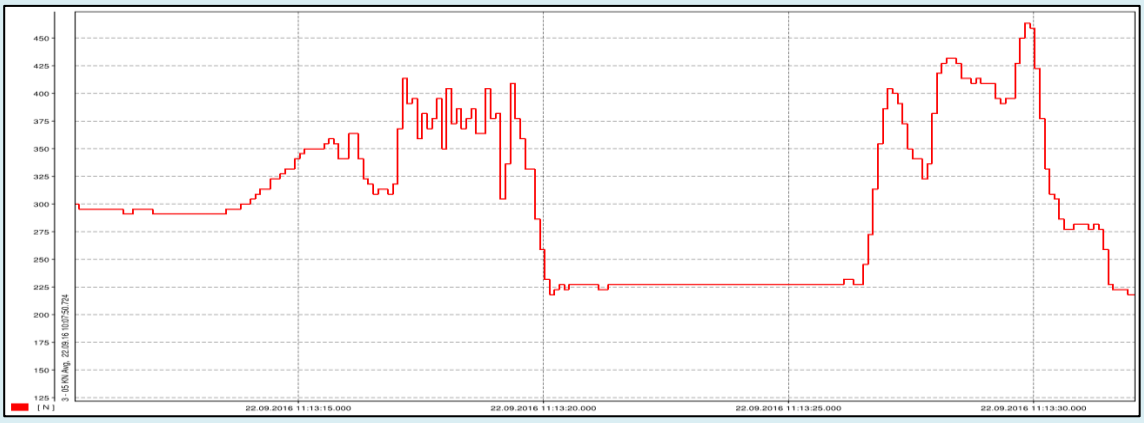
…/ Test procedure



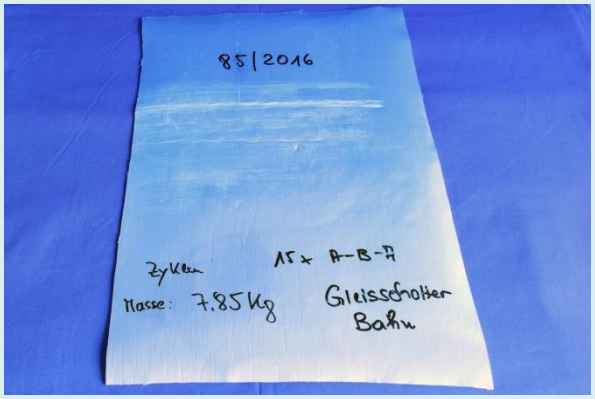
(2) Dry abrasion area 10 x 80 cm = 800 cm²
21.4 SVS ballast stone protection made of aluminium composite film with thermolaminated sweling material (480 g/m²)

(3a) Overhead ballast stones, height 50 cm, weight 6.1 kg. Force exerted by stones in grid: 7.85 kg = 0.785 N/cm²
- Pulling direction from A to B and back with sudden impacts, 15 cycles
- Tensile load: ≥ 300 N ≤ 470 N
  Pulling force of DMS load cell 5 KN
- (7) Joint cavity width 10 cm
- Testing temperature: 20° C

Protocol No. 05_2016 (5 KN)



3. Test result **Resistance of SVS ballast stone protection to overhead ballast stones (basalt) with dynamic movement**



Result: Pressure marks of the overhead ballast stones were visible, but there was no damage to the aluminium composite film

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Test

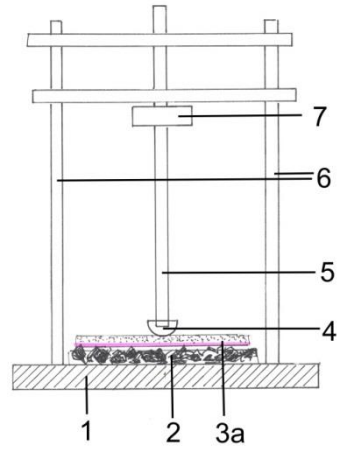
Mechanical and environment-related performance of movement-joint sealing systems

Test sample of:	**21.4 SVS Ballast stone protection** or equivalent **13.1 VF-QV-DF Surface protection** or **13.2 VF-QV-DES Liquid and diffusion blocking layer** (The above products are all Wolf trade names)

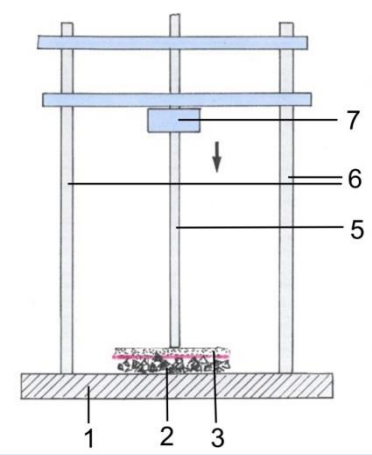
1. Test setup based on DIN EN 60794-1-21/ Method E4

Resistance to shock and impact stress on ballast stones

Variation 1: With a hammer and intermediate steel mandrel



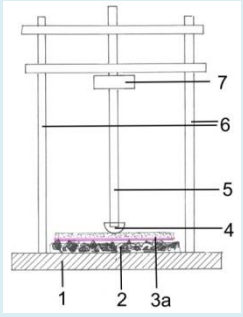
Variation 2: Steel hammer



1 Steel base slab
2 Ballast stones (basalt)
3 SVS ballast stone protection film (swelling-material side facing the stones)
3a SVS ballast stone protection film (film side facing the stones)
4 Intermediate steel mandrel
5 Guide rod
6 Supports
7 Hammer

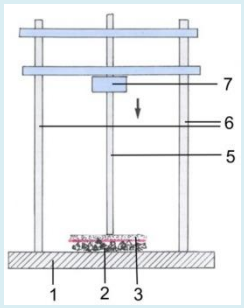
2. Test procedure

Variation 1



2 Ballast stones: basalt 31,5/63
3a Test sample: film side facing the stones
4 Impact area
☒ Radius: 10 mm
☒ Radius: 25 mm
☐ Radius: 25 mm, max. length 50 mm
7 Hammer
☐ 3 J
☐ 4.2 J
☒ 10 J
☒ 50 J
☒ Test procedure and evaluation

Variation 2



2 Ballast stones: basalt 31,5/63
3 SVS ballast stone protection strip ~~Aluminium side~~ facing the stones
Dropping height 1 m
Hammer
☐ Ø 30 mm 2.7 J
☒ Ø 50 mm 4.2 J
☐ Ø 60 mm 4.2 J
☒ Test procedure and evaluation

3. Test results of resistance to shock and impact stress on ballast stones

Variation 1 with impact energy 10 J:
Radius r= 10 mm

After 10 impacts with 10 J there were visible dents in the surface, but the aluminium laminate was undamaged.

Variation 1 with impact energy 50 J:
r = 25 mm

After 3 impacts with 50 J there was visible damage to the aluminium laminate. The QV coating had a tear 1 x 10 mm.
But there was still no water leakage through the torn area.

Variation 2:
Impact energy 10 J: Impacting rod Ø 50 mm
After 10 impacts with 10 J there were visible dents in the surface, but the aluminium laminate was undamaged.

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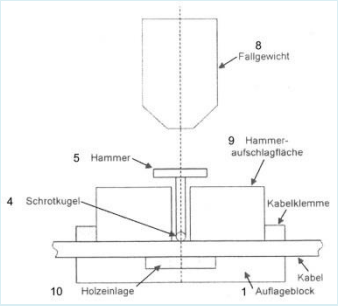
Test

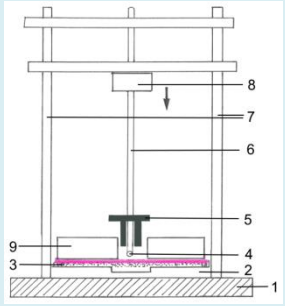
Mechanical and environment-related performance of movement-joint sealing systems

Test sample of:	**21.4 SVS Ballast stone protection** or equivalent **13.1 VF-QV-DF Surface protection** or **13.2 VF-QV-DES Liquid and diffusion blocking layer** (The above products are all Wolf trade names)

1. Test setup based on DIN EN 60794-1-21 Method E13

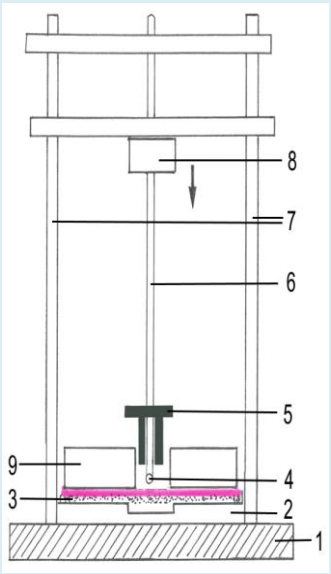
Resistance to damge caused by sharp ballast stones (basalt) or shot pellets

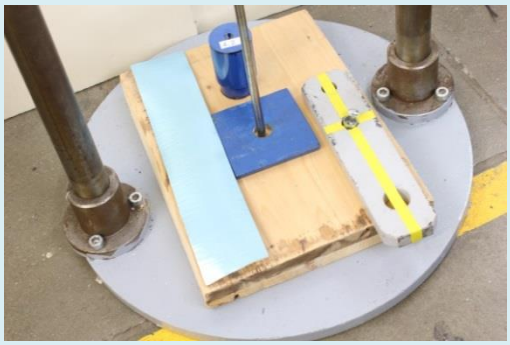


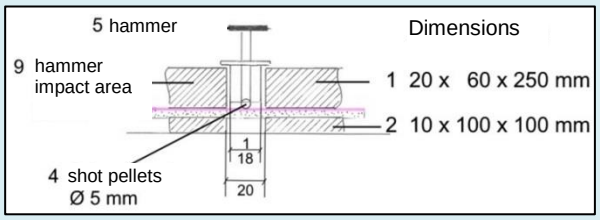


1 Steel base slab
2 Support block
3 SVS ballast protection strip or an equivalent (480 g/m²) thermolaminated aluminium film
4 Shot pellets
5 Hammer
6 Guide
7 Supports
8 Falling weight
9 Hammer impact surface

2. Test procedure







Test setup, shot size Ø 5 mm

3. Test results

Impact energy 1.5 J
Shot size Ø = 5 mm:
At 1.5 J, Ø 5 mm impact energy
no holes are to be seen.

Impact energy 4.2 J
Shot size Ø 5 mm:
At 4.2 J, Ø 5 mm impact
there are visible holes
(going right through).

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Test

Mechanical and environment-related performance of movement-joint sealing systems

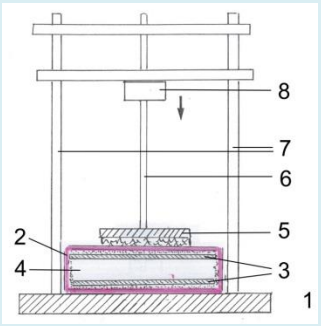
Test sample of:	**21.4 SVS Ballast stone protection** or equivalent **13.1 VF-QV-DF Surface protection** or **13.2 VF-QV-DES Liquid and diffusion blocking layer** (The above products are all Wolf trade names)

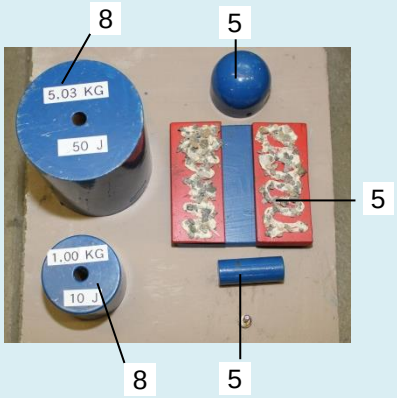
1. Test setup based on DIN EN -60794-1-21 Method E13

Resistance to fine-grain basalt
Damage due to shock impact or shot pellets in temperature range -25°C to +65°C
based on E DIN EN-60794-1-21 / E 4 Impact
E13 Shot pellets
E DIN EN-60794-1-22 / F 1 Temperature cycling

Temperature cycling test — **Acc. to E DIN EN-60794-1-22 / F 1 -25°C / +65°C, 10 cycles**

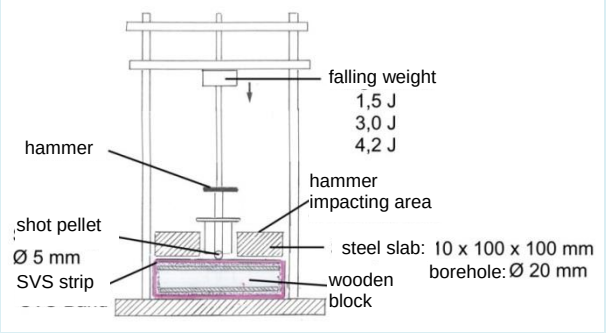
Variation 1: Impact/shock, 21 E4





1 Steel base slab
2 SVS ballast stone protection strip, flood protection and aluminium film in the same quality with laminated swelling material 480 g/m², aluminium side facing the source of impact
3 Wooden inserts
4 Polystyrene block
5 Hammer impacting area
6 Guide
7 Supports
8 Falling weight (hammer)

Variation 2: Shot, 21 E13



Standard E DIN EN 60794-1-21 / E 13, with wooden block
Test procedure as described in section 1.6

2. Test results

Variation 1: Schock /impact

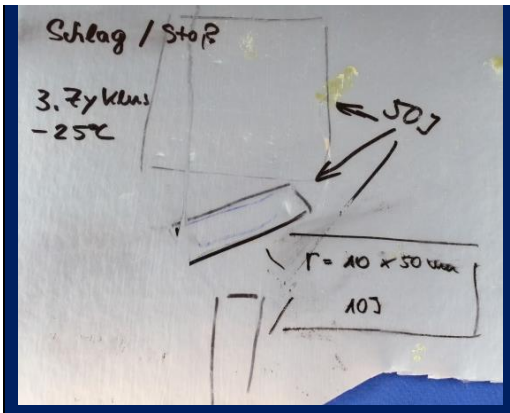


Photo 1

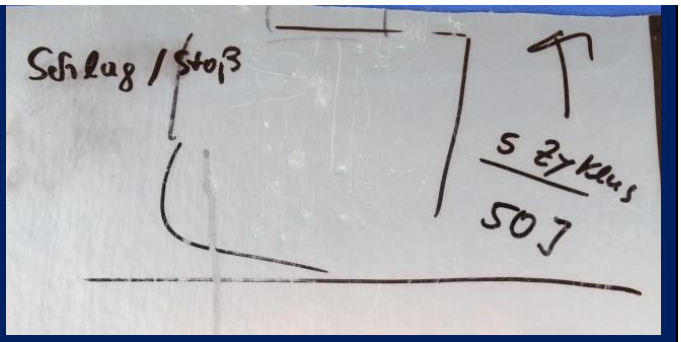


Photo 2

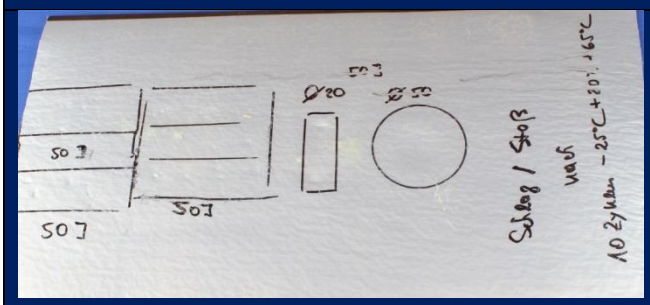


Photo 3

Impact energy 50 J

Photo 1: 3rd cycle -25°C lowest temperature
Denting of the hammer impact area.
The aluminium laminate is undamaged.

Photo 2: 5th cycle -25°C lowest temperature
Denting of the hammer impact area.
The aluminium laminate is undamaged..

Photo 3: after 10 cycles -25°C / +65°C
Visible denting from the ballast stones
The aluminium laminate is undamaged.

Variation 2: Shot

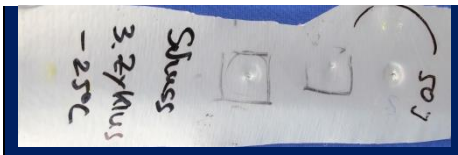


Photo 4

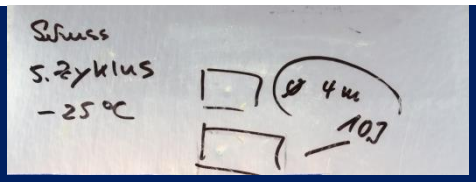


Photo 5

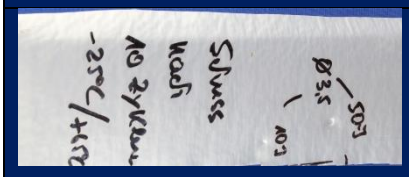


Photo 6

Photo 4: Impact energy 50 J.
3rd cycle -25°C lowest temperature
Damage from the shot pellet can be seen.

Photo 5: Impact energy 10 J.
5th cycle -25°C lowest temperature
Damage from the shot pellet can be seen

Photo 6: Impact energy 10 J.
after 10 cycles -25°C / +65°C
Damage from the shot pellet can be seen

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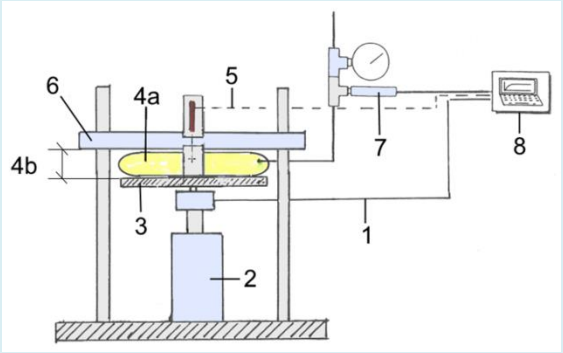
Test

Mechanical and environment-related performance of movement-joint sealing systems

Test sample of:	**21.1 QADK/V L or S**	**Sealing cushions to prevent the passage of water, icicles and black ice**
	21.3 SVS-QADK/V L or S	**Ballast stone protection film for protection against falling stones and the passage of water**
	(The above products are all Wolf trade names)	

1. Test setup based on DIN EN 60794-1-21/ E3

Transverse pressure exerted on the sealing system by the smallest and largest movement in the direction of the x axis



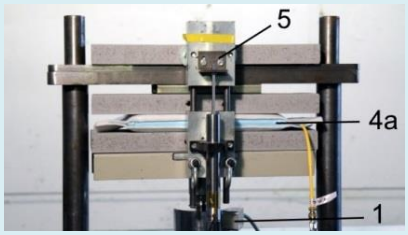
1	DMS load cell
2	Pressure cylinder
3	Movable slab
4a	Joint-sealing cushion valve) 13x25 cm
4b	Height of the sealing cushion
5	Cylinder for measuring expansion (movement)
6	Base slab
7	Supply of pressure (transmitter/measuring PC)
8	Measuring PC

2. Test procedure

The weight load exerted by a 50 cm depth of overhead ballast stones corresponds to a surface pressure load of 0.78 N/cm²

Joint width 1:	4.8 cm
Overpressure:	0.11 bar
Transverse pressure:	200 N

Joint width 2:	1,9 cm
Overpressure:	0,9 bar
Transverse pressure:	2580 N



3. Test results

To follow

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Test

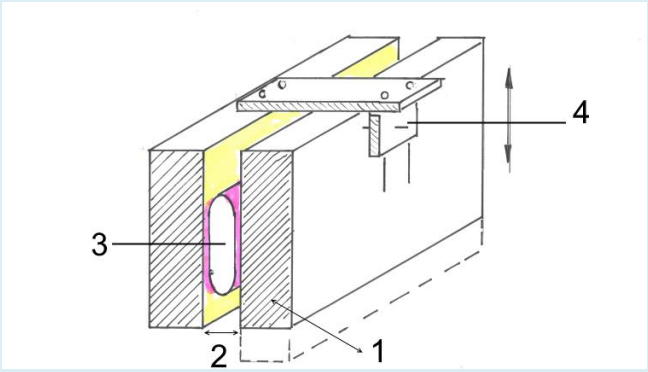
Mechanical and environment-related performance of movement-joint sealing systems

Test sample of:	**21.1 QADK/V L or S**	**Sealing cushions to prevent the passage of water, icicles and black ice**
	21.3 SVS-QADK/V L or S	**Ballast stone protection film for protection against falling stones and the passage of water**

(The above products are all Wolf trade names)

1. Test setup based on DIN 50100-78/ DIN 53442-75

Dynamic- elastic performance under vibratory stress in the direction of the x axis



1 Concrete slab
2 Joint width
3 QADK/V sealing cushion or SVS-QADK/V ballast stone protection film
4 Path transducer

2. Test procedure (Simulation model)

Vibration in the direction of the z axis: 20 x Sealing cushion overpressure:
type L: 0.2 bar; type S: ≤ 0.1 bar; additional load from the ballast stones (basalt 31,5/ 63)

(3) 21.3 SVS-QADK/V L-
Joint widths from 3 cm to < 8 cm

Vibration in the direction of the z axis

(3) 21.3 SVS-QADK/V S-
Joint widths from 3 cm to ≤ 16 cm

3. Test results

To follow

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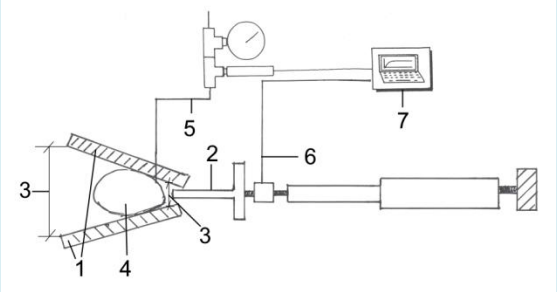
Test

Mechanical and environment-related performance of movement-joint sealing systems

Test sample of:	**21.1 QADK/V L or S**	**Sealing cushions to prevent the passage of water, icicles and black ice**
	21.3 SVS-QADK/V L or S	**Ballast stone protection film for protection against falling stones and the passage of water**
	(The above products are all Wolf trade names)	

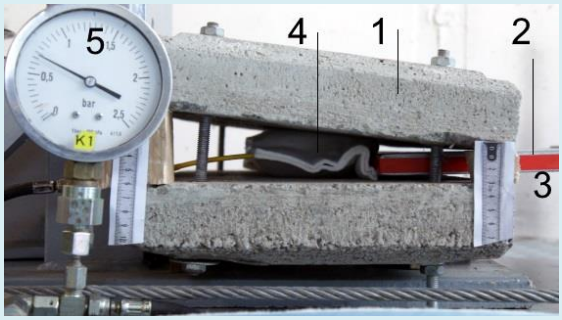
1. Test setup based on E DIN EN 60794-1-21/ E22

Loosening of the sealing systems due to compression, load from ballast stones and/or water pressure in the direction of the Z axis



1 Concrete slab
2 Movable displacement slab
3 Joint width
4 QADK/V L-
5 Inflation overpressure Pv
6 DMS load cell
7 Measuring PC

2. Test procedure

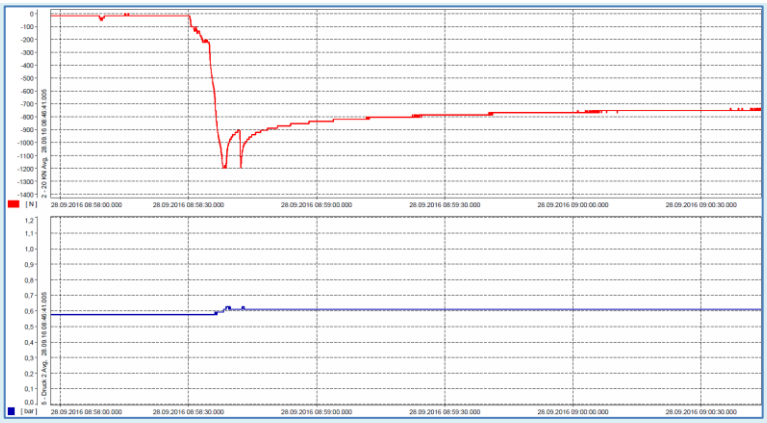


The sealing cushion is placed between two concrete slabs positioned with a defined gap width of 3 cm - 6 cm (average width 4.5 cm) and inflated to max. filling pressure.
Pressure is then created using a thrust plate, and the holding strength of the sealing system under operational movement (ageing) is tested in the direction of the Z-axis.

…/ Test procedure

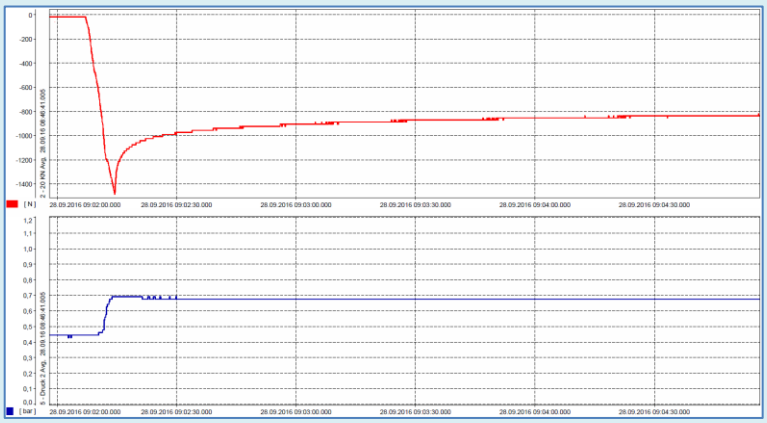
Protocol 089 / 2016
- Cycle 1
(20 kN + Pressure 2)

Pressure filling 0.58 bar



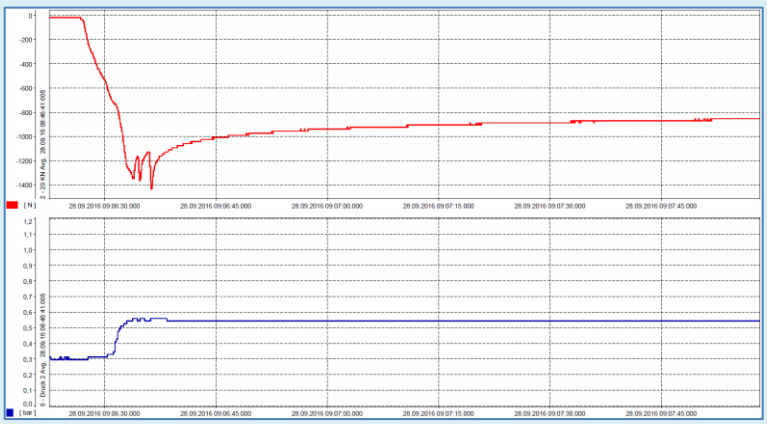
Protocol 089 / 2016
- Cycle 2
(20 kN + Pressure 2)

Pressure filling 0.45 bar



Protocol 089 / 2016
- Cycle 1
20 kN + Pressure 3)

Pressure filling 0.3 bar



3. Test results

The sealing cushion was not pressed out of the joint.

Detailed results to follow.

fibre optics
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Test

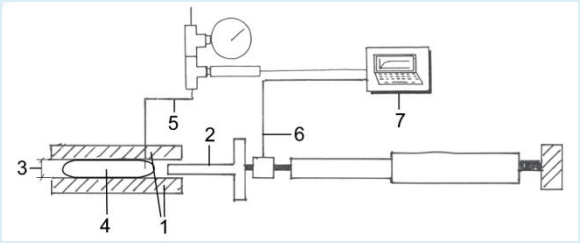
Mechanical and environment-related performance of movement-joint sealing systems

Test sample of:	**21.1 QADK/V L or S**	**Sealing cushions to prevent the passage of water, icicles and black ice**
	21.3 SVS-QADK/V L or S	**Ballast stone protection film for protection against falling stones and the passage of water**

(The above products are all Wolf trade names)

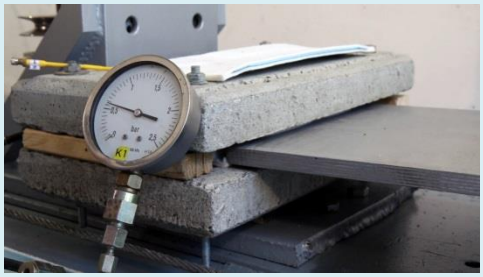
1. Prüfaufbau in Anlehnung an E DIN EN 60794-1-21/ E22

Movement of the sealing systems due to compression, load from ballast stones and/or water pressure in the direction of the Z axis



1 Concrete slab
2 Movable displacement slab
3 Joint width
4 QADK/V L-
5 Inflation overpressure Pv
6 DMS load cell
7 Measuring PC

2. Test procedure



Joint width b_f = 3 cm

Shear strength (t_B)

parallel in direction oft he Z axis

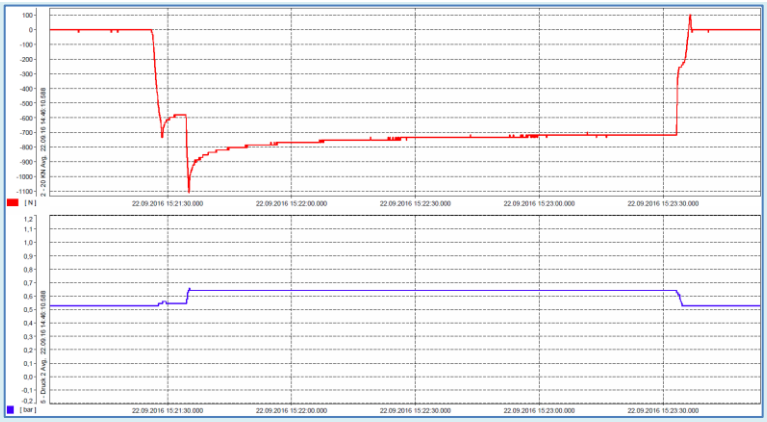
…/ Test procedure joint width 3 cm

Test Protocol No. 87/2016:

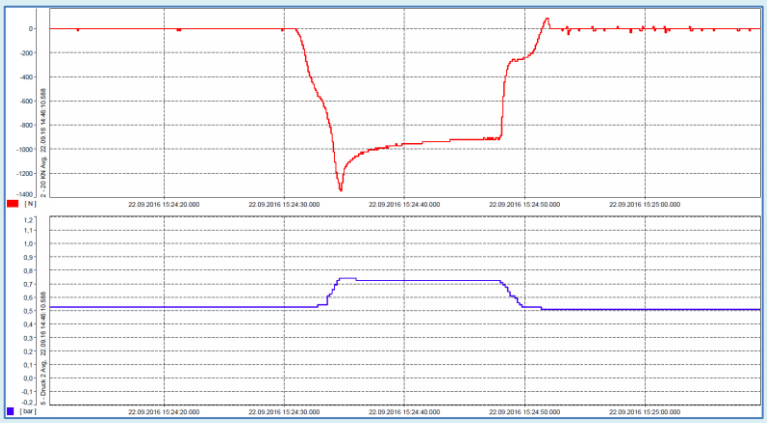
Pro 087 / 2016 - Cycle 4

Pressure: 0.55 bar – 0.65 bar

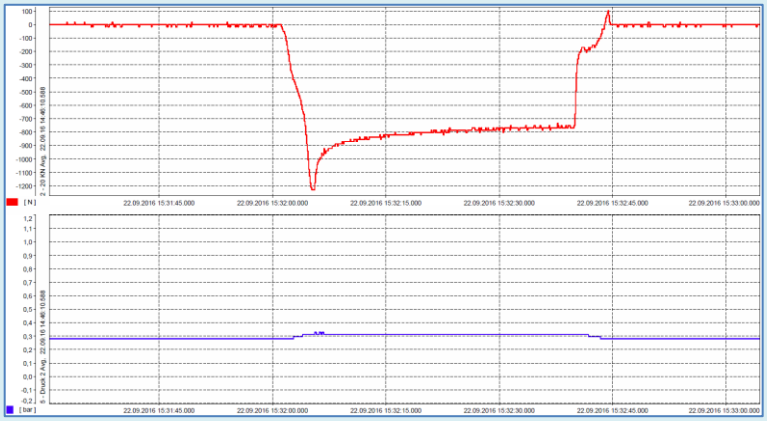
Force: 1100 N – 720 N



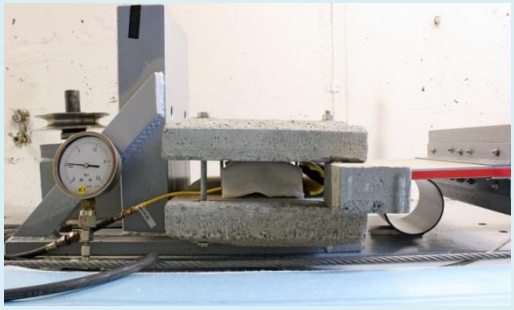
Protocol 087 / 2016 - Cycle 5
Pressure: 0.52 bar – 0.75 bar
Force: 1350 N – 950 N

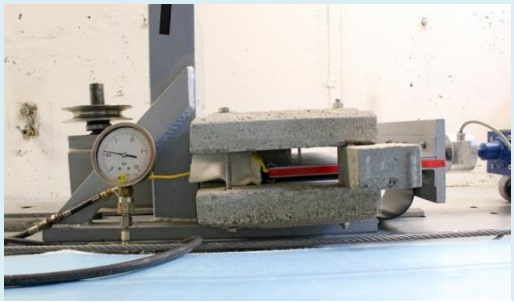


Protocol 087 / 2016 - Cycle 6
Pressure: 0.28 bar – 0.32 bar
Force: 1250 N – 780 N



…. / Test procedure joint width 3 cm





Joint width b_f = 6 cm

Shear strength (t_B) parallel in direction of Z axis

Pressure filling (overpressure) 0.5 bar

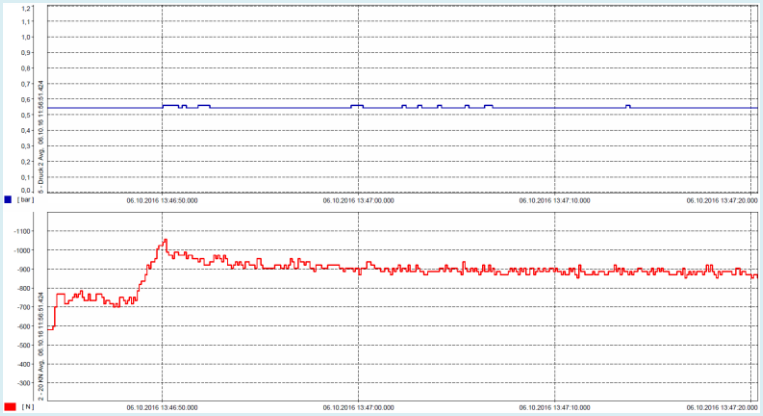
without shear load

Shear strength < 900 N

Test Protocol No. 091/2016

Protocol 091 / 2016 - Cycle 1

Pressure: 0.55 bar
Force: 1050 N – 900 N



3. Test results

Details of results to follow

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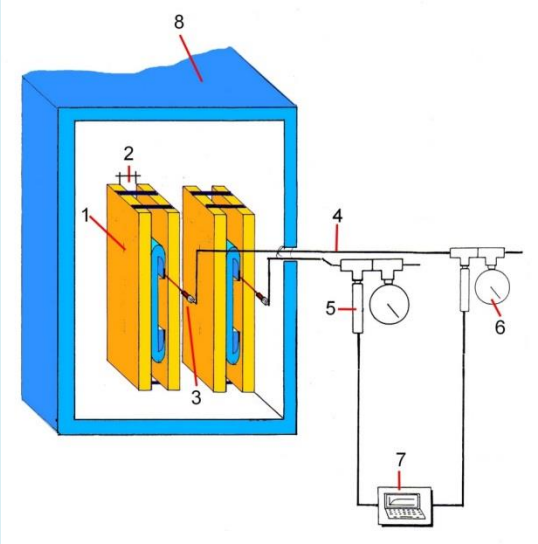
Test

Mechanical and environment-related performance of movement-joint sealing systems

Test samples	**21.1 QADK/V**	**Sealing cushions to prevent the passage of water, icicles and black ice**
	21.1 QADK/VV	**Sealing cushion for central dividing walls, to prevent the passage of water, icicles and black ice**
	21.3 SVS-QADK/V	**Ballast stone protection film for protection against falling stones and the passage of water**
	(The above products are all Wolf trade names)	

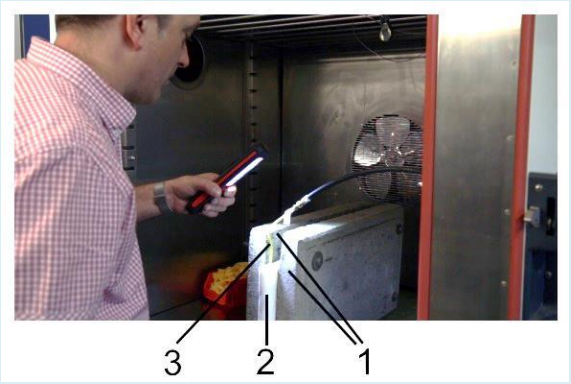
1. Test setup based on IEC 60794-1-22/ F1

Stability of joint seals with temperature cycling



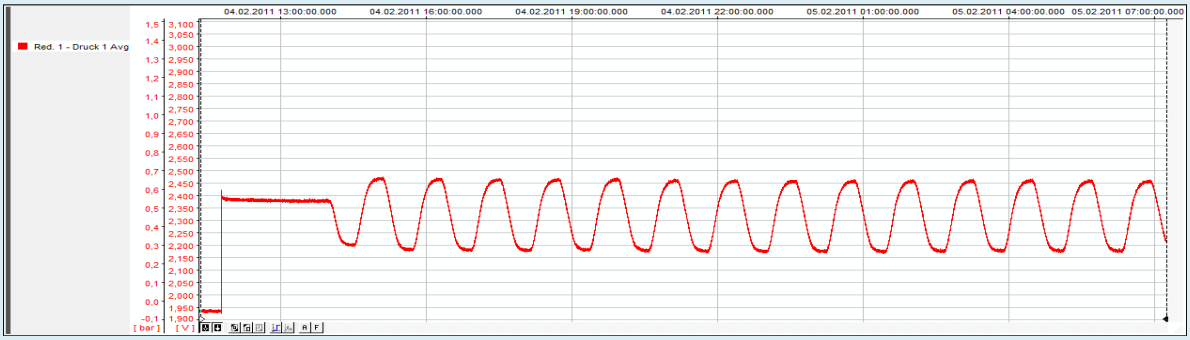
1 Concrete slabs 6x 30 x 50 cm
2 Gap (expansion joint) 3 cm
3 Valve extensions of sealing cushions
4 Pressure connection cables
5 Pressure transmitter
6 Pressure gauge
7 Measuring PC 2
8 Climate chamber based on IEC 60068-2-14, Section. 2 Test Nb

2. Test procedure

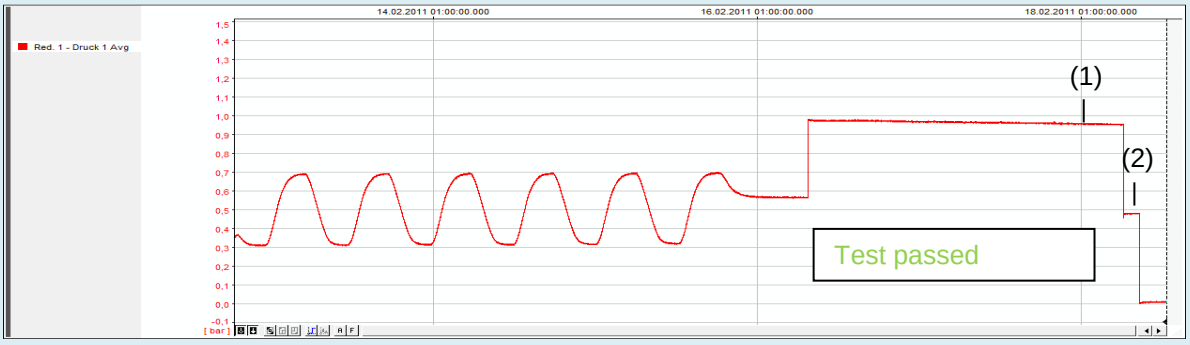


1 Concrete slabs 6 x 30 x 50 cm
2 Sealing cushion QADK/V
3 Pressure transmitter supply cable

Test protocol: Temperature cycling -30°C / +45°C(No. of cycles 30)
Protocol 16/2011 Pressure 1 Cycle A



Protocol 16/2011 Pressure 1 Cycle B



(1) Pressure top-up for extended service life
(2) Pressure reduction "Verification of tightness"

3. Test results

Detailed results to follow.

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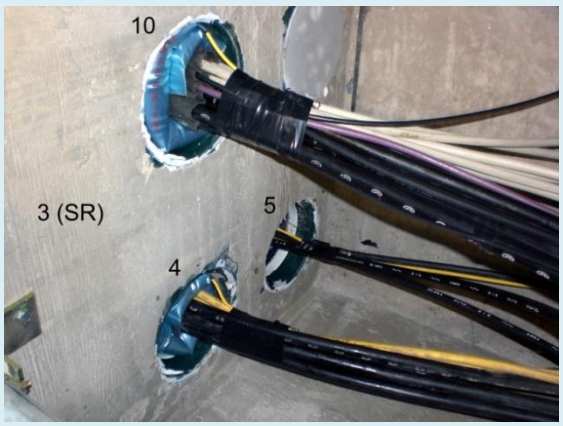
Test

Mechanical and environment-related performance of cable or movement-joint sealing systems

Test samples:	**Joint-sealing systems**	
	21.1 QADK/V	**21.3 SVS-QADK/V**
	21.1 QADK/VV	
	Cable sealing systems	
	16.1 QAK/V L 30 - 500	**20.1 ADE/V L 30 - 150**
	17.1 UA/V L 30 - 500	**20.1 ADE/V L 30 - 150**
	(The above products are all Wolf trade names)	

1. Test setup based on DIN 50019 Open air climate

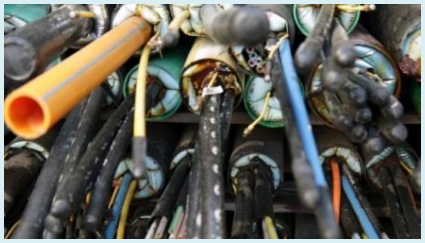
Ageing performance of cable or joint seals that are permanently in the open



2. Test procedure

Weathering resistance (ageing in the open) based on DIN 50019 Open air climate

Tightness of pressure-resistant cable sealing cushions with valve kept in the open since 2006



Tightness of pressure-resistant joint-sealing cushions with valve

3. Test results

So far all the seals are tight!

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Test

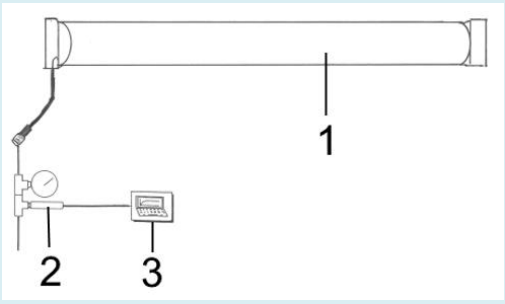
Mechanical and environment-related performance of cable or movement-joint sealing systems

Test samples:	**21.1 QADK/V**	**Sealing cushion to prevent the passage of water, icicles and black ice**
	21.1 QADK/VV	**Sealing cushion for central dividing walls, to prevent the passage of water, icicles and black ice**
	21.3 SVS-QADK/V	**Ballast stone protection film for protection against stones falling from above and the passage of water**

(The above products are all Wolf trade names)

1. Test setup based on DIN EN 60794-1-22/ F8

Pressure resistance of joint-sealing elements



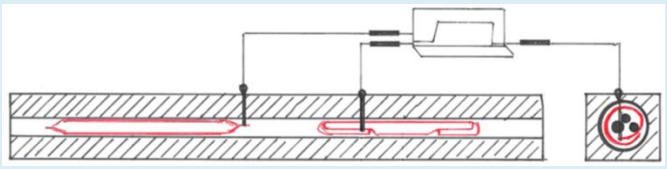
Test setup A:

Company's own on-site, non-destructive product monitoring

1 Joint-sealing cushion

2 Pressure transmitter

3 Measuring PC



Test setup B:

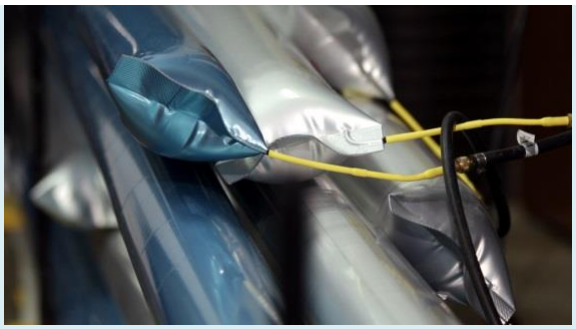
Company's own destruct-test system monitoring

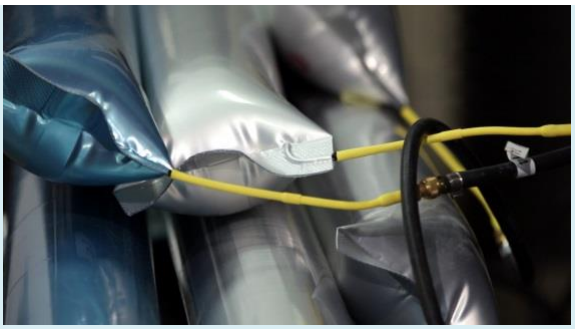
Short-term burst-pressure test

2. Test procedure

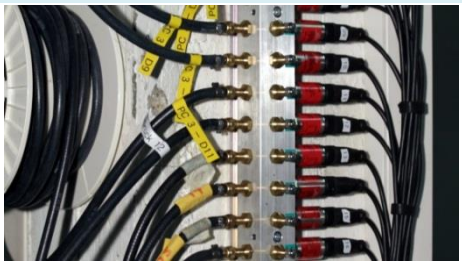
Test procedure: **Test setup A**

Company's own on-site, non-destructive product monitoring

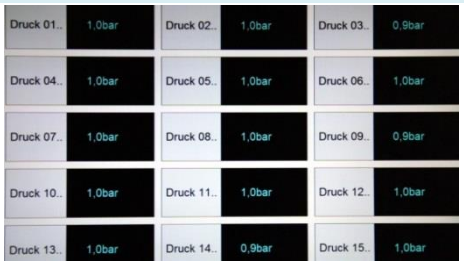


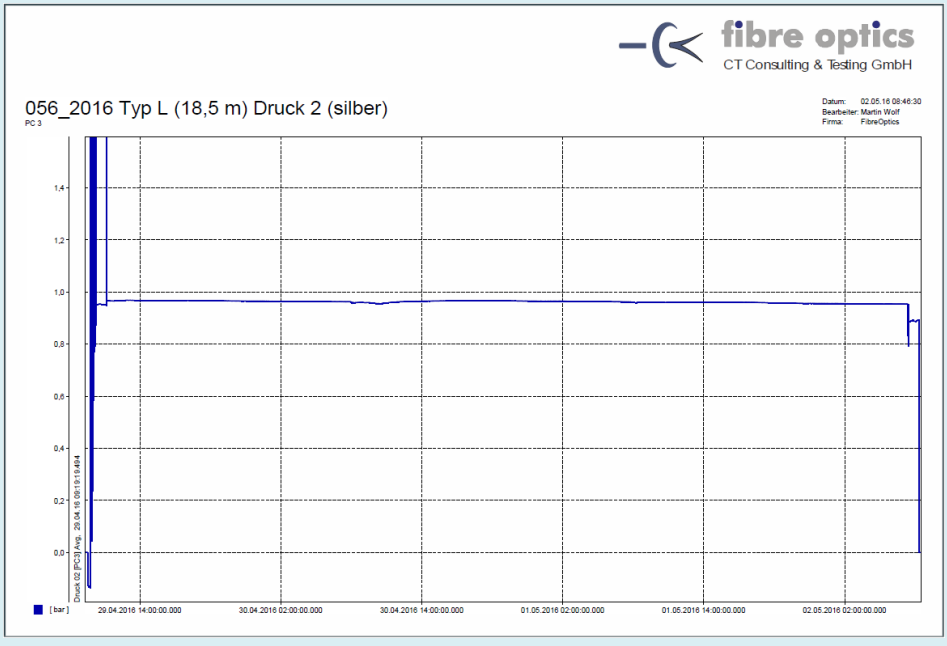


The samples are left for 1 - 3 days at 20°C



Measuring equipment
Pressure ports
Pressure transmitter



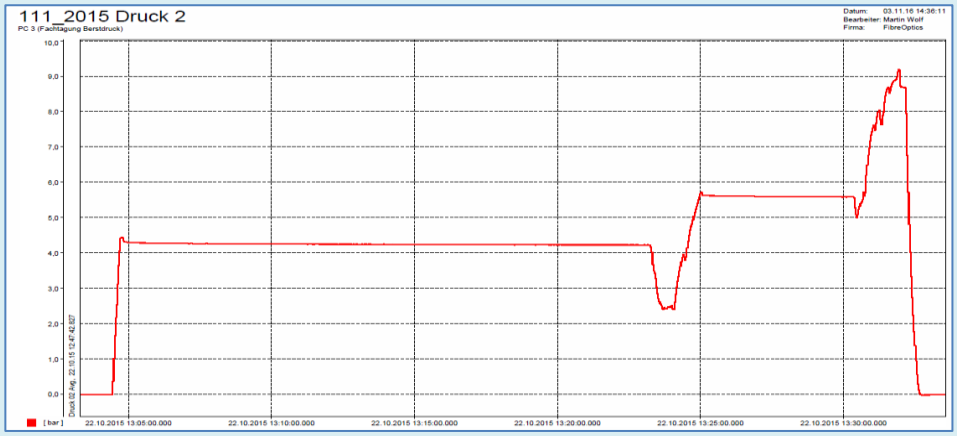


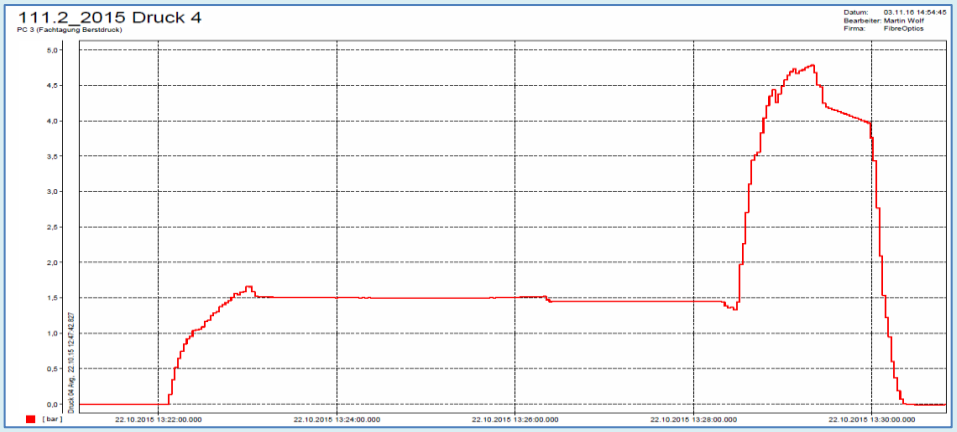
…/ Test procedure

Test procedure: **Test setup B**

On-site destruct-test system monitoring

Short-term burst-pressure test





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Test

Mechanical and environment-related performance of cable or movement-joint sealing systems

Test samples:	**21.4 SVS film** **13.1 VF-QV** **13.3 VF-QV-DES** (The above products are all Wolf trade names)

1. Test setup

Tightness of damaged swelling material thermolaminated to aluminium film (e.g. as a result of dry sliding abrasion, penetration by railway ballast stones or after fixture with screws)

Tightness against non-pressing water, temporary buildups of water, non-accumulating water seepage in bridges or tunnels built with the open-cut construction method

2. Test procedure

The test sample is deliberately damaged (pierced). The damaged area is then exposed to water. The test is passed if the damaged area closes up and lets less than 10 ml water through.

3. Test result

Less than 10 ml water leaked through.

The above-named test samples passed the tests..

fibre optics
CT Consulting & Testing GmbH

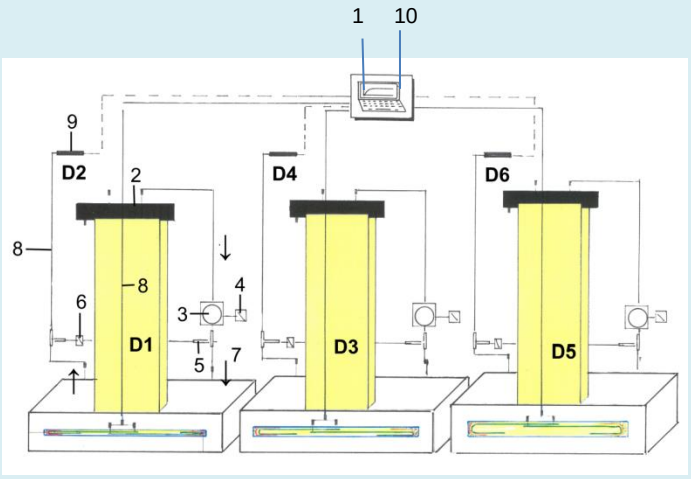
Test

Mechanical and environment-related performance of cable or movement-joint sealing systems

Test sample:	**21.1 QADK/V L or S** (The above products are both Wolf trade names)

1. Test setup based on IEC DIN EN 61300-2-38

Tightness of joint-sealing cushions in a situation where 2 sealing cushions are placed one directly on top of the other



1. Measuring PC
2. Water tank
3. Diaphragm water pump
4. 24 V power switch, water pump
5. Water diverter
6. water gate valve
7. Testing chamber, water entry point
8. Testing chamber, pressure line
9. Pressure transmitter
10. Measuring PC

2. Test procedure

Test procedure:

Type 2
Joint width 5 cm

Type 1
Joint width 3 cm

Type 3
Joint width 8 cm

…

Test, 1.6 m water column

3. Test result

To follow