Coroflex

Part of the Coroplast Group

SILICONE ENSURES THE FUTURE OF ELECTRIC MOBILITY

HCR – Excellence

16.04.2024

SILICONE ENSURES THE FUTURE OF ELECTRIC MOBILITY

Company Portrait

Coroflex Understanding of eMobility

Bending and Flexibility Requirements

Savety over Lifetime


Coroplast
group
Coroplast
tape
Coroflex
WEWIRE

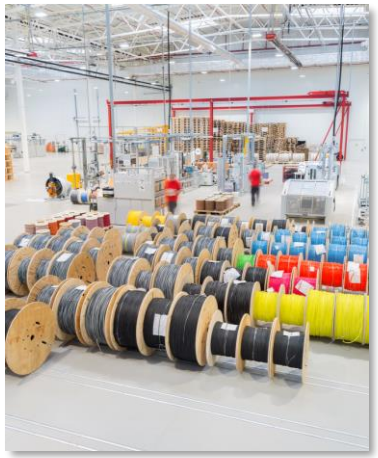
Production Capabilities and Expertise

Wuppertal, Germany

- Production of silicone cables
- Production area: approx. 8,000 m²
- eMobility applications

Kunshan, China

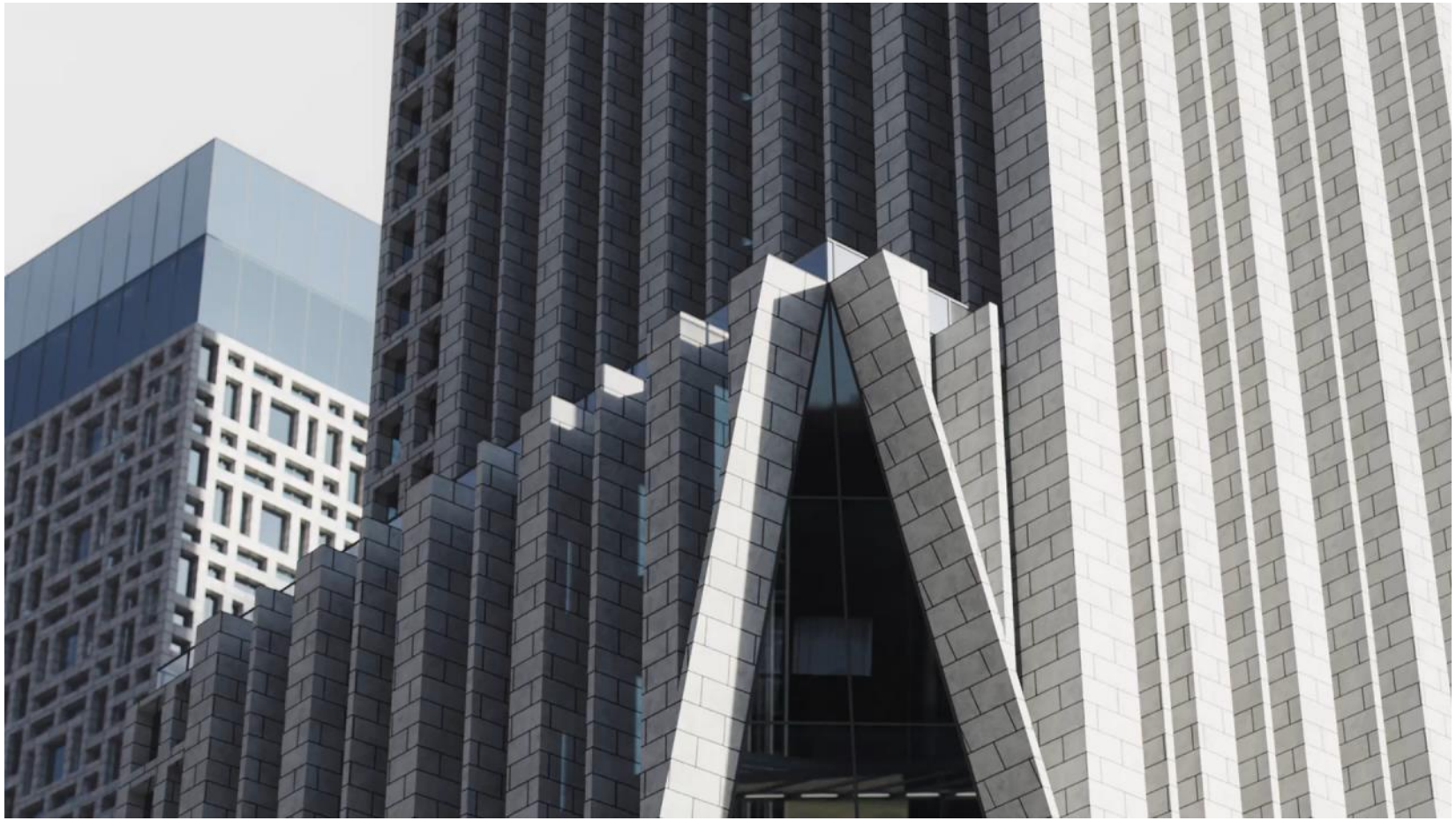
- Production of silicone, fluorine and thermoplastic cables
- Production area: approx. 7,790 m²
- eMobility, Industry, Data, Automotive applications



Strzelce Opolskie, Poland

- Production of thermoplastic and fluorine cables
- Production area: approx. 11,841 m²
- Industry, Data, Automotive applications

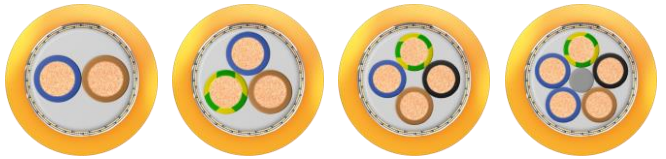
Coroflex understanding of eMobility



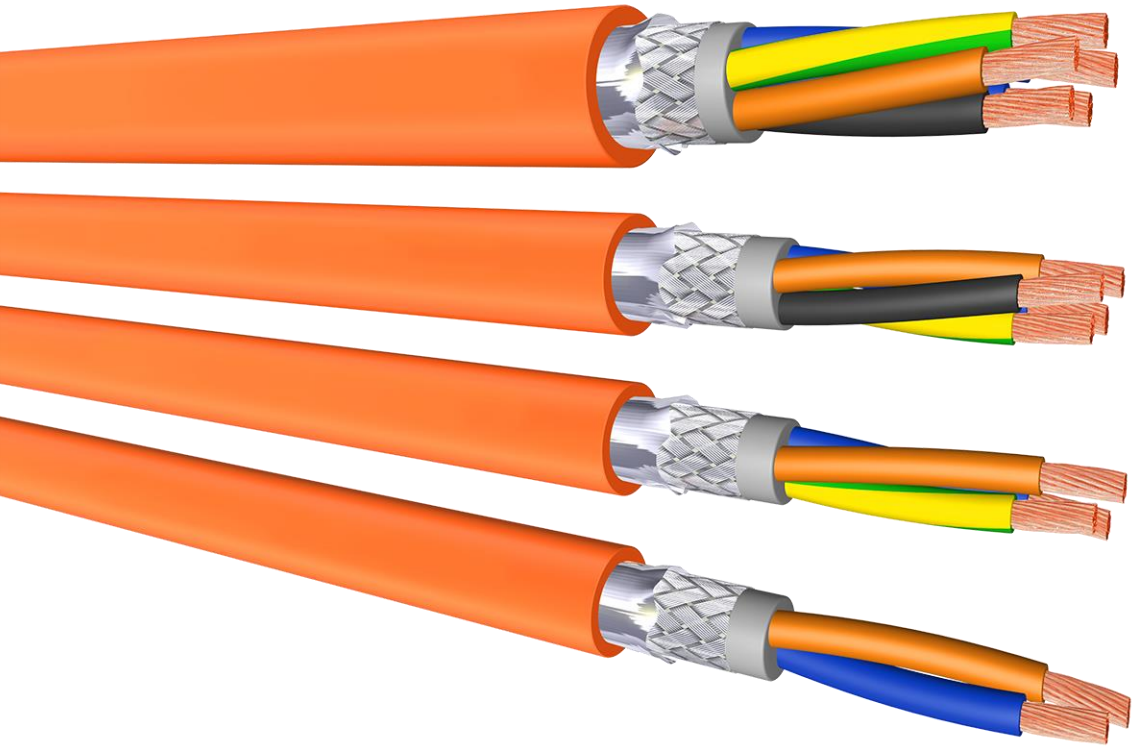
Coroflex Single-Core High-Voltage Cables
Temperature classes T150 and T180 available

Characteristics

- Shielded and unshielded
- Conductor Copper and Aluminum
- Conductor sizes 1.5 mm² up to 120 mm²
- Available voltage classes
  - LV 216 600 Volt a.c. / 1000 Volt d.c.
  - ISO 19642 1000 Volt a.c. / 1500 Volt d.c



Coroflex Multi-Core High-Voltage Cables
Developed already based on processing requirements



Characteristics

- Shielded and unshielded
- Conductor Copper
- Cores 2 x 2.5 mm² up to 5 x 6.0 mm²
- Available voltage classes
  - LV 216 600 Volt a.c. / 1000 Volt d.c.
  - ISO 19642 1000 Volt a.c. / 1500 Volt d.c

FLEXIBILITY AND BENDING

Requirements for static and dynamic installations

Investigation static bending radii
Installation space must be saved

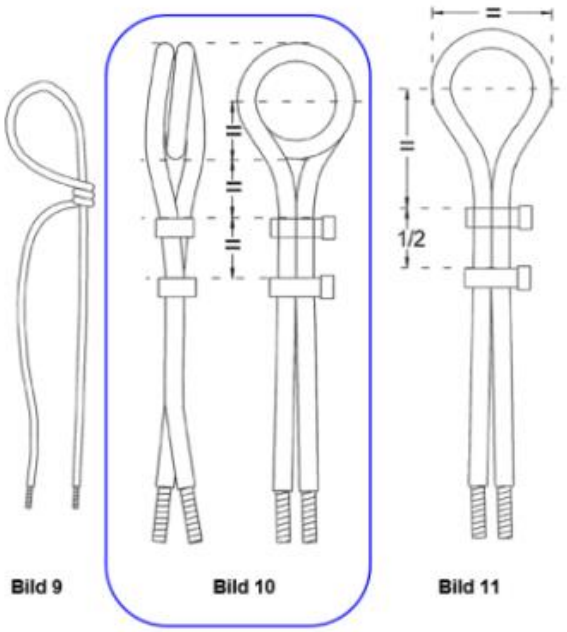
Ageing requirements higher than usual according to LV 216-2

⇨ Mandrel diameter 1 x d_{max} / 240 h @ +205 °C

⇨ Bending with angle 360 ° as an alternative to usual angle 180 °

Tabelle 19

maximaler Leitungs-durchmesser d_{max} in mm	kleinster zulässiger Biegeradius in mm	maximaler Wickeldorn-durchmesser in mm	Ausführungsart
≤ 3,0 (≈ bis 2,5 mm²)	2,0 × d_{max}	-	3 mal 360° um sich selbst gewickelt, siehe Bild 9
> 3,0 und ≤ 5,0 (≈ von 4,0 mm² bis 6,0 mm²)	2,0 × d_{max}	1,5 × d_{max}	2 mal 360° um Dorn wickeln, Befestigung mit zwei Kabelbindern: 1. Kabelbinder im halben Abstand des entstehenden Schlaufendurchmessers; 2. Kabelbinder im halben Abstand des entstehenden Schlaufendurchmessers, Dorn entfernen (siehe Bild 9).
> 5,0 (ab ≈ 6,0 mm²)	3,0 × d_{max}	2,0 × d_{max} 1,0 × d_{max}	180° um Dorn gebogen, Befestigung mit Kabelbindern: 1. Kabelbinder im einfachen Abstand des entstehenden Schlaufendurchmessers; 2. Kabelbinder im halben Abstand des entstehenden Schlaufendurchmessers Dorn entfernen (siehe Bild 9).

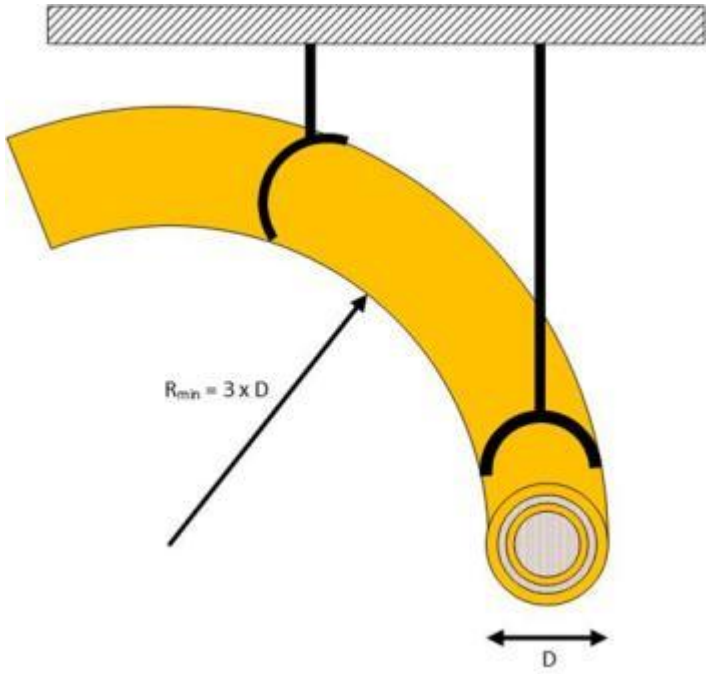


OEM will increase requirements down to 2 x cable-Ø to be tested at short-term ageing 240 h @ T_O + 50 °C

Mechanische Eigenschaften			***Mechanical properties***		
Biegeradius:			*Bend radius:*		
- min. 3 x Außen-Ø:	statische Verlegung	→	*- min. 3 x cable-Ø:*	*static installation*	
- min. 6 x Außen-Ø:	dynamische Verlegung		*- min. 6 x cable-Ø:*	*dynamic installation*	

LV 216-2 (9.6.7.4): **Definition and specification of the bending radius for static installation**

- the installation of the cable, including fasteners, will be performed on one movement level (see figure)
- there are no relative movements between the different attachment points of the cable allowed
- the minimum permissible bending radius for static installation in the vehicle corresponds to 3 times the specified maximum outer diameter of the cable.



Investigation static bending radii
Installation space must be saved

Ageing requirements higher than usual according to LV 216-2

⇨ Ageing tests with bending diameter
1 x cable-Ø / 240 h @ +205 °C

Measurement Sequence

1. Bending Mandrel diameter 1 x d_{max}
2. Measurement insulation resistance @ +20 °C
3. Thermal ageing 240 h @ +205 °C
4. ***Measurement insulation resistance @ +205 °C***
   - after ageing time 24 h / 120 h / 240 h
5. ***Cooling down 16 h @ +20 °C***
6. ***Measurement insulation resistance @ +20 °C***
7. High-Voltage test
   - 30 minutes 1 kVolt a.c.
   - 5 minutes 5 kVolt a.c.
   - 10 minutes 10 kVolt a.c.
8. ***Rewind the HV-cable***
9. ***High-Voltage test***
   - 30 minutes 1 kVolt a.c.
   - 5 minutes 5 kVolt a.c.
   - 10 minutes 10 kVolt a.c.
10. Visual inspection

Investigation static bending radii
Installation space must be saved

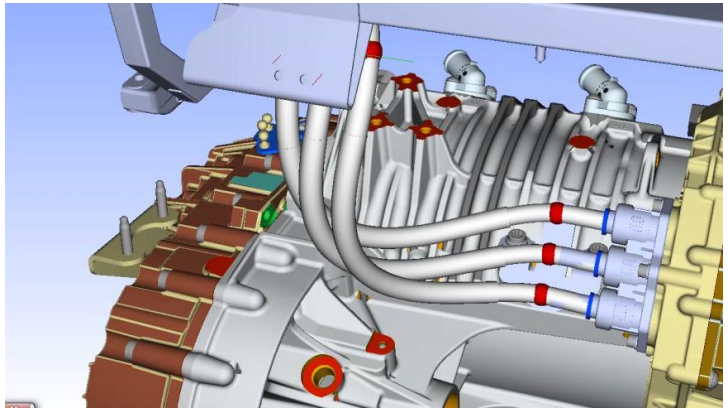
Insulation resistance

- Depending on the temperature
- Influence winding diameter not recognizable
- Influence conductor size not recognizable

High-Voltage Performance

- Requirement normative
  - 30 minutes 1 kVolt a.c.
  - 5 minutes 5 kVolt a.c.
- No defaults
- Requirement additional
  - 10 minutes 10 kVolt a.c.
- No defaults

OEM will create new requirements for testing of dynamic bending diameter

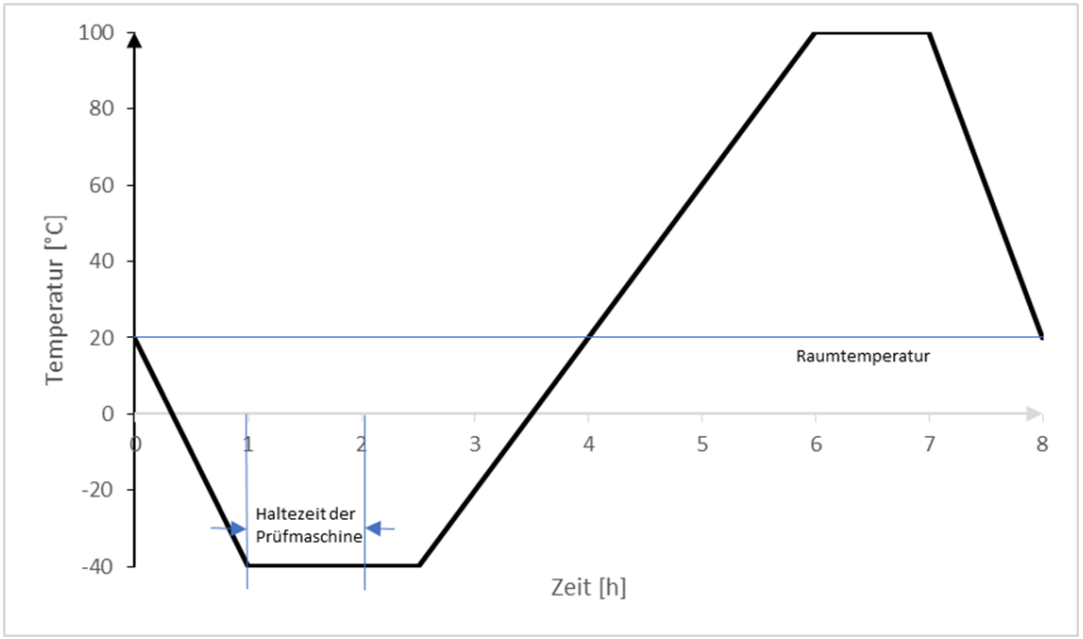


Mechanische Eigenschaften			***Mechanical properties***		
Biegeradius:			*Bend radius:*		
- min. 3 x Außen-Ø:	statische Verlegung		*- min. 3 x cable-Ø:*	*static installation*	
- min. 6 x Außen-Ø:	dynamische Verlegung		*- min. 6 x cable-Ø:*	*dynamic installation*	

LV 216-2 (9.6.7.4): **Definition and guideline of the bending radius for dynamic installation**

- the installation of the cable, including fasteners, will be performed on different movement levels
- relative movements between the different attachment points of the cable are allowed
- for the application in the vehicle, the minimum bending radius must be agreed with the specialist departments
- as a guideline Rmin = 6 x cable-Ø (maximum specified outer diameter of the cable)

Hydropulse testing based on VW PV 3589
Test requirements customized for High-Voltage Cables



Customized investigations already performed

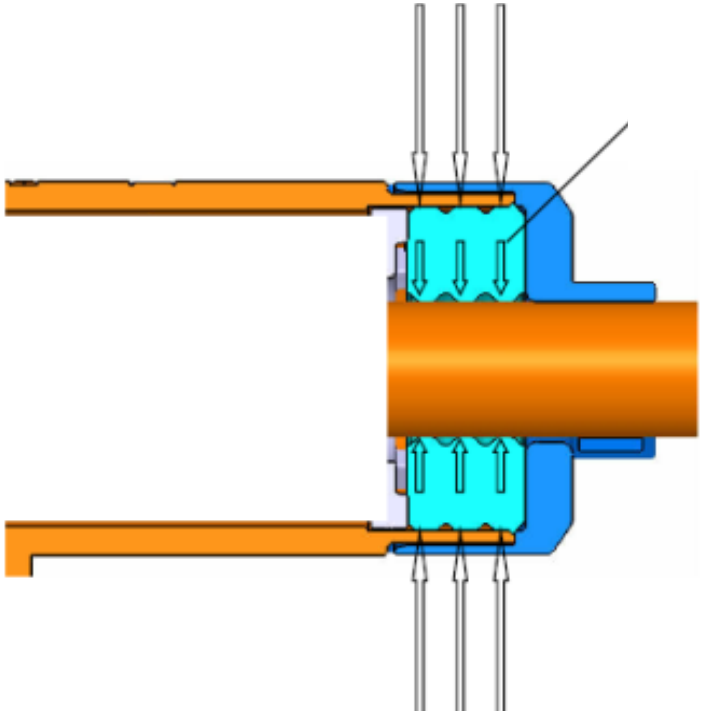
- 8 cycles of 8 h each at 9 Hz with amplitude of +/- 10 mm
  226.800 strokes / cycle

SAFETY OVER LIFE-TIME

Fuse protection sealing area HV cable / HV connector

Optimized sealing behavior to protect against moisture.

Applied forces through
housing / sealing element



Source: Kostal

Remaining deformation
approx. 10%
of original cable diameter
seems acceptable

Remaining cable deformation:

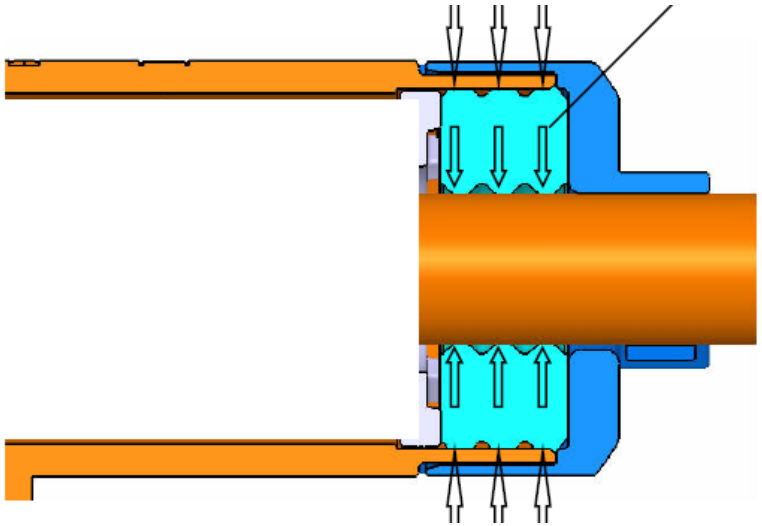
- influences the tightness of the plug contact
- an optimized compression set of the silicone material leads to better tightness:
  - ➢ Depends on silicone quality
- fuse protection by Coroflex addition cured Silicone compounds

The sealing behavior depends on insulation material qualities and robust manufacturing processes of the HV-cables

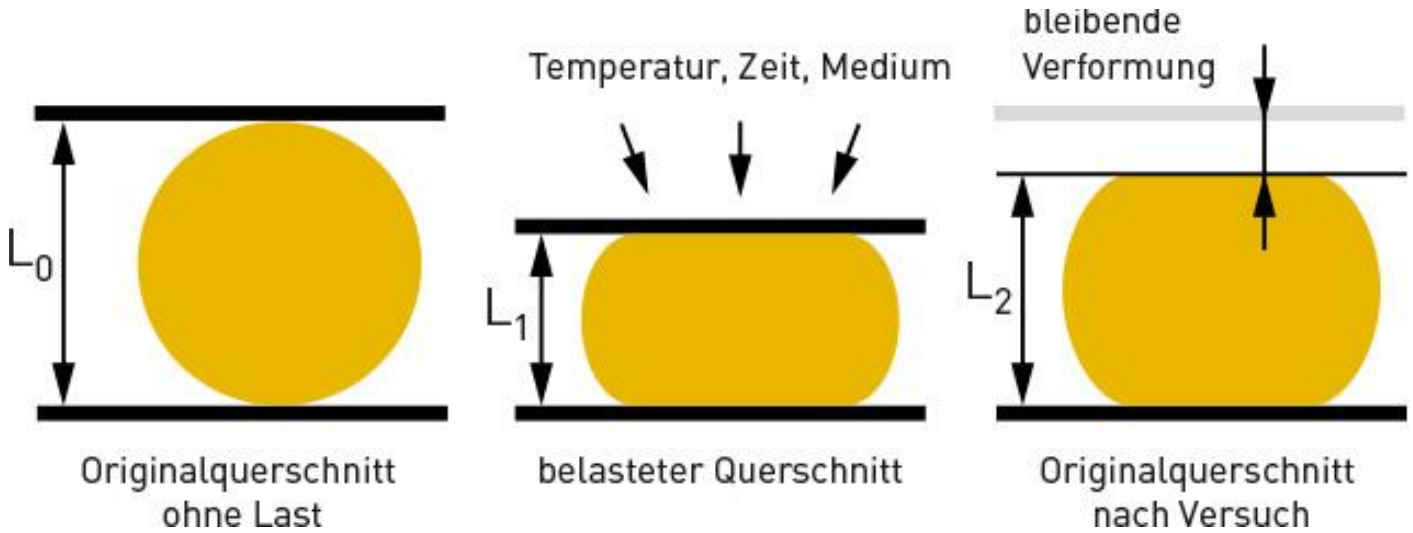
Designation	XPO HV Cable supplier A	XPO HV Cable supplier B	TPU HV Cable Coroflex prototype	Silicone HV-Cable Coroflex 9-2611
Surface Pressure	1.0 MPa for 4 h			
Operating / Testing Temperature	+ 150 °C	+ 150 °C	+ 150 °C	+ 180 °C
Penetration depth	approx. 25-30 %	approx. 85-95 %	approx. 45-50 %	approx. 8-10 %
Pics				

Source: Coroflex pretests

Investigation determination of compression set directly on High-Voltage Cables

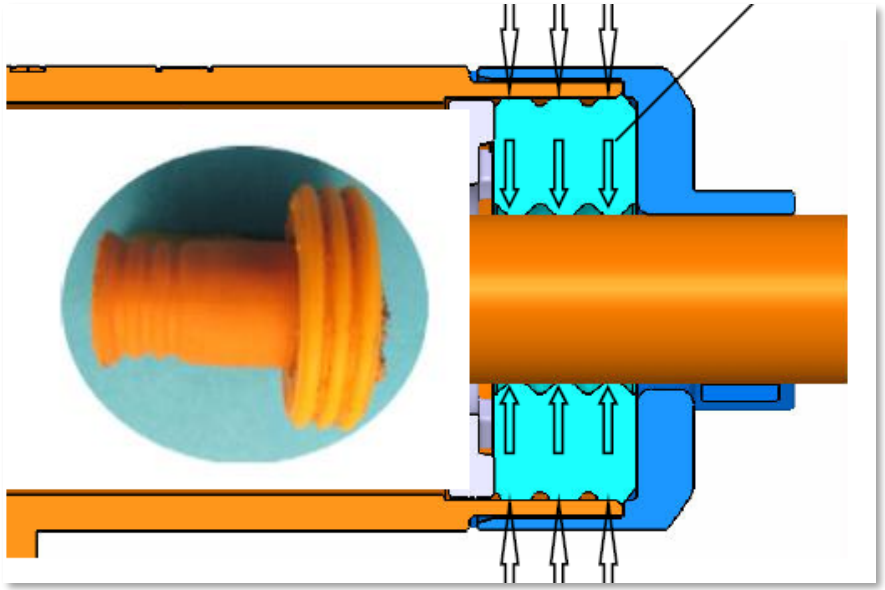


Source: Kostal



Source: https://www.tecnoseal.at/dichtungen/service/druckverformungsrest-dvr/

Investigation determination of compression set directly on High-Voltage Cables



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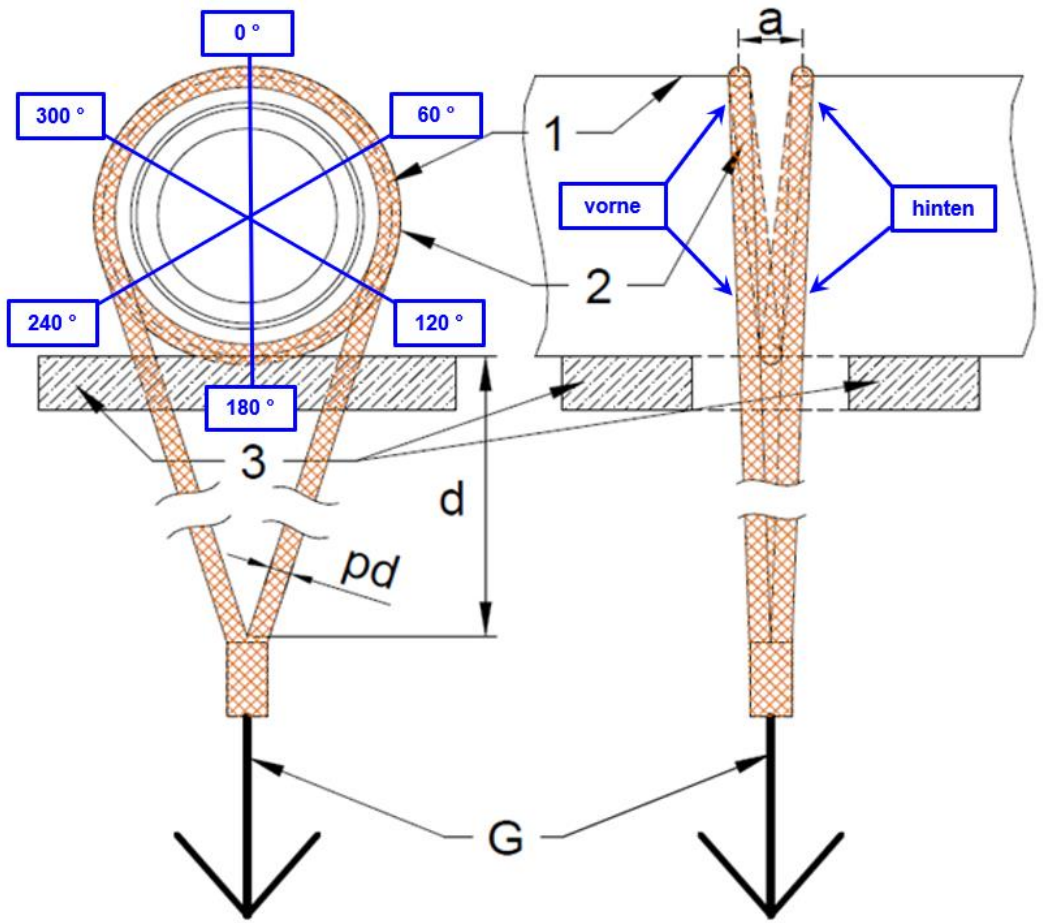
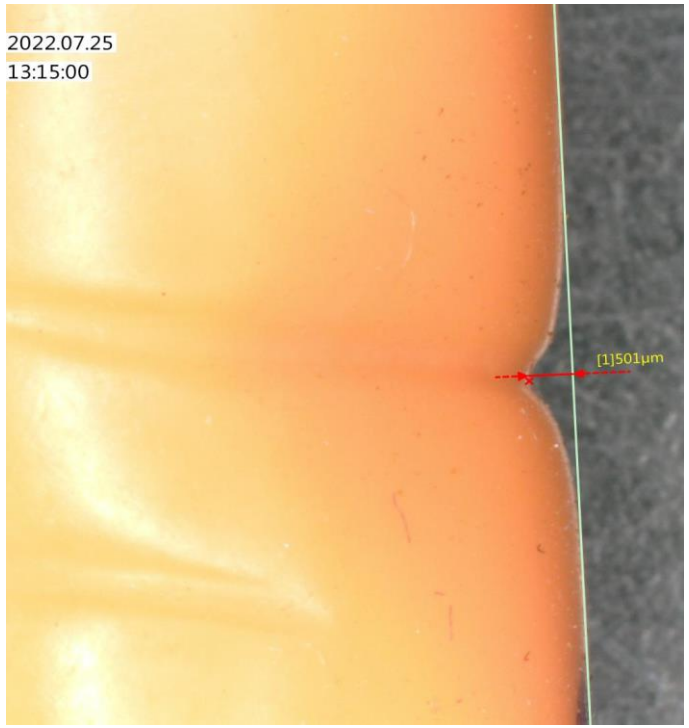


In preparation by Coroflex long-term measurements

- T180 Silicone High-Voltage Cables 1,000 h @ +180 °C
- T150 Silicone High-Voltage Cables 1,000 h @ +150 °C

Low slight residual plastic deformation due to relaxation of the insulation material

1. Measurement
after ageing 4 h @ T_O



2. Measurement
after 24 h @ RT

3. Measurement
after ageing 24 h @ T_O +25 °C

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Material Overview

Silicone has proven successfully and provides confidence

	SiR T180 & T150	XPO T150	XPE T150 & T125	PP HFFR T125	PVC T115
Bending radius depending on temperature rate	No influence of the temperature	Depending on cross link density	Depending on cross link density	Depending on melt point	Depending on melt point
Specific electrical insulations resistance	Tested at humidity, temperature, aging and bending radius	Influence of compound filling to humidity and aging	Influence of compound filling to humidity and aging	Influence of compound filling to humidity and aging	Influence of compound filling to humidity and aging
Bending radius and flexibility	High performance elongation values	Good elongation values	Developed for small LV FLR-cables	Developed for small LV FLR-cables	Compound softener
Sealing properties (Compression-Set)	Elastomer Quality Depending on humidity, temperature, aging	Thermoplastic content predominate in the compound	Thermoplastic content predominate in the compound	Thermoplastic material, depending on sealing method	Thermoplastic material, depending on sealing method

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& Test Laboratories

Wires & Cables

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