

TEST REPORT

1506-158

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NO FIRNO®

RESITITE®
technology

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**RADIAL AND AXIAL DISPLACEMENTS WITH
NOFIRNO® PIPE SEALING SYSTEM
VARYING SPEEDS AND DISPLACEMENTS**

SCOPE OF MECHANICAL TESTING

The NOFIRNO® sealing system for pipe transits has proven its excellent performance in shipbuilding, offshore and naval applications. The system has been tested for harshest applications, such as Jet Fires, Hydrocarbon Fires and also according to the regular FTP (marine) and EN1366-3:2009 (building industry) standards. The system has obtained EC (marine MED certificates) and CE (ETAG certification for the building industry).

Furthermore the NOFIRNO® sealing system has been exposed to severe mechanical testing, such as shock and vibration tests, static and dynamic pressure tests and long term pressure exposure.

The NOFIRNO® rubber grade is UV, Ozone, weathering and salt water resistance, does not age and maintains under normal conditions its flexibility over decades. The rubber has a very low stress relaxation and would even hold tight when compressed for more than two decades.

NOFIRNO® is worldwide the system of choice for numerous installations. Especially in environments with a high humidity and or water exposure, the system has proven its properties to prevent so-called CUI (corrosion underneath insulation), what stands for invisible corrosion inside pipe penetrations. Based on the layers of NOFIRNO® sealant at both sides of the conduit it is prevented that any moisture can enter the inside of the sealing system.

The system technology of the NOFIRNO® sealing system, developed by BEELE® Engineering, offers not only optimum ease of installation, but also a high degree of flexibility to absorb mechanical loads to prevent stress and fatigue to the construction.

The high performance with regard to fire and pressure exposure and the extended service life the system offers, has made the system very successful in shipbuilding, offshore and industrial installations. On a regular basis BEELE® Engineering is contacted for all kinds of special applications and solutions for encountered problems.

BEELE® Engineering has a certified laboratory in the R&D center, enabling to carry out all kinds of tests and investigations any time. The laboratory is equipped with state-of-the-art equipment. In this respect it makes not only the product line of the company unique, but offers also a technically based customer support. New products and technologies are developed continuously, offering the markets the highest quality and durability.

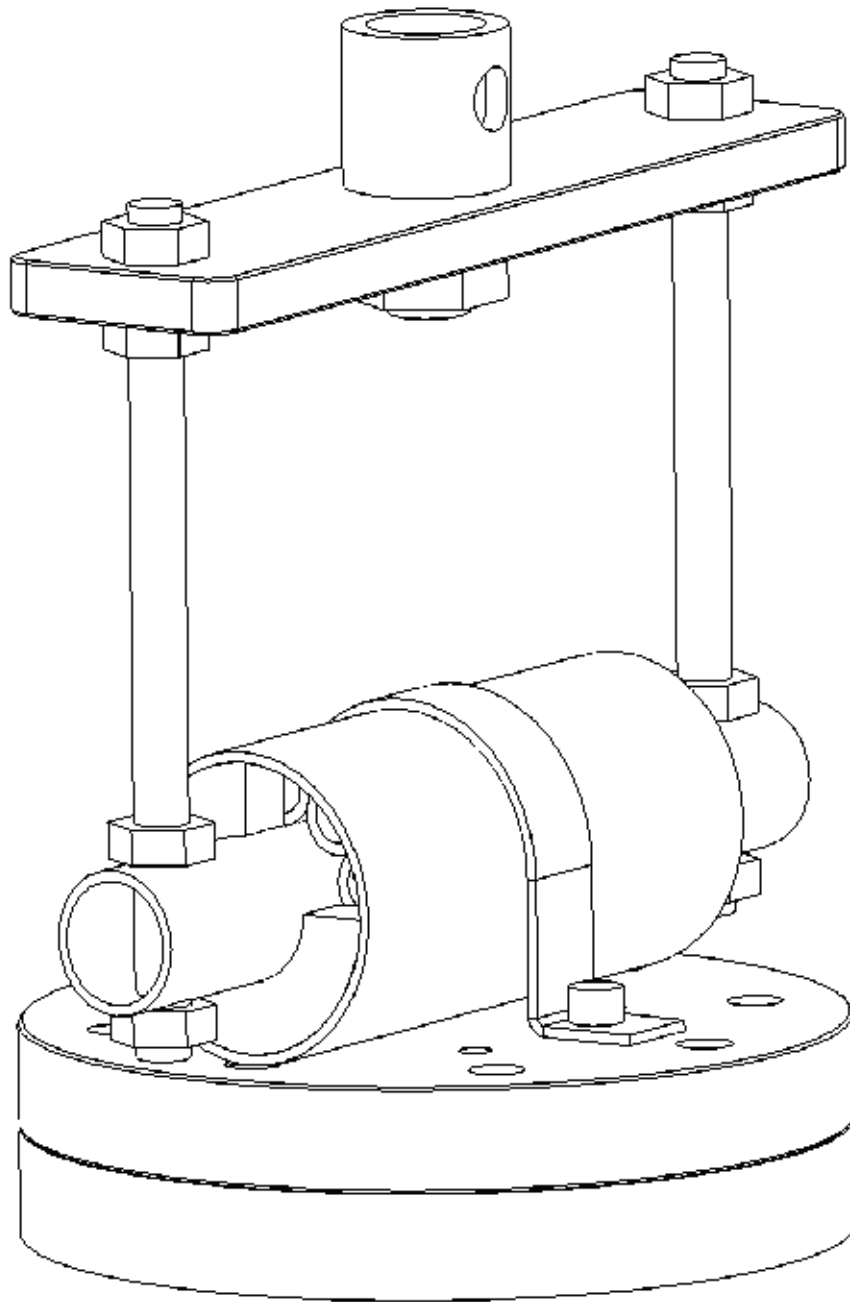
On request of the market place test program has been initiated to investigate the feasibilities of the NOFIRNO® system to cope with radial and axial movements. This with a view to instantaneous displacements, which can occur on underground ducting of pipes in shock sensitive areas, blast walls exposed to explosive forces, but also by normal operating forces as expansion and vibrations in pipe lines.

A series of initial test has been carried out in the R&D center of BEELE® Engineering with positive results. The testing has already delivered sufficient data for the design of NOFIRNO® sealing systems to be optimized for axial and radial movements and allowing to determine stiffness of penetrations in relationship with the field requirements.

Especially continuous exposure to radial movements is harsh since the rubber is exposed both to stretch and compression every cycle. Proof has been delivered meanwhile that the NOFIRNO® system can cope with this on longer duration. The system has been tested to extremes. It has been found that even after such exposures the system holds tight.

On the basis of the first series of testing optimum values have been determined. The next step in the investigations is find an optimum stiffness and to find a method for calculating forces. The preliminary investigations are listed in this test report.





Description: Test unit for radial displacements (cycles)

Mat.: NOFIRNO rubber sleeves and sealant

Ref.: DMM

Date:

12-06-15

Scale: 1 : 2

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Rev. 1

Rev. 2

T 0591



**TESTING UP TO THE
EXTREMES TO DETERMINE
OPTIMUM PERFORMANCE**

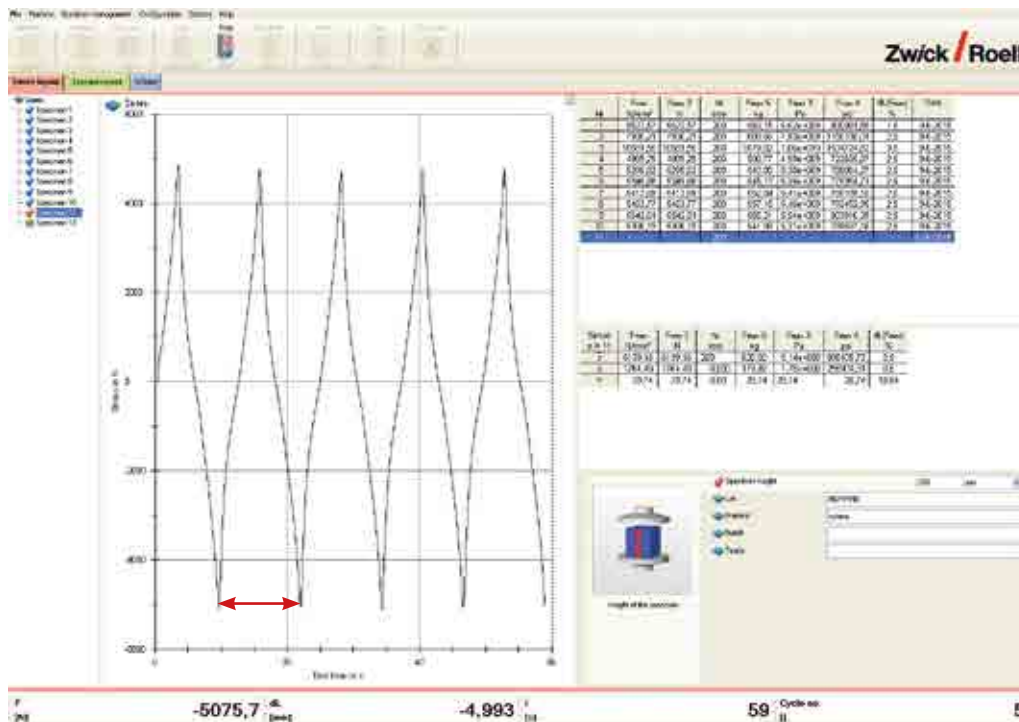
CONDUIT SLEEVE
DUCTED PIPE
LENGTH OF CONDUIT SLEEVE
CLEARANCE
AXIAL DISPLACEMENT
SPEED OF DISPLACEMENT
CYCLES
CYCLES

CYCLES

CYCLES

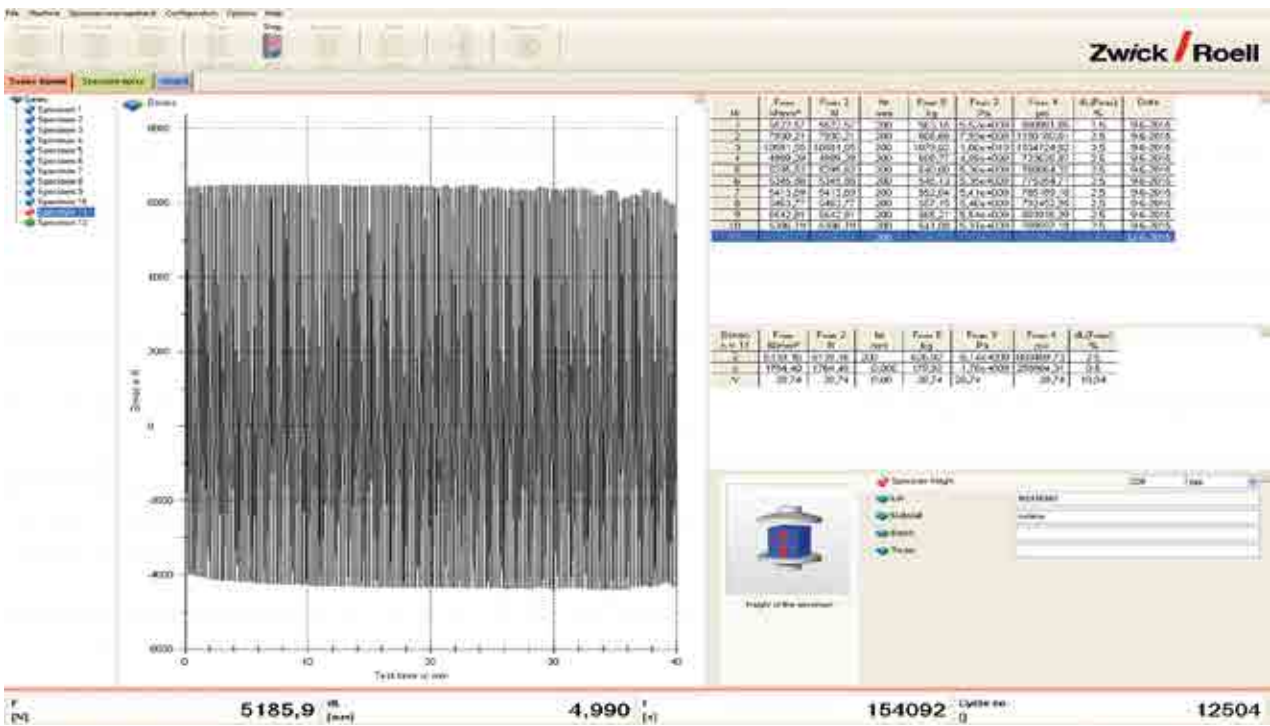
TOTAL

72 mm ID
42 mm OD
200 mm
15 mm
+/- 3, 5 and 7 mm
50 mm/minute
15 each displacement
50 each at speeds
100, 200, 300, 400
500 and 700 mm/minute
10.000 displacement 5 mm
speed 100 mm/minute
12.500 displacement 5 mm
100 mm/minute
22.845 cycles



FORCE UP
FORCE DOWN
ONE CYCLE \longleftrightarrow
DISPLACEMENT
LENGTH OF EACH CYCLE
SPEED OF DISPLACEMENT
DURATION ONE CYCLE -----

+ 5000 N
- 5000 N
FULL UP/FULL DOWN
+/- 5 mm
20 mm
100 mm/minute
12 seconds



FORCE UP

FORCE DOWN

ONE CYCLE \longleftrightarrow

DISPLACEMENT

LENGTH OF EACH CYCLE

SPEED OF DISPLACEMENT

DURATION ONE CYCLE

DURATION IN SECONDS

+ 5000 N

- 5000 N

FULL UP/FULL DOWN

+/- 5 mm

20 mm

100 mm/minute

12 seconds

12.504 = 154092 SEC

TOTAL EXPOSURE CYCLES

OF 345+10.000+12.500

22.845 CYCLES

= 274.140 SEC

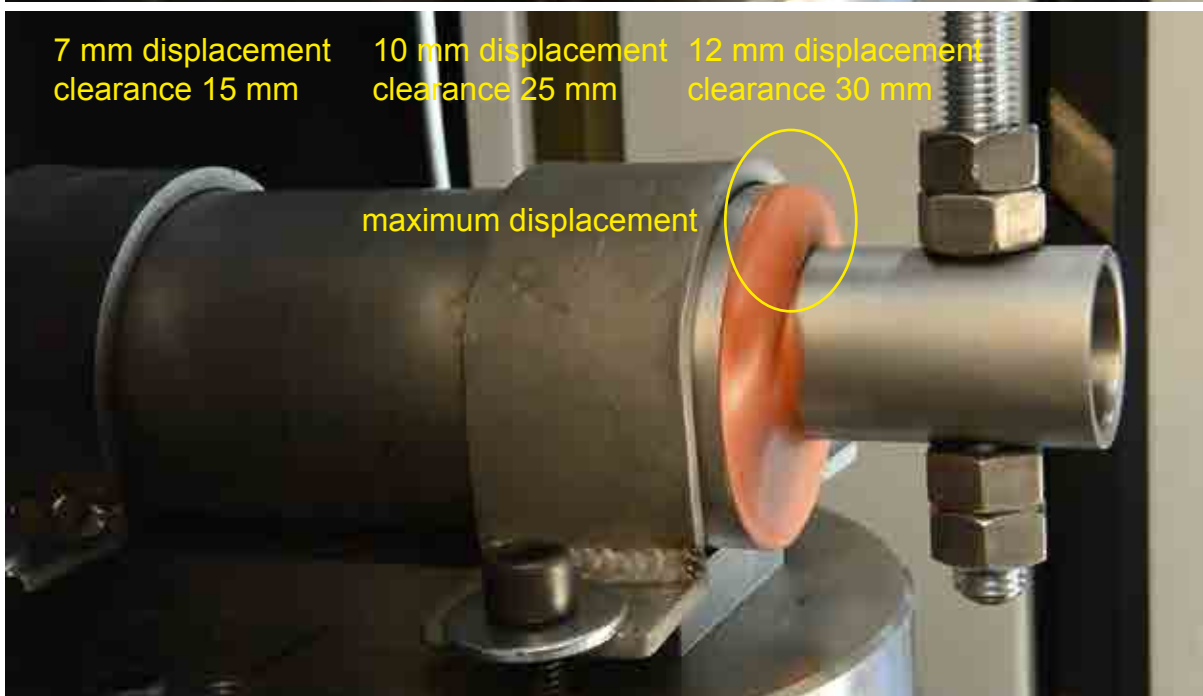
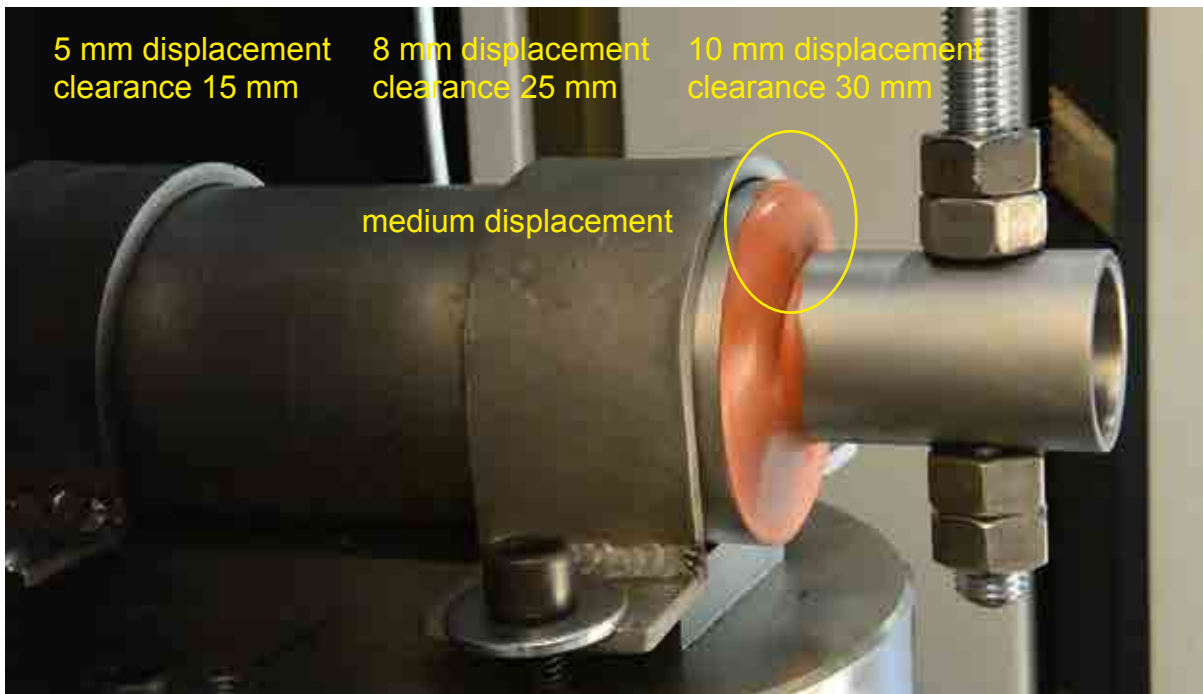
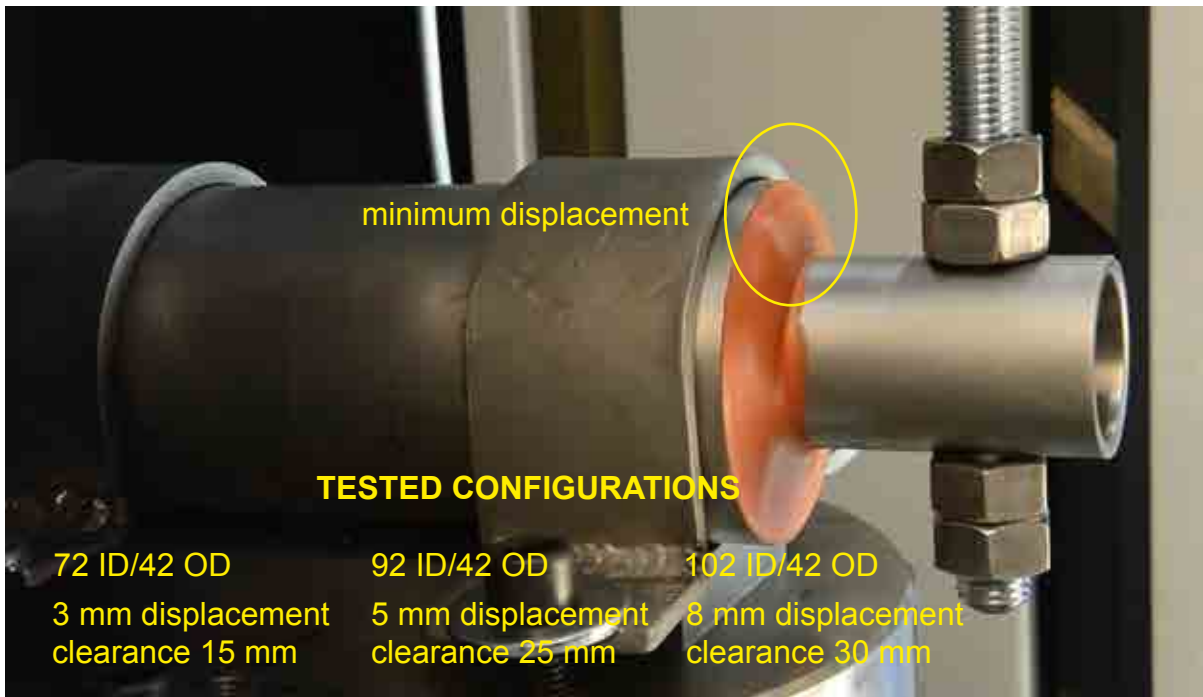
= 76 HOURS

TOTAL MOVEMENT

456,9 METER

NO DAMAGE TO THE SEALING SYSTEM; COMPRESSION/STRETCH FORCES SIMILAR DURING TEST DURATION.

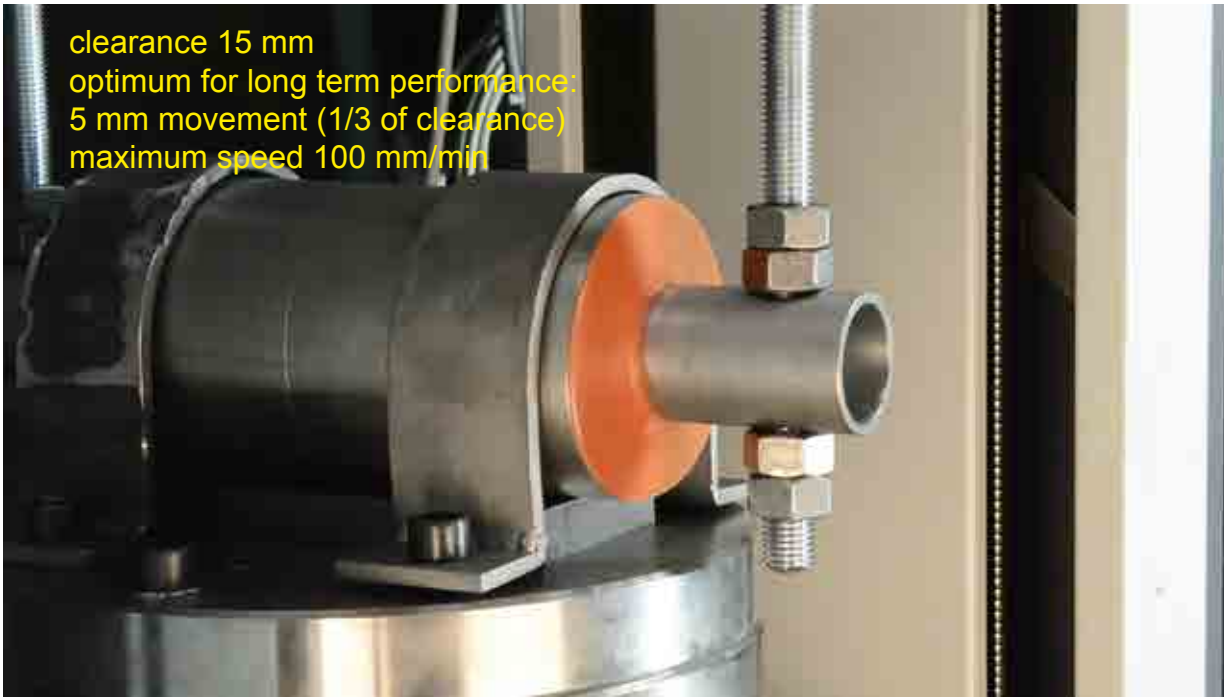
SOME FATIGUE OF THE SEALANT LAYER OCCURS AFTER 25.000 CYCLES EXPOSURE, DUE TO THE CHOSEN SPEED AND THE COMBINATION OF CONTINUOUS STRETCH AND COMPRESSION.



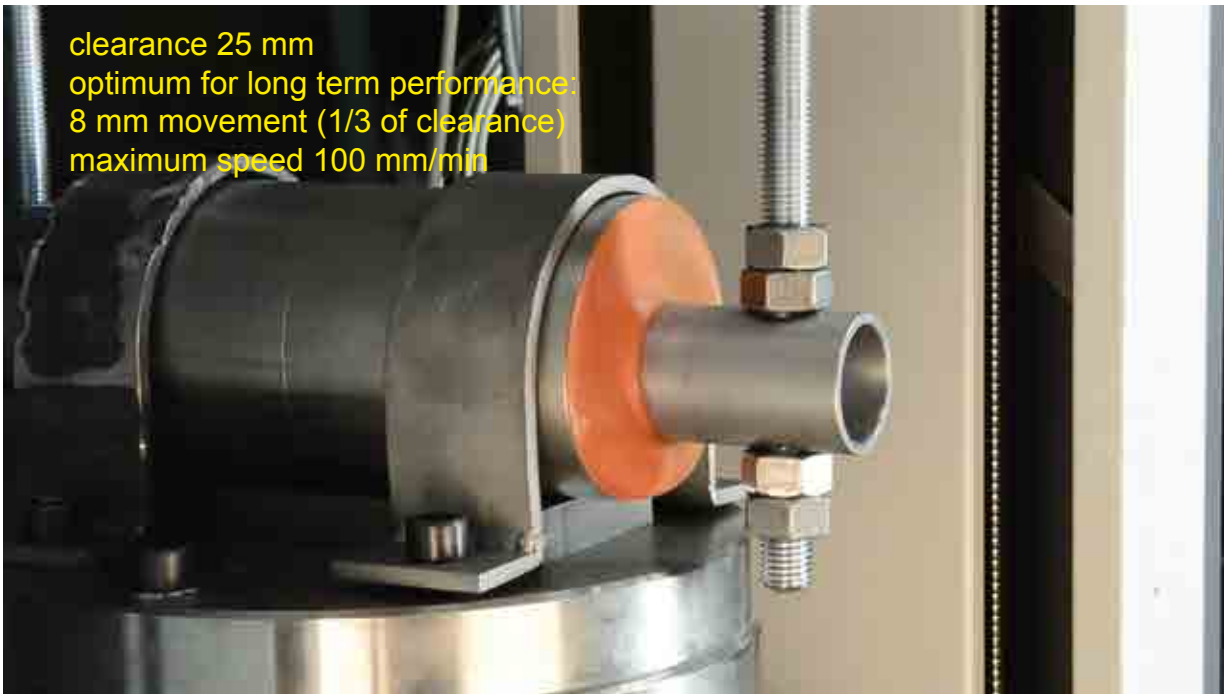


CONDUIT SLEEVE	92 mm ID
DUCTED PIPE	42 mm OD
LENGTH OF CONDUIT SLEEVE	200 mm
CLEARANCE	25 mm
DISPLACEMENTS	+/- 3, 5 and 7 mm
SPEEDS OF DISPLACEMENT	50, 100, 200, 300, 400, 500 and 700 mm/minute
TOTAL AMOUNT OF CYCLES	345
POST WATER TIGHTNESS	25 bar

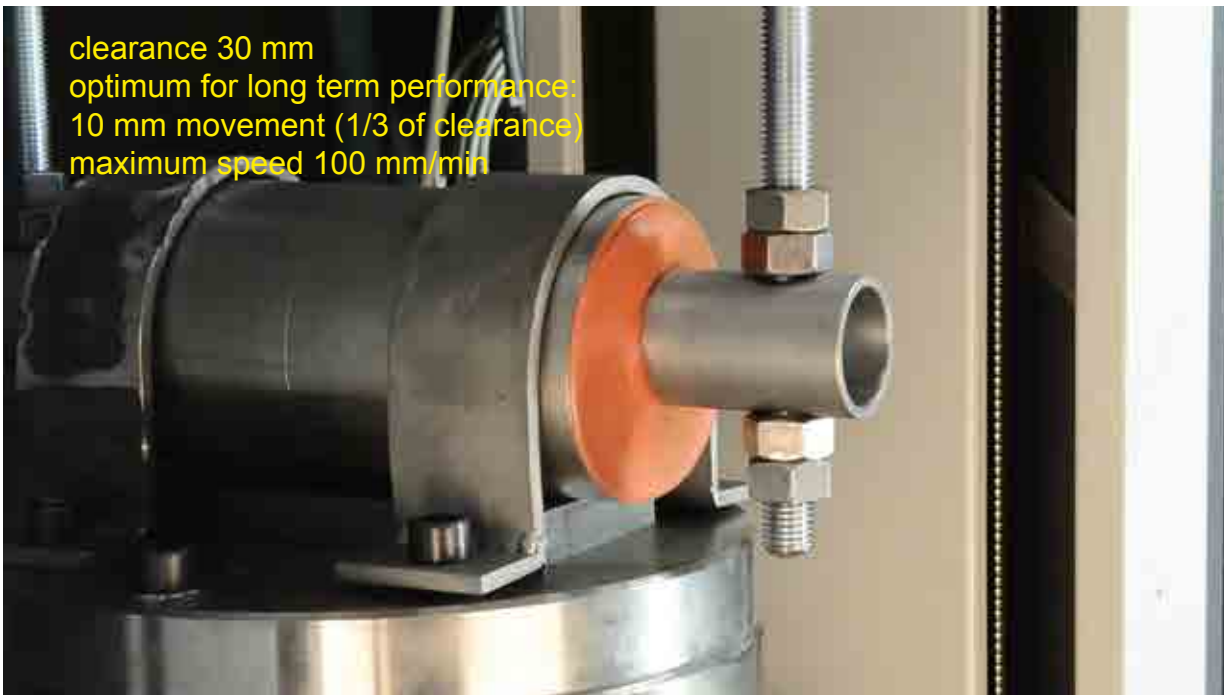
clearance 15 mm
optimum for long term performance:
5 mm movement (1/3 of clearance)
maximum speed 100 mm/min

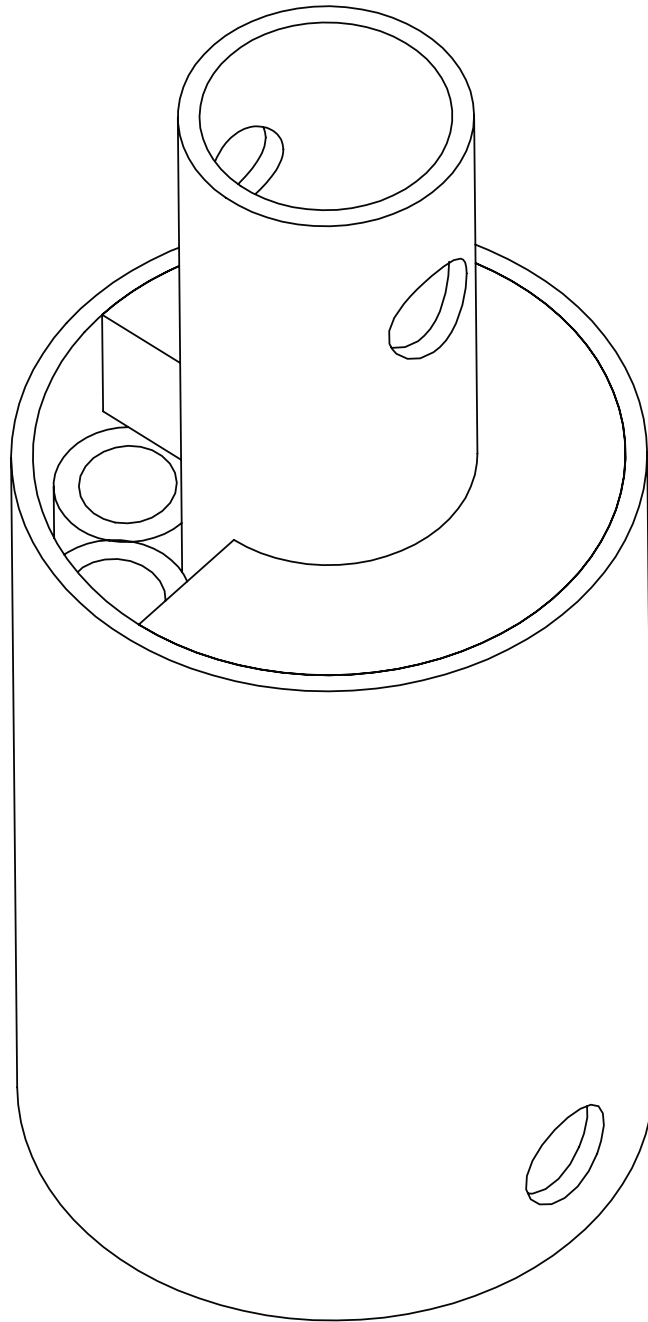


clearance 25 mm
optimum for long term performance:
8 mm movement (1/3 of clearance)
maximum speed 100 mm/min



clearance 30 mm
optimum for long term performance:
10 mm movement (1/3 of clearance)
maximum speed 100 mm/min





Description: Test unit for axial displacements (cycles)

Mat.: NOFIRNO rubber sleeves and sealant

Ref.: DMM

Date:

12-06-15

Scale: 1 : 1

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Rev. 1

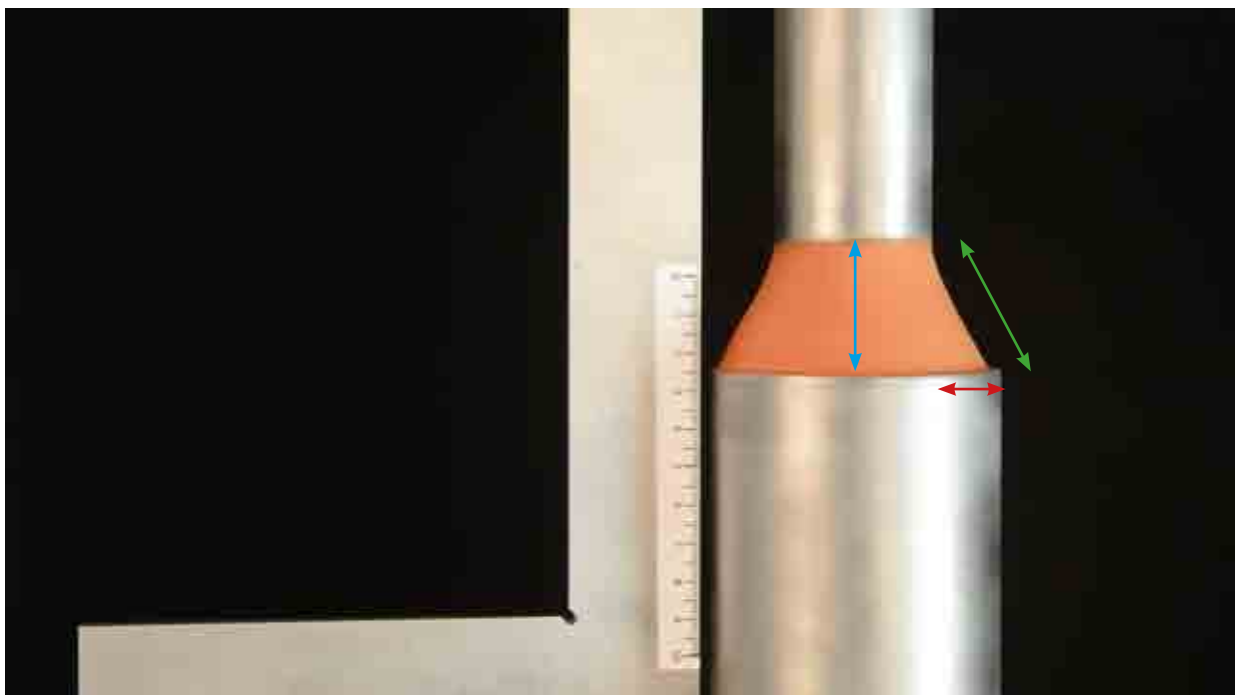
Rev. 2

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**TESTING UP TO THE
EXTREMES TO
DETERMINE OPTIMUM
PERFORMANCE**



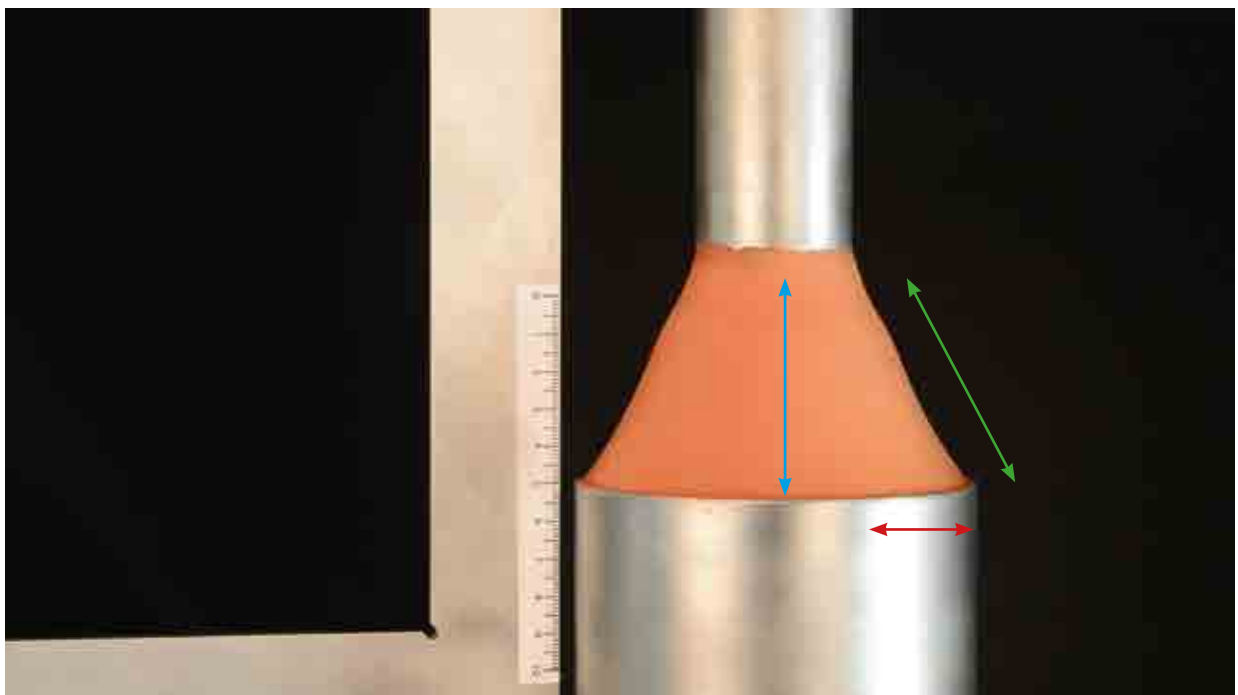
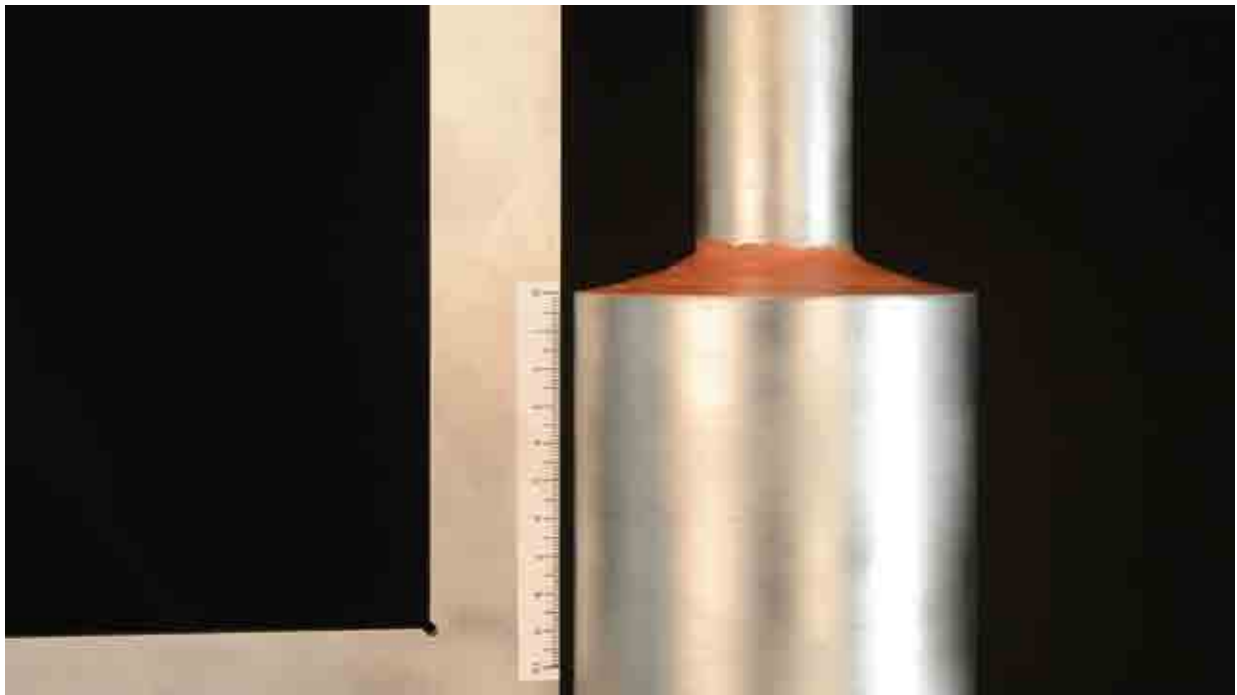
CONDUIT SLEEVE	72 mm ID
DUCTED PIPE	42 mm OD
LENGTH OF CONDUIT SLEEVE	100 mm
CLEARANCE	15 mm
STRETCH	195%
DISPLACEMENT	25 mm
STRETCH LENGTH	29.15 mm
SPEED OF DISPLACEMENT	50, 100, 200, 400, 600 and 750 mm/minutes
TOTAL AMOUNT OF CYCLES	100 (50 at 750 mm/min)



CONDUIT SLEEVE	92 mm ID
DUCTED PIPE	42 mm OD
LENGTH OF CONDUIT SLEEVE	100 mm
CLEARANCE	25 mm
STRETCH	195%
DISPLACEMENT	42 mm
STRETCH LENGTH	48.9 mm
SPEED OF DISPLACEMENT	50, 100, 200, 400, 600 and 750 mm/minutes
TOTAL AMOUNT OF CYCLES	100 (50 at 750 mm/min)



CONDUIT SLEEVE	102 mm ID
DUCTED PIPE	42 mm OD
LENGTH OF CONDUIT SLEEVE	100 mm
CLEARANCE	30 mm
STRETCH	195%
DISPLACEMENT	50 mm
STRETCH LENGTH	58.3 mm
SPEED OF DISPLACEMENT	50, 100, 200, 400, 600 and 750 mm/minutes
TOTAL AMOUNT OF CYCLES	100 (50 at 750 mm/min)



TESTING UP TO THE EXTREMES TO DETERMINE OPTIMUM PERFORMANCE

CONDUIT SLEEVE
DUCTED PIPE
LENGTH OF CONDUIT SLEEVE
PRESSURE TESTED

149 mm ID
88,9 mm OD
180 mm
4.5 bar

CONDUIT SLEEVE
DUCTED PIPE
LENGTH OF CONDUIT SLEEVE
PRESSURE TESTED

81,7 mm ID
34 mm OD
180 mm
4.5 bar

CONDUIT SLEEVE
5 DUCTED PIPES
LENGTH OF CONDUIT SLEEVE
PRESSURE TESTED

81,7 mm ID
16 mm OD
180 mm
4.5 bar

ALL UNITS:
CONTINUOUS EXPOSURE 2.5 bar 3 months

