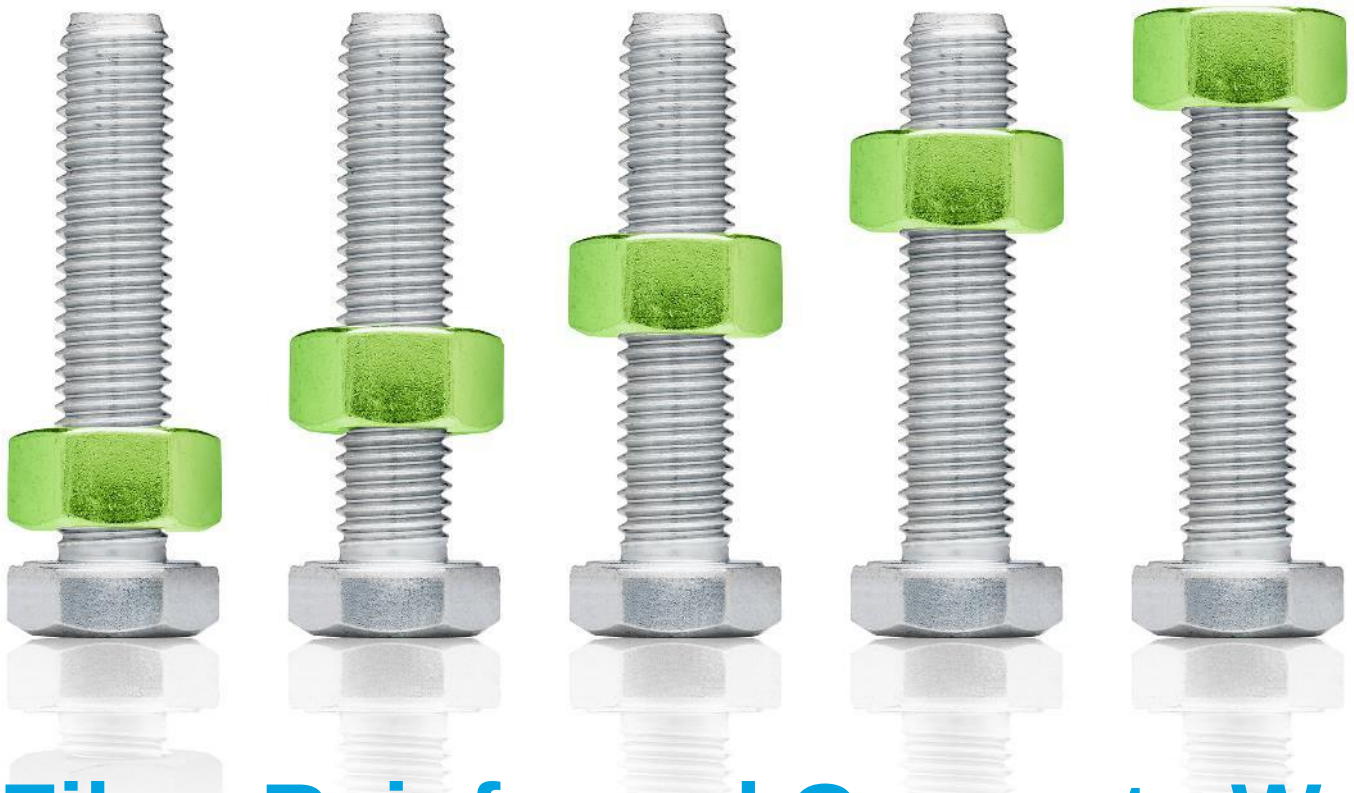


OPTIMAS
Efficiency Up

Fiber Reinforced Concrete Workshop

Connection and Accessories for Segments

27.05.2025 – Christophe Delus

Agenda

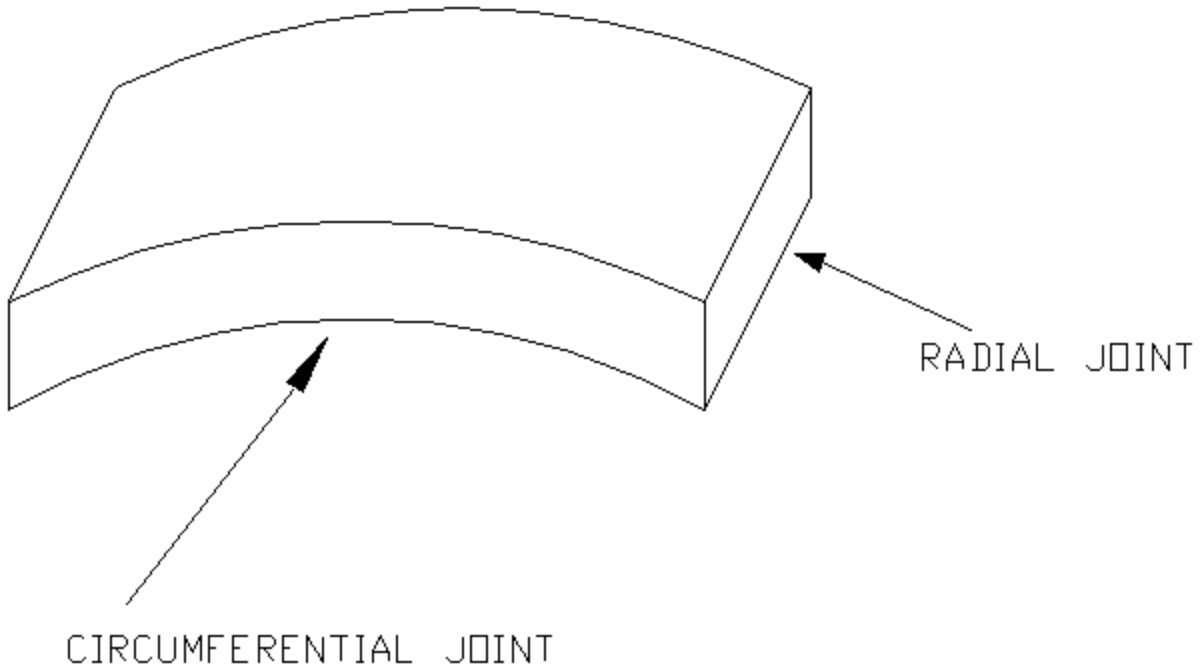
Role and Evolution of the connectors

Current State of the Art Solutions

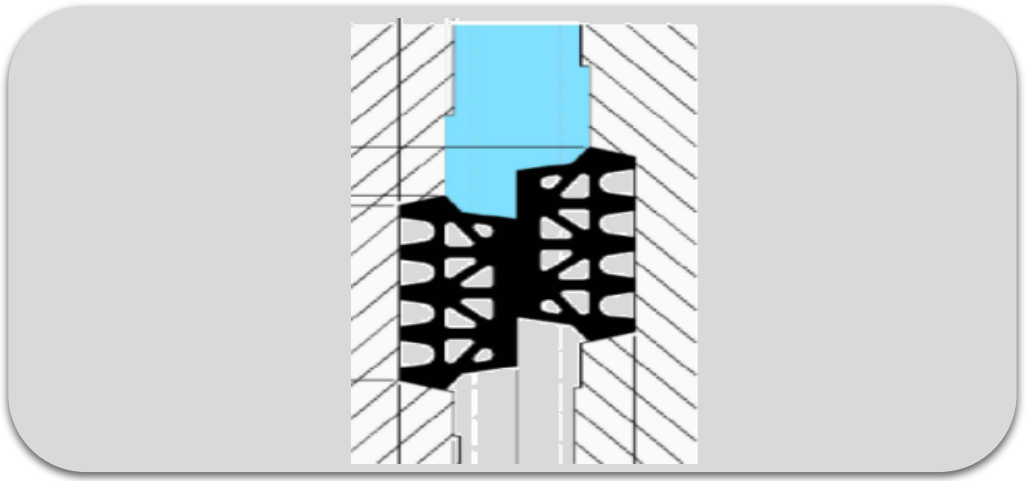
- Dowels
- Bolting systems
- Guiding rods
- Bicones / Shear cones

Grout-Lift sockets

Role and Evolution of the connector



Role and Evolution of the connector

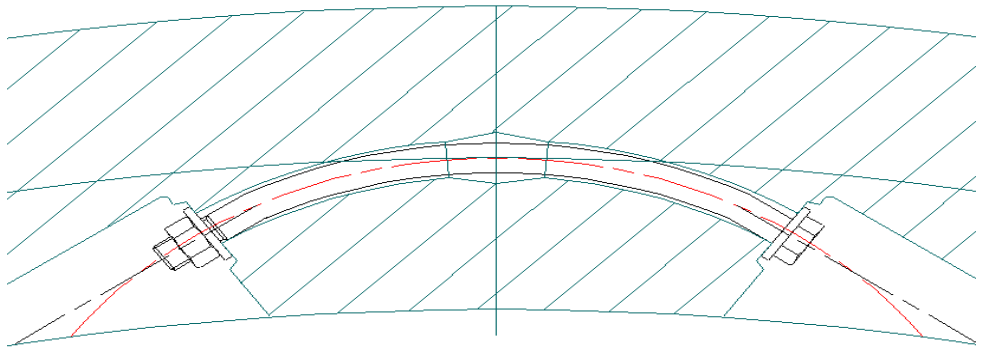


- Compression of the gasket

Role and Evolution of the connector

CURVED BOLTS

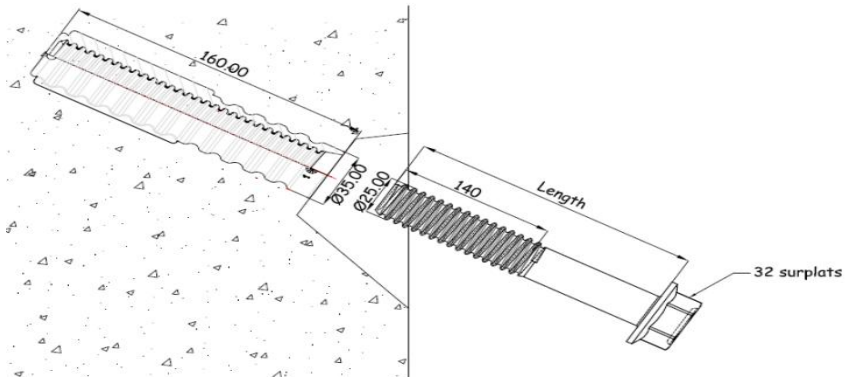
- ✓ Watertighness
- ✓ Gasket compression
- ✗ No stress or torque control



Role and Evolution of the connector

STRAIGHT BOLTS + SOCKETS

- ✓ Watertighness
- ✓ Gaskets compression
- ✓ Stress and torque control



Role and Evolution of the connector

TORQUE DEFINITION

(Norm NF E25-030 - French Standard)

$T = F(0.16\,P + \mu\,(0.583\,D2 + rm))$

T: Torque applied

F: Tensile force exerted by the bolting system

P: Pitch of the bolt thread

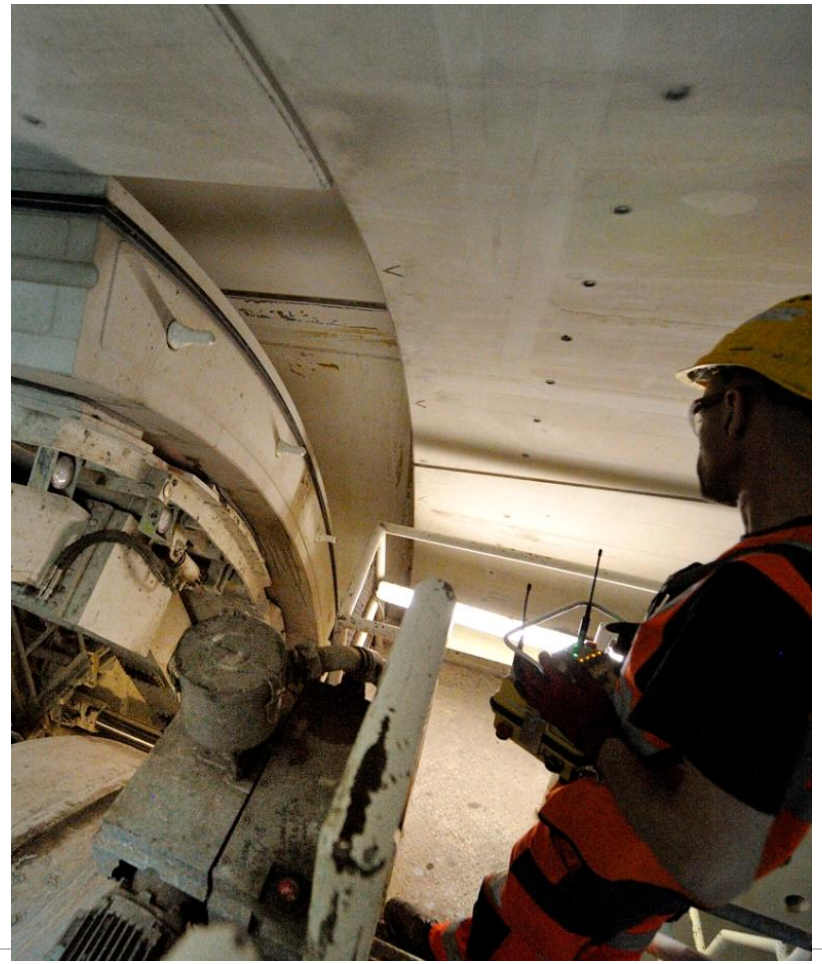
μ: Mean friction coefficient (under the bolt head and in the bolt thread)

D2: Diameter on the flank thread

rm: Mean radius of the bearing surface under the bolt head

OPTIMAS

Role and Evolution of the connector



- Compression of the gasket
- Alignment of the segment

Current State of the Art Solutions

Dowel systems

Dowel systems evolved a lot from the early stage, from wooden dowels to plastic friction dowels first.

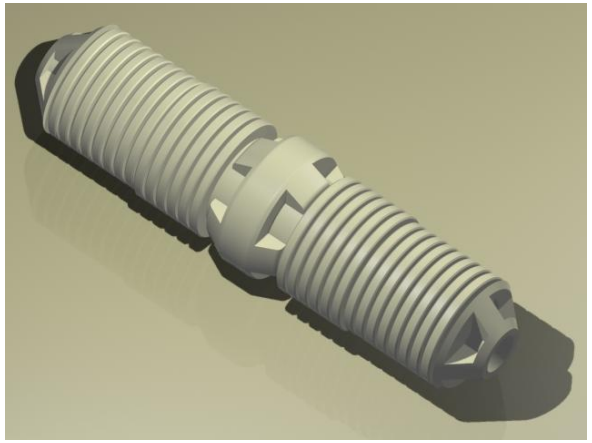
The dowels were mainly used on utility tunnels at this time.

Recently, the mechanical performances of dowel systems have allowed the usage for larger diameter projects.

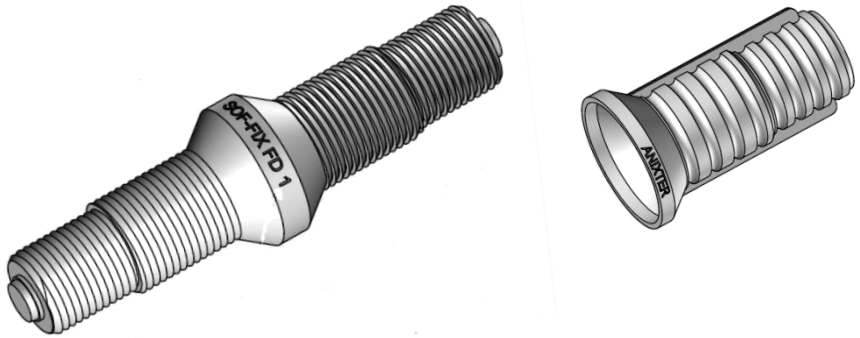
Current State of the Art Solutions

Initial dowel systems

SOF.CLIP



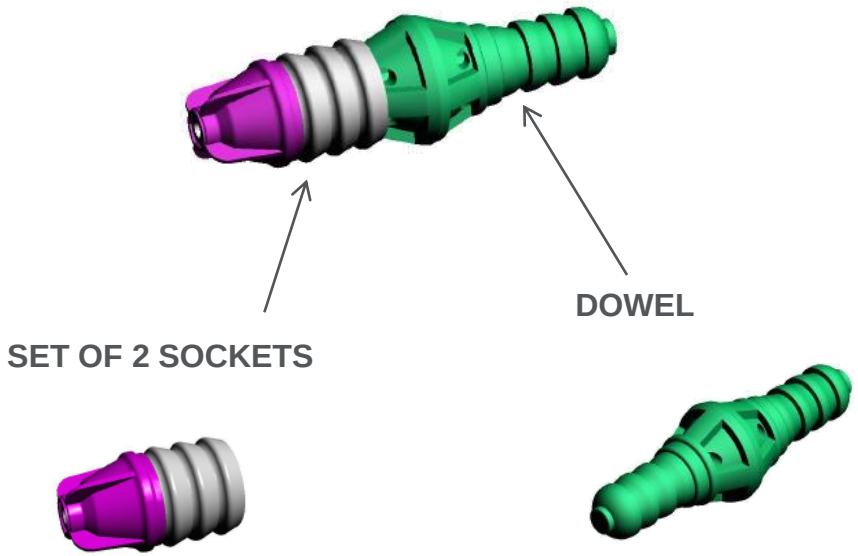
SOF.FIX.FD



SOF.FIX.ZUB

Current State of the Art Solutions

SOF-FIX dowel system

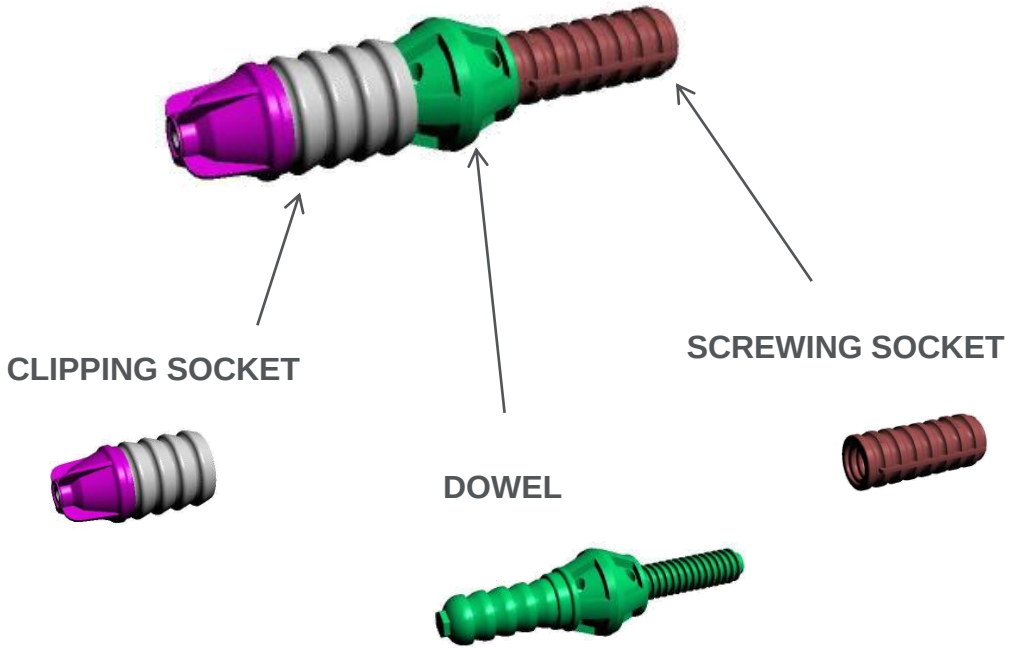


TYPE	Yield Pull-out Resistance	Ultimate Pull-out Resistance	Shear Resistance
SOF.FIX.60	60 kN	90 kN	160 kN
SOF.FIX.80	80 kN	120 kN	160 kN
SOF.FIX.110	110 kN	140 kN	160 kN

OPTIMAS

Current State of the Art Solutions

SOF-FAST dowel system



TYPE	Yield Pull-out Resistance	Ultimate Pull-out Resistance	Shear Resistance
SOF.FAST.60	60 kN	90 kN	160 kN
SOF.FAST.80	80 kN	120 kN	160 kN
SOF.FAST.110	110 kN	140 kN	160 kN

OPTIMAS

Current State of the Art Solutions

SOF-FAST dowel system

Benefits

Better Ergonomy by screwing the dowel with a screwdriver	Lower elongation under pull-out sollicitation	Reduction of the installation tolerance	Economic benefit	Compatible with packers implementation
				

OPTIMAS

Current State of the Art Solutions

SOF-FIX FAST dowel system

VERSIONS

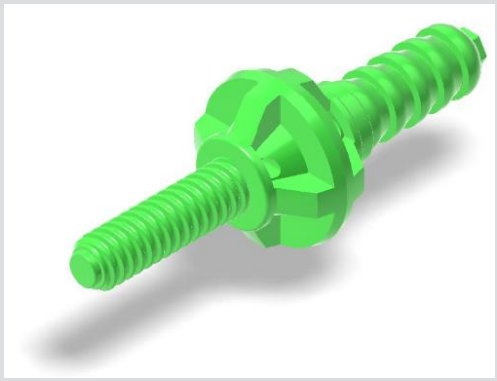
Bicone Ø version

Ø59

Ø68 (standard)

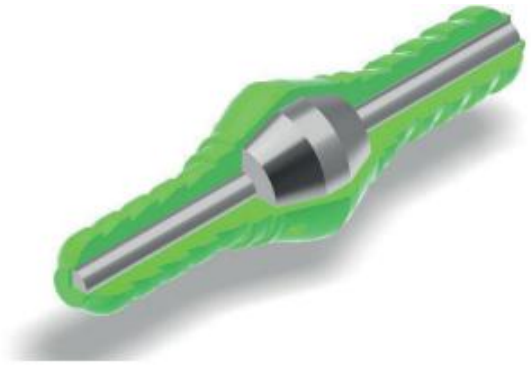
Ø76

Ø88



Dowel TP

Dowel HSR



Current State of the Art Solutions

SOF-FIX / FAST dowel systems OPTIONS

Removable dowel

USE : - for temporary segments (in belt e.g.)

No Pull-out resistance but good Alignment of the segments

Dowel for Rolling compensation

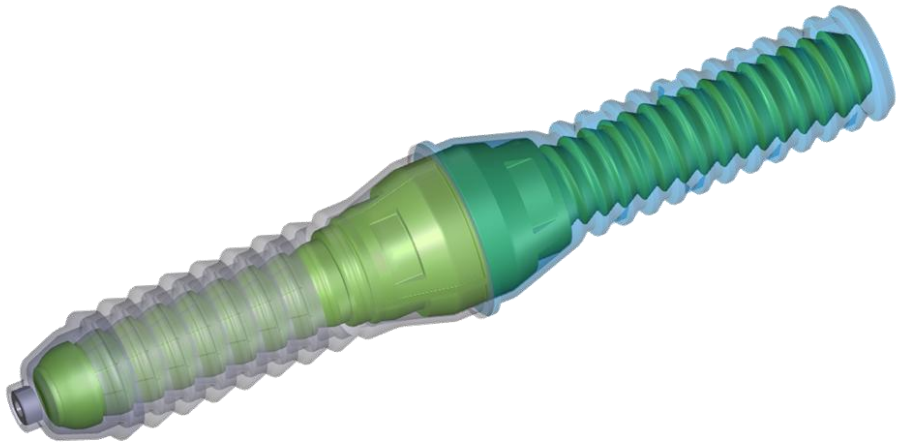
USE : - for a calibration of the ring after rolling

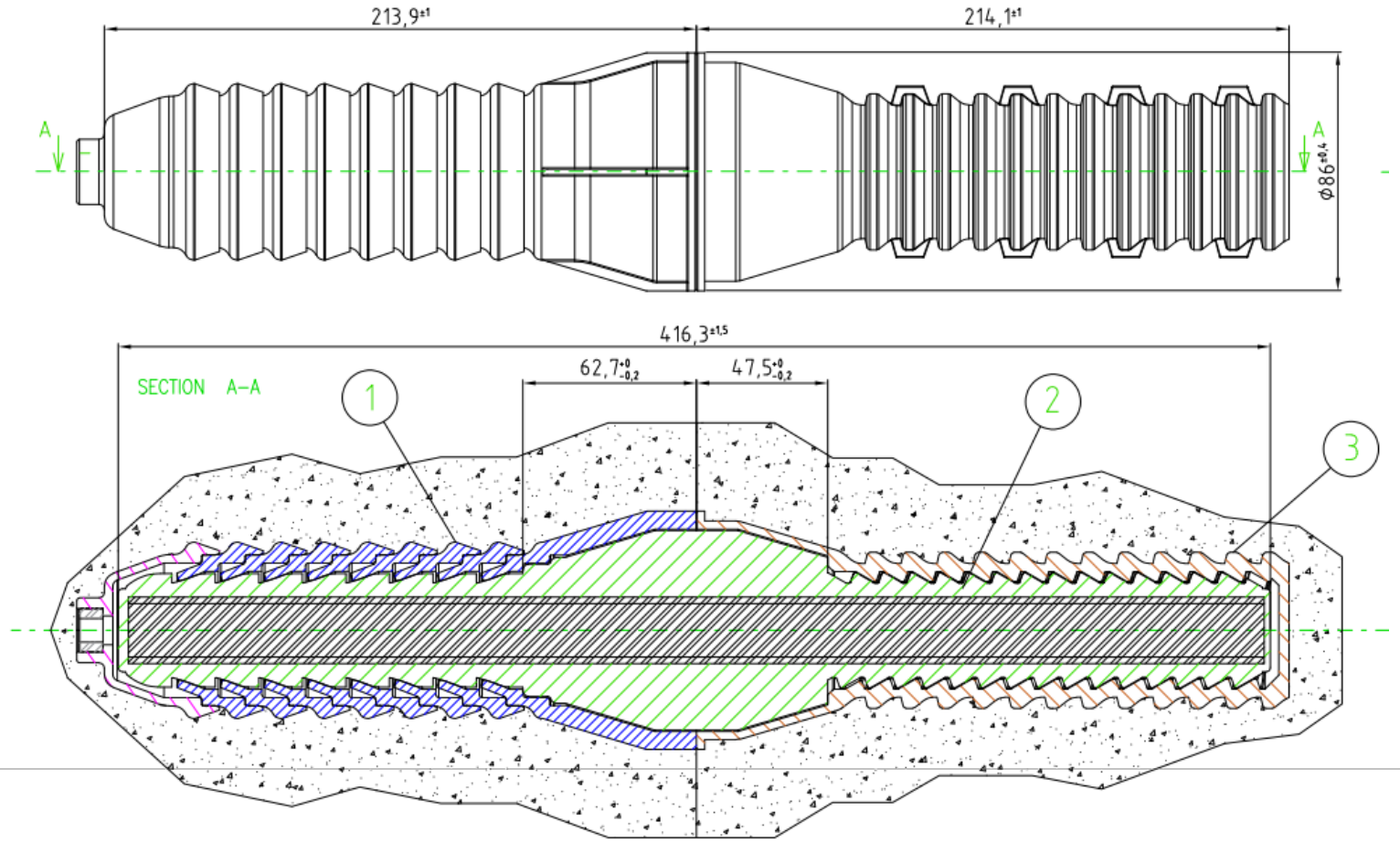
Half dowel

USE : - to link the segment to a steel frame (1st ring e.g.) :
the M16 steel insert can be used with an M16 nut and washer

Current State of the Art Solutions

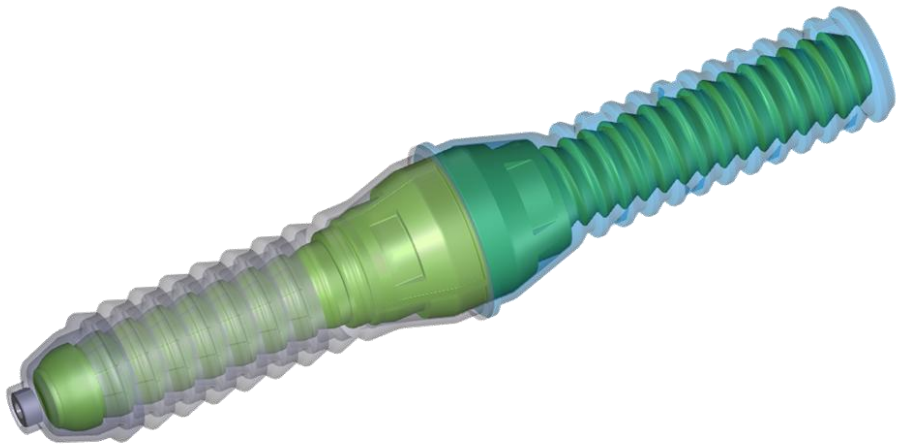
SOF-FAST 200 - 250





Current State of the Art Solutions

SOF-FAST 200 - 250

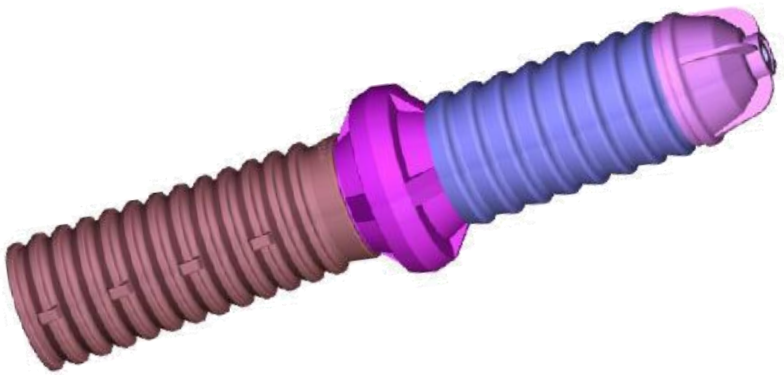


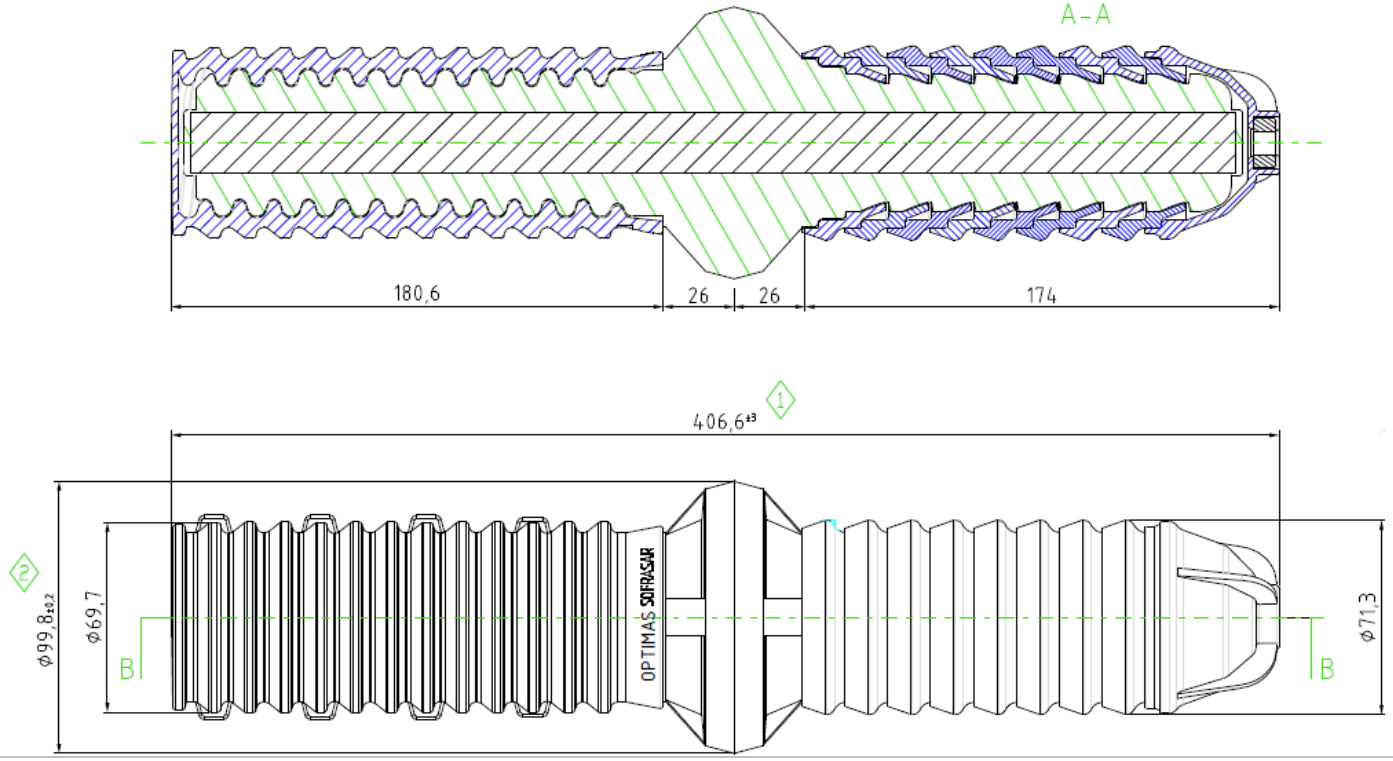
TYPE	Steel Insert	Yield Pull-out Resistance	Ultimate Pull-out Resistance	Shear Resistance
SOF.FAST 200	M24 Grade 8.8	200 kN	230 kN	250 kN
SOF.FAST 250	M27 Grade 8.8	250 kN	280 kN	250 kN

Resistance defined by FEA ran in January 2023

Current State of the Art Solutions

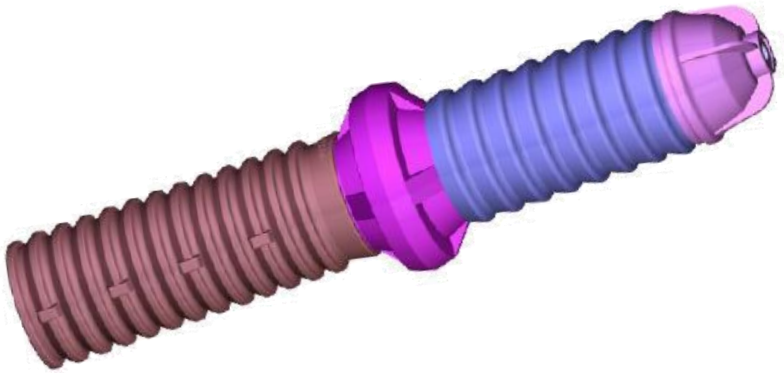
SOF-FAST 300





Current State of the Art Solutions

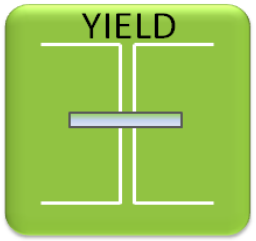
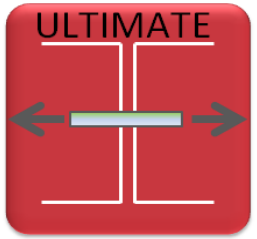
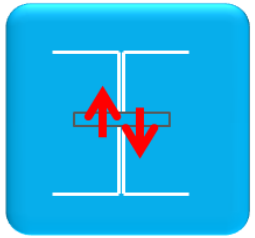
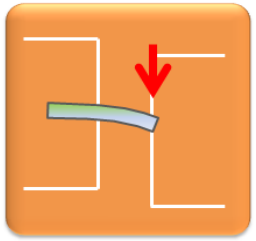
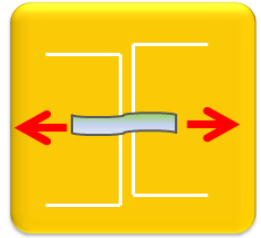
SOF-FAST 300



TYPE	Steel Insert	Yield Pull-out Resistance	Ultimate Pull-out Resistance	Shear Resistance
SOF.FAST 300	M27 Grade 8.8	300 kN	320 kN	380 kN

Current State of the Art Solutions

FEATURES

	 Pull-out YIELD	 Pull-out ULTIMATE	 Shear ULTIMATE	 Pull-out AFTER BENDING (45mm)	 Pull-out AFTER STAY IN CHARGE (30 min)	 Pull-out WITH OFFSET (8mm)
SOF.FIX	✓	✓	✓	✓	✓	✓
SOF.FAST	✓	✓	✓	✓	✓	✓
SOF.FIX.ZUB	✗	✓	✓	✗	✗	✗
SOF.FIX.FD	✗	✓	✓	✓	✗	✗

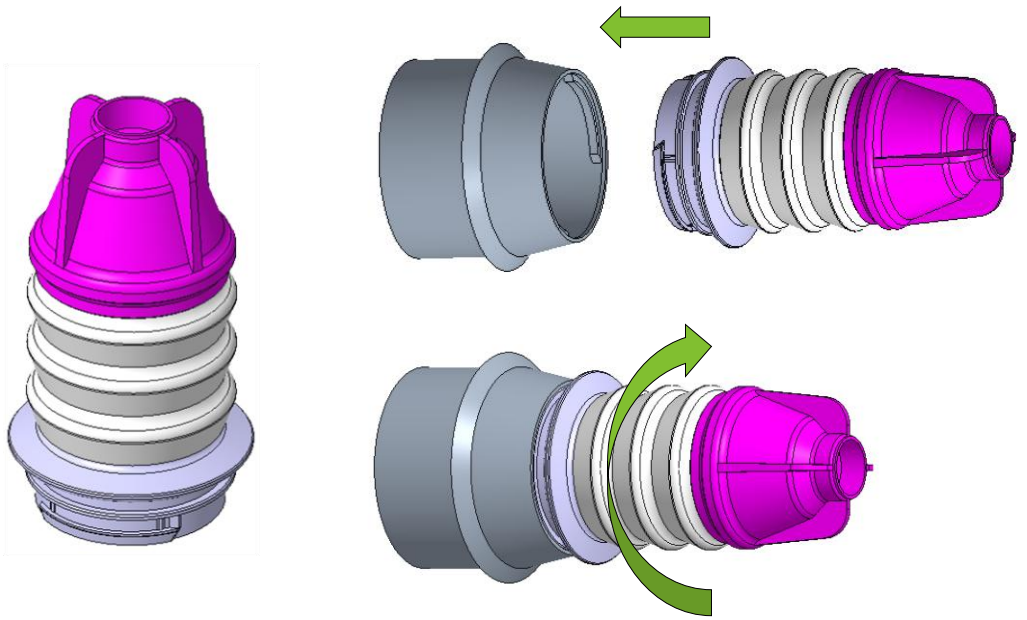
OPTIMAS

Current State of the Art Solutions

OPTIFIX

PREVIOUS SYSTEM

OPTIFIX SYSTEM



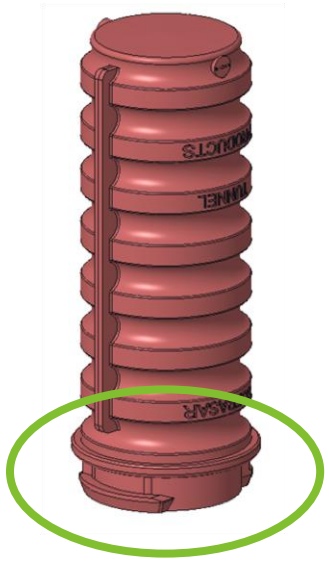
Current State of the Art Solutions

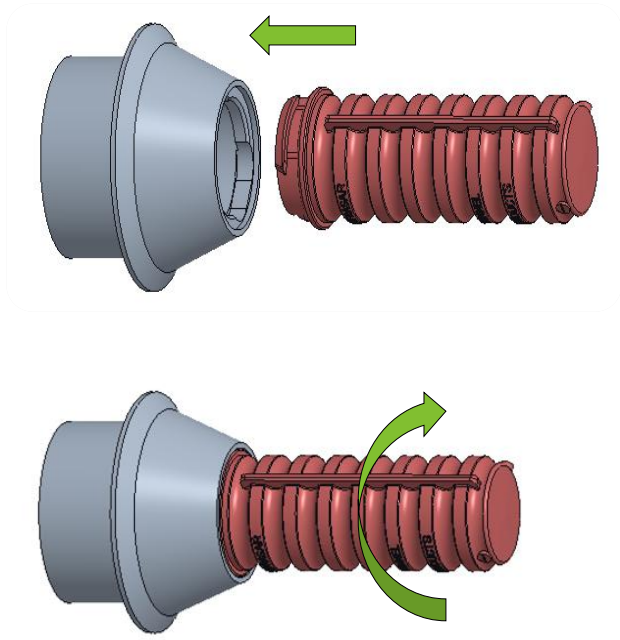
OPTIFIX

PREVIOUS SYSTEM

SOCKET T28x100

OPTIFIX SYSTEM





Current State of the Art Solutions

Bolting systems

Bolting systems evolved in their design and material.

The first solutions were from the railway industry, for the fixation of the sleepers.

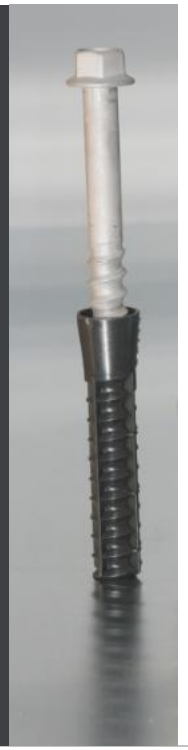
With the time, specific design and material have been developped for the tunnel industry.

Current State of the Art Solutions

BOLTING Systems

T19x100

T20x135



T25

- T25x80
- T25x100
- T25x105
- T25x120
- T25x140
- T25x160

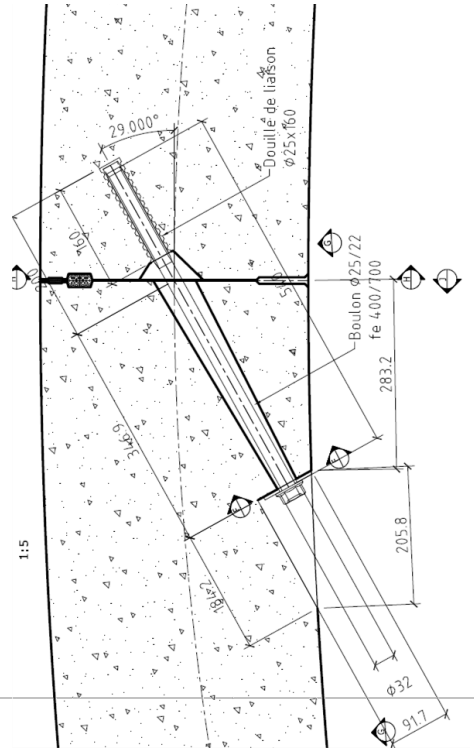
T28

- T28x100
- T28x120
- T28x145
- T28x160
- T28x175

Current State of the Art Solutions

STEEL Grades

	Pull-out Resistance			Pull-out Resistance	
	Yield *[Rp0,002]*	**Ultimate** *[Rm]*		**Yield** *[Rp0,002]*	**Ultimate** *[Rm]*
AF65 **C45**	400 MPa	700 MPa	ASTM **A307**	58’000 Psi	101’000 Psi
Grade **8.8**	640 MPa	800 MPa	ASTM **A325**	92’000 Psi	116’000 Psi
Other steel grades on request					



Current State of the Art Solutions

BOLT Finish

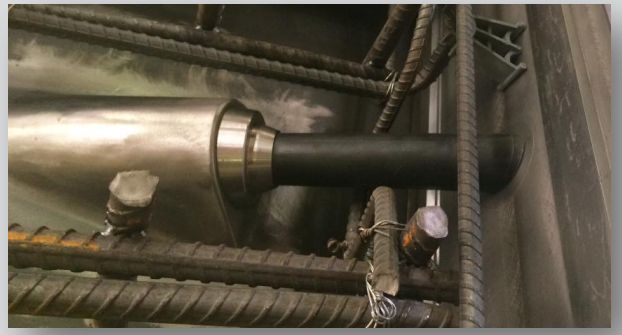
Black Steel

Hot Dip Galvanized

Stainless steel
(Grade on request – Bolt + Socket)

Current State of the Art Solutions

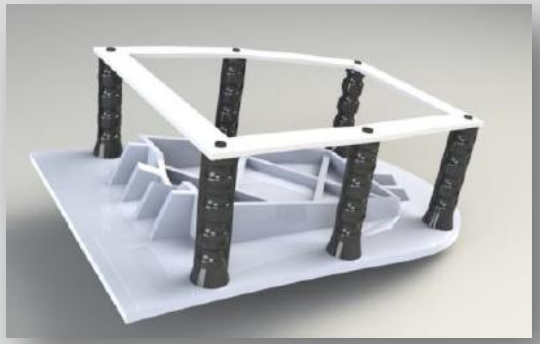
ACCESSORIES

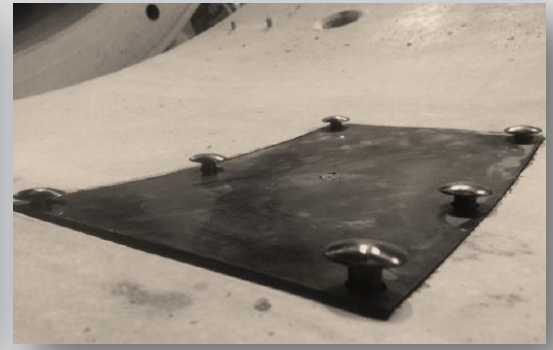
Steel Washer		Plastic Sheath	
Overmoulded Washer			

Current State of the Art Solutions

ACCESSORIES

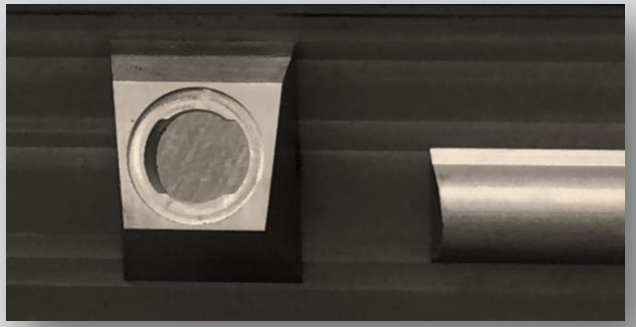
Bolt Pocket Cover

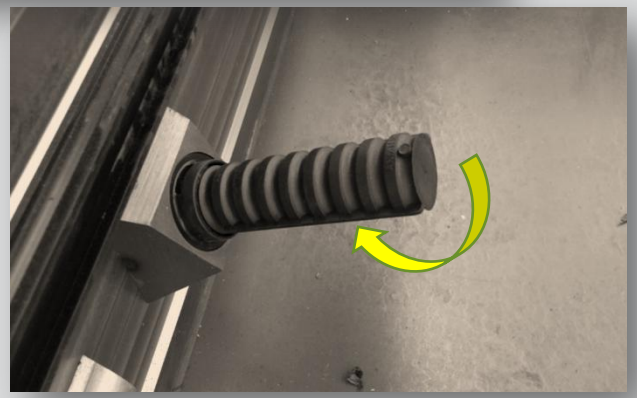




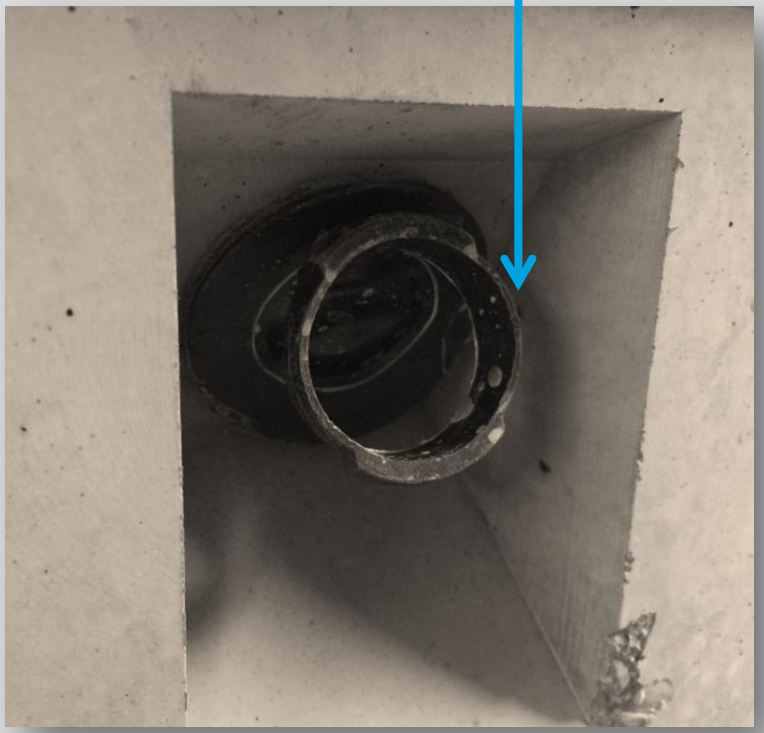
Current State of the Art Solutions

OPTIFIX

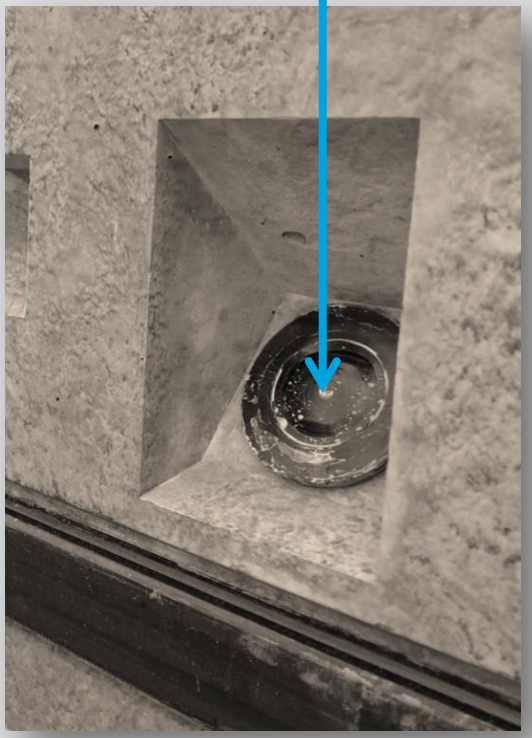




Breakaway plastic holder



Integrated sealing cap



Current State of the Art Solutions

Guiding rods

Guiding rod is relatively new to our industry.

It is an alignment dowel for the radial joint, helping for the ringbuild and in reducing the offset

Current State of the Art Solutions

GUIDING Rods

Diameter [mm]	Shear Resistance [kN/100mm]
Ø 30	15.0 kN
Ø 35	17.5 kN
Ø 40	20.0 kN
Ø 50	24.0 kN
Ø 60	29.0 kN
Ø 80	39.0 kN

OPTIMAS

Current State of the Art Solutions

GUIDING Rods

Guiding Rods made in
100 % recycled Material

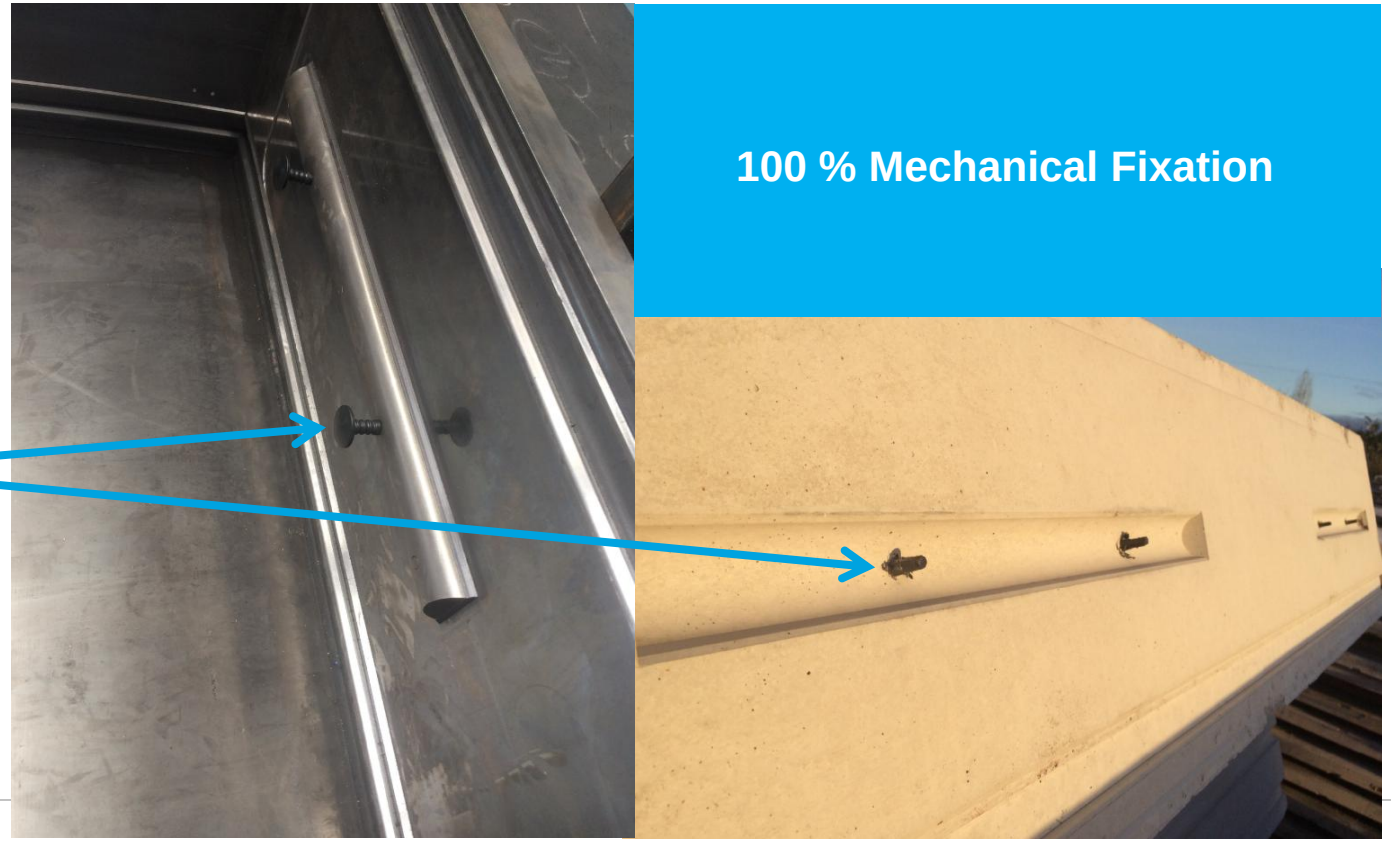
→ **a Low Carbon Footprint**

OPTIMAS

Current State of the Art Solutions

GUIDING Rods

Plastic Studs



100 % Mechanical Fixation

Time Saving

No Glue Solution

High Efficiency

No Weather Sensitivity

OPTIMAS

Current State of the Art Solutions

Bicones

Bicones were initially used in conjunction with bolting system.

Now, they are used for different applications mainly for cross passage.

Current State of the Art Solutions

SHEAR Cones

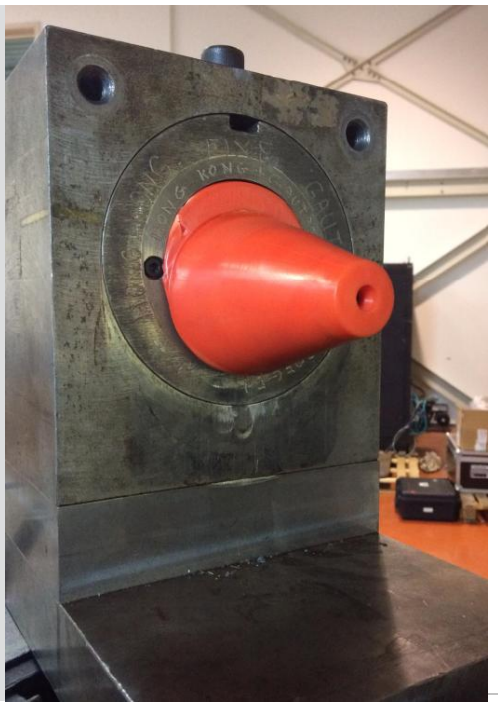
A shear cone is characterized by :

- **the shear resistance**
- **the displacement**

} **Stiffness**

One Project

One Bicone



Current State of the Art Solutions

SHEAR Cones

One Recess

Several Bicones

SOF.SHEAR.150S

Tunnel

Saverne

SOF.SHEAR.250L

Tunnel

Lima

SOF.SHEAR.375M

Tunnel

Miami

SOF.SHEAR.500

Tunnel

Tuen Mun

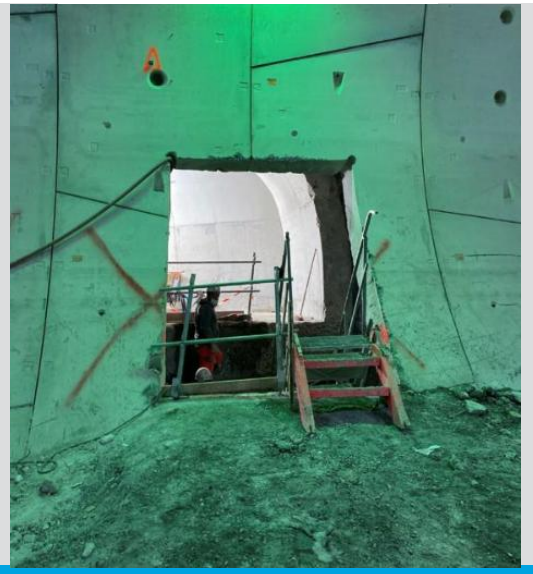
OPTIMAS

Current State of the Art Solutions

SHEAR Cones

SOF.SHEAR.150

Ø80



SOF.SHEAR.180

Ø100

Building of cross-passages and tunnel at the same time

Current State of the Art Solutions

SHEAR Cones

SOF.SHEAR.250

Ø120

SOF.SHEAR.420

Ø80

SOF.SHEAR.400

Ø120

Excavation of the stations without any additional external stabilization

OPTIMAS

Current State of the Art Solutions

SHEAR Cones with Tie-Rods

Assembly of the last rings together at the tunnel break-out

Bicone SOF.SHEAR.150S + M27 coupler

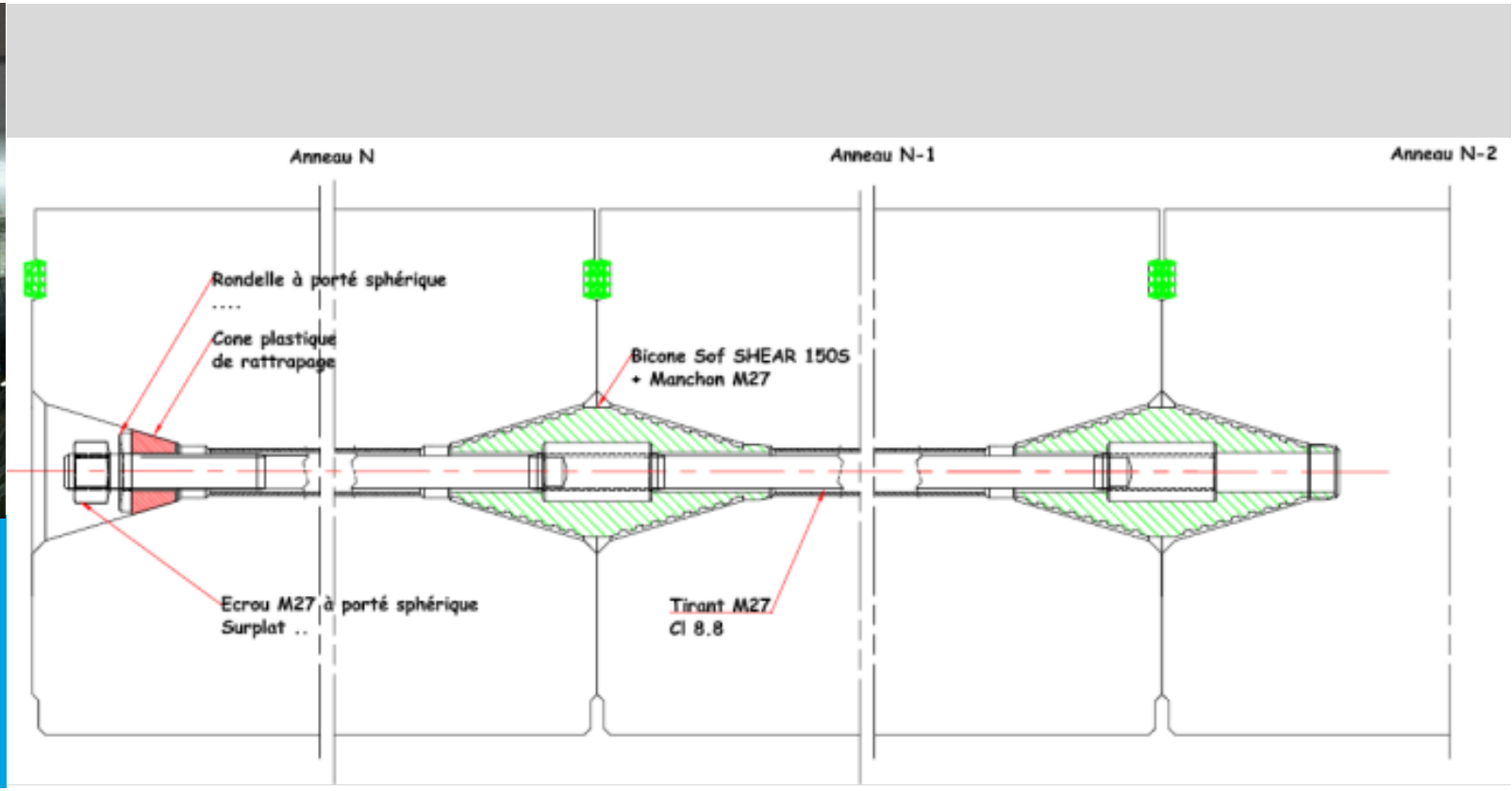
Tie-Rod M27, Steel Grade 8.8, HDG

OPTIMAS

Current State of the Art Solutions

SHEAR Cones with Tie-Rods

No temporary steel profile



Current State of the Art Solutions

SHEAR Cones with Tie-Rods

Screwing tool

Identification by colors

Grout-Lift Sockets

Grout-lift sockets

Initially, these sockets were used for the erection of the ring with mechanical erector.

With the usage of the vacuum which is now used on almost all projects, these sockets became grout socket only, used for the secondary grouting

Grout-Lift Sockets

GROUT & LIFT Sockets

SOF.GROUT Type Ix140

SOF.GROUT Type Ix180

SOF.GROUT Type I
+ extension

SOF.GROUT Type
IVx190

SOF.GROUT Type IV
+ extension

Ø40

Ø70

Grout-Lift Sockets

GROUT Sockets

SOF.GROUT Type ZUx100

SOF.GROUT Type ZUx140
+ extension

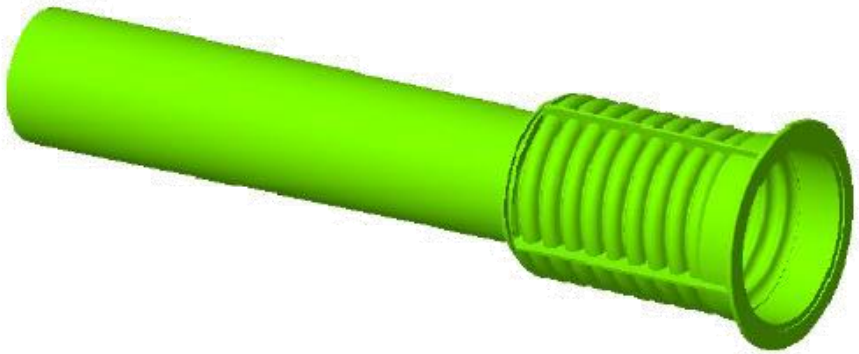
SOF.GROUT Type III
+ extension

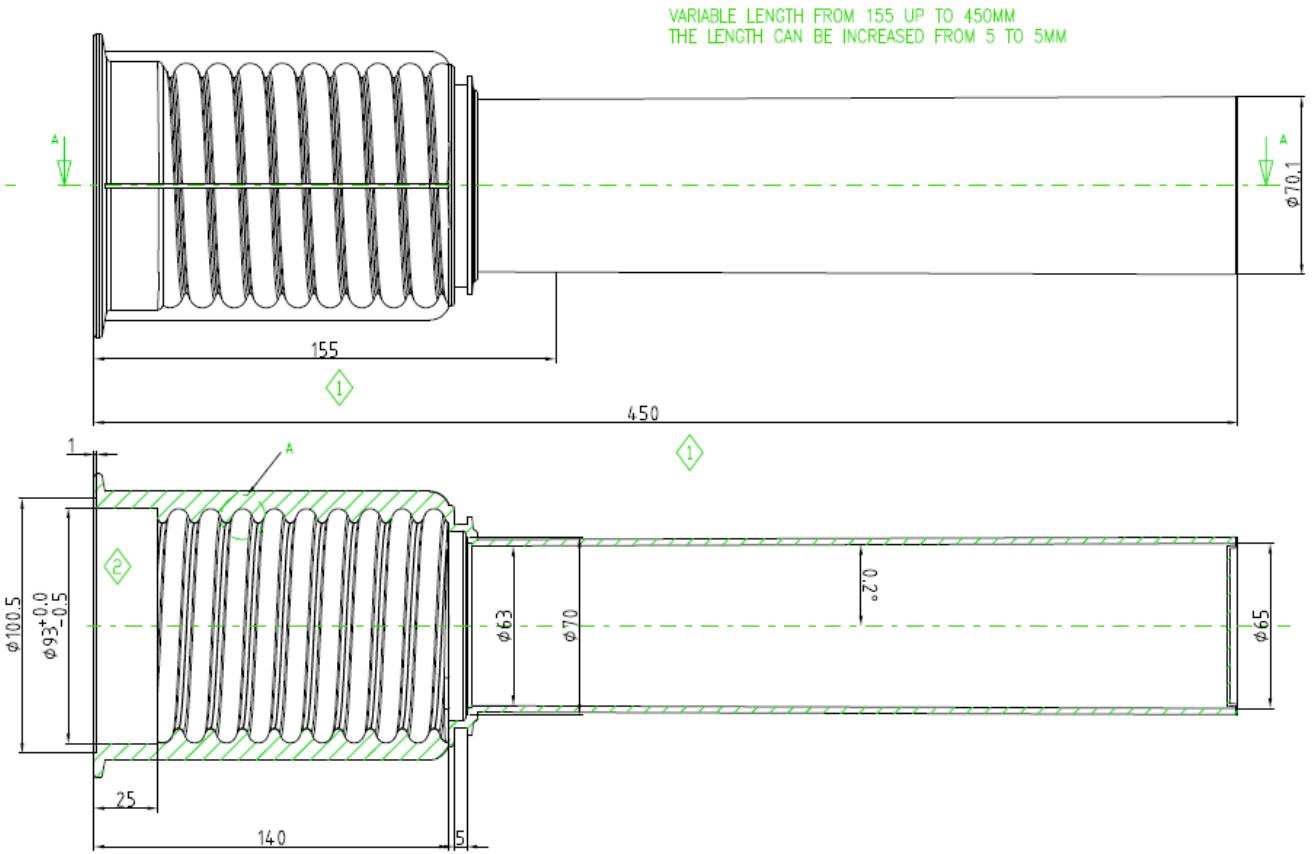
SOF.GROUT Type V
+ extension

Ø40	Ø70	Ø96

Grout-Lift Sockets

Type II

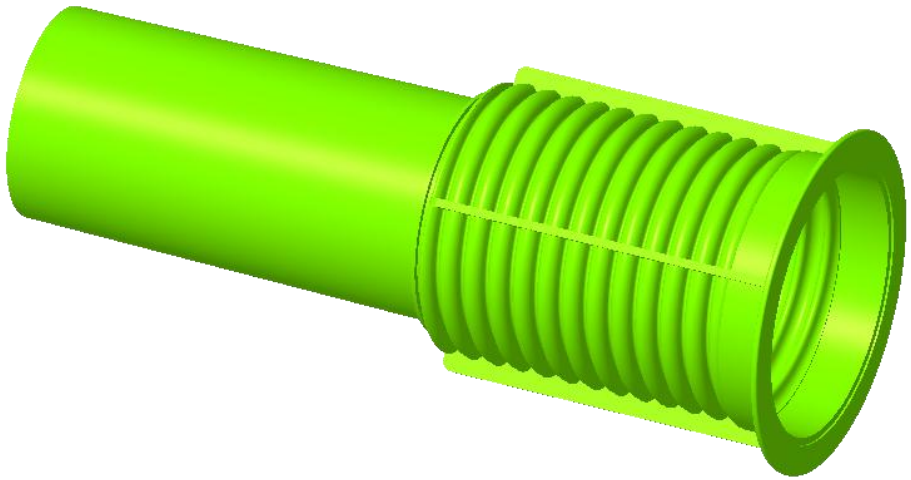


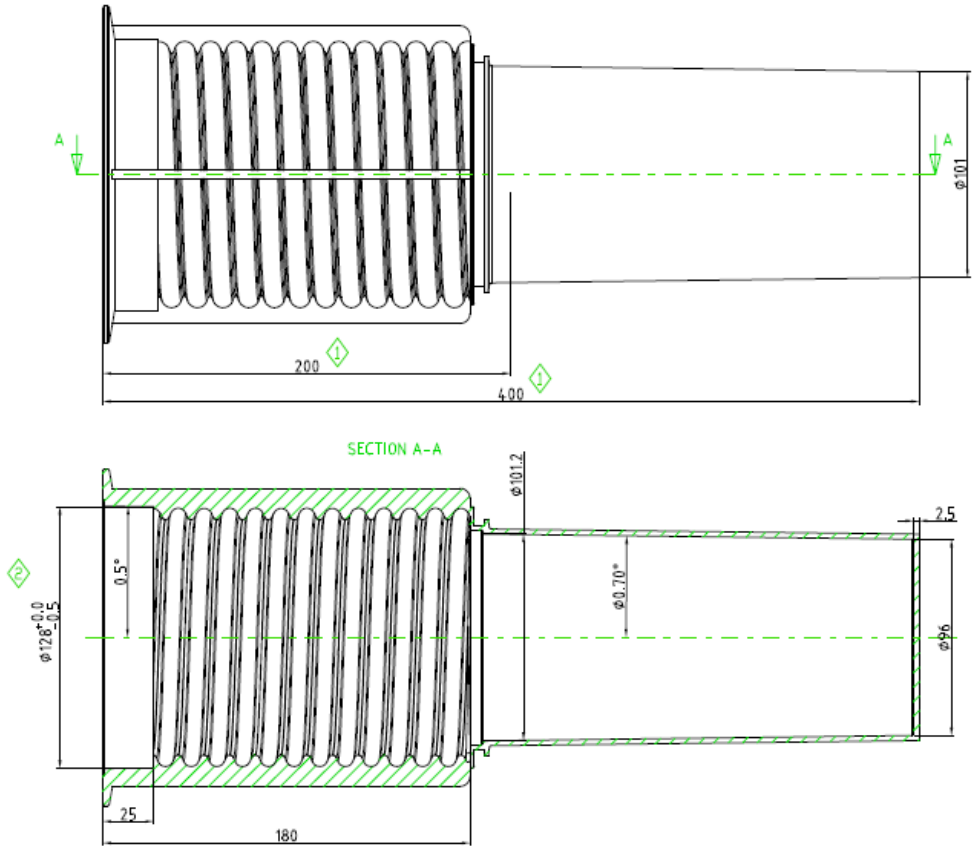


New design of socket with a pipe part of the body, length adjustable from 155 up to 450mm, accessories with same design than Type III and IV. Socket exists as standard socket or with breakaway (Optifix)

Grout-Lift Sockets

Type V – New Design





Grout-Lift Sockets

OPTIFIX

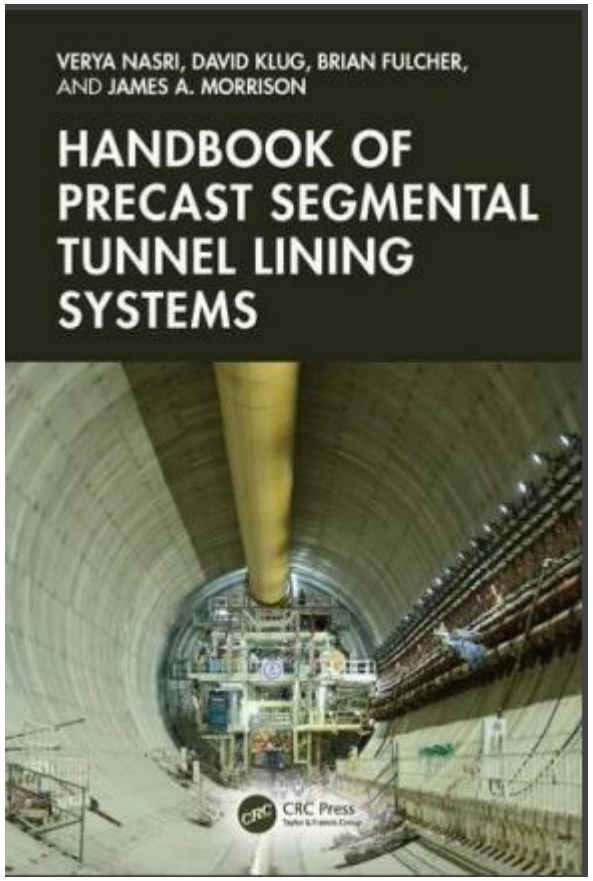
Allows an **inclined position** of the socket on the intrados surface

Breakaway system

Easy to fix by a **¼ of turn**

The socket can be protected by **an integrated cap** until its use

OPTIMAS



Thank you for your attention