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FREYSSINET PRODUCTS CO.

PRODUCT DESCRIPTION

Geotechnics

Temporary Strand Anchor

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FREYSSINET

SUSTAINABLE TECHNOLOGY

REVISION INDICES FOLLOW-UP TABLE

Rev	Date	Modification	Prepared by	Checked by	Approved by
0	08/06/18	First issue	C. GAUCHERAND	F. ROBERT	E. THIBOEUF

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1. INTRODUCTION

1.1. Scope of the document

This document is intended to describe the product in term of design, manufacturing and inspection.

1.2. Geotechnics

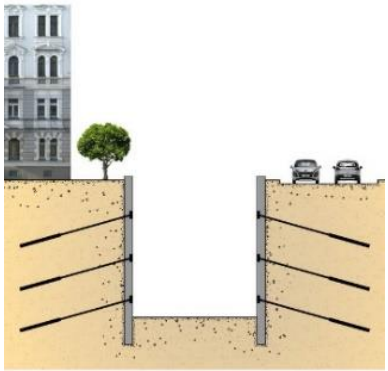
The Freyssinet Group is the world leader in specialized civil engineering, working in two fields: structures and soil. The soil activities include ground anchors, soil nails, rock bolts, micropiles and port tie-rods. As part as these activities, Freyssinet supplies the Temporary Strand Anchor.
The Freyssinet Group is organized in geographical zones around the world with strong local roots, with 70 bases in more than 50 countries. It is a subsidiary of Vinci Construction, world leader in construction and associated services, which combines almost 2,500 companies in more than 100 countries all around the world.
The Temporary Strand Anchor developed by Freyssinet is designed to answer several standards and world normative requirements but also the environmental requirements specific to this type of product.
FPC is the industrial branch of the Freyssinet Group and its headquarters are located in St. Eusèbe (France), from where the manufacturing of Freyssinet products (pre-stressing, stay cables, bridge fittings, geotechnical products, etc.) is organized and controlled.
To cope with the increasing demand of all the Freyssinet subsidiaries in the world, FPC has developed an important network of production facilities all over the world, implementing the same Quality Control System worldwide, in accordance with International Quality Standards.
As a result of this group strategy of procurement network, the Freyssinet subsidiaries have improved their services worldwide, and offer flexible and reactive solutions to their clients' needs.

1.3. Ground anchors scope of use

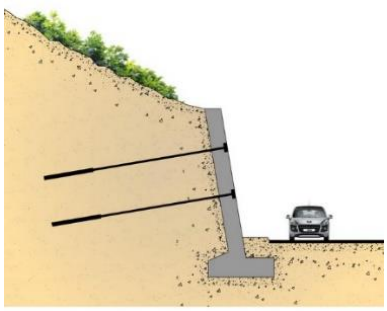
The Temporary Strand Anchor is mainly used for stabilization of slopes, retaining walls.

Developed by Freyssinet, the Temporary Strand Anchor is made of PT strand and its associated anchorages.

The typical cases are detailed below.



Excavation



Slope stabilization

1.4. Design

The Temporary Strand Anchor system complies with EN1537. The design is specific to Freyssinet. It can be adapted upon request.

1.5. Manufacturing

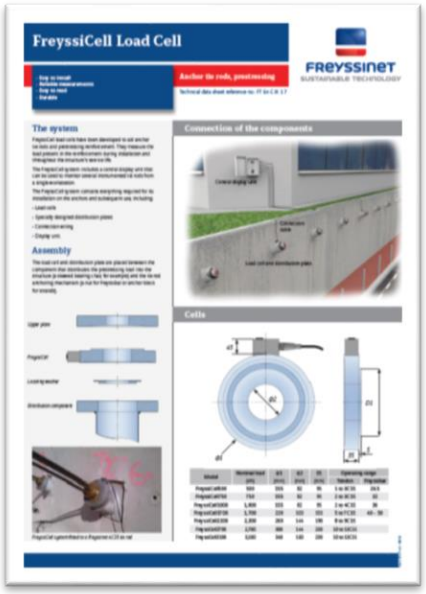
As Temporary Strand Anchor is manufactured by Freyssinet, all customers will receive the same level of excellence and quality in the products and services. This complete control over our products and systems means that we can adapt our solutions to a wide range of applications and extreme operating conditions.

1.6. Installation

Installation is generally carried out by the customer. Special attentions are detailed in chapter 6.

1.7. Surveillance

Like any other system, the surveillance must be defined by the contractor depending on the scope of use. In addition to the visual controls of the anchor heads, a monitoring is generally installed in order to measure the tensile load in the anchors, according to the Freyssicell technical data sheet:


FreyssiCell Load Cell

FREYSSINET

Anchor tie rods, prestressing

The system

Assembly

Connection of the components

Cells

See chapter 3.4.2

2. APPLICABLE DOCUMENTATIONS

2.1. Specific documentation

The use of the Temporary Strand Anchor is inseparable from the following documentation (last version):

- ETA-06/0226
- EN1537: Execution of special geotechnical work – Ground anchors
- BS 8081 - 2015 British code of practice for Ground anchor
- TA 95 – Recommandations concernant la conception, le calcul, l'exécution et le contrôle.

2.2. Standards for components

FPC has analyzed all standards in order to satisfy the specific requirements of each norm. FPC uses the same equivalent material standard when it's possible in order to optimize the price of raw material.
The system complies with geometrical, mechanical and technological requirements as defined by most of the relevant national and international standards.

2.2.1. Tendon

Designation	Applicable standard	Material
Steel strand	prEN 10138-3 CSP AP Rc1	PT Strand

2.2.2. Accessories

Designation	Applicable standard	Material
Bearing plates	EN10025-2	Grade S355 flame cut or cold sheared
Anchor block	EN 10083-2	C45 or more
Jaw	Internal specifications	16MnCr5Pb
Plastic caps	Freyssinet Specifications	30% glass fiber reinforced PA 6

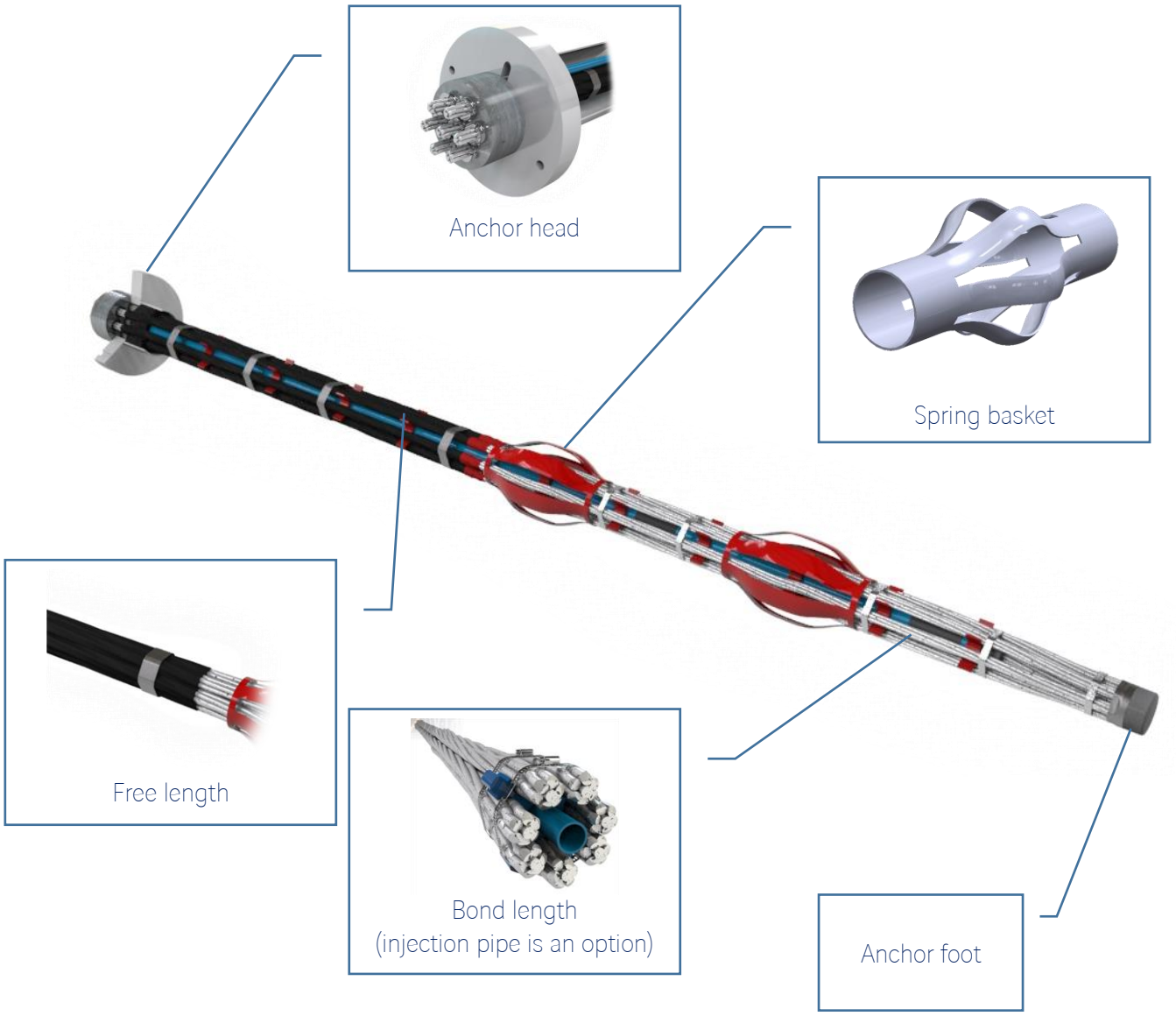
2.3. Standards for control

Designation	Applicable standard
Mill certificates for blocks and plates	Certificate 3.1 according to EN10204

3. DESCRIPTION OF THE TEMPORARY STRAND ANCHOR

3.1. Overview

The Temporary Strand Anchor is a multi-strand ground anchors, designed as a post-tension anchoring solution in the geotechnical field. The strands and the anchor head components are coming from the Freyssinet post-tensionning system (European Technical Approval n° 06-0226 and CE marking). The corrosion protection of the anchor body consists of a grease cover and an individual PE sheath-ing around the strands. This insures a temporary corrosion protection and the mechanical isolation of the strands on the free length. The anchor head corrosion protection complies with the EN1537. Upon request and for low life time, the Temporary Strand Anchor can be produced without any corrosion protection, which results in no grease on the the strands and no protection of the anchor head.



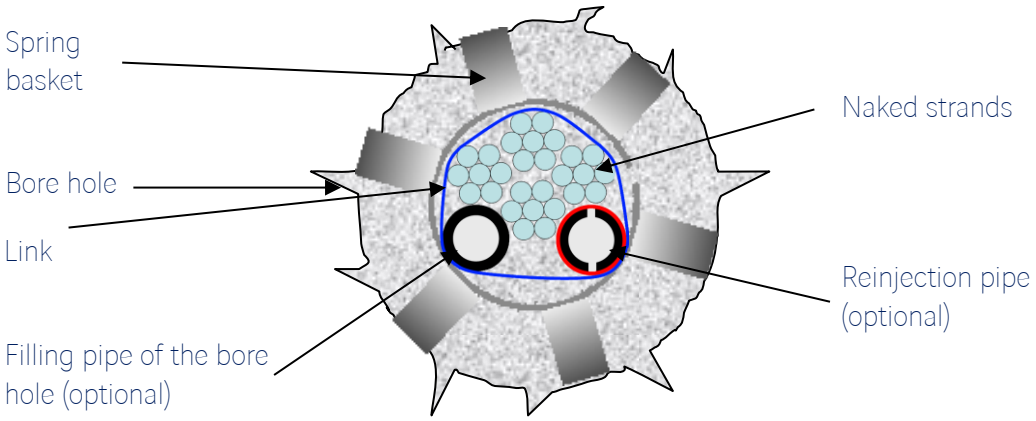
3.2. Tendon

The tendon is made of several post-tensionning strands. The capacity of a tendon depends of the number of stands used.
Standard single stands are T15,7 (or 0'62) and T15,2 (or 0'60), but other strands can be used if the anchor head is adapted (see chapter 3.3), as well are combinations with more strands.

Typical References	Yield Strength	Ultimate strength	Young Modulus	Nominal cross section	Linear mass (strand only)	Ultimate Load	Yield load
	MPa	MPa	MPa	mm^2	Kg/m	kN	kN
2T15,2	1640	1860	~195 000	278	2,18	520	440
3T15,2				417	3,27	780	660
4T15,2				556	4,36	1040	880
5T15,2				695	5,45	1300	1100
6T15,2				834	6,54	1560	1320
7T15,2				973	7,63	1820	1540
8T15,2				1112	8,72	2080	1760
9T15,2				1251	9,81	2340	1980
10T15,2				1390	10,90	2600	2200
11T15,2				1529	11,99	2860	2420
12T15,2				1668	13,08	3120	2640
13T15,2				1807	14,17	3380	2860
2T15,7	1640	1860	~195 000	300	2,36	558	492
3T15,7				450	3,54	837	738
4T15,7				600	4,72	1116	984
5T15,7				750	5,90	1395	1230
6T15,7				900	7,08	1674	1476
7T15,7				1050	8,26	1953	1722
8T15,7				1200	9,44	2232	1968
9T15,7				1350	10,62	2511	2214
10T15,7				1500	11,80	2790	2460
11T15,7				1650	12,98	3069	2706
12T15,7				1800	14,16	3348	2952
13T15,7				1950	15,34	3627	3198

3.2.1. Bond length

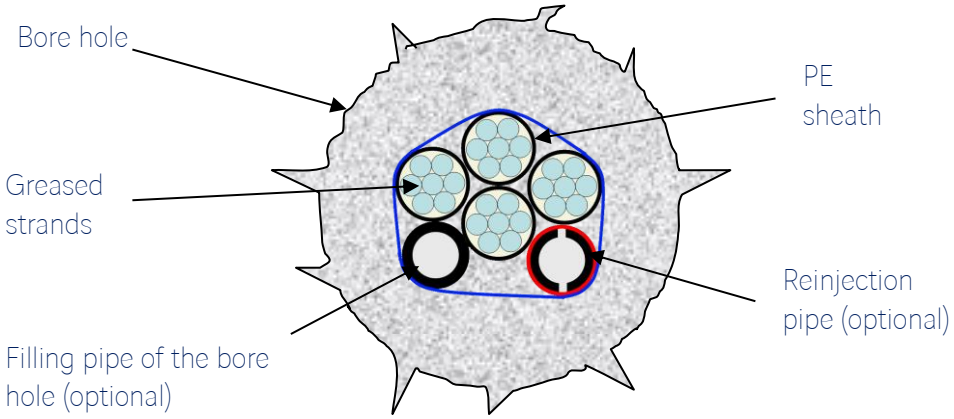
The bond length consists of naked strands, totally surrounded the cement grout injected in the bore hole, When stressing the anchor, the loads are transmitted from the strand to the cement, then from the cement to the ground,
The minimum grout cover of 10 mm around the anchor is insured by a sprig basket every 2 meters,



Generally a spacer is placed approximately every 2 meters in order to keep the strands properly assembled

3.2.2. Free length

On the free length, the strands are protected by an anticorrosive grease, and covered by an individual PE sheath, Upon request, grease can be cancelled,

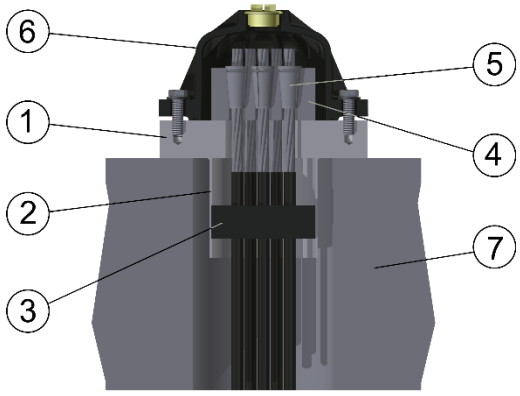


3.3. Anchor head

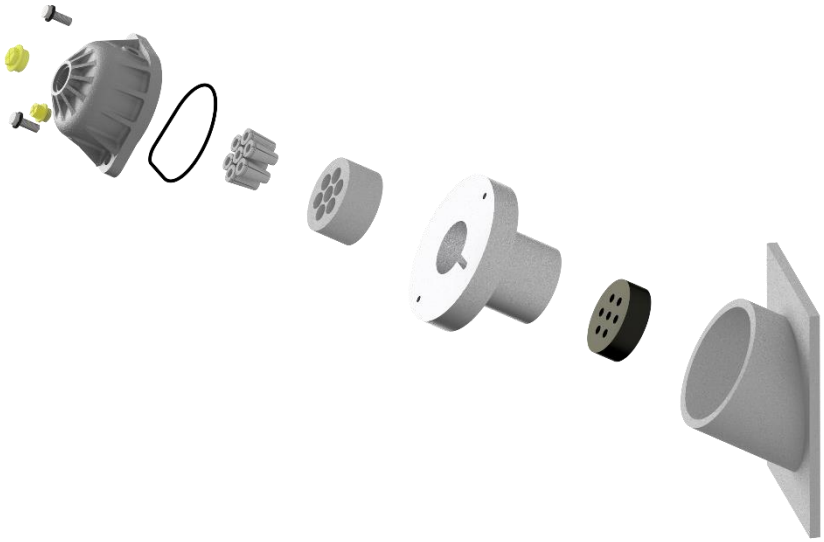
3.3.1. Standard

A standard anchor head is made of an anchor block (4) and wedges (5), It is placed on a bearing a plate (1), mounted on the extra length of the ground anchor, A joint is installed at extra length of the ground anchor (3), in a trumpet tube filled with wax (2), A cap (6) is screwed and also filled with wax,
The whole system transmits the loads of the ground anchor to the structure (7)
This system is strictly conformed to the EN 1537:

- Corrosion protection
- CE marking of the anchor head (block and wedge)

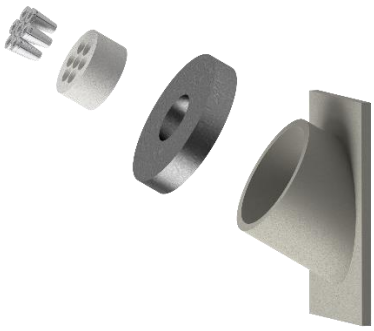


The components are assembled as follow:



An angular chair can be installed between the plate and the structure when the ground anchor axis is not perpendicular to the bearing surface,

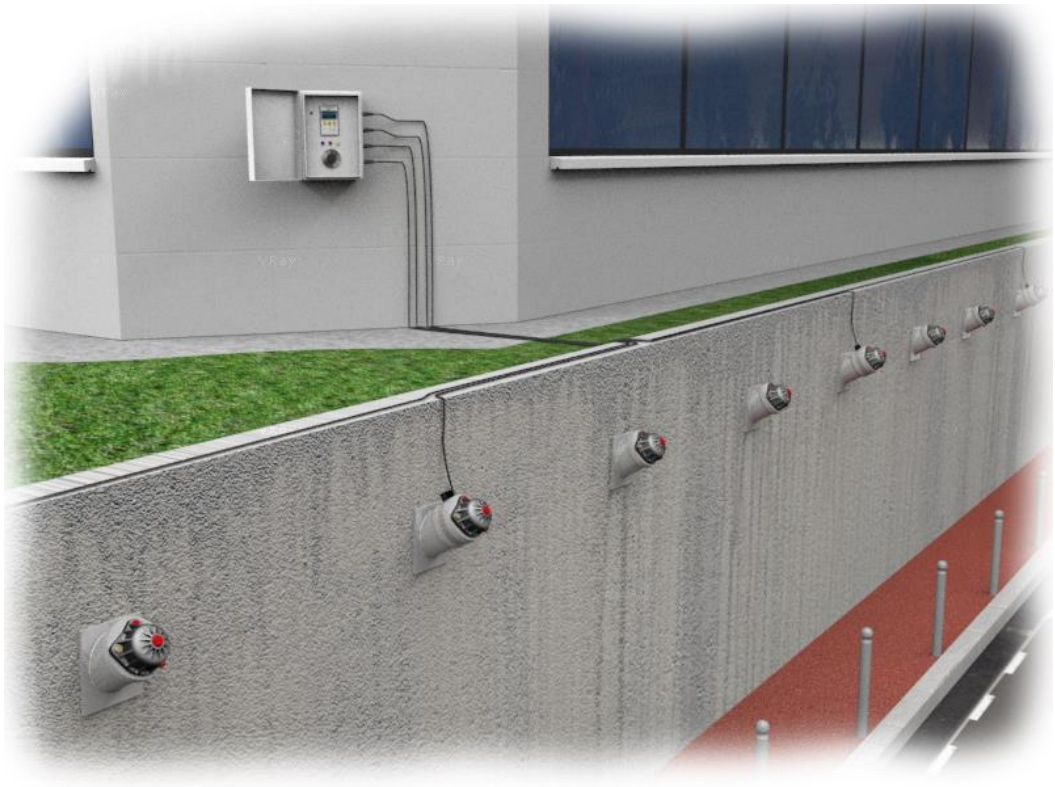
In special cases (very low life time) no corrosion protection is applied (not conform to EN 1537):



3.3.2. Monitored

A load cell is placed between the anchor plate and a bearing plate:

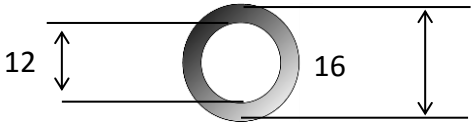
It is connected to the reading device according to the standard solution shown in the technical data sheet FREYSSICELL:



3.4. Injection pipe

3.4.1. Filling pipe

This filling pipe is generally installed among the strands bar on the job site, On the bottom, a bevelled cut must be done on site, and some holes must be drilled (3 on the last 1,50 m), to allow the flow of the cement grout, even if the pipe is blocked by earth on the bottom during insertion of the anchor,

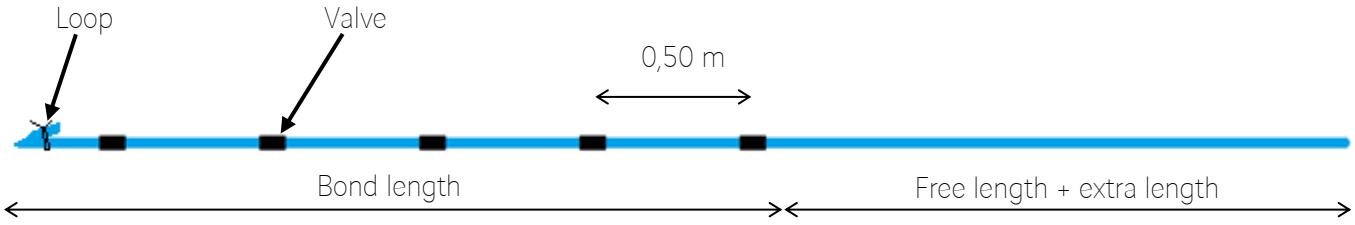


Delivered in 500 lm coils

3.4.2. Single re-grouting pipe

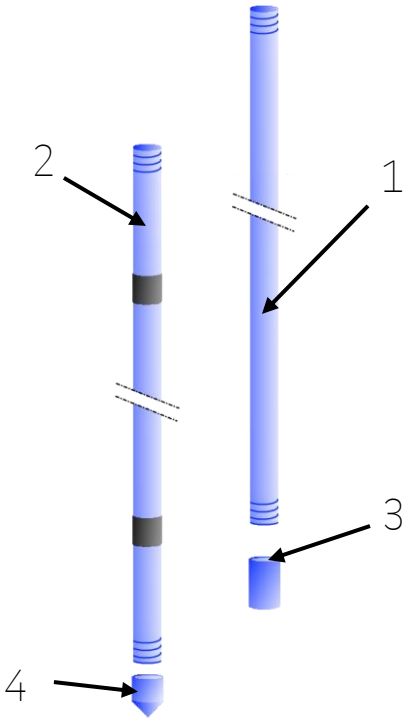
This reinjection pipe is generally installed along the bar on the job site, It is generally added to a filling pipe, The first grouting is made with the filling pipe, and the reinjection with the top reinjection pipe, The bottom is obtruded by a loop of the tube, On the bond length, a valve is made every 0,50 m by a hole D=6mm obtruded with an adhesive tape,

Diameter (d x D)	Limite pressure	Delivered
12 x 16	28 bar	Prepared at the right length, as required, and rolled



3.4.3. Sleeved re-grouting pipe

The pipe is made of PVC+, anti- shock, It is delivered in bars of 3 or 6 meters long which can be connected with a special coupler (3), Some elements are totally smooth with a male thread on both sides (1), Some elements include one sleeve per meter (2), These sleeves are outside the pipe, On the bottom, a female threaded plug is screwed to seal the pipe (4), The bursting pressure of the pipe is 70 bars, The external diameter is 50 mm, the inner diameter is 40 mm,



3.5. Marking

3.5.1. Tendons

Each tendon is identified with a label containing:

- Customer name
- Type of tendon
- Length
- Batch number
- Weight: net and gross

3.5.2. Accessories

The marking of the accessories is done on a label attached to the case or pallet,

4. DESIGN

4.1. Calculation

The design of the anchor head (anchor block + wedges), according to EN1537, complies with ETAG 013 and the strand complies with ASQPE and prEN10138-3,

4.2. Testing

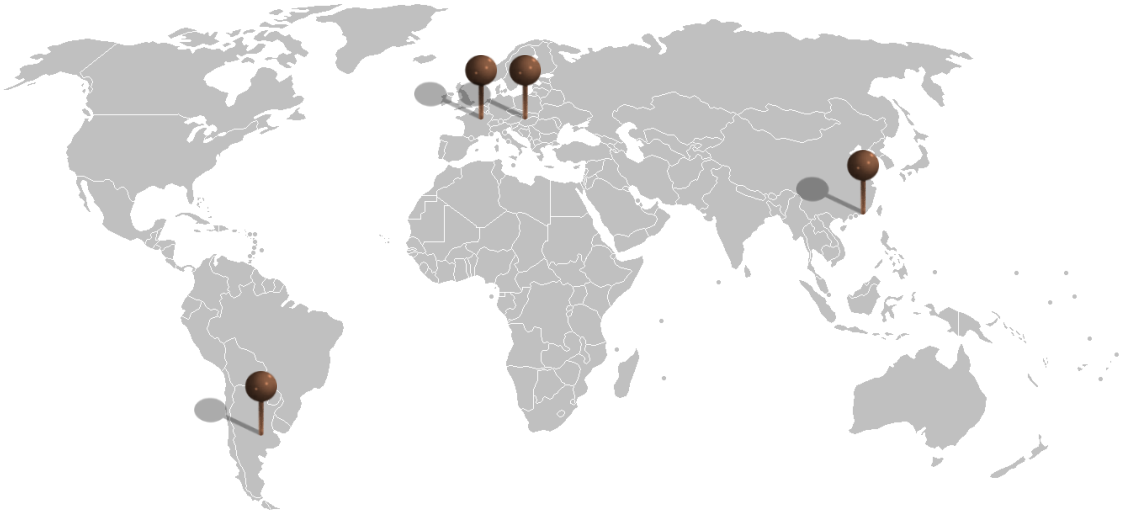
The CE marking of the anchor head insures that all the tests have been done according to ETAG 013,

The certification of the strands insures that all tests have been done according to prEN10138-3 and ASQPE referential,

5. MANUFACTURING

5.1. Site of production & distribution

The tendon can be produced in a Freyssinet factory (France, Switzerland, Czech Republic, Hong Kong, Argentina) or on site,
The anchor heads are produced in France in the FPC factory,



5.2. Manufacturing process of the tendon

5.2.1. Products incoming inspection

When stand and accessories are received at the production site, all material certificates are checked and recorded,

5.2.2. Individual strands

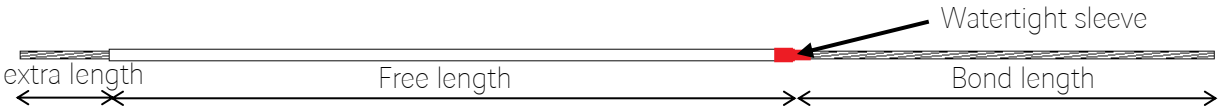
On the free length, the strands are protected by a anticorrosive grease, and covered by a individual PE sheath, This protection is done with a specific automatic device ensuring a perfect greasing, Then a heatshrinking sleeve or a solid adhesive tape is placed to keep the sheath in place,

Programming

Separating the strand

Greasing

When the production is done on site, the greasing can be done without this automatic device,



5.2.3. Full tendon

All the components are assembled together to create the final tendon:

- Individual sheathed strands
- Spacers
- Optional injection and re-injection pipes

They are hold with reinforced adhesive tape,

On the anchor foot, two steel strip minimum must hold the strands together, If the tendon has to be handled with a crane or rolled, a strong steel sleeve must be placed:

5.2.4. Packing

5.2.4.1. Tendon

If they are produced on site, the tendons are placed directly in the bore hole after prefabrication and don't need special packaging, If they are produced in a factory, they are rolled and place on special wooden pallets 2,00 m x 2,00 m

5.2.4.2. Accessories

Wedges of a same batch are packed together by 150 units in plastic bucket, Anchor blocks are packed in case, in a plastic bag which is sealed, Plates and other components are packed together with in wooden boxes or pallets,

5.3. QSE

The quality assurance system in force in the factory supplying the ground anchors units shall comply with, or be equivalent to, the standard ISO 9001: 2008,

5.3.1. Quality - ISO 9001

FPC is certified since September 1997 (according to successive standards as ISO 9002 v94 and ISO 9001 v2000), Since the renewal audit of September 2009, the company is certified ISO 9001 v2008, Manufacturing, sale and trade of structure equipment (road expansion joints, bearings and seismic protection devices) and components for cable stays and concrete prestressing,
Trade of products for structure reinforcement,

5.3.2. Safety - OHSAS 18001

FPC is certified OHSAS 18001 v 2007 since April 2011,

5.3.3. Environment – ISO 14001

FPC is certified ISO 14001 since October 2010

5.3.4. Quality documentation

Different levels of quality documentation can be proposed (level 0, 1 or 2), The level of the quality documentation has to be determined at the beginning of the project, Each level includes the following documents:

Item	Documentation	Level 0	Level 1	Level 2
General Documentation	Delivery note	X	X	X
Full tendon	Assembling report	-	-	X
PT Strand	Material certificate 3,1	-	X	X
Anchor block	Material certificate 3,1	-	-	X
Wedges	Material certificate 3,1	-	-	X

All documents can be shown during an audit,

6. INSTALLATION ON SITE

6.1. Preparation of the tendon

Receiving the tendon on site, each of them is identified,

Then it is unrolled and the spring baskets are placed on the bond length

6.2. Drilling

The drilling operation is done by the main contractor, The following requirements must be fulfilled:

1. The deepness of the bore hole should allow the introduction of the anchor, If necessary, an over drilling of 0,5 to 1 meter can be done to ensure that the available length is enough, even if cuttings are falling to the bottom,
2. The diameter should allow the introduction of the anchor with the injection pipes and a final grout cover of 10 mm minimum, If a casing is used, its internal diameter must be considered to check the capability to install the anchors,
3. The borehole should not collapse from the time of the drilling to the time of injection, If the ground is too loose, a dense injection fluid can be used (bentonite, cement grout, foam, mud) or a casing hole method can be adopted (ODEX, OD, TUBEX, …),

6.3. Installation of the anchors

This operation is done by the main contractor, The adapted and safe lifting equipment must be used,
The foot of the anchor is guided in the borehole and the top end is lifted up (1), Then the anchor is progressively introduced in the borehole,
If required, Freyssinet can propose a technical assistance at this step,

Special uncoiling equipement can be provided by Freyssinet :

6.4. Grouting

This operation is done by the main contractor,
The injection process should allow a good filling of the borehole and should allow to obtain the required resistance of the bonding of the anchor in the ground,
On the top of the borehole, the cement grout should be correctly stopped in order to allow a good installation of the anchor head,
When the injection is finished, the extra length of injection pipes must be cut of and removed,

A special care is needed to allow a good behavior of the anchor and a proper installation of the anchor head,

6.4.1. Gravity injection

This method involves filling the bore hole with cement grout via the bottom, A filling pipe is installed along the anchor, Once the anchor has been inserted in the bore hole, the cement grout is injected via the tube until it reappears at the surface, In some cases, there is no injection pipe and the bore hole is filled with cement grout before the anchor is inserted, The injection pressure corresponds to the pressure needed to form the column of grout,
This simple yet effective method provides acceptable anchorage strength in rock and compact sand, but is often inadequate in loose soil and clay when the ground is fractured, the anchor can be fitted with a geotextile cover to prevent grout loss,

6.4.2. Global reinjection (IGU)

The aim is to inject cement grout into the anchor zone at a higher pressure than with gravity injection,
The anchor is fitted with a reinjection pipe featuring sleeves and is closed at the end,
Gravity injection is carried out first, When the grout starts to set (10 to 24 hours after gravity injection), further injection is carried out via the reinjection pipe has at least one sleeve per meter,
The pressure of the grout at the end of injection is generally between 10 bar and half the pressure limit for the ground,
This method is highly effective for ground anchors grouted in sand or compact ground for passive anchors in all types of ground,
In some cases, it is used in fractured rock for reinjection into areas where grout has been lost,

6.4.3. Selective reinjection (IRS)

This method ensures perfect control over the injection volume and pressure in each grouting zone,
A sleeved reinjection pipe enabling a double packer to be inserted is installed along the anchor, After an initial gravity injection phase, reinjection is carried out using the double packer inserted in the sleeved reinjection pipe, The injection can thus be precisely controlled at each sleeve,
The pressure at the end of injection is generally higher than the pressure limit for the ground and may not exceed 40 bar,

6.5. Installation of the anchor head

A control of the surfaces is done prior to any installation, If necessary, a mortar is made to insure a good bearing surface between the plate and the structure,
All the components are installed
After stressing, the cap is installed and filled with wax (see chapter 3,4)

6.6. Stressing-testing

All the testing and stressing operations must be done according the applicable norms and specifications,
For example, according to EN 1537, the following tests must be done:

- 2 investigation test on "lost" anchors
- 3 suitability tests minimum on service ground anchors
- 1 acceptance test on each service ground anchor

6.6.1. Investigation test

This test is done according "Step method", §9,4,1,c) of the EN 1537
The load applied on the anchor during the test is minimum 1,5 x estimated resistance of the bonding
The number of tendons must be chosen in order to reach this value without exceeding the maximum applicable force (se §3,6)
The load will be applied in 9 steps of 1 hour duration
These tests will be done prior to permanent anchors works, in order to valid the bond lengths,

6.6.2. Suitability test

This test is done according "Step method", §9,4,1,c) of the EN 1537
The load applied on the anchor during the test is minimum 1,15 x Service load
The load will be applied in 5 steps of 1 hour duration

6.6.3. Stressing & acceptance test

During stressing, each anchor will be tested at 1,15[1] Service load,

[1] Can be adapted to any other applicable standard

7. REFERENCES