CE

FREYSSIBAR

The prestressing bar for civil works

Design, Build, Maintain

Freyssinet

SUSTAINABLE TECHNOLOGY

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FREYSSIBAR
PRESTRESSING SYSTEM

Developed by Freyssinet, worldwide leader in prestressing activities, the Freyssibar prestressing system comprises a wide range of threaded bars and associated anchoring, coupling and extension devices.
This prestressing system is adapted to many applications.
Among these are :

- Permanent or temporary prestressing
- Holding down bolts for cranes, wind turbines, etc.
- Bridge construction systems
- Ground and rock anchors, rock bolts for geotechnical, mining, tunnelling works
- Heavy lifting
- Tie rods for marine works

Freyssinet is the holder of the European Technical Approval (ETA) n° ETA 09/0169 for the Freyssibar post-tensioning kit for prestressing of structures.
The Freyssibar flat anchorages and couplers for fully threaded bars up to 50 mm are approved to the requirements of ETAG 013.

Freyssinet has also obtained the EC-certificate of conformity: certificate n°1244-CPD-1014. The ETA and the EC-marking are followed by a notified body.

CONTENTS

Technology

The bars

The bars are hot rolled from high strength alloyed steel. They are subsequently cold worked by stretching and then threaded over their full length or on the extremities by cold rolling. The standard range of nominal diameters is: 26.5; 32; 36; 40 and 50 mm. Non-standard diameter bars can be delivered on request.

Lifting : prestressed connection between a segment and a beam.

The fabrication process provides a high quality thread ensuring high fatigue resistance and a low susceptibility to stress corrosion.
The nature of the Freyssibar manufacturing method also ensures that every single bar is stress tested to 85% of the guaranteed ultimate tensile strength of the bar.

The geometry of the thread is specifically designed to ensure ease of use on site, providing fast, accurate and easy tightening.

Bars are available in maximum lengths of 11.8 meters. Beyond this length, extension sleeves allow bars to be connected together.

Anchorage of steel ropes

The anchorages

The anchor devices are designed to anchor the force in the bar and transfer it to the structure. Four types of anchorages are available:

- Standard anchorages with a nut and washer;
- Hinge anchorages using a nut with a spherical seat;
- Standard anchorages using a low rotation spherical nut and spherical washer;
- Fixed anchorages using a threaded end plate.

All nuts are hot forged. Also, couplers allow primary bars to be connected to secondary bars.

The accessories

Freyssinet offers a full range of sheathing that is easy to install.
In particular:

- Steel strip corrugated sheath, threaded over its full length, which allows easy and fast connections;
- High density polyethylene tube, with elements mirror welded to achieve a leak free and non corrodible envelope;
- Sheathing accessories specific to the tensioning and coupling devices, required to fit the coupler geometry. The length of the ducting element used is project specific, so as to allow the coupler displacement over a sufficient length during the tensioning operations.

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Technology

Properties

Fatigue : The system has a fatigue resistance in excess of two million cycles of loading over a tensile stress range of 590-670 N/mm^2, exceeding the ETAG 013 requirements.

Relaxation : After 1000 hours the loss of stress due to relaxation in the Freyssibar system loaded to 70% Fpk is below 3% which is better than the 4% maximum as described in pr EN 10138-4.

Anchorage strength : Freyssibar post-tensioning system is tested to ensure that the failure load on the bar with coupler and anchorage is more than 95% of the strength of the bar alone.

Protection against corrosion

Stress corrosion tests have been performed in accordance to prEN 10138. The bars have been stressed under corrosive environment during 500 hours and passed the subsequent tensile test to failure. Freyssibar is not susceptible to stress corrosion but depending on the conditions of exposure, a specific corrosion protection can be applied under request.
The corrosion protection system is selected in accordance to the expected design life time and the conditions of exposure.

Permanent ties for quay walls

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Surface coating

- Hot dip galvanizing after sand blasting (no risk of hydrogen embrittlement due to acid pickling)
- Metalization (Dunois, etc.)
- Petrolatum tape
- Epoxy coating

Prefabricated bar tendons

Specific injection products

- Wax : hot injection
- Grease

} Allow for subsequent re-tensioning of the bars

- Cement grout : alkaline environment

Ducting

- Corrugated ducts: light and easy to install
- Smooth pipes: stiff and resistant to shock

Ducts and pipes can be either in steel or in HDPE (non corrodible).

Different protection systems can be combined to enhance the degree of protection.

Quality control

The fabrication of the bars and the anchorages is carried out under a quality assurance system in compliance with the quality standard ISO 9000 : 2000. Flat anchorages and bars have passed all the tests required in ETAG 013.

Ground anchors

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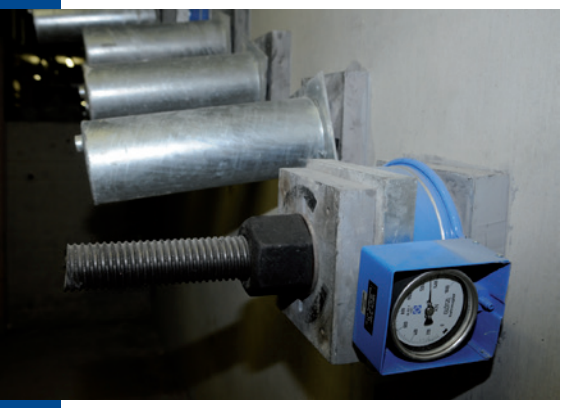
Installation

The accuracy of the prestressing force actually introduced into the structure and the durability of the tendons depend on the quality of the installation. The detailed installation procedure is available on request.

Shimming of the anchorages

When anchorages are applied onto an existing concrete element, it is recommended to shim under the bearing plate using a non-shrink mortar, free from chlorides.



Load cell

Tensioning

The tensioning equipment provided by Freyssinet ensures the accuracy of the load applied within +/- 2%. This is achieved through regular calibration of the pump pressure gauge and the jacks.

Safety factors

The maximum allowable stressing force in the prestressing bars is given by the relevant design standards. Recommendations are given below as examples: (Note: Fpk means the guaranteed tendon tensile breaking load and Fp0.1% means the proof load).

A/ In post-tensioned structures, the Eurocode limits the tension to either 0.9 Fp0.1% or 0.8 Fpk, whichever is lower.

B/ In prestressed ground anchors, the norm EN 1537 prescribes a final force limited to 0.75 Fp0.1% for temporary ground anchors and 0.60 Fp0.1% for permanent ground anchors.

C/ In case of re-use, the tensioning force of the bar is limited to 0.60 Fpk for the first use, and to 0.50 Fpk for all subsequent uses.

Stressing with the hinged jack

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Injection

Precast segments assembly

Injection accessories

Two types of jacks

Two types of jacks can be used: with a tie rod connected to the tendon or with a direct connection. Jacks should be used in conjunction with Freyssinet hydraulic pumps, with high pressure and a low flow rate to allow a progressive tensioning of the bar. Space must be allocated around the anchorage to allow the correct installation of the jack.

Service

Freyssinet, world leader in prestressing, offers:

- worldwide advice for specific works, from our specialists,
- a huge material park providing jacks and equipment for the best application of the Freyssibar installation,
- an on site technical assistance given by our highly qualified technicians, at the time of installation.

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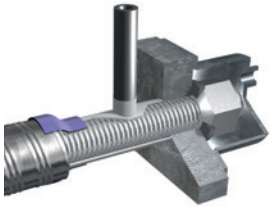
Characteristics

Bar

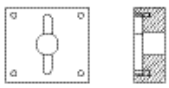
Characteristic	Unit	Nominal diameter (mm)					Ref.
		26.5	32	36	40	50	
Steel grade	MPa	1030	1030	1030	1030	1030	B
Cross section area	mm²	552	804	1018	1257	1964	
Linear mass	kg/m	4.56	6.66	8.45	10.41	16.02	
Characteristic value of maximum force: F_{pk}	kN	568	828	1048	1295	2022	
Characteristic value of 0.1% proof force: $F_{p0.1\%}$	kN	461	672	850	1049	1640	
Maximum tensioning force*	kN	414	604	765	944	1475	
Thread pitch	mm	6	6	6	8	8	
Average Young's modulus	GPa	170	170	170	170	170	
Minimum elongation at maximum force	%	3.5	3.5	3.5	3.5	3.5	

* Maximum tensioning force equals to min[0.9 $F_{p0.1\%}$; 0.8 F_{pk}] according to Eurocode2.

You can order all the products presented in the above table on ***www.freyssibar.com***



Flat anchorage

Item	Sketch	Dimensions	Unit	Nominal bar diameter (mm)					Ref.
				26.5	32	36	40	50	
Flat nut		Length	mm	37	41	46	55	71	N
		Width on flat surface	mm	50	56	62	65	90	
Flat washer		External diameter	mm	65	70	75	80	105	W
		Thickness	mm	6	6	6	6	6	
Flat plate		Dimensions	mm	110x125	125x125	140x160	160x160	200x200	FP
		Thickness	mm	35	35	40	40	45	
		Hole diameter	mm	34	40	44	50	60	
Injection plate		Dimensions	mm	110x125	125x125	140x160	160x160	200x200	FPG
		Thickness	mm	35	35	40	40	45	
		Hole diameter	mm	34	40	44	50	60	

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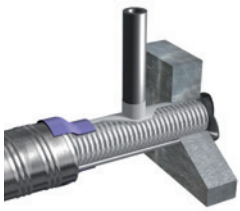

Fixed anchorage

Item	Sketch	Dimensions	Unit	Nominal bar diameter (mm)					Ref.
				26.5	32	36	40	50	
Threaded plate		Dimensions	mm	110x125	125x125	140x140	150x150	185x185	TEP
		Thickness	mm	40	50	50	60	70	
Welded cap (option)		Length	mm	15	20	20	25	25	CW

Available upon request

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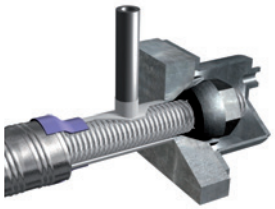

Spherical anchorage type 1 ± 3°

Item	Sketch	Dimensions	Unit	Nominal bar diameter (mm)					Ref.
				26.5	32	36	40	50	
Spherical nut		Length	mm	45	51	56	60	71	SN
		Width on flat surface	mm	50	56	62	65	90	
Spherical plate		Dimensions	mm	160x115	160x125	160x140	160x160	190x190	SP
		Thickness	mm	40	40	40	40	60	

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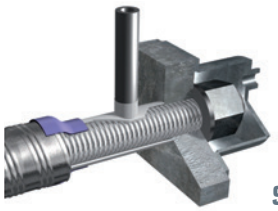

Spherical anchorage type 2 ± 0.6°

Item	Sketch	Dimensions	Unit	Nominal bar diameter (mm)					Ref.
				26.5	32	36	40	50	
Spherical nut Type 2		Length	mm	37	41	46	55	71	SN Type 2
		Width on flat surface	mm	50	56	62	65	90	
Spherical washer		External diameter	mm	75	80	90	95	125	SW Type 2
		Thickness	mm	10	10	10	10	15	
Flat plate		Dimensions	mm	110x125	125x125	140x160	160x160	200x200	FP
		Thickness	mm	35	35	40	40	45	
		Hole diameter	mm	34	40	44	50	60	
Injection plate		Dimensions	mm	110x125	125x125	140x160	160x160	200x200	FPG
		Thickness	mm	35	35	40	40	45	
		Hole diameter	mm	34	40	44	50	60	

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Couplers

Sketch	Dimensions	Unit	Nominal bar diameter (mm)					Ref.
			26.5	32	36	40	50	
	External diameter	mm	45	50	60	65	76	C
	Length	mm	90	115	130	140	170	

You can order all the products presented in the above table on ***www.freyssibar.com***

Accessories

Item		Dimensions	Unit	Nominal bar diameter (mm)					Ref.
				26.5	32	36	40	50	
Formwork tube		Length	mm	250	250	250	250	250	T
		External diameter	mm	42.9	48.5	50.8	57.2	70	
		Thickness	mm	2	2	2	2	2	
		Air vent connection	"	1/2	1/2	1/2	1/2	1/2	V
Caps	Short caps	Length	mm	95	100	120	120	150	CS
	Long caps	Length	mm	210	220	220	220	280	CL

You can order all the products presented in the above table on ***www.freyssibar.com***

Ducts

Item	Dimensions	Unit	Nominal bar diameter (mm)					Ref.
			26.5	32	36	40	50	
Steel corrugated sheath	Internal diameter	mm	45	50	55	60	75	G1
	Thickness	mm	0.45	0.45	0.45	0.45	0.50	
	Volume of grout	L/m	1.0	1.2	1.4	1.6	2.5	
	Connection element (internal diameter)	mm	50	55	65	70	85	G'1
HDPE tube	External diameter	mm	63	63	75	75	90	G2
	Thickness	mm	5.8	5.8	6.8	6.8	8.2	
	Volume of grout	L/m	1.5	1.3	1.9	1.7	2.3	
For prolongation sleeve	External diameter	mm	70	76.2	88.9	95	114.3	GR
	Thickness	mm	2	2	2	2	2	
	Minimum length (L = sleeve)	mm	180 + L	205 + L	220 + L	230 + L	260 + L	
For coupling sleeve	External diameter	mm	88.9	88.9	101.6	114.3	152.4	GC
	Thickness	mm	2	2	2	2	2	
	Maximum length	mm	210	235	255	265	320	

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Ground and rock anchors

The Freyssibar prestressing bars, thanks to their thread over their full length, allow to build ground and rock anchors fulfilling the requirements of international standards. Lengths over 12 m can be obtained by means of one or several sleeves.

The ducting accessories and the anchorage corrosion protection systems are adjusted to the design life time of the anchor: temporary or permanent.

In addition, the anchors can be fitted with injection tubes to fill the bore hole and reinjection tubes to improve the bonding to the substrate.

PERMANENT

Item	Dim.	Nominal diameter bars (mm)					Ref.
		26.5	32	36	40	50	
Steel formwork tube	Ø	80	89	89	89	108	FTUB
Plastic smooth sheath	Ø	60	70	70	75	90	STUB
Plastic ribbed sheath	Ø	55	65	65	70	85	RTUB
Plastic spacer	Ø	95	105	105	110	125	SPC
End protective cap	Ø	95	101,6	114,3	114,3	139,7	CE

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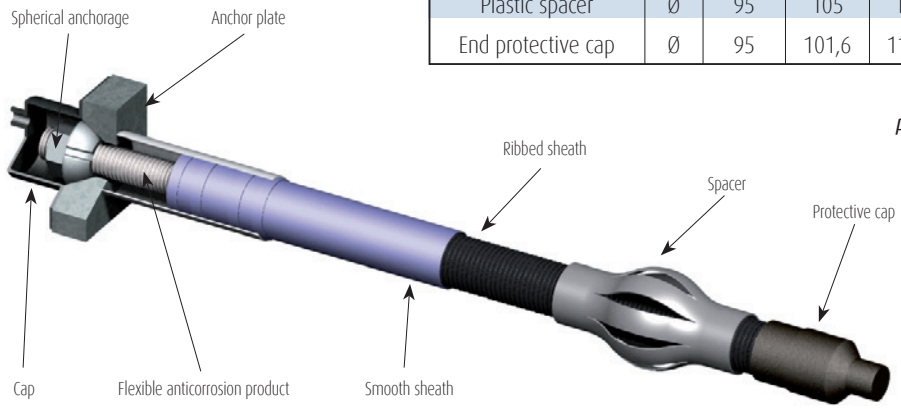

TEMPORARY

Item	Dim.	Nominal diameter bars (mm)					Ref.
		26.5	32	36	40	50	
Plastic smooth sheath	Ø	50	50	50	60	65	SPC
Plastic spacer	Ø	55	60	65	80	90	CE

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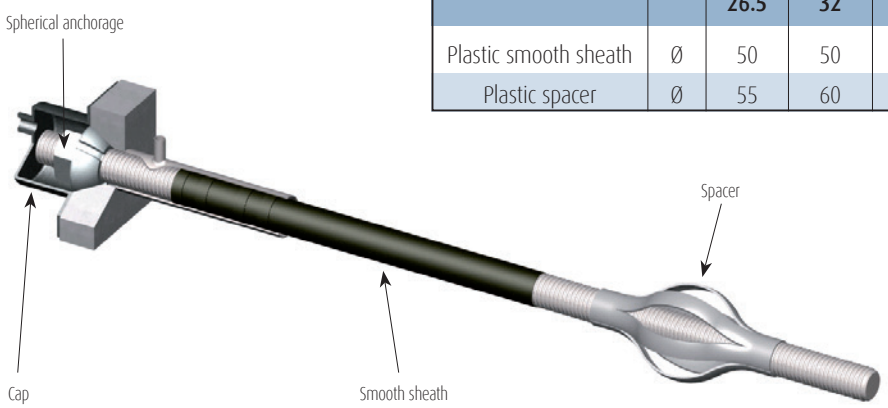

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