

# PT concrete slabs



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Prestressing by post-tensioning, commonly used in structures throughout the world for very many years, is making a name for itself in the building field. An increasing number of architects, developers and design offices have understood its advantages and make the most of it for constructing buildings.

In keeping with our life style, modern architectural trends favour large areas with no floors breaking them up, flexible internal layout, the ease of converting and moving spaces around. So many requirements that may be met by resorting to prestressing by post-tensioning allowing long spans to be constructed with no obstructions, with a minimum number of columns and reduced floor depths.

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## An active system

Prestressing cables, consisting of bonded or sheathed greased strands, also called «active reinforcement» - are located and wedged in formworks then tensioned after concreting with light equipment.

An «upwards» reaction is exerted in spans by their being curved and this acts against gravity loads relieving the slab. Since the permanent loads are compensated in this way, deflection of the parts and internal loads are reduced. As for the curvature of cables, directed downwards at supports, this acts against punching shear stresses around the columns.

Lastly, thanks to prestressing, the entire concrete thickness plays a part in bending strength whatever the load system, and therefore floor depths may be reduced in relation to a reinforced concrete solution for a similar span.

The unit consisting of the steel reinforcement (or strand(s)), the protective sheath containing these strands, and the protective product is called the «cable».

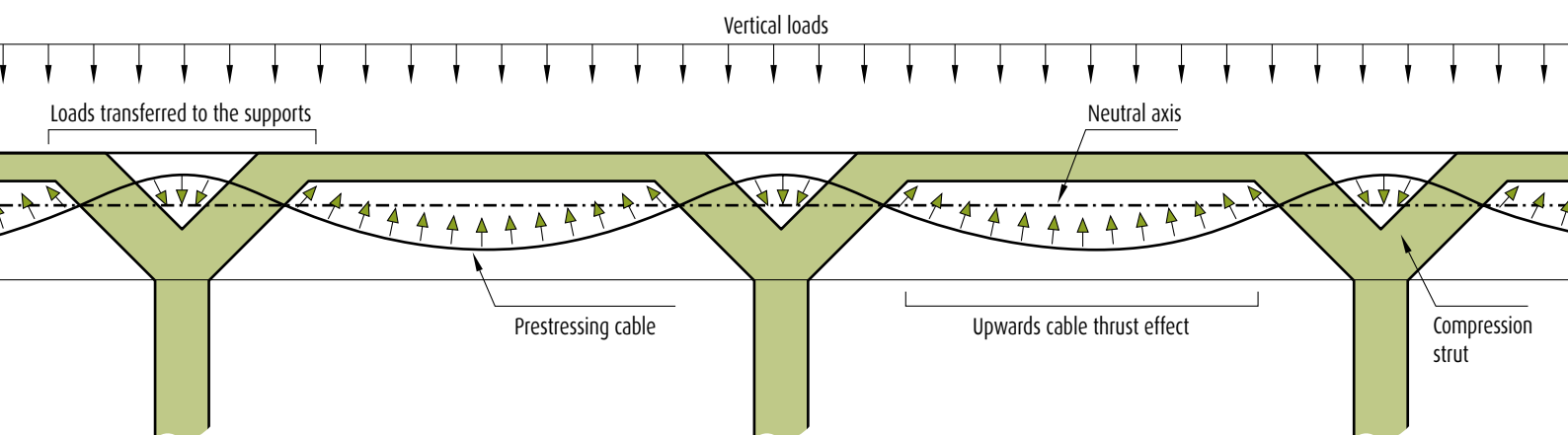


Prestressing by post-tensioning, as opposed to bonded wires tensioned before the concrete is poured, comes in two types:

- unbonded prestressing, represented by greased sheathed strands or sheaths injected with a flexible product (wax, grease, etc.);
- bonded prestressing or with «rigid» grouting (cement grout) identical to the one used in civil engineering.



Only the failure behaviour of the element varies depending on the kind of prestressing applied. It has been possible to calculate the sections of passive reinforcement required for obtaining equivalent failure safety for the two processes, from very many tests.





## Various applications

Flexibility of application - made with light equipment - and the mechanical features of Freyssinet prestressing by post-tensioning, provide architects, consulting engineers, design offices and developers with a cost effective solution for designing floors and terraces in a wide variety of projects:

- office or residential towers;
- underground car parks and multi-storey car parks;
- hospitals;
- schools;
- business centres;
- industrial buildings;
- sports buildings;
- special structures (multiple stage settling basins, storage reservoirs).

Two areas of application should be considered.



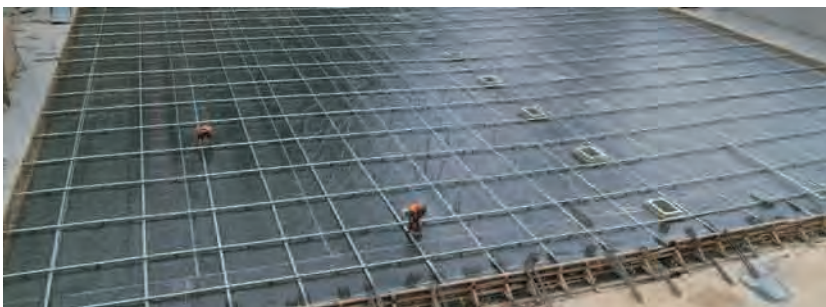
### Floors and foundation slabs of buildings

Prestressing plays a part in bending strength due to working loads (slabs) or ground reactions (foundation slabs). It is the same for overhead or underground parking areas, office buildings, records offices, hospitals, etc.

Permanently compressing the concrete provides an extra guarantee of waterproofing the building for foundation slabs subject to uplift.

### Industrial slabs

Rectilinear centred prestressing mainly plays a part in withstanding concrete shrinkage effects and improving bending strength. Thus very large size industrial slabs may be constructed, without intermediate joints, and this is especially considerable for automatic controlled conveyor installation, for which areas have to be perfectly smooth. It is also an advantage for doing without joints that are weak points for wear on account of traffic. Very carefully finished plane slabs can be produced using prestressing.

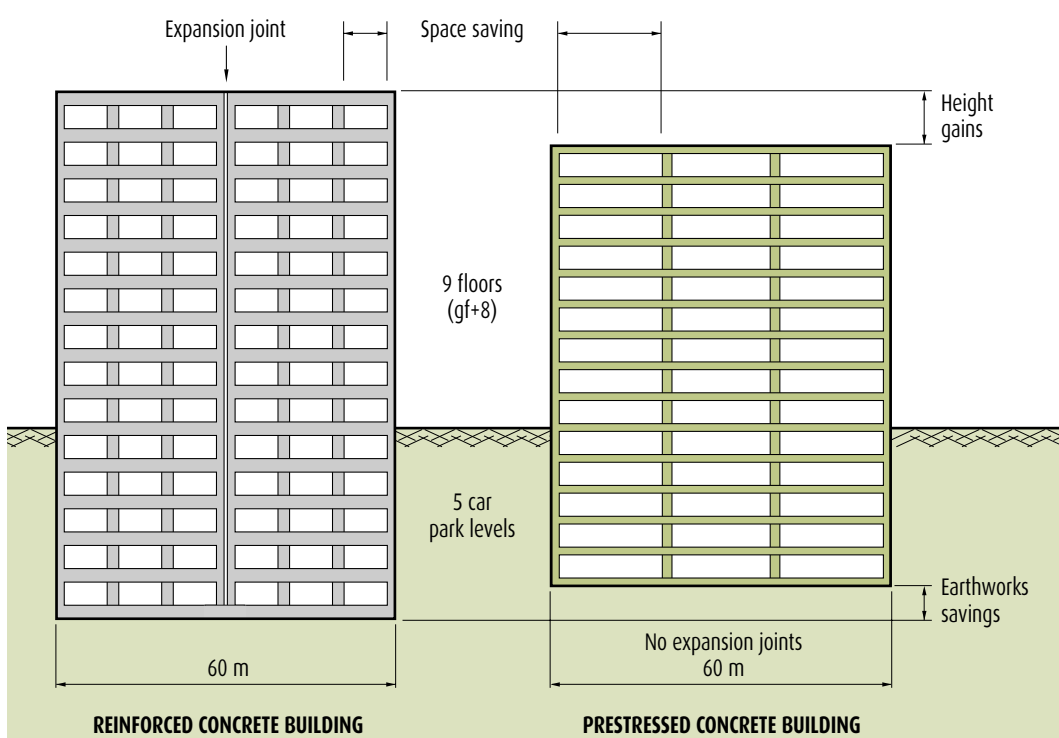


## The benefits of state-of-the-art technology

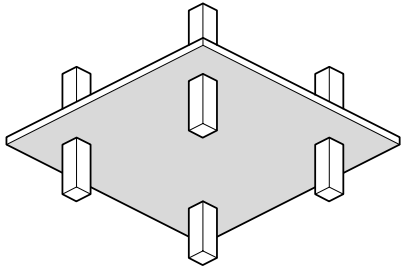
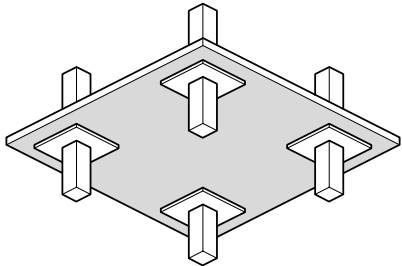
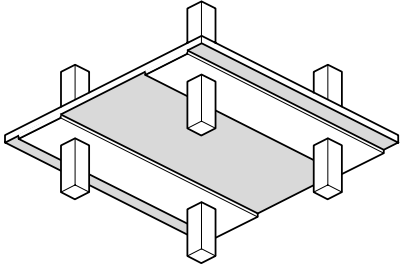
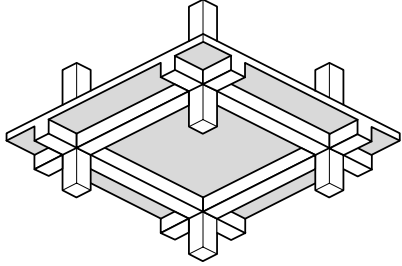
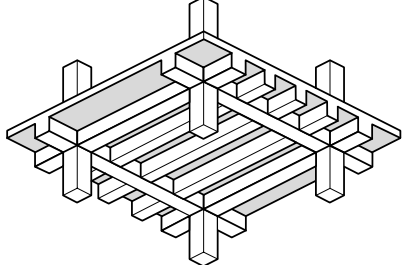
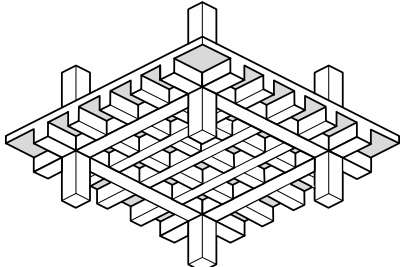
Freyssinet developed a compact prestressing system covered by European Technical Approval, specially appropriate for flat unit prestressing. This system usefully replaces traditional slabs of reinforced concrete or other mixed systems used in building.

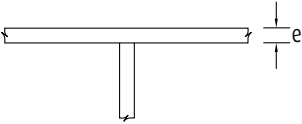

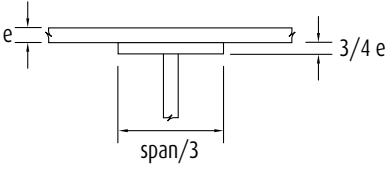

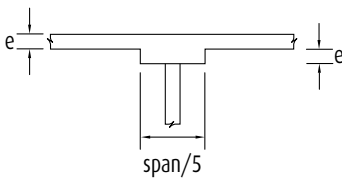

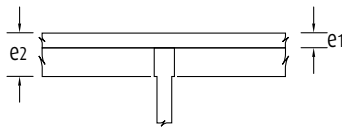
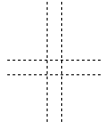
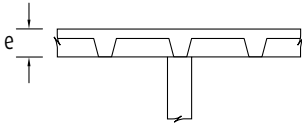
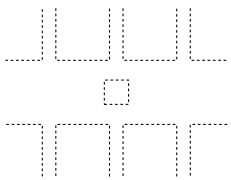
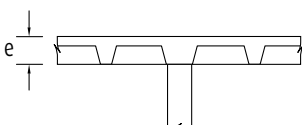
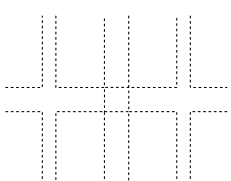
It provides a great many options including :

- increasing spans and load carrying capacity;
- reducing slab thickness;
- reducing beam downstands;
- reducing own weight, quantities of materials and loads on foundations;
- considerably reducing and simplifying passive reinforcement;
- reducing the number of expansion joints and columns;
- better punching shear characteristics;
- outstanding behaviour in seismic zones;
- increased cracking resistance;
- increased waterproofing due to concrete compression;
- using self-protected strands;
- deflection compensation;
- removal of the formwork within 3 days;
- matching variable complex geometry in buildings.



## Construction types and dimensions

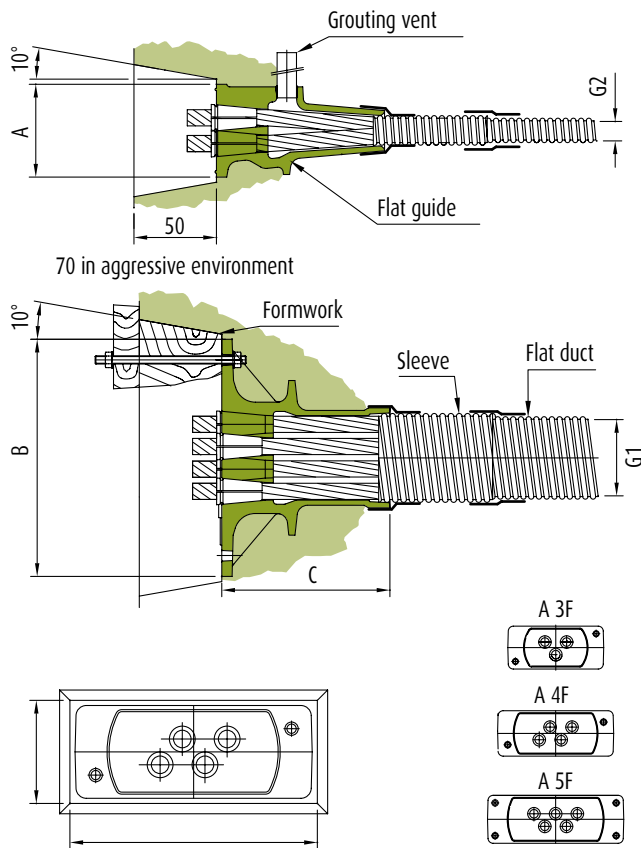
	<i>Types of floors</i>	<i>Fields of application</i>
solid flat slab		<ul style="list-style-type: none"> <li>• Spans approximately equal both ways.</li> <li>• Relatively light working loads.</li> <li>• Residential buildings, office buildings, hotels, hospitals, parking areas.</li> <li>• Spans: 5 to 12m.</li> </ul>
solid flat slab with drop panels		<ul style="list-style-type: none"> <li>• Applications are the same as for slab floors, but for spans up to 16m.</li> </ul>
banded flat slab		<ul style="list-style-type: none"> <li>• Recommended for buildings mainly spanning one way.</li> <li>• Relatively moderate working loads.</li> <li>• Business centres, parking areas, schools.</li> <li>• Cantilever span: up to 16m.</li> </ul>
flat slab		<ul style="list-style-type: none"> <li>• Spans approximately equal both ways.</li> <li>• Relatively moderate working loads.</li> <li>• Office buildings, hotels, hospitals, parking areas.</li> <li>• Spans: 10 to 20m.</li> </ul>
ribbed slab		<ul style="list-style-type: none"> <li>• To be used for heavy live loads.</li> <li>• File storage, industrial buildings, airport buildings.</li> <li>• Spans: 10 to 20m.</li> </ul>
coffered flat slab		

Common size	Working load $\text{kN/m}^2$	Span/depth (e) ratio	
 	1.5	42	
	2.5	40	
	5.0	36	
 	1.5	46	
	2.5	44	
	5.0	40	
 	1.5	48	
	2.5	45	
	5.0	40	
 	1.5	SLAB (e1) 46	BEAM (e2) 20
	2.5	42	18
	5.0	38	16
 	2.5	30	
	5.0	27	
	10.0	24	
 	2.5	25	
	5.0	23	
	10.0	20	

These «common» ratios are given for information

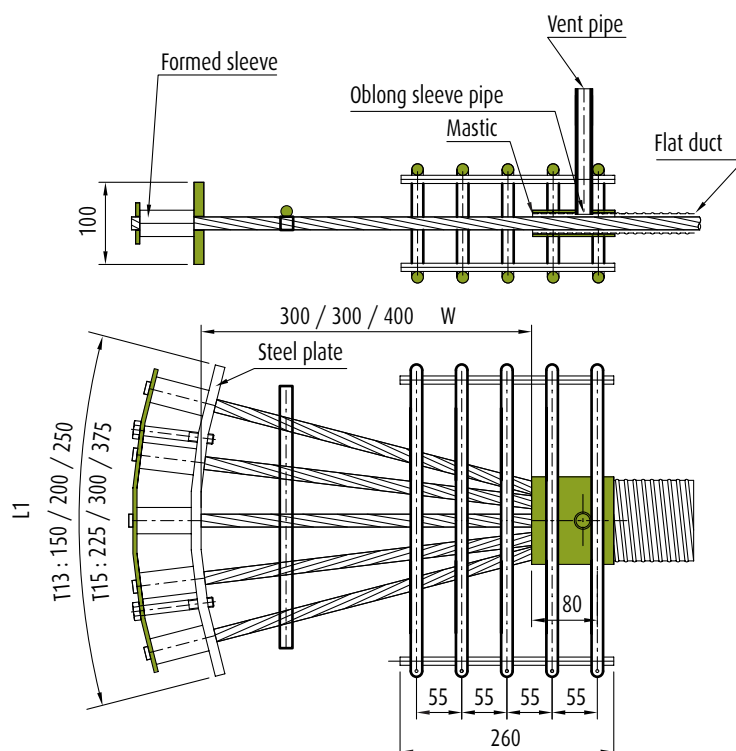
## Bonded prestressing (bare strands)

### Active anchorage (F range)

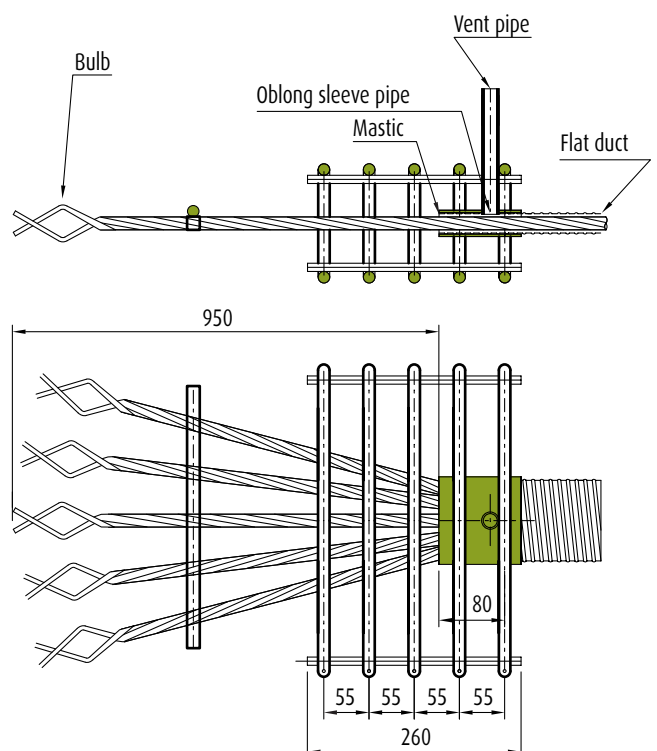


ANCHORAGE	DIM.	A	B	C	G	H	G1 x G2
	A 3F 13	85	180	163	95	190	58 x 21
	A 4F13	85	230	163	95	240	58 x 21
	A 5F 13	85	270	163	95	280	75 x 21
	A 3F 15	85	190	163	95	200	58 x 21
	A 4F 15	90	230	163	100	240	75 x 21
	A 5F 15	95	270	163	105	280	90 x 21

### Fixed Anchors (NE)



### (G)



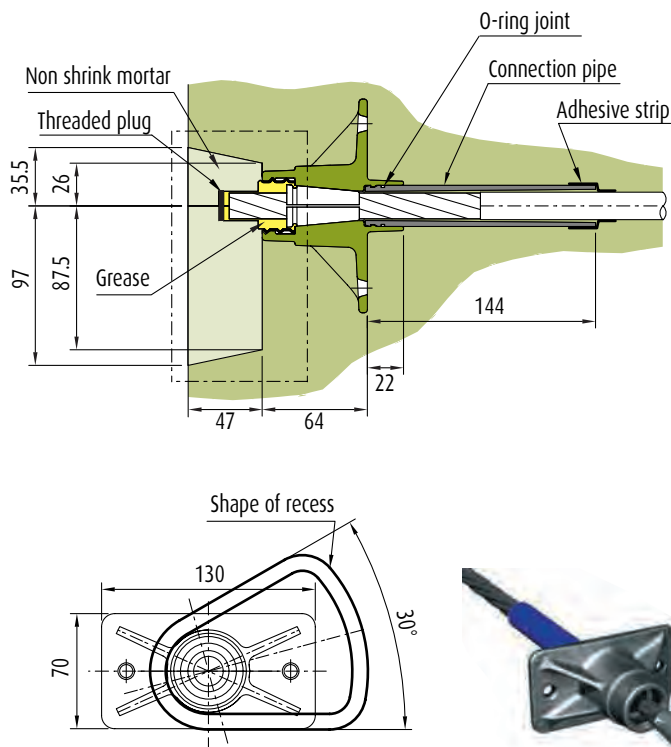
The L1 and W values are respectively given for units of 3, 4 and 5 strands.



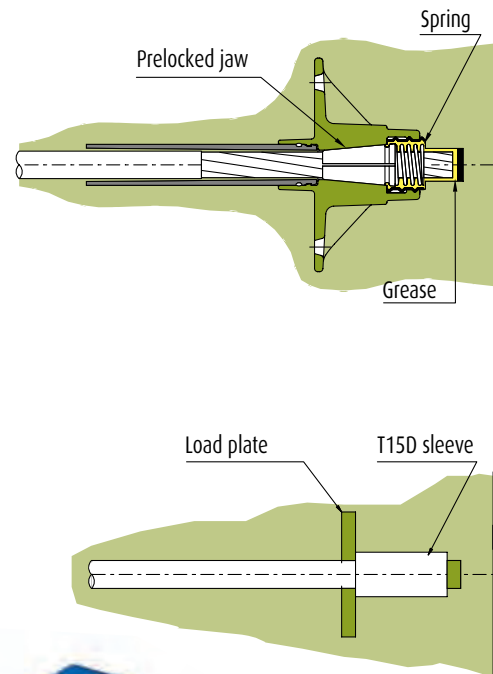
# Unbonded prestressing (sheathed greased strands)

## Monostrand unit (1F13/1F15)

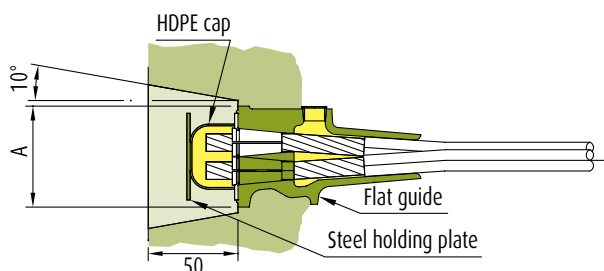
### Active anchorage



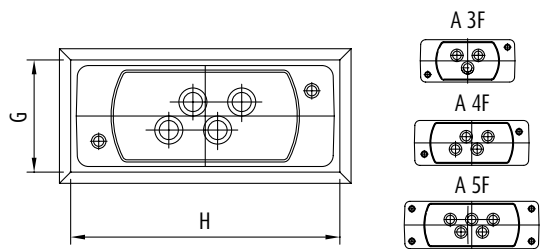
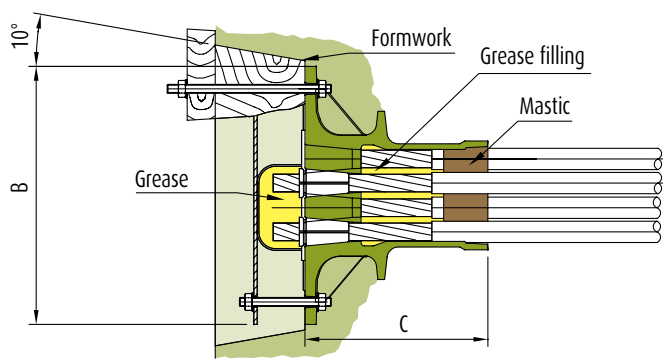
### Fixed anchorage



## Multi strand unit (F Range)



70 in aggressive environment



ANCHORAGE	DIM.	A	B	C	G	H
	A 3F 13	85	180	163	95	190
	A 4F 13	85	230	163	95	240
	A 5F 13	85	270	163	95	280
	A 3F 15	85	190	163	95	200
	A 4F 15	90	230	163	100	240
	A 5F 15	95	270	163	105	280

## Installation

### Installing prestressing cables



Strands for bonding prestressing are supplied to the site rolled on reels (about 3 tonnes). They are unrolled, cut to length and threaded in the sheaths before concreting.

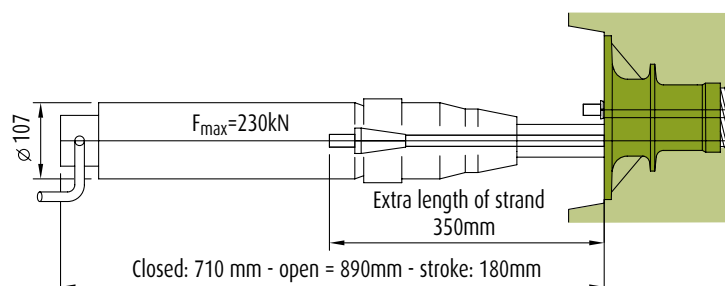
Cables for unbonded prestressing are more frequently supplied prefabricated (with anchor blocks fitted on the ends). They are directly located in the reinforcement, on chairs fixed on the formwork.

### Concreting

Cables may be tensioned with a light monostrand jack three days generally after concreting, thus allowing for the removal of the formwork.



### Light compact tensioning jacks





## References

- 1/ Concorde Lafayette Hotel in Paris (France), 1974.
- 2/ C&P Storage Area in Jurong (Singapore), 1997.
- 3/ European Parliament in Strasbourg (France), 1998.
- 4/ Auchan Gramont Parking Area, Toulouse (France), 2003-2004.
- 5/ Malaysia Telekom Tower in Kuala Lumpur (Malaysia), 1998.



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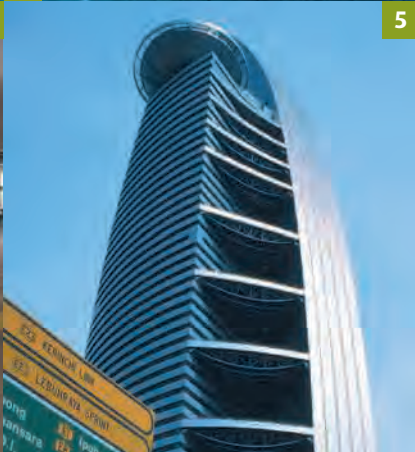
3



2



4



5



6



7



8

6/ Blenheim Center Storage Area in Hounslow (Great Britain), 2005.

7/ National Bank Tower in Abu Dhabi (United Arab Emirates), 2004.

8/ Parking Area at the Department Building in Versailles (France), 1989.



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