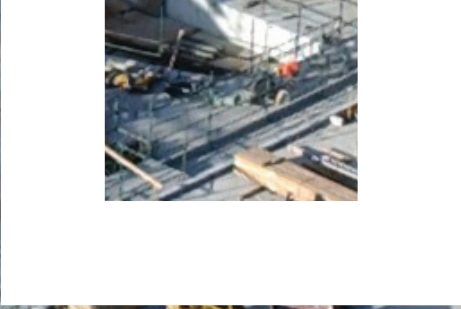
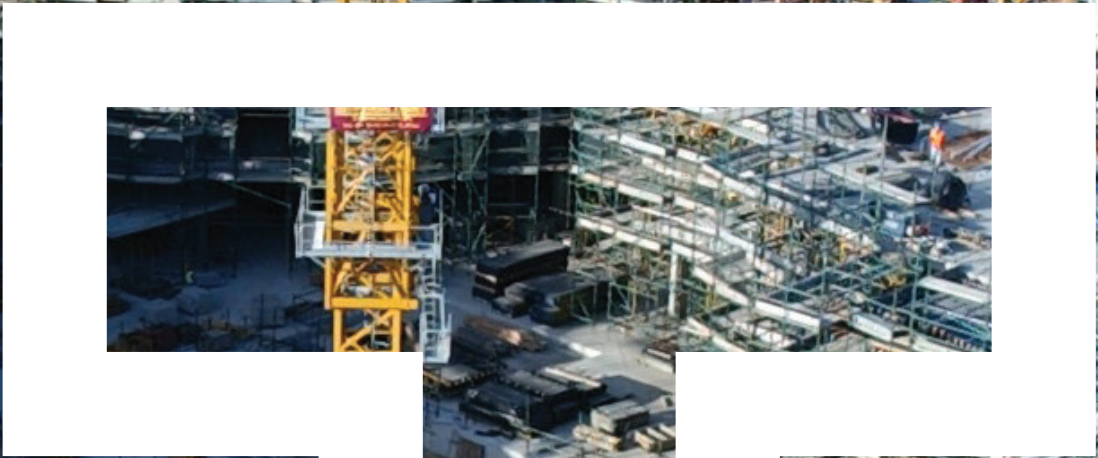


# PRESTRESSING TECHNOLOGY

We're the one contractor who can do it all





Peppers Pier Resort, QLD

# Prestressing Technology

**SRG Global are world leaders in prestressing technology, which enables faster construction, a reduction in reinforcement, thinner and more economical slabs, larger floor spans and fewer columns.**

Our innovative design, advanced construction techniques and effective project management skills make SRG Global the leader in the design and installation of prestressing systems.

Our in-house construction design capacity allows us to customise the slab for every job, and we investigate multiple paths to reducing slab thickness, steel usage and construction times. Optimising the design for both concrete and steel usage saves time and money and minimises environmental impact.

Customers choose SRG Global because we are able to provide smart and efficient solutions to difficult problems, drawing on a depth of operational experience unparalleled in our industry.

Prestressing - or post-tensioning as it is commonly referred to - is a method of reinforcing (strengthening) concrete or other materials with high-strength steel strands.

The benefits post-tensioning brings to a structure include:

- Large open plan column free floor spaces
- Reduced construction costs
- Faster construction
- Water resistant properties
- Floor to floor height reduction
- Reduced carbon footprint
- Greater loading capacity
- Larger spans

The technology reduces the amount of conventional reinforcement and concrete required thus delivering a more economical and environmentally friendly solution.

SRG Global is committed to improving the standard of design and construction in the post-tensioning industry and is a founding corporate member of the Post-Tensioning Institute of Australia.

## Slab Post-Tensioning

## Multi-Strand Post-Tensioning

## External Prestressing

## Unbonded Band Post-Tensioning

## Multi-Wire Post-Tensioning

## Bar Post-Tensioning



**PTIA**

**Macalloy**

## Post-Tensioning Design Data

### STRAND PROPERTIES

STANDARD	NOMINAL DIAMETER	NAME TAG <sup>(9)</sup>	STRAND GRADE	NOMINAL STRAND AREA mm <sup>2</sup>	NOMINAL MASS kg/lm	STRAND MBL / FM <sup>(7)</sup> kN	MIN. PROOF LOAD kN	STRAND RELAXATION <sup>(6)</sup> (%)	MODULUS OF ELASTICITY MPa
	mm								
AS 4672 <sup>(1)</sup>	12.7	SUPER	1,870	98.6	0.774	184	156 <sup>(4)</sup>	2.5	185 to 205x10 <sup>3</sup>
	15.2	SUPER	1,750	143	1.122	250	212 <sup>(4)</sup>	2.5	185 to 205x10 <sup>3</sup>
	15.2	EHT	1,830	143	1.122	261	222 <sup>(4)</sup>	2.5	185 to 205x10 <sup>3</sup>
ASTM A-416 <sup>(10)</sup>	12.7	GRADE 270	1,860	98.71	0.775	183.7	156.1 <sup>(9)</sup>	2.5	Approx 195x10 <sup>3</sup>
	15.24	GRADE 270	1,860	140	1.102	260.7	221.5 <sup>(9)</sup>	2.5	Approx 195x10 <sup>3</sup>
BS 5896 <sup>(2)</sup>	12.9	SUPER	1,860	100	0.785	186	158.1 <sup>(5)</sup>	2.5	180 to 205x10 <sup>3</sup>
	15.7	SUPER	1,770	150	1.180	265	225.3 <sup>(5)</sup>	2.5	180 to 205x10 <sup>3</sup>
PREN 10138-3 <sup>(3)</sup>	12.9	REGULAR	1,770	100	0.781	177	156 <sup>(5)</sup>	2.5	180 to 205x10 <sup>3</sup>
	15.3	REGULAR	1,770	140	1.093	248	218 <sup>(5)</sup>	2.5	180 to 205x10 <sup>3</sup>
	15.7	REGULAR	1,770	150	1.172	266	229 <sup>(5)</sup>	2.5	180 to 205x10 <sup>3</sup>
	12.9	SUPER	1,860	100	0.781	186	164 <sup>(5)</sup>	2.5	180 to 205x10 <sup>3</sup>
	15.3	SUPER	1,860	140	1.093	260	234 <sup>(5)</sup>	2.5	180 to 205x10 <sup>3</sup>
	15.7	SUPER	1,860	150	1.172	279	246 <sup>(5)</sup>	2.5	180 to 205x10 <sup>3</sup>

Notes: (1) Australian / New Zealand Standard AS 4672 steel prestressing materials.

(2) British Standard BS 5896 high tensile steel wire and strand for prestressing of concrete.

(3) European Standard prEN 10138-3 Prestressing steels - Part 3: Strand.

(4) At 0.2% offset, refer AS 4672.

(5) At 0.1% offset, refer BS 5896 or prEN 10138-3 as applicable.

(6) Relaxation after 1000 hrs at 0.7 x breaking load.

(7) MBL = Minimum Breaking Load (to AS 4672 and BS 5896). Fm = Characteristic Force (to prEN 10138-3).

(8) Name tag refers to (i) as described in Standard, or (ii) as otherwise known in Industry.

(9) Minimum Load @ 1% extension.

(10) ASTM / A416M - 02.

• All strands are 7 wire relax 2 steel.

### WIRE PROPERTIES

STANDARD	NOMINAL DIAMETER mm	NOMINAL STEEL AREA mm <sup>2</sup>	NOMINAL MASS kg/lm	STRAND MBL / FM <sup>(7)</sup> kN	MIN. PROOF LOAD kN	STRAND RELAXATION (%)	MODULUS OF ELASTICITY MPa
AS 4672 <sup>(1)</sup>	7 LR	38.5	0.302	64.3	54.7 <sup>(4)</sup>	2.0	195 to 215x10 <sup>3</sup>
BS 5896 <sup>(2)</sup>	7 LR	38.5	0.302	64.3	53.4 <sup>(5)</sup>	2.5	195 to 205x10 <sup>3</sup>

Notes: (1) Australian / New Zealand Standard AS 4672 steel prestressing materials.

(2) British Standard BS 5896 high tensile steel wire and strand for prestressing of concrete.

(3) European Standard prEN 10138-3p prestressing steels - Part 3: Strand.

(4) At 0.2% offset, refer AS 4672.

(5) At 0.1% offset, refer BS 5896 or prEN 10138-3 as applicable.

(6) Relaxation after 1000 hrs at 0.7 x breaking load.

(7) MBL = Minimum Breaking Load (to AS 4672 and BS 5896).

Fm = Characteristic Force (to prEN 10138-3).

### MAXIMUM JACKING FORCES - RECOMMENDED VALUES

SRG POST-TENSIONING SYSTEM	STANDARD	
	AS 3600	EN 1992
BBR VT CONA CMI SYSTEM	80% MBL	80% MBL
BBR VT CONA CME SYSTEM	77% MBL	77% MBL
BBR VT CONA CMB SYSTEM	80% MBL	80% MBL
SLAB SYSTEM	85% MBL	80% MBL
WIRE SYSTEM	80% MBL	80% MBL
BAR SYSTEM	75% MBL	75% MBL

Notes: • In some cases higher or lower jacking forces are permitted by local standards.

• MBL = Minimum Breaking Load of tendon.

### PRESTRESSING LOSSES - TYPICAL DATA

SYSTEM	BBR VT CONA CMI	BBR VT CONA CME	BBR VT CONA CMB	SLAB	WIRE	BAR
ANCHORAGE & JACKING LOSS (%)	0.08 to 1.2	0.8 to 1.2	0.9 to 1.2	2 <sup>(1)</sup>	0 to 1	0 to 1
DRAW-IN ALLOWANCE (mm)	6	6	6	6	2 to 3	1 to 2
DUCT FRICTION Q	Round Steel Duct	0.16 to 0.24	0.16 to 0.24	N/A	0.15 to 0.20	0.15 to 0.20
	Flat Steel Duct	N/A	N/A	N/A	0.20	N/A
	Polyethylene Duct Greased & Sheathed	0.10 to 0.14	0.10 to 0.12	0.06 to 0.12	0.10 to 0.15	0.10 to 0.15
TENDON WOBBLE β (k) rad/m*	Round Steel Duct ≤ 50mm	0.016 - 0.024	N/A	N/A	0.016	0.008 - 0.016
	Round Steel Duct > 50mm	0.008 - 0.016	N/A	N/A	0.008 - 0.012	0.008 - 0.016
	Flat Steel Duct	N/A	N/A	N/A	N/A	N/A
	Greased & Sheathed	N/A	N/A	N/A	0.016 - 0.024	N/A

Notes: • To reduce excess friction, it may be possible to flush the tendon with water or water soluble oil.

• If the duct or strand has a film or rust or the ducts are full of water, the friction values can increase significantly.

(1) Allow for 5% loss in effective jacking force at surface recessed stressing pans.

(\*) Tendon wobble values listed are indicative only. Actual wobble is often dependent on construction technique and workmanship.



# Prestressing Technology

**Post-Tensioning (PT) is an efficient way of reinforcing concrete while you are building - often allowing the construction of something which might otherwise have been impossible.**

It can also be combined with other structural materials, such as steel and masonry structures. PT provides active reinforcement and places the concrete structure under compression in those regions where load causes tensile stress.

Developments in post-tensioning over the past decades means that it is now a mainstream component of the construction industry and is applied in bridges, buildings, arenas, dams, nuclear power stations, wind farms, cryogenic LNG tanks, silos, wastewater treatment plants, water reservoirs, marine structures, retaining walls, towers and tunnels.

## **Post-Tensioning vs. Pre-Tensioning**

Both post-tensioning and pre-tensioning create prestressed concrete. Pre-tensioned systems, however, must be fabricated in a precast plant and are limited to straight, harped, or circular tendons. In addition, construction of continuous structures is very limited with this method.

Post-tensioning, on the other hand, allows almost any shape to be constructed and is able to match nearly any design requirement. Internal, bonded, unbonded and external post-tensioning is usually performed on the project site and provides superior corrosion protection features.

## **Internal vs. External Post-Tensioning**

Tendons installed in the formwork prior to pouring the concrete are known as internal tendons. External tendons are placed on the other surface of concrete structures. This type of post-tensioning allows access for maintenance and replacement and is therefore the solution of choice for bridge enhancements and refurbishments. It can also be applied to many other types of structures.



### Internal Bonded Vs. Unbonded Post-Tensioning

Internal bonded post-tensioning systems can range from a single strand to multiple strands per tendon. The strands are inserted into a metal or plastic duct that is then filled with cementitious grout, creating a bond with the surrounding concrete. The grout creates an alkaline environment which ensures corrosion protection of the prestressing steel.

Unbonded PT differs from bonded post-tensioning in that it provides each individual tendon with permanent freedom of movement relative to the concrete.

(Note: Unbonded systems are not typically used in Australia.)

### Professional Installation Practice

Post-tensioning and grouting operations require the highest level of professionalism which is exactly what the certified BBR PT specialists and members of the BBR Network

deliver. These well-trained and experienced staff are continuously educated through practical and theoretical training courses to ensure professional execution of PT works. All SRG Global operatives are trained under the Post-Tensioning Institute of Australia's (PTIA's) training programmes.

Installation of the post-tensioning starts in conjunction with the non-tensioned reinforcement and after the formwork has been erected. The first step in the process is to affix the anchorages and to layout the ducting, then the high tensile steel strands are installed. Once the concrete is poured and has attained its transfer strength the tendon is stressed utilising a hydraulic jack and then locked off at the anchorage. The anchorage maintains the applied force in the tendon and transfers it to the surrounding concrete. The duct is then filled with a cementitious grout or flexible corrosion inhibitor. Grouting is carried out carefully under controlled conditions to ensure that the whole tendon is completely filled. Installation can also be performed with a fully or partially prefabricated tendon.

### Key Benefits of Post-Tensioning Structures

- **Greater flexibility of design** - PT allows highly creative architectural approaches and very demanding geometry requirements.
- **Increased deflection control and improved crack control** - virtually crack-free concrete delivers long term durability.
- **Faster construction program** - early strength stressing promotes a faster cycle time, allowing the structure to progress more rapidly.
- **Lower construction material costs** - PT can decrease the size of a structural member and reduce the quantity of concrete and steel required for the superstructure.
- **Reduced environmental impact** - less material creates fewer carbon emissions in terms of production and transportation.
- **Reduced construction costs** - a faster cycle time and decreased amount of material minimise costs.



# Slab Post-Tensioning

The Slab Post-Tensioning System comprises high strength steel strands, up to six in number, placed inside flat ducting, typically anchored at one end by deforming the strand and casting it into the concrete then at the other end by means of a steel anchorage casting and anchor block(s) with gripping wedges.

After the concrete has reached it's transfer strength, the individual strands have specified load applied. The duct is filled with a high strength cementitious grout mixture to ensure the system is bonded and corrosion protection is maintained in service.

## **Applications for the SRG Global Slab Post-Tensioning System include:**

- Low to high rise residential and commercial buildings
- Industrial floor slabs on grade
- Transfer floor structures
- Carparks
- Water tank bases and walls
- Transverse stressing of bridge decks



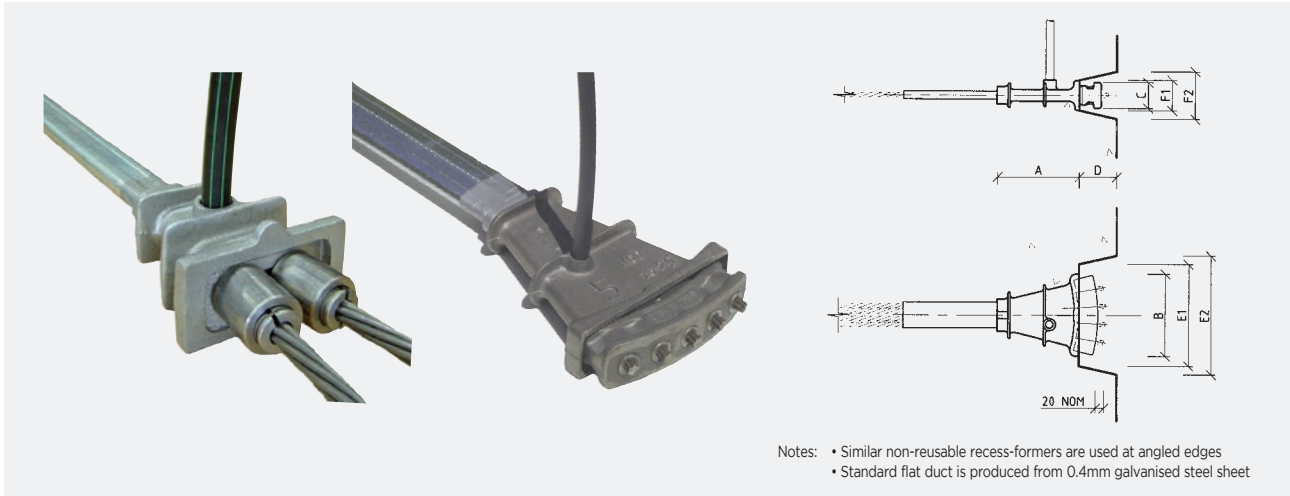




Coca-Cola Warehouse - Eastern Creek VIC

# SLAB POST-TENSIONING

## Live End Anchorages



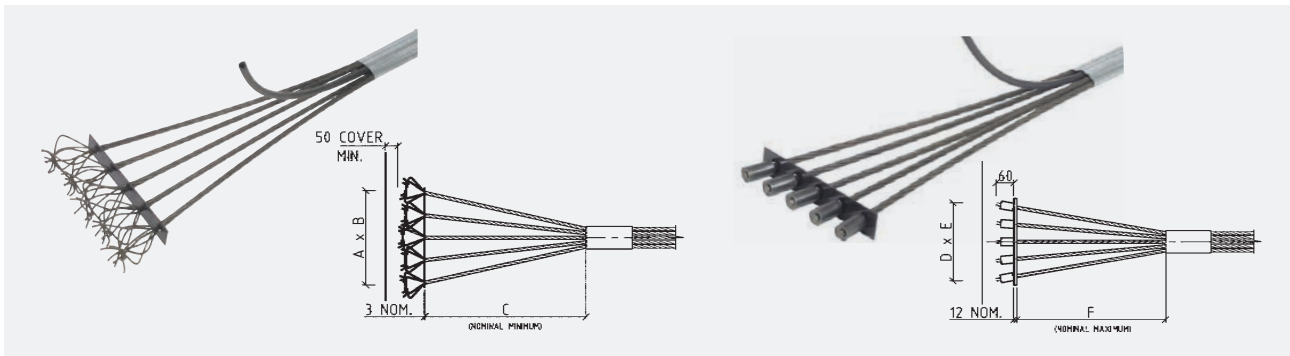
- Similar non-reusable recess-formers are used at angled edges
- Standard flat duct is produced from 0.4mm galvanised steel sheet

### STRESSING ANCHORAGE (LIVE ENDS)

STRAND SIZE	TENDON UNIT	No. STRANDS	ANCHORAGE CASTING				RECESS FORMER				FLAT DUCT SIZE mm
			A mm	B mm	C mm	D mm	E1 mm	E2 mm	F1 mm	F2 mm	
12.7 mm and 12.9 mm	205	2	152	135	70	100	180	180	100	100	43 x 19
	305	3	152	135	70	100	180	180	100	100	43 x 19
	505	4 or 5	215	220	78	100	265	270	80	100	70 x 19
	605	6	270	262	78	100	265	300	80	100	90 x 19
15.2 mm and 15.7 mm	206	2	152	135	70	100	180	180	100	100	43 x 19
	406	3 or 4	215	220	78	100	265	300	80	100	70 x 19
	506	5	270	262	78	100	265	300	80	100	90 x 19

- Notes:
- Tendon units 205, 605, and 206 are supplied with individual barrel anchorages in lieu of anchorage blocks.
  - Grout tubes are 13mm ID or 19mm ID polyethylene pipe supplied to each end of tendon. Additional intermediate vents can also be supplied (designer to specify requirements).
  - All sizes are nominal. Some dimensions have been rounded up for normal space, detailing and tolerance requirements.

## Dead-End Anchorages



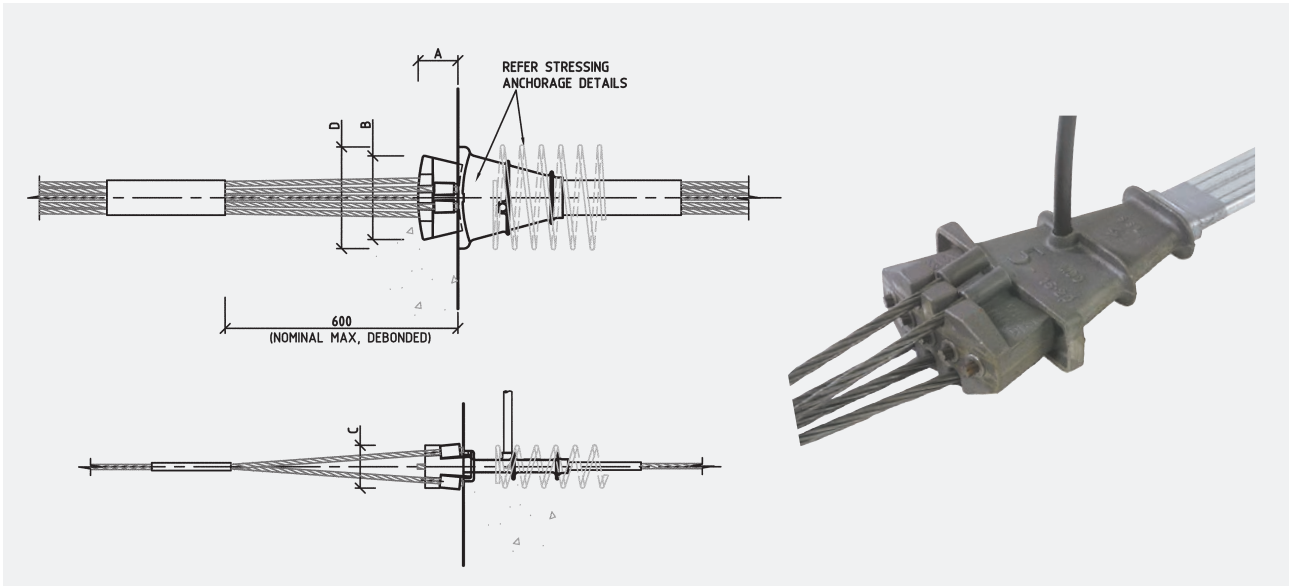
### STRESSING ANCHORAGE (DEAD ENDS)

STRAND SIZE	TENDON UNIT	BULB DEAD END ANCHORAGE DIMENSIONS			SWAGE TYPE DEAD END ANCHORAGE DIMENSIONS		
		A mm	B mm	C mm	D mm	E mm	F mm
12.7mm and 12.9mm	105	75	50	800	100	75	600
	205	135	50	800	125	75	600
	305	230	50	800	200	75	600
	405	270	50	800	250	75	600
	505	350	50	800	300	75	600
	605	400	50	800	350	75	600
15.2mm and 15.7mm	106	75	50	800	125	75	600
	206	135	50	800	150	75	600
	306	230	50	800	225	75	600
	406	270	50	800	300	75	600
	506	350	50	800	350	75	600

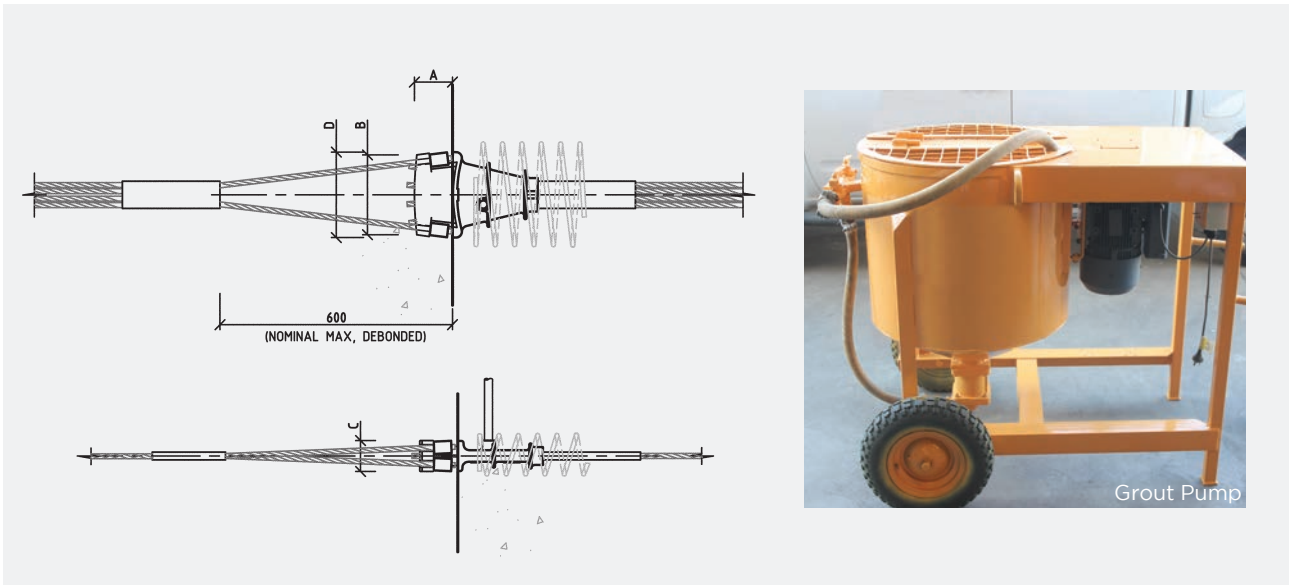
# SLAB POST-TENSIONING

## Coupling Anchorages

### COUPLING ANCHORAGE - 505, 406 & 506



### COUPLING ANCHORAGE - 405



### COUPLING ANCHORAGES

STRAND SIZE	COUPLING UNIT	COUPLING ANCHORAGE DETAILS DIMENSIONS (MM)			
		A	B	C	D
12.7mm / 12.9mm	405	100	220	80	220
	505	100	220	110	220
15.2mm / 15.7mm	506	100	240	120	265

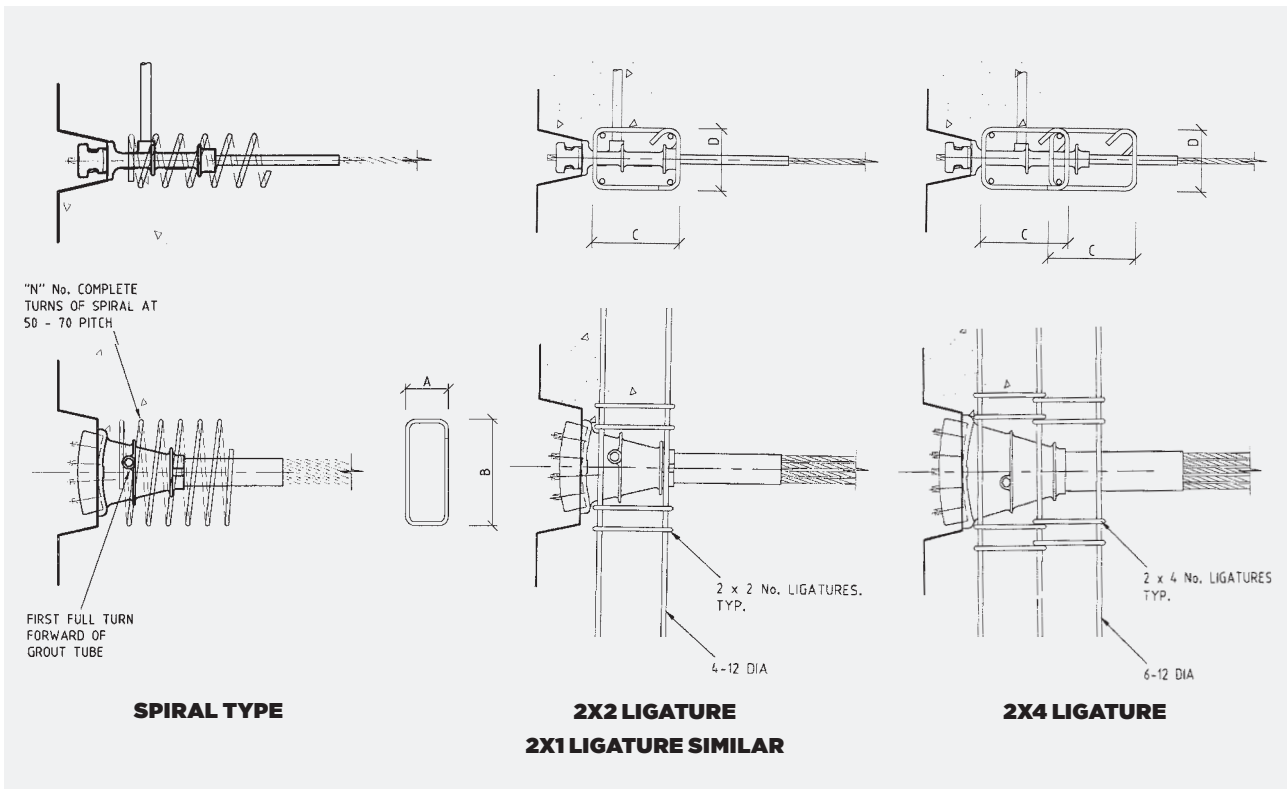
Note: 3 and 4-strand units are coupled using the applicable 5-strand coupler, UNO.

# SLAB POST-TENSIONING

## ANCHORAGE REINFORCEMENT - SLAB SYSTEMS

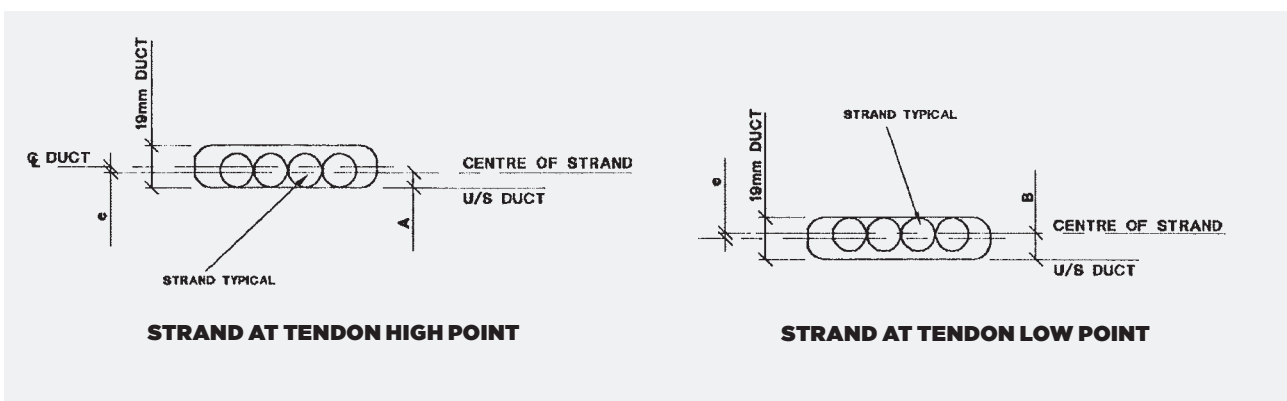
TENDON UNIT	No. OF STRANDS	SPIRAL TYPE (PREFERRED)			LIGATURE TYPE			f <sub>cp</sub> MPa
		A mm	B mm	N No.	C mm	D mm	N No.	
205	2	90	200	4	200	100	2 x 1	22
305	3	90	200	4	200	100	2 x 1	22
505	4 or 5	90	270	6	200	130	2 x 2	22
605	6	100	300	8	200	150	2 x 4	22
206	2	90	200	4	200	110	2 x 2	25
406	3 or 4	90	270	6	200	130	2 x 2	25
506	5	100	300	8	200	150	2 x 4	25

Notes: • Reinforcement size 10dia, grade 500MPa to AS/NZS 4671 or grade 460 to BS4449.  
 • f<sub>cp</sub> = min required site and air-cured cylinder strength as measured by test at anchorage at time of stressing.  
 • Details of anchorage bursting reinforcement shown are the minimum required. Designers must satisfy themselves of the adequacy of bursting and spalling reinforcement as required for specific situations.



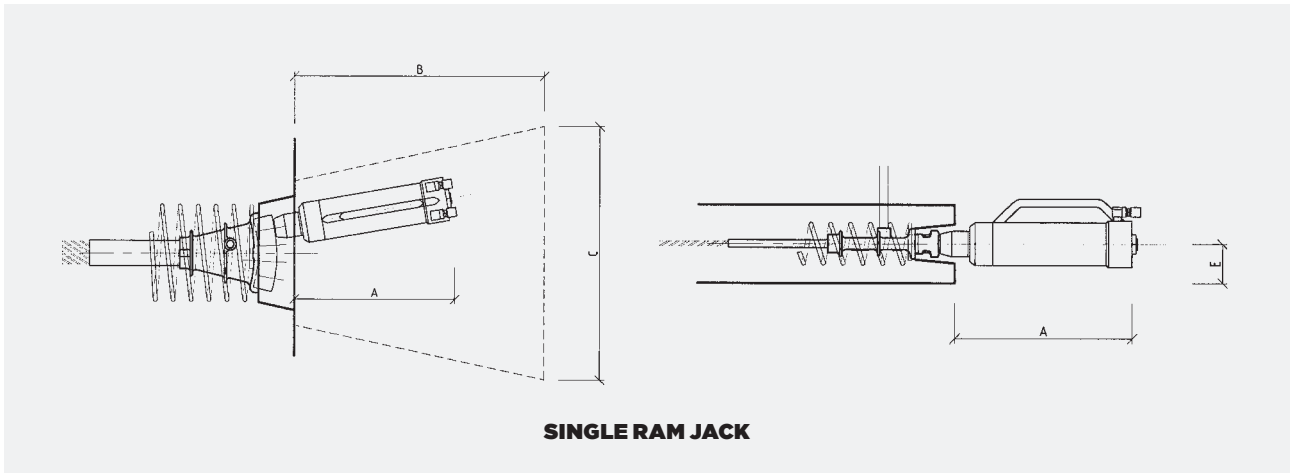
## SUGGESTED ALLOWANCES - STRAND OFFSETS FOR 19MM FLAT DUCT

STRAND SIZE	A	B	E
12.7mm / 12.9mm	7mm	12mm	2.5mm
15.2mm / 15.7mm	8mm	11mm	1.5mm



# SLAB POST-TENSIONING

## Jacking Clearances

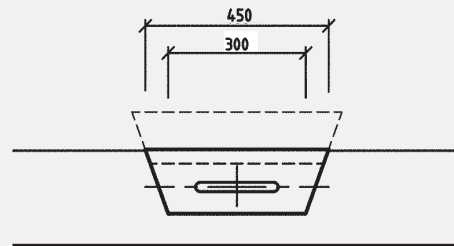
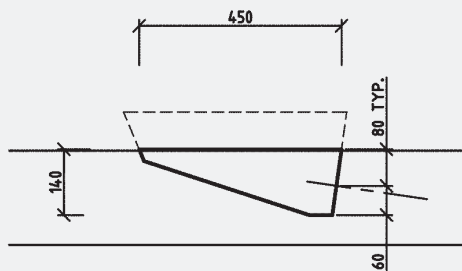
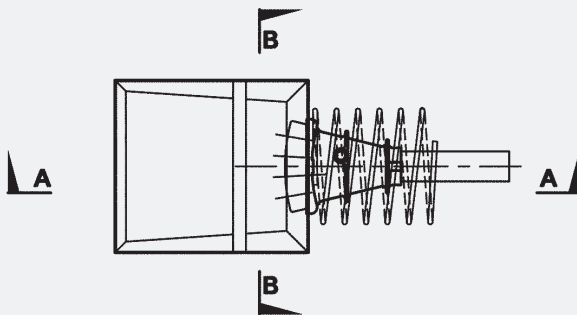
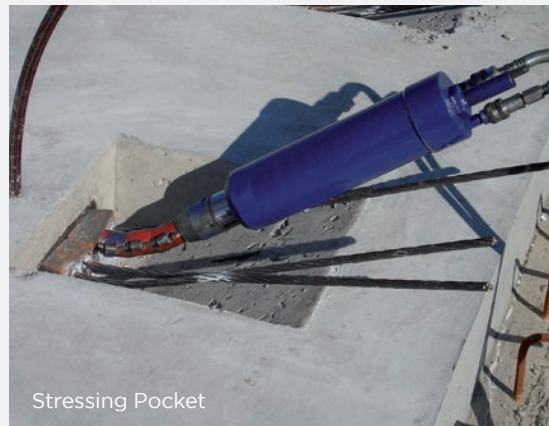


### JACKING CLEARANCES

STRAND SIZE	A mm	B mm	C mm	D mm	E mm
12.7mm / 12.9mm	500	900	750	450	75
15.2mm / 15.7mm	600	900	850	450	75

### SURFACE RECESSED STRESSING PANS

Surface recessed stressing pans are used where standard edge stressing is impractical, subject to design check. Details shown provide typical pocket spacing requirements. Actual details may vary.



# Suspended Slab Post-Tensioning

**Post-tensioning provides many benefits to a wide range of suspended structures.**

These benefits include:

- Reduced construction cost
- Faster construction
- Water resistant properties
- Early formwork stripping
- Floor to floor height reduction
- Reduced foundation load
- Improved deflection control
- Greater column free areas
- Larger spans
- Greater loading capacity

Many types of suspended slab structures typically realise the benefits of post tensioning, such as:

- Carparks
- Apartment buildings
- Commercial office space
- Retail centres
- Vertical load transfer structures
- Hospitals
- Storage facilities
- Public buildings such as stadiums, exhibition centres, schools and institutional facilities

Different formwork systems are compatible with post-tensioning, namely:

- Conventional plywood systems
- Permanent metal deck systems
- Ribbed slabs
- Precast systems

SRG Global has many years of experience in the design and installation of post-tensioned suspended slabs and can bring measurable benefits to your project.



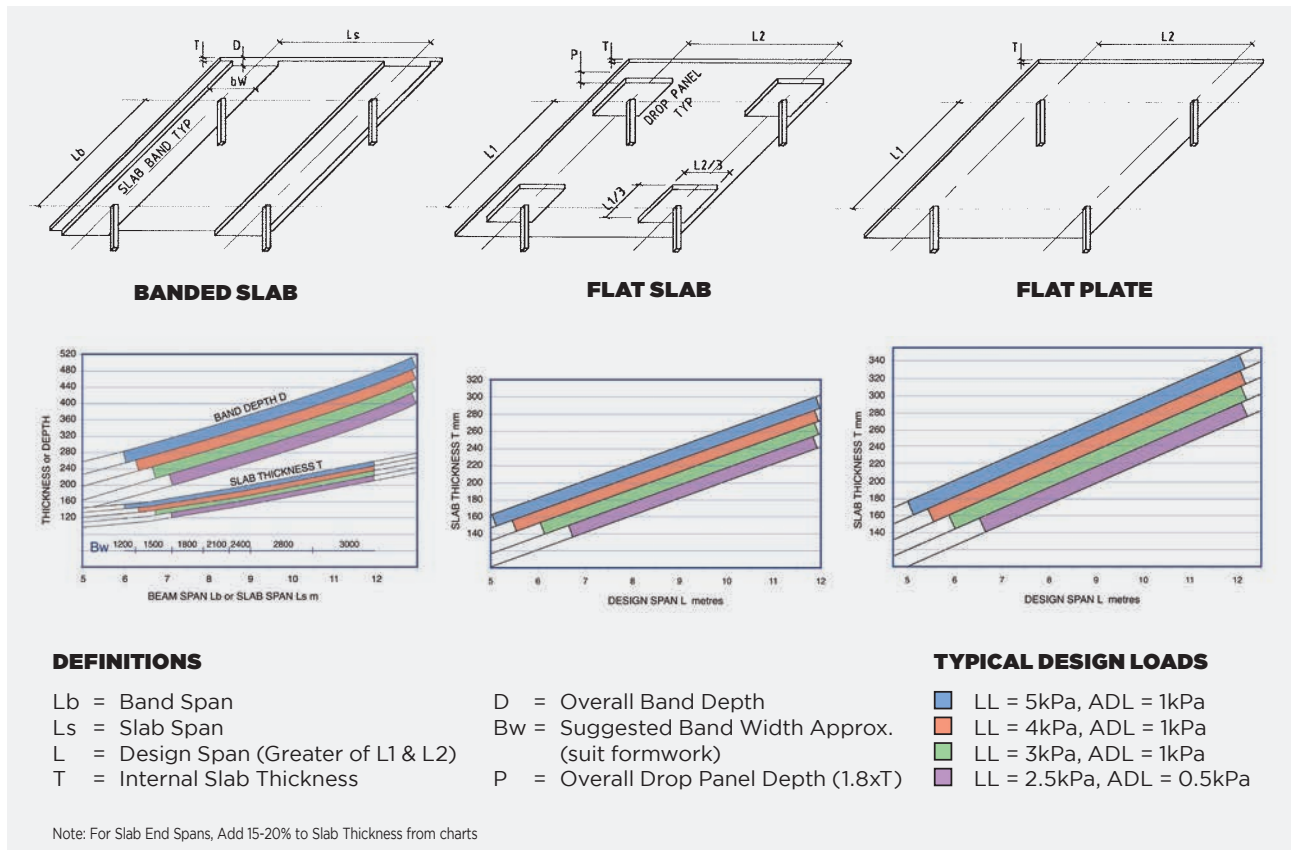


Barangaroo, Sydney NSW

## SLAB POST-TENSIONING - SUSPENDED SLABS

**The design of post-tensioned suspended slabs requires sound engineering consideration in order to maximize the benefits for all stakeholders in a project.**

SRG Global can offer design input from initial advice to fully detailed design for construction drawings. Typical post-tensioned floor configuration and details are:



### Specifying Post-Tensioning

It is important that the design requirements are achieved on site. Good engineering notation can greatly assist in achieving this, with particular attention to the following:

#### The System

State that the design is based on SRG Global's Slab post-tensioning system. This ensures that a fully tested and code compliant system will be installed.

#### Concrete

Nominate the 28 day characteristic compressive strength and shrinkage characteristics required. Some projects may have additional requirements.

### Concrete Strength at Transfer $f_{cp}$

This is the minimum compressive strength that is required prior to fully stressing the tendons. Concrete testing of site and air cured specimens should be carried out to ensure this strength has been achieved prior to application of the final stressing.

#### Tendons

Clearly indicate the type and location of anchorages and number of strands in each tendon. Check that stressing access is possible at live ends.

#### Profiling

High and low points should be nominated. Full tendon profiles can then be determined on installation shop drawings. Profiles are usually parabolic.

### Stressing Procedure

A two stage stressing procedure is usually specified. Initial or 25% load is applied at a specified initial concrete transfer strength (usually 9MPa and 24 hours after concrete is poured), and final or 100% load is applied when the concrete transfer strength is released.

#### Grout

A water / cement ratio of not more than 0.45 is usually sufficient to ensure adequate grouting and strength.



# SLAB POST-TENSIONING - SUSPENDED SLABS

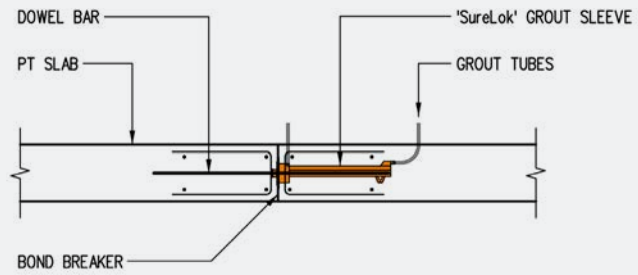
## Detailing of post-tensioned - suspended slabs

Structural detailing is a skill that engineers develop with experience and it is an essential part of a cost effective and reliable structure. Below are a selection of tried and proven details that SRG Global recommend for a range of situations. A key factor in achieving a successful post-tensioned structure is a sound understanding of and a considered allowance for normal concrete shrinkage movements.

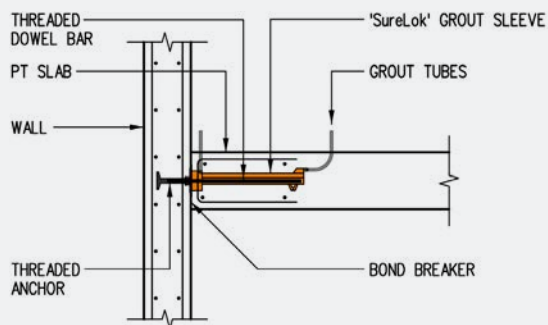
## Construction

SRG Global designers have worked closely over many years with builders and construction personnel resulting in a well understood system that enhances the construction process. An appreciation of the construction process will enable all parties involved in the on site works to benefit from the system. The typical construction sequence is as follows:

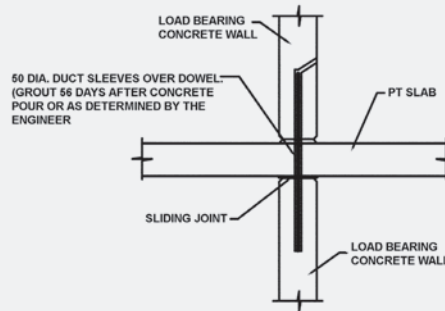
- Erect formwork
- Install bottom reinforcement
- Install post-tensioning
- Install top reinforcement
- Prepour inspection and pour concrete
- Strip edge forms
- Initial / partial stressing of tendons
- Final / full stressing of tendons
- Obtain engineers approval and cut off excess tendon strand
- Grout the tendons
- Strip formwork and back prop as required



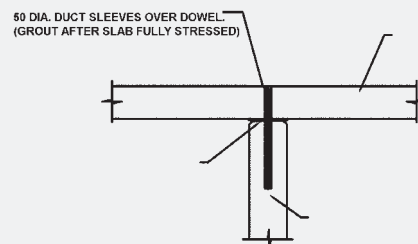
**TEMPORARY MOVEMENT JOINT - SURELOK™ - SLAB TO SLAB**



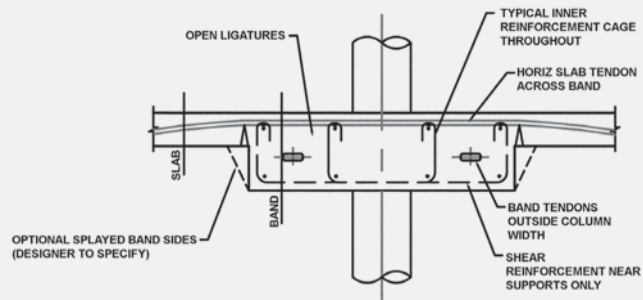
**TEMPORARY MOVEMENT JOINT - SURELOK™ - SLAB TO WALL**



**LOAD BEARING WALL OVER AND UNDER - PT SLAB / BEAM**



**LOAD BEARING WALL UNDER - PT SLAB / BEAM**



**TYPICAL SLAB BAND SECTION**

# Slab on Ground Post-Tensioning

**The post-tensioning of slabs on ground provides many developers and builders with a cost effective pavement solution.**

Benefits realised with post-tensioned slabs on ground include:

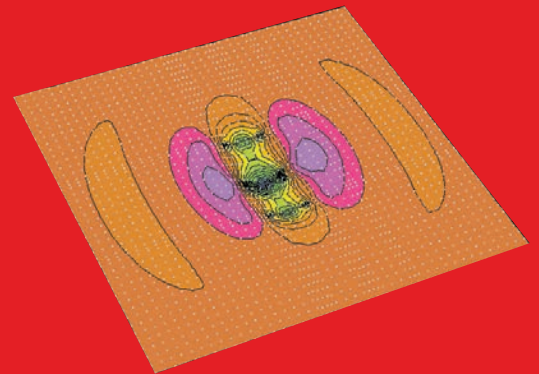
- Large joint free slab areas
- Reduced construction costs
- Less sub base preparation and/or excavation
- Faster construction time
- Reduced on going maintenance
- Greater loading capacity

Facilities that have adopted a post-tensioned slab on ground system include:

- Distribution warehouses
- Freezer stores
- Container terminal facilities
- Rail freight facilities
- Aircraft hangers
- Water retaining structures
- Sporting venues
- Raft slabs

## Design

The design of post-tensioned slabs on ground involves the careful analysis of the loads applied to the slab, the interaction between the slab and the ground that supports it, restraint forces and temperature effects. SRG Global has refined the design process and has achieved outstanding results on many projects. Our design and construction expertise for preliminary design advice through to final design and construction activities is available to assist builders, engineers and developers in achieving optimum solutions for slab on ground applications.



**Computer modelling and analysis**





Container Pavement, Port Botany - NSW

# SLAB POST-TENSIONING - SLAB ON GROUND

## Design of post-tensioned slabs on ground

### Points to consider in the design process include:

- Design loads and load configuration
- Thermal effects
- Sub-grade friction
- Sub-base parameters
- Constructions / constraints requirements

### Thermal Effects

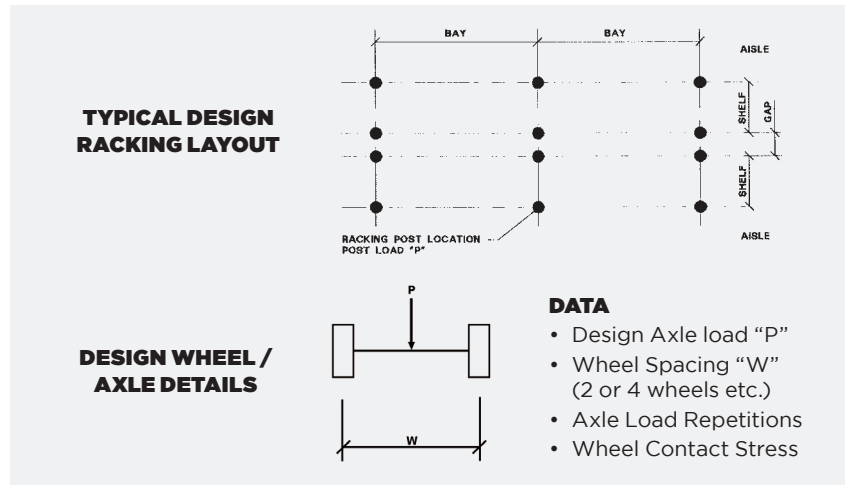
Daily ambient temperature variations give rise to temperature gradient stresses through the slab depth which need to be accounted for in the design. Typical gradients of 0.02 °C/mm and 0.04 °C/mm are often used for internal and external slabs respectively causing bottom fibre tensile stresses that are additional to the load stresses.

### Sub-grade Friction

Normal elastic and shrinkage movements give rise to frictional restraint stresses between the slab and the prepared subgrade. The typical design friction coefficient for concrete laid on a plastic membrane over clean sand bedding is around 0.5 to 0.6.

### Sub-base Parameters

A typical slab design will include the analysis of the slab supported by the ground sub-base. Modelling of the sub-base requires geotechnical data such as CBR, (California Bearing Ratio) and / or the modulus of sub-grade reaction.



## Construction

SRG Global's design and construction experience is based on being the leader in the field of post-tensioned slabs on ground. The combination of innovative design and expedient site practices ensures that the construction phase is a seamless operation. The main items to consider for the construction phase are pour size, pour sequence and curing and weather and protection.

### Pour Size

A pour size of between 1500m<sup>2</sup> and 2000m<sup>2</sup> should typically be considered and planned.

### Pour Sequence

The sequence of slab pours & their respective stressing requirements should be optimized to ensure the best programme outcome.

### Curing & Weather Protection

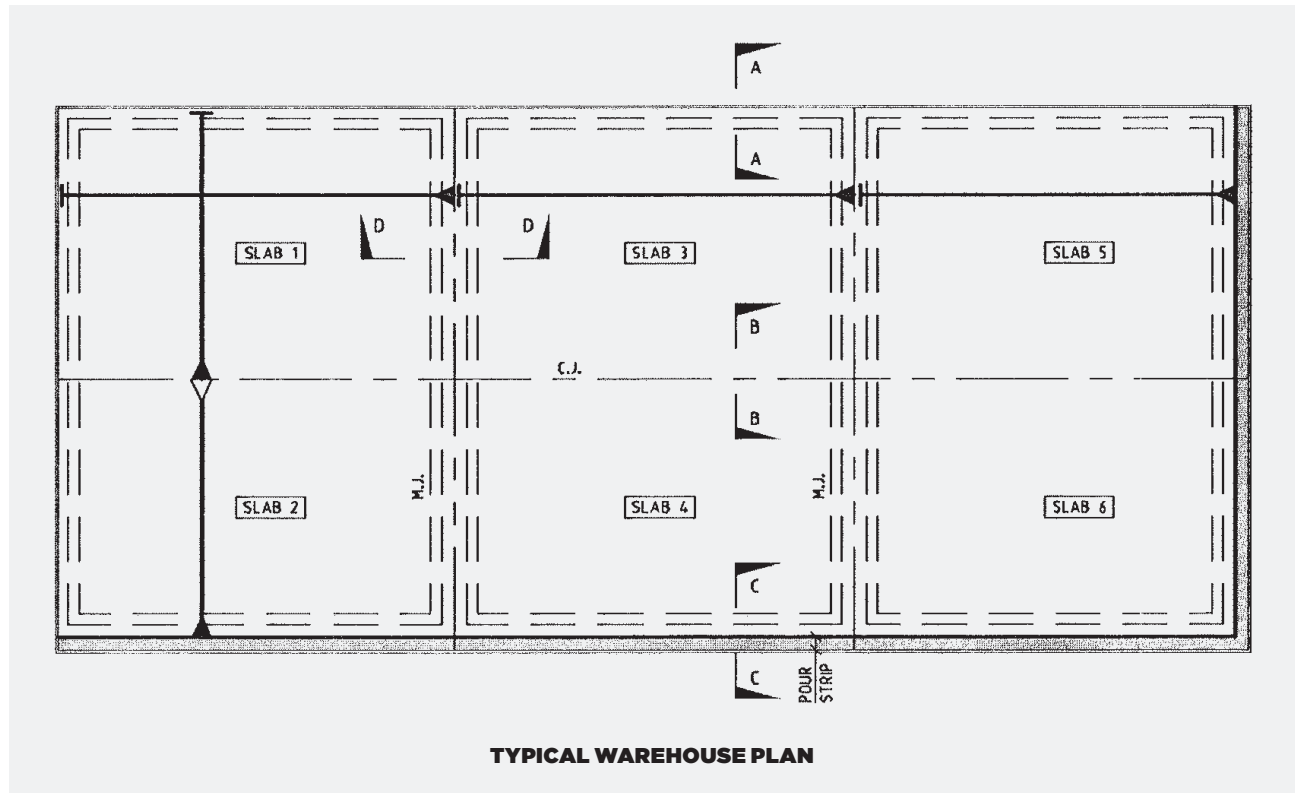
With large pours the slab is initially susceptible to shrinkage effects hence it is important to cure and protect the slab from extreme conditions such as heat, high evaporation or extreme cold. The construction of warehouse roofs prior to pouring slabs is a typical technique adopted to provide some protection.



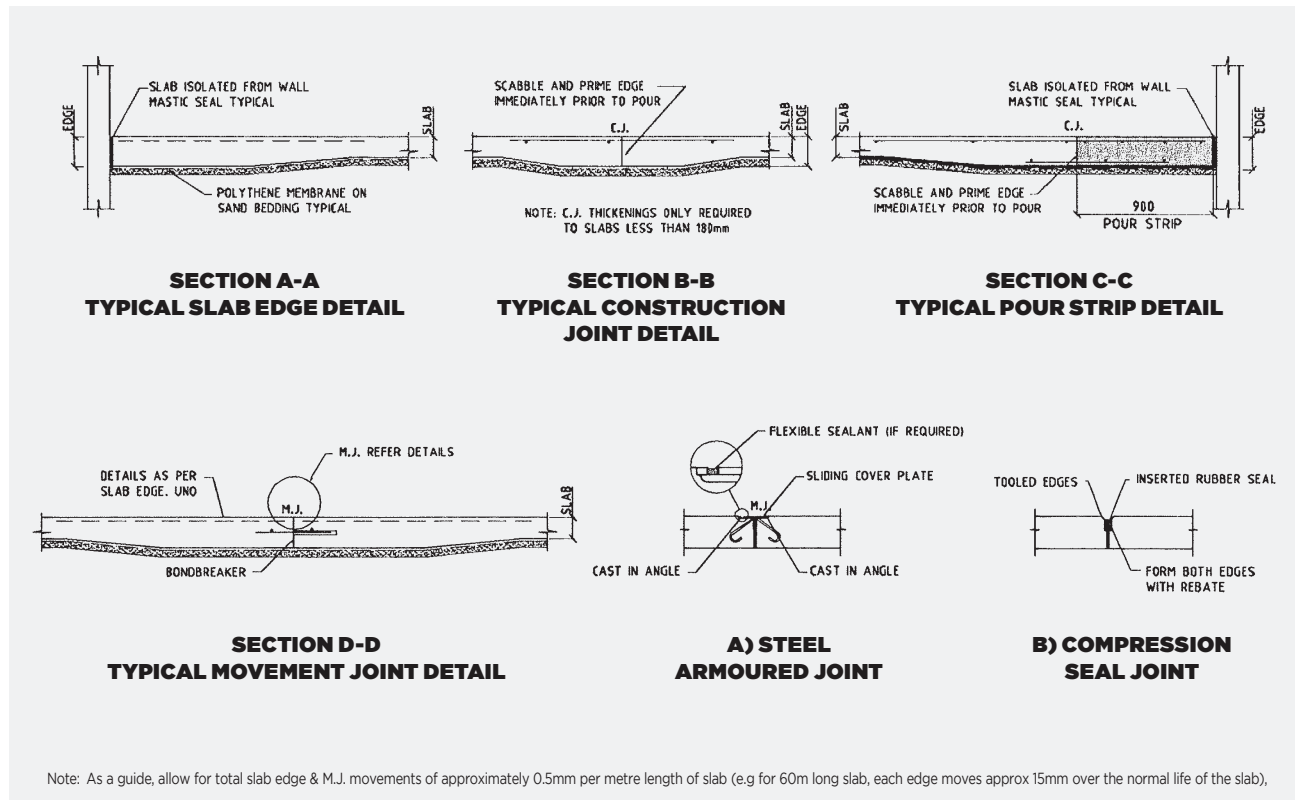
## SLAB POST-TENSIONING - SLAB ON GROUND

**Good detailing of post-tensioned slabs on ground is vital in achieving a successful and relatively crack free slab.**

The following diagrams indicate key details typically recommended by SRG Global.



**TYPICAL WAREHOUSE PLAN**



Note: As a guide, allow for total slab edge & M.J. movements of approximately 0.5mm per metre length of slab (e.g for 60m long slab, each edge moves approx 15mm over the normal life of the slab),

# Multistrand Post-Tensioning

**Multistrand post-tensioning is a robust and reliable “bonded” prestressing system.**

Multistrand post-tensioning is predominantly used in civil structures including bridges, silos, tanks and off-shore structures and is also used for transfer beams in buildings.

## **BBR VT CONA CMI**

The BBR VT CONA CMI post-tensioning system is a multi-strand system for all types of internally post-tensioned applications. The CMI system is part of the CMX family of post-tensioning anchorages and the most economical and up to date range available from BBR. Earlier BBR anchorage systems such as the Cona Compact range are still available by special request, but these have been superseded by the CMX range. The standard tendon sizes range from 1 to 73 seven-wire prestressing strands. Larger sizes are also possible and CONA CMI tendons with 91 strands have already been used. Most commonly, 0.60”-0.62” (15.2-15.7mm) strands with a cross-sectional area of 150mm<sup>2</sup> and a characteristic tensile strength of up to 1,860 MPa are used, with individual strand strengths of 250kN, 261kN and 279kN. The use of 0.5” (12.7mm) strands with a cross-sectional area of 100mm<sup>2</sup> and a characteristic tensile strength of 1,860 MPa, with individual strand strength of 184kN is by special request only, at additional cost.

The system has been granted European Technical Approval in accordance with the testing procedures contained within ETAG013 and is CE marked.

These tests included static tests, fatigue test, load transfer and cryogenic tests.

European Technical Approval provides clear independent review, full and complete system testing to the highest European standard, quality assurance, and independent auditing of all system components.

On completion of the full system testing, the approval body evaluated the test results, drawings and specifications. The package was then circulated to all member states of the EU for ratification.

Regular independent auditing is undertaken to ensure full compliance. The BBR e-Trace system ensures that all components can be fully traced including batch and material property details from production through to site installation.

Copies of the BBR VT European Approval documents are available for download from [www.bbrnetwork.com](http://www.bbrnetwork.com).

The BBR VT CONA CMI system has significant advantages over the previous BBR Cona Multi system as well as significant competitive advantage over other ETAG approved systems. These advantages include:

- Less space is required in the anchor zone which results in less concrete, slimmer structures and less eccentricity in the anchors.
- Significantly lower concrete strength prior to stressing resulting in shorter construction cycles.
- Less reinforcement in the anchorage zone resulting in time and cost savings.



LNG Tanks - South Hook UK

## MULTISTRAND POST-TENSIONING

### Anchorage Configuration

The main components in the anchor zone of the CONA CMI system are the wedges, anchor head, trumplate / square plate and trumpet. In the anchorage zone, the duct is connected to the trumpet and the strand bundle is spread out towards the anchor head, where each strand is individually locked with BBR wedges.

For the load transfer to the concrete, the CONA CMI BT (bearing trumplate) can be used for tendon sizes with 02 to 61 strands and the CONA CMI SP (square plate) can be used for 01 to 73 strands.

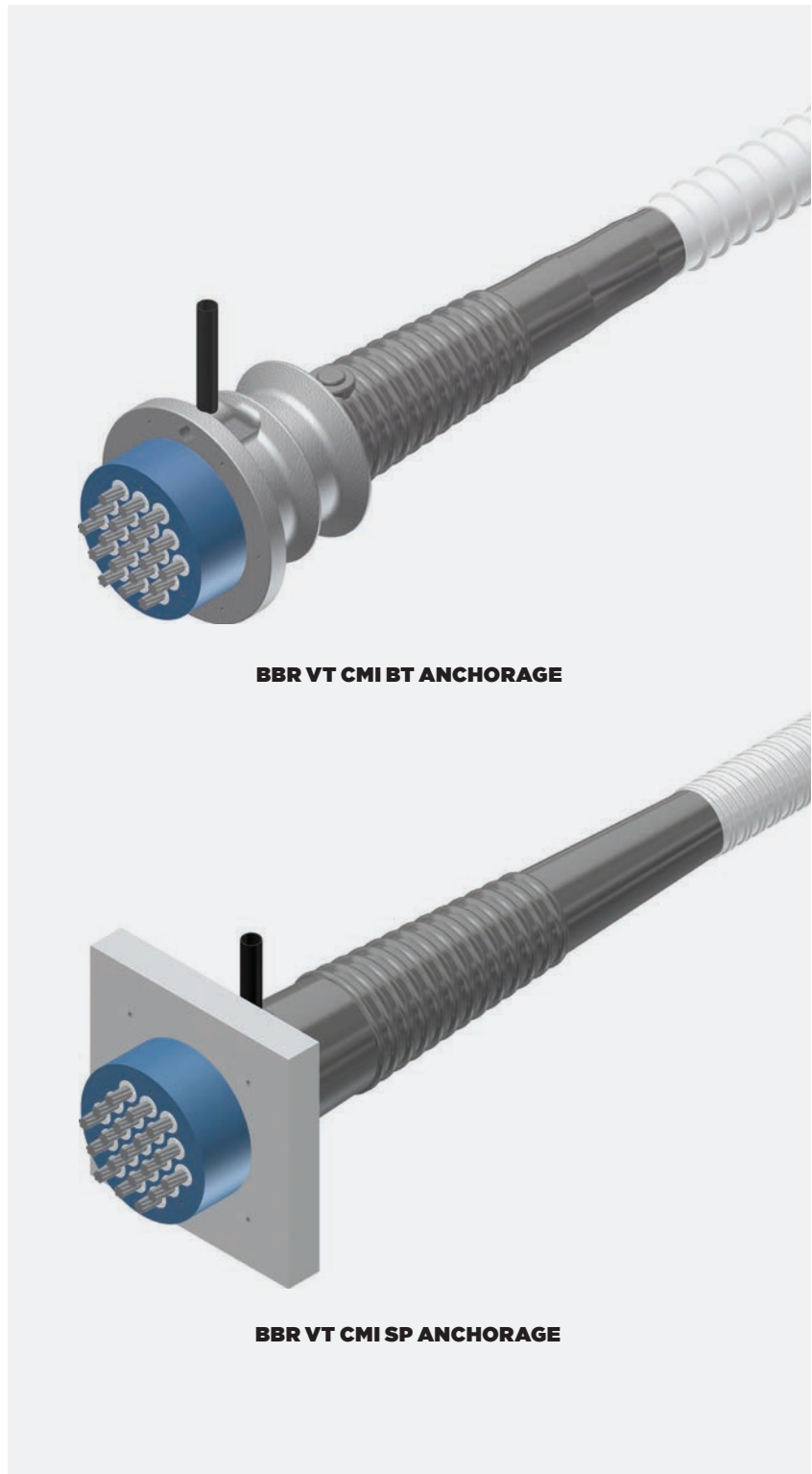
The CONA CMI BT (bearing trumplate) system makes use of an advanced and proprietary three plane load transfer allowing for very small centre and edge distances at the anchorages, as well as application of the full post-tensioning load at very low concrete strengths. The CONA CMI SP (square plate) is a system with a single plane load transfer to the concrete.

Note: Cona CMI BT anchorages are typically more economical than Cona CMI SP anchorages.

Technical data on the BBRVT CONA CMI SP system can be found on pages 26 to 30.

### Stressing and Fixed Anchorages

The BBR VT CONA CMI anchorages are available in two types, these are Type S stressing / active anchorages and Type F fixed / passive anchorages. The anchor heads of the stressing and fixed anchorages are secured by special wedge retaining measures and are protected by a cap during concreting. For re-stressable and exchangeable tendons, excess strand length is required at the anchorage. The extent of the excess strand length depends on the jack used for re-stressing or releasing and the strand protruding beyond the anchor head requires permanent corrosion protection and an adequate cap.





## MULTISTRAND POST-TENSIONING



Interchange No. 4 Sheikh Zayed Road - Dubai UAE

### Fixed, Stressable and Movable Couplers

CONA CMI tendons can be coupled using proprietary Type K overlap coupler for tendons ranging from 2 to 31 strands or Type H sleeve coupler for 1 to 73 strands. Both coupler types can serve as a stressing / active anchorage coupler (Type S) or fixed / passive anchorage coupler (Type F) bearing against the load transfer unit or as movable couplers (Type B) along the length of the tendon.

In the first stage of construction, the tendon is installed, stressed and anchored in the coupler which is placed in the section joint between the first and second stage. Next, the second stage tendon is put in place and coupling is achieved by pushing the strands into the already

tensioned Type K anchor head or by coupling the Type H anchor heads with a Type H sleeve. In some countries, it is not permitted for one section joint to have only couplers. In this situation, it is mandatory that at least 30% of all tendons must be continuous in order to obtain an even distribution of the prestressing force in the structure.

The movable coupler serves to lengthen unstressed tendons and the tendon elongation during stressing is ensured by a cylindrical sheathing box appropriate for the expected elongation at the location of the coupler. Movable couplers may be used to couple continuity tendons at the construction joint. Where possible, Type K couplers are preferred, Type H are available by special request.

### Corrosion Protection

The strand bundle is enclosed in a corrugated round steel or plastic duct. For special applications, such as loop tendons - smooth round steel or plastic ducts can be used. The use of flat steel or plastic ducts is also possible for smaller tendon sizes. The filling of the tendons in bonded applications is completed using a high performance grout. For unbonded applications, the duct can be injected with grease / wax. The CONA CMI post-tensioning kits can also be executed as fully electrically isolated tendons to provide the highest possible level of corrosion protection.

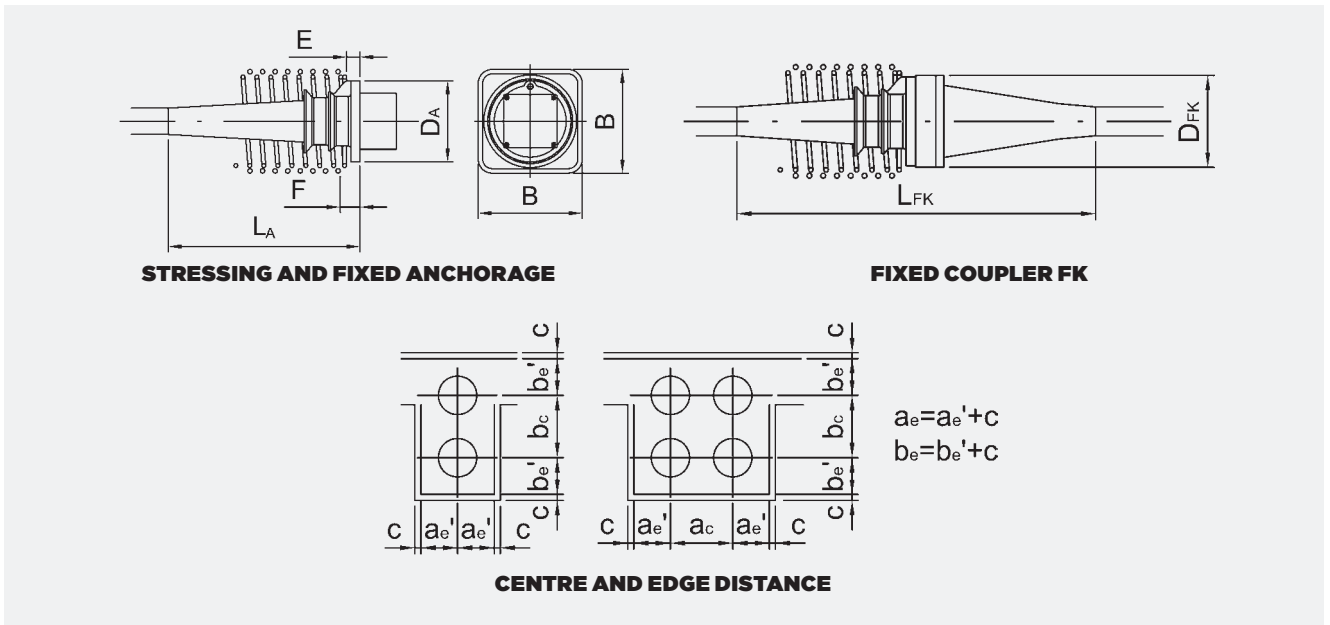
# MULTISTRAND POST-TENSIONING

## TECHNICAL DATA OF ANCHORAGES BBR VT CONA CMI BT (BEARING TRUMPLATE)

BBR VT CONA CMI BT			4					7					9				12				15							
STRAND	mm <sup>2</sup>		140		150			140		150			140		150		140		150		140		150					
CROSS SECTIONAL AREA	mm <sup>2</sup>		560		600			980		1,050			1,260		1,350		1,680		1,800		2,100		2,250					
CHARACT. TENSILE STRENGTH	R <sub>m</sub>	MPa	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860		
CHARACT. MAXIMUM FORCE	F <sub>m</sub>	kN	992	1,040	1,064	1,116	1,736	1,820	1,862	1,953	2,232	2,340	2,394	2,511	2,976	3,120	3,192	3,340	3,720	3,900	3,990	4,185						
HELIX AND ADDITIONAL REINFORCEMENT																												
MIN. CONCRETE STRENGTH (CYL.)	F <sub>cm,0</sub>	MPa	19	23	28	31	35	19	23	28	31	35	19	23	28	31	35	19	23	28	31	35	19	23	28	31	35	
HELIX																												
OUTER DIAMETER	mm	180	160	160	160	155	230	200	200	200	200	280	260	255	250	250	330	280	275	260	250	375	330	315	305	305		
BAR DIAMETER	mm	10	10	10	10	10	12	12	12	12	12	14	12	12	12	12	14	14	14	14	14	14	14	14	14	14	14	14
LENGTH, APPROX.	mm	185	185	185	185	185	254	256	231	231	231	282	281	281	281	281	332	332	332	332	282	432	432	382	332	332		
PITCH	mm	45	45	45	45	45	45	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
NUMBER OF PITCHES		5	5	5	5	5	6	6	5	5	5	6	6	6	6	6	7	7	7	7	6	9	9	8	7	7		
DISTANCE	E	mm	15	15	15	15	15	18	18	18	18	18	20	20	20	20	20	20	20	20	20	27	27	27	27	27		
ADDITIONAL REINFORCEMENT																												
NUMBER OF STIRRUPS		3	3	4	4	3	5	4	4	4	4	5	5	5	4	5	7	6	5	5	6	7	6	5	6	5		
BAR DIAMETER	mm	12	12	10	10	12	14	14	12	14	14	12	14	12	14	14	12	14	16	16	14	14	16	16	16	16	16	
SPACING	mm	60	55	45	45	55	55	60	55	55	55	60	55	55	65	55	60	55	70	70	50	60	65	65	55	60		
DISTANCE FROM ANCHOR PLATE	F	mm	30	30	30	30	33	33	33	33	33	35	35	35	35	35	35	35	35	35	35	42	42	42	42	42		
OUTER DIMENSIONS	BxB	mm	220	200	190	190	290	270	240	240	240	330	300	290	290	290	390	350	320	310	290	440	400	360	350	350		
CENTRE AND EDGE SPACING																												
MIN. CENTRE SPACING	a <sub>c</sub> , b <sub>c</sub>	mm	235	215	210	210	205	310	285	260	255	255	350	320	310	310	310	405	370	340	325	310	455	415	380	365	365	
MIN. EDGE DISTANCE (PLUS C)	a <sub>e</sub> ', b <sub>e</sub> '	mm	110	100	95	95	95	145	135	120	120	120	165	150	145	145	145	195	175	160	155	145	220	200	180	175	175	
DIMENSIONS OF ANCHORAGES																												
ANCHOR DIAMETER	D <sub>A</sub>	mm	130					170					225					280										
ANCHOR LENGTH	L <sub>A</sub>	mm	320					456					773					658										
COUPLER FK DIAMETER	D <sub>FK</sub>	mm	185					205					240					290										
COUPLER FK LENGTH	L <sub>FK</sub>	mm	875					1,181					1,708					1,478										

Reinforcement can be rounded up to next available bar size, if size shown is not available

Details of anchorage reinforcement given are the minimum required. Designers must satisfy themselves of the adequacy of bursting and spalling reinforcement as required for specific situations.



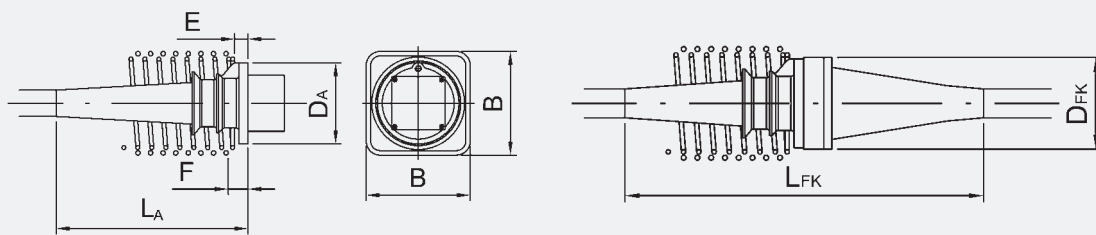
# MULTISTRAND POST-TENSIONING

## TECHNICAL DATA OF ANCHORAGES BBR VT CONA CMI BT (BEARING TRUMPLATE)

BBR VT CONA CMI BT			19					22					24					27					31																													
STRAND	mm <sup>2</sup>		140					150					140					150					140					150																								
CROSS SECTIONAL AREA	mm <sup>2</sup>		2,660					2,850					3,080					3,300					3,360					3,600					3,780					4,050					4,340					4,650				
CHARACT. TENSILE STRENGTH	R <sub>m</sub>	MPa	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860	1,770	1,860																
CHARACT. MAXIMUM FORCE	F <sub>m</sub>	kN	4,712	4,940	5,054	5,301	5,456	5,720	5,852	6,138	5,952	6,240	6,384	6,696	6,696	7,020	7,182	7,533	7,688	8,060	8,246	8,649																														
HELIX AND ADDITIONAL REINFORCEMENT																																																				
MIN. CONCRETE STRENGTH (CYL.)	F <sub>cm,0</sub>	MPa	19	23	28	31	35	19	23	28	31	35	19	23	28	31	35	19	23	28	31	35	19	23	28	31	35	19	23	28	31	35	19	23	28	31	35															
HELIX																																																				
OUTER DIAMETER	mm		420	360	360	330	325	475	420	390	360	340	475	430	410	360	360	520	475	440	420	390	560	520	475	430	430																									
BAR DIAMETER	mm		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14																									
LENGTH, APPROX.	mm		457	457	432	432	382	482	482	432	432	382	532	532	482	482	432	532	532	482	482	432	532	532	482	482	432																									
PITCH	mm		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50																										
NUMBER OF PITCHES			10	10	9	9	8	10	10	9	9	8	11	11	10	10	9	11	11	10	10	9	11	11	10	10	9																									
DISTANCE	E	mm	27	27	27	27	27	31	31	31	31	31	32	32	32	32	32	35	35	35	35	35	35	35	35	35																										
ADDITIONAL REINFORCEMENT																																																				
NUMBER OF STIRRUPS			7	7	7	7	7	6	7	8	7	8	7	7	7	7	8	8	7	7	8	8	9	8	8	8	8																									
BAR DIAMETER	mm		16	16	16	16	16	20	20	20	20	16	20	20	20	20	20	20	20	20	20	20	20	20	20	20																										
SPACING	mm		65	65	65	65	60	80	75	65	65	50	80	80	70	65	55	80	80	75	60	60	80	75	70	65	60																									
DISTANCE FROM ANCHOR PLATE	F	mm	42	42	42	42	42	46	46	46	46	46	47	47	47	47	47	50	50	50	50	50	50	50	50	50																										
OUTER DIMENSIONS	BxB	mm	490	450	410	390	370	530	480	440	420	400	560	510	460	440	420	590	540	490	470	440	630	580	530	500	480																									
CENTRE AND EDGE SPACING																																																				
MIN. CENTRE SPACING	a <sub>c</sub> , b <sub>c</sub>	mm	510	465	425	410	390	550	500	460	440	420	575	525	480	460	435	610	555	505	485	460	650	595	545	520	495																									
MIN. EDGE DISTANCE (PLUS C)	a <sub>e</sub> ', b <sub>e</sub> '	mm	245	225	205	195	185	265	240	220	210	200	280	255	230	220	210	295	270	245	235	220	315	290	265	250	240																									
DIMENSIONS OF ANCHORAGES																																																				
ANCHOR DIAMETER	D <sub>A</sub>	mm	280					310					325					360																																		
ANCHOR LENGTH	L <sub>A</sub>	mm	774					921					1,098					1,121					1,006																													
COUPLER FK DIAMETER	D <sub>FK</sub>	mm	290					310					340					390																																		
COUPLER FK LENGTH	L <sub>FK</sub>	mm	1,644					1,866					2,308					2,511					2,286																													

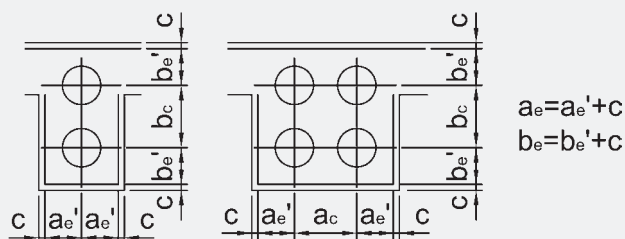
Note: For larger sizes use BBR VT COMA CMI SP (square plate)

Details of anchorage reinforcement given are the minimum required. Designers must satisfy themselves of the adequacy of bursting and spalling reinforcement as required for specific situations.



STRESSING AND FIXED ANCHORAGE

FIXED COUPLER FK



CENTRE AND EDGE DISTANCE

# MULTISTRAND POST-TENSIONING

## STRESSING ANCHORAGE RECESS DETAILS

STRAND SIZE		BBR VT CONA CMI BT														
15.2mm / 15.7mm		406 04	706 07	906 09	1206 12	1506 15	1906 19	2206 22	2406 24	2706 27	3106 31	3706 37	4206 42	4806 48	5506 55	6106 61
DIMENSIONS	RECESS - INNER	200x200	240x240	295x295	295x295	350x350	350x350	380x380	430x430	430x430	430x430	470x470	495x495	555x555	555x555	590x590
	RECESS - OUTER	250x250	290x290	350x350	350x350	400x400	400x400	420x420	480x480	480x480	480x480	520x520	545x545	605x605	605x605	640x640
	RECESS - DEPTH	130	135	140	140	160	160	170	180	180	185	195	205	215	225	230

## BEARING TRUMPLATES

NO. OF STRANDS		BBR VT CONA CMI BT														
		04	07	09	12	15	19	22	24	27	31	37	42	48	55	61
BEARING TRUMPLATE	DIAMETER $\phi_b$ (mm)	130	170	225	225	280	280	310	325	360	360	400	425	485	485	520
	HEIGHT $H_b$ (mm)	120	128	150	150	195	195	206	227	250	250	275	290	340	340	350
	HOLE DIAMETER (mm)	70	90	127	127	160	160	180	205	205	205	225	239	265	265	297

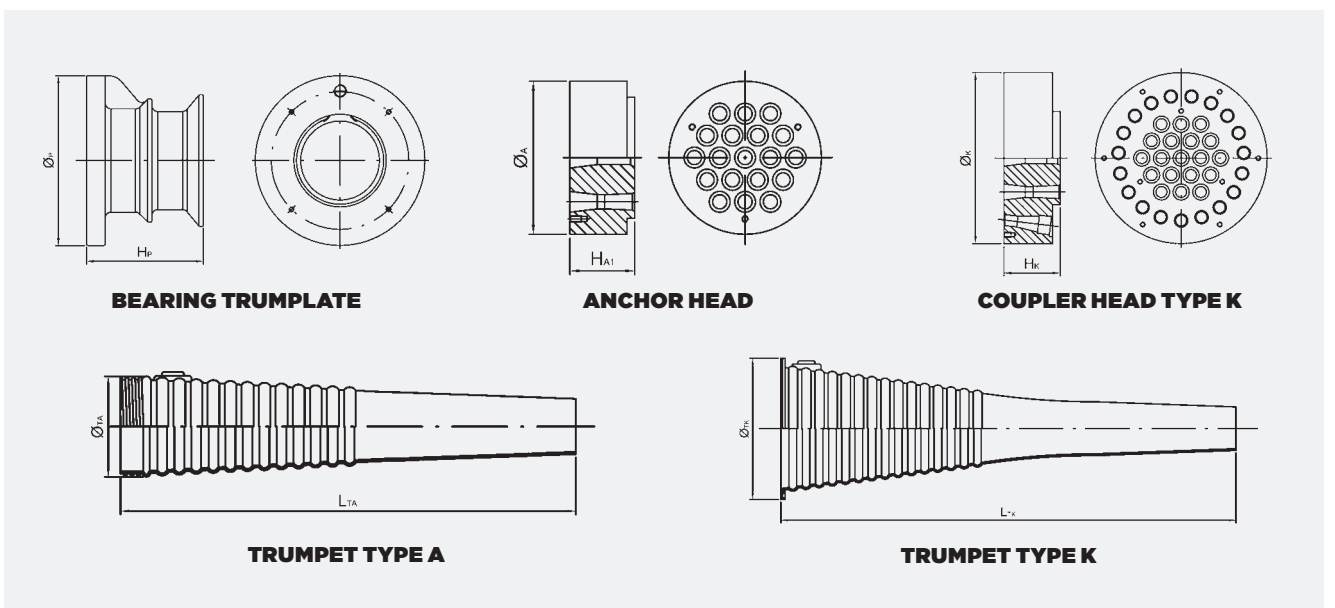
## ANCHOR AND COUPLER HEADS

NO. OF STRANDS		BBR VT CONA CMI BT														
		04*	07*	09	12*	15	19*	22*	24	27	31*	37	42	48	55	61
ANCHOR HEAD	DIAMETER $\phi_A$ (mm)	100	130	160	160	200	200	225	240	255	255	285	300	325	335	365
	HEIGHT $H_{A1}$ (mm)	50	55	60	65	75	85	95	100	105	110	120	130	140	150	155
COUPLER HEAD K	DIAMETER $\phi_K$ (mm)	185	205	240	240	290	290	310	340	390	390	REFER TO SRG OFFICE FOR H COUPLER DETAILS				
	HEIGHT $H_K$ (mm)	85	85	90	90	90	95	105	120	125	130					

\* Preferred sizes

## PLASTIC TRUMPETS

NO. OF STRANDS		BBR VT CONA CMI BT														
		04	07	09	12	15	19	22	24	27	31	37	42	48	55	61
TRUMPET A	DIAMETER $\phi_{TA}$ (mm)	72	88	127	127	153	153	170	191	191	191	219	229	254	254	278
	LENGTH $L_{TA}$ (mm)	200	328	623	508	694	579	715	871	871	756	1,060	1,060	1,244	1,244	1,290
TRUMPET K	DIAMETER $\phi_{TK}$ (mm)	185	203	240	240	275	275	305	330	375	375	REFER TO SRG OFFICE FOR H COUPLER DETAILS				
	LENGTH $L_{TK}$ (mm)	470	640	845	730	890	775	840	1,090	1,265	1,150					

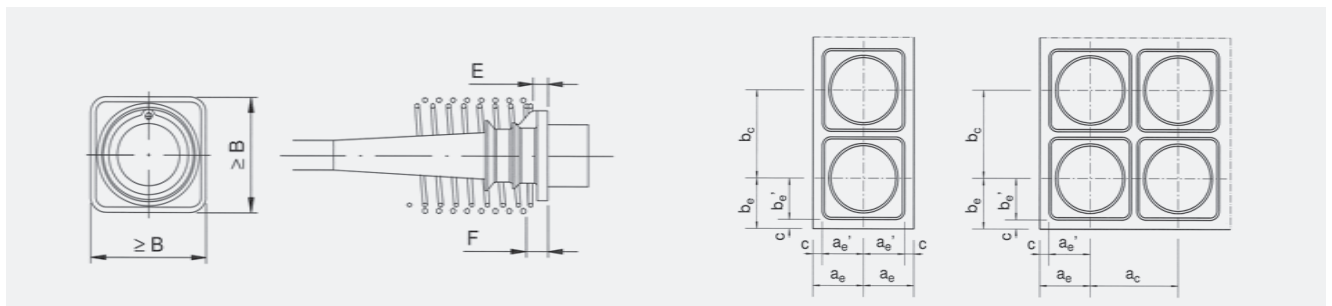


# MULTISTRAND POST-TENSIONING

## TECHNICAL DATA OF ANCHORAGES BBR VT CONA CMI SP (SQUARE PLATE)

BBR VT CONA CMI SP		3706						4206						5506						6106						
7-WIRE PRESTRESSING STEEL STRAND																										
NOMINAL DIAMETER 15.7MM .. NOMINAL CROSS SECTION 150MM <sup>2</sup> .. MAXIMUM CHARACTERISTIC TENSILE STRENGTH 1,860 MPA <sup>1)</sup>																										
TENDON																										
CROSS SECTIONAL AREA	$A_p$	mm <sup>2</sup>	4,650						6,300						8,250						9,150					
CHARACT. VALUE OF MAX. FORCE	$F_{pk}$	kN	8,649						11,718						15,345						17,019					
CHARACT. VALUE OF 0.1% PROOF FORCE	$F_{p0.1k}$	kN	7,626						10,332						13,530						15,006					
MAX. PRESTRESSING FORCE	$0.90 F_{p0.1k}$	kN	6,863						9,299						12,177						13,505					
MAX. OVERSTRESSING FORCE	$0.95 F_{p0.1k}$	kN	7,245						9,815						12,854						14,256					
MINIMUM CONCRETE STRENGTH / HELIX / ADDITIONAL REINFORCEMENT / CENTRE AND EDGE SPACING / STEEL PLATE DIMENSIONS																										
MIN. CONCRETE STRENGTH																										
CUBE	$f_{cm0}$	MPa	26	28	34	38	43	46	26	28	34	38	43	46	26	28	34	38	43	46	26	28	34	38	43	46
CYLINDER	$f_{cm0}$	MPa	21	23	28	31	35	38	21	23	28	31	35	38	21	23	28	31	35	38	21	23	28	31	35	38
HELIX																										
OUTER DIAMETER	mm	620	620	620	620	620	620	660	660	660	660	660	660	790	790	790	790	790	790	860	860	860	860	860	860	
BAR DIAMETER	mm	16	16	16	16	16	16	16	16	16	16	16	16	25	25	25	25	25	25	25	25	25	25	25	25	
LENGTH, APPROX.	mm	566	566	566	566	566	566	616	616	616	616	616	616	940	940	940	940	940	940	985	985	985	985	985	985	
PITCH	mm	50	50	50	50	50	50	50	50	50	50	50	50	70	70	70	70	70	70	60	60	60	60	60	60	
NUMBER OF PITCHES		12	12	12	12	12	12	13	13	13	13	13	13	14	14	14	14	14	14	17	17	17	17	17	17	
DISTANCE	E	mm	70	70	70	70	70	70	75	75	75	75	75	75	90	90	90	90	90	90	90	90	90	90	90	90
ADDITIONAL REINFORCEMENT																										
NUMBER OF STIRRUPS		11	11	11	11	11	11	11	11	11	11	11	11	12	12	12	12	12	12	13	13	13	13	13	13	
BAR DIAMETER <sup>3)</sup>	mm	20	20	20	20	20	20	20	20	20	20	20	20	16	16	16	16	16	16	16	16	16	16	16	16	
SPACING	mm	75	75	75	75	75	75	75	75	75	75	75	75	70	70	70	70	70	70	70	70	70	70	70	70	
DISTANCE FROM ANCHOR PLATE	F	mm	90	90	90	90	90	95	95	95	95	95	95	110	110	110	110	110	110	110	110	110	110	110	110	
MIN. OUTER DIMENSIONS	BxB	mm	695	695	695	695	695	745	745	745	745	745	745	885	885	885	885	885	885	940	940	940	940	940	940	
CENTRE AND EDGE SPACING																										
MIN. CENTRE SPACING	$a_c, b_c$	mm	715	715	715	715	715	765	765	765	765	765	765	905	905	905	905	905	905	960	960	960	960	960	960	
MIN. EDGE DISTANCE	$a_e, b_e$	mm	350	350	350	350	350	375	375	375	375	375	375	445	445	445	445	445	445	470	470	470	470	470	470	
STEEL PLATE DIMENSIONS <sup>2)</sup>																										
SIDE LENGTH	$S_{sp}$	mm	480	480	480	480	480	510	510	510	510	510	510	595	595	595	595	595	595	620	620	620	620	620	620	
THICKNESS	$T_{sp}$	mm	70	70	70	70	70	75	75	75	75	75	75	90	90	90	90	90	90	90	90	90	90	90	90	

- Notes: Details of anchorage reinforcement given are the minimum required. Designers must satisfy themselves of the adequacy of bursting and spalling reinforcement as required for specific situations
- c = Concrete cover
  - 1) = Prestressing strand with nominal diameter of 15.3mm, cross sectional area of 140mm<sup>2</sup> or with characteristic tensile strength below 1,860 MPa may also be used
  - 2) = The steel plate dimensions are minimum values, therefore larger or thicker plates may be used
  - 3) = Bar diameter of 14mm can be replaced by 16mm



# MULTISTRAND POST-TENSIONING

## STRESSING ANCHORAGE RECESS DETAILS

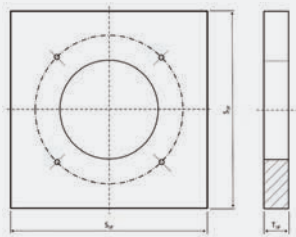
STRAND SIZE		BBR VT CONA CMI SP														
15.2mm / 15.7mm	ANCHORAGE UNIT MAX NO. OF STRANDS	406 04	706 07	906 09	1206 12	1506 15	1906 19	2206 22	2406 24	2706 27	3106 31	3706 37	4206 42	4806 48	5506 55	6106 61
DIMENSIONS	RECESS - INNER	225x225	275x275	325x325	335x335	390x390	410x410	440x440	460x460	485x485	510x510	550x550	580x580	620x620	665x665	690x690
	RECESS - OUTER	275x275	325x325	375x375	385x385	440x440	460x460	490x490	510x510	535x535	560x560	600x600	630x630	670x670	715x715	740x740
	RECESS - DEPTH	130	135	140	140	160	160	170	180	180	185	195	205	215	215	230

## ANCHOR AND COUPLER HEADS

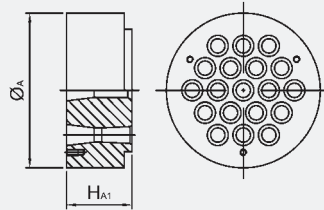
		BBR VT CONA CMI SP														
NO. OF STRANDS		04	07	09	12	15	19	22	24	27	31	37	42	48	55	61
ANCHOR HEAD	DIAMETER $\varnothing_A$ (mm)	100	130	160	160	200	200	225	240	255	255	285	300	325	335	365
	HEIGHT $H_A$ (mm)	50	55	60	65	75	85	95	100	105	110	120	130	140	150	155
COUPLER HEAD K	DIAMETER $\varnothing_K$ (mm)	185	205	240	240	290	290	310	340	390	390	REFER TO SRG OFFICE FOR COUPLER DETAILS				
	HEIGHT $H_K$ (mm)	85	85	90	90	90	95	105	120	125	130					

## TRUMPETS

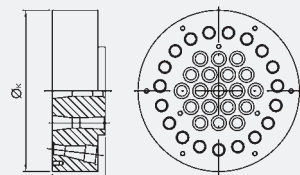
		BBR VT CONA CMI SP														
NO. OF STRANDS		04	07	09	12	15	19	22	24	27	31	37	42	48	55	61
TRUMPET A SP (STEEL)	DIAMETER $\varnothing_{TA}$ (mm)	70	90	128	128	160	160	180	195	210	210	230	245	270	270	305
	LENGTH $L_{TA}$ (mm)	421	401	739	739	894	894	1,017	1,196	1,150	1,150	1,270	1,315	1,506	1,506	1,684
TRUMPET K (PLASTIC)	DIAMETER $\varnothing_{TK}$ (mm)	185	203	240	240	275	275	305	330	375	375	219	229	254	254	278
	LENGTH $L_{TK}$ (mm)	539	640	845	730	890	775	840	1,090	1,265	1,150	1,060	1,060	1,244	1,244	1,290



**SQUARE PLATE**



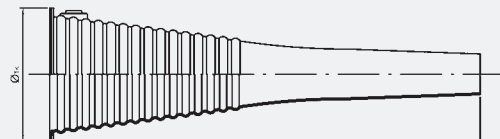
**ANCHOR HEAD**



**COUPLER HEAD TYPE K**



**TRUMPET TYPE A SP**



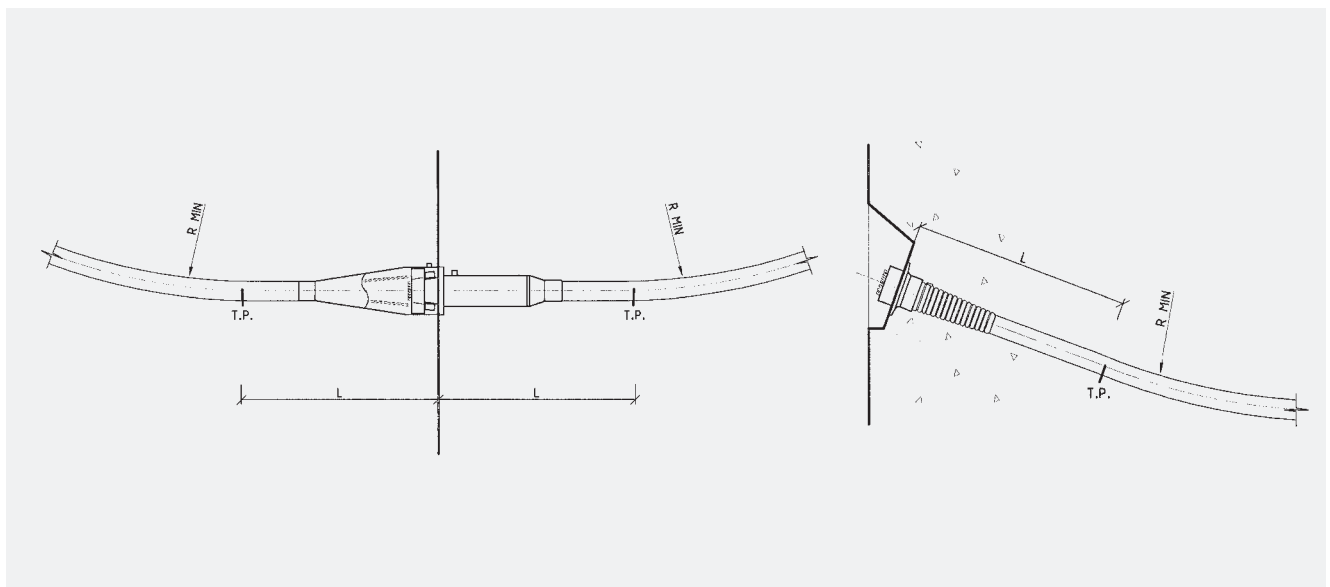
**TRUMPET TYPE K**

# MULTISTRAND POST-TENSIONING

## TENDON PROPERTIES

TENDON UNIT	MAXIMUM NUMBER OF STRANDS	MAXIMUM STEEL DUCT DIAMETERS  ØID / ØOD  mm	MINIMUM RADII OF CURVATURE / MINIMUM STRAIGHT PORTION  $R_{min} / 'L'$  m	TENDON BREAKING LOAD						
				STRAND SIZE	15.2mm	15.2mm	15.2mm	15.24	15.7mm	15.7mm
				TAG	SUPER	SUPER	EHT	GRADE 270	SUPER	SUPER
				CODE	AS 4672	prEN 10138-3	AS 4672	ASTM A-416	BS 5896	prEN 10138-3
				GRADE	1,750MPa	1,860MPa	1,830MPa	1,860MPa	1,770MPa	1,860MPa
				NOM. AREA	143mm <sup>2</sup>	140mm <sup>2</sup>	143mm <sup>2</sup>	140mm <sup>2</sup>	150mm <sup>2</sup>	150mm <sup>2</sup>
				MBL	250kN	260.4kN	261kN	260.7kN	265kN	279kN
406	4	45 / 50	3.0 / 0.8	1,000kN	1,042kN	1,044kN	1,043kN	1,060kN	1,116kN	
706*	7	60 / 65	4.0 / 0.9	1,750kN	1,823kN	1,827kN	1,825kN	1,855kN	1,953kN	
906	9	70 / 75	4.5 / 1.0	2,250kN	2,344kN	2,349kN	2,346kN	2,385kN	2,511kN	
1206*	12	80 / 85	5.2 / 1.0	3,000kN	3,125kN	3,132kN	3,128kN	3,180kN	3,348kN	
1506	15	90 / 95	5.8 / 1.25	3,750kN	3,906kN	3,915kN	3,911kN	3,975kN	4,185kN	
1906*	19	100 / 105	6.5 / 1.25	4,750kN	4,948kN	4,959kN	4,953kN	5,035kN	5,301kN	
2206*	22	105 / 110	7.0 / 1.4	5,500kN	5,729kN	5,742kN	5,735kN	5,830kN	6,138kN	
2406	24	110 / 115	7.3 / 1.6	6,000kN	6,250kN	6,264kN	6,257kN	6,360kN	6,696kN	
2706	27	120 / 125	7.7 / 1.6	6,750kN	7,031kN	7,047kN	7,039kN	7,155kN	7,533kN	
3106*	31	120 / 125	8.4 / 1.6	7,750kN	8,072kN	8,091kN	8,082kN	8,215kN	8,649kN	
2706	37	140 / 145	9.2 / 2.0	9,250kN	9,635kN	9,657kN	9,646kN	9,805kN	10,323kN	
4206	42	150 / 155	9.6 / 2.1	10,500kN	10,937kN	10,962kN	10,949kN	11,130kN	11,718kN	
4806	48	160 / 165	10.2 / 2.4	12,000kN	12,499kN	12,528kN	12,514kN	12,720kN	13,392kN	
5506	55	175 / 180	11.3 / 2.4	13,750kN	14,322kN	14,355kN	14,339kN	14,575kN	15,345kN	
6106	61	180 / 185	11.7 / 2.5	15,250kN	15,884kN	15,921kN	15,903kN	16,165kN	17,019kN	
6906	69	BY REQUEST	BY REQUEST	17,250kN	17,968kN	18,009kN	17,988kN	18,285kN	19,251kN	
7306	73	BY REQUEST	BY REQUEST	18,250kN	19,009kN	19,053kN	19,031kN	19,345kN	20,367kN	

Notes: \*Common tendon sizes.  
 Tendon units 3706 to 6106 subject to special order.  
 MBL = Minimum breaking load  
 Duct sizes are indicative, use larger diameters for aggressive profiles and long tendons - Refer SRG office  
 Duct coupler external diameter is 10mm larger than internal diameter  
 Tendon Curvature:  
 A straight portion 'L' adjacent to the anchorage must be observed and be perpendicular to the anchorage face.  
 A reduction may be possible in special cases - Refer SRG office

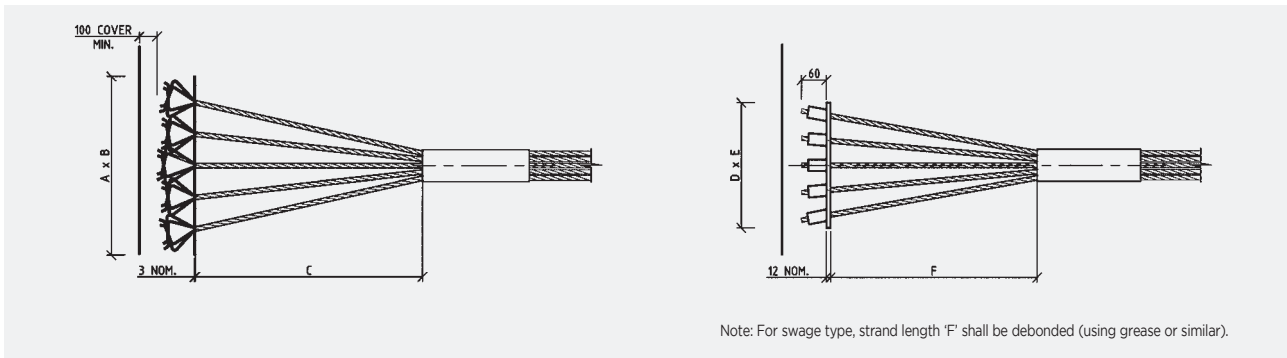


# MULTISTRAND POST-TENSIONING

## DEAD END ANCHORAGES - BULB TYPE AND SWAGE TYPE

STRAND SIZE	ANCHORAGE POINT	BULB TYPE ANCHORAGE (mm)*			SWAGE TYPE ANCHORAGE (mm)		
		A	B	C	D	E	F
15.2mm and 15.7mm	0406	150	150	600	150	150	250
	0706	200	170	600	200	200	350
	0906	300	300	800	250	250	450
	1206	350	300	1,000	250	250	500
	1506	350	350	1,000	300	300	500
	1906	450	350	1,000	300	300	500
	2206	450	450	1,000	300	300	500
	2406	450	450	1,000	300	300	600
	2706	500	450	1,100	350	350	650
	3106	550	475	1,100	350	350	650
	3706	N/A	N/A	N/A	400	350	800
	4206	N/A	N/A	N/A	400	350	850
	4806	N/A	N/A	N/A	550	475	1,000
	5506	N/A	N/A	N/A	550	475	1,000
	6106	N/A	N/A	N/A	550	550	1,200

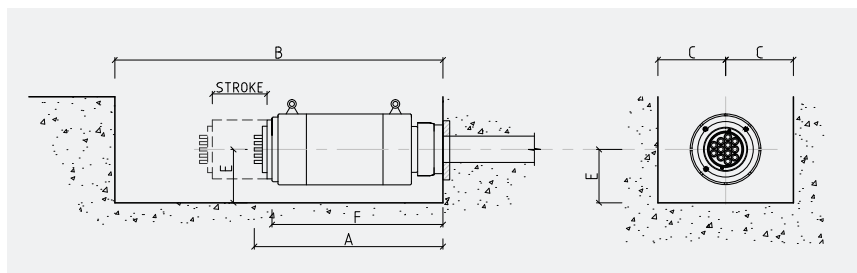
Notes: Swage type dead ends recommended for 1906 tendons and larger.  
 Local zone and several zone anchorage reinforcement is required for all unit types and details are to be determined by the designer to suit the specific application.  
 \* Not usually adopted in civil engineering applications



## SPACE REQUIREMENTS FOR STRESSING JACKS

		STRAND SIZE															
15.2mm /15.7mm	TENDON UNIT	0406	0706	0906	1206	1506	1906	2206	2406	2706	3106	3706	4206	4806	5506	6106	7306
	JACK UNIT	J110	J200	J300	J300	J600	J600	J600	J630	J630	J630	J900	J900	J1200	J1200	J1500	J2200
DIMENSIONS (mm)	A	710	750	810	810	1,200	1,200	1,200	1,000	1,000	1,000	1,400	1,400	1,500	1,500	1,650	1,650
	B	1,400	1,800	1,600	2,000	2,400	2,400	2,400	2,000	2,800	3,000	2,800	2,800	3,000	3,000	3,100	3,300
	C	250	500	330	500	500	500	500	600	600	600	650	650	650	650	650	680
	E	200	230	260	260	400	400	400	500	500	500	550	550	550	550	550	580
	F	595	620	675	675	1,100	1,100	1,100	950	950	950	1,300	1,300	1,400	1,400	1,500	1,500

Notes: Details based on jacks having 200mm working stroke.  
 Alternative jacks may be available and/or more suitable. Contact SRG for further details. Check jack size and availability with your local SRG office.





# MULTISTRAND POST-TENSIONING

## Sheathing and Corrosion Protection

For conventional applications, corrugated galvanised steel ducts are used with a typical wall thickness of 0.3mm. For applications requiring enhanced corrosion protection and improved fatigue resistance of the tendons, use of corrugated plastic

duct is recommended. This fully encapsulated, watertight system offer superb corrosion protection, and the plastic duct eliminates fretting fatigue between the strand and duct. It also provides reduced duct friction. All ducts

are manufactured in a variety of standard lengths and are coupled on site. Steel ducts are readily available in diameters ranging from 40mm to 160mm in approximately 5mm increments.

## ECCENTRICITY OF TENDONS

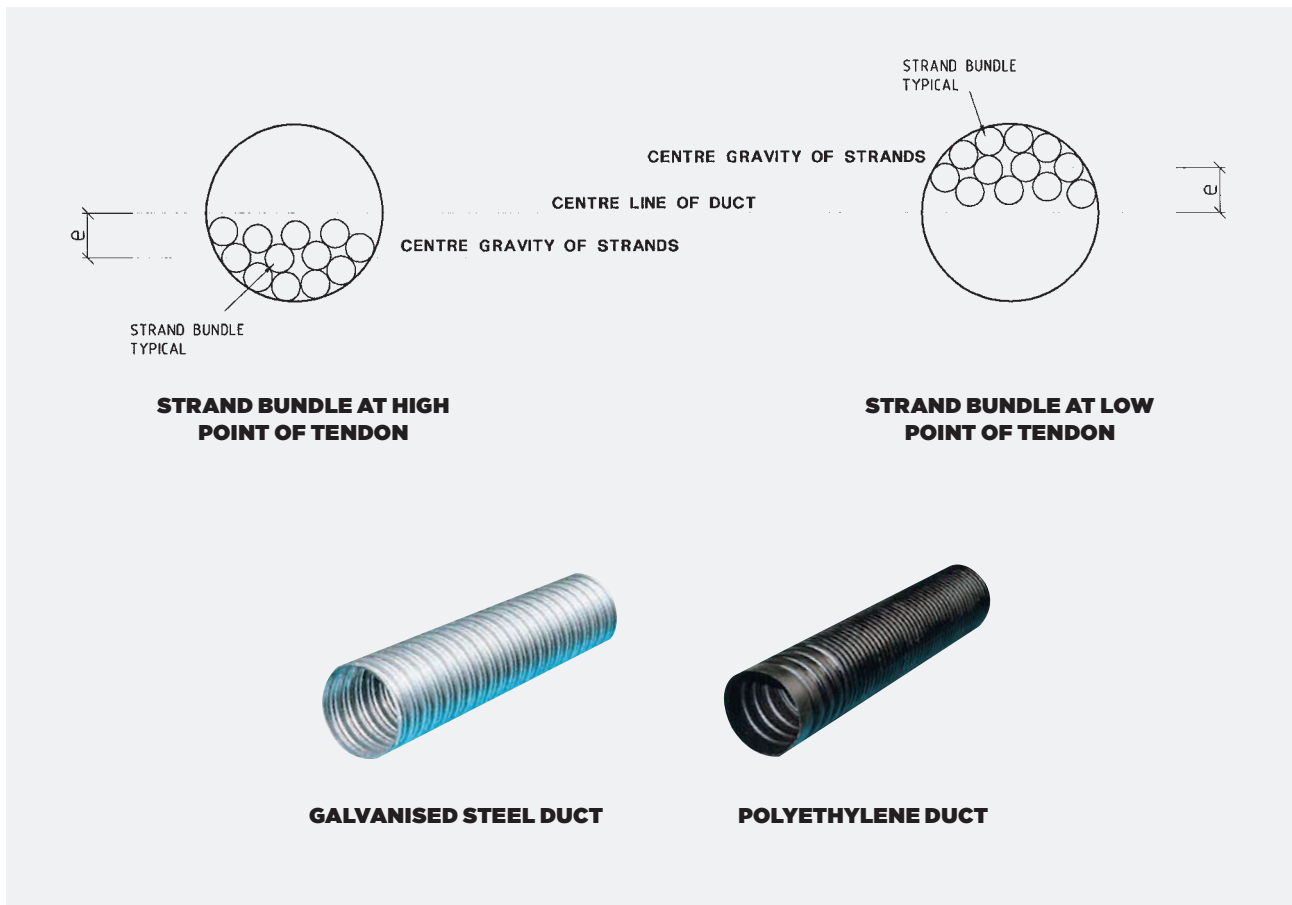
TENDON TYPE	0406	0706	1206	1906	2206	3106	3706	4206	4806	5506	6106
ECCENTRICITY e (mm)	10	11	14	15	21	25	23	25	27	29	32

Notes: "e" is indicative only and depends on actual duct ID and number of strands in tendon.

## TENDON SHEATHING AND CORROSION PROTECTION POLYETHYLENE DUCT DETAILS

TENDON TYPE		15.2mm / 15.7mm					
		0406	0706	1206	1906	3106	3706
HDPE DUCT DIMENSIONS (mm)	OD	59	73	101	116	135	152
	ID	48	59	85	100	115	129
	WALL THICKNESS	2.0	2.0	2.5	3.0	3.5	4.0

Notes: Check with SRG office for availability and lead time for standard and / or alternative polyethylene duct sizes. Add for duct couplers above duct OD.



# External Prestressing

**External prestressing was first used in the late 1920's and has recently undergone a resurgence being used in bridges, both for new construction as well as strengthening of existing structures.**

## Features of External Prestressing

External prestressing is characterised by the following features:

- The prestressing tendons are placed on the outside of the physical cross section (mostly in concrete) of the structure.
- The forces exerted by the prestressing tendons are only transferred to the structure at the anchorages and at deflectors.
- No bond is present between the tendon and the structure, except at anchorage and deflector locations.

## Advantages of External Prestressing

Compared to internal bonded post-tensioning the external prestressing has the following distinct advantages:

- The application of external prestressing can be combined with a broad range of construction materials such as steel, timber, concrete, composite structures

and plastic materials. This can considerably widen the scope of the post-tensioning applications.

- Due to the location and accessibility of the tendons, monitoring and maintenance can be readily carried out compared to internal, bonded prestressing.
- Due to the absence of bond, it is possible to restess, destress and exchange any external prestressing cable, provided that the structural detailing allows for these actions.
- Improves the concrete placing due to the absence of tendons in the webs.
- Improvement of conditions for tendon installation which can take place independently from the concrete works.
- Reduction of friction losses, because the unintentional angular changes, known as wobble, are practically eliminated. Furthermore with the use of a polyethylene sheathing the friction coefficient is drastically reduced compared to internal bonded prestressing using corrugated metal ducts.

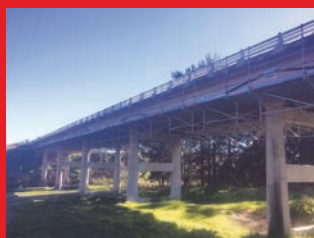
- External prestressing tendons can easily and without major cost implication be designed to be replaceable, de-stressable and re-stressable.
- Generally the webs can be made thinner, resulting in an overall lighter structure.
- Strengthening capabilities.

As an overall result, better concrete quality can be obtained leading to a more durable structure.

## Typical Applications for External Prestressing

Typical applications where external tendons are feasible, practical and economical, are:

- Repair work and strengthening of all kinds of structures
- Precast segmental construction
- Simple and continuous spans
- Underslung structures
- Incremental launching procedure, in particular concentric prestressing.





External post-tensioning - Sydney Metro Northwest Project

## EXTERNAL PRESTRESSING

### BBR VT CONA CME

#### Standard Tendon Sizes

The CONA CME post-tensioning kit is a multi-strand system for all types of externally post-tensioned applications and part of the CMX family of post-tensioning anchorages. The standard tendon sizes range from 1 to 61 seven-wire prestressing strands. Larger sizes are also possible and CONA CME tendons with 73 strands have already been used. Most commonly, 0.62" (15.7mm) strands with a cross sectional area of 150mm<sup>2</sup> and a characteristic tensile strength of 1,860 MPa are used.

#### Anchor Configuration

The main components in the anchor zone of the CONA CME system are the wedges, anchor head, trumplate / square plate and trumpet. In the anchorage zone, the duct is connected to the trumpet and the strand bundle is spread out towards the anchor head, where each strand is individually locked with special BBR wedges.

For the load transfer to the concrete, the CONA CME BT (bearing trumplate) can be used for tendon sizes from 2 to 61 strands and the CONA CME SP (square plate) can be used for 1 to 73 strands.

The CONA CME BT bearing trumplate system makes use of an advanced and proprietary three

plane load transfer, allowing for very small center and edge distances at the anchorages, as well as application of the full post-tensioning load at very low concrete strengths. The CONA CME SP (square plate) is a system with a single plane load transfer to the concrete.

#### The Stressing and Fixed Anchorages

The anchorages are Type S stressing / active anchorages and Type F fixed / passive anchorages. The anchor heads of the stressing and fixed anchorages are identical. For construction works, the wedges of inaccessible fixed anchorages are secured by special wedge retaining plates and are protected by a cap during concreting. For re-stressable and exchangeable tendons, excess strand length is required at the anchorage. The extent of the excess strand length depends on the jack used for re-stressing or releasing and the strand protruding beyond the anchor head requires permanent corrosion protection and an adequate cap.

#### Fixed and Stressable Couplers

Although less common for external tendons, CONA CME tendons can be coupled using proprietary Type K overlap coupler for tendons ranging

from 2 to 31 strands (larger sizes on request) or Type H sleeve coupler for 1 to 73 strands. Type H couplers are available by special request only.

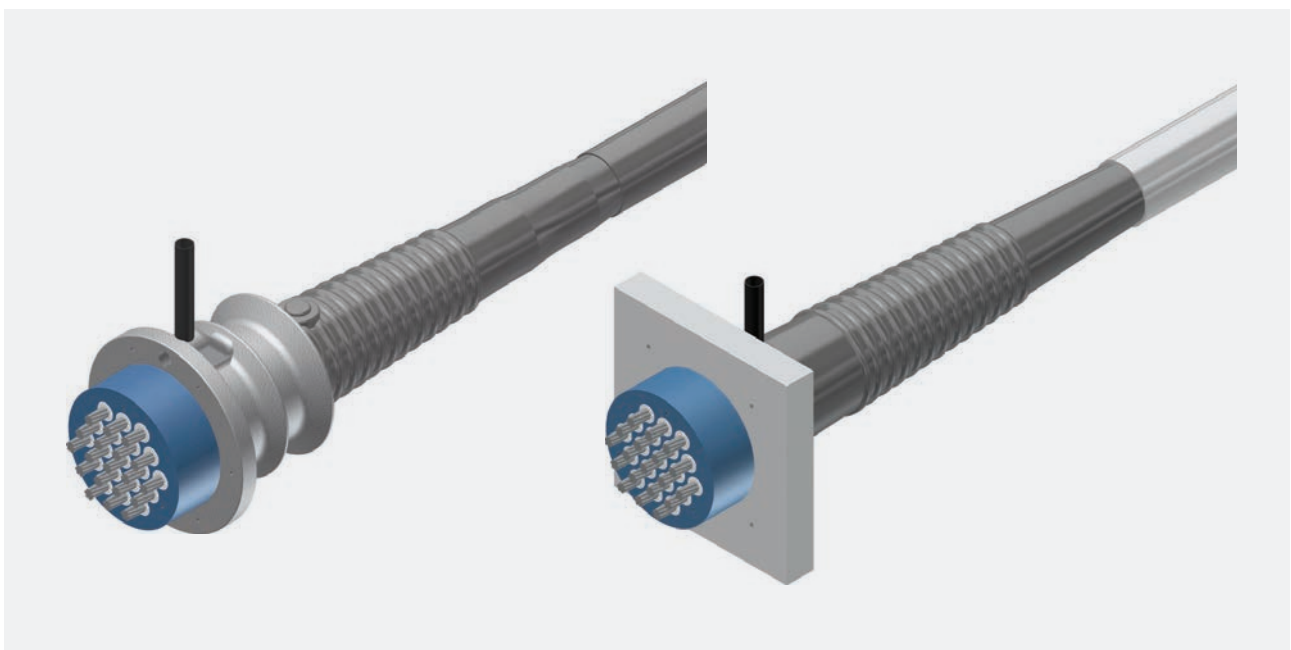
#### Deviator / Saddle

An element that is specific to external prestressing is the deviator / saddle. The deviator transfers the transversal forces generated by the tendon to the structure and provides a smooth surface for the tendons. The deviator can be made of concrete, steel, HDPE or equivalent.

#### Corrosion Protection

The strand bundle is enclosed in a smooth round plastic or steel duct. The filling of the tendons is carried out using a high performance grout or grease / wax. The use of greased / waxed and HDPE sheathed monostrand is a further possibility.

(\*) Other prestressing strands approved at the place of use, such as strands having a cross-sectional area of 140mm<sup>2</sup> and / or a characteristic tensile strength lower than 1,860 MPa can be used with the same anchorage components.

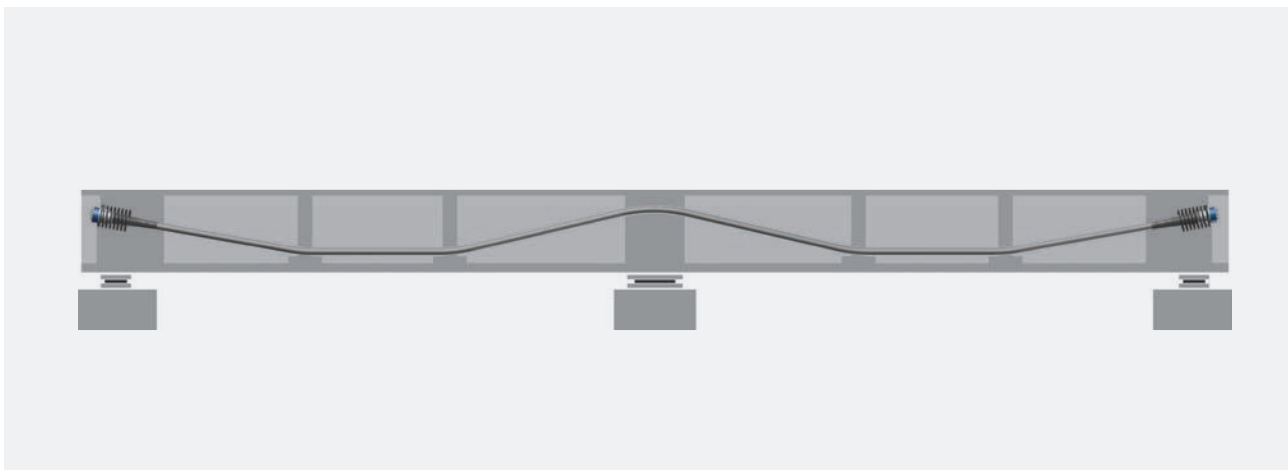


# EXTERNAL PRESTRESSING

## TENDON SIZES AVAILABLE FOR CME SYSTEM

BBR VT CONA CME			
No. STRANDS	CHARACTERISTIC ULTIMATE RESISTANCE OF TENDON (kN)		
STRAND AREA EACH mm <sup>2</sup>	TENDON	140 (0.60")	150 (0.62")
STRAND GRADE MPA	TAG	1,860	1,860
01	0106	260	279
02	0206	521	558
03	0306	781	837
04*	0406	1,042	1,116
05	0506	1,302	1,395
06	0606	1,562	1,674
07*	0706	1,823	1,953
08	0806	2,083	2,232
09	0906	2,344	2,511
12*	1206	3,125	3,348
13	1306	3,385	3,627
15	1506	3,906	4,185
16	1606	4,166	4,464
19*	1906	4,948	5,301
22*	2206	5,729	6,138
24	2406	6,250	6,696
25	2506	6,510	6,975
27	3106	7,031	7,533
31*	3706	8,072	8,649
37	4206	9,635	10,323
42	4306	10,937	11,718
43	4806	11,197	11,997
48	5506	12,499	13,392
55	6106	14,322	15,345
61	6906	15,884	17,019
69	6906	17,968	19,251
73	7306	19,009	20,367

\* Common sizes adopted



# Unbonded Band Post-Tensioning

**The CONA CMB post-tensioning kit is a multi-strand system for special external and also internal unbonded post-tensioned applications.**

The CONA CMB post-tensioning kit is a multi-strand system for special external and also internal unbonded post-tensioned applications. The standard tendons range from 1 to 16 seven-wire prestressing strands. Most commonly 0.62" (15.7 mm) strands with a cross-sectional area of 150mm<sup>2</sup> and a characteristic tensile strength of 1,860 MPa and a compacted 0.6" (15.2mm) strands with a cross-sectional area of 165mm<sup>2</sup> and a characteristic tensile strength of 1820 MPa are used.

## Anchorage configuration

The main components in the anchor zone of the CONA CMB SP system are the wedges, anchor head, load transfer element and trumpet. In the anchorage zone the strand bundle is spread out towards the anchor head, where each strand is individually locked with special BBR wedges. For the load transfer to the concrete, the CONA CMB SP (square plate) is used.

The anchorages are the Type S stressing / active anchorages and the Type F fixed / passive anchorages. The anchor heads of the stressing and fixed anchorages are identical. For restressable and exchangeable tendons, excess strand length is required at the anchorage. The extent of the excess strand length depends on the jack used for stressing or releasing and strand protruding beyond the anchor head requires permanent corrosion protection and an adequate cap.

## Deviator / Saddle

An element that is specific to external prestressing is the deviator / saddle. The deviator transfers the transversal forces generated by the tendon to the structure and provides a smooth surface for the tendons. The deviator can be made of concrete, steel, HDPE or equivalent.

## Corrosion Protection

The strands are greased / waxed and individually sheathed in the factory with a continuously extruded HDPE sheathing and subsequently grouped parallel and then contained within an additional extruded smooth rectangular plastic sheath.

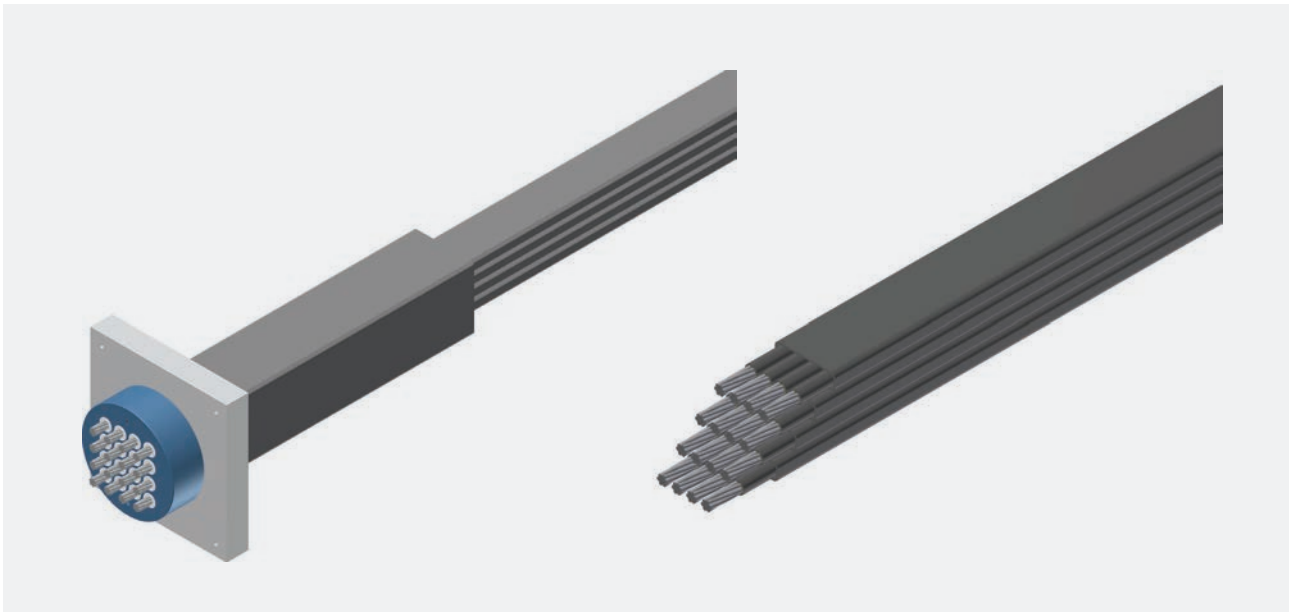
*(\*) Other prestressing strands approved at the place of use, such as strands having a cross-sectional area of 140mm<sup>2</sup> and / or a characteristic tensile strength lower than 1860 MPa or 1820 MPa respectively can be used with the same anchorage components.*



# UNBONDED BAND POST-TENSIONING

## TENDON SIZES AVAILABLE FOR CMB SYSTEM

BBR VT CONA CMB				
No. STRANDS	CHARACTERISTIC ULTIMATE CAPACITY OF TENDON (kN)			
STRAND AREA EACH mm <sup>2</sup>	TENDON	140	150	165
STRAND GRADE MPA	TAG	1,860	1,860	1,820
01	0106	260	279	300
02	0206	521	558	601
04	0406	1,042	1,116	1,201
06	0606	1,562	1,674	1,802
08	0806	2,083	2,232	2,402
12	1206	3,125	3,348	3,604
16	1606	4,166	4,464	4,805



# Multiwire Post-Tensioning

**Multiwire post-tensioning is a compact alternative to the multistrand system and is often preferred for coupled cables in incrementally launched bridges.**

Multiwire post-tensioning is ideally suited where cables are to be prefabricated and where restressing or destressing is required.

The multiwire tendon is composed of a bundle of 7mm diameter wires (plain or galvanised). Each individual wire is fixed in the anchorage with a multiwire button head, this button head is cold formed onto the wire by means of special machines.

Each wire is mechanically fixed in the anchor head and reached the full rupture load of the prestressing steel without any slippage. Therefore the wire bundle can sustain the maximum ultimate load.

The prestressing force is transmitted to the concrete under precisely known conditions without any risk of slippage of the prestressing steel.

Monitoring of the prestressing force, and if necessary - restressing, can be carried out reliably and economically.

If required, the tendon can also be completely destressed.

Typical applications of multiwire post-tensioning include:

- Coupled cables in incrementally launched bridges
- Stay cable applications
- Restressable tendons
- Heavy lifting and lowering cables
- Restressable ground anchors

## Standard Tendons

The anchoring method allows the production of post-tensioning tendons with any number of single wires and therefore with any given magnitude of prestressing force. The most commonly used wire diameter is 7mm.

With the following range of standard tendons, all prestressing requirements occurring in the construction of bridges, building and other structures can be met. For special applications, i.e. nuclear vessels, tendons up to 15,000 kN ultimate capacity are available. Note: Wire tendons are subject to special order.

## Grouting of Ducts

SRG Global has developed grouting methods utilising special colloidal mixers which result in an optimal grouting of the tendon ducts.

## Prestressing Equipment

The prestressing equipment consists of a hydraulic jack, trestle and pull-rod, which is connected to the stressing anchorage. For tendon elongations greater than the stroke of the jack, the pull-rod is temporarily anchored with a lock-nut and the jack is recycled. The prestressing force can be measured with an accuracy of 2% by using calibrated 150mm face bourdon type pressure gauges.







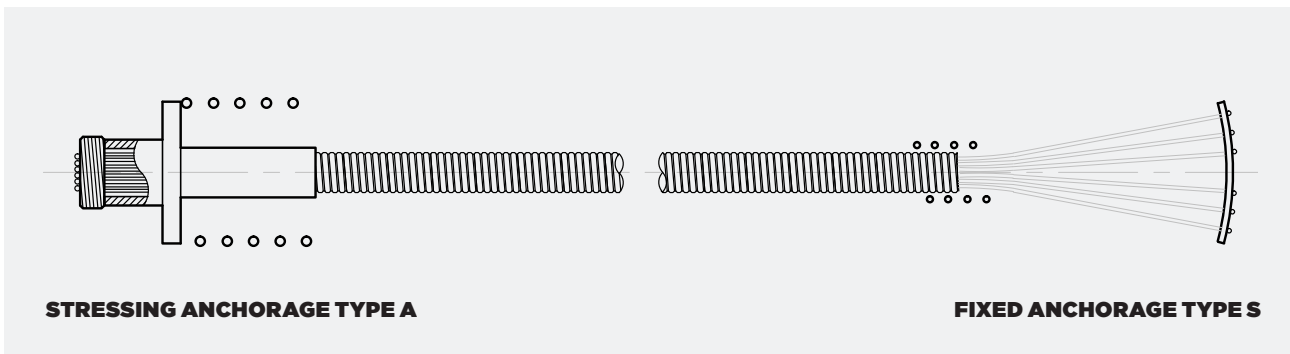
Mandurah Marina Footbridge, WA

# MULTIWIRE POST-TENSIONING

## STANDARD SRG WIRE TENDONS

NUMBER OF WIRES (DIA. 7MM)		8	19	31	42	55	61	85	109	121	143
MIN BREAKING LOAD (RM=1670MPA)	kN	514	1,222	1,993	2,701	3,537	3,922	5,466	7,009	7,780	9,195
STRESSING FORCE AT 0.8 X MBL	kN	412	977	1,595	2,160	2,829	3,138	4,372	5,607	6,224	7,356
STRESSING FORCE AT 0.75 X MBL	kN	386	916	1,495	2,025	2,652	2,942	4,099	5,257	5,835	6,896
TENDON NOMINAL CROSS SECTIONAL AREA	mm <sup>2</sup>	308	731	1,194	1,617	2,118	2,349	3,273	4,197	4,659	5,506
WEIGHT OF TENDON WIRE	kg/m	2.42	5.74	9.36	12.68	16.61	18.42	25.67	32.92	36.54	43.19
DUCT ID	mm	35	50	55	65	80	85	100	110	120	130

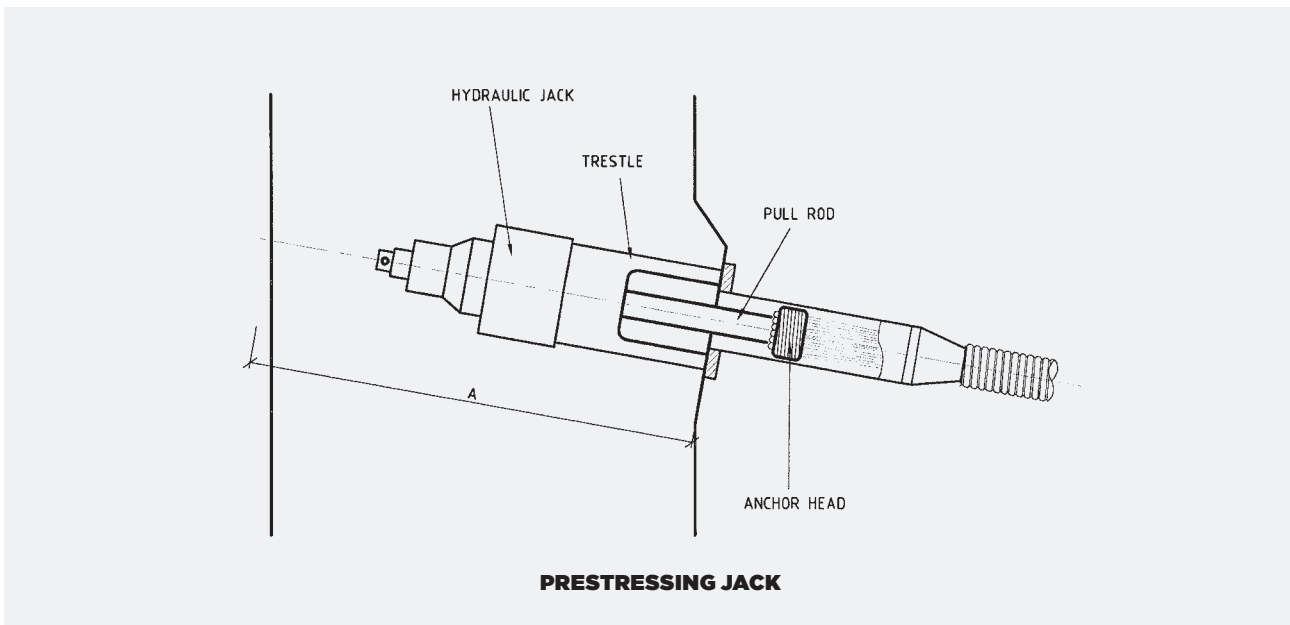
Notes: Rm = Characteristic tensile strength to AS 4672 and /or BS 5896.



## PRESTRESSING JACKS

STRESSING JACK TYPE		J060	J100	J150	J200	J250	J300	J500	J800
MAX JACKING FORCE	kN	620	1,030	1,545	2,060	2,575	3,090	5,150	8,000
JACK DIAMETER	mm	160	205	250	290	315	350	560	660
JACK STROKE	mm	100	100	100	100	100	100	400	400
JACK WEIGHT	kg	28	50	83	117	147	196	1,260	2,000
CLEARANCE REQUIREMENT A	mm	1,700	1,700	1,700	2,000	2,000	2,000	2,500	2,500

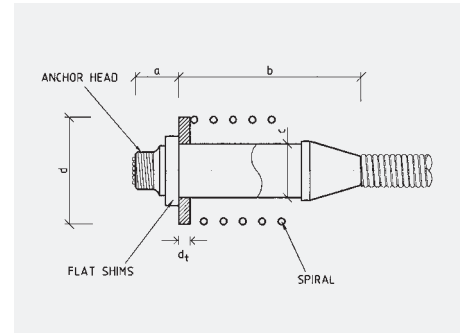
Notes: Check jack size and availability with your local SRG office.



# MULTIWIRE POST-TENSIONING

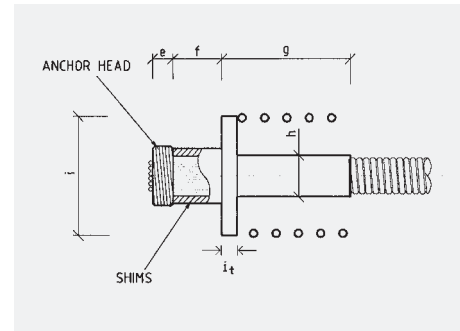
## STRESSING ANCHORAGE TYPE L

NUMBER OF WIRES (DIA. 7mm)		8	12	19	31	42	55	61	85	109	121	143
ANCHOR	a mm	63	74	91	108	123	135	156	180	205	240	245
TRUMPET LENGTH	b mm	250	250	250	280	300	300	300	340	360	400	500
DIAMETER	c mm	70	88	102	123	138	153	171	193	219	240	252
BEARING PLATE	d mm	140	170	200	245	285	315	345	400	450	500	520
THICKNESS	d <sub>t</sub> mm	14	16	20	25	30	35	40	50	60	70	70



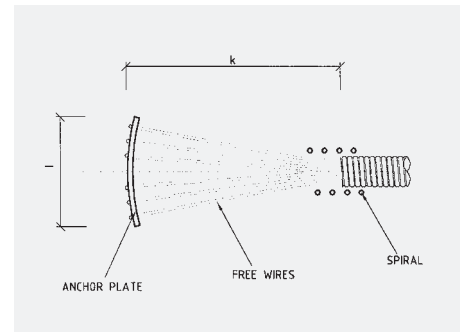
## STRESSING ANCHORAGE TYPE A

NUMBER OF WIRES (DIA. 7mm)		8	12	19	31	42	55	61	85	109	121	143
ANCHOR	e mm	25	27	36	43	49	56	67	78	85	140	145
ELONGATION, MAX	f mm	200	200	200	200	200	250	250	350	350	400	400
TRUMPET LENGTH	g mm	170	185	200	280	310	335	360	390	420	450	500
DIAMETER	h mm	37	49	59	76	87	97	105	120	135	145	160
BEARING PLATE	i mm	140	170	200	235	270	300	330	380	430	480	500
THICKNESS	i <sub>t</sub> mm	16	20	25	30	40	45	50	60	70	80	80



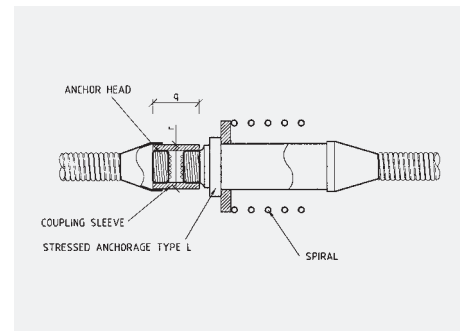
## FIXED ANCHORAGE TYPE S

NUMBER OF WIRES (DIA. 7mm)		8	12	19	31	42	55	61	85	109	121	143
FAN LENGTH	k mm	460	550	660	830	880	960	1,010	1,060	1,180	1,220	1,260
ANCHOR PLATE, SQ	l mm	120	160	200	250	280	320	350	400	450	470	520
RECTANGULAR	l mm	70	90	120	140	160	180	200	240	260	280	300
	w mm	200	270	340	420	500	560	600	660	760	790	900



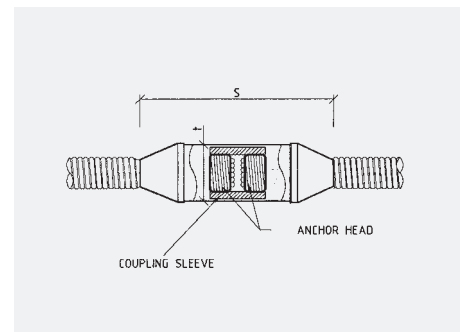
## FIXED ANCHORAGE TYPE LK

NUMBER OF WIRES (DIA. 7mm)		8	12	19	31	42	55	61	85	109	121	143
TRUMPET LENGTH	q mm	230	260	290	350	410	430	470	570	630	680	730
DIAMETER	r mm	70	88	102	123	138	153	171	193	219	250	260



## MOVABLE COUPLING TYPE LK1

NUMBER OF WIRES (DIA. 7mm)		8	12	19	31	42	55	61	85	109	121	143
TRUMPET LENGTH MIN	s mm	600	620	670	750	810	880	950	1,080	1,150	1,220	1,260
DIAMETER	t mm	70	88	102	123	138	153	171	193	219	250	260



## Special Application Anchorages

Details of Anchorages for various special applications are also available on request.

# Bar Post-Tensioning

**Macalloy Bar Systems are ideal for the economic application of post-tensioning forces on relatively short tendons.**

Through the use of threaded connections and anchorages they are simple to use and lend themselves to many applications.

The robust coarse thread (CT) on the Macalloy bar ensures rapid and reliable assembly. This is particularly suitable for onsite use and reuse.

## Typical Applications

### Buildings

- Prestressed Beams and Columns
- Precast Connections
- Temporary Bracing

### Bridges

- Stay Cables and Hangers
- Precast Segments
- Strengthening (Timber & Steel Bridges)
- Tension Piles and Caissons

### Wharves & Jetties

- Stressed Deck Planks
- Tie Backs

### Soil and/or Rock Anchors

- Permanent and Temporary Anchors
- Uplift Anchors (Dam & Foundation)
- Tunnel Roof Bolting
- Soil Nails and Rock Bolts
- Slope Stabilisation
- Crane and Tower Bases

### Specialist Engineering

- Heavy Lifting
- Formwork Ties and Hangers
- Frame Ties
- Pile Testing
- Architectural Ties and Stays

### Characteristic Properties

Macalloy Bar Properties are listed in the following tables.

### Corrosion Protection

All bars and fittings must receive protection when installed under permanent conditions. In normal concrete construction the use of galvanised duct, injected with

grout, provides excellent protection. Anchorage recesses must also be filled with cement mortar to protect these end zones.

When bars are used in an exposed environment then other corrosion protection systems are available for the bar and fittings. These include:

- Greased and sheathing bar
- Denso wrapping
- Epoxy painting

### Temporary Bar Anchors

Anchors used in a temporary environment may be used without protection apart from grout required to the bond length.

### Permanent Bar Anchors

These anchors require installation into corrugated polyethylene sheathing or galvanised duct similar to strand anchors to provide multiple levels of protection. This is accomplished by the internal grout and sheathing barrier.





Stockyard Hill Wind Farm Anchors

# BAR POST-TENSIONING

## RANGE OF MACALLOY 1030 BAR

NOMINAL DIAMETER mm	NOMINAL CROSS SECTION AREA mm <sup>2</sup>	MASS OF BAR		MAJOR DIAMETER OF THREADS mm	MIN. HOLE DIAMETER IN STEELWORK mm
		MACALLOY 1030 kg/m	*MACALLOY S1030 kg/m		
20	315	-	2.53	22.0	24
25	491	4.09	4.09	28.9	31
26.5	552	4.58	4.58	30.4	33
29	660	5.45	5.45	33.8	38
32	804	6.63	6.63	36.2	40
36	1,018	8.35	8.35	40.2	44
40	1,257	10.30	10.30	45.3	49
50	1,963	15.72	15.72	54.8	59
75	4,185	33.00	-	77.2	82

\* Macalloy S1030 is made from stainless steel.

## MECHANICAL PROPERTIES OF MACALLOY 1030 BAR

GRADE	CHARACTERISTIC ULTIMATE TENSILE STRENGTH MPa	MINIMUM 0.1% PROOF STRESS MPa	MINIMUM ELONGATION %	APPROXIMATE MODULUS OF ELASTICITY GPa
MACALLOY 1030 25-50mm	1,030	835	6	170 <sup>(1)</sup>
MACALLOY 1030 50-75mm	1,030	835	6	205
MACALLOY S1030*	1,030	835	10	185

\* Macalloy S1030 is made from stainless steel.

(1) Secant modulus of elasticity in range 5-70% UTS

## CHARACTERISTIC LOADS FOR MACALLOY 1030 BAR

NOMINAL DIAMETER mm	CHARACTERISTIC BREAKING LOAD (MBL)		MINIMUM 0.1% PROOF LOAD	
	MACALLOY 1030 kN	*MACALLOY S1030 kN	MACALLOY 1030 kN	*MACALLOY S1030 kN
20	-	323	-	262
25	506	506	410	410
26.5	569	569	460	460
29	667	667	603	603
32	828	828	670	670
36	1,049	1,049	850	850
40	1,295	1,295	1,050	1,050
50	2,022	2,022	1,639	1,639
75	4,311	-	3,495	-

\* Macalloy S1030 is made from stainless steel.

# BAR POST-TENSIONING

## MACALLOY 1030 COMPONENT PARAMETERS

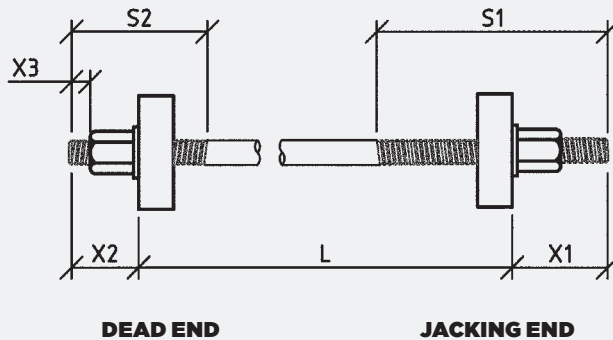
ITEM	UNIT	NOMINAL BAR DIAMETER - mm									
		'20'	25'	26.5	29	32	36	40	50	75	
BARS	SECTIONAL AREA	mm <sup>2</sup>	314.2	490.9	551.5	660.0	804.3	1,017.9	1,256.6	1,963.5	4,185.4
	MASS PER METRE	kg	2.46	4.09	4.58	5.45	6.63	8.35	10.30	15.72	33.00
	METRE RUN OF BAR PER TONNE	m	405	246	219	183	150	118	96	62	30
	CHARACTERISTIC FAILING LOAD	kN	314	506	568	667	828	1,048	1,294	2,022	4,311
	PRESTRESS AT 70% CHARACTERISTIC	kN	220	354	398	467	580	734	907	1,415	3,018
FLAT NUTS*	NUT REFERENCE	-	FSSN20	FN25	FN26.5	FN29	FN32	FN36	FN40	FN50	FN75
	LENGTH	mm	25	33	37	41	41	46	51	71	100
	WIDTH ACROSS FLATS (DIA FOR 75MM BAR)	mm	42	45	50	56	56	62	72	90	135
	WEIGHT	kg	-	-	0.46	0.58	0.56	0.74	0.86	2.55	7.70
FLAT WASHERS*	WASHER REFERENCE	-	FSSW20	FSW25	FSW26.5	FSW29	FSW32	FSW36	FSW40	FSW50	-
	OUTSIDE DIAMETER	mm	50	60	65	70	70	75	90	105	-
	THICKNESS	mm	5	5	5	5	5	5	5	5	-
COUPLERS	COUPLER REFERENCE	-	FSSC20	FC25	FC26.5	FC29	FC32	FC36	FC40	FC50	FC75
	OUTSIDE DIAMETER	mm	35	42.5	42.5	50	50	57.5	62.5	76	110
	LENGTH - STANDARD	mm	-	85	90	115	115	130	140	170	230
	LENGTH - STAINLESS	mm	65	80	-	95	95	-	120	-	-
	WEIGHT	kg	-	-	0.54	0.97	0.94	1.50	1.78	3.10	9.00
END PLATES	PLATE REFERENCE	-	FSSP20	FPP25	FPP26.5	FPP29	FPP32	FPP36	FPP40	FPP50	FPP75
	LENGTH	mm	100	100	110	125	125	140	160	200	300
	WIDTH	mm	100	100	110	125	125	140	160	200	300
	HOLE DIAMETER	mm	26	34	36	39	41	45	51	61	82
	THICKNESS - STANDARD	mm	25	40	40	50	50	50	60	60	75
	THICKNESS - THREADED	mm	-	40	40	50	50	50	60	70	110
DUCTS	SHEATHING I/D	mm	40	40	40	50	50	50	60	70	90
	COUPLER-SHEATHING I/D (REC)	mm	50	60	60	65	66	70	75	90	125
	COUPLER-SHEATHING (MIN)	mm	45	55	55	60	60	65	70	90	125
THREADS	PITCH	mm	2.5	6.0	6.0	6.0	6.0	6.0	8.0	8.0	8.0
STANDARD THREAD LENGTHS (SEE FIG ON P30)	LENGTH - JACKING END (STANDARD) S1	mm	250	250	250	250	250	250	250	250	360
	LENGTH - DEAD END (STANDARD) S2	mm	100	100	100	100	100	100	100	100	160
	LENGTH - COUPLER (STANDARD)	mm	40	45	50	60	60	65	75	85	150
	X1 (MIN)	mm	75	82	91	105	105	115	130	165	235
	X2 (MIN)	mm	42	49	53	57	57	62	71	91	116
	X3 (MIN)	mm	12	12	12	12	12	12	16	16	16

\* Spherical nuts and washers are available if required for rotation.

† 20mm bar available in stainless steel grade only.

‡ Bar range available on request

### MACALLOY 1030 BAR END THREAD DIMENSIONS

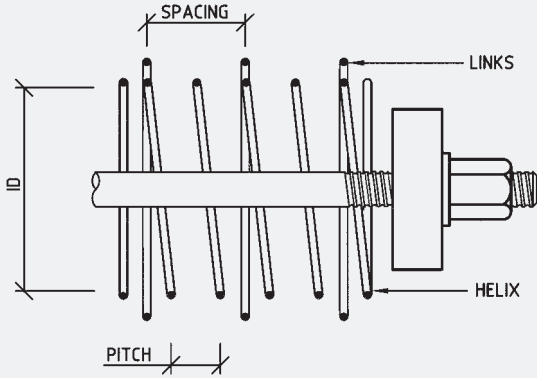


X1 = live end  
 X2 = dead end  
 X3 = length of bar past nut or through threaded plate

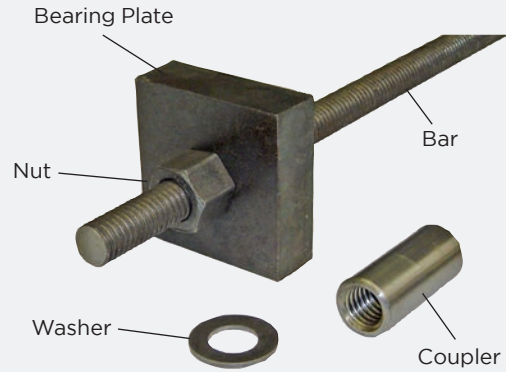
S1 = live end thread  
 S2 = dead end thread  
 L = length over plates

# BAR POST-TENSIONING

## MACALLOY 1030 TYPICAL END BLOCK ARRANGEMENT



## MACALLOY 1030 BAR COMPONENTS



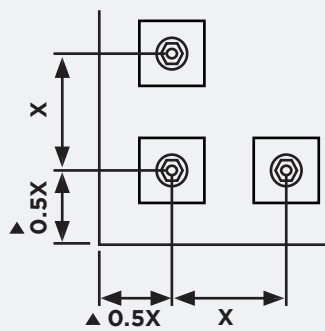
Note: Helix and links must be used together with minimum 35 MPa concrete - see figure above

## MACALLOY 1030 SUGGESTED MILD STEEL END BLOCK REINFORCEMENT

MACALLOY DIAMETER mm	HELIX				LINKS			
	ROD DIAMETER. mm	O/D mm	PITCH mm	TURNS NO.	ROD DIAM. mm	SQU mm	SPACING mm	NUMBER
25	12	175	40	4	8	200	70	6
26.5	12	180	40	4	8	205	70	6
29	12	190	40	5	8	220	70	7
32	12	190	40	5	8	220	70	7
36	12	210	40	6	8	235	70	7
40	12	240	40	7	10	265	75	8
50	12	300	40	8	12	330	80	9
75	16	450	50	8	16	490	100	10

- Notes:
- A longitudinal length of rod may be used to attach the links but it is not required as part of the reinforcement
  - A more detailed explanation of the Macalloy Post Tensioning System is available in the Macalloy Design Data Handbook
  - There are many permutations possible to achieve satisfactory construction details, and advice is readily available from SRG
  - Bar diameters up to 50mm have ETA approval

## MINIMUM ANCHORAGE SPACING AND EDGE DISTANCE



NOMINAL BAR DIAMETER	X
25	220
26.5	230
32	240
36	260
40	290
50	355

▲ PLUS ANY ADDITIONAL REQUIRED COVER



## BAR POST-TENSIONING

### Other Macalloy bar systems also available

- Macalloy 460 carbon steel tendons
- Macalloy S460 stainless steel tendons
- Macalloy Guy Linking stainless steel bar tendons
- Macalloy Guy Linking stainless steel cable tendons
- Macalloy 17MHS Sheet piling ties
- Macalloy 500 Reinforcing bars
- Macalloy 500 Tie bars
- Macalloy 650 Stainless Tie bars
- Macalloy-Tensoteci Galvanised cable tendons



# Our global footprint

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