

BBR VT CONA CMX

Strand Post-tensioning Systems



Strong and Versatile

Volume 1: System Applications



A Global Network of Experts
www.bbrnetwork.com



BBR A Global Network of Experts www.bbrnetwork.com

The BBR Network is recognized as the leading group of specialized engineering contractors in the field of post-tensioning, stay cable and related construction engineering. The innovation and technical excellence, brought together in 1944 by its three Swiss founders – Antonio Brandestini, Max Birkenmaier and Mirko Robin Ros – continues, more than 60 years later, in that same ethos and enterprising style. From technical headquarters in Switzerland, the BBR Network reaches out around the globe and has at its disposal some of the most talented engineers and technicians, as well as the very latest internationally approved technology.

THE GLOBAL BBR NETWORK

Within the Global BBR Network, established traditions and strong local roots are combined with the latest thinking and leading edge technology. BBR grants each local BBR Network Member access to the latest technical knowledge and resources – and facilitates the exchange of information on a broad scale and within international partnering alliances. Such global alliances and co-operations create local competitive advantages in dealing with, for example, efficient tendering, availability of specialists and specialized equipment or transfer of technical know-how.

ACTIVITIES OF THE NETWORK

All BBR Network Members are well-respected within their local business communities and have built strong connections in their respective regions. They are all structured differently to suit the local market and offer a variety of construction services, in addition to the traditional core business of post-tensioning.

BBR TECHNOLOGIES

BBR Technologies have been applied to a vast array of different structures – such as bridges, buildings, cryogenic LNG tanks, dams, marine structures, nuclear power stations, retaining walls, tanks, silos, towers, tunnels, wastewater treatment plants, water reservoirs and wind farms. The BBR brands and trademarks – BBR®, CONA®, BBRV®, HiAm®, DINA®, BBR E-Trace® and CONNAECT® – are recognized worldwide. The BBR Network has a track record of excellence and innovative approaches – with thousands of structures built using BBR Technologies. While BBR's history goes back to 1944, the BBR Network is focused on constructing the future – with professionalism, innovation and the very latest technology.

BBR VT International Ltd is the Technical Headquarters and Business Development Centre of the BBR Network located in Switzerland. The shareholders of BBR VT International Ltd are: BBR Holding Ltd (Switzerland), a subsidiary of the Tectus Group (Switzerland); Spenneteknikk International AS (Norway), a member of the KB Group (Norway); BBR Pretensados y Técnicas Especiales PTE, S.L. (Spain), a member of the FCC Group (Spain).

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Strong, fast, green

Within the BBR Network, we have a long history of innovation founded on listening to what our customers want and then going the extra mile to deliver it – the BBR VT CONA CMX® range of post-tensioning is our response to current needs. This brochure is the ultimate ‘must-have’ guide for designers and engineers, as it contains details of the complete range of BBR VT CONA CMX technology.

You will see that we’ve focused on creating a sound solution which offers benefits for all types of construction applications and to all stakeholders. We have combined the requirement for strength and reliability with a completely flexible and environmentally responsible approach. When this comes together with the expertise and professionalism of the BBR Network to advise on and install post-tensioning systems, it is an unbeatable combination – and we are sure you will agree that there’s no finer solution on the market! Our new technology allows more freedom than ever before for architectural and design creativity and it can save valuable program time, while reducing impact on budgets and the environment. But there’s even more, we’ve had our systems independently tested – and have even gone beyond the requirements of international norms. Our CONA CMX range has European Technical Approval (ETA) and, thus, bears the CE marking.

You may have guessed by now that we are very proud of our BBR VT CONA CMX range of post-tensioning technology – and we believe that you will be too!

How to use this brochure



Check system specifications

All system specifications are contained in a separate brochure within which all relevant detailed technical data can be found.



Check ETA

CONA CMX systems have European Technical Approval ETA which can be downloaded on www.bbrnetwork.com or obtained at BBR VT International Ltd.

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Post-tensioning – the clever way

Owners, designers, builders and end users of any structures require more efficiencies today than ever before. BBR VT CONA CMX post-tensioning offers all stakeholders in a project many benefits. For over 60 years, BBR post-tensioning technology has been applied to thousands of different structures in the civil engineering and building construction industry. All CONA CMX systems are backed by the European Technical Approval ETA and the associated Certificate of Conformity.

Post-tensioning (PT) is a fiendishly clever way of reinforcing concrete while you are building – occasionally even allowing the construction of something which might otherwise have been impossible. But it can also be combined with other structural materials, such as steel, masonry and timber structures. PT provides active reinforcement and places the concrete structure under compression in those regions where load causes tensile stress.

Since the first applications in the early 1950s, BBR PT technology has advanced significantly – particularly in the field of performance, quality assurance and durability, as well as corrosion protection. Massive developments in the PT method over the past decades, mean that it is now a significant feature in construction 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.



Pre-tensioning



Post-tensioning



Internal bonded vs. unbonded post-tensioning

Internal bonded post-tensioning systems can range from a single strand to multiple strands (multi-strand) in one tendon. The tendons are inserted into a metal or plastic duct that is embedded in the concrete. By filling the duct with special cementitious grout, the tendon is 'bonded' with the surrounding concrete. The grout creates an alkaline environment which ensures corrosion protection of the prestressing steel.

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

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 outer 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, but can also be applied to many other types of structure.



Key benefits of post-tensioned 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 minimize costs.



External post-tensioning



Internal bonded post-tensioning

Multi-strand systems

Bonded internal post-tensioning systems are comprised of tendons from 1 to 73 or even more strands – see BBR VT CONA CMI internal bonded. They have been extensively used in civil construction applications including various types of bridges (both cast-in-situ and precast segmental), tanks and silos, but have also been applied successfully to commercial buildings for large structural members such as beams and girders. Large multi-strand tendons for cryogenic applications are installed in LNG tank projects.

The advantages of internal bonded technology are:

- The tendon can be easily ‘weaved’ in order to match exactly the designer’s specifications with a few limitations
- Extremely long span bridges can be constructed without the use of temporary intermediate supports
- Increased load-carrying capacity of large structural elements
- Reduced structural depths
- A fully bonded tendon cannot completely lose its tension in accidents. Bonded PT provides resistance to progressive collapse because any loss of tendon force would be localized

Corrosion protection

Protection against corrosion is provided by waterproofing, dense impermeable concrete, sealed ducts and good quality grouts – a multilayer protection strategy. PT has been provided with a first protective barrier against corrosion – namely grout. The second protective barrier is provided by the ducting. Enhanced corrosion protection and improved fatigue resistance can be achieved with corrugated plastic ducts such as BBR VT Plastic Ducts. Segmental plastic duct couplers are the ideal solution for joints of precast structures. The highest protection standard can be provided with electrically-isolated tendons.

Slab post-tensioning

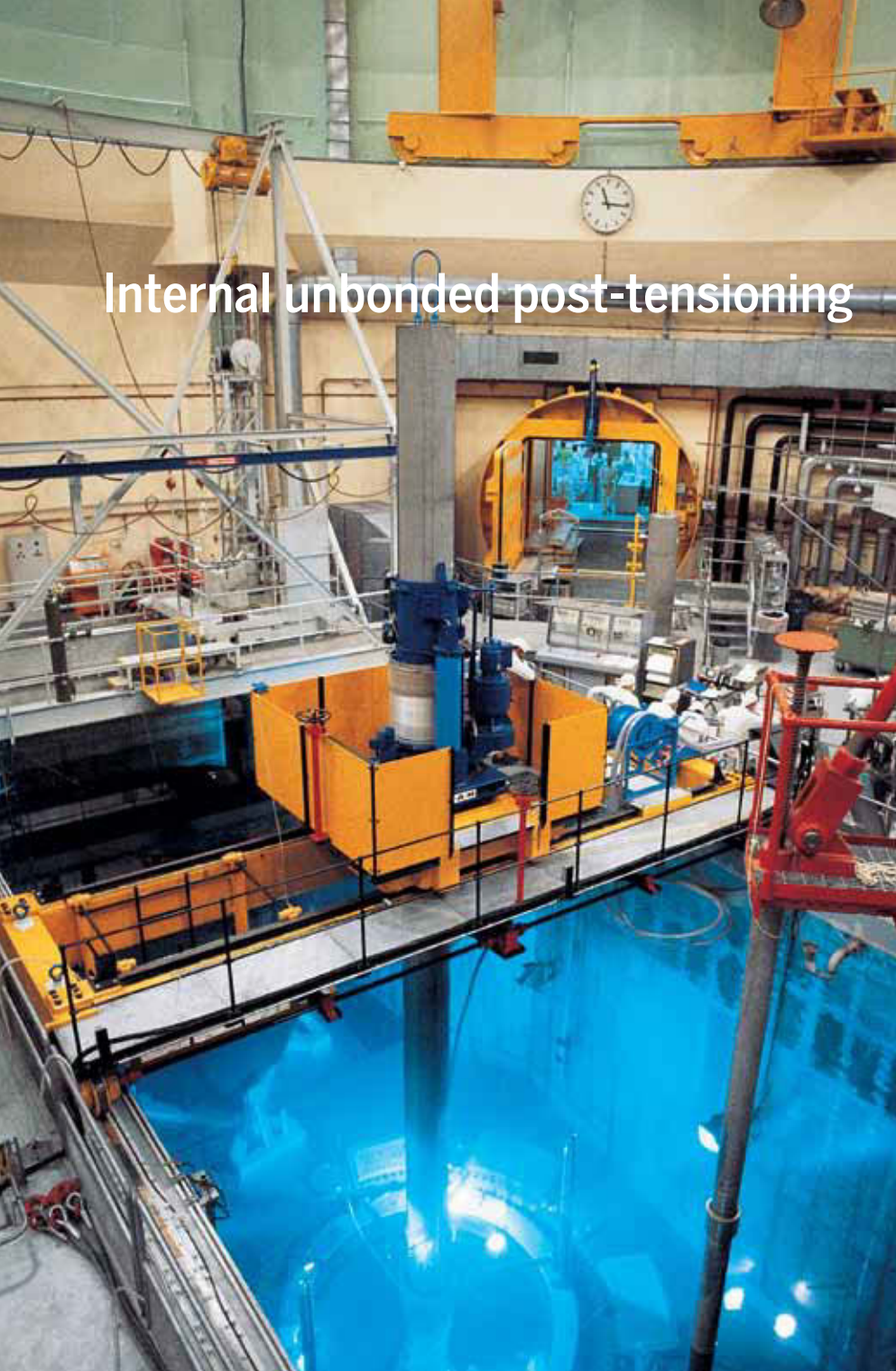
Slab or flat anchorage PT technology, such as the BBR VT CONA CMF or CMM SINGLE bonded system, is the preferred solution when it comes to thin structural elements. Typical applications include suspended slabs of car parks, apartment buildings, commercial office space, retail centres, hospitals, stadia and slabs on ground for distribution warehouses, terminal facilities, hangars and sporting venues. But it has also been successfully installed on vertical

structural members and bridge decks. A flat anchorage system is comprised of strands placed inside flat ducting and anchored by means of flat anchorages. Corrosion protection is ensured by a grout.

The design of slab PT structures requires sound engineering consideration in order to maximize the benefits for all stakeholders:

- Reduced slab depths
- Early formwork stripping
- Floor-to-floor height reduction which can allow extra floors to be added or an overall saving in cladding costs
- Greater clear spans and column-free areas.
- PT slabs require less concrete, thus enabling fewer shear walls, smaller columns and reduced foundation loads
- Minimized dead loads require less groundwork
- Reduced maintenance costs – joints in a floor slab – for example – can be reduced or even eliminated, thus minimizing joint maintenance
- Less sub base preparation and/or excavation





Internal unbonded post-tensioning

- A tendon can be de-stressed before attempting repair work
- No grouting procedure
- Easy and swift installation of tendons
- Light and flexible design

Monostrand technology

Unbonded internal PT tendons such as the BBR VT CONA CMM unbonded system are typically applied in construction for elevated slabs, slabs on grade, girders, beams and more. As they remain unbonded to the surrounding concrete throughout their service life, they can move in relation to the structural element. Protection against corrosion is ensured with soft filling materials such as grease and plastic sheathing formed in an extrusion process. If the tendon or anchorage becomes damaged, the cable can de-stress and burst out of the slab.

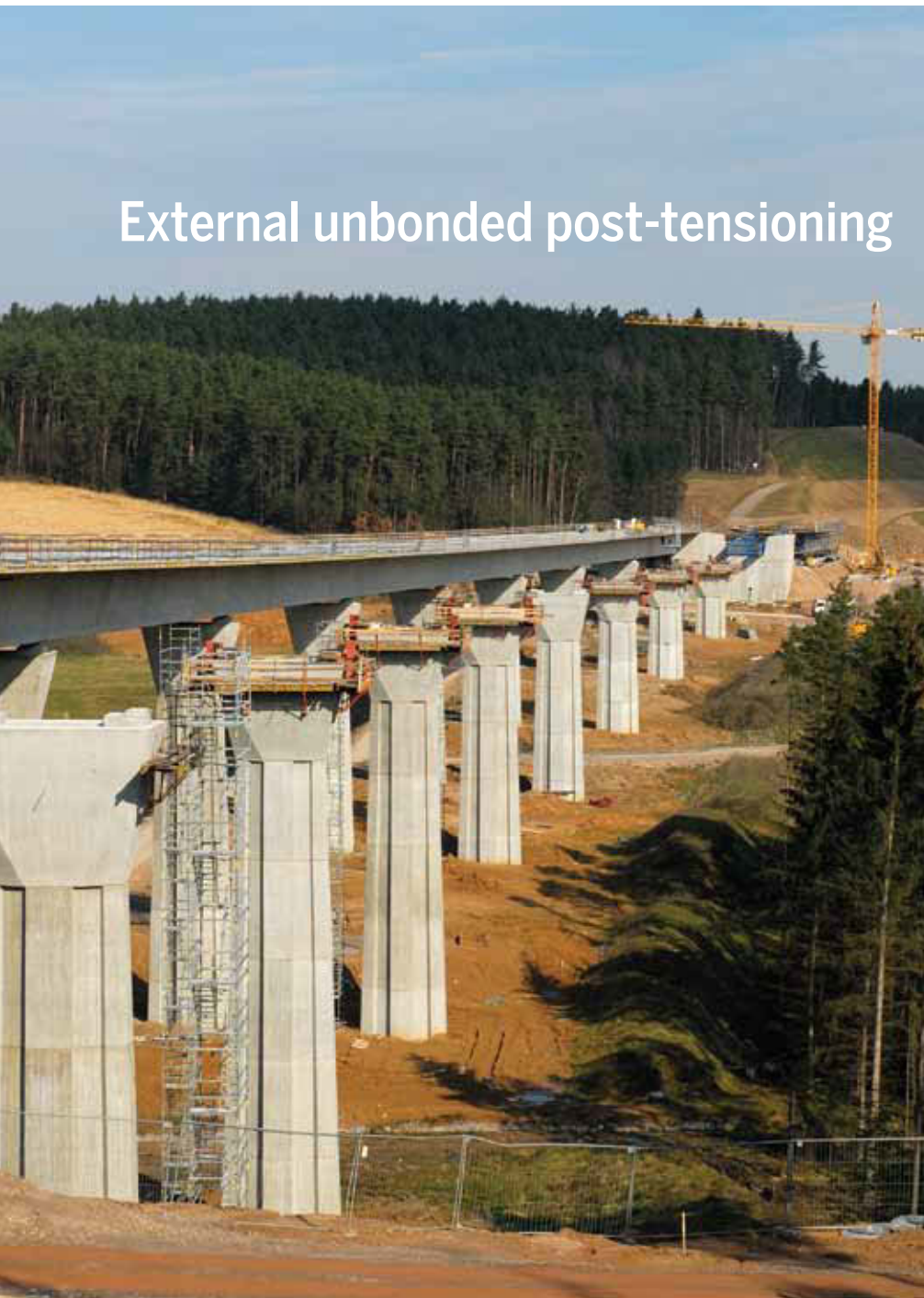
High capacity tendons

Multi-strand unbonded PT systems, such as BBR VT CONA CMI internal unbonded, are used for special applications including prestressing of nuclear vessels. Such high capacity tendons are either filled with grease or wax, but can also be protected with circulating dry air. BBR VT CONA CMF unbonded tendons are a possible solution for thin structural construction elements.





External unbonded post-tensioning



- External PT can be combined with a broad range of construction materials including concrete, steel, masonry and timber
- Monitoring, inspection and maintenance can be easily carried out
- Option for restressing, destressing and replacing external cables
- Improved concrete placing and tendon installation

External post-tensioning tendons, such as the BBR VT CONA CME external or BBR VT CONA CMB band system, are placed outside of the cross-section of the structure and transfer the forces to the structure only at the anchorages and deviators. They are not bonded to the structure. Typical applications are for the prestressing of bridges, wind towers, precast segmental construction and repair and strengthening works to all kinds of structures.

External PT systems are grouted or greased/waxed in HDPE ducts, but can also be double sheathed and greased/waxed.

The best proof is experience

The BBR Network's long history of innovative development began during the Second World War. Max Birkenmaier, Antonio Brandestini and Mirko Robin Ros explored the savings to be made by using pre-tensioned reinforcement for concrete support girders. BBR developed and produced a button heading anchorage configuration from cold drawn high tensile wire. This anchoring method was named BBRV. In the 1950s, the Swiss BBRV kit was the only reliable PT system available on the construction market.

Subsequently, BBR developed a complete range of prestressing and post-tensioning systems covering all structural engineering applications. Since those early applications, there have been many more stories to tell of successes and innovations. The BBR Network's commitment to major technological innovation has been continuous and will also continue into the future.



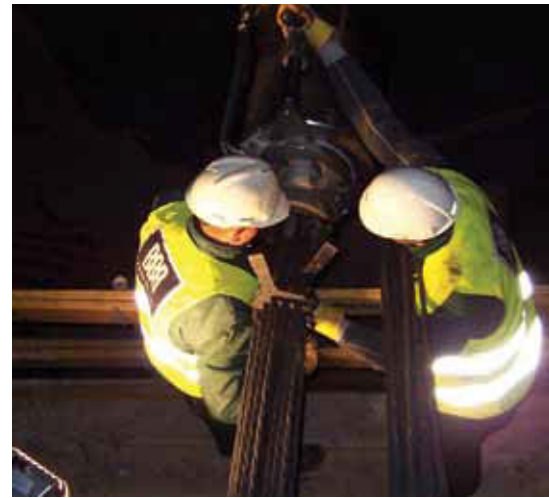
- 1944** Company founded by Max Birkenmaier, Antonio Brandestini and Mirko Robin Ros
- 1945** BBR's first product, the pre-tensioned small beam, was brought to market
- 1948** Button head wire post-tensioning system BBRV patented
- 1952** Construction of first major bridge project – the Andelfingen Viaduct for Swiss Federal Railways
- 1965** Prestressing of nuclear power vessels around the world started
- 1972** Development of BBR CONA PT system
- 2005** Launch of latest European approved and CE-marked BBR VT CONA CMX PT series
- 2009** Launch of BBR E-Trace, the innovative trading and quality assurance platform for CONA CMX systems





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.



Work on post-tensioning starts after any formwork or reinforcement has been installed. The ducting is laid out and the anchorages partially installed. When the concrete has attained its minimum strength and the strands have been pushed into the duct, the tendon is stressed with a hydraulic jack and 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.



State-of-the-art international post-tensioning certification

Post-tensioning kits for use in the European Community are required to have European Technical Approval, which is based on a set of defined testing procedures which must be fulfilled. Once the post-tensioning systems are placed on the market, they are subjected to factory production control and independent and continuous surveillance. Post-tensioning kits must be installed by trained Post-tensioning Specialist Companies to ensure professional and system-conforming installation.

Legal basis

With the introduction of the Eurocode and according to the European Construction Products Directive – (CPD), construction products used in the European Community (EC) are required to carry “CE marking” – a mandatory conformity mark. CE stands for Conformité Européenne – “European conformity”. Post-tensioning kits can only carry CE marking if a European Technical Approval (ETA) has been obtained from a nominated Approval Body and after an EC – Certificate of Conformity has been obtained from an eligible Approved / Notified Body. The official guidance document giving the requirements for obtaining an ETA was published in 2002 within ETAG 013 “Guideline for European Technical Approval of Post-tensioning Kits for Prestressing of Structures” which details a set of testing

procedures which have to be fulfilled. The European Organization for Technical Approvals (EOTA) comprises the Approval Bodies nominated to issue ETA after the testing provisions stipulated in ETAG 013 have been fulfilled and after European consultation has been successfully completed. European consultation involves circulation of the technical documentation of the post-tensioning kit, with a summary of the tests performed on the system, to all nominated Approval Bodies within the European Union. An ETA is valid for five years and is issued for a proprietary post-tensioning kit to the Approval Holder with a designated Kit Manufacturing Plant of the components. As of 2008, use of CE marked post-tensioning systems has been mandatory throughout the whole of Europe



and use of the Eurocode is mandatory from 2010 onwards. The provisions made for European approved post-tensioning kits are based on an assumed intended working life of the PT system of 100 years. The EC – Certificate of Conformity attests that the manufacturing of the individual components is subject to the continuous surveillance of an independent authority (Approved / Notified Body), which checks that the manufactured components comply with the components outlined in the particular ETA.

BBR VT CONA CMI
Blonded Post-tensioning System

European Technical Approval
ETA – 06/0147

ÖSTERREICHISCHES INSTITUT FÜR BAUTECHNIK
OIB
Mitglied der EOTA

European Technical Approval ETA-06/0147
English translation; the original version is in German

| | |
|---|---|
| Herstellerbezeichnung | BBR VT CONA CMI – Spannschleifen im Verbund mit 04 bis 31 Litzen |
| Trade name | BBR VT CONA CMI – Bonded Post-tensioning System with 04 to 31 Strands |
| Zulassungsinhaber Name of Approval | BBR VT International Ltd Bühnenstrasse 23 CH-4900 Schönenbuch (DN) Schweiz/Suisse |
| Zulassungsinhaber und Vertriebsgesellschaft Name of Approval and Distribution Company | Lizen-Spannschleifen, Innen- im Verbund, für alle Vorspannen von Tragwerken Post-tensioning kit for prestressing of structures with internal tendon system |
| Geltungsbereich vom Validity from | 01.06.2008 |
| bis zum to | 01.06.2013 |
| Hersteller Manufacturing plant | BBR VT International Ltd Bühnenstrasse 23 CH-4900 Schönenbuch (DN) Schweiz/Suisse |
| Class Europäische Technische Zulassung (certificate) The European Technical Approval certificate | 03 Serien, einschliesslich 12 Anlagungen 03 Paper including 12 Annexes |

MPA NRW
MATERIALPRÜFUNGSAMT NORDRHEIN-WESTFALEN

EC-CERTIFICATE OF CONFORMITY
0432-CPD-11 0101-1/1

In compliance with the Directive 89/106/EEC of the Council of European Communities of 21 December 1989 and the approximation of laws, regulations and administrative provisions of the Member States relating to the construction products (Construction Products Directive – CPD) adopted by the Directive 02/90/EEC of the Council of European Communities of 23 July 1990, it has been stated that the construction product:

BBR VT CONA CMI – Bonded Post-tensioning System with 04 to 31 Strands

placed on the market by:

BBR VT International Ltd
Bühnenstrasse 23
CH-4900 Schönenbuch (DN)
Schweiz/Suisse

and produced in the factory:

BBR VT International Ltd
Bühnenstrasse 23
CH-4900 Schönenbuch (DN)
Schweiz/Suisse

is authorized by the manufacturer:

- to a factory production control and
- to the further testing of samples taken at the factory in accordance with a prescribed test plan.

AND FOR THE APPROVED BODY – MPA NRW –

- has performed the initial type testing for the relevant characteristics of the product
- the initial inspection of the factory and of the factory production control
- and performs the production surveillance, assessment and approval of the factory production control and
- an ongoing testing of samples taken at the factory in the interest of the construction site.

This certificate attests that all provisions concerning the situation of conformity and the performance described in the European Technical Approval

ETA-06/0147 from 01.06.2008

was issued and that the product fulfils all the prescribed requirements.

This certificate was first issued on 01.06.2008 and remains valid as long as the certificate last states in the harmonized technical specification or reference in the manufacturing conditions in the factory or the TTC last are not modified significantly and latest on 01.06.2013.

01.06.2008

English translation; the original version is in German.

Definition of a post-tensioning kit

A post-tensioning kit comprises all elements that make up the complete tendon which is being marketed and sold by the BBR Post-Tensioning Specialist Company (BBR PT Specialist Company), who will take full responsibility for all components and the installation.

For practical reasons, the reinforcement may be provided by the contractor, but must fully comply with the specifications and dimensions given in the specific ETA and quality records collected by the BBR PT Specialist Company.

The delivery notes for the proprietary components of the specific BBR VT CONA CMX PT kit contain the CE marking. Delivery notes for standardized components must also contain CE marking – or a certificate of conformity to the relevant national standard.

At the end of a project, a definitive CE marking record relating to the installed kit is created from the individual delivery notes which are archived for ten years.

At the end of construction, the delivery notes with CE marking and summarized definitive CE marking record are the documents provided to the client. No other documents, such as detailed test reports of the post-tensioning kits or detailed test reports on the components, are required.

- Proprietary components**
- Fixed (passive) / stressing (live) anchor
 - Fixed or movable coupler units
 - Wedges
 - Bearing plates
 - Trumpets
 - Protection caps
 - Plastic duct
 - Special filling material
- Standardized components**
- Seven-wire prestressing strand
 - Steel duct
 - Common filling material
 - Reinforcement



CE

0432

ETA-06/0147
BBR VT CONA CMI
Bonded Post-tensioning System with 04 to 31 Strands

BBR VT International Ltd
Ringstrasse 2, 8603 Schwerzenbach (Switzerland)
www.bbrnetwork.com

043-CPD-11 9181-1/1

07

CE marking of CONA CMI system



State-of-the-art international post-tensioning certification continued

Typical testing provisions

ETAG 013 "Guideline for European Technical Approval of Post-Tensioning Kits for Prestressing of Structures" details the full scale tests the post-tensioning kit has to undergo. The basic testing provisions include the following:

Static tensile tests for each anchorage and coupler type

– A complete tendon is first stressed by means of standard stressing equipment to 80% of the characteristic ultimate tensile strength of the tendon (UTS). The load of 80% UTS is then maintained for a duration of two hours, after which the tendon is stressed – by means of an external testing machine – to failure. An efficiency of at least 95% of the actual ultimate tensile strength of the tendon and 2% elongation must be achieved.

Fatigue tests for each anchorage and coupler type

– The acceptance criteria is to pass two million load cycles with a stress range of 80 MPa without fatigue failure in the anchorage components and with no more than 5% of the tensile element cross-section being lost. Fatigue testing of post-tensioning systems is a new requirement in many parts of the world and passing such a test requires particular care in detailing the components of the anchorage and the transition with the duct.

Load transfer tests for each anchorage type and concrete strength

– During a load transfer test, the anchorage components, including relevant reinforcement and concrete with the desired dimensions for a particular concrete strength, are subjected to 10 load cycles between 12% and 80% UTS, before the complete assembly is loaded to failure. An efficiency of at least 110% UTS must be achieved.

Additional mandatory tests are described in ETAG 013 – such as assembly and grouting tests, as well as a whole range of tests for special applications. Examples include saddle tests for external post-tensioning and tests under cryogenic conditions.

Factory Production Control

ETAG 013 specifies the minimum production control frequencies that have to be achieved, e.g. 100% material control, 5% dimension control, 100% visual check.

Compliance with these and the complete factory production process are fully audited by the Approved / Notified Body and any non-conformity must be rectified prior to any CE marking.

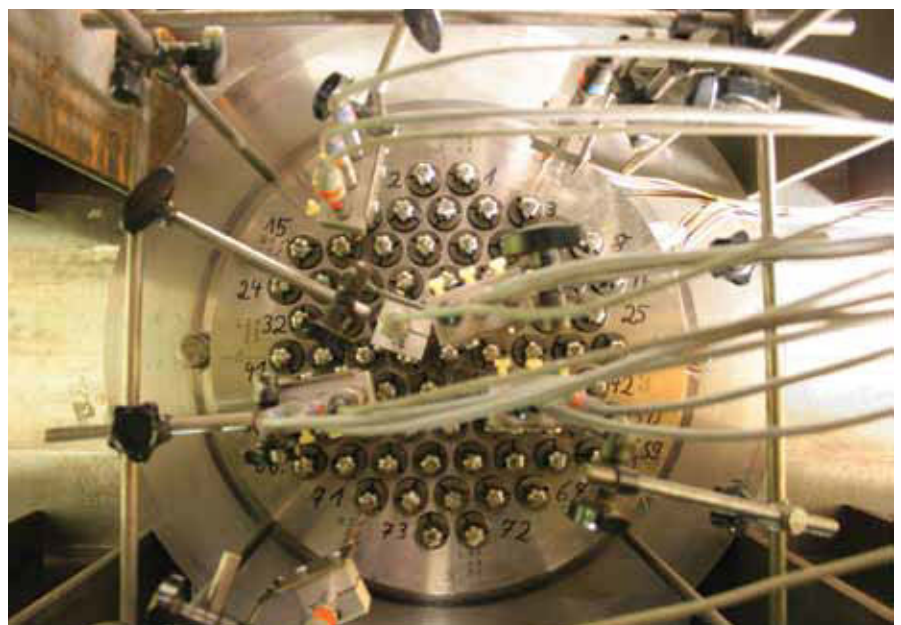
During the validity period of the ETA, the Approved / Notified Body continues to exert full control of the production – in addition to the audits and testing by the Kit Manufacturer:

- the ETA Holder and the Kit Manufacturer are audited every year
- each Component Manufacturer is audited during the five year validity of the ETA
- kit components are collected from site annually for independent testing and checking of the mechanical performance.

These provisions guarantee proper quality and compliance of the kit components



CE



State-of-the-art international post-tensioning certification continued

BBR Post-tensioning Specialist Companies

European Approved and CE marked post-tensioning kits must be installed by certified PT Specialist Companies. The BBR PT Specialist Company is responsible, under supervision of the ETA holder, for compliance with all regulations set out in the relevant technical approvals for the post-tensioning kit and with the respective standards and regulations in force at the place of use, and must ensure a professional execution of the post-tensioning works, which includes the following key points:

- logistics and supply of a complete post-tensioning kit to the construction site
- full assembly and installation service of the post-tensioning kit on the construction site
- quality assurance and endorsement of all relevant health and safety regulations relating to the work place

The key personnel of the BBR PT Specialist Company must be continuously trained in the usage of the particular post-tensioning kits and be certified for the post-tensioning works by the ETA Holder – BBR VT International Ltd.



An international passport ensuring the highest standards

The CE marking and the European Technical Approval create an international passport for post-tensioning kits. CE marked BBR VT CONA CMX post-tensioning systems installed by certified and responsible BBR Post-Tensioning Specialist Companies provide the highest level of quality and assure the owners of the structures to which the post-tensioning kits are applied that only high quality and state-of-the-art products are

being used with the required level of safety. The key parameters of all CE marked post-tensioning systems are summarized in the particular ETA which becomes the reference technical document defining the conditions of use of the system. The full ETA document is made available to designers, engineers, contractors and clients.





BBR VT CONA CMX

CE marked state-of-the-art posttensioning kits

The BBR Network offers a complete range of post-tensioning systems, covering all possible applications in structural and civil engineering. With the introduction of CE marking for all construction products in Europe, European Technical Approval (ETA), Euronorms (EN) and Eurocodes, we developed and launched the BBR VT CONA CMX post-tensioning range – the post-tensioning system for the 21st century – which is now used worldwide by the BBR Network.

Its modular design means that a CONA CMX post-tensioning kit can easily be configured to match very special requirements and therefore only the most commonly used configurations are described in this brochure. Please contact the Swiss-based BBR Headquarters or your local BBR Network representative to discuss your specific needs.

The modular BBR VT CONA CMX post-tensioning range is comprised of five main systems:

- **BBR VT CONA CMI**
Internal post-tensioning system
- **BBR VT CONA CME**
External post-tensioning system
- **BBR VT CONA CMF**
Flat anchorage post-tensioning system
- **BBR VT CONA CMM**
Monostrand post-tensioning system
- **BBR VT CONA CMB**
Band post-tensioning system

The main benefits of the BBR VT CONA CMX series are:

- modular system
- most compact and lightest anchorage system
- full stressing at lowest concrete strength
- widest range of standard tendons – ranging from 173 kN to over 20,000 kN characteristic ultimate resistance
- most comprehensive range of systems and tendon sizes

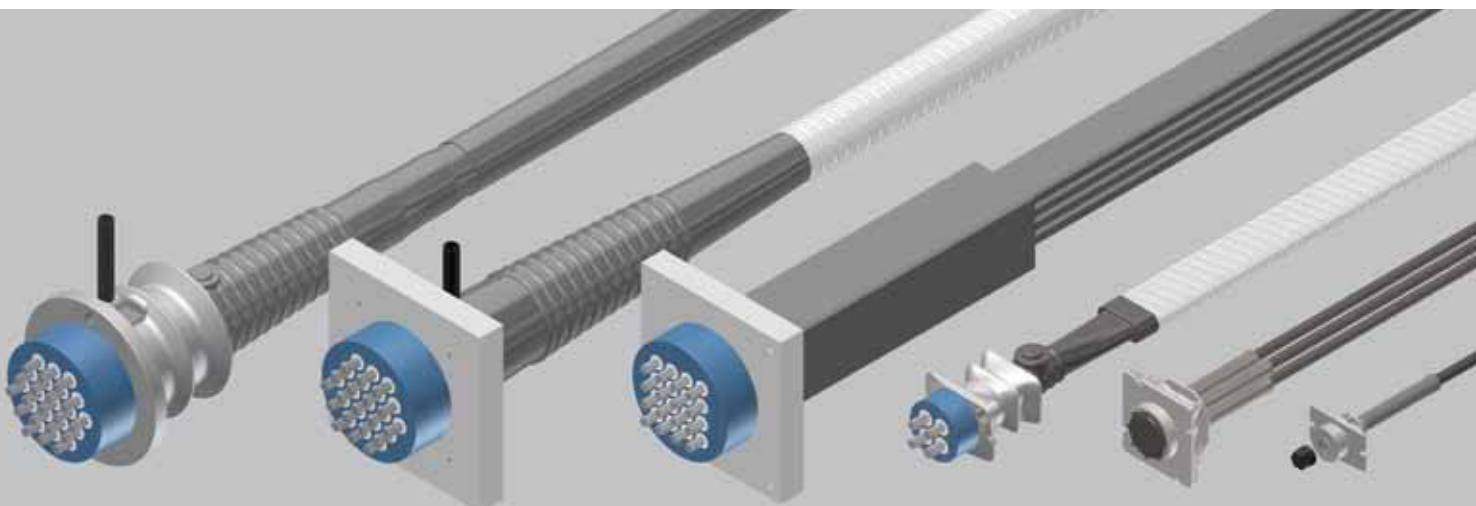
Seven-wire prestressing strands

Seven-wire strands are comprised of a central wire, normally identified as 'king wire', and an external crown of six wires which are twisted around the king wire. Strands with a characteristic tensile

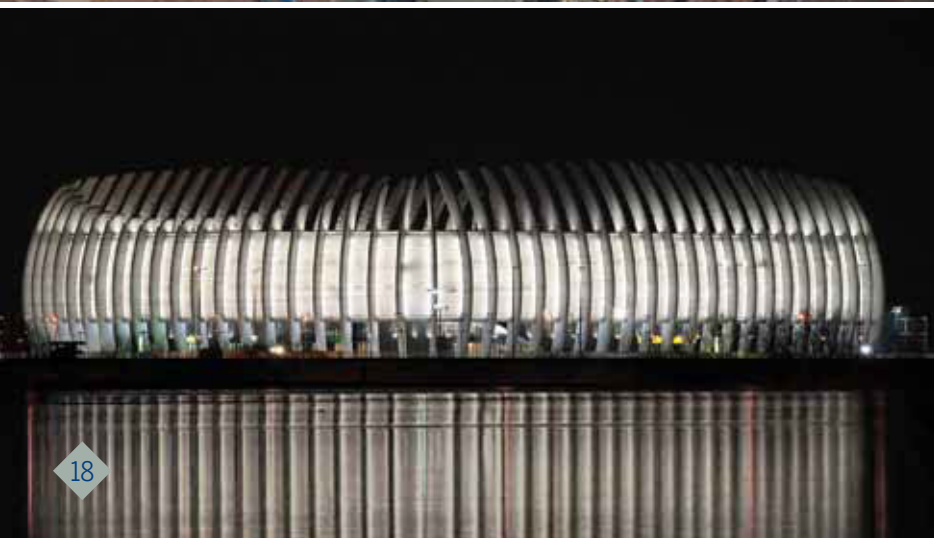
strength equal to 1,860 MPa are normally used; however steel strands with a lower characteristic strength, 1,770 MPa or 1,820 MPa, may also be used.

Characteristic values of strands according to prEN 10138-3

| Type | | | 05 | | 06 | | |
|---|----------|-----------------|-------|-------|-------|-------|-------|
| Characteristic tensile strength | f_{pk} | MPa | 1,860 | 1,860 | 1,860 | 1,860 | 1,820 |
| Nominal diameter | d | mm | 12.5 | 12.9 | 15.3 | 15.7 | 15.2 |
| Nominal cross-sectional area | A_p | mm ² | 93 | 100 | 140 | 150 | 165 |
| Characteristic value of maximum force | F_{pk} | kN | 173 | 186 | 260 | 279 | 300 |
| Greased/waxed monostrands are sheathed in the factory with a continuously extruded HDPE sheathing | | | | | | | |
| External diameter of strand (incl. HDPE) | ≈ | mm | 16 | 16 | 20 | 20 | 20 |







BBR VT CONA CMI

Internal bonded or unbonded post-tensioning system

Standard tendon sizes

The BBR VT CONA CMI post-tensioning kit is a multi-strand system for all types of internally post-tensioned applications. 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, 0.62" (15.7 mm) strands with a cross-sectional area of 150 mm² and a characteristic tensile strength of 1,860 MPa are used. The use of 0.5" (12.9 mm) strands with a cross-sectional area of 100 mm² and a characteristic tensile strength of 1,860 MPa is also possible (*, see page 20).

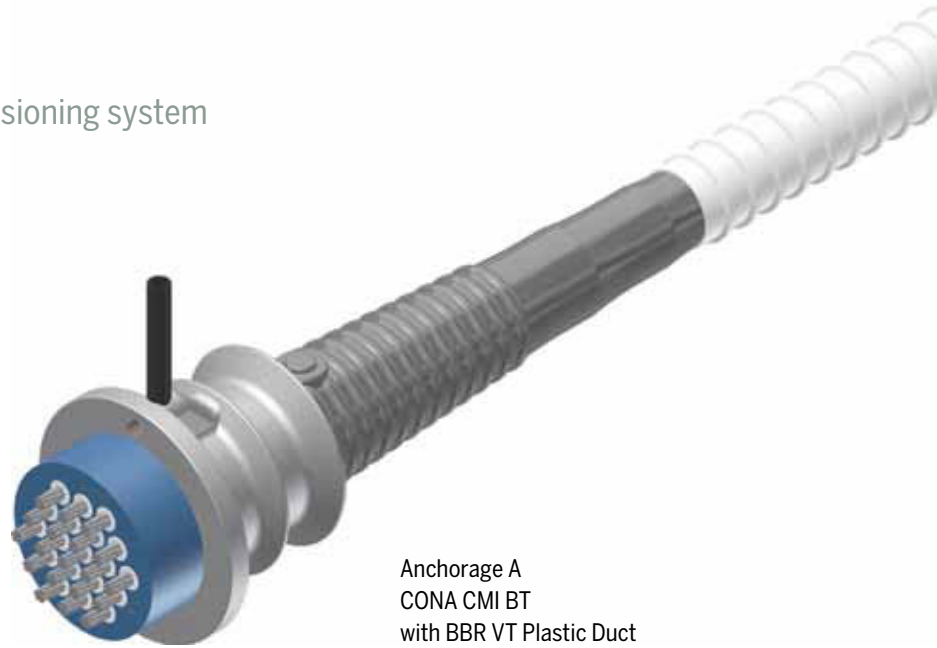
Anchorage configuration

The main components in the anchor zone of the CONA CMI system are the wedges, anchor head, load transfer element and trumpet.

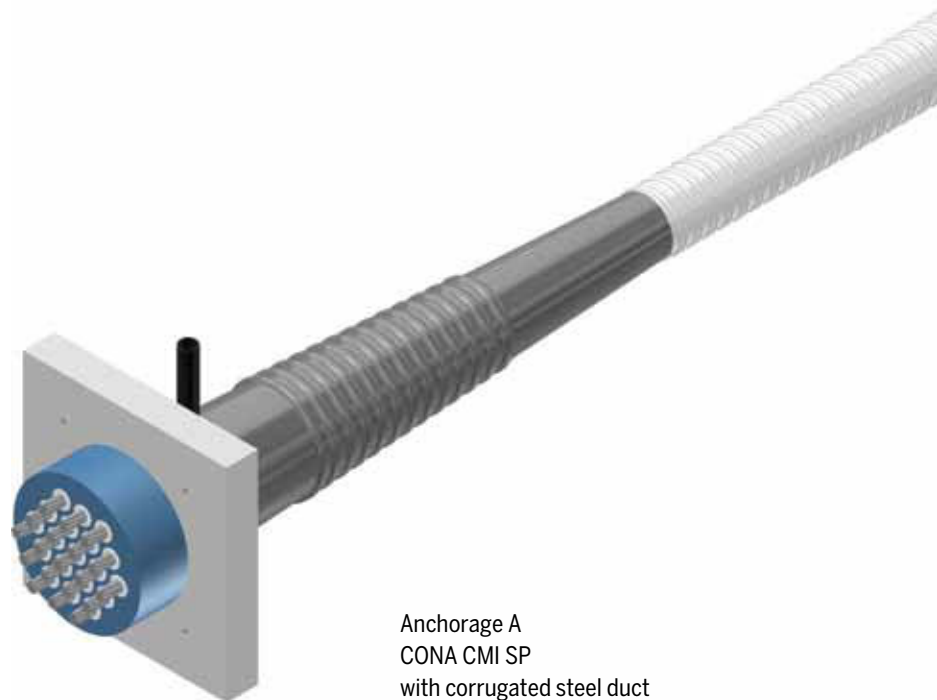
In the anchorage zone, the duct is connected to the trumpet and the strand bundle is spread out towards the anchor head, where each strand is individually locked with special BBR wedges.

For the load transfer to the concrete, the CONA 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 more traditional system with a single plane load transfer to the concrete.



Anchorage A
CONA CMI BT
with BBR VT Plastic Duct



Anchorage A
CONA CMI SP
with corrugated steel duct

Vent



Inaccessible fixed anchorage FA

Grouting inlet / vent (optional)

The stressing and fixed anchorages

These 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 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.

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 (larger sizes on request) 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.

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 BBR grout. For unbonded applications, the duct can be injected with grease/wax or circulating dry air.

The CONA CMI post-tensioning kits can also be executed as fully electrically isolated tendons to provide the highest possible level of corrosion protection and inspectability.

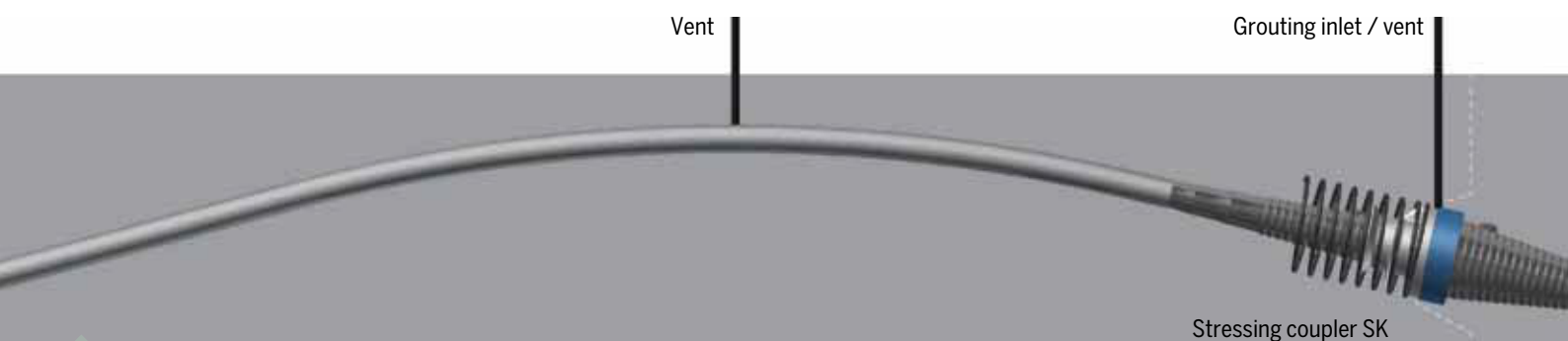


Coupler K
CONA CMI BT



Movable Coupler BK
CONA CMI

(*) Other prestressing strands approved at the place of use, such as strands having a cross-sectional area of 140 mm² or 93 mm² respectively and/or a characteristic tensile strength lower than 1,860 MPa can be used with the same anchorage components.



Vent

Grouting inlet / vent

Stressing coupler SK



Coupler H
CONA CMI BT



Movable Coupler BH
CONA CMI

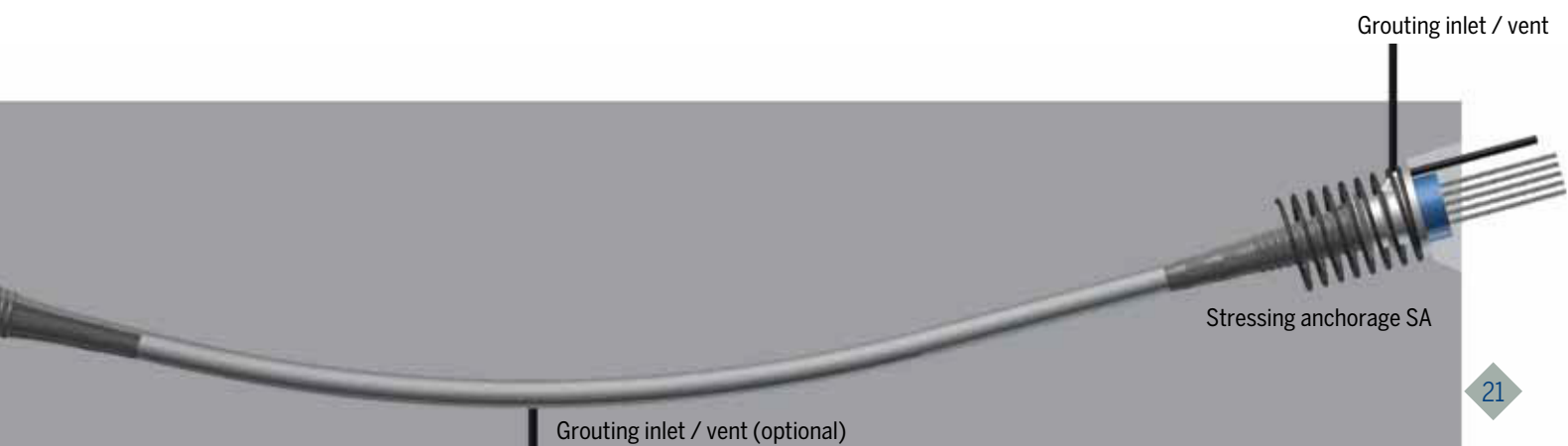
Available tendon sizes

Type of stands

| in | 05 | | 06 | |
|-----------------|-------|-------|-------|-------|
| mm ² | 93 | 100 | 140 | 150 |
| MPa | 1,860 | 1,860 | 1,860 | 1,860 |

Tendon sizes

| Strands | Characteristic ultimate resistance of tendon [kN] | | | |
|---------|---|-------|--------|--------|
| 01 | 173 | 186 | 260 | 279 |
| 02 | 346 | 372 | 521 | 558 |
| 03 | 519 | 558 | 781 | 837 |
| 04 | 692 | 744 | 1,042 | 1,116 |
| 05 | | | 1,302 | 1,395 |
| 06 | | | 1,562 | 1,674 |
| 07 | 1,211 | 1,302 | 1,823 | 1,953 |
| 08 | | | 2,083 | 2,232 |
| 09 | | | 2,344 | 2,511 |
| 12 | 2,076 | 2,232 | 3,125 | 3,348 |
| 13 | | | 3,385 | 3,627 |
| 15 | | | 3,906 | 4,185 |
| 16 | | | 4,166 | 4,464 |
| 19 | 3,287 | 3,534 | 4,948 | 5,301 |
| 22 | | | 5,729 | 6,138 |
| 24 | | | 6,250 | 6,696 |
| 25 | | | 6,510 | 6,975 |
| 27 | | | 7,031 | 7,533 |
| 31 | 5,362 | 5,766 | 8,072 | 8,649 |
| 37 | | | 9,635 | 10,323 |
| 42 | | | 10,937 | 11,718 |
| 43 | | | 11,197 | 11,997 |
| 48 | | | 12,499 | 13,392 |
| 55 | | | 14,322 | 15,345 |
| 61 | | | 15,884 | 17,019 |
| 69 | | | 17,968 | 19,251 |
| 73 | | | 19,009 | 20,367 |



BBR VT CONA CME

External post-tensioning system

Standard tendon sizes

The CONA CME post-tensioning kit is a multi-strand system for all types of externally post-tensioned applications. 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" (15.7 mm) strands with a cross-sectional area of 150 mm² and a characteristic tensile strength of 1,860 MPa are used (*, see Page 23).

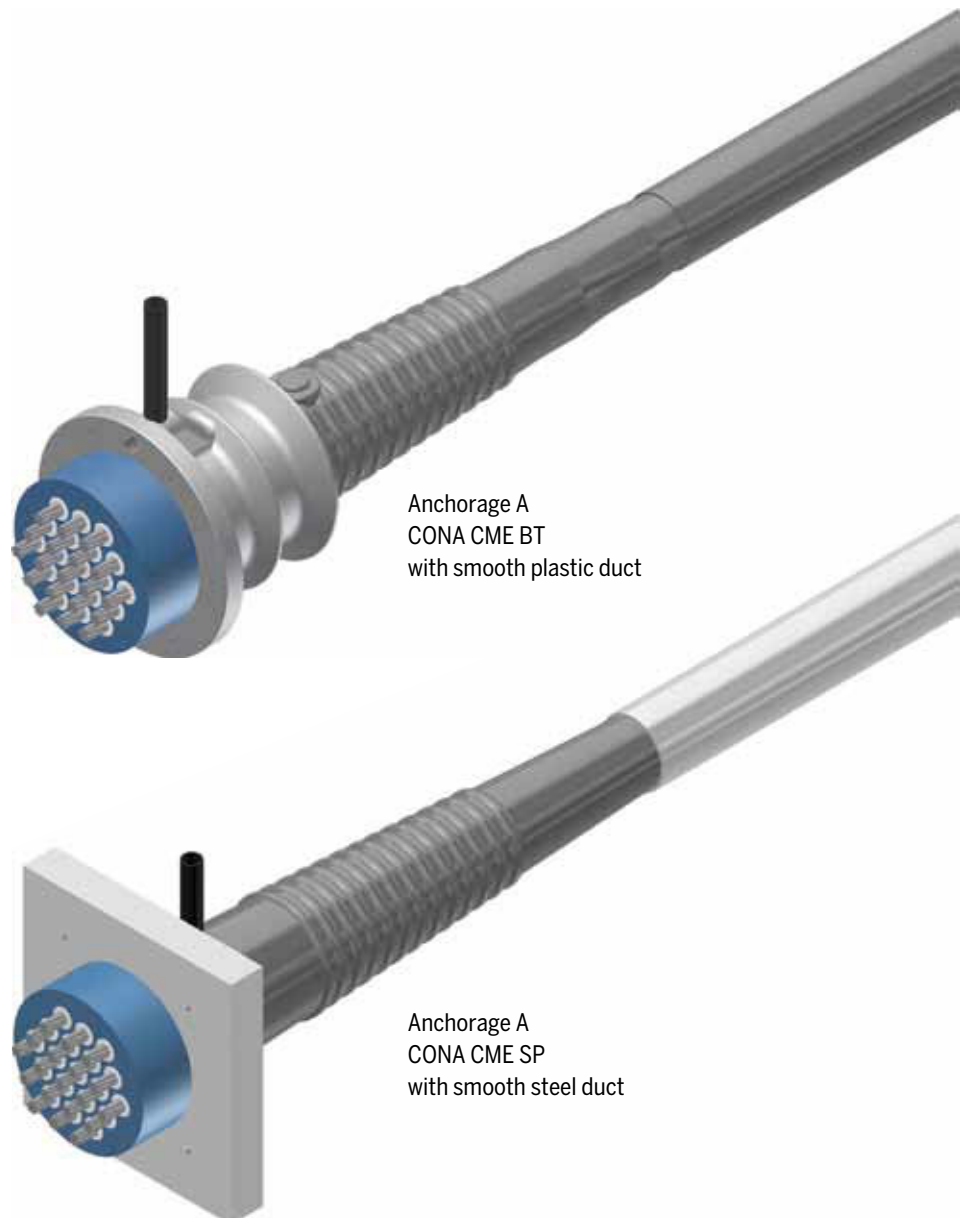
Anchorage configuration

The main components in the anchor zone of the CONA CME system are the wedges, anchor head, load transfer element 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 centre 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 more traditional 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 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.





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.

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 BBR 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 140 mm² and/ or a characteristic tensile strength lower than 1,860 MPa can be used with the same anchorage components.

Available tendon sizes

Type of stands

| in | 06 | |
|-----------------|-------|-------|
| mm ² | 140 | 150 |
| MPa | 1,860 | 1,860 |

Tendon sizes

| Strands | Characteristic ultimate resistance of tendon [kN] | |
|---------|---|--------|
| 01 | 260 | 279 |
| 02 | 521 | 558 |
| 03 | 781 | 837 |
| 04 | 1,042 | 1,116 |
| 05 | 1,302 | 1,395 |
| 06 | 1,562 | 1,674 |
| 07 | 1,823 | 1,953 |
| 08 | 2,083 | 2,232 |
| 09 | 2,344 | 2,511 |
| 12 | 3,125 | 3,348 |
| 13 | 3,385 | 3,627 |
| 15 | 3,906 | 4,185 |
| 16 | 4,166 | 4,464 |
| 19 | 4,948 | 5,301 |
| 22 | 5,729 | 6,138 |
| 24 | 6,250 | 6,696 |
| 25 | 6,510 | 6,975 |
| 27 | 7,031 | 7,533 |
| 31 | 8,072 | 8,649 |
| 37 | 9,635 | 10,323 |
| 42 | 10,937 | 11,718 |
| 43 | 11,197 | 11,997 |
| 48 | 12,499 | 13,392 |
| 55 | 14,322 | 15,345 |
| 61 | 15,884 | 17,019 |
| 69 | 17,968 | 19,251 |
| 73 | 19,009 | 20,367 |



Grouting inlets and vents not shown

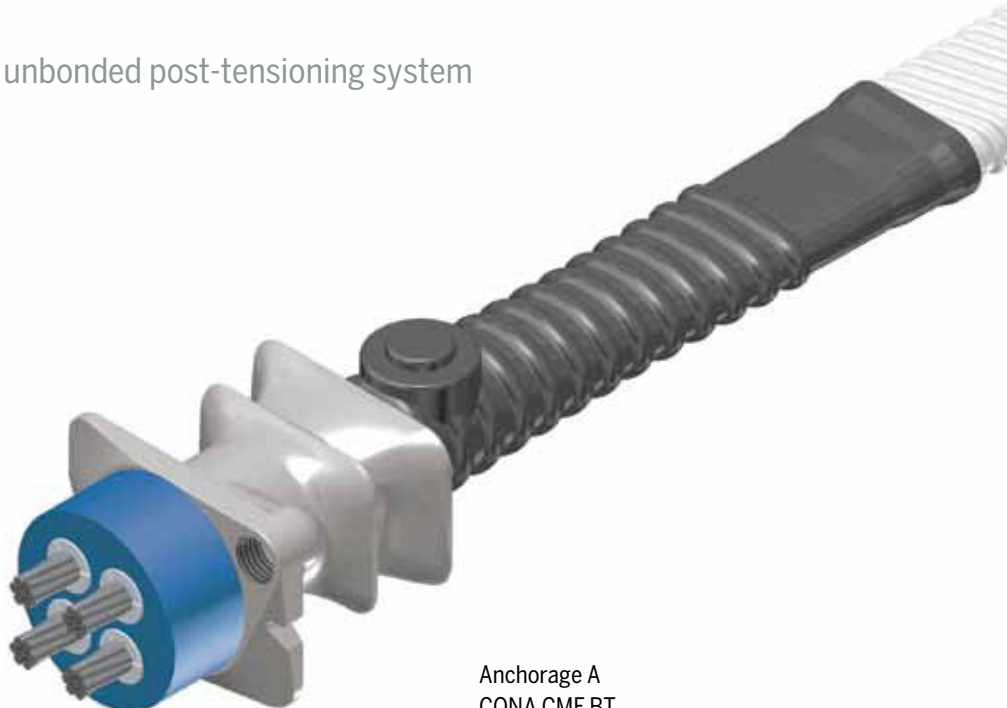


BBR VT CONA CMF

Flat anchorage internal bonded or unbonded post-tensioning system

Standard tendon sizes

The CONA CMF post-tensioning kit is a multi-strand system for internally post-tensioned applications where the anchoring has to be carried out in very thin concrete cross-sections, such as slabs. The standard tendon sizes range from 2 to 4 seven-wire prestressing strands. Both 0.62" (15.7 mm) strands with a cross-sectional area of 150 mm² and 0.5" (12.9 mm) strands with a cross-sectional area of 100 mm² are commonly used, whereas the characteristic tensile strength for both strands is 1,860 MPa (*, see Page 25).



Anchorage A
CONA CMF BT
with flat steel duct



Anchorage configuration

The main components in the anchor zone of the CONA CMF system are the wedges, anchor head, load transfer element 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 CMF BT (bearing trumplate) is used, which makes use of an advanced and proprietary three plane load transfer especially developed for anchoring in thin cross section. This allows 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 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 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 strand protruding beyond the anchor head requires permanent corrosion protection and an adequate cap.

Fixed and stressable couplers

CONA CMF tendons can be coupled using propriety Type H sleeve couplers. The coupler can serve as a stressing / active anchorage coupler (Type S) or fixed / passive anchorage coupler (Type F) bearing against the bearing trumplate or as movable couplers (Type B) along the length of the tendon.

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 carried out using a high performance BBR grout. For unbonded applications the duct can be injected with grease/wax or circulating dry air.

(*) Other prestressing strands approved at the place of use, such as strands having a cross-sectional area of 140 mm² or 93 mm² respectively and/or a characteristic tensile strength lower than 1,860 MPa can be used with the same anchorage components.



Coupler H
CONA CMF BT

Available tendon sizes

Type of stands

| in | 05 | | 06 | |
|-----------------|-------|-------|-------|-------|
| mm ² | 93 | 100 | 140 | 150 |
| MPa | 1,860 | 1,860 | 1,860 | 1,860 |

Tendon sizes

| Strands | Characteristic ultimate resistance of tendon [kN] | | | |
|---------|---|-----|-------|-------|
| 02 | 346 | 372 | 521 | 558 |
| 03 | 519 | 558 | 781 | 837 |
| 04 | 692 | 744 | 1,042 | 1,116 |





BBR VT CONA CMM SINGLE

Monostrand unbonded or bonded post-tensioning system

Standard tendon sizes

The CONA CMM SINGLE post-tensioning kit is a monostrand system with one strand for internally unbonded or bonded applications. Both 0.62" (15.7 mm) strands with a cross-sectional area of 150 mm² and 0.5" (12.9 mm) strands with a cross-sectional area of 100 mm² are commonly used, whereas the characteristic tensile strength for both strands is 1,860 MPa. For unbonded applications, use of a compacted 0.6" (15.2 mm) strand with a cross-sectional area of 165 mm² and a characteristic tensile strength of 1,820 MPa is possible (*, see Page 27).

Anchorage configuration

The main components in the anchor zone of the CONA CMM SINGLE system are the wedge, monolithic anchorage and an individual trumpet tube.

In the anchorage zone, the strand is guided into the individual trumpet tube to the monolithic anchorage, where the strand is individually locked with a special BBR wedge. The anchoring of the strand and load transfer to the concrete is done with one and the same

unit, allowing for a high economy, small centre and edge distances at the anchorage, as well as application of the full post-tensioning load at very low concrete strengths.



Anchorage A
CONA CMM SINGLE



Fixed anchorage FA

The stressing and fixed anchorages

The anchorages are stressing / active anchorage (Type S) and the fixed / passive anchorage (Type F). Both types are identical. For construction works, the wedges of inaccessible fixed anchorages are secured by special wedge retaining measures and are protected by a cap during concreting. 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 restressing or releasing and the strand protruding beyond the anchor head requires permanent corrosion protection and an adequate cap.

Fixed and stressable couplers

CONA CMM SINGLE tendons can be coupled using proprietary Type H sleeve coupler, whereas the coupler can serve as a stressing / active anchorage coupler (Type S) or fixed / passive anchorage coupler (Type F) during the first construction stage.

Corrosion protection

For unbonded CONA CMM SINGLE applications, the strands are greased/waxed and individually sheathed in the factory with a continuously extruded HDPE sheathing. For bonded CONA CMM SINGLE tendons, the single monostrand is enclosed in a corrugated round plastic duct, which is then injected with a high performance BBR grout.

(*) Other prestressing strands approved at the place of use, such as strands having a cross-sectional area of 140 mm² or 93 mm² respectively and/or a characteristic tensile strength lower than 1,860 MPa or 1,820 MPa respectively, can be used with the same anchorage components.



Greased monostrand with HDPE sheathing and single strand with cement grouted plastic duct



Coupler H
CONA CMM SINGLE

Available tendon sizes

| Type of stands | | | | | |
|-----------------|---|-------|-------|-------|-------|
| in | 05 | | 06 | | |
| mm ² | 93 | 100 | 140 | 150 | 165 |
| MPa | 1,860 | 1,860 | 1,860 | 1,860 | 1,820 |
| Tendon sizes | | | | | |
| Strands | Characteristic ultimate resistance of tendon [kN] | | | | |
| 01 | 173 | 186 | 260 | 279 | 300 |





BBR VT CONA CMM TWO/FOUR

Monostrand unbonded post-tensioning system

Standard tendon sizes

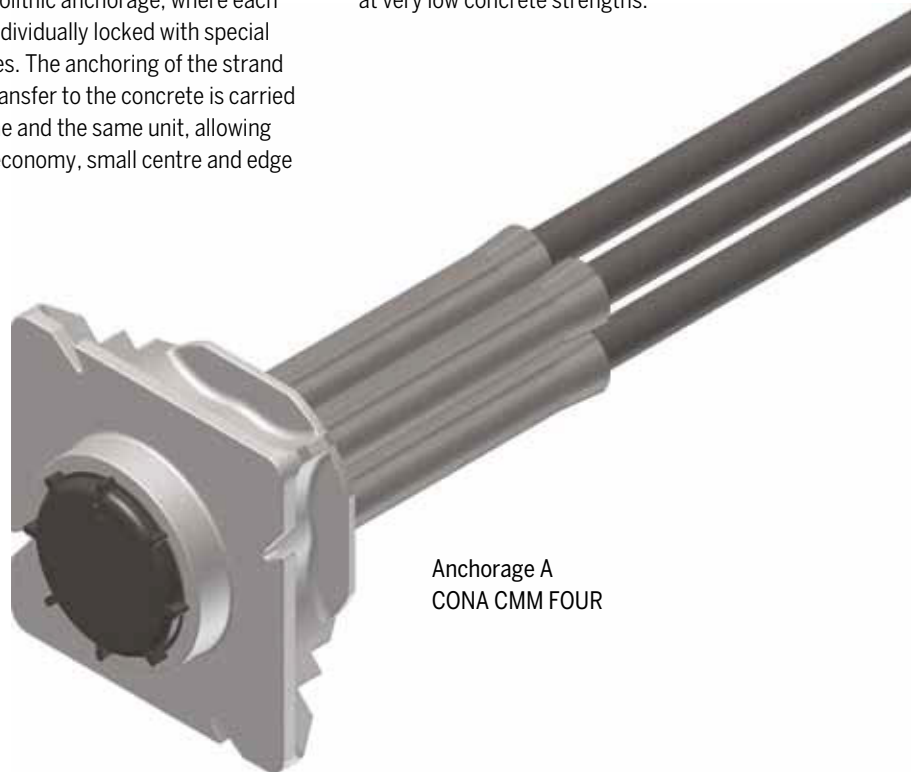
The CONA CMM TWO and FOUR post-tensioning kit is a monostrand system for internally unbonded applications. The standard tendons have 2 or 4 seven-wire prestressing strands. Most commonly 0.62" (15.7 mm) strands with a cross-sectional area of 150 mm² and a characteristic tensile strength of 1,860 MPa and special compacted 0.6" (15.2 mm) strands with a cross-sectional area of 165 mm² and a characteristic tensile strength of 1,820 MPa are used (*, see Page 29).

Anchorage configuration

The main components in the anchor zone of the CONA CMM system are the wedges, monolithic anchorage and individual trumpet tubes.

In the anchorage zone, the strands are guided into the individual trumpet tubes to the monolithic anchorage, where each strand is individually locked with special BBR wedges. The anchoring of the strand and load transfer to the concrete is carried out with one and the same unit, allowing for a high economy, small centre and edge

distances at the anchorages, as well as application of the full post-tensioning load at very low concrete strengths.



Anchorage A
CONA CMM FOUR





The stressing and fixed anchorages

The anchorages are stressing / active anchorage (Type S) and the fixed / passive anchorage (Type F). Both types are identical. For construction works, the wedges of inaccessible fixed anchorages are secured by special wedge retaining measures and are protected by a cap during concreting. 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 restressing or releasing and strand protruding beyond the anchor head requires permanent corrosion protection and an adequate cap.



Coupler H
CONA CMM FOUR

(*) Other prestressing strands approved at the place of use, such as strands having a cross-sectional area of 140 mm² and/or a characteristic tensile strength lower than 1,860 MPa or 1,820 MPa respectively, can be used with the same anchorage components.

Fixed and stressable couplers

CONA CMM FOUR tendons can be coupled using propriety Type H sleeve coupler, whereas the couplers can serve as a stressing / active anchorage coupler (Type S) or fixed / passive anchorage coupler (Type F) during the first construction stage.

Corrosion protection

For CONA CMM TWO and FOUR applications, the monostrand are greased / waxed and individually sheathed in the factory with a continuously extruded HDPE sheathing.

Available tendon sizes

Type of stands

| in | 06 | | |
|-----------------|-------|-------|-------|
| mm ² | 140 | 150 | 165 |
| MPa | 1,860 | 1,860 | 1,820 |

Tendon sizes

| Strands | Characteristic ultimate resistance of tendon [kN] | | |
|---------|---|-------|-------|
| 02 | 521 | 558 | 601 |
| 04 | 1,042 | 1,116 | 1,201 |



BBR VT CONA CMB

Band post-tensioning system

Standard tendon sizes

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 150 mm² and a characteristic tensile strength of 1,860 MPa and a compacted 0.6" (15.2 mm) strands with a cross-sectional area of 165 mm² and a characteristic tensile strength of 1,820 MPa are used (*, see Page 31).

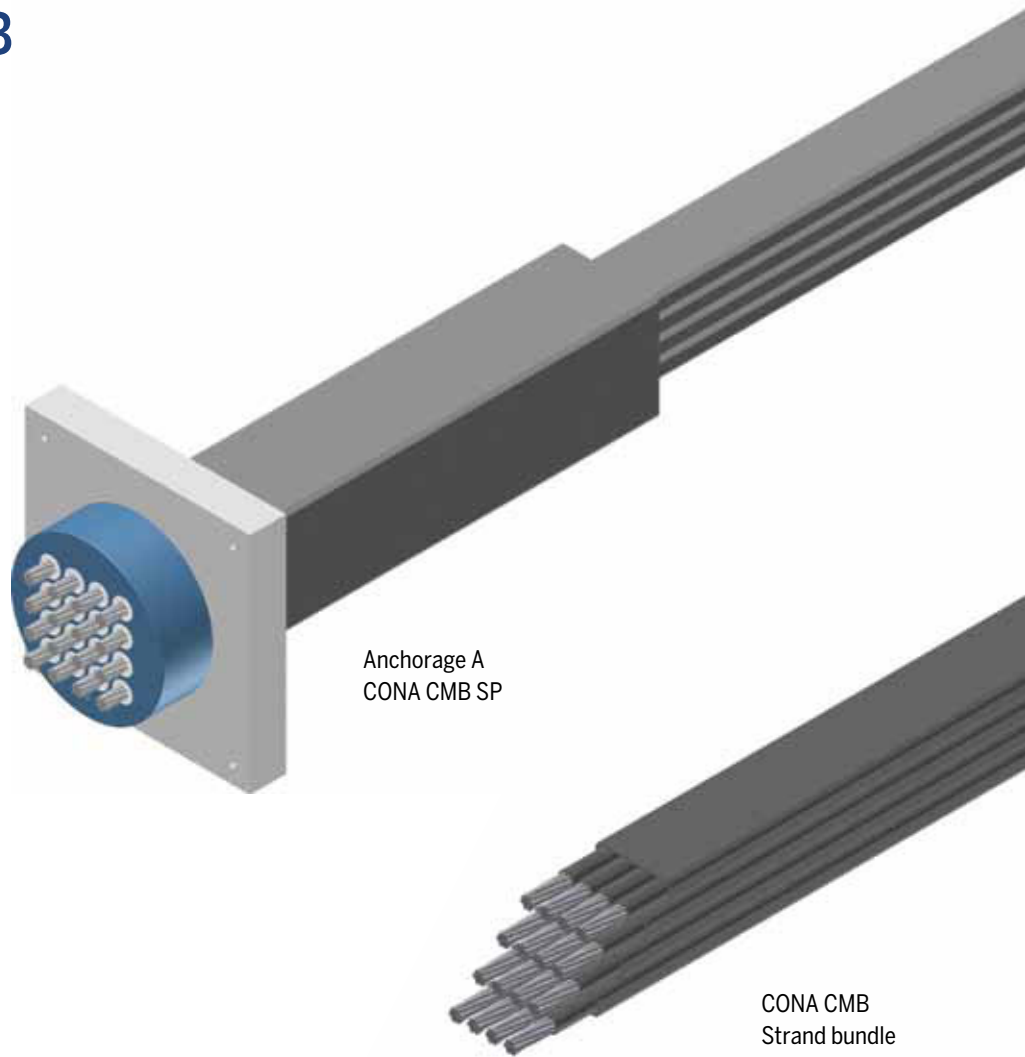
Anchorage configuration

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.

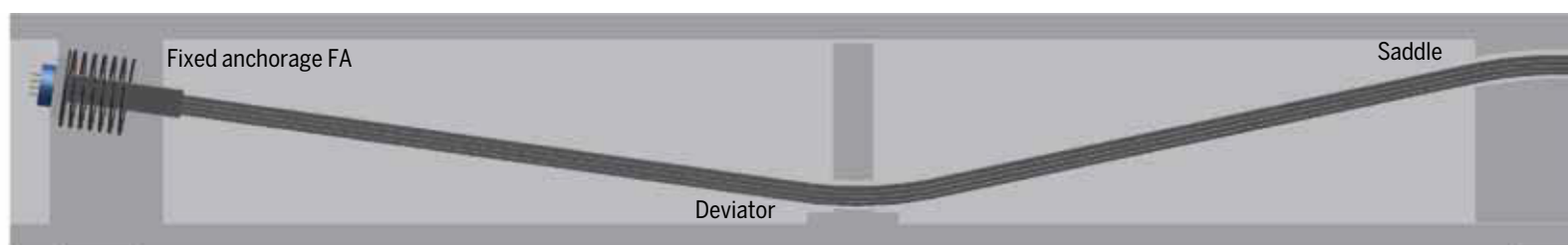
The stressing and fixed anchorages

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 restressing 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 140 mm² and/or a characteristic tensile strength lower than 1,860 MPa or 1,820 MPa respectively can be used with the same anchorage components.

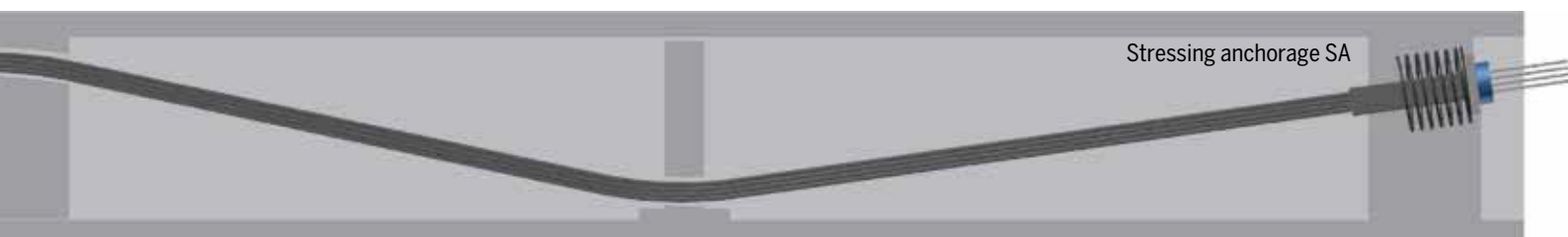
Available tendon sizes

Type of stands

| | | | |
|-----------------|-----------|-------|-------|
| in | 06 | | |
| mm ² | 140 | 150 | 165 |
| MPa | 1,860 | 1,860 | 1,820 |

Tendon sizes

| Strands | Characteristic ultimate resistance of tendon [kN] | | |
|-----------|---|-------|-------|
| 01 | 260 | 279 | 300 |
| 02 | 521 | 558 | 601 |
| 04 | 1,042 | 1,116 | 1,201 |
| 06 | 1,562 | 1,674 | 1,802 |
| 08 | 2,083 | 2,232 | 2,402 |
| 12 | 3,125 | 3,348 | 3,604 |
| 16 | 4,166 | 4,464 | 4,805 |

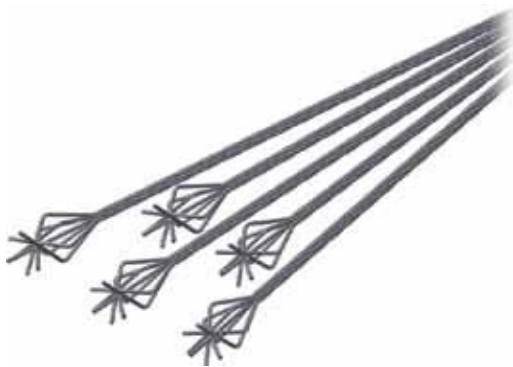


BBR VT CONA CMC

Cast-in and inaccessible bond anchorages

Load transfer is achieved by a local deformation of the strand and bond to the concrete. Local BBR Network Members

offer a variety of solutions, such as onion or loop anchorages which fully comply with regulations applicable at the place of use.



Flat onion anchorage
CONA CMC



Bundle onion anchorage
CONA CMC

BBR VT Classical Systems

Additional BBR VT post-tensioning systems

Since 1944, BBR has developed and pioneered post-tensioning introducing many systems over the past six decades. In specific markets, some of these earlier systems might still be used to complement

special applications – or, in some cases, they are still the locally approved systems. The BBR CONA, CONA compact, CONA multi, CONA single and CONA flat post-tensioning systems have been used for decades and

in 2005, the BBR post tensioning range was further complemented with the post-tensioning systems previously used by Vorspann-Technik (Austria / Germany).



BBR CONA multi



BBR CONA compact



BBR CONA flat

And finally ...

Having reached this page, you can certainly be in no doubt as to our commitment to the finest technology and our enthusiasm for delivering our projects.

Our seven decades of experience has resulted in BBR technology being applied to thousands of structures around the world and, in the process, we have continued to refine and enhance our range. The result is that we can supply simply the best technology available – the BBR VT CONA CMX system.

Technology does not however develop by itself – all through the years, we have been fortunate enough to have attracted some of the best engineers in the business. It is their dedication which has maintained the BBR reputation – and continues to do so today.

Our well-established worldwide network is supported in the development of major structures by our Special Projects Team who will help to specify and procure the systems required. So, local knowledge synchronises with international know-how to realise projects – some large, some smaller, but always technically excellent and fit-for-purpose!



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