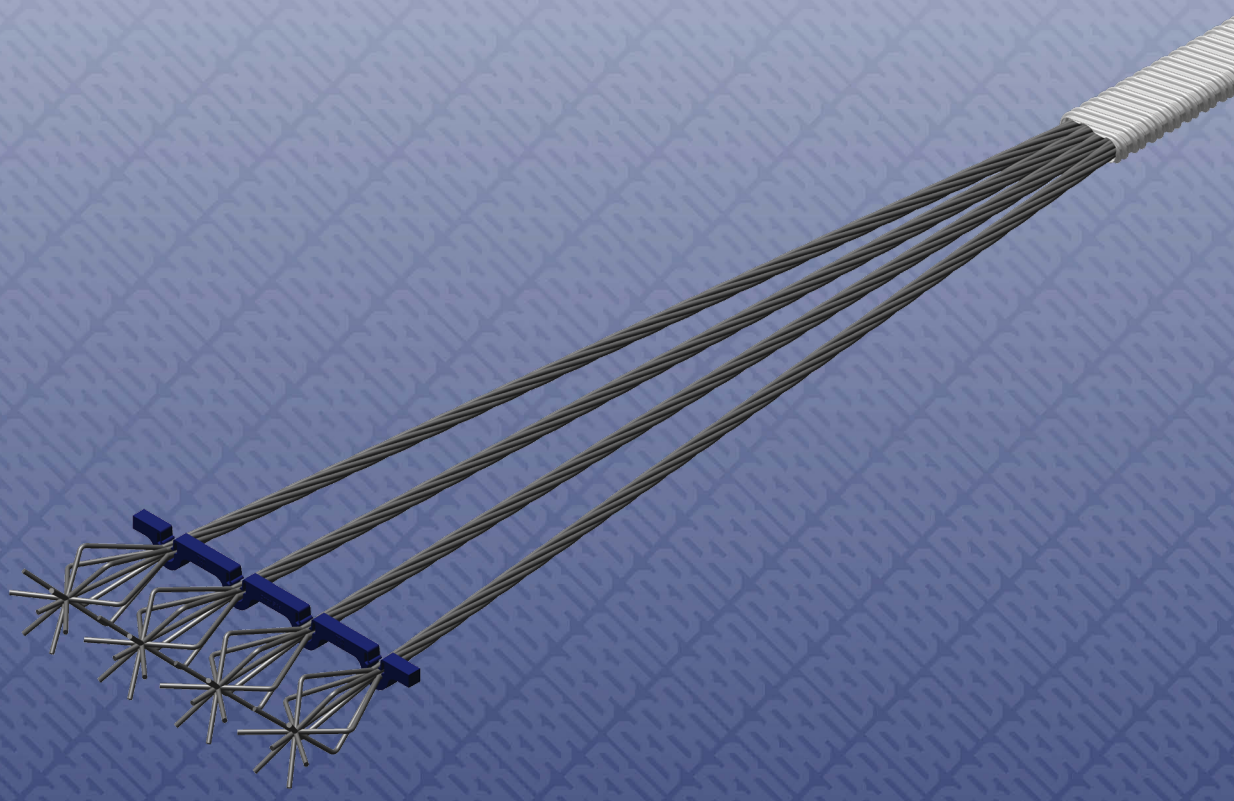
BBR VT CONA CMO

Bonded Post-tensioning System with 02 to 06 Strands

European Technical Assessment
ETA – 15/0808

CE



A Global Network of Experts
www.bbrnetwork.com

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ETA-15/0808
BBR VT CONA CMO
Bonded Post-tensioning System with 02 to 06 Strands

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

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Responsible BBR PT Specialist Company

CE

The delivery note accompanying components of the BBR VT CONA CMO Post-tensioning System will contain the CE marking.

Assembly and installation of BBR VT CONA CMO tendons must only be carried out by qualified BBR PT Specialist Companies. Find the local BBR PT Specialist Company by visiting the BBR Network website www.bbrnetwork.com.

European Organisation for Technical Approvals
Europäische Organisation für Technische Zulassungen
Organisation Européenne pour l'Agrément technique

ETAG 013 — Guideline for European Technical Approval of Post-tensioning Kits for Prestressing of Structures

CWA 14646 — Requirements for the installation of post-tensioning kits for prestressing of structures and qualification of the specialist company and its personnel

BBR E-TRACE 2

BBR E-Trace is the trading and quality assurance platform of the BBR Network linking the Holder of Approval, BBR VT International Ltd, BBR PT Specialist Companies and the BBR Manufacturing Plant. Along with the established BBR Factory Production Control, BBR E-Trace provides effective supply chain management including installation, delivery notes and highest quality standards, as well as full traceability of components.

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European Technical Assessment

ETA-15/0808 of 22.02.2016

General part

Technical Assessment Body issuing the European Technical Assessment	Österreichisches Institut für Bautechnik (OIB) Austrian Institute of Construction Engineering
Trade name of the construction product	BBR VT CONA CMO – Bonded Post-tensioning System with 02 to 06 Strands
Product family to which the construction product belongs	Post-tensioning kit for prestressing of structures with internal bonded strands
Manufacturer	BBR VT International Ltd Ringstrasse 2 8603 Schwerzenbach (ZH) Switzerland
Manufacturing plant	BBR VT International Ltd Ringstrasse 2 8603 Schwerzenbach (ZH) Switzerland
This European Technical Assessment contains	25 pages including Annexes 1 to 11, which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	ETAG 013, Post-Tensioning Kits for Prestressing of Structures, Edition June 2002, used according to Article 66 3. of Regulation (EU) № 305/2011 as European Assessment Document.

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Remarks

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Specific parts

1 Technical description of the product

1.1 General

The European Technical Assessment – ETA – applies to a kit, the PT system

BBR VT CONA CMO
Bonded Post-tensioning System with 02 to 06 Strands,

comprising the following components, see Annex 1.

– Tensile element

7-wire prestressing steel strand with nominal diameters and maximum characteristic tensile strength as given in Table 1.

Table 1: Tensile elements

Designation	Nominal diameter	Nominal cross-sectional area	Maximum characteristic tensile strength
	mm	mm^2	MPa
05	12.5	93	1 860
	12.9	100	
06	15.3	140	
	15.7	150	

NOTE 1 MPa = 1 N/mm^2

– Fixed (passive) anchorage

Inaccessible bond anchorage with bulb-ends (onions)

Bulb-strand spacer for 02, 03, 04, 05, and 06 strands

– Stressing (active) anchorage

Anchorage of strands with ring wedges

Stressing anchorage according to ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076

– Corrosion protection for tensile elements and anchorages

The fixed anchorage of BBR VT CONA CMO is installed together with a PT system according to ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076, all from BBR VT International. In this respect, the PT system according to ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076 is referred to as the basic PT system.

PT system

1.2 Designation and range of the anchorages

1.2.1 Designation

End anchorage e.g. F A CONA CMO 0406-150 1860

Fixed (F)

Anchorage (A)

Designation of the PT system
with information on number, cross-sectional area, and characteristic tensile strength of the strands

1.2.2 Anchorage

BBR VT CONA CMO provides only an inaccessible fixed bond anchorage of the tendon. The principal dimensions of the fixed anchorage are given in Annex 1, Annex 2, and Annex 3.

For stressing anchorage the anchorage from one of the basic systems with identical number of tensile elements – possibly with incomplete equipped anchor heads – is employed. The available tendon configurations comprised of 02 to 06 strands are listed in Table 2.

Table 2: Tendon configurations

		Basic Systems			
		BBR VT CONA CMI BT/SP ETA-06/0147, ETA-09/0286, and ETA-09/0287		**BBR VT CONA CMF BT** ETA-12/0076	
	Number of strands	Seven wire prestressing steel strand			
		05	06	*05*	06
BBR VT CONA CMO	02	—	+	+	+
	03	—	+	+	+
	04	—	+	+	+
	05	—	+	—	—
	06	—	+	—	—

Key
+..... Available tendon configuration
—..... Tendon configuration not available

1.2.3 Range

The tendons consist of 02, 03, 04, 05, or 06 strands. Tendon ranges are listed in Annex 6.

Prestressing and overstressing forces are given in the corresponding standards and regulations in force at the place of use. The maximum prestressing and overstressing forces according to Eurocode 2 are listed in Annex 7.

1.3 Centre spacing and edge distance of anchorages

In general, minimum values for spacing and distance are given in Annex 2, and Annex 3. However, centre spacing of tendon anchorages may be reduced in one direction by up to 15 %, but not

smaller than the outside diameter of the bulb-ends and placing of bulb-strand spacer is still possible. In this case centre spacing in the perpendicular direction is increased by the same percentage, see also Annex 4.

NOTE Bulb-strand spacers and hence spacing between bulb-ends are maintained unchanged despite modification of centre spacing.

The corresponding edge distances are calculated by

$$a_e = \frac{a_c}{2} - 10\ \text{mm} + c$$

$$b_e = \frac{b_c}{2} - 10\ \text{mm} + c$$

Where

a_c .....mm .....Centre spacing

b_c .....mm .....Centre spacing in the direction perpendicular to a_c

a_e .....mm .....Edge distance

b_e .....mm .....Edge distance in the direction perpendicular to a_e

c .....mm .....Concrete cover

No helix and no additional reinforcement is required for the fixed bond anchorage of the BBR VT CONA CMO PT system.

NOTE Concrete cover refers to reinforcement of the structure, placed in the same cross section. Standards and regulations on concrete cover in force at the place of use are to be observed.

1.4 Concrete strength at time of stressing

Concrete in conformity with EN 206[1] is used. At the time of stressing the mean concrete compressive strength, $f_{cm,\,0}$, is at least 26 MPa, cube strength on a 150 mm cube, or 21 MPa, cylinder strength on a cylinder, 150 mm diameter. Concrete test specimens for verification of mean concrete compressive strength are subjected to the same curing conditions as the structure.

For partial prestressing with 30 % of the full prestressing force, the actual mean value of the concrete compressive strength is at least $0.5 \cdot f_{cm,\,0,\,cube}$ or $0.5 \cdot f_{cm,\,0,\,cylinder}$. Intermediate values may be interpolated linearly according to Eurocode 2.

1.5 Slip at anchorages

For calculation the tendon length continues until the bulb-ends of the fixed bond anchorage. Slip of bulb-ends may be assumed as zero.

1.6 Designation of tendons

Tendon designation follows the basic system, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

1.7 Ducts

The tendon follows the duct specification of the basic system, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

1.8 Minimum radii of curvature

The minimum radii of curvature of the basic system apply, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

[1] Standards and other documents referred to in the European Technical Assessment are listed in Annex 11.

1.9 Friction losses

Friction losses are considered according to the basic system, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

1.10 Support of tendons

For tendon support the basic system applies, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

Components

1.11 Strands

Only 7-wire prestressing steel strands with characteristics according to Table 3 are used, see also Annex 5.

Table 3: Prestressing steel strands

Maximum characteristic tensile strength [1)]	f_{pk}	MPa	1 860			
Nominal diameter	d	mm	12.5	12.9	15.3	15.7
Nominal cross-sectional area	A_p	mm^2	93	100	140	150
Mass of prestressing steel	M	kg/m	0.726	0.781	1.093	1.172

[1)] Prestressing steel strands with a characteristic tensile strength below 1 860 MPa may also be used.

In the course of preparing the European Technical Assessment no characteristic has been assessed for prestressing steel strands.

1.12 Anchorages

Bulb-ends and bulb-strand spacer conform to the specifications in Annex 1 and the technical file[2]. Therein dimensions, materials and material identification data with tolerances are given.

In order to assure the distance between the bulb-ends, the bulb-strands are placed into bulb-strand spacers. The bulb-strand spacers are made of HDPE and slots with a clip-lock accommodate the bulb-strands.

1.13 Permanent corrosion protection

To protect the tendons from corrosion, the ducts are completely filled with grout according to EN 447 or special grout according to ETAG 013 as applicable at the place of use.

2 Specification of the intended uses in accordance with the applicable European Assessment Document (hereinafter EAD)

2.1 Intended uses

For the BBR VT CONA CMO PT system the same intended uses as for the bonded tendons of the basic systems apply, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076. The specific intended uses according to tendon configuration and material of the structure are listed in Table 4.

[2] The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

Table 4: Intended uses

Line №	Use category
Use categories according to tendon configuration and material of structure	
1	Internal bonded tendon for concrete and composite structures
2	For special structures according to Eurocode 2 and Eurocode 4
Optional use category	
3	For special structures according to Eurocode 6

2.2 Assumptions

2.2.1 General

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to provide advice on transport, storage, maintenance, replacement and repair of the product as considered necessary. Further details are according to the basic system, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

2.2.2 Design

2.2.2.1 General

The ETA holder ensures that all necessary information on design and installation is submitted to those responsible for design and execution of the works, executed with the PT system. Regarding design the following items are essential.

- Design of the structure permits correct installation and stressing of the tendons.
- The reinforcement in the anchorage zone permits correct placing and compacting of the concrete.
- Maximum prestressing and overstressing forces according to Eurocode 2 are listed in Annex 7.

Regarding design the basic system is considered too, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

2.2.3 Installation

2.2.3.1 General

Assembly and installation of the PT system is only carried out by qualified PT specialist companies with the required resources and experience in the use of multi-strand bonded post-tensioning systems, see ETAG 013, Annex D.1 and CWA 14646. The company's PT site manager has a certificate, stating that she or he has been trained by the ETA holder of the PT system and that she or he possesses the necessary qualifications and experience with the "BBR VT CONA CMO – Bonded Post-tensioning System with 02 to 06 Strands".

Installation is carried out according to Annex 8. In general the tendon is installed as given for the basic system, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

Before placing the concrete a final check of the installed bulb-strands with bulb-strand spacers is carried out.

The respective standards and regulations in force at the place of use are considered.

2.2.3.2 Stressing operation

With a mean concrete compressive strength in the anchorage zone according to the values laid down in Annex 2 and Annex 3 full prestressing may be applied. See Clause 1.4 for partial prestressing.

In general stressing is performed as given for the basic system, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

2.2.3.3 Welding

Welding is not intended for the BBR VT CONA CMO PT system. However, welding may be performed on components and under conditions of the basic system, see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076. In case of welding operations near tendons, precautionary measures are required to avoid damage.

2.3 Assumed working life

The European Technical Assessment is based on an assumed working life of the PT system of 100 years, provided that the PT system is subject to appropriate installation, use and maintenance, see Clause 2.2. The indications given as to the working life of the PT system cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by the Technical Assessment Body, but are regarded only as a means for selecting the appropriate products in relation to the expected economically reasonable working life of the works[3].

3 Performance of the product and references to the methods used for its assessment

3.1 Essential characteristics

The performances of the PT system for the essential characteristics are given in Table 5 and Table 6. In Annex 9 the combinations of essential characteristics and corresponding intended uses are listed in Table 15.

Table 5: Essential characteristics and performances of the product

№	Essential characteristic	Product performance
(1)	(2)	(3)
Product BBR VT CONA CMO Intended use The PT system is intended to be used for the prestressing of structures, Clause 2.1, Table 4, lines № 1 and 2.		
Basic requirement for construction works 1: Mechanical resistance and stability		
1	Resistance to static load	See Clause 3.1.1.1.
2	Resistance to fatigue	See Clause 3.1.1.2.
3	Load transfer to the structure	See Clause 3.1.1.3.
4	Friction coefficient	See Clause 3.1.1.4.
5	Deviation, deflection (limits)	See Clause 3.1.1.5.
6	Practicability, reliability of installation	See Clause 3.1.1.6.

[3] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works are subject, as well as on the particular conditions of design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product can also be shorter than the assumed working life.

№	Essential characteristic	Product performance
(1)	(2)	(3)
Basic requirement for construction works 2: Safety in case of fire		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 3: Hygiene, health and the environment		
7	Content, emission and/or release of dangerous substances	See Clause 3.1.2.
Basic requirement for construction works 4: Safety and accessibility in use		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 5: Protection against noise		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 6: Energy economy and heat retention		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 7: Sustainable use of natural resources		
—	No characteristic assessed.	—
Related aspects of serviceability		
8	Related aspects of serviceability	See Clause 3.1.3.

Table 6: Essential characteristics and performances of the product in addition to Table 4 for specific intended uses

№	Additional essential characteristic	Product performance
(1)	(2)	(3)
Product BBR VT CONA CMO Specific intended use Clause 2.1, Table 4, lines № 3, special structures according to Eurocode 6.		
Basic requirement for construction works 1: Mechanical resistance and stability		
9	Load transfer to the structure	See Clause 3.1.4.1.

3.1.1 Mechanical resistance and stability

3.1.1.1 Resistance to static load

The PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.1-I. The characteristic values of maximum force, F_{pk}, of the tendon for prestressing steel strands according to Annex 5 are listed in Annex 6.

3.1.1.2 Resistance to fatigue

The PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.2-I. The characteristic values of maximum force, F_{pk}, of the tendon for prestressing steel strands according to Annex 5 are listed in Annex 6.

3.1.1.3 Load transfer to the structure

The PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.3-I. The characteristic values of maximum force, F_{pk}, of the tendon for prestressing steel strands according to Annex 5 are listed in Annex 6.

3.1.1.4 Friction coefficient

The PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.4-I. For friction losses including friction coefficient see Clause 1.9.

3.1.1.5 Deviation, deflection (limits)

The PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.5-I. For minimum radii of curvature see Clause 1.8.

3.1.1.6 Practicability, reliability of installation

The PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.6-I.

3.1.2 Hygiene, health and the environment

Content, emission and/or release of dangerous substances is determined according to ETAG 013, Clause 5.3.1. No dangerous substance is the performance of the PT system in this respect. A manufacturer's declaration to this effect has been submitted.

NOTE In addition to specific clauses relating to dangerous substances in the European Technical Assessment, there may be other requirements applicable to the product falling within their scope, e.g. transposed European legislation and national laws, regulations and administrative provisions. These requirements also need to be complied with, when and where they apply.

3.1.3 Related aspects of serviceability

The PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.7.

3.1.4 Mechanical resistance and stability

3.1.4.1 Load transfer to the structure

For special structures according to Eurocode 6, masonry structures, the PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.3-II(h). The characteristic values of maximum force, F_{pk}, of the tendon for prestressing steel strands according to Annex 5 are listed in Annex 6.

Load transfer of prestressing force to masonry structures is via concrete members designed according to the European Technical Assessment, especially according to the Clauses 1.3 and 1.4. The concrete members have such dimensions as to permit a force of $1.1 \cdot F_{pk}$ being transferred into the masonry. The verification is performed according to Eurocode 6 as well as to the respective standards and regulations in force at the place of use.

3.2 Assessment methods

The assessment of the essential characteristics in Clause 3.1 of the PT system for the intended uses and in relation to the requirements for mechanical resistance and stability, and for hygiene,

health and the environment in the sense of the basic requirements for construction works № 1 and 3 of Regulation (EU) № 305/2011 has been made in accordance with the Guideline for European technical approvals of "Post-Tensioning Kits for Prestressing of Structures", ETAG 013, Edition June 2002, used according to Article 66 3. of Regulation (EU) № 305/2011 as European Assessment Document, based on the assessment for internal bonded systems.

3.3 Identification

The European Technical Assessment for the PT system is issued on the basis of agreed data[4] that identify the assessed product. Changes to materials, to composition or characteristics of the product, or to the production process could result in these deposited data being incorrect. Österreichisches Institut für Bautechnik should be notified before the changes are introduced, as an amendment of the European Technical Assessment is possibly necessary.

4 Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

4.1 System of assessment and verification of constancy of performance

According to the Commission Decision 98/456/EC the system of assessment and verification of constancy of performance to be applied to the PT system is System 1+. System 1+ is detailed in Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, Annex, 1.1., and provides for the following items.

(a) The manufacturer shall carry out

  (i) factory production control;

  (ii) further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan[5].

(b) The notified product certification body shall decide on the issuing, restriction, suspension or withdrawal of the certificate of constancy of performance of the construction product on the basis of the outcome of the following assessments and verifications carried out by that body

  (i) an assessment of the performance of the construction product carried out on the basis of testing (including sampling), calculation, tabulated values or descriptive documentation of the product;

  (ii) initial inspection of the manufacturing plant and of factory production control;

  (iii) continuing surveillance, assessment and evaluation of factory production control;

  (iv) audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities.

4.2 AVCP for construction products for which a European Technical Assessment has been issued

Notified bodies undertaking tasks under System 1+ shall consider the European Technical Assessment issued for the construction product in question as the assessment of the performance of that product. Notified bodies shall therefore not undertake the tasks referred to in Clause 4.1, point (b) (i).

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[4] The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik and, in so far as is relevant to the tasks of the notified product certification body involved in the assessment and verification of constancy of performance, is handed over to the notified product certification body.

[5] The prescribed test plan has been deposited with Österreichisches Institut für Bautechnik and is handed over only to the notified product certification body involved in the procedure for the assessment and verification of constancy of performance. The prescribed test plan is also referred to as control plan.

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

5.1 Tasks for the manufacturer

5.1.1 Factory production control

In the manufacturing plant the manufacturer shall establish and continuously maintain a factory production control. All procedures and specification adopted by the manufacturer shall be documented in a systematic manner. The factory production control shall ensure the constancy of performances of the PT system with regard to the essential characteristics.

The manufacturer shall only use raw materials supplied with the relevant inspection documents as laid down in the control plan. The incoming raw materials shall be subject to controls by the manufacturer before acceptance. Check of incoming materials shall include control of inspection documents presented by the manufacturer of the raw materials.

The records shall be kept at least for ten years after the construction product has been placed on the market and shall be presented to the notified product certification body involved in continuous surveillance. On request the records shall be presented to Österreichisches Institut für Bautechnik.

If test results are unsatisfactory, the manufacturer shall immediately implement measures to eliminate the defects. Construction products or components that are not in conformity with the requirements shall be removed. After elimination of the defects, the respective test – if verification is required for technical reasons – shall be repeated immediately.

The basic elements of the prescribed test plan are given in Annex 10, conform to ETAG 013, Annex E.1 and are specified in the quality management plan of the “BBR VT CONA CMO – Internal Bonded Post-tensioning System with 02 to 06 Strands”.

5.1.2 Declaration of performance

The manufacturer is responsible for preparing the declaration of performance. When all the criteria of the assessment and verification of constancy of performance are met, including the certificate of constancy of performance issued by the notified product certification body, the manufacturer shall draw up a declaration of performance. Essential characteristics to be included in the declaration of performance for the corresponding intended use are given in Table 5. In Annex 9 the combinations of essential characteristics and corresponding intended uses are listed in Table 15.

5.2 Tasks for the notified product certification body

5.2.1 Initial inspection of the manufacturing plant and of factory production control

The notified product certification body verifies the ability of the manufacturer for a continuous and orderly manufacturing of the PT system according to the European Technical Assessment. In particular the following items shall be appropriately considered.

- Personnel and equipment
- Suitability of the factory production control established by the manufacturer
- Full implementation of the prescribed test plan

5.2.2 Continuing surveillance, assessment and evaluation of factory production control

The notified product certification body visits the factory at least once a year for routine inspection. In particular the following items are appropriately considered.

- Manufacturing process including personnel and equipment
- Factory production control
- Implementation of the prescribed test plan

The results of continuous surveillance are made available on demand by the notified product certification body to Österreichisches Institut für Bautechnik. When the provisions of the European Technical Assessment and the prescribed test plan are no longer fulfilled, the certificate of constancy of performance is withdrawn by the notified product certification body.

5.2.3 Audit-testing of samples taken at the manufacturing plant or at the manufacturer's storage facilities

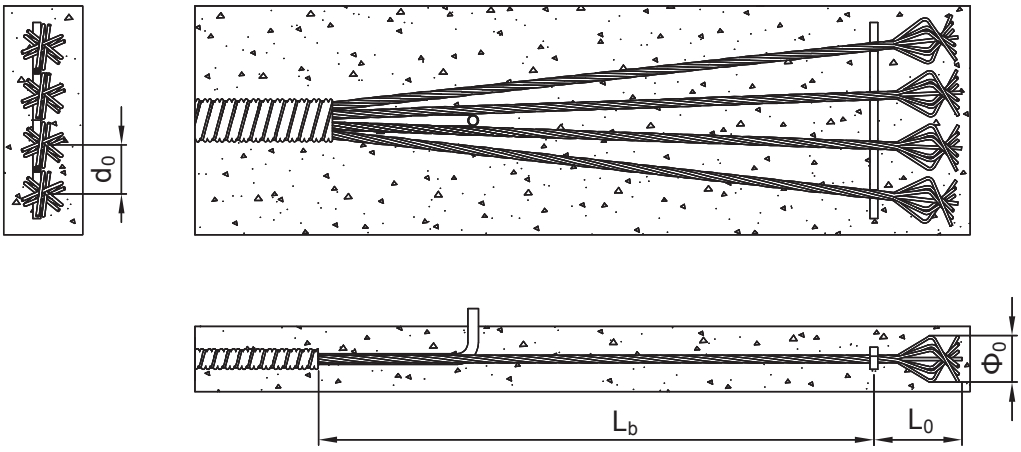
The PT system BBR VT CONA CMO – Internal Bonded Post-tensioning System with 02 to 06 Strands does not include any component that should be subjected to audit-testing by the notified product certification body. For audit-testing of the components of the basic system see ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

Issued in Vienna on 22 February 2016
by Österreichisches Institut für Bautechnik

The original document is signed by

Rainer Mikulits
Managing Director

Centre spacing of bulb-ends



Bulb-strand spacer

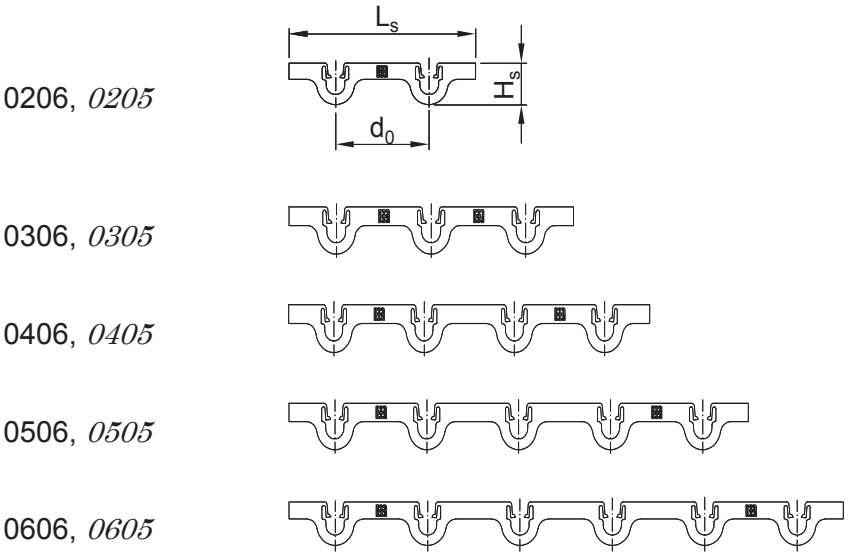
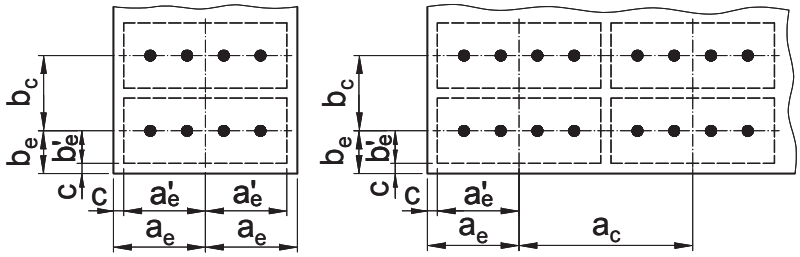


Table 7: Bond anchorage – Dimensions

BBR VT CONA CMO			*05*					**06**				
Bond anchorage			***0205***	***0305***	***0405***	***0505***	***0605***	**0206**	**0306**	**0406**	**0506**	**0606**
Bond length	L_b	mm	1 150	1 150	1 150	1 150	1 200	1 400	1 400	1 400	1 400	1 600
Centre spacing	d_0	mm	75					90				
Bulb-end length	L_0	mm	~ 130–150					~ 130–150				
Bulb-end diameter	Φ_0	mm	~ 75 ± 10					~ 90 ± 10				
Bulb-strand spacer												
Length	L_s	mm	150	225	300	375	450	180	270	360	450	540
Height	H_s	mm	38					38				

Centre spacing and edge distance



$a_e = a'_e + c$

$b_e = b'_e + c$

c … Concrete cover

Table 8: Bond anchorage – Tendon with *05* strands

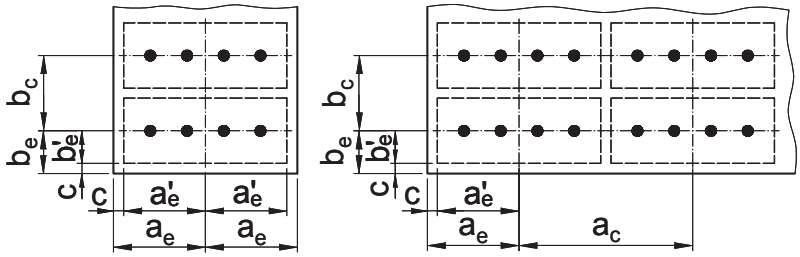
BBR VT CONA CMO *05*			*0205*	*0305*	*0405*	*0505*	*0605*
Strand arrangement							
7-wire prestressing steel strand Nominal diameter **12.9 mm** – Nominal cross-sectional area **100 mm²** Maximum characteristic tensile strength **1 860 MPa** [1]							
Strand		mm²	100	100	100	100	100
Cross-sectional area	A_p	mm²	200	300	400	500	600
Characteristic value of maximum force	F_{pk}	kN	372	558	744	930	1 116
Characteristic value of 0.1 % proof force [2]	$F_{p0.1k}$	kN	328	492	656	820	984
Maximum prestressing force [2]	$0.90 \cdot F_{p0.1k}$	kN	295	443	590	738	886
Maximum overstressing force [2]	$0.95 \cdot F_{p0.1k}$	kN	312	467	623	779	935
Minimum concrete strength – Helix – Additional reinforcement – Centre spacing and edge distance							
Minimum concrete strength, cube	$f_{cm,0}$	**MPa**	**26**	**26**	**26**	**26**	**26**
Minimum concrete strength, cylinder	$f_{cm,0}$	**MPa**	**21**	**21**	**21**	**21**	**21**
Helix [3]			**Ribbed reinforcing steel, $R_e \geq 500$ MPa**				
Outer diameter		mm					
Bar diameter		mm					
Length, approximately		mm					
Pitch		mm					
Number of pitches		—					
Distance		mm					
Additional reinforcement [3]			**Ribbed reinforcing steel, $R_e \geq 500$ MPa**				
Number of stirrups		—					
Bar diameter		mm					
Spacing		mm					
Distance from anchor plate		mm					
Minimum outer dimensions		mm					
Centre spacing and edge distance							
Minimum centre spacing	a_c / b_c	mm	180/150	270/150	350/150	440/150	530/150
Minimum edge distance	a'_e / b'_e	mm	90/75	135/75	175/75	220/75	265/75

[1] Prestressing steel strand with nominal diameter of 12.5 mm, cross-sectional area of 93 mm² or with characteristic tensile strength below 1 860 MPa may also be used.

[2] For strands according to prEN 10138-3, 09.2000, the value shall be multiplied by 0.98.

[3] No helix and no additional reinforcement is required for this anchorage.

Centre spacing and edge distance



$a_e = a'_e + c$

$b_e = b'_e + c$

c … Concrete cover

Table 9: Bond anchorage – Tendon with 06 strands

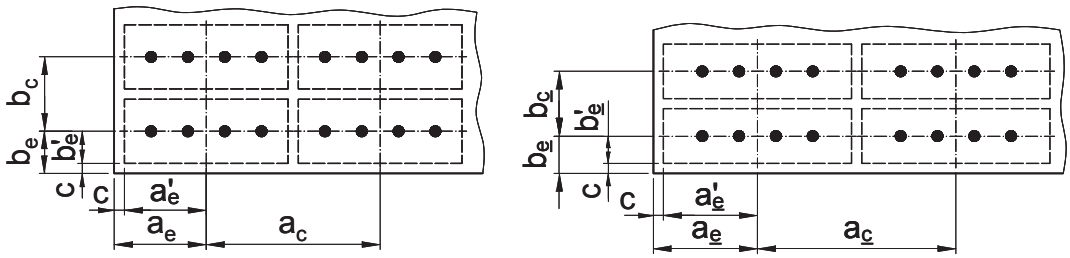
BBR VT CONA CMO 06			**0206**	**0306**	**0406**	**0506**	**0606**
Strand arrangement							
7-wire prestressing steel strand Nominal diameter **15.7 mm** – Nominal cross-sectional area **150 mm²** Maximum characteristic tensile strength **1 860 MPa** [1]							
Strand		mm²	150	150	150	150	150
Cross-sectional area	A_p	mm²	300	450	600	750	900
Characteristic value of maximum force	F_{pk}	kN	558	837	1 116	1 395	1 674
Characteristic value of 0.1 % proof force [2]	$F_{p0.1k}$	kN	492	738	984	1 230	1 476
Maximum prestressing force [2]	$0.90 \cdot F_{p0.1k}$	kN	443	664	886	1 107	1 328
Maximum overstressing force [2]	$0.95 \cdot F_{p0.1k}$	kN	467	701	935	1 169	1 402
Minimum concrete strength – Helix – Additional reinforcement – Centre spacing and edge distance							
Minimum concrete strength, cube	$f_{cm,0}$	**MPa**	**26**	**26**	**26**	**26**	**26**
Minimum concrete strength, cylinder	$f_{cm,0}$	**MPa**	**21**	**21**	**21**	**21**	**21**
Helix [3]			**Ribbed reinforcing steel, $R_e \geq 500$ MPa**				
Outer diameter		mm					
Bar diameter		mm					
Length, approximately		mm					
Pitch		mm					
Number of pitches		—					
Distance		mm					
Additional reinforcement [3]			**Ribbed reinforcing steel, $R_e \geq 500$ MPa**				
Number of stirrups		—					
Bar diameter		mm					
Spacing		mm					
Distance from anchor plate		mm					
Minimum outer dimensions		mm					
Centre spacing and edge distance							
Minimum centre spacing	a_c / b_c	mm	220/180	320/180	420/180	520/180	630/180
Minimum edge distance	a'_e / b'_e	mm	110/90	160/90	210/90	260/90	315/90

[1] Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1 860 MPa may also be used.

[2] For strands according to prEN 10138-3, 09.2000, the value shall be multiplied by 0.98.

[3] No helix and no additional reinforcement is required for this anchorage.

Modification of centre spacing and edge distance



$a_c = b_c$ $\qquad$ $a_c > b_c$

$a_e = b_e$ $\qquad$ $a_e > b_e$

Modification of centre spacing and edge distance shall be in accordance with Clause 1.3.

$b_c \geq 0.85 \cdot b_c$

$$a_c \geq \frac{A_c}{b_c}$$

$A_c = a_c \cdot b_c \leq a_c \cdot b_c$

Corresponding edge distances

$$a_e = \frac{a_c}{2} - 10\ \text{mm} + c$$

and

$$b_e = \frac{b_c}{2} - 10\ \text{mm} + c$$

c ..... Concrete cover. Concrete cover to be understood as concrete cover of reinforcement in the same cross section.

Seven-wire prestressing steel strands according to prEN 10183-3 [1)]

Table 10: Prestressing steel strand – Y1770S7

Prestressing steel strand			**Y1770S7**			
Tensile strength	f_{pk}	MPa	1 770			
Diameter	d	mm	12.5	12.9	15.3	15.7
Nominal cross-sectional area	A_p	mm^2	93	100	140	150
Nominal mass per metre	M	kg/m	0.726	0.781	1.093	1.172
Permitted deviation from nominal mass		%	± 2			
Characteristic value of maximum force	F_{pk}	kN	165	177	248	266
Maximum value of maximum force	$F_{m,\,max}$	kN	190	204	285	306
Characteristic value of 0.1 % proof force [2)]	$F_{p0.1}$	kN	145	156	218	234
Minimum elongation at maximum force, $L_0 \geq 500$ mm	A_{gt}	%	3.5			
Modulus of elasticity	E_p	MPa	195 000 [3)]			

Table 11: Prestressing steel strand – Y1860S7

Prestressing steel strand			**Y1860S7**			
Tensile strength	f_{pk}	MPa	1 860			
Diameter	d	mm	12.5	12.9	15.3	15.7
Nominal cross-sectional area	A_p	mm^2	93	100	140	150
Nominal mass per metre	M	kg/m	0.726	0.781	1.093	1.172
Permitted deviation from nominal mass		%	± 2			
Characteristic value of maximum force	F_{pk}	kN	173	186	260	279
Maximum value of maximum force	$F_{m,\,max}$	kN	199	214	299	321
Characteristic value of 0.1 % proof force [2)]	$F_{p0.1}$	kN	152	164	229	246
Minimum elongation at maximum force, $L_0 \geq 500$ mm	A_{gt}	%	3.5			
Modulus of elasticity	E_p	MPa	195 000 [3)]			

1) Suitable strands according to standards and regulations in force at the place of use may also be used.
2) For strands according to prEN 10138-3, 09.2000, the value shall be multiplied by 0.98.
3) Standard value

Table 12: Tendon ranges

Number of strands	n	—	02	03	04	05	06
Strand with nominal diameter of **12.5 mm** and nominal cross-sectional area of **93 mm²**							
Nominal cross-sectional area of prestressing steel	A_p	mm²	186	279	372	465	558
Nominal mass of prestressing steel	M	kg/m	1.45	2.18	2.90	3.63	4.36
Characteristic tensile strength f_{pk} = **1 770 MPa**							
Characteristic value of maximum force of tendon	F_{pk}	kN	330	495	660	825	990
Characteristic tensile strength f_{pk} = **1 860 MPa**							
Characteristic value of maximum force of tendon	F_{pk}	kN	346	519	692	865	1 038
Strand with nominal diameter of **12.9 mm** and nominal cross-sectional area of **100 mm²**							
Nominal cross-sectional area of prestressing steel	A_p	mm²	200	300	400	500	600
Nominal mass of prestressing steel	M	kg/m	1.56	2.34	3.12	3.91	4.69
Characteristic tensile strength f_{pk} = **1 770 MPa**							
Characteristic value of maximum force of tendon	F_{pk}	kN	354	531	708	885	1 062
Characteristic tensile strength f_{pk} = **1 860 MPa**							
Characteristic value of maximum force of tendon	F_{pk}	kN	372	558	744	930	1 116
Strand with nominal diameter of **15.3 mm** and nominal cross-sectional area of **140 mm²**							
Nominal cross-sectional area of prestressing steel	A_p	mm²	280	420	560	700	840
Nominal mass of prestressing steel	M	kg/m	2.19	3.28	4.37	5.47	6.56
Characteristic tensile strength f_{pk} = **1 770 MPa**							
Characteristic value of maximum force of tendon	F_{pk}	kN	496	744	992	1 240	1 488
Characteristic tensile strength f_{pk} = **1 860 MPa**							
Characteristic value of maximum force of tendon	F_{pk}	kN	520	780	1040	1 300	1 560
Strand with nominal diameter of **15.7 mm** and nominal cross-sectional area of **150 mm²**							
Nominal cross-sectional area of prestressing steel	A_p	mm²	300	450	600	750	900
Nominal mass of prestressing steel	M	kg/m	2.34	3.52	4.69	5.86	7.03
Characteristic tensile strength f_{pk} = **1 770 MPa**							
Characteristic value of maximum force of tendon	F_{pk}	kN	532	798	1 064	1 330	1 596
Characteristic tensile strength f_{pk} = **1 860 MPa**							
Characteristic value of maximum force of tendon	F_{pk}	kN	558	837	1 116	1 395	1 674

Table 13: Maximum prestressing and overstressing forces – Tendon with *05* strands

Maximum force		Maximum prestressing force [1), 3)]				Maximum overstressing force [1), 2), 3)]			
		0.90 · $F_{p0.1}$				0.95 · $F_{p0.1}$			
Designation		CONA CMO *05*							
		n05-93		*n05*-100		*n05*-93		*n05*-100	
Characteristic tensile strength	MPa	1 770	1 860	1 770	1 860	1 770	1 860	1 770	1 860
—	—	kN	kN	kN	kN	kN	kN	kN	kN
n Number of strands	*02*	261	274	281	295	276	289	296	312
	03	392	410	421	443	413	433	445	467
	04	522	547	562	590	551	578	593	623
	05	653	684	702	738	689	722	741	779
	06	783	821	842	886	827	866	889	935

Table 14: Maximum prestressing and overstressing forces – Tendon with 06 strands

Maximum force		Maximum prestressing force [1), 3)]				Maximum overstressing force [1), 2), 3)]			
		0.90 · $F_{p0.1}$				0.95 · $F_{p0.1}$			
Designation		CONA CMO 06							
		n06-140		n06-150		n06-140		n06-150	
Characteristic tensile strength	MPa	1 770	1 860	1 770	1 860	1 770	1 860	1 770	1 860
—	—	kN	kN	kN	kN	kN	kN	kN	kN
n Number of strands	02	392	412	421	443	414	435	445	467
	03	589	618	632	664	621	653	667	701
	04	785	824	842	886	828	870	889	935
	05	981	1 031	1 053	1 107	1 036	1 088	1 112	1 169
	06	1 177	1 237	1 264	1 328	1 243	1 305	1 334	1 402

1) The given values are maximum values according to Eurocode 2. The actual values shall be taken from the standards and regulations in force at the place of use. Conformity with the stabilisation and crack width criteria in the load transfer test has been verified to a load level of 0.80 · F_{pk}.

2) Overstressing is permitted if the force in the prestressing jack can be measured to an accuracy of ± 5 % of the final value of the prestressing force.

3) For strands according to prEN 10138-3, 09.2000, the value shall be multiplied by 0.98

Where

F_{pk}.....Characteristic value of maximum force of tendon

$F_{p0.1}$.....Characteristic value of 0.1 % proof force of the tendon

Installation of the PT system

1 Preparatory work

The components of the PT system shall be stored in such a way as to avoid any damage or corrosion.

2 Placing of sheaths

The sheaths are placed on supports with spacing and minimum radii of curvature according to the basic system. The sheaths are jointed water-proof and supported such that any movement is prevented.

The same applies for prefabricated tendons.

3 Installation of tensile elements – prestressing steel strand

The prestressing steel is pushed or pulled into the sheath before concreting the structure.

4 Assembly of inaccessible fixed bond anchorage

After passing the strands through the duct, the ends of all strands are individually formed into the bulb-strand shape using a bulb-strand jack. Then the bulb-strand are individually clipped into the bulb-strand spacer. Forming of bulb-ends may as well be performed prior of threading the strands.

Ventilation is provided at the duct end of each fixed bond anchorage.

5 Fixing the bulb-strand spacer

The bulb-strand spacer is fastened to the already placed reinforcement.

6 Checking the tendons before concreting

Before concreting the structure, position and fastening of the entire tendon have to be checked and corrected if necessary. The sheaths shall be checked for any damage.

7 Stressing operation

At the time of stressing the mean concrete compressive strength shall be at least according to the provisions of Clause 1.4. Stressing and possible wedging at the stressing anchorage of the basic system is carried out with a suitable prestressing jack and in accordance with ETA-06/0147, ETA-09/0286, ETA-09/0287, or ETA-12/0076.

Elongations of tendon and applied prestressing forces are systematically checked and recorded during the stressing operation.

Table 15: Essential characteristics for the intended uses of the PT system

№	Essential characteristic	Clause	Intended use Line № according to Clause 2.1, Table 4		
			1	2	3
1	Resistance to static load	3.1.1.1	+	+	+
2	Resistance to fatigue	3.1.1.2	+	+	+
3	Load transfer to the structure	3.1.1.3	+	+	—
4	Friction coefficient	3.1.1.4	+	+	+
5	Deviation, deflection (limits)	3.1.1.5	+	+	+
6	Practicability, reliability of installation	3.1.1.6	+	+	+
7	Content, emission and/or release of dangerous substances	3.1.2	+	+	+
8	Related aspects of serviceability	3.1.3	+	+	+
9	Load transfer to the structure	3.1.4.1	—	—	+

Key
+ ..... Essential characteristic relevant for the intended use
— ..... Essential characteristic not relevant for the intended use

For combinations of intended uses the essential characteristics of all intended uses composing the combination are relevant.

Table 16: Contents of the prescribed test plan

Component	Item	Test / Check	Traceability	Minimum frequency	Documentation
Strand	Material	Check	Full	100 %	"CE" [2]
	Diameter	Test		each coil	No
	Visual inspection [1]	Check		each coil	No
Bulb-strand spacer	Material	Check	Full	100 %	No
	Dimensions	Test		0.5 % ≥ 2 specimens	Yes
	Visual inspection [1]	Check		100 %	No

[1] Visual inspections include e.g.: Main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, smoothness, corrosion, coating etc., as detailed in the prescribed test plan.

[2] If the basis for CE marking of prestressing steel is not available, an approval or certificate according to the respective standards and regulations in force at the place of use shall accompany each delivery.

Full ..... Full traceability of each component to its raw materials.

Reference documents

Guideline for European Technical Approval

ETAG 013, 06.2002	Guideline for European Technical Approval of Post-Tensioning Kits for Prestressing of Structures

Standards

Eurocode 2	Eurocode 2: Design of concrete structures
Eurocode 4	Eurocode 4: Design of composite steel and concrete structures
Eurocode 6	Eurocode 6: Design of masonry structures
EN 206, 12.2013	Concrete – Specification, performance, production and conformity
EN 447, 10.2007	Grout for prestressing tendons – Basic requirements
prEN 10138-3, 08.2009	Prestressing steels – Part 3: Strand
prEN 10138-3, 09.2000	Prestressing steels - Part 3: Strand
CWA 14646, 01.2003	Requirements for the installation of post-tensioning kits for prestressing of structures and qualification of the specialist company and its personnel

ETAs

ETA-12/0076	BBR VT CONA CMF BT – Internal Post-tensioning System with Flat Anchorages and 02, 03, and 04 Strands
ETA-06/0147	BBR VT CONA CMI – Bonded Post-tensioning System with 04 to 31 Strands
ETA-09/0286	BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands
ETA-09/0287	BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands
98/456/EC	Commission decision 98/456/EC of 3 July 1998 on the procedure for attesting the conformity of construction products pursuant to Article 20 (2) of Council Directive 89/106/EEC as regards post-tensioning kits for the prestressing of structures, Official Journal of the European Communities L 201 of 17 July 1998, p. 112
305/2011	Regulation (EU) № 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 88 of 4 April 2011, p. 5, amended by Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, OJ L 157 of 27.05.2014, p. 76 and Commission Delegated Regulation (EU) № 574/2014 of 21 February 2014, OJ L 159 of 28.05.2014, p. 41
568/2014	Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014 amending Annex V to Regulation (EU) № 305/2011 of the European Parliament and of the Council as regards the assessment and verification of constancy of performance of construction products, OJ L 157 of 27.05.2014, p. 76

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