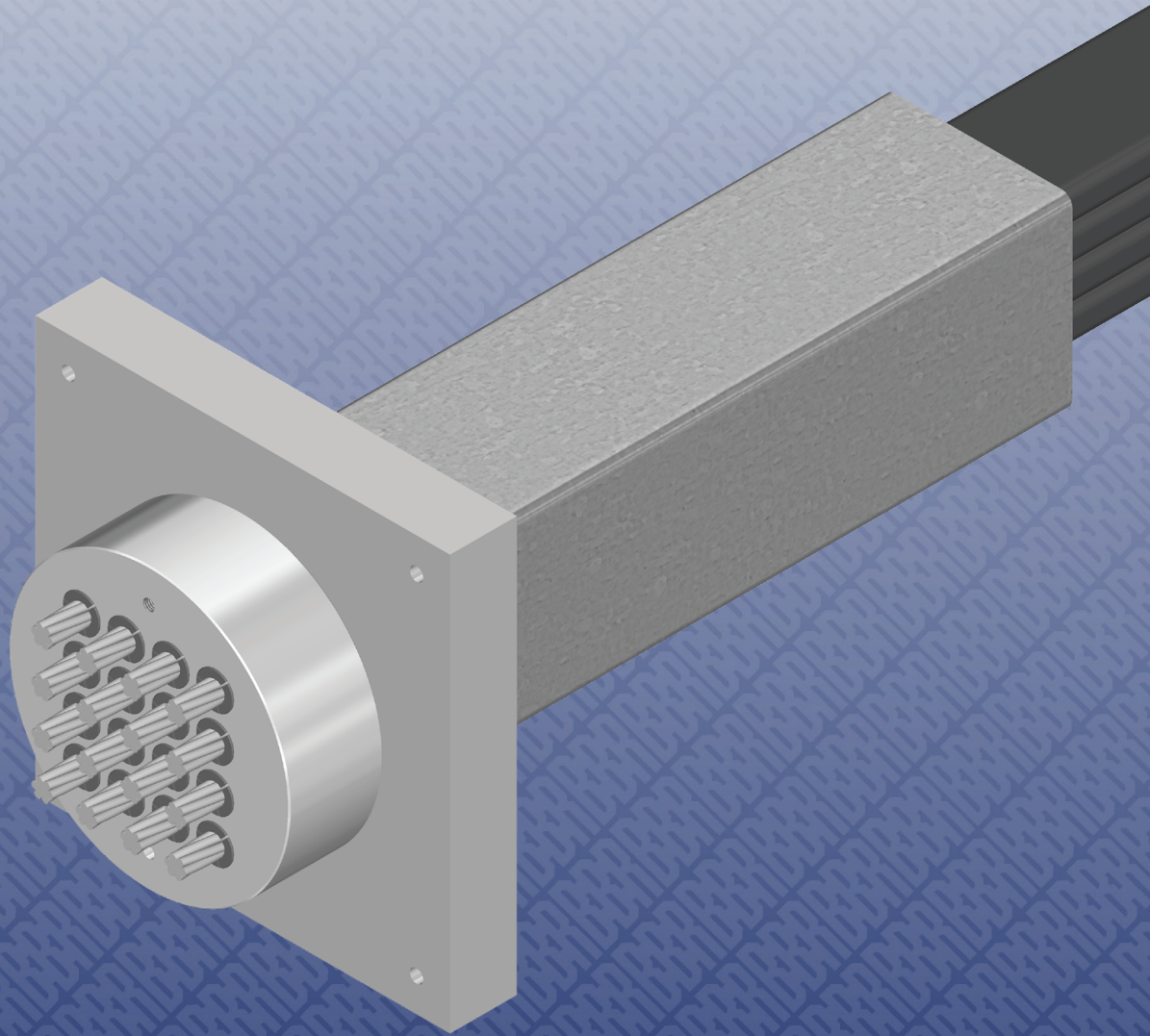


# BBR VT CONA CMB SP

Unbonded Band Post-tensioning System with 01 to 16 Strands



European Technical Assessment  
ETA – 10/ 0065

CE



A Global Network of Experts  
[www.bbrnetwork.com](http://www.bbrnetwork.com)



Responsible BBR PT Specialist Company



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



Assembly and installation of BBR VT CONA CMB SP 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](http://www.bbrnetwork.com).



European Organisation for Technical Approvals  
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**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 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-10/0065**  
of 19.02.2016

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 CMB SP – Unbonded Band Post-tensioning System with 01 to 16 Strands

**Product family to which the construction product belongs**

Post-tensioning kit for prestressing of structures with unbonded strands

**Manufacturer**

BBR VT International Ltd  
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Switzerland

**Manufacturing plant**

BBR VT International Ltd  
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**This European Technical Assessment contains**

47 pages including Annexes 1 to 26, 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) No 305/2011 as European Assessment Document.

**This European Technical Assessment replaces**

European technical approval ETA-10/0065 with validity from 29.09.2010 to 16.05.2015.

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## Remarks

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## Specific parts

### 1 Technical description of the product

#### 1.1 General

The European Technical Assessment<sup>1</sup> – ETA – applies to a kit, the PT system

### **BBR VT CONA CMB SP – Unbonded Band Post-tensioning System with 01 to 16 Strands,**

comprising the following components, see Annex 1.

– Tendon

Unbonded tendon with 01 to 16 tensile elements.

– Tensile element

7-wire prestressing steel strand with nominal diameters and characteristic tensile strengths as given in Table 1, factory-provided with a corrosion protection system consisting of a corrosion protective filling material and a single or double HDPE-sheathing.

**Table 1: Tensile elements**

Nominal diameter	Nominal cross-sectional area	Maximum characteristic tensile strength
mm	mm <sup>2</sup>	MPa
15.3 <sup>1)</sup>	140	1 860
15.7	150	
15.2 <sup>2)</sup>	165	1 820

<sup>1)</sup> Only for bands of non-interconnected individual monostrands

<sup>2)</sup> Compacted strand

NOTE 1 MPa = 1 N/mm<sup>2</sup>

– Anchorage

Anchorage of the strands with ring wedges

End anchorage

Fixed (passive) anchor and stressing (active) anchor as end anchorage for 01, 02, 04, 06, 08, 12, and 16 strands

– Steel plate with recess tube for 01, 02, 04, 06, 08, 12, and 16 strands

<sup>1</sup> ETA-10/0065 was firstly issued in 2010 as European technical approval with validity from 17.05.2010, amended in 2010 with validity from 29.09.2010 and converted in 2015 to European Technical Assessment ETA-10/0065 of 19.02.2016.

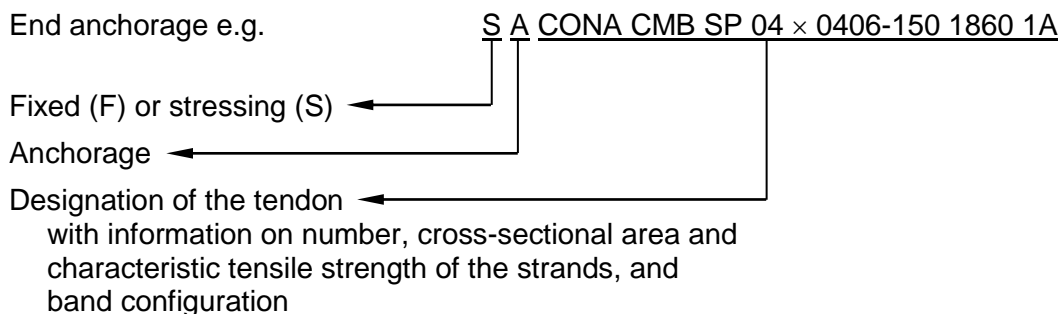
- Helix and additional reinforcement in the region of the anchorage
- Corrosion protection for tensile elements and anchorages

## PT system

### 1.2 Designation and range of the anchorages

#### 1.2.1 Designation

End anchorage e.g.



#### 1.2.2 Anchorage

##### 1.2.2.1 General

The anchor heads of the fixed and stressing anchorages are identical. A differentiation is needed for the construction works. The principal dimensions of the anchorages are given in Annex 6, Annex 7, Annex 8, Annex 13, Annex 17, and Annex 18.

All anchor heads are placed perpendicular to the tendon axis, see Annex 18.

##### 1.2.2.2 Restressable and exchangeable tendons

Characteristic to a restressable tendon is the excess length of the strands. The extent of the excess length depends on the jack used for restressing or releasing. Exchangeable tendons are without or with strand excess length. Strand protrusions – if any – require a permanent corrosion protection and an adapted cap.

Band configurations 1B, 1C, and 2 with single sheathing, see Table 3, are for exchangeable tendons only.

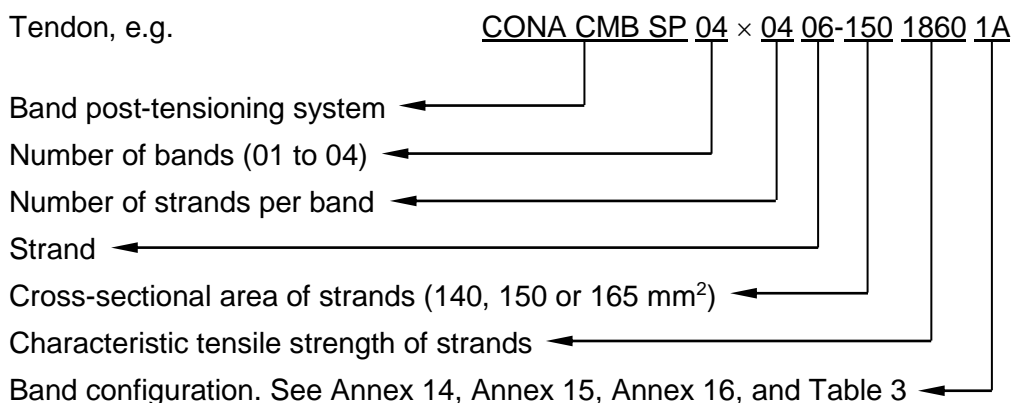
#### 1.2.3 Layout of the anchorage recesses

The dimensions of the anchorage recesses, in case recesses are provided, are adapted to the prestressing jacks used. The ETA holder saves for reference information on the minimum dimensions of the anchorage recess. The formwork for the anchorage recesses should be slightly conical for ease of removal.

### 1.3 Designation and range of the tendons

#### 1.3.1 Designation

Tendon, e.g.





Tendons can be comprised of 01 to 16 tensile elements, 7-wire prestressing steel strands according to Annex 12.

### 1.3.2 Range

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 5.

The tendons consist of 01, 02, 04, 06, 08, 12, or 16 strands.

- CONA CMB SP n06-140 Config.

7-wire prestressing steel strand

Nominal diameter ..... 15.3 mm

Nominal cross-sectional area ..... 140 mm<sup>2</sup>

- CONA CMB SP n06-150 Config.

7-wire prestressing steel strand

Nominal diameter ..... 15.7 mm

Nominal cross-sectional area ..... 150 mm<sup>2</sup>

- CONA CMB SP n06-165 Config.

7-wire prestressing steel strand

Nominal diameter ..... 15.2 mm

Nominal cross-sectional area ..... 165 mm<sup>2</sup>

Where

n ..... Number of prestressing steel strands, n = 01 to 16

Config. .... Configuration of band, 1A, 1B, 1C, or 2. For possible configurations see Table 3

Tendon ranges of CONA CMB SP n06-140, -150, and -165 are given in Annex 4.

### 1.4 Centre spacing and edge distance of anchorages

In general, minimum values for spacing and distance are given in Annex 6, Annex 7, and Annex 8. 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 helix and placing of additional reinforcement is still possible. In this case, centre spacing in the perpendicular direction is increased by the same percentage, see also Annex 9. 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

Standards and regulations on concrete cover in force at the place of use are to be observed.

## 1.5 Concrete strength at time of stressing

Concrete in conformity with EN 206<sup>2</sup> is used. At the time of stressing the mean concrete compressive strength,  $f_{cm,0}$ , is at least 35 MPa, cube strength on a 150 mm cube, or 29 MPa, cylinder strength on a 150 mm cylinder 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  $0.5 \cdot f_{cm,0, \text{cube}}$  or  $0.5 \cdot f_{cm,0, \text{cylinder}}$ . Intermediate values may be interpolated linearly according to Eurocode 2.

Helix, additional reinforcement, centre spacing and edge distance are specified in Annex 6, Annex 7, and Annex 8, see also the Clauses 1.11.6 and 2.2.2.2.

## 1.6 Slip at anchorages

Slip at fixed and stressing anchorages is 6 mm. At the stressing anchorage the slip is 4 mm, provided a prestressing jack with a wedging system and a wedging force of around 25 kN per strand is used.

## 1.7 Deflection

### 1.7.1 Deviators

At the deviation points the bands are guided in deviators made of galvanized or stainless steel, HDPE or a similar synthetic material. The side parts of the deviators correspond to the alignment of the tendon. Changes of the dimensions and the position of the deviator while placing the concrete shall be prevented.

Kinks of the tendon at the deviator ends have to be avoided. Therefore, in addition to the intended deflection, an additional deviation angle,  $\Delta\alpha$ , is provided, see Annex 19. However, the tendon can be installed with a limited deviation at a chamfered concrete edge according to Annex 19.

### 1.7.2 Deviators with sliding surface

Within deviators made of synthetic material, the sliding surface between band and deviator is greased.

Within deviators made of steel a synthetic strip with a minimum thickness of 4 mm is inserted. The sliding surface between synthetic strip and band is greased.

As an alternative solution, a steel sheet and a PTFE strip may be inserted between the deviator and the band. The sliding surface between the steel sheet and the PTFE strip is greased, see also Annex 19.

### 1.7.3 Minimum radii of curvature

The minimum radii of curvature,  $R_{V, \text{min}}$ , in Annex 20 are applicable for predominantly external sliding, see Clause 1.12.2. The radii of curvature are applicable for 4 bands lying one on top of each other and are specified for the corresponding minimal wall thicknesses of the PE sheathing for single and double sheathing.

Table 21 and Table 23 in Annex 20 specifies the radii of curvature for prestressing steel strands with a nominal cross-sectional area of 140 mm<sup>2</sup> or 150 mm<sup>2</sup>, provided that the curvature around the second, perpendicular axis is  $R_H \geq 10 \text{ m}$ .

Table 22 and Table 24 in Annex 20 specifies the radii of curvature for prestressing steel strands with a nominal cross-sectional area of 165 mm<sup>2</sup> and the corresponding deflections around the second, perpendicular axis,  $R_H$ .

<sup>2</sup> Standards and other documents referred to in the European Technical Assessment are listed in Annex 26.

If the number of the bands placed one on top of each other is smaller than 4 or a prestressing steel with a strength,  $f_{pk, act}$ , smaller than  $f_{pk} = 1\,860\text{ MPa}$  or  $f_{pk} = 1\,820\text{ MPa}$  respectively is installed, the minimum radius of curvature,  $R_{v, min}$ , may be multiplied by the factor

$$\frac{k}{4} \cdot \frac{f_{pk, act}}{1\,860} \dots\dots\dots \text{for } R_{v, min} \text{ according to Table 21 and Table 23 in Annex 20}$$

or

$$\frac{k}{4} \cdot \frac{f_{pk, act}}{1\,820} \dots\dots\dots \text{for } R_{v, min} \text{ according to Table 22 and Table 24 in Annex 20}$$

However, the minimum radius of curvature is  $R_{v, min} \geq 2\text{ m}$ .

With a radius of curvature around the second, perpendicular axis of  $10\text{ m} < R_H < 25\text{ m}$ , the values according to Table 22 and Table 24 in Annex 20 can be interpolated linearly.

Where

- $R_{v, min}$  .....m..... Minimum radius of curvature
- $R_H$ .....m..... Radius of curvature perpendicular to  $R_v$
- $k$  ..... – ..... Actual number of bands,  $k = 1$  to  $4$
- $f_{pk}$ ..... MPa ..... Characteristic tensile strength of prestressing steel
- $f_{pk, act}$  ... MPa ..... Actual characteristic tensile strength of prestressing steel

### 1.8 Friction losses

For the calculation of loss of prestressing force due to friction Coulomb's law applies. The calculation of the friction losses is carried out using the equation

$$F_x = F_0 \cdot e^{-\mu \cdot \alpha}$$

Where

- $F_x$ .....kN .....prestressing force at a distance  $x$  along the tendon
- $F_0$ .....kN .....prestressing force at  $x = 0\text{ m}$
- $\mu$  .....  $\text{rad}^{-1}$  .....friction coefficient
- $\alpha$  .....  $\text{rad}$ .....sum of the angular displacements over distance  $x$ , irrespective of direction or sign
- $x$  .....  $\text{m}$ .....distance along the tendon from the point where prestressing force is equal to  $F_0$

NOTE 1  $1\text{ rad} = 1\text{ m/m} = 1$

NOTE 2 Wobble effect can be neglected for external tendons

With deviators designed according to Clause 1.7 the relative movement takes place between the tendon and the deviator. The friction coefficient is  $\mu = 0.06$ , independently of the number of bands.

The friction loss,  $\Delta F_s$ , in anchorages is low and can be neglected.

### 1.9 Masonry structures

Load transfer of prestressing force from the anchorages to masonry structures is via concrete or steel members designed according to the European Technical Assessment, especially according to the Clauses 1.4, 1.5, 1.11.6 and 2.2.2.2 or Eurocode 3 respectively.

The concrete or steel members supporting the anchorages have dimensions that permit a force of  $1.1 \cdot F_{pk}$  to be transferred to 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.

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Deviators are made of plastic, concrete or steel. The load transfer from the deviator to the masonry is verified according to Eurocode 6 as well as to the standards and regulations in force at the place of use.

Equal specifications, accordingly adapted apply, where members in steel are concerned.

## Components

### 1.10 Strands

Only 7-wire prestressing steel strands with characteristics according to Table 2 are used, see also Annex 12.

**Table 2: Prestressing steel strands**

Maximum characteristic tensile strength <sup>1)</sup>	$f_{pk}$	MPa	1 860		1 820
Nominal diameter	d	mm	15.3	15.7	15.2
Nominal cross-sectional area	$A_p$	mm <sup>2</sup>	140	150	165
Mass of prestressing steel	M	kg/m	1.093	1.172	1.289

<sup>1)</sup> Prestressing steel strands with a characteristic tensile strength below 1 860 MPa or 1 820 MPa may also be used.

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

### 1.11 Anchorages

The components of the anchorages conform to the specifications given in Annex 13 and the technical file<sup>3</sup>. Therein the component dimensions, materials and material identification data with tolerances are given.

#### 1.11.1 Anchor heads

The anchor heads are made of steel. Regularly arranged conical holes drilled in parallel serve to accommodate prestressing steel strands and wedges. At the back exit of the strands the conical holes are threaded to hold the transition pipes. An additional hole is provided as air vent when grouting the recess tube. Threaded holes to attach the protection cap can be provided.

An intermediate plate may be optionally attached at the anchor head towards the bearing plate. The intermediate plate facilitates filling the voids around the strands with corrosion protective filling material at the anchorage. However, anchorages without intermediate plate are acceptable as well.

#### 1.11.2 Transition pipes

The plastic transition pipes are threaded into the anchor head or the intermediate plate, see Annex 17 and Annex 21. Their length is determined in accordance with the elongation of the strands and as a minimum 150 mm.

#### 1.11.3 Anchor plates with recess tube

The square anchor plates are made of steel and are provided with square or rectangular openings. Holes for fixing the anchor plate at the formwork are arranged in the corners.

A rectangular or square recess tube made of steel is jointed to the anchor plate with a seal weld around the opening of the anchor plate. The minimum length of the tube is 300 mm. The length of the recess tube may be enlarged to the extent of the concrete member by an inlet tube.

<sup>3</sup> The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

#### 1.11.4 Inlet tubes

The inlet tubes made of plastic or steel are rectangular or square-shaped and may have a curved profile for the longitudinal deflection of the tendon, see Annex 18.

#### 1.11.5 Ring wedges

The ring wedges are in three pieces, which are held together by spring rings. Two kinds of ring wedges are used. Within one anchorage only one kind of ring wedge is used.

#### 1.11.6 Helix and additional reinforcement

Helix and additional reinforcement are made of ribbed reinforcing steel. The end of the helix on the anchorage side is welded to the following turn. The helix is placed in the tendon axis. Dimensions of the helix conform to the values specified in Annex 6, Annex 7 and Annex 8.

If required for a specific project design, the reinforcement given in Annex 6, Annex 7 and Annex 8 may be modified in accordance with the respective regulations in force at the place of use as well as with the relevant approval of the local authorities and of the ETA holder to provided equivalent performance.

#### 1.11.7 Protection caps

Protection caps are made of steel or plastic. If required air vents are provided and the protection caps are attached with screws or threaded rods, see Annex 21.

#### 1.11.8 Materials

Material specifications of the components are given in Annex 22.

### 1.12 Permanent corrosion protection

#### 1.12.1 General

In the course of preparing the European Technical Assessment no characteristic has been assessed for components and materials of the corrosion protection system referred to in the Clauses 1.12.2 to 1.12.4. In execution, all components or materials have to be selected according to the standards and regulations in force at the place of use. Where no such standards or regulations are present, components and materials in accordance with ETAG 013, Annex C.1, should be deemed to be acceptable. However, corrosion protective filling material is grease or an equivalent soft material.

#### 1.12.2 Corrosion protection of the strand

The tendons of the PT system BBR VT CONA CMB SP consist of 1, 2, or 4 prestressing strands arranged side by side, see Annex 2 and Annex 3. The prestressing steel strands are factory-provided with a corrosion protective filling material and an extruded HDPE sheathing.

Tendons with band configuration 1A have double sheathing protection so that protective sheathing 1 is encased by a second HDPE sheathing, protective sheathing 2, with a thickness of  $\geq 2.5$  mm, see Annex 14 and Annex 20. Tendons with band configurations 1B and 1C only have single sheathing protection, the inner protective sheathing 1, see Annex 15, Annex 16, and Annex 20. The thickness of protective sheathing 1 is  $\geq 1.8$  mm for band configurations 1A and 1B and  $\geq 2.5$  mm for band configuration 1C.

Tendons with single sheathing and tendons with double sheathing are each in two configurations: CONA CMB SP Band 1 and CONA CMB SP Band 2. CMB SP Band 1 is shown in Annex 2, Annex 3, Annex 14, Annex 15, and Annex 16. The protective sheathings of the individual strands are interconnected with webs, resulting in a monolithic band. CONA CMB SP Band 2 is similar to Band 1, but comprises individual monostrands without interconnections.

The possible tendon configurations are listed in Table 3.



**Table 3: Tendon configurations**

Tendon configuration	Monolithic band			Individual monostrands	
	1A	1B	1C	2	
Sheathing	Double sheathing	Single sheathing	Single sheathing	Double sheathing	Single sheathing
Strand 140 mm <sup>2</sup>	—	—	—	+	+
Strand 150 mm <sup>2</sup>	++	++	++	+	+
Strand 165 mm <sup>2</sup>	++	++	++	+	+

Key  
 CONA CMB SP Bands 1A, 1B, and 1C are monolithic bands with interconnected protective sheathing 1  
 CONA CMB SP Band 2 are monostrands without interconnections of the individual protective sheathings 1  
 Single sheathing is protective sheathing 1 only  
 Double sheathing is protective sheathing 1 encased by protective sheathing 2  
 Strand 140, 150, and 165 mm<sup>2</sup> are prestressing steel strands with nominal cross-sectional areas of 140, 150, or 165 mm<sup>2</sup>.  
 ++..... Preferred tendon configuration  
 +..... Possible tendon configuration  
 —..... Tendon configuration not available

In order to provide a permanent corrosion protection system for a restressable tendon according to ETAG 013 and at a minimum radius of curvature according to Clause 1.7.3 the difference in displacement between strand and external protective sheathing is limited. The difference in displacement between strand and external protective sheathing after stressing is

$$\leq \text{minimum} \begin{cases} 20 \% \text{ of the elongation of the strand} \\ 200 \text{ mm} \end{cases}$$

For verification, the displacement of the external protective sheathing is measured at the recess tube of the stressing anchor during the stressing procedure, starting at a load level of  $0.4 \cdot F_{pk}$ . The measured displacement of the external sheathing from  $0.4 \cdot F_{pk}$  up to the specified prestressing force has to be

$$\begin{cases} \geq 80 \% \text{ of the strand elongation, measured at the above mentioned point} \\ \text{and} \\ \leq 200 \text{ mm difference between displacement of external sheathing and strand elongation.} \end{cases}$$

For tendons with band configurations 1C and a limited local deviation at a chamfered concrete edge according to Annex 19, the difference in displacement between strand and sheathing is  $\leq 1\,000$  mm.

Band configurations 1B, 1C, and 2 with single sheathing, see Table 3, are for exchangeable tendons only.

### 1.12.3 Corrosion protection of the anchorage

At the end anchorages the surfaces of the dismantled strands that are not protected by the protective sheathings are completely encased by the transition pipe and the anchor head is provided with a protection cap or equivalent.

In the final state the overlapping length of the protective sheathing 1 in the transition pipes is  $\geq 100$  mm and of the protective sheathing 2 in the trumpet  $\geq 50$  mm, see also Annex 21. At the end anchorages with straight trumpet and without deviation, or when the trumpet is not filled with cement grout, the protective sheathing 2 should be retained to prevent slippage.

To facilitate filling the voids around the strands with corrosion protective filling material an intermediate plate may be attached optionally to the anchor head towards the bearing plate. However, anchorages without intermediate plate are acceptable as well.

In addition, the recess tube may be filled with corrosion protective filling material according to Clause 1.12.1 or grout according to EN 447.

#### 1.12.4 Corrosion protection of exposed steel parts

All exposed external surfaces of steel parts, which are not covered by an appropriate cover of concrete or grout, are provided with an adequate corrosion protection, as long as they are not made of stainless steel.

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

### 2.1 Intended uses

The PT system is intended to be used for the prestressing of structures. The specific intended uses are listed in Table 4.

**Table 4: Intended uses**

Line №	Use category
Use categories according to tendon configuration and material of structure	
1	External tendon where the tendon path is situated outside the cross section of the structure, but normally inside the envelope of the cross section of the structure, for normal weight concrete in concrete and composite structures. This includes tendons inside the cross section and only at anchorages and deviators in contact with the structure.
2	For special structures according to Eurocode 2 and Eurocode 4
3	For special structures according to Eurocode 6
Optional use categories	
4	Restressable tendons
5	Exchangeable tendons
6	Tendon for cryogenic applications with anchorages not exposed to cryogenic conditions

NOTE The intended uses in Table 4 include vertical tendons.

### 2.2 General assumptions

#### 2.2.1 Packaging, transport and storage

The manufacturer undertakes the appropriate measures and prepares advice on product packaging, transport, and storage. It is the responsibility of the manufacturer of the product to ensure that this information is given to those who are concerned.

Advice on packaging, transport, and storage includes:

- During transport of the tendons a minimum radius of curvature of 0.80 m is observed.
- Temporary protection of prestressing steel and components in order to prevent corrosion during transportation from the production site to the job site
- Transportation, storage and handling of the prestressing steel and other components in a manner as to avoid damage by mechanical or chemical impact
- Protection of prestressing steel and other components from moisture

- Keeping tensile elements separate from areas where welding operations are performed

## 2.2.2 Design

### 2.2.2.1 General

The manufacturer 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.
- The design of the structure should take into account the protection of the external tendons against damage, e.g. by vehicle impact, vibrations etc.
- Clearance is required for handling of the prestressing jacks and for stressing. The ETA holder saves for reference information on jack dimensions and appropriate clearance behind the anchorage.
- Maximum prestressing and overstressing forces are listed in Annex 5.

### 2.2.2.2 Reinforcement in the anchorage zone

Verification of the transfer of the prestressing forces to the structural concrete is not required if the centre spacing and edge distance of the anchorages as well as grade and dimensions of helix and additional reinforcement, see Annex 6, Annex 7 and Annex 8, are conformed to. In the case of grouped anchorages the additional reinforcement of the individual anchorages can be combined, provided appropriate anchorage is ensured. However, number, cross-sectional area and position with respect to the anchor plate remains unchanged.

The reinforcement of the structure is not employed as additional reinforcement. Reinforcement exceeding the required reinforcement of the structure may be used as additional reinforcement, provided appropriate placing is possible.

The forces outside the area of the additional reinforcement are verified and, if necessary, dealt with by appropriate reinforcement.

If required for a specific project design, the reinforcement given in Annex 6, Annex 7 and Annex 8 may be modified in accordance with the respective regulations in force at the place of use as well as with the relevant approval of the local authority and of the ETA holder to provide equivalent performance.

## 2.2.3 Installation

### 2.2.3.1 General

Assembly and installation of tendons is only carried out by qualified PT specialist companies with the required resources and experience in the use of multi-strand unbonded band 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 CMB SP – Unbonded Band Post-tensioning System with 01 to 16 Strands".

The anchor plate and the anchor head are placed perpendicular to the tendon's axis. At the anchorages the tendon layout provides a straight section over the length indicated in Annex 18.

Installation is carried out according to Annex 10 and Annex 11.

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 6, Annex 7 and Annex 8 full prestressing may be applied. See Clause 1.5 for partial prestressing.

Stressing and, if applicable, wedging is carried out using a suitable prestressing jack. The wedging force corresponds to approximately 25 kN per wedge.

In general prestressing is carried out by stressing the strands of all bands simultaneously. Tendons deflected in one plane may be stressed band by band, starting with the innermost band. Tendons deviated in two planes with radii of curvature  $R_v < 10$  m may be stressed band by band only up to 30 % of the final prestressing force.

At deviators with an indistinct lateral position of the bands, clamps are used while stressing to secure the position and, after prestressing, where required the lateral clearances are fitted with permanent PE shim plates at least on one side of the deviator.

Elongation and prestressing forces are checked continuously during the stressing operation. The results of the prestressing operation are recorded and the measured elongations are compared with the prior calculated values. The displacements of the bands are measured and recorded at particular deviators and finally at the recess tubes after stressing according to Clause 1.12.2.

After releasing the prestressing force from the prestressing jack, the tendon pulls the strands by the amount of the slip into the anchor head.

Information on the prestressing equipment has been submitted to Österreichisches Institut für Bautechnik.

#### 2.2.3.3 Restressing

Restressing of tendons may be performed in combination with release and reuse of wedges, whereby the wedges bite into at least 15 mm of virgin strand surface and no wedge bites remain inside the final length of the tendon between anchorages.

To facilitate restressing during the entire service life, a strand protrusion adequate to the prestressing jack is preserved. The strand protrusions are provided with an appropriate corrosion protection. To allow for free movement of the PE sheathing, the anchorage area is not filled with cement grout, see Clause 1.12.3.

Restressing is only possible if the difference in the displacement between strand and external protective sheathing does not exceed the limits specified in Clause 1.12.2. Difference in the displacement between strand and external protective sheathing is measured and documented during restressing and added to the difference of the previous stressing operations.

#### 2.2.3.4 Exchanging tendons

The specifications for the exchangeable tendons are defined during the design phase.

Exchangeable tendons are without or with strand excess length. For exchangeable tendons with strand excess length, strand protrusion remains at the stressing anchor with a length allowing safe release of the complete prestressing force.

Stressing and fixed anchorages are accessible and adequate space is provided behind the anchorages.

#### 2.2.3.5 Filling of recess tubes and inlet tubes

If required, recess tube or inlet tube are filled completely with either a corrosion protective filling material according to Clause 1.12.1 or grout according to EN 447. For filling, a hose is inserted into the recess tube or inlet tube and the gap at the tendon inlet side is sealed with PU foam.

### 2.2.3.6 Welding

The helix may be welded to the anchor plate to secure its position.

After installation of the strands further welding are not carried out on the tendons. 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<sup>4</sup>.

## 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 23 the combinations of essential characteristics and corresponding intended uses are listed in Table 26.

**Table 5: Essential characteristics and performances of the product**

No	Essential characteristic	Product performance
(1)	(2)	(3)
Product BBR VT CONA CMB SP		
Intended use The PT system is intended to be used for the prestressing of structures, Clause 2.1, Table 4, lines No 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.
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		

<sup>4</sup> 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.



No	Essential characteristic	Product performance
(1)	(2)	(3)
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**

No	Additional essential characteristic	Product performance
(1)	(2)	(3)
Product BBR VT CONA CMB SP		
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.
Specific intended use Clause 2.1, Table 4, lines № 4, restressable tendon		
Basic requirement for construction works 1: Mechanical resistance and stability		
10	Practicability, reliability of installation	See Clause 3.1.4.2.
Specific intended use Clause 2.1, Table 4, lines № 5, exchangeable tendon		
Basic requirement for construction works 1: Mechanical resistance and stability		
11	Practicability, reliability of installation	See Clause 3.1.4.3.

№	Additional essential characteristic	Product performance
(1)	(2)	(3)
Specific intended use Clause 2.1, Table 4, lines № 6, tendon for cryogenic applications with anchorages not exposed to cryogenic conditions		
Basic requirement for construction works 1: Mechanical resistance and stability		
12	Resistance to static load	See Clause 3.1.4.4.

### 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 12 are listed in Annex 4.

#### 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 12 are listed in Annex 4.

#### 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 12 are listed in Annex 4.

#### 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 1.8.

#### 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 1.7.3.

#### 3.1.1.6 Practicability, reliability of the 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 substances 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 12 are listed in Annex 4.

#### 3.1.4.2 Practicability, reliability of the installation

For restressable tendons the PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.6-II(a).

#### 3.1.4.3 Practicability, reliability of the installation

For exchangeable tendons the PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.6-II(b).

#### 3.1.4.4 Resistance to static load

For tendons for cryogenic applications with anchorages not exposed to cryogenic conditions the PT system as described in the ETA meets the acceptance criteria of ETAG 013, Clause 6.1.6-II(c). The characteristic values of maximum force,  $F_{pk}$ , of the tendon for prestressing steel strands according to Annex 12 are listed in Annex 4.

## 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 external systems.

## 3.3 Identification

The European Technical Assessment for the PT system is issued on the basis of agreed data<sup>5</sup> 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;

<sup>5</sup> 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.

- (ii) further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan<sup>6</sup>.
- (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).

### **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 establishes and continuously maintains a factory production control. All procedures and specification adopted by the manufacturer are documented in a systematic manner. Purpose of the factory production control is to ensure the constancy of performances of the PT system with regard to the essential characteristics.

The manufacturer only uses raw materials supplied with the relevant inspection documents as laid down in the control plan. The incoming raw materials are subjected 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.

At least once a year the manufacturer shall audit the manufacturers of the components given in Annex 25.

The basic elements of the prescribed test plan are given in Annex 24, conform to ETAG 013, Annex E.1 and are specified in the quality management plan of the “BBR VT CONA CMB SP – Unbonded Band Post-tensioning System with 01 to 16 Strands”.

<sup>6</sup> The prescribed test plan has been deposited with Österreichisches Institut für Bautechnik and is handed over only to the notified factory production control 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.

### 5.1.2 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 draws 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 and Table 6. In Annex 23 the combinations of essential characteristics and corresponding intended uses are listed in Table 26.

## 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

During surveillance inspections the notified product certification body takes samples of components of the PT system for independent testing. Sampling and testing is specified in the control plan, see Annex 25.

Issued in Vienna on 19 February 2016  
by Österreichisches Institut für Bautechnik

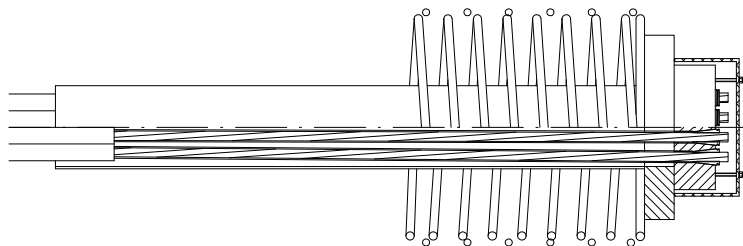
The original document is signed by

Rainer Mikulits  
Managing Director

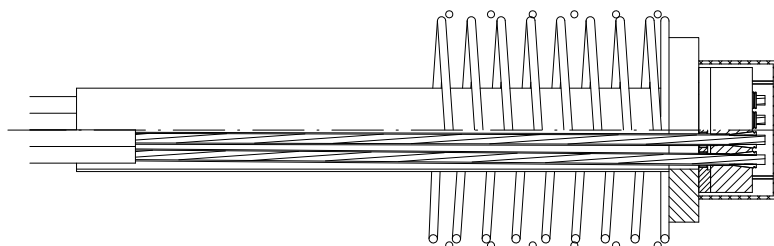


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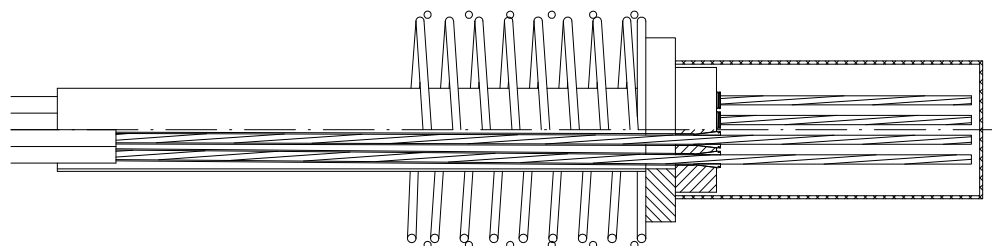
Stressing or fixed anchorage <sup>1)</sup>



Stressing or fixed anchorage with optional intermediate plate <sup>1)</sup>



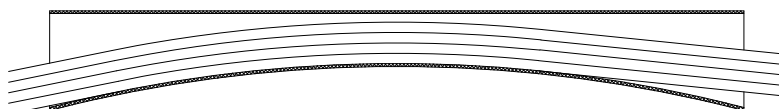
Restressable and exchangeable anchorage with strand excess length <sup>1)</sup>



Stressing or fixed anchorage with deviation <sup>1)</sup>



Deviation



<sup>1)</sup> Exchangeable anchorages are without or with strand excess length.

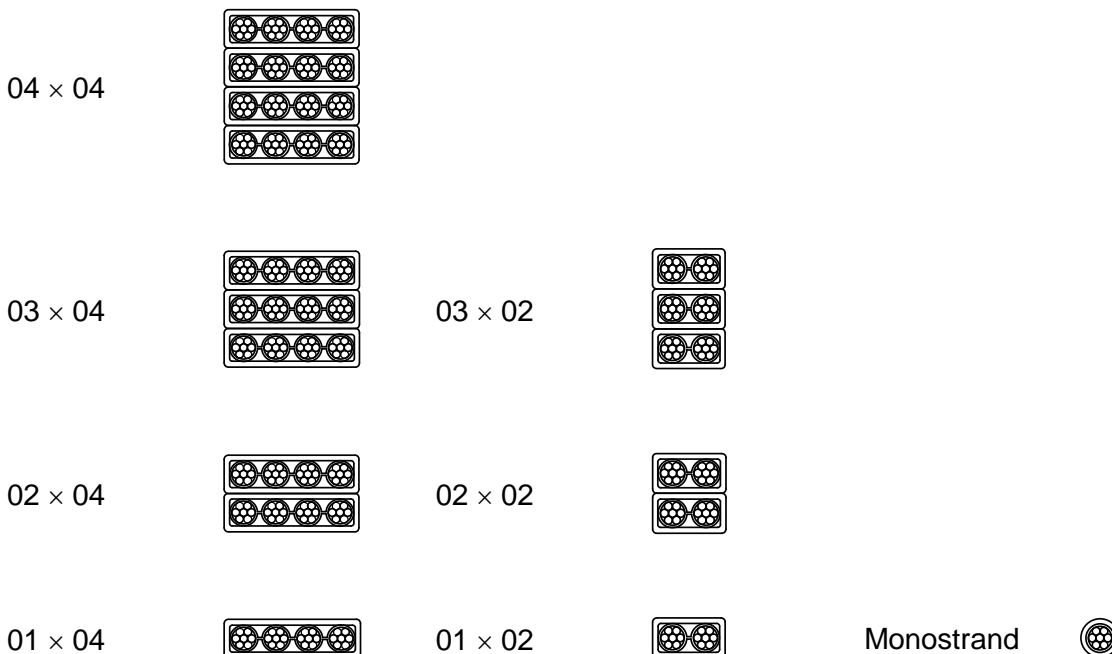


**Unbonded Band Post-tensioning System**  
Overview on anchorages

**Annex 1**  
of European Technical Assessment  
ETA-10/0065 of 19.02.2016

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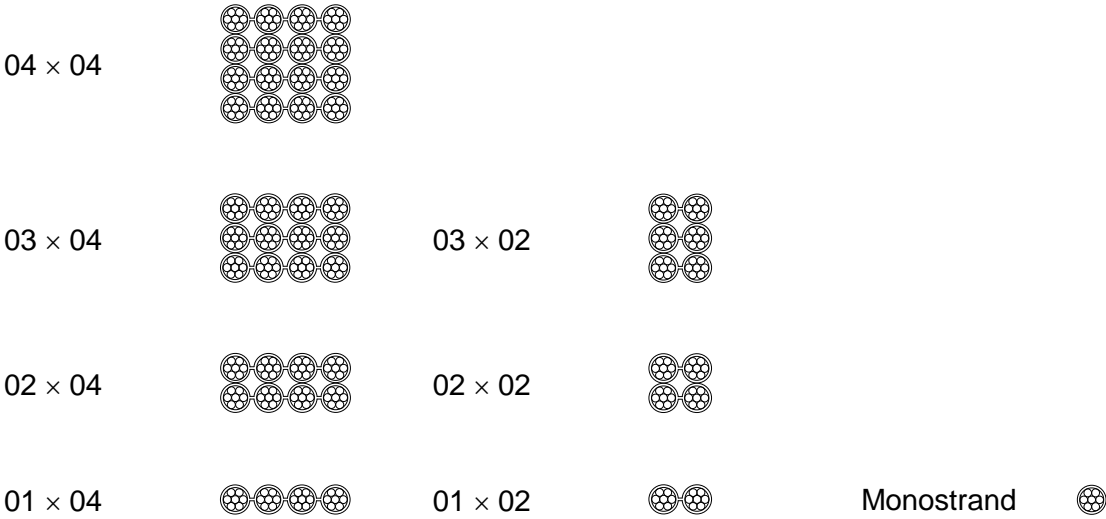
Configurations of tendons with band 1A<sup>1)</sup>, double sheathing



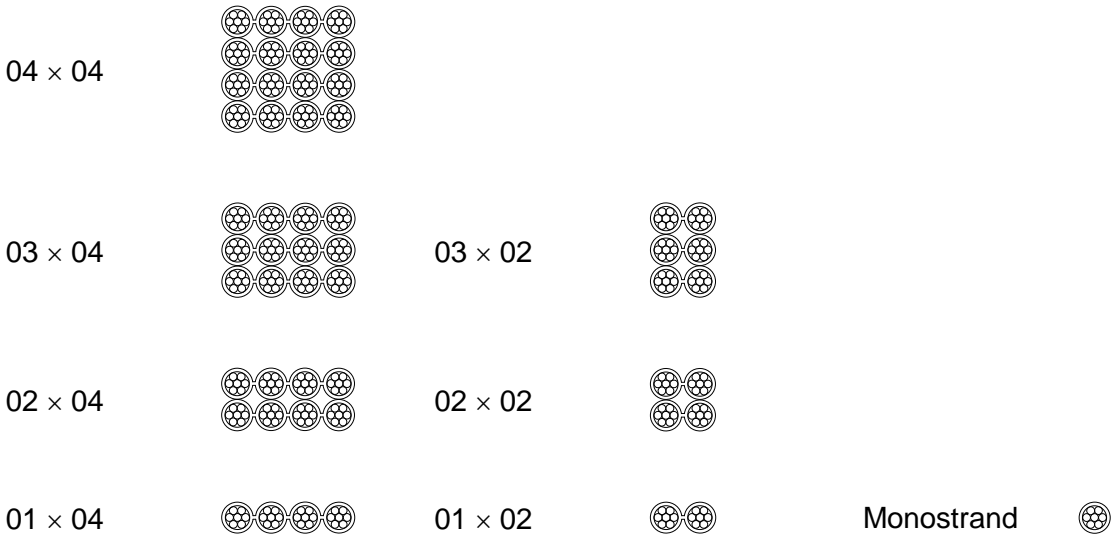
<sup>1)</sup> ..... Tendons of band configuration 2 comprising individual monostrands without interconnections follow a similar pattern.

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Configurations of tendons with band 1B<sup>1), 2)</sup>, single sheathing



Configurations of tendons with band 1C<sup>1), 2)</sup>, single sheathing



1) ..... Tendons of band configuration 2 comprising individual monostrands without interconnections follow a similar pattern.  
 2) ..... In free length the strands of outer bands may after stressing lie in the valley-like grooves of the inner bands.



**Unbonded Band Post-tensioning System**  
 Tendon configurations

**Annex 3**  
 of European Technical Assessment  
 ETA-10/0065 of 19.02.2016



**Table 10: Maximum prestressing and overstressing forces**

Designation		CONA CMB SP					
		n06-140	n06-150	n06-165	n06-140	n06-150	n06-165
Characteristic tensile strength $f_{pk}$	MPa	1 860	1 860	1 820	1 860	1 860	1 820
—		Maximum prestressing force <sup>1)</sup> $0.90 \cdot F_{p0.1}$			Maximum overstressing force <sup>1), 2)</sup> $0.95 \cdot F_{p0.1}$		
—		kN	kN	kN	kN	kN	kN
n Number of strands	01	206	221	238	218	234	251
	02	412	443	475	435	467	502
	04	824	886	950	870	935	1 003
	06	1 237	1 328	1 426	1 305	1 402	1 505
	08	1 649	1 771	1 901	1 740	1 870	2 006
	12	2 473	2 657	2 851	2 611	2 804	3 010
	16	3 298	3 542	3 802	3 481	3 739	4 013

- 1) The given values are maximum values according to Eurocode 2. The actual values can be found in the standards and regulations in force at the place of use. Conformity with the stabilisation and crack width criteria in load transfer test has been verified to a load level of  $0.80 \cdot F_{pk}$ .
- 2) Overstressing is permitted if the force in the prestressing jack can be measured to an accuracy of  $\pm 5 \%$  of the final value of the prestressing force.

Where

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

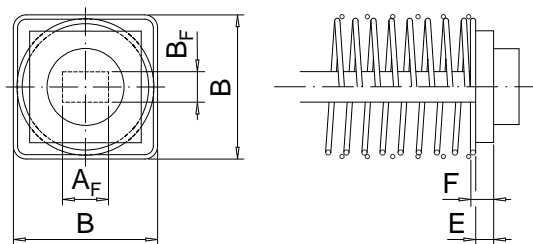


**Unbonded Band Post-tensioning System**  
 Maximum prestressing and overstressing forces

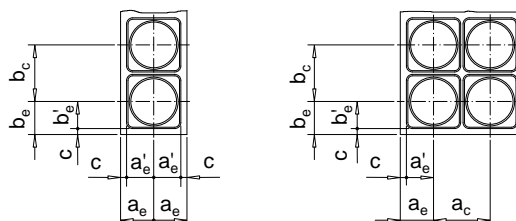
**Annex 5**  
 of European Technical Assessment  
 ETA-10/0065 of 19.02.2016



Stressing and fixed anchorage



Centre spacing and edge distances



$$a_e = a'_e + c$$

$$b_e = b'_e + c$$

c ... Concrete cover

Table 11: Technical data of anchorages

BBR VT CONA CMB SP		01 × 01			01 × 02			02 × 02		
Strand arrangement		⊙			⊙⊙			⊙⊙⊙		
<b>Strand</b>	mm <sup>2</sup>	<b>140</b>	<b>150</b>	<b>165</b>	<b>140</b>	<b>150</b>	<b>165</b>	<b>140</b>	<b>150</b>	<b>165</b>
Cross-sectional area	$A_p$ mm <sup>2</sup>	140	150	165	280	300	330	560	600	660
<b>Characteristic tensile strength<sup>1)</sup></b>	$f_{pk}$ MPa	<b>1 860</b>			<b>1 820</b>			<b>1 860</b>		
Characteristic maximum force <sup>1)</sup>	$F_{pk}$ kN	260	279	300	520	558	600	1 040	1 116	1 200
Maximum prestressing force	$0.90 \cdot F_{p0.1}$ kN	206	221	238	412	443	475	824	886	950
Maximum overstressing force	$0.95 \cdot F_{p0.1}$ kN	218	234	251	435	467	502	870	935	1 003
<b>Helix and additional reinforcement</b>										
<b>Min. concrete strength, cube</b>	$f_{cm,0}$ MPa	35			35			35		
<b>Min. concrete strength, cylinder</b>	$f_{cm,0}$ MPa	29			29			29		
<b>Helix</b>	—	<b>Ribbed reinforcing steel, <math>R_e \geq 500</math> MPa</b>								
Outer diameter	mm	/						180		
Bar diameter	mm							10		
Length, approximately	mm							180		
Pitch	mm							40		
Number of pitches	—							5		
Distance	$E$ mm							25		
<b>Additional reinforcement</b>	—	<b>Ribbed reinforcing steel, <math>R_e \geq 500</math> MPa</b>								
Number of stirrups	—	3			5			4		
Bar diameter	mm	12			12			10		
Spacing	mm	40			40			55		
Distance from anchor plate	$F$ mm	30			35			45		
Minimum outer dimensions	$B$ mm	90			140			200		
<b>Centre spacing and edge distance</b>										
Minimum centre spacing	$a_c = b_c$ mm	115			160			220		
Minimum edge distance	$a'_e = b'_e$ mm	50			70			100		

c ... Concrete cover

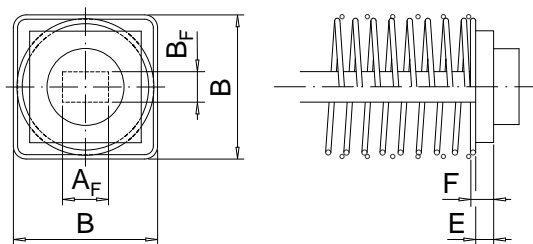
<sup>1)</sup> For strands with tensile strength of 1 770 MPa see Table 7 and Table 8



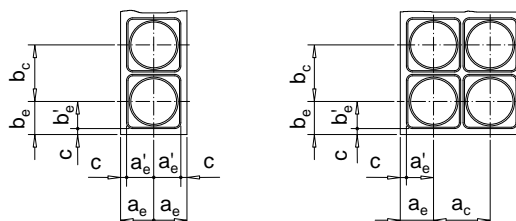
**Unbonded Band Post-tensioning System**  
 Anchorage zone – Dimensions  
 Helix and additional reinforcement, and spacing

**Annex 6**  
 of European Technical Assessment  
 ETA-10/0065 of 19.02.2016

Stressing and fixed anchorage



Centre spacing and edge distances



$a_e = a'_e + c$   
 $b_e = b'_e + c$   
c ... Concrete cover

Table 12: Technical data of anchorages

BBR VT CONA CMB SP			03 × 02			01 × 04			02 × 04		
Strand arrangement											
<b>Strand</b>	mm <sup>2</sup>		<b>140</b>	<b>150</b>	<b>165</b>	<b>140</b>	<b>150</b>	<b>165</b>	<b>140</b>	<b>150</b>	<b>165</b>
Cross-sectional area	$A_p$	mm <sup>2</sup>	840	900	990	560	600	660	1 120	1 200	1 320
<b>Characteristic tensile strength<sup>1)</sup></b>	$f_{pk}$	<b>MPa</b>	<b>1 860</b>		<b>1 820</b>	<b>1 860</b>		<b>1 820</b>	<b>1 860</b>		<b>1 820</b>
Characteristic maximum force <sup>1)</sup>	$F_{pk}$	kN	1 560	1 674	1 800	1 040	1 116	1 200	2 080	2 232	2 400
Maximum prestressing force	$0.90 \cdot F_{p0.1}$	kN	1 237	1 328	1 426	824	886	950	1 649	1 771	1 901
Maximum overstressing force	$0.95 \cdot F_{p0.1}$	kN	1 305	1 402	1 505	870	935	1 003	1 740	1 870	2 006
<b>Helix and additional reinforcement</b>											
<b>Min. concrete strength, cube</b>	$f_{cm,0}$	MPa	35			35			35		
<b>Min. concrete strength, cylinder</b>	$f_{cm,0}$	MPa	29			29			29		
<b>Helix</b>	—		<b>Ribbed reinforcing steel, <math>R_e \geq 500</math> MPa</b>								
Outer diameter	mm		210			210			260		
Bar diameter <sup>2)</sup>	mm		12			12			14		
Length, approximately	mm		224			274			278		
Pitch	mm		50			50			50		
Number of pitches	—		5			6			6		
Distance	E	mm	30			30			30		
<b>Additional reinforcement</b>	—		<b>Ribbed reinforcing steel, <math>R_e \geq 500</math> MPa</b>								
Number of stirrups	—		4			4			4		
Bar diameter	mm		12			12			12		
Spacing	mm		70			70			70		
Distance from anchor plate	F	mm	50			50			50		
Minimum outer dimensions	B	mm	240			230			275		
<b>Centre spacing and edge distance</b>											
Minimum centre spacing	$a_c = b_c$	mm	260			250			290		
Minimum edge distance	$a'_e = b'_e$	mm	120			115			135		

c ... Concrete cover

<sup>1)</sup> For strands with tensile strength of 1 770 MPa see Table 7 and Table 8.

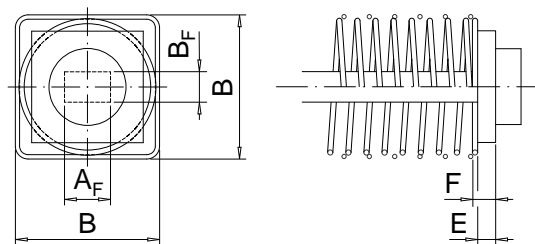
<sup>2)</sup> Bar diameter 14 mm can be replaced by 16 mm.



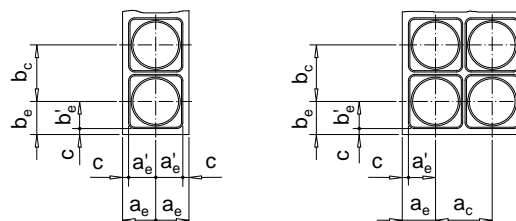
**Unbonded Band Post-tensioning System**  
Anchorage zone – Dimensions  
Helix and additional reinforcement, and spacing

**Annex 7**  
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Stressing and fixed anchorage



Centre spacing and edge distances



$a_e = a'_e + c$   
 $b_e = b'_e + c$   
c ... Concrete cover

Table 13: Technical data of anchorages

BBR VT CONA CMB SP		03 × 04 – (a) <sup>1)</sup>			03 × 04 – (b) <sup>1)</sup>			04 × 04			
Strand arrangement											
<b>Strand</b>	mm <sup>2</sup>	<b>140</b>	<b>150</b>	<b>165</b>	<b>140</b>	<b>150</b>	<b>165</b>	<b>140</b>	<b>150</b>	<b>165</b>	
Cross-sectional area $A_p$	mm <sup>2</sup>	1 680	1 800	1 980	1 680	1 800	1 980	2 240	2 400	2 640	
<b>Characteristic tensile strength</b> <sup>2)</sup>	$f_{pk}$	<b>1 860</b>		<b>1 820</b>	<b>1 860</b>		<b>1 820</b>	<b>1 860</b>			
Characteristic maximum force <sup>2)</sup>	$F_{pk}$	kN	3 120	3 348	3 600	3 120	3 348	3 600	4 160	4 464	4 800
Maximum prestressing force $0.90 \cdot F_{p0.1}$	kN	2 473	2 657	2 851	2 473	2 657	2 851	3 298	3 542	3 802	
Maximum overstressing force $0.95 \cdot F_{p0.1}$	kN	2 611	2 804	3 010	2 611	2 804	3 010	3 481	3 739	4 013	
<b>Helix and additional reinforcement</b>											
<b>Min. concrete strength, cube</b>	$f_{cm,0}$	MPa	35			35			35		
<b>Min. concrete strength, cylinder</b>	$f_{cm,0}$	MPa	29			29			29		
<b>Helix</b>	—	<b>Ribbed reinforcing steel, <math>R_e \geq 500</math> MPa</b>									
Outer diameter	mm	320			320			380			
Bar diameter <sup>3)</sup>	mm	14			14			14			
Length, approximately	mm	303			303			328			
Pitch	mm	50			50			50			
Number of pitches	—	6.5			6.5			7			
Distance	E	mm	40			40			50		
<b>Additional reinforcement</b>	—	<b>Ribbed reinforcing steel, <math>R_e \geq 500</math> MPa</b>									
Number of stirrups	—	6			6			6			
Bar diameter	mm	12			12			12			
Spacing	mm	65			65			70			
Distance from anchor plate	F	mm	60			60			70		
Minimum outer dimensions	B	mm	340			340			400		
<b>Centre spacing and edge distance</b>											
Minimum centre spacing	$a_c = b_c$	mm	370			370			420		
Minimum edge distance	$a'_e = b'_e$	mm	180			180			200		

c ...Concrete cover

<sup>1)</sup> For dimensions of anchorages 03 × 04 – (a) and 03 × 04 – (b) see Annex 13

<sup>2)</sup> For strands with tensile strength of 1 770 MPa see Table 7 and Table 8.

<sup>3)</sup> Bar diameter 14 mm can be replaced by 16 mm.

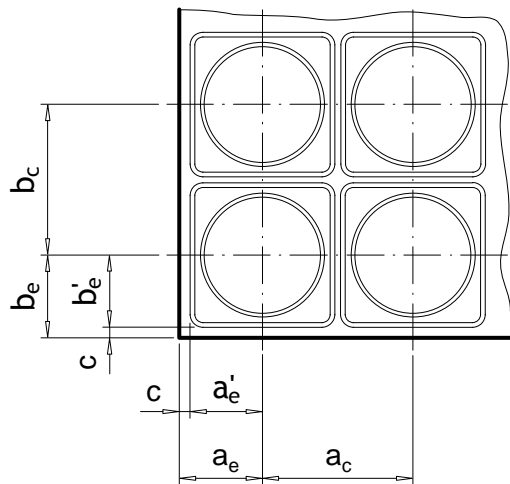


CONA CMB SP

**Unbonded Band Post-tensioning System**  
Anchorage zone – Dimensions  
Helix and additional reinforcement, and spacing

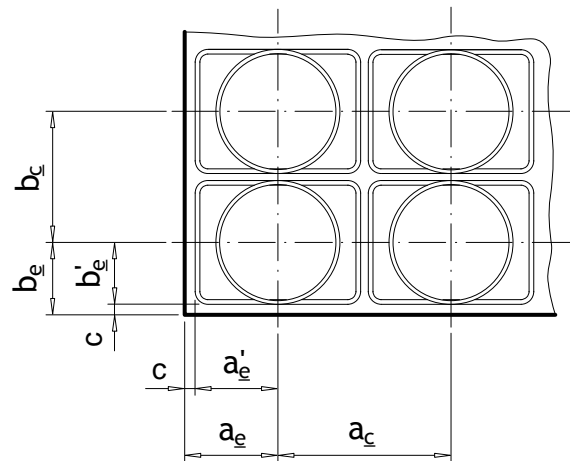
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Centre spacing and edge distances



$$a_c = b_c$$

$$a_e = b_e$$



$$a_c > b_c$$

$$a_e > b_e$$

Modification of centre spacing and edge distance shall be in accordance with Clause 1.4.

$$b_c \geq \begin{cases} 0.85 \cdot b_c \\ \text{and} \\ \text{Helix, outside diameter } ^1) \end{cases}$$

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

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

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

<sup>1)</sup> The outer dimensions of the additional reinforcement shall be adjusted accordingly. Further modifications of reinforcement have to be in accordance with Clause 2.2.2.2.



CONA CMB SP

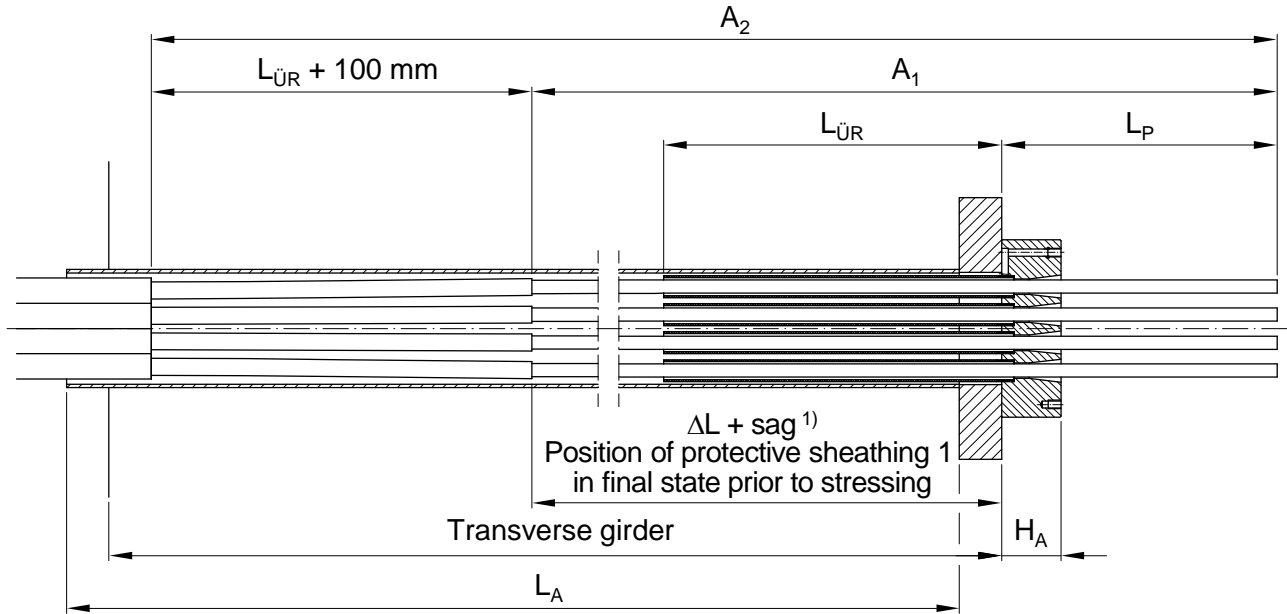
**Unbonded Band Post-tensioning System**  
 Anchorage zone – Dimensions  
 Modification of centre spacing and edge distance

**Annex 9**  
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**Situation at the stressing anchorage prior to stressing**



**Installation procedure at the stressing anchorage side**

Removal of the sheathing 2 along the length of

$$A_2 = L_P + \Delta L + \text{sag}^1) + L_{\text{ÜR}} + 100 \text{ mm}$$

$L_P$  = Strand protrusion for prestressing jack operation

$L_A$  = Recess tube length ( $\geq L_{\text{ÜR}} + 100 \text{ mm}$ ,  $L_A \geq L_{\text{min}}$ )

$L_{\text{min}}$  = Minimum straight length, see Annex 18

$\Delta L$  = Calculated elongation

$L_{\text{ÜR}}$  = Length of transition pipes,  $\geq 150 \text{ mm}$

Removal of sheathing 1 along the length of

$$A_1 = L_P + \Delta L + \text{sag}^1)$$

Separation of webs from the tendon end to the sheathing 2

**Installation procedure at the fixed anchorage side**

$$A_2 = A_1 + L_{\text{ÜR}}$$

$$A_1 = H_A + \text{approx. } 30 \text{ mm}$$

$L_{\text{ÜR}}$  = Length of transition pipes ( $\geq 150 \text{ mm}$ )

Alignment of tensioning bands

In case of multi-layered bands, ensure that the bands are placed as exactly as possible one above the other. Their position in the deviators and recess tubes is controlled again after applying a preliminary load of approximately 10 % of the tensioning force and, if necessary, secured with clamps. At each deviator each tendon has to be provided with a mark at a defined distance from the deviator by means of which the movements of the sheathing 2 of the individual bands to the deviator can be precisely determined during stressing.

<sup>1)</sup> Sag does not need to be taken into account if the tendon, prior to cutting the sheathing to length, is supported between the deviators and anchorages in such a way that it nearly achieves the geometry of the final alignment (no festoon-like sag).



**Unbonded Band Post-tensioning System**  
 Description of installation  
 Removal of the sheathing in the anchorage zone

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**Table 14: Strands according to prEN 10138-3<sup>1)</sup>**

Designation of prestressing steel			Y1770S7	Y1860S7	Y1770S7	Y1860S7	Y1820S7G
Tensile strength	$f_{pk}$	MPa	1 770	1 860	1 770	1 860	1 820
Nominal diameter	d	mm	15.3	15.3	15.7	15.7	15.2
Nominal cross-sectional area	$A_p$	mm <sup>2</sup>	140	140	150	150	165
Mass per metre	M	kg/m	1.093		1.172		1.289
Permitted deviation from nominal mass		%	± 2				
Characteristic value of maximum force	$F_{pk}$	kN	248	260	266	279	300
Maximum value of maximum force	$F_{m, max}$	kN	292	307	314	329	354
Characteristic force at 0.1% proof force	$F_{p0.1}$	kN	218	229	234	246	264
Minimum elongation at maximum force, $l_0 \geq 500$ mm	$A_{gt}$	%	3.5				
Modulus of elasticity	$E_p$	MPa	195 000 <sup>2)</sup>				

1) Suitable strands according to standards and regulations in force at the place of use may also be used.

2) Standard value

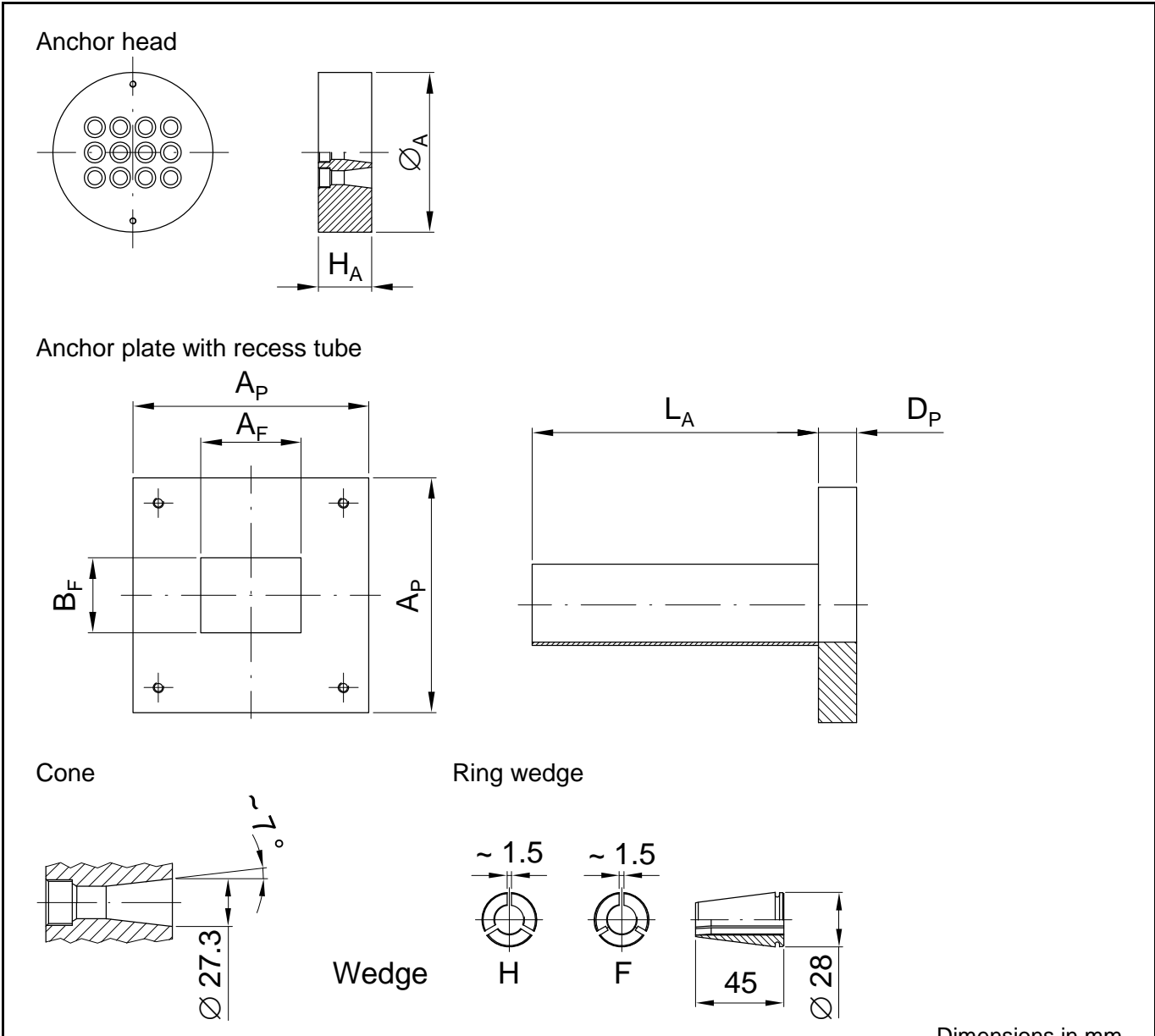


CONA CMB SP

**Unbonded Band Post-tensioning System**  
 Strand specification

**Annex 12**  
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**Table 15: Anchorage components – Dimensions**

Number of strands		01 × 01	01 × 02	02 × 02	03 × 02	01 × 04	02 × 04	03 × 04 – (a)	03 × 04 – (b), 04 × 04	
<b>Anchor head</b>										
Diameter	ØA	mm	60	100	110	160	180	180	200	210
Height	HA	mm	60	60	60	60	60	60	65	70
<b>Anchor plate</b>										
Side length	AP × AP	mm	80	120	160	200	230	230	270	310
Thickness	DP	mm	10	15	20	25	30	30	40	50
Side length	AF × BF	mm	34 × 34	64 × 34	64 × 64	64 × 104	134 × 34	134 × 64	134 × 104	134 × 134
Min. length	LA	mm	300	300	300	300	300	300	300	300

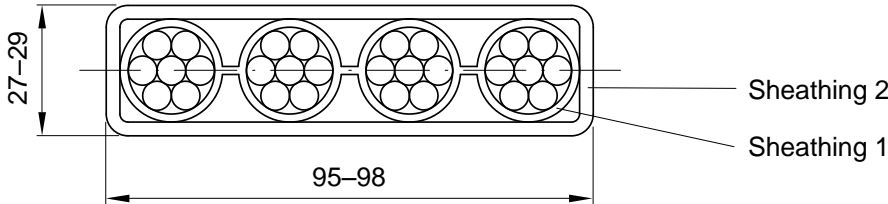


**Unbonded Band Post-tensioning System**  
 Anchorage components

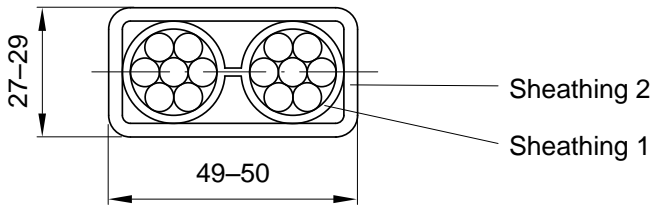
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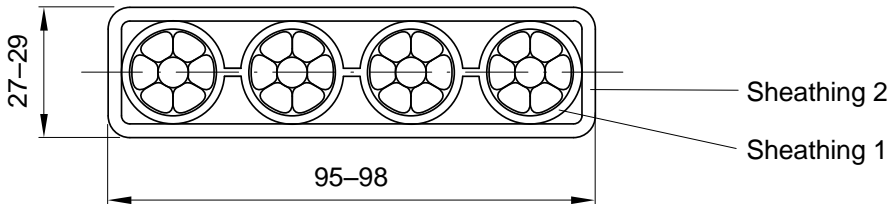
CONA CMB SP 0406 with strands with 150 mm<sup>2</sup> cross-sectional area



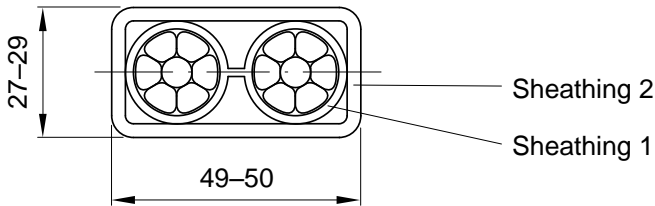
CONA CMB SP 0206 with strands with 150 mm<sup>2</sup> cross-sectional area



CONA CMB SP 0406 with strands with 165 mm<sup>2</sup> cross-sectional area



CONA CMB SP 0206 with strands with 165 mm<sup>2</sup> cross-sectional area



Dimensions in mm

**Table 16: Mass of band 1A<sup>1)</sup>**

Strand, nominal cross-sectional area	A <sub>P</sub>	mm <sup>2</sup>	150	165
CONA CMB SP 0406	kg/m		6.1	6.5
CONA CMB SP 0206	kg/m		3.1	3.3
CONA CMB SP 0106	kg/m		1.5	1.6

<sup>1)</sup> The values are based on the characteristic values for the wall thickness of the HDPE sheathings.

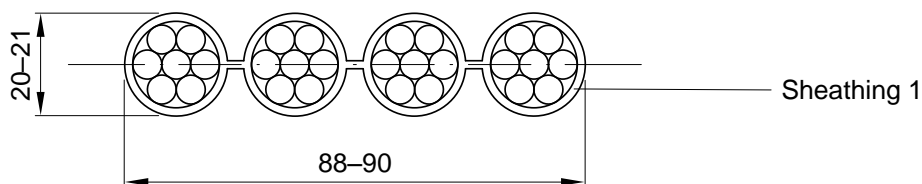


**Unbonded Band Post-tensioning System**  
 Corrosion protection of the tendon with band 1A

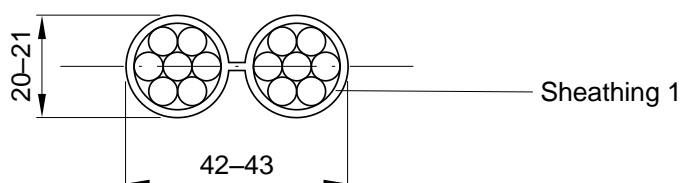
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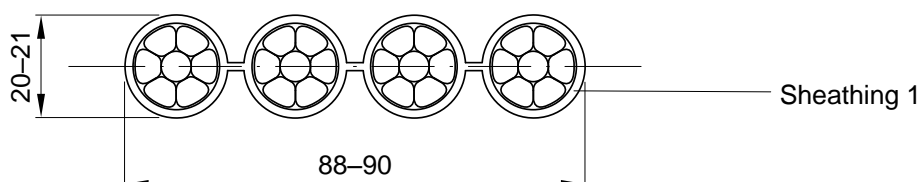
CONA CMB SP 0406 with strands with 150 mm<sup>2</sup> cross-sectional area



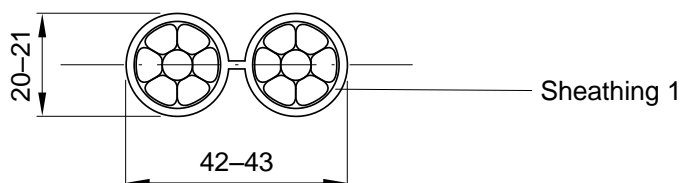
CONA CMB SP 0206 with strands 150 mm<sup>2</sup> cross-sectional area



CONA CMB SP 0406 with strands with 165 mm<sup>2</sup> cross-sectional area



CONA CMB SP 0206 with strands with 165 mm<sup>2</sup> cross-sectional area



Dimensions in mm

**Table 17: Mass of band 1B<sup>1)</sup>**

Strand, nominal cross-sectional area	A <sub>P</sub>	mm <sup>2</sup>	150	165
CONA CMB SP 0406		kg/m	5.3	5.7
CONA CMB SP 0206		kg/m	2.6	2.9
CONA CMB SP 0106		kg/m	1.3	1.4

<sup>1)</sup> The values are based on the characteristic values for the wall thickness of the HDPE sheathings.



CONA CMB SP

**Unbonded Band Post-tensioning System**  
 Corrosion protection of the tendon with band 1B

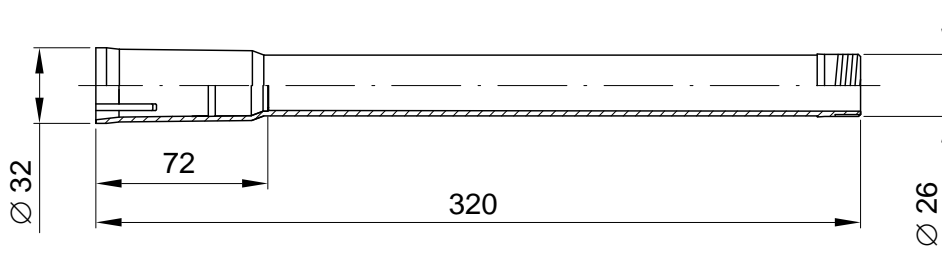
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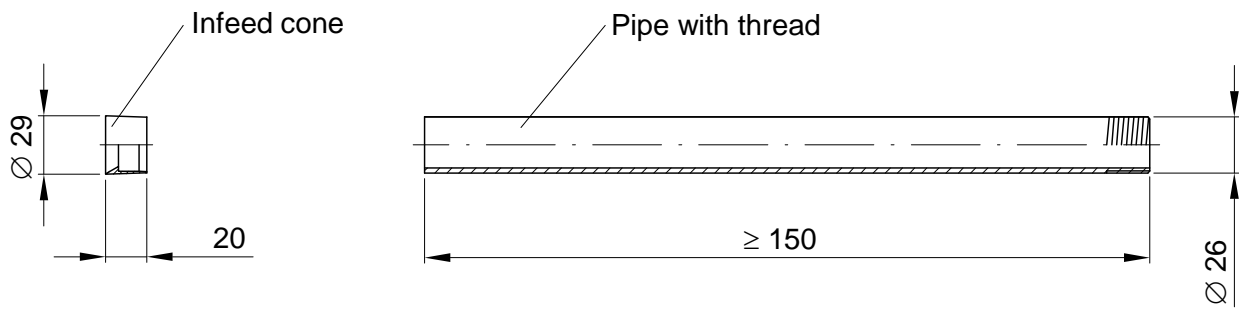


Transition pipe for bands 1A and 1B <sup>1)</sup>

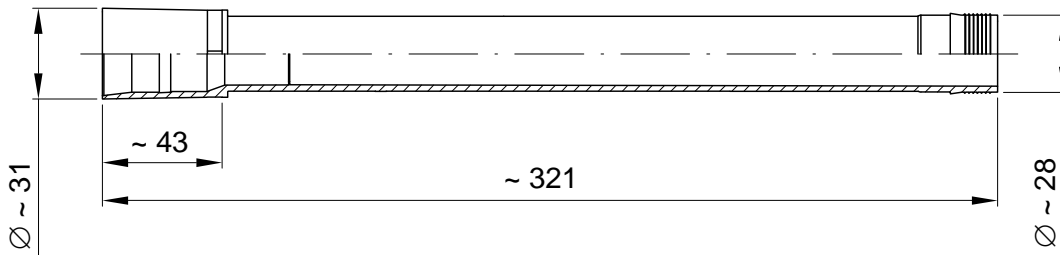
Transition pipe I



Transition pipe II



Transition pipe for band 1C <sup>1)</sup>



<sup>1)</sup> The transition pipe is suitable for bands of configuration 2 as well, where the dimensions of the HDPE sheathing are equivalent to the dimensions of the monolithic bands.

Dimensions in mm

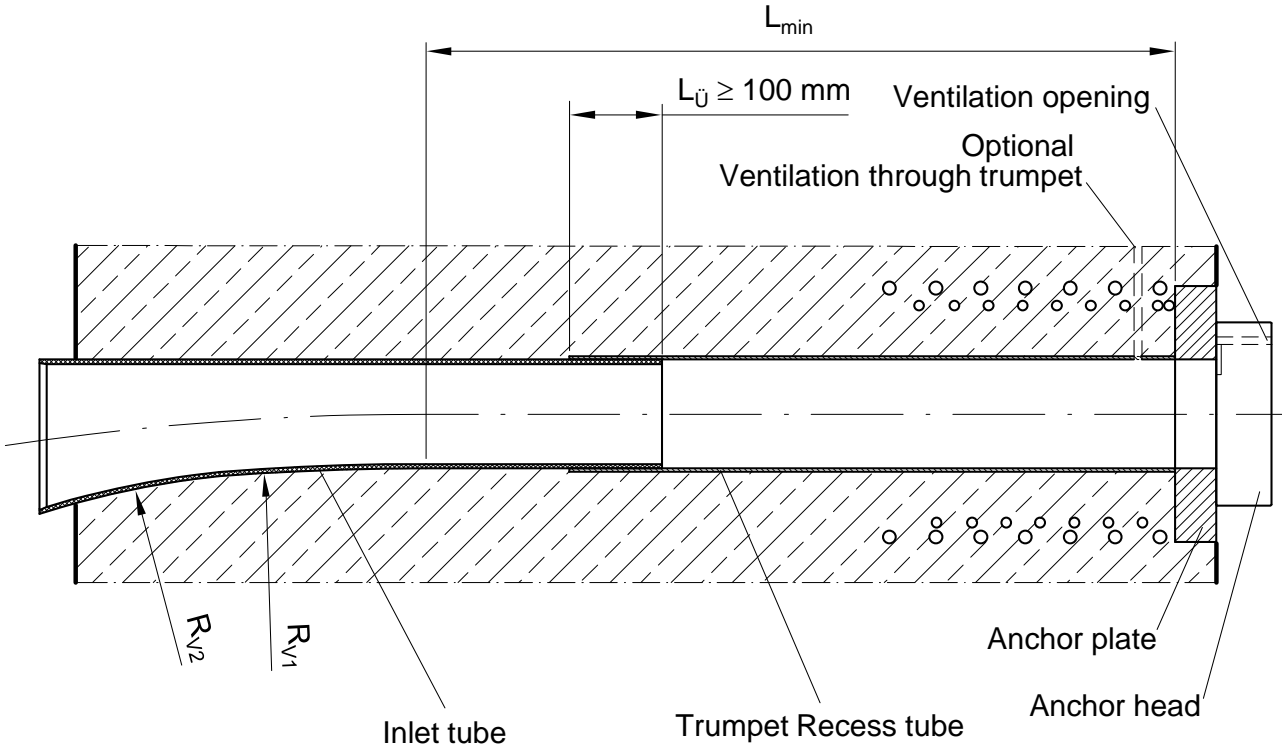


**Unbonded Band Post-tensioning System**  
 Transition pipes

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Straight length at stressing and fixed anchorage



$$R_{V1} \geq R_{V2} \geq R_{Vmin}$$

Additional deviation angle, e.g. 3 °

Table 19: Dimensions of deviation saddle

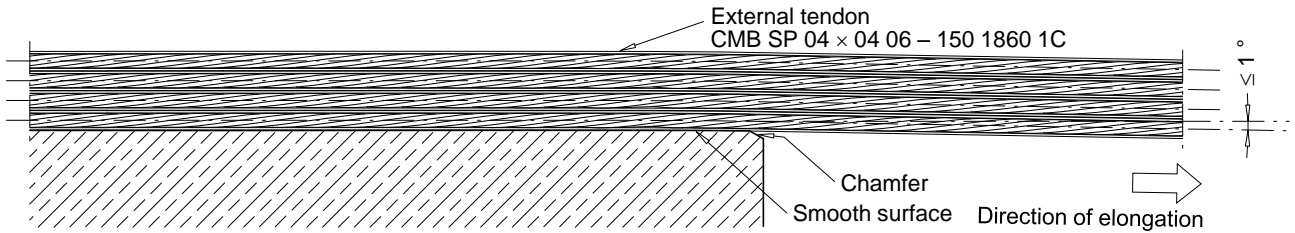
Number of strands			01 × 01	01 × 02	02 × 02	03 × 02	01 × 04	02 × 04	03 × 04	04 × 04
Minimum straight length	$L_{min}$	mm	215	275	360	420	430	460	560	650



Unbonded Band Post-tensioning System  
 Deviation components

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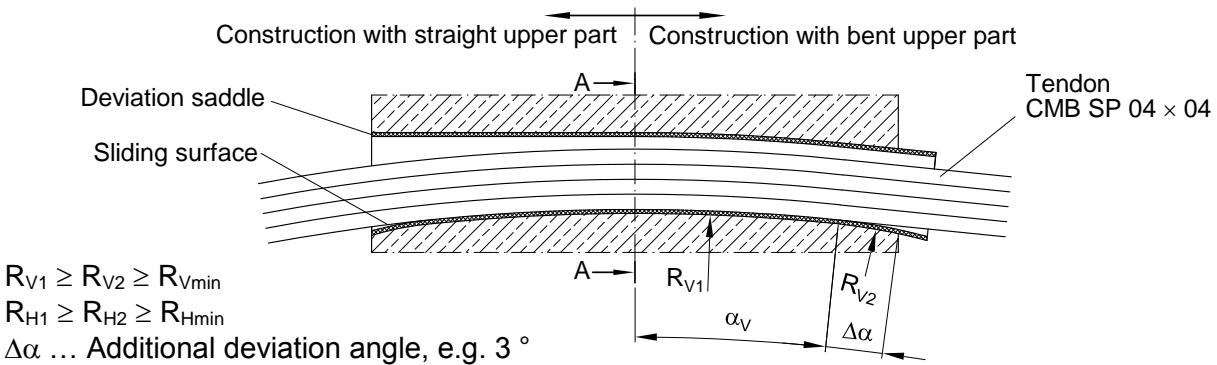
Limited deviation of tendon at chamfered concrete edge



Deviation of tendon at a chamfered edge of formed concrete with

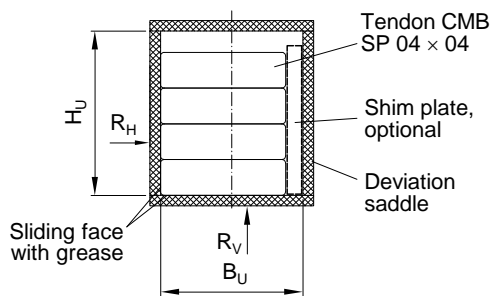
- An angle of  $\leq 1^\circ$
- Contact of tendon to a smooth formed concrete surface with chamfer, free of fins, honeycombing, and free of other irregularities
- Installed indoor with almost dry ambient climate at  $\leq 40^\circ\text{C}$
- Exchangeable tendon, CMB SP 04 x 04 06 - 150 1860 1C or smaller 1C band configurations

Deviation of tendon at deviation saddle



Section A - A Deviation saddle in plastic

Sliding surface  
 PE - PE <sup>1)</sup>



Deviation saddle in steel

Sliding surface  
 PE - PE <sup>1)</sup> or  
 steel sheet - PTFE

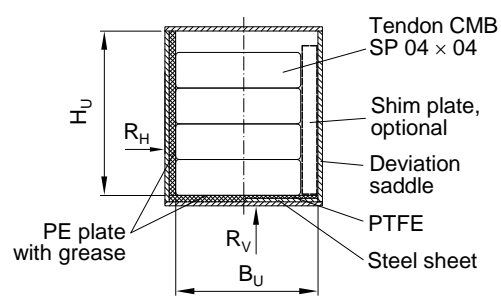


Table 20: Dimensions of deviation saddle <sup>2)</sup>

Number of strands		01 x 01	01 x 02	02 x 02	03 x 02	01 x 04	02 x 04	03 x 04	04 x 04
Min. width (inside)	B <sub>U</sub> mm	35	70	70	70	110	110	110	110
Min. height (inside)	H <sub>U</sub> mm	40	40	70	100	40	70	100	130

<sup>1)</sup> Or plastic material with similar properties  
<sup>2)</sup> Guide values









**Table 26: 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	4	5	6
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 the 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	—	—	+	—	—	—
10	Practicability, reliability of the installation	3.1.4.2	—	—	—	+	—	—
11	Practicability, reliability of the installation	3.1.4.3	—	—	—	—	+	—
12	Resistance to static load	3.1.4.4	—	—	—	—	—	+

**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.



CONA CMB SP

**Unbonded Band Post-tensioning System**  
 Essential characteristics for intended uses

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**Table 27: Contents of the prescribed test plan**

Component	Item	Test / Check	Traceability	Minimum frequency	Documentation
Anchor plate	Material	Check	Full	100 %	"3.1" <sup>1)</sup>
	Detailed dimensions	Test		3 % ≥ 2 specimens	Yes
	Visual inspection <sup>2)</sup>	Check		100 %	No
Intermediate plate	Material	Check	Bulk	100 %	"2.2" <sup>3)</sup>
	Detailed dimensions	Test		3 % ≥ 2 specimens	Yes
	Visual inspection <sup>2)</sup>	Check		100 %	No
Anchor head	Material	Check	Full	100 %	"3.1" <sup>1)</sup>
	Detailed dimensions <sup>4)</sup>	Test		5 % ≥ 2 specimens	Yes
	Visual inspection <sup>2), 5)</sup>	Check		100 %	No
Ring wedge	Material	Check	Full	100 %	"3.1" <sup>1)</sup>
	Treatment, Hardness <sup>6), 7)</sup>	Test		0.5 % ≥ 2 specimens	Yes
	Detailed dimensions <sup>2)</sup>	Test		5 % ≥ 2 specimens	Yes
	Visual inspection <sup>2), 8)</sup>	Check		100 %	No
Strand <sup>8)</sup>	Material	Check	Full	100 %	"CE" <sup>9)</sup>
	Diameter	Test		each coil	No
	Visual inspection <sup>2)</sup>	Check		each coil	No
Constituents of filling material as per EN 447	Cement	Check	Full	100 %	"CE"
	admixtures, additions	Check	Bulk	100 %	"CE"
Monostrand as per ETAG 013, Annex C.1 and monolithic band as per ETA-06/0165	Material	Check	Full	100 %	Yes

1) "3.1": Inspection certificate type "3.1" according to EN 10204

2) Visual inspection includes e.g. main dimensions, gauge testing, correct marking or labelling, check of records regarding appropriate performance, surfaces, fins, kinks, smoothness, corrosion, coating etc., as detailed in the prescribed test plan.

3) "2.2": Test report type "2.2" according to EN 10204

4) Other dimensions than <sup>2)</sup>

5) Dimensions: All conical bores of the anchor heads regarding angle, diameter and surface condition, thread dimensions of all anchor heads

6) Geometrical properties

7) Surface hardness

8) Teeth, cone surface

9) As long as the basis for CE marking for prestressing steel is not available, an approval or certificate according to the respective rules in force at the place of use shall accompany each delivery.

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

Bulk ..... Traceability of each delivery of components to a defined point.



CONA CMB SP

**Unbonded Band Post-tensioning System**  
Contents of the prescribed test plan

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**Table 28: Audit-testing**

Component	Item	Test / Check	Sampling <sup>2)</sup> – Number of components per visit
Anchor head, Anchor plate	Material according to specification	Test / Check	1
	Detailed dimensions	Test	
	Visual inspection <sup>1)</sup>	Check	
Ring wedge	Material according to specification	Test / Check	2
	Treatment	Test	2
	Detailed dimensions	Test	1
	Main dimensions, surface hardness and surface finish	Test	5
	Visual inspection <sup>1)</sup>	Check	5
Single tensile element test	Single tensile element test according to ETAG 013, Annex E.3	Test	1 series

<sup>1)</sup> Visual inspection means e.g. main dimensions, gauge testing, correct marking or labelling, appropriate performance, surfaces, fins, kinks, smoothness, corrosion protection, corrosion, coating etc., as given in the prescribed test plan.

<sup>2)</sup> All samples shall be randomly selected and clearly identified.

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**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 3 Eurocode 3: Design of steel 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
- EN 10025-2+AC (06.2005) Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels
- EN 10083-1 (08.2006) Steels for quenching and tempering – Part 1: General technical delivery conditions
- EN 10083-2 (08.2006) Steels for quenching and tempering – Part 2: Technical delivery conditions for non alloy steels
- EN 10084 (04.2008) Case hardening steels – Technical delivery conditions
- EN 10204 (10.2004) Metallic products – Types of inspection documents
- EN 10277-2 (03.2008) Bright steel products - Technical delivery conditions – Part 2: Steels for general engineering purposes
- EN ISO 1872-1 (05.1999) Plastics – Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specifications
- EN ISO 1874-1 (09.2000) Plastics – Polyamide (PA) moulding and extrusion materials – Part 1: Designation
- prEN 10138-3 (08.2009) Prestressing steels – Part 3: Strands
- 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
  
- 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



CONA CMB SP

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 Reference documents

**Annex 26**  
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**Materialprüfungsamt Nordrhein-Westfalen**

Prüfen · Überwachen · Zertifizieren

**Certificate of constancy of performance****0432-CPR-00299-1.6**

Version 01

In compliance with Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 (the Construction products Regulation or CPR), this certificate applies to the construction product

**BBR VT CONA CMB SP – Unbonded Band Post-tensioning  
System with 01 to 16 Strands**

placed on the market under the name or trade mark of

**BBR VT International Ltd**Ringstr. 2  
8603 Schwerzenbach (ZH) / Switzerland

and produced in the manufacturing plant(s)

**BBR VT International Ltd**Ringstr. 2  
8603 Schwerzenbach (ZH) / Switzerland

This certificate attests that all provisions concerning the assessment and verification of constancy of performance described in the

**ETA-10/0065, issued on 19.02.2016**

and


**ETAG 013 - Post Tensioning Kits for prestressing of Structures**

under **system 1+** for the performance set out in the ETA are applied and that the factory production control conducted by the manufacturer is assessed to ensure the

**constancy of performance of the construction product.**

This certificate was first issued on 03.11.2010 and will remain valid until 26.02.2021 as long as neither the ETA, the EAD, the construction product, the AVCP methods nor the manufacturing conditions in the plant are modified significantly, unless suspended or withdrawn by the notified product certification body.

Dortmund, 26.02.2016

2<sup>nd</sup> copy  
Dipl.-Ing. Hönig  
Certification Manager

This Certificate consists of 1 page.

This Certificate replaces the Certificate no. 0432-CPD-11 9181-1.6/2 dated 03.11.2010.

The original of this document was issued in German language.

In case of doubt only the German version is valid.



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**A Global Network of Experts**  
[www.bbrnetwork.com](http://www.bbrnetwork.com)