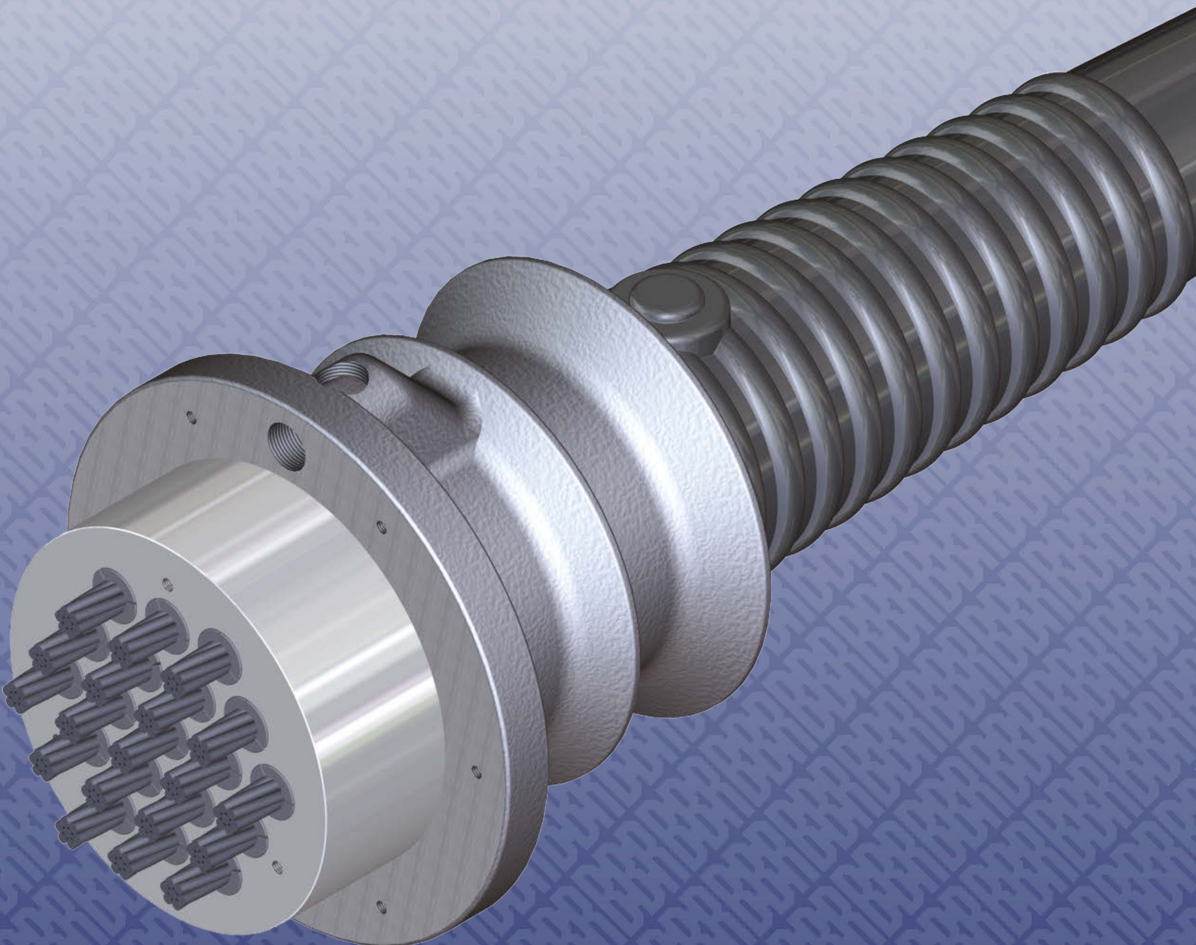
BBR VT CONA CMI BT

Internal Post-tensioning System with 02 to 61 Strands

European Technical Assessment
ETA – 09/ 0286

CE



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ETA-09/0286

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Internal Post-tensioning System with 02 to 61 Strands

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SPECIMEN

Responsible BBR PT Specialist Company

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

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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-09/0286 of 19.09.2018

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 CMI BT – Internal Post-tensioning System with 02 to 61 Strands
Product family to which the construction product belongs	Bonded or unbonded post-tensioning kits for prestressing of structures with 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	60 pages including Annexes 1 to 33, which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with Regulation (EU) № 305/2011, on the basis of	EAD 160004-00-0301, European Assessment Document for Post-Tensioning Kits for Prestressing of Structures.
This European Technical Assessment replaces	European technical approval ETA-09/0286 with validity from 30.06.2013 to 29.06.2018.

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Specific parts

1 Technical description of the product

1.1 General

The European Technical Assessment[1] – ETA – applies to a kit, the PT system

BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands,

comprising the following components, see Annex 1, Annex 2, Annex 3, Annex 4, Annex 5, and Annex 6.

– Tendon

  Internal tendon with 02 to 61 tensile elements

– Tensile element

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

Table 1 Tensile elements

Nominal diameter	Nominal cross-sectional area	Maximum characteristic tensile strength
mm	mm^2	MPa
15.3	140	1 860
15.7	150	

NOTE 1 MPa = 1 N/mm^2

– Anchorage and coupler

  Anchorage of the prestressing steel strands with ring wedges

  End anchorage

    Fixed (passive) anchor or stressing (active) anchor as end anchorage, FA or SA, for tendons with 02, 03, 04, 05, 06, 07, 08, 09, 12, 13, 15, 16, 19, 22, 24, 25, 27, 31, 37, 42, 43, 48, 55, and 61 prestressing steel strands

[1] ETA-09/0286 was firstly issued in 2010 as European technical approval with validity from 17.05.2010, amended in 2010 with validity from 29.09.2010, extended in 2013 with validiy from 30.06.2013, and converted in 2018 to European Technical Assessment ETA-09/0286 of 19.09.2018.

Fixed or stressing coupler

Single plane coupler, FK or SK, for tendons with 02, 03, 04, 05, 06, 07, 08, 09, 12, 13, 15, 16, 19, 22, 24, 25, 27, and 31 prestressing steel strands

Sleeve coupler, FH or SH, for tendons with 02, 03, 04, 05, 06, 07, 08, 09, 12, 13, 15, 16, 19, 22, 24, 25, 27, 31, 37, 42, 43, 48, 55, and 61 prestressing steel strands

Moveable coupler

Single plane coupler, BK, for tendons with 02, 03, 04, 05, 06, 07, 08, 09, 12, 13, 15, 16, 19, 22, 24, 25, 27, and 31 prestressing steel strands

Sleeve coupler, BH, for tendons with 02, 03, 04, 05, 06, 07, 08, 09, 12, 13, 15, 16, 19, 22, 24, 25, 27, 31, 37, 42, 43, 48, 55, and 61 prestressing steel strands

- Bearing trumplate for tendons with 02, 03, 04, 05, 06, 07, 08, 09, 12, 13, 15, 16, 19, 22, 24, 25, 27, 31, 37, 42, 43, 48, 55, and 61 prestressing steel strands
- Helix and additional reinforcement in the region of the anchorage
- Corrosion protection for tensile elements, anchorages, and couplers

PT system

1.2 Designation and range of anchorages and couplers

1.2.1 General

End anchorages can be fixed or stressing anchorages. Couplers are fixed, stressing, or moveable. The principal dimensions of anchorages and couplers are given in Annex 2, Annex 3, Annex 4, Annex 5, Annex 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24.

1.2.2 Designation

End anchorage e.g. S A CONA CMI BT 1906-150 1860

Fixed (F) or stressing (S) ← S

Anchorage ← A

Designation of the tendon ← CONA CMI BT 1906-150 1860
with information on number, cross-sectional area, and characteristic tensile strength of prestressing steel strands

Coupler e.g. F K CONA CMI BT 1906-150 1860

Fixed (F), stressing (S) or moveable (B) ← F

Coupler anchor head (K or H) ← K

Designation of the tendon ← CONA CMI BT 1906-150 1860
with information on number, cross-sectional area, and characteristic tensile strength of prestressing steel strands

1.2.3 Anchorage, FA or SA

1.2.3.1 General

Anchorage of prestressing steel strands is achieved by wedges and anchor heads, see Annex 1, Annex 2, and Annex 6. The anchor heads of the fixed and stressing anchorage are identical. A differentiation is needed for the construction works.

The wedges of inaccessible fixed anchors are secured with either a wedge retaining plate or springs and a wedge retaining plate. An alternative is pre-locking each individual prestressing steel strand with ~ 0.5 · F_{pk} and applying a wedge retaining plate.

Where

F_{pk} .... Characteristic value of maximum force of one single prestressing steel strand

1.2.3.2 Restressable and exchangeable tendon

Significant to a restressable and exchangeable tendon is the excess length of the prestressing steel strands, see Annex 1. The extent of the excess length depends on the jack used for restressing or releasing. The protrusions of the prestressing steel strands require a permanent corrosion protection and an adapted cap.

1.2.4 Fixed and stressing coupler

1.2.4.1 General

Anchorage of prestressing steel strands is achieved by wedges and coupler anchor heads, see Annex 1, Annex 3, Annex 4, and Annex 6.

1.2.4.2 Single plane coupler, FK or SK

The coupling is achieved by means of a coupler anchor head K. The prestressing steel strands of the first construction stage are anchored by means of wedges in machined cones, drilled in parallel. The arrangement of the cones of the first construction stage is identical to that of the anchor head of a fixed or stressing anchorage. The prestressing steel strands of the second construction stage are anchored in a circle around the cones of the first construction stage by means of wedges in machined cones, drilled at an inclination of 7 °. The wedges for the second construction stage are secured by means of holding springs and a cover plate.

1.2.4.3 Sleeve coupler, FH or SH

The coupler anchor head H is of the same basic geometry as the anchor head of the fixed or stressing anchorage. Compared to the anchor head of the fixed or stressing anchorage, the coupler anchor head H is higher and provide an external thread for the coupler sleeve. The wedges for the second construction stage are secured by means of a wedge retaining plate.

The connection between the coupler anchor heads H of the first and second construction stages is achieved by means of a coupler sleeve.

1.2.5 Moveable coupler, BK or BH

Anchorage of prestressing steel strands is achieved by wedges and coupler anchor heads, see Annex 1, Annex 3, Annex 4, and Annex 6. The moveable coupler is either a single plane coupler or a sleeve coupler in a coupler sheathing made of steel or plastic. Length and position of the coupler sheathing are for the expected elongation displacement, see Clause 2.2.4.

The coupler anchor heads and the coupler sleeve of the moveable coupler are identical to the coupler anchor heads and the coupler sleeve of the fixed or stressing coupler. The wedges for the first construction stage are secured by means of a wedge retaining plate and the wedges of the second construction stage are secured by wedge retaining plate or holding springs and cover plate.

A 100 mm long and at least 3.5 mm thick PE-HD insert is installed at the deviating point at the end of the trumpet. The insert is not required for plastic trumpets where the ducts are slipped over the plastic trumpet.

1.2.6 Layout of the anchorage recess

All bearing trumplates, anchor heads, and coupler anchor heads are placed perpendicular to the axis of the tendon, see Annex 16.

The dimensions of the anchorage recess 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 recess should be slightly conical for ease of removal. In case of an internal anchorage fully embedded in concrete, the recess is designed so as to permit a reinforced concrete cover with the required dimensions and in any case with a thickness of at least 20 mm. In case of an exposed anchorage, see Annex 16, concrete cover on anchorage and bearing trumplate is not required. However, the exposed surfaces of bearing trumplate and steel cap are provided with corrosion protection.

1.3 Designation and range of the tendons

1.3.1 Designation

Tendon e.g. CONA CMI BT 19 06-150 1860

- CONA CMI BT → Internal PT
- 19 → Number of prestressing steel strands (02 to 61)
- 06 → Prestressing steel strand
- 150 → Cross-sectional area of prestressing steel strands (140 or 150 mm²)
- 1860 → Characteristic tensile strength of the prestressing steel strands

The tendons comprise 02 to 61 tensile elements, 7-wire prestressing steel strands according to Annex 28.

1.3.2 Range

1.3.2.1 General

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 15.

The tendons consist of 02, 03, 04, 05, 06, 07, 08, 09, 12, 13, 15, 16, 19, 22, 24, 25, 27, 31, 37, 42, 43, 48, 55, or 61 prestressing steel strands. By omitting prestressing steel strands in the anchorages and couplers in a radially symmetrical way, also tendons with numbers of prestressing steel strands lying between the numbers given above can be installed. Any unnecessary hole either remains undrilled or is provided with a short piece of prestressing steel strand and a wedge is inserted. For coupler anchor head K the cones of the outer pitch circle, second construction stage, may be equally redistributed if prestressing steel strands are omitted. However, the overall dimensions of the coupler anchor head K remain unchanged.

With regard to dimensions and reinforcement, anchorages and couplers with omitted prestressing steel strands remain unchanged compared to anchorages and couplers with a full number of prestressing steel strands.

1.3.2.2 CONA CMI BT n06-140

7-wire prestressing steel strand

Nominal diameter .... 15.3 mm

Nominal cross-sectional area .... 140 mm²

Maximum characteristic tensile strength.....................1 860 MPa

Annex 7 lists the available tendon range for CONA CMI BT n06-140.

1.3.2.3 CONA CMI BT n06-150

7-wire prestressing steel strand

Nominal diameter .... 15.7 mm

Nominal cross-sectional area .... 150 mm^2

Maximum characteristic tensile strength....................1 860 MPa

Annex 8 lists the available tendon range for CONA CMI BT n06-150.

1.4 Duct

1.4.1 Use of duct

For a bonded tendon a corrugated steel duct is used.

For special application, such as loop tendon and unbonded tendon, a smooth duct is used.

Alternatively, a corrugated or smooth plastic duct may be used as well, if permitted at the place of use. Minimum wall thicknesses are given in Table 3.

Table 2 Steel ducts, minimum wall thickness, t_{min}

Number of prestressing steel strands	Wall thickness
n	t_{min}
—	mm
02–13	1.5
15–25	2.0
27–37	2.5
42–61	3.0

Table 3 Plastic ducts, minimum wall thickness, t_{min}

Number of strands	Corrugated plastic duct		Smooth plastic duct	
	Maximum degree of filling	Minimum wall thickness	Maximum degree of filling	Minimum wall thickness
n	f	t_{min}	f	t_{min}
—	—	mm	—	mm
02–04	0.3	2.0	0.25	3.0
05–07	0.4	2.0	0.3	3.6
08–12	0.4	2.5	0.35	4.3
13–15	0.4	2.5	0.35	5.3
16–22	0.4	3.0	0.35	6.0
23–27	0.4	3.5	0.35	6.7
28–37	0.4	4.0	0.35	7.7
38–48	0.45	4.5	0.35	8.6
49–55	0.45	5.0	0.35	9.6
56–61	0.45	5.5	0.35	10.8

1.4.2 Degree of filling

The degree of filling, f, for a circular duct is generally between 0.35 and 0.50. However, the smaller values of degree of filling, 0.35 to 0.40, are used for long tendons or if the tensile elements are installed after concreting. The minimum radius of curvature can be defined with the equation given in Clause 1.9. Typical degrees of filling, f, and corresponding minimum radii of curvature, R_{min}, are given in Annex 9, Annex 10, and Annex 11. The degree of filling is defined as

$$f = \frac{\text{cross-sectional area of prestressing steel}}{\text{cross-sectional area of inner diameter of sheath}}$$

1.4.3 Circular steel strip sheath

Steel strip sheath in conformity with EN 523[2], with minimum wall thicknesses according to Table 2, is used. For diameters exceeding EN 523 the requirements are met analogous. The degree of filling, f, is according to Clause 1.4.2 and the minimum radius of curvature to Clause 1.9.

Annex 10 and Annex 11 give internal duct diameters and minimum radii of curvature in which $p_{R,\,max}$ has been set to 200 kN/m and 140 kN/m respectively. Smaller radii of curvature are acceptable according to the respective standards and regulations in force at the place of use.

1.4.4 Flat corrugated steel duct

For a tendon with 2, 3, 4, or 5 prestressing steel strands, a flat duct may be used, whereas EN 523 applies accordingly. Inner dimensions of the duct and the minimum radii of curvature are defined in Annex 9.

Annex 9 gives minor and major internal flat duct diameters and minimum radii of curvature, both minor and major, in which $p_{R,\,max}$ has been set to 200 kN/m and 140 kN/m respectively. Smaller radii of curvature are acceptable according to the respective standards and regulations in force at the place of use.

1.4.5 Pre-bent smooth circular steel duct

If permitted at the place of use, a smooth steel duct according to EN 10255, EN 10216-1, EN 10217-1, EN 10219-1, or EN 10305-5 is used. The degree of filling, f, conforms to Clause 1.4.2 and the minimum radius of curvature to Clause 1.9. The duct is pre-bent and free of any kinks. The minimum radii of curvature, R_{min}, is according to Clause 1.9. The minimum wall thickness of the steel duct meets the specification of Table 2.

1.5 Friction losses

For calculation of loss of prestressing force due to friction, Coulomb's law applies. Calculation of friction loss is by the equation

$$F_x = F_0 \cdot e^{-\mu \cdot (\alpha + k \cdot x)}$$

Where

F_x .... kN .... Prestressing force at a distance x along the tendon

F_0 .... kN .... Prestressing force at x = 0 m

μ .... rad^{-1} .... Friction coefficient, see Table 4

α .... rad .... Sum of angular displacements over distance x, irrespective of direction or sign

k .... rad/m .... Wobble coefficient, see Table 4

[2] Standards and other documents referred to in the European Technical Assessment are listed in Annex 32 and Annex 33.

x .... m..............Distance along the tendon from the point where the prestressing force is equal to F_0

NOTE 1 1 rad = 1 m/m = 1

NOTE 2 As far as acceptable at the place of use, due to special measures like oiling or for a tendon layout with only few deviations the friction coefficient can be reduced by 10 to 20 %. Compared to e.g. the use of prestressing steel or sheaths with a film of rust this value increases by more than 100 %.

Table 4 Friction parameters

Duct	**Recommended values**		**Range of values**	
	μ	**k**	**μ**	**k**
	rad^{-1}	**rad/m**	**rad^{-1}**	**rad/m**
Steel strip duct	0.18	0.005	0.17–0.19	0.004–0.007
Smooth steel duct	0.18		0.16–0.24	
Corrugated plastic duct	0.12		0.10–0.14	
Smooth plastic duct	0.12		0.10–0.14	

Friction loss in stressing anchorage and stressing coupler first construction stage are given in Table 5. The loss is taken into account for determination of elongation and prestressing force along the tendon.

Table 5 Friction losses in anchorages

Tendon	**Friction loss**		
CONA CMI BT 0206 to 0406	ΔF_s	%	1.2
CONA CMI BT 0506 to 0906			1.1
CONA CMI BT 1206 to 3106			0.9
CONA CMI BT 3706 to 6106			0.8

Where

ΔF_s........ %..............Friction loss in stressing anchorage and first construction stage of stressing coupler.

1.6 Support of tendon

Spacing of supports is between 1.0 and 1.8 m. In the region of maximum tendon curvature, a spacing of 0.8 m is applied and 0.6 m in case the minimum radius of curvature is smaller than 4.0 m. The tendons are systematically fastened in their position so that they are not displaced by placing and compacting of concrete.

1.7 Slip at anchorage and coupler

Slip at stressing and fixed anchorages and at fixed and stressing couplers, first and second construction stages, is 6 mm. Slip at moveable couplers is twice this amount. At the stressing anchorage and at the first construction stage of the stressing couplers, slip is 4 mm, provided a prestressing jack with a wedging system and a wedging force of around 25 kN per prestressing steel strand is used.

1.8 Centre spacing and edge distance for the anchorage

In general, spacing and distances are not less than given in Annex 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24, see also Annex 12 and Annex 13.

However, a reduction of up to 15 % of the centre spacing of tendon anchorages in one direction is permitted, but should not be less than the outside diameter of the helix and placing of additional reinforcement still is possible, see Annex 25. In this case, spacing in the perpendicular direction is increased by the same percentage. The corresponding edge distance is calculated by

$$a_e = \frac{a_c}{2} - 10\text{ mm} + c \qquad a_{\underline{e}} = \frac{a_{\underline{c}}}{2} - 10\text{ mm} + c$$

$$b_e = \frac{b_c}{2} - 10\text{ mm} + c \qquad b_{\underline{e}} = \frac{b_{\underline{c}}}{2} - 10\text{ mm} + c$$

Where

a_c, $a_{\underline{c}}$ ....mm.......... Centre spacing before and after modification

b_c, $b_{\underline{c}}$ ....mm.......... Centre spacing in the direction perpendicular to a_c before and after modification

a_e, $a_{\underline{e}}$ ....mm.......... Edge distance before and after modification

b_e, $b_{\underline{e}}$ ....mm.......... Edge distance in the direction perpendicular to a_e before and after modification

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

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

The minimum values for a_c, b_c, a_e, and b_e are given in Annex 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24.

1.9 Minimum radii of curvature

The minimum radii of curvature of the tendon, R_{min}, given in Annex 9, Annex 10, and Annex 11 correspond to

- a prestressing force of the tendon of 0.85 · $F_{p0.1}$ per prestressing steel strand Y1860S7
- a nominal diameter of the prestressing steel strand of d = 15.7 mm
- a maximum pressure under the prestressing steel strands of $p_{R,\,max}$ = 200 kN/m and 140 kN/m
- a concrete compressive strength of $f_{cm,\,0,\,cube}$ = 23 MPa.

In case of different tendon parameters or a different pressure under the prestressing steel strands, the calculation of the minimum radius of curvature of the tendon with circular duct can be carried out using the equation

$$R_{min} = \frac{2 \cdot F_{pm,\,0} \cdot d}{d_i \cdot p_{R,\,max}}$$

Where

R_{min} ....m................ Minimum radius of curvature

$F_{p0.1}$ ....kN............... Characteristic force at 0.1 % proof force of one single prestressing steel strand, see Annex 28

$F_{pm,\,0}$ ....kN............... Prestressing force of the tendon

d ....m................ Nominal diameter of the prestressing steel strand

d_i.............m................ Nominal inner duct diameter

$p_{R,\,max}$ ....kN/m............ Maximum pressure under the prestressing steel strands

For tendons with predominantly static loading, reduced minimum radii of curvature can be used. Recommended values for the pressure under the prestressing steel strands are

$p_{R,\,max}$ = 140–200 kN/m for internal bonded tendons

$p_{R,\,max}$ = 800 kN/m for smooth steel duct and predominantly static loading

In case of reduced minimum radius of curvature, the degree of filling, f, as defined in Clause 1.4.2, is between 0.25 and 0.30 to allow for proper tendon installation. Depending on the concrete strength at the time of stressing, additional reinforcement for splitting forces may be required in the areas of reduced minimum radius of curvature.

Standards and regulations on minimum radius of curvature or on the pressure under the prestressing steel strands in force at the place of use are observed.

1.10 Concrete strength at time of stressing

Concrete in conformity with EN 206 is used. At the time of stressing, the mean concrete compressive strength, $f_{cm,\,0}$, is at least according to Table 6. The concrete test specimens are subjected to the same curing conditions as the structure.

For partial stressing with 30 % of the full prestressing force, the actual mean 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.

Helix, additional reinforcement, centre spacing and edge distance corresponding to the concrete compressive strengths are taken from Annex 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24, see also the Clauses 1.12.7 and 2.2.3.5.

Table 6 Compressive strength of concrete

Mean concrete strength		**$f_{cm,\,0}$**				
Cube strength, $f_{cm,\,0,\,cube}$ 150 mm cube	MPa	23	28	34	38	43
Cylinder strength, $f_{cm,\,0,\,cylinder}$ 150 mm cylinder diameter	MPa	19	23	28	31	35

Where

$f_{cm,\,0,\,cube\,150}$ ....Mean concrete compressive strength at time of stressing, determined at cubes, 150 mm

$f_{cm,\,0,\,cylinder\,\varnothing\,150}$ ....Mean concrete compressive strength at time of stressing, determined at cylinders, diameter 150 mm

Components

1.11 Prestressing steel strands

Only 7-wire prestressing steel strands with characteristics according to Table 7 are used, see also Annex 28.

In a single tendon only prestressing steel strands spun in the same direction are used.

In the course of preparing the European Technical Assessment, no characteristic has been assessed for prestressing steel strands. In execution, a suitable prestressing steel strand that conforms to Annex 28 and is according to the standards and regulations in force at the place of use is taken.

Table 7 Prestressing steel strands

Maximum characteristic tensile strength 1)	f_{pk}	MPa	1 860	
Nominal diameter	d	mm	15.3	15.7
Nominal cross-sectional area	A_p	mm²	140	150
Mass of prestressing steel	M	kg/m	1.093	1.172

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

1.12 Anchorage and coupler

1.12.1 General

The components of anchorage and coupler are in conformity with the specifications given in Annex 2, Annex 3, Annex 4, Annex 5, and Annex 6 and the technical file[3]. Therein the component dimensions, materials and material identification data with tolerances are given.

1.12.2 Anchor head

The anchor head, A1 to A8, is made of steel and provides regularly arranged conical holes drilled in parallel to accommodate prestressing steel strands and wedges, see Annex 2. The back exits of the bore holes are provided with bell mouth openings or plastic ring cushions. In addition, threaded bores may be provided to attach a protection cap and springs A, see Annex 1 and Annex 6, and wedge retaining plate KS, see Annex 1 and Annex 6.

At the back of the anchor head there may be a step, for ease of centring the anchor head on the bearing trumplate.

1.12.3 Bearing trumplate

The bearing trumplate made of cast iron transmits the force via three anchorage planes to the concrete, see Annex 5. Air-vents are situated at the top and at the interface plane to the anchor head. A ventilation tube can be fitted to these air-vents. On the tendon-side end there is an inner thread to accommodate the trumpet.

1.12.4 Trumpet

The conical trumpet A, see Annex 5, and conical trumpet K, see Annex 3, is made either in steel or in PE.

The trumpet manufactured in steel has a corrugated or plain surface. In case the transition from trumpet to duct is made in steel, a 100 mm long and at least 3.5 mm thick PE-HD insert is installed at the deviating point of the prestressing steel strands.

The conical trumpet made of PE may have either a corrugated or a plain surface. At the duct-side end there is a radius for the deviation of the prestressing steel strands and a smooth surface, to ensure a good transition to the duct. The opposite end is connected to the bearing trumplate or coupler anchor head K.

1.12.5 Coupler anchor head

The coupler anchor head K, see Annex 3, for the single plane coupler is made of steel and provides in the inner part, for anchorage of the prestressing steel strands of the first construction stage, the same arrangement of holes as the anchor head for the stressing or fixed anchorage. In the outer pitch circle there is an arrangement of holes with an inclination of 7 ° to accommodate the prestressing steel strands of the second construction stage. At the back of coupler anchor head K there is a step for ease of centring the coupler anchor head on the

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

bearing trumplate. Wedge retaining plate KS, see Annex 6, and springs K, see Annex 6, with cover plate K, see Annex 3, are fastened by means of additional threaded bores.

The coupler anchor heads H1 or H2 for the sleeve coupler are made of steel and have the same basic geometry as the anchor head of the stressing or fixed anchorage, see Annex 4. Compared to the anchor head of the stressing and fixed anchorage, the coupler anchor head H is higher and provide an external thread for the coupler sleeve. At the back of the coupler anchor head H1 and H2 there is a step for ease of centring the coupler anchor head on the bearing trumplate. Wedge retaining plate KS, see Annex 6, is fastened by means of additional threaded bores.

The coupler sleeve H is a steel tube, see Annex 4, with an inner thread and is provided with ventilation holes.

Ring cushions, see Annex 4, are inserted in coupler anchor head H2.

1.12.6 Ring wedge

The ring wedge, see Annex 6, is in three pieces. Two different ring wedges are used.

- Ring wedge H in three pieces, fitted with spring ring
- Ring wedge F in three pieces, without spring ring or fitted with spring ring

Within one anchorage or coupler only one of these ring wedges is used.

The wedges of an inaccessible fixed anchorage are secured with either a wedge retaining plate or springs and a wedge retaining plate. An alternative is pre-locking each individual prestressing steel strand with $\sim 0.5 \cdot F_{pk}$ and applying a wedge retaining plate as per Clause 1.2.3.1. In couplers the wedges are secured with wedge retaining plate and cover plate.

1.12.7 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 helix and additional reinforcement conforms to the values specified in Annex 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24, see also Clause 2.2.3.5.

If required for a specific project design, the reinforcement given in Annex 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24 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.

1.12.8 Protection cap

The protection cap is made of steel or plastic. It is provided with air vents and fastened with screws or threaded rods.

1.12.9 Material specifications

Annex 14 lists the material standards or specifications of the components.

1.13 Permanent corrosion protection

In the course of preparing the European Technical Assessment no characteristic has been assessed for components and materials of the corrosion protection system. In execution, all components and materials are selected according to the standards and regulations in force at the place of use.

Corrosion protection of the bonded tendon is provided by completely filling duct, anchorage, and coupler with grout according to EN 447, special grout according to EAD 160027-00-0301, or ready-mixed grout with an adequate composition according to standards and regulations in force at the place of use.

To protect an unbonded tendons from corrosion, ducts, couplers, and anchorages are completely filled with corrosion protection filling material as applicable at the place of use. Applicable corrosion protection filling materials are grease, wax, or an equivalent soft material. Actively circulating dry air allows for corrosion protection of a tendon as applicable at the place of use.

In case of an anchorage fully embedded in concrete, the recess is designed as to permit a reinforced concrete cover with the required dimensions and in any case with a thickness of at least 20 mm. With an exposed anchorage or with an anchorage with insufficiently thick concrete cover, the surfaces of bearing trumplate and steel cap are provided with corrosion protection.

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

2.1 Intended uses

The BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands is intended to be used for the prestressing of structures. The specific intended uses are listed in Table 8.

Table 8 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	Internal unbonded tendon for concrete and composite structures
Optional use category	
3	Internal tendon for cryogenic applications with anchorage outside the possible cryogenic zone

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 advise his clients on transport, storage, maintenance, replacement, and repair of the product as he considers necessary.

2.2.2 Packaging, transport, and storage

Advice on packaging, transport, and storage includes.

- During transport of prefabricated tendons, a minimum diameter of curvature of
  - 1.65 m for tendons up to CONA CMI BT 1206,
  - 1.80 m for tendons up to CONA CMI BT 3106,
  - 2.00 m for tendons larger than CONA CMI BT 3106, of prestressing steel strand is observed.
- Temporary protection of prestressing steel and components in order to prevent corrosion during transport from production site to job site
- Transportation, storage and handling of 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

2.2.3 Design

2.2.3.1 General

It is the responsibility of the ETA holder to ensure that all necessary information on design and installation is submitted to those responsible for the design and execution of the structures executed with "BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands".

Design of the structure permits correct installation and stressing of the tendons. The reinforcement in the anchorage zone permits correct placing and compacting of concrete.

2.2.3.2 Fixed and stressing coupler

The prestressing force at the second construction stage may not be greater than that at the first construction stage, neither during construction, nor in the final state, nor due to any load combination.

2.2.3.3 Anchorage Recess

Clearance is required for handling of the prestressing jack and for stressing. The dimensions of the anchorage recess are adapted to the prestressing jack used. The ETA holder saves for reference information on the minimum dimensions of the anchorage recesses and appropriate clearance behind the anchorage.

The anchorage recess is designed with such dimensions as to ensure the required concrete cover and at least 20 mm at the protection cap in steel in the final state.

In case of exposed anchorages concrete cover on anchorage and bearing trumplate is not required. However, the exposed surface of bearing trumplate and steel cap is provided with corrosion protection.

2.2.3.4 Maximum prestressing forces

Prestressing and overstressing forces are specified in the respective standards and regulations in force at the place of use. Annex 15 lists the maximum possible prestressing and overstressing forces according to Eurocode 2.

2.2.3.5 Centre spacing, edge distance, and reinforcement in the anchorage zone

Centre spacing, edge distance, helix, and additional reinforcement given in Annex 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24 are adopted, see Clause 1.8.

Verification of transfer of prestressing forces to structural concrete is not required if centre spacing and edge distance of anchorages and couplers as well as grade and dimensions of additional reinforcement, see Annex 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24, 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 bearing trumplates remain 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 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24 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.

2.2.3.6 Tendons in masonry structures – load transfer to the structure

Post-tensioning kits are primarily used in structures made of concrete. They can, however, be used with other structural materials, e.g. in masonry structures. However, there is no particular assessment in EAD 160004-00-0301 for these applications. Hence, load transfer of stressing force from the anchorage to masonry structures is via concrete or steel members, designed according to the European Technical Assessment, especially according to the Clauses 1.8, 1.10, 1.12.7, and 2.2.3.5, or according to Eurocode 3, respectively.

The concrete or steel members have dimensions as to permit a force of $1.1 \cdot F_{pk}$ being transferred into the masonry. The verification is according to Eurocode 6 as well as to the respective standards and regulations in force at the place of use.

2.2.4 Installation

2.2.4.1 General

It is assumed that the product will be installed according to the manufacturer's instructions or – in absence of such instructions – according to the usual practice of the building professionals.

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 internal post-tensioning systems, see CWA 14646. The respective standards and regulations in force at the place of use are considered. The company's PT site manager has a certificate, stating that she or he has been trained by the ETA holder and that she or he possesses the necessary qualifications and experience with the "BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands".

The sequence of work steps for installation of anchorage, fixed and moveable coupler is described in Annex 26 and Annex 27.

The tendons may be manufactured on site or in the factory, i.e. prefabricated tendons. The tendons are carefully handled during production, transport, storage, and installation. To avoid confusion on each site, only prestressing steel strands with one nominal diameter are used.

Bearing trumplate, anchor head, and coupler anchor head are placed perpendicular to the tendon's axis, see Annex 16. Couplers are situated in a straight tendon section. At the anchorages and couplers, the tendon layout provides a straight section over a length of at least 250 mm beyond the end of the trumpet. In case of tendons with a minimum or reduced radius of curvature after the trumpet, the following minimum straight lengths after the end of trumpet are recommended.

- Degree of filling $0.35 \leq f \leq 0.50$, minimum straight length = $5 \cdot d_i \geq 250$ mm
- Degree of filling $0.25 \leq f \leq 0.30$, minimum straight length = $8 \cdot d_i \geq 400$ mm

Where

f............ —............ Degree of filling

d_i .... mm............ Nominal inner diameter of duct

Before placing the concrete, a final check of the installed tendon or duct is carried out.

In case of the single plane coupler K, the prestressing steel strands are provided with markers to be able to check the depth of engagement.

In case of a moveable coupler it is ensured by means of the corresponding position and length of the coupler sheath, that in the area of the coupler sheath and corresponding trumpet area a displacement of the moveable coupler of at least $1.15 \cdot \Delta l + 30$ mm is possible without any hindrance, where Δl is the maximum expected displacement of the coupler at stressing.

2.2.4.2 Stressing operation

With a mean concrete compressive strength in the anchorage zone according to the values laid down in Annex 17, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, and Annex 24 full prestressing may be applied.

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

Elongation and prestressing forces are continuously checked during the stressing operation. The results of the stressing operation are recorded and the measured elongations compared with the prior calculated values.

After releasing the prestressing force from the prestressing jack, the tendon is pulled in and reduces the elongation by the amount of slip at the anchor head of the stressing anchorage.

Information on the prestressing equipment has been submitted to Österreichisches Institut für Bautechnik. The ETA holder keeps available information on prestressing jacks and appropriate clearance behind the anchorage.

The safety-at-work and health protection regulations shall be complied with.

2.2.4.3 Restressing

Restressing of tendons in combination with release and reuse of wedges is permitted, whereas the wedges bite into a least 15 mm of virgin strand surface and no wedge bite remains inside the final length of the tendon between anchorages.

Tendons with 7-wire prestressing steel strands that remain restressable throughout the working life of the structure. Grease, wax, or an equivalent soft material is used as filling material or circulating dry air is used as corrosion protection. Moreover, a strand protrusion at the stressing anchor remains with a length compatible with the prestressing jack used.

2.2.4.4 Exchanging tendons

Exchange of unbonded tendons is permitted, subject of acceptance at the pace of use. The specifications for exchangeable tendons are defined during the design phase.

For exchangeable tendons, wax or grease is used as filling material or circulating dry air is used as corrosion protection. Moreover, a 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.

2.2.4.5 Filling operations

2.2.4.5.1 Grouting

Grout is injected through the inlet holes until it escapes from the outlet tubes with the same consistency. To avoid voids in the hardened grout special measures are applied for long tendons, tendon paths with distinct high points, or inclined tendons. All vents, grouting inlets, and protection caps are sealed immediately after grouting. In case of couplers K, the second stage holes, wedges and springs are checked for cleanness before and immediately after grouting the first construction stage.

The standards observed for cement grouting in prestressing ducts are EN 445, EN 446, and EN 447 or the standards and regulations in force at the place of use are applied for ready mixed grout.

2.2.4.5.2 Filling with grease, wax, and an equivalent soft material

The recommendations of the supplier are relevant for the filling material applied. The filling process with grease, wax, and an equivalent soft material follows a similar procedure as the one specified for grouting. However, a different filling procedure might be possible if permitted at the place of use.

2.2.4.5.3 Circulating dry air

Actively circulating dry air allows for corrosion protection of tendons, provided a permanent monitoring of the drying and circulation system is in place. This is in general only applicable to structures of particular importance. The respective standards and regulations in force at the place of use are observed.

2.2.4.5.4 Filling records

The results of the grouting and filling operation are recorded in detail in filling records.

2.2.4.6 Welding

Ducts may be welded.

The helix may be welded to the bearing trumplate to secure its position.

After installation of the prestressing steel strands further welding operations may not be carried out on the tendons. In case of welding operations near tendons, precautionary measures are required to avoid damage to the corrosion protection system. However, plastic components may be welded even after installation of the tendons.

2.3 Assumed working life

The European Technical Assessment is based on an assumed working life of the BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands of 100 years, provided that the BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands is subject to appropriate installation, use, and maintenance, see Clause 2.2. These provisions are based upon the current state of the art and the available knowledge and experience.

In normal use conditions, the real working life may be considerably longer without major degradation affecting the basic requirements for construction works[4].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee, neither given by the product manufacturer or his representative nor by EOTA nor by the Technical Assessment Body, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

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

3.1 Essential characteristics

The performances of the BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands for the essential characteristics are given in Table 9 and Table 10. In Annex 31 the combinations of essential characteristics and corresponding intended uses are listed.

Table 9 Essential characteristics and performances of the product

№	Essential characteristic	Product performance
Product BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands Intended use The PT system is intended to be used for the prestressing of structures, Clause 2.1, Table 8, lines № 1 and 2.		
Basic requirement for construction works 1: Mechanical resistance and stability		
1	Resistance to static load	See Clause 3.2.1.1.

4 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 may also be shorter than the assumed working life.

№	Essential characteristic	Product performance
2	Resistance to fatigue	See Clause 3.2.1.2.
3	Load transfer to the structure	See Clause 3.2.1.3.
4	Friction coefficient	See Clause 3.2.1.4.
5	Deviation, deflection (limits) for internal bonded and internal unbonded tendon	See Clause 3.2.1.5.
6	Assessment of assembly	See Clause 3.2.1.6.
7	Corrosion protection	See Clause 3.2.1.7.
Basic requirement for construction works 2: Safety in case of fire		
8	Reaction to fire	See Clause 3.2.2.1.
Basic requirement for construction works 3: Hygiene, health and the environment		
9	Content, emission and/or release of dangerous substances	See Clause 3.2.3.1.
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.	—

Table 10 Essential characteristics and performances of the product in addition to Table 9 for an optional use category

№	Additional essential characteristic	Product performance
Product BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands Optional use category The PT system is intended to be used for the prestressing of structures, Clause 2.1, Table 8, line № 3, Internal tendon for cryogenic applications with anchorage outside the possible cryogenic zone		
Basic requirement for construction works 1: Mechanical resistance and stability		
10	Resistance to static load under cryogenic conditions for applications with anchorage/coupling outside the possible cryogenic zone	See Clause 3.2.4.1.

3.2 Product performance

3.2.1 Mechanical resistance and stability

3.2.1.1 Resistance to static load

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.1. The characteristic values of maximum force, F_{pk}, of the tendon for prestressing steel strands according to Annex 28 are listed in Annex 7 and Annex 8.

3.2.1.2 Resistance to fatigue

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.2. The characteristic values of maximum force, F_{pk}, of the tendon for prestressing steel strands according to Annex 28 are listed in Annex 7 and Annex 8.

3.2.1.3 Load transfer to the structure

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.3. The characteristic values of maximum force, F_{pk}, of the tendon for prestressing steel strands according Annex 28 are listed in Annex 7 and Annex 8.

3.2.1.4 Friction coefficient

For friction losses including friction coefficient see Clause 1.5.

3.2.1.5 Deviation, deflection (limits) for internal bonded and internal unbonded tendon

For minimum radii of curvature see Clause 1.9.

3.2.1.6 Assessment of assembly

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.7.

3.2.1.7 Corrosion protection

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.13.

3.2.2 Safety in case of fire

3.2.2.1 Reaction to fire

The performance of components made of steel or cast iron is Class A1 without testing.

The performance of components of other materials has not been assessed.

3.2.3 Hygiene, health and the environment

3.2.3.1 Content, emission and/or release of dangerous substances

According to the manufacturer's declaration, the PT system does not contain dangerous substances.

– SVOC and VOC

  The performance of components made of steel or cast iron that are free of coating with organic material is no emission of SVOC and VOC.

  The performance of components of other materials has not been assessed.

– Leachable substances

  The product is not intended to be in direct contact to soil, ground water, and surface water.

3.2.4 Mechanical resistance and stability

3.2.4.1 Resistance to static load under cryogenic conditions for applications with anchorage/coupling outside the possible cryogenic zone

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.8. The characteristic values of maximum force, F_{pk}, of the tendon for prestressing steel strands according to Annex 28 are listed in Annex 7 and Annex 8.

3.3 Assessment methods

The assessment of the essential characteristics in Clause 3.1 of the BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands for the intended uses and in relation to the requirements for mechanical resistance and stability, safety in case of fire, and for hygiene, health and the environment in the sense of the basic requirements for construction works № 1, 2, and 3 of Regulation (EU) № 305/2011 has been made in accordance with Annex A of EAD 160004-00-0301, Post-tensioning kits for prestressing of structures, for

– Item 1, Internal bonded tendon
– Item 2, Internal unbonded tendon
– Item 8, Optional Use Category. Internal tendon – Cryogenic applications with anchorage/coupling outside the possible cryogenic zone

3.4 Identification

The European Technical Assessment for the BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands is issued on the basis of agreed data[5] that identify the assessed product. Changes to materials, to composition, or to 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 Commission Decision 98/456/EC the system of assessment and verification of constancy of performance to be applied to the BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands is System 1+. System 1+ is detailed in Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, Annex, point 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[6].

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

[6] 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.

(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

The kit manufacturer exercises permanent internal control of the production. All the elements, procedures, and specifications adopted by the kit manufacturer are documented in a systematic manner in the form of written policies and procedures.

– Control of the incoming materials

The manufacturer checks the incoming materials to establish conformity with their specifications.

– Inspection and testing

Kind and frequency of inspections, tests, and checks, conducted during production and on the final product normally include.

- Definition of the number of samples taken by the kit manufacturer
- Material properties e.g. tensile strength, hardness, surface finish, chemical composition, etc.
- Determination of the dimensions of components
- Check correct assembly
- Documentation of tests and test results

All tests are performed according to written procedures with suitable calibrated measuring devices. All results of inspections, tests, and checks are recorded in a consistent and systematic way. The basic elements of the prescribed test plan are given in Annex 29, conform to EAD 160004-00-0301, Table 3, and are specified in the quality management plan of the BBR VT CONA CMI BT – Internal Post-tensioning System with 02 to 61 Strands.

The results of inspections, tests, and checks are evaluated for conformity. Shortcomings request the manufacturer to immediately implement measures to eliminate the defects.

- Control of non-conforming products

  Products, which are considered as not conforming to the prescribed test plan, are immediately marked and separated from such products that do conform. Factory production control addresses control of non-conforming products.

- Complaints

  Factory production control includes procedures to keep records of all complaints about the PT system.

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

At least once a year the manufacturer audits the manufacturers of the components given in Annex 30.

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 the declaration of performance. Essential characteristics to be included in the declaration of performance for the corresponding intended use are given in Table 9 and Table 10. In Annex 31 the combinations of essential characteristics and corresponding intended uses are listed.

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 establishes that, in accordance with the prescribed test plan, the manufacturing plant, in particular personnel and equipment, and the factory production control are suitable to ensure a continuous manufacturing of the PT system according to the given technical specifications. For the most important activities, EAD 160004-00-0301, Table 4 summarises the minimum procedure.

5.2.2 Continuing surveillance, assessment, and evaluation of factory production control

The activities are conducted by the notified product certification body and include surveillance inspections. The kit manufacturer is inspected at least once a year. Factory production control is inspected and samples are taken for independent single tensile element tests.

For the most important activities, the control plan according to EAD 160004-00-0301, Table 4 summarises the minimum procedure. It is verified that the system of factory production control and the specified manufacturing process are maintained, taking account of the control plan.

Each manufacturer of the components given in Annex 30 is audited at least once in five years. It is verified that the system of factory production control and the specified manufacturing process are maintained, taking account 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 by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities

During surveillance inspection, the notified product certification body takes samples of components of the PT system for independent testing. Audit-testing is conducted at least once a year by the notified product certification body. For the most important components, Annex 30 summarises the minimum procedures. Annex 30 conforms to EAD 160004-00-0301, Table 4. In particular, at least once a year, the notified product certification body also carries out one single tensile element test series according to EAD 160004-00-0301, Annex C.7 and Clause 3.3.4 on specimens taken from the manufacturing plant or at the manufacturer's storage facility.

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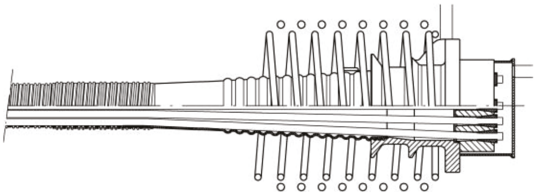
by Österreichisches Institut für Bautechnik

The original document is signed by

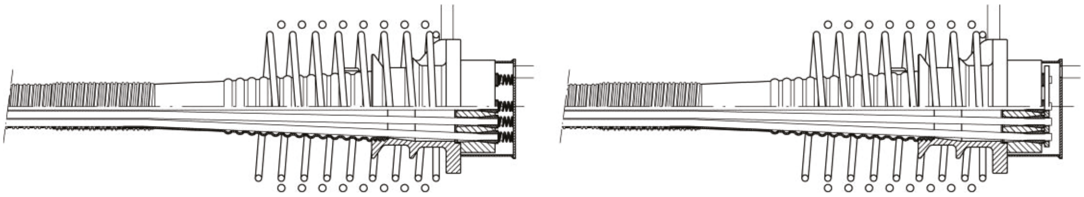
Rainer Mikulits
Managing Director

OIB Member of EOTA

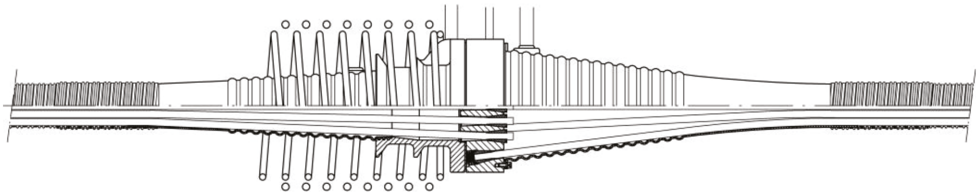
Stressing anchorage SA, accessible fixed anchorage FA



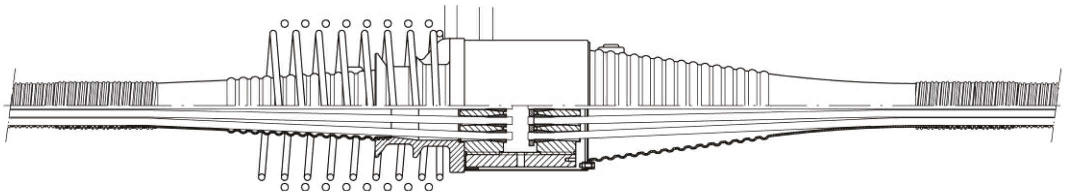
Inaccessible fixed anchorage FA



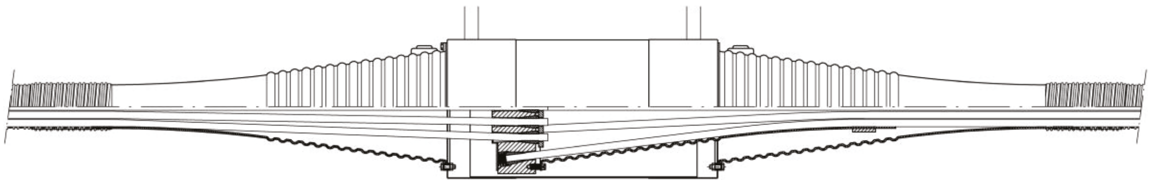
Fixed and stressing coupler FK, SK



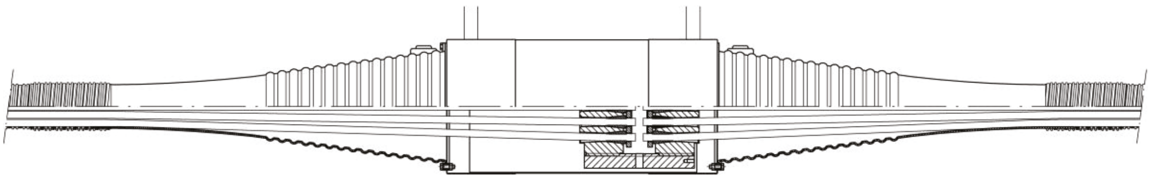
Fixed and stressing coupler FH, SH



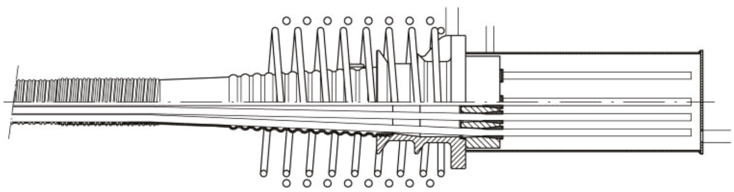
Movable coupler BK



Movable coupler BH



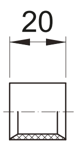
Restressable / exchangeable anchorage



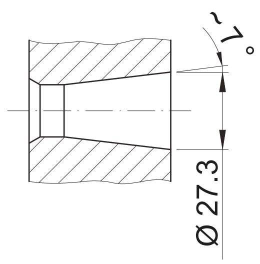
Anchor head A1-A4

Anchor head A5-A8

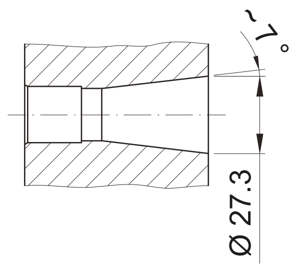
Ring cushion
Anchor head A5-A8



Cone
A1–A4



Cone
A5–A8

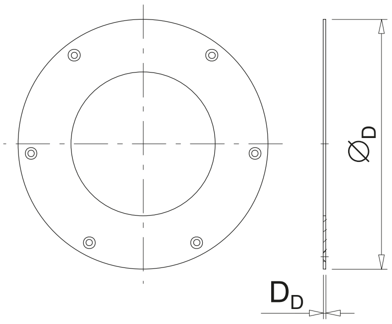


Dimensions in mm

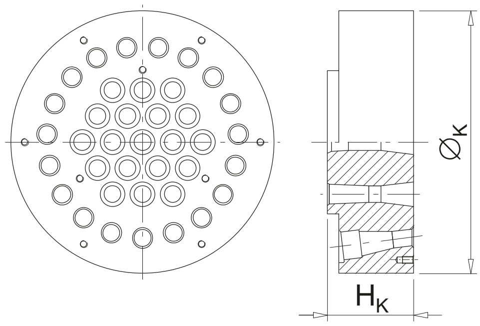
Number of strands			02	03	04	05	06	07	08	09	12	13	15	16
Anchor head														
Nominal diameter	$\varnothing_A$	mm	90	100	100	130	130	130	150	160	160	180	200	200
Height head A1-A4	H_A	mm	50	50	50	50	55	55	60	60	65	72	75	80
Height head A5-A8	H_A	mm	65	65	65	65	65	65	65	65	70	72	75	80

Number of strands			19	22	24	25	27	31	37	42	43	48	55	61
Anchor head														
Nominal diameter	$\varnothing_A$	mm	200	225	240	255	255	255	285	300	320	325	335	365
Height head A1-A4	H_A	mm	85	95	100	100	105	110	—	—	—	—	—	—
Height head A5-A8	H_A	mm	85	95	100	100	105	110	120	130	130	140	150	155

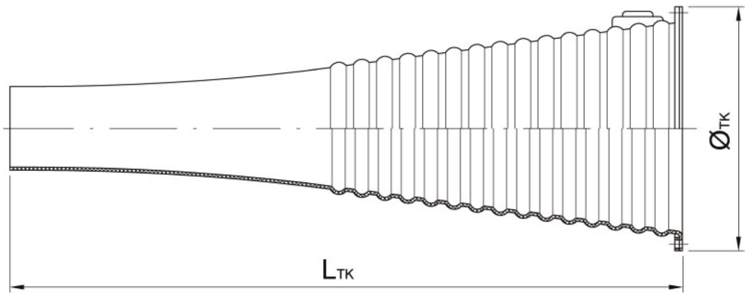
Cover plate K



Coupler head K



Trumpet K

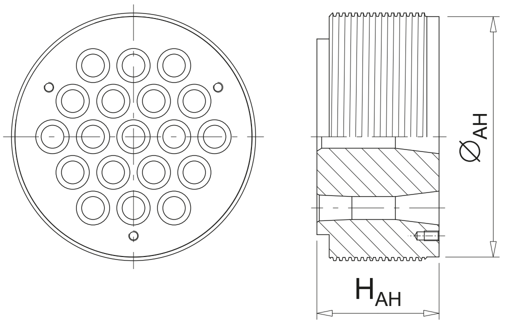


Number of strands			02	03	04	05	06	07	08	09	12
Coupler head K											
Diameter	$\varnothing_K$	mm	195	195	195	210	210	210	250	250	250
Height	H_K	mm	85	85	85	85	85	85	90	90	90
Cover plate											
Diameter	$\varnothing_D$	mm	192	192	192	207	207	207	246	246	246
Thickness	D_D	mm	3	3	3	3	3	3	3	3	3
Trumpet K											
Diameter	$\varnothing_{TK}$	mm	185	185	185	203	203	203	240	240	240
Length	L_{TK}	mm	470	470	470	640	640	640	845	845	730

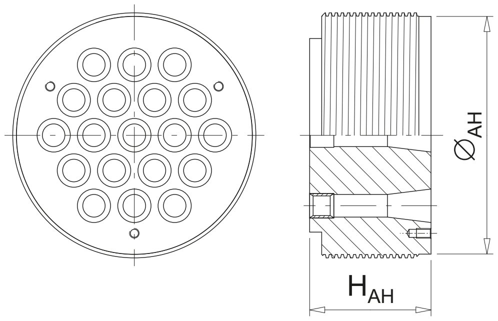
Number of strands			13	15	16	19	22	24	25	27	31
Coupler head K											
Diameter	$\varnothing_K$	mm	290	290	290	290	310	340	390	390	390
Height	H_K	mm	90	90	95	95	105	120	125	125	130
Cover plate											
Diameter	$\varnothing_D$	mm	286	286	286	286	306	336	386	386	386
Thickness	D_D	mm	3	3	3	3	5	5	5	5	5
Trumpet K											
Diameter	$\varnothing_{TK}$	mm	275	275	275	275	305	330	375	375	375
Length	L_{TK}	mm	890	890	890	775	840	1 090	1 265	1 265	1 150

OIB Member of EOTA

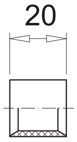
Coupler head H1



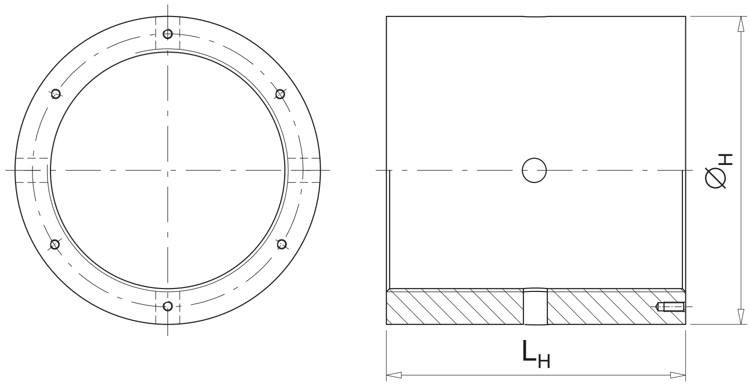
Coupler head H2



Ring cushion
Coupler head H2



Coupler sleeve H

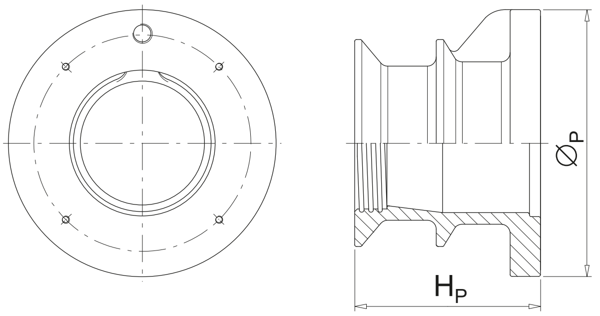


Dimensions in mm

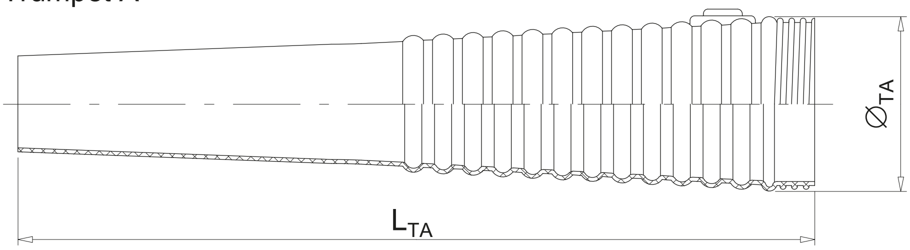
Number of strands			02	03	04	05	06	07	08	09	12	13	15	16
Coupler anchor heads H1 and H2														
Nominal diameter	$\varnothing_{AH}$	mm	90	95	100	130	130	130	150	160	160	180	200	200
Height head H1	H_{AH}	mm	50	50	55	55	60	65	65	70	80	80	80	85
Height head H2	H_{AH}	mm	65	65	65	65	65	65	65	70	80	80	80	85
Coupler sleeve H														
Minimum diameter	$\varnothing_{H}$	mm	114	124	133	163	167	170	192	203	213	233	259	259
Length sleeve	L_H	mm	180	180	180	180	190	200	200	210	230	230	240	250

Number of strands			19	22	24	25	27	31	37	42	43	48	55	61
Coupler anchor heads H1 and H2														
Nominal diameter	$\varnothing_{AH}$	mm	200	225	240	255	255	255	285	300	320	325	335	365
Height head H1	H_{AH}	mm	95	100	100	100	105	115	—	—	—	—	—	—
Height head H2	H_{AH}	mm	95	100	100	100	105	115	125	135	135	145	160	160
Coupler sleeve H														
Minimum diameter	$\varnothing_{H}$	mm	269	296	312	327	330	338	373	395	413	425	443	475
Length sleeve	L_H	mm	270	270	280	280	300	320	340	360	360	380	410	410

Bearing trumplate



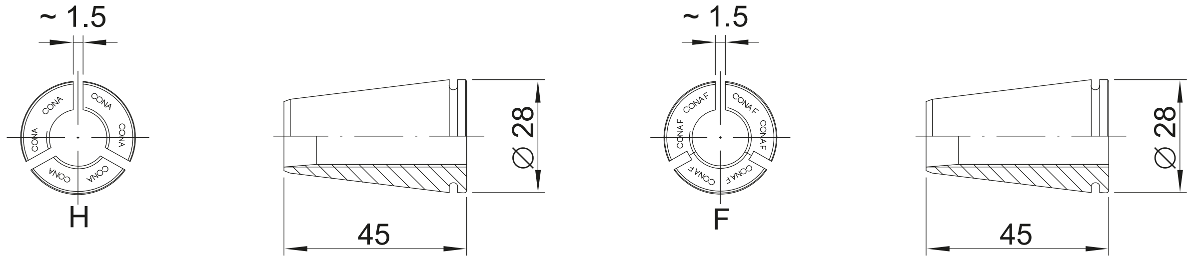
Trumpet A



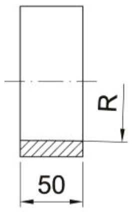
Number of strands			02	03	04	05	06	07	08	09	12	13	15	16
Bearing trumplate														
Diameter	$\varnothing_P$	mm	130	130	130	170	170	170	195	225	225	240	280	280
Height	H_P	mm	120	120	120	128	128	128	133	150	150	160	195	195
Trumpet A														
Diameter	$\varnothing_{TA}$	mm	72	72	72	88	88	88	127	127	127	153	153	153
Length	L_{TA}	mm	200	200	200	328	328	328	623	623	508	694	694	694

Number of strands			19	22	24	25	27	31	37	42	43	48	55	61
Bearing trumplate														
Diameter	$\varnothing_P$	mm	280	310	325	360	360	360	400	425	485	485	485	520
Height	H_P	mm	195	206	227	250	250	250	275	290	340	340	340	350
Trumpet A														
Diameter	$\varnothing_{TA}$	mm	153	170	191	191	191	191	219	229	254	254	254	278
Length	L_{TA}	mm	579	715	866	866	866	751	1 060	1 060	1 244	1 244	1 244	1 290

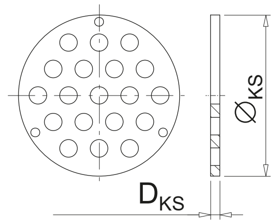
Wedges



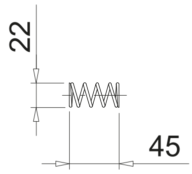
Tension ring



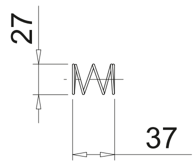
Wedge retaining plate KS



Spring A



Spring K



Dimensions in mm

Number of strands			02	03	04	05	06	07	08	09	12	13	15	16
Wedge retaining plate KS														
Diameter	$\varnothing_{KS}$	mm	65	73	91	117	117	117	130	157	157	145	185	185
Thickness	D_{KS}	mm	5	5	5	5	5	5	8	8	8	10	10	10

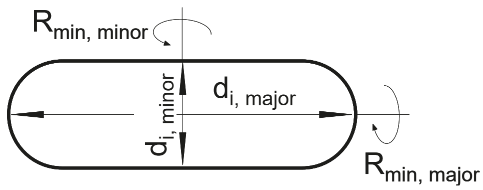
Number of strands			19	22	19	22	24	25	27	31	37	42	43	48
Wedge retaining plate KS														
Diameter	$\varnothing_{KS}$	mm	185	205	232	234	234	234	240	275	275	275	310	310
Thickness	D_{KS}	mm	10	10	10	10	10	10	12	12	12	12	12	12

CONA CMI BT n06-140

Number of strands	Nominal cross-sectional area of prestressing steel	Nominal mass of prestressing steel	Characteristic value of maximum force of tendon	
			f_{pk} = 1 770 MPa	f_{pk} = 1 860 MPa
n	A_p	M	F_{pk}	F_{pk}
—	mm²	kg/m	kN	kN
02	280	2.2	496	520
03	420	3.3	744	780
04	560	4.4	992	1 040
05	700	5.5	1 240	1 300
06	840	6.6	1 488	1 560
07	980	7.7	1 736	1 820
08	1 120	8.7	1 984	2 080
09	1 260	9.8	2 232	2 340
12	1 680	13.1	2 976	3 120
13	1 820	14.2	3 224	3 380
15	2 100	16.4	3 720	3 900
16	2 240	17.5	3 968	4 160
19	2 660	20.8	4 712	4 940
22	3 080	24.0	5 456	5 720
24	3 360	26.2	5 952	6 240
25	3 500	27.3	6 200	6 500
27	3 780	29.5	6 696	7 020
31	4 340	33.9	7 688	8 060
37	5 180	40.4	9 176	9 620
42	5 880	45.9	10 416	10 920
43	6 020	47.0	10 664	11 180
48	6 720	52.5	11 904	12 480
55	7 700	60.1	13 640	14 300
61	8 540	66.7	15 128	15 860

CONA CMI BT n06-150

Number of strands	Nominal cross-sectional area of prestressing steel	Nominal mass of prestressing steel	Characteristic value of maximum force of tendon	
			f_{pk} = 1 770 MPa	f_{pk} = 1 860 MPa
n	A_p	M	F_{pk}	F_{pk}
—	mm^2	kg/m	kN	kN
02	300	2.3	532	558
03	450	3.5	798	837
04	600	4.7	1 064	1 116
05	750	5.9	1 330	1 395
06	900	7.0	1 596	1 674
07	1 050	8.2	1 862	1 953
08	1 200	9.4	2 128	2 232
09	1 350	10.5	2 394	2 511
12	1 800	14.1	3 192	3 348
13	1 950	15.2	3 458	3 627
15	2 250	17.6	3 990	4 185
16	2 400	18.8	4 256	4 464
19	2 850	22.3	5 054	5 301
22	3 300	25.8	5 852	6 138
24	3 600	28.1	6 384	6 696
25	3 750	29.3	6 650	6 975
27	4 050	31.6	7 182	7 533
31	4 650	36.3	8 246	8 649
37	5 550	43.4	9 842	10 323
42	6 300	49.2	11 172	11 718
43	6 450	50.4	11 438	11 997
48	7 200	56.3	12 768	13 392
55	8 250	64.5	14 630	15 345
61	9 150	71.5	16 226	17 019



Inner dimensions, d_i, of flat duct and minimum radius of curvature, R_{min}, for $p_{R,\,max}$ = 200 kN/m

Number of strands	Inner dimensions		Radius of curvature	
n	$d_{i,\,major}$	$d_{i,\,minor}$	$R_{min,\,major}$	$R_{min,\,minor}$
—	mm	mm	m	m
02	40	20	2.0	2.1
03	55	20	2.0	3.1
04	70	20	2.0	4.2
05	85	20	2.0	5.2

Inner dimensions, d_i, of flat duct and minimum radius of curvature, R_{min}, for $p_{R,\,max}$ = 140 kN/m

Number of strands	Inner dimensions		Radius of curvature	
n	$d_{i,\,major}$	$d_{i,\,minor}$	$R_{min,\,major}$	$R_{min,\,minor}$
—	mm	mm	m	m
02	40	20	2.0	3.0
03	55	20	2.0	4.5
04	70	20	2.0	6.0
05	85	20	2.0	7.5

Inner diameter of circular duct, d_i, and minimum radius of curvature, R_{min}, for $p_{R, max}$ = 200 kN/m

Number of strands	f ≈ 0.35		f ≈ 0.40		f ≈ 0.45		f ≈ 0.50	
n	d_i	R_{min}	d_i	R_{min}	d_i	R_{min}	d_i	R_{min}
—	mm	m	mm	m	mm	m	mm	m
02	35	2.0	—	—	—	—	—	—
03	40	2.5	—	—	—	—	—	—
04	45	2.9	45	2.9	—	—	—	—
05	50	3.3	50	3.3	—	—	—	—
06	55	3.6	55	3.6	—	—	—	—
07	60	3.8	60	3.8	—	—	—	—
08	65	4.0	60	4.4	60	4.4	—	—
09	70	4.2	65	4.5	60	4.9	60	4.9
12	80	4.9	75	5.3	70	5.6	70	5.6
13	85	5.0	80	5.3	75	5.7	70	6.1
15	90	5.5	85	5.8	80	6.2	75	6.6
16	95	5.5	85	6.2	80	6.6	80	6.6
19	100	6.2	95	6.6	90	6.9	85	7.3
22	110	6.6	100	7.2	95	7.6	90	8.0
24	115	6.9	105	7.5	100	7.9	95	8.3
25	115	7.1	110	7.5	105	7.8	100	8.2
27	120	7.4	115	7.7	105	8.4	100	8.9
31	130	7.8	120	8.5	115	8.8	110	9.3
37	140	8.7	135	9.0	125	9.7	120	10.1
42	150	9.2	140	9.8	135	10.2	125	11.0
43	155	9.1	145	9.7	135	10.5	130	11.0
48	160	9.8	150	10.5	145	10.9	135	11.7
55	175	10.3	160	11.3	155	11.6	145	12.5
61	180	11.1	170	11.8	160	12.5	155	12.9

Inner diameter of circular duct, d_i, and minimum radius of curvature, R_{min}, for $p_{R,\,max}$ = 140 kN/m

Number of strands	f ≈ 0.35		f ≈ 0.40		f ≈ 0.45		f ≈ 0.50	
n	d_i	R_{min}	d_i	R_{min}	d_i	R_{min}	d_i	R_{min}
—	mm	m	mm	m	mm	m	mm	m
02	35	2.7	—	—	—	—	—	—
03	40	3.5	—	—	—	—	—	—
04	45	4.2	45	4.2	—	—	—	—
05	50	4.7	50	4.7	—	—	—	—
06	55	5.1	55	5.1	—	—	—	—
07	60	5.5	60	5.5	—	—	—	—
08	65	5.8	60	6.3	60	6.3	—	—
09	70	6.0	65	6.5	60	7.0	60	7.0
12	80	7.0	75	7.5	70	8.0	70	8.0
13	85	7.2	80	7.6	75	8.1	70	8.7
15	90	7.8	85	8.3	80	8.8	75	9.4
16	95	7.9	85	8.8	80	9.4	80	9.4
19	100	8.9	95	9.4	90	9.9	85	10.5
22	110	9.4	100	10.3	95	10.9	90	11.5
24	115	9.8	105	10.7	100	11.3	95	11.8
25	115	10.2	110	10.7	105	11.2	100	11.7
27	120	10.6	115	11.0	105	12.1	100	12.7
31	130	11.2	120	12.1	115	12.6	110	13.2
37	140	12.4	135	12.9	125	13.9	120	14.5
42	150	13.1	140	14.1	135	14.6	125	15.8
43	155	13.0	145	13.9	135	14.9	130	15.5
48	160	14.1	150	15.0	145	15.5	135	16.7
55	175	14.7	160	16.1	155	16.6	145	17.8
61	180	15.9	170	16.8	160	17.9	155	18.5

Minimum centre spacing of tendon anchorages

Tendon		Minimum centre spacing $a_c = b_c$				
$f_{cm, 0, cube, 150}$	MPa	23	28	34	38	43
$f_{cm, 0, cylinder, \varnothing 150}$	MPa	19	23	28	31	35
CONA CMI BT 0206	mm	210	210	210	210	205
CONA CMI BT 0306	mm	210	210	210	210	205
CONA CMI BT 0406	mm	235	215	210	210	205
CONA CMI BT 0506	mm	265	250	250	250	250
CONA CMI BT 0606	mm	290	265	250	250	250
CONA CMI BT 0706	mm	310	285	260	255	255
CONA CMI BT 0806	mm	330	305	280	275	275
CONA CMI BT 0906	mm	350	320	310	310	310
CONA CMI BT 1206	mm	405	370	340	325	310
CONA CMI BT 1306	mm	425	390	355	340	325
CONA CMI BT 1506	mm	455	415	380	365	365
CONA CMI BT 1606	mm	470	430	390	375	365
CONA CMI BT 1906	mm	510	465	425	410	390
CONA CMI BT 2206	mm	550	500	460	440	420
CONA CMI BT 2406	mm	575	525	480	460	435
CONA CMI BT 2506	mm	590	535	485	465	450
CONA CMI BT 2706	mm	610	555	505	485	460
CONA CMI BT 3106	mm	650	595	545	520	495
CONA CMI BT 3706	mm	—	680	680	680	680
CONA CMI BT 4206	mm	—	735	735	735	735
CONA CMI BT 4306	mm	—	755	755	755	755
CONA CMI BT 4806	mm	—	805	805	805	805
CONA CMI BT 5506	mm	—	875	875	875	875
CONA CMI BT 6106	mm	—	940	940	940	940

Minimum edge distance of tendon anchorages

Tendon		Minimum centre spacing $a_c = b_c$				
$f_{cm, 0, cube, 150}$	MPa	23	28	34	38	43
$f_{cm, 0, cylinder, \varnothing 150}$	MPa	19	23	28	31	35
CONA CMI BT 0206	mm	95 + c	95 + c	95 + c	95 + c	95 + c
CONA CMI BT 0306	mm	95 + c	95 + c	95 + c	95 + c	95 + c
CONA CMI BT 0406	mm	110 + c	100 + c	95 + c	95 + c	95 + c
CONA CMI BT 0506	mm	125 + c	115 + c	115 + c	115 + c	115 + c
CONA CMI BT 0606	mm	135 + c	125 + c	115 + c	115 + c	115 + c
CONA CMI BT 0706	mm	145 + c	135 + c	120 + c	120 + c	120 + c
CONA CMI BT 0806	mm	155 + c	145 + c	130 + c	130 + c	130 + c
CONA CMI BT 0906	mm	165 + c	150 + c	145 + c	145 + c	145 + c
CONA CMI BT 1206	mm	195 + c	175 + c	160 + c	155 + c	145 + c
CONA CMI BT 1306	mm	205 + c	185 + c	170 + c	160 + c	155 + c
CONA CMI BT 1506	mm	220 + c	200 + c	180 + c	175 + c	175 + c
CONA CMI BT 1606	mm	225 + c	205 + c	185 + c	180 + c	175 + c
CONA CMI BT 1906	mm	245 + c	225 + c	205 + c	195 + c	185 + c
CONA CMI BT 2206	mm	265 + c	240 + c	220 + c	210 + c	200 + c
CONA CMI BT 2406	mm	280 + c	255 + c	230 + c	220 + c	210 + c
CONA CMI BT 2506	mm	285 + c	260 + c	235 + c	225 + c	215 + c
CONA CMI BT 2706	mm	295 + c	270 + c	245 + c	235 + c	220 + c
CONA CMI BT 3106	mm	315 + c	290 + c	265 + c	250 + c	240 + c
CONA CMI BT 3706	mm	—	330 + c	330 + c	330 + c	330 + c
CONA CMI BT 4206	mm	—	360 + c	360 + c	360 + c	360 + c
CONA CMI BT 4306	mm	—	370 + c	370 + c	370 + c	370 + c
CONA CMI BT 4806	mm	—	395 + c	395 + c	395 + c	395 + c
CONA CMI BT 5506	mm	—	430 + c	430 + c	430 + c	430 + c
CONA CMI BT 6106	mm	—	460 + c	460 + c	460 + c	460 + c

c..... Concrete cover in mm

Material specifications

Component	Standard / Specification
Anchor head A CONA CMI BT 0206 to 6106	EN 10083-1 EN 10083-2
Coupler anchor head K CONA CMI BT 0206 to 3106	EN 10083-1 EN 10083-2
Coupler anchor head H CONA CMI BT 0206 to 6106	EN 10083-1 EN 10083-2
Bearing trumplate CONA CMI BT 0206 to 6106	EN 1561 EN 1563
Coupler sleeve H CONA CMI BT 0206 to 6106	EN 10210-1
Wedge retaining plate, cover plate KS CONA CMI BT 0206 to 6106	EN 10025-2
Trumpet A and K	EN ISO 17855-1
Ring cushion	EN ISO 17855-1 EN ISO 19069-1
Tension ring B	EN 10210-1
Ring wedge H and F	EN 10277-2 EN 10084
Spring A and K	EN 10270-1
Helix	Ribbed reinforcing steel $R_e \geq 500$ MPa
Additional reinforcement, stirrups	Ribbed reinforcing steel $R_e \geq 500$ MPa
Sheaths	EN 523

Maximum prestressing and overstressing forces

Designation		Maximum prestressing force 1) $0.9 \cdot F_{p0.1}$				Maximum overstressing force 1), 2) $0.95 \cdot F_{p0.1}$			
		CONA CMI BT							
		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
	07	1 373	1 443	1 474	1 550	1 450	1 523	1 556	1 636
	08	1 570	1 649	1 685	1 771	1 657	1 740	1 778	1 870
	09	1 766	1 855	1 895	1 993	1 864	1 958	2 001	2 103
	12	2 354	2 473	2 527	2 657	2 485	2 611	2 668	2 804
	13	2 551	2 679	2 738	2 878	2 692	2 828	2 890	3 038
	15	2 943	3 092	3 159	3 321	3 107	3 263	3 335	3 506
	16	3 139	3 298	3 370	3 542	3 314	3 481	3 557	3 739
	19	3 728	3 916	4 001	4 207	3 935	4 133	4 224	4 440
	22	4 316	4 534	4 633	4 871	4 556	4 786	4 891	5 141
	24	4 709	4 946	5 054	5 314	4 970	5 221	5 335	5 609
	25	4 905	5 153	5 265	5 535	5 178	5 439	5 558	5 843
	27	5 297	5 565	5 686	5 978	5 592	5 874	6 002	6 310
	31	6 082	6 389	6 529	6 863	6 420	6 744	6 891	7 245
	37	7 259	7 626	7 792	8 192	7 663	8 049	8 225	8 647
	42	8 240	8 656	8 845	9 299	8 698	9 137	9 337	9 815
	43	8 437	8 862	9 056	9 520	8 905	9 355	9 559	10 049
	48	9 418	9 893	10 109	10 627	9 941	10 442	10 670	11 218
	55	10 791	11 336	11 583	12 177	11 391	11 965	12 227	12 854
	61	11 968	12 572	12 847	13 505	12 633	13 271	13 560	14 256

1) The given values are maximum values according to Eurocode 2. The actual values are 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 $0.80 \cdot F_{pk}$.

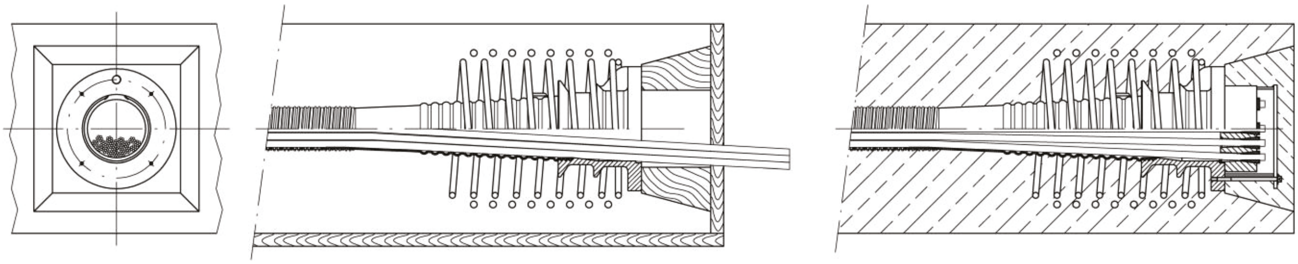
2) Overstressing is permitted if the force in the prestressing jack is measured to an accuracy of ± 5 % of the final value of the prestressing force.

Where

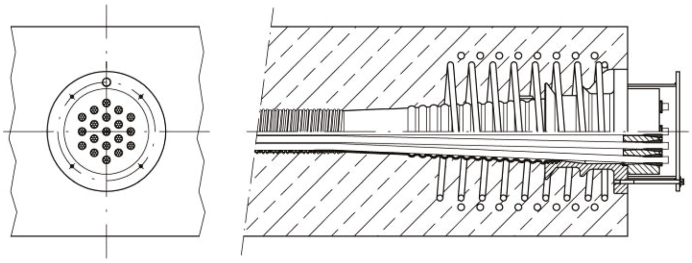
F_{pk} .....Characteristic value of maximum force of tendon

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

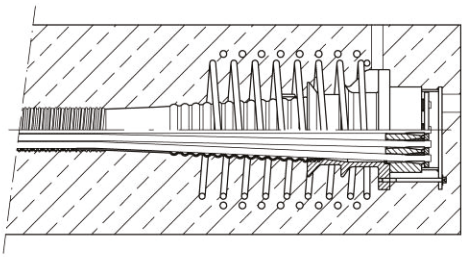
Recessed stressing anchorage SA



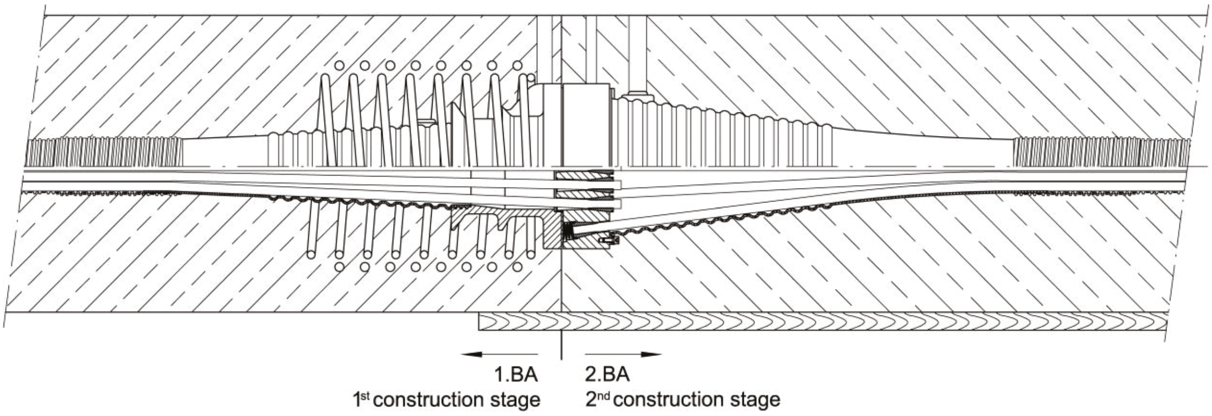
Exposed stressing anchorage SA



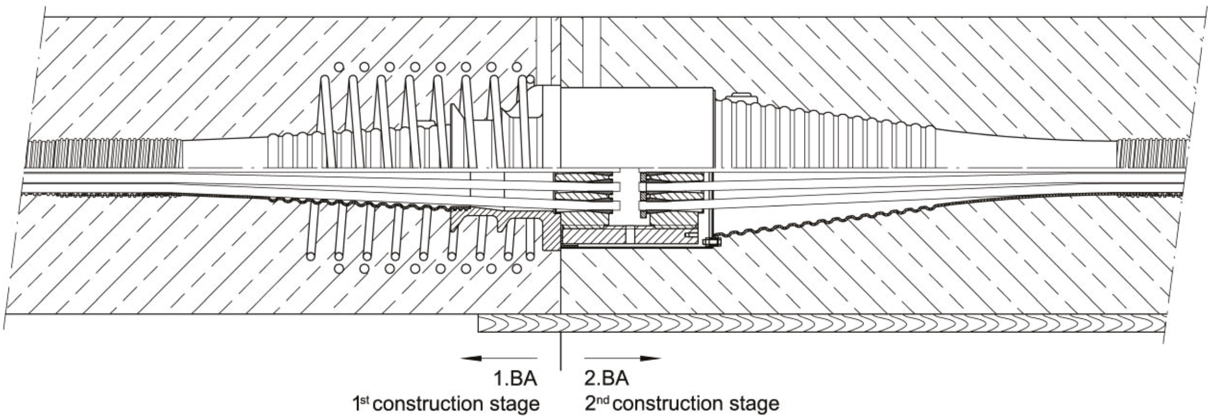
Fixed anchorage FA



Fixed and stressing coupler FK, SK

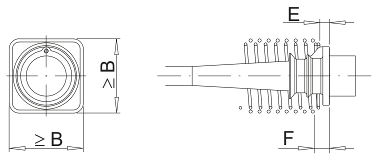


Fixed and stressing coupler FH, SH

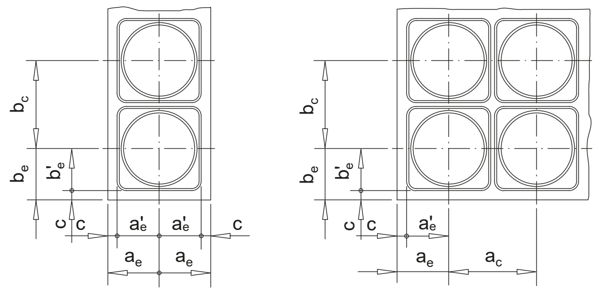


BBR CONA CMI BT	**Internal Post-tensioning System** Construction stages	**Annex 16** of European Technical Assessment **ETA-09/0286** of 19.09.2018

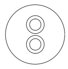
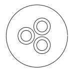
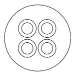
Stressing and fixed anchorage / coupler



Centre spacing and edge distance



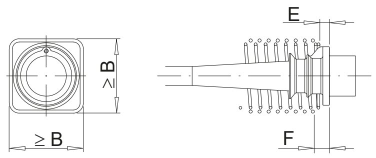
$a_e = a'_e + c$
$b_e = b'_e + c$
c … Concrete cover

BBR VT CONA CMI BT		0206					0306					0406				
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]																
Tendon																
Cross-sectional area A_p	mm^2	300					450					600				
Char. value of maximum force F_{pk}	kN	558					837					1 116				
Char. value of 0.1% proof force $F_{p0.1}$	kN	492					738					984				
Max. prestressing force $0.90 \cdot F_{p0.1}$	kN	443					664					886				
Max. overstressing force $0.95 \cdot F_{p0.1}$	kN	467					701					935				
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance																
Minimum concrete strength																
Cube $f_{cm, 0, cube, 150}$	**MPa**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**
Cylinder $f_{cm, 0, cylinder, \varnothing 150}$	**MPa**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**
Helix																
Outer diameter	mm	160	160	160	160	155	160	160	160	160	155	180	160	160	160	155
Bar diameter	mm	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Length approximately	mm	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185
Pitch	mm	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Number of pitches	—	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Distance E	mm	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Additional reinforcement																
Number of stirrups	mm	3	3	3	3	3	4	3	4	4	3	3	3	4	4	3
Bar diameter	mm	8	8	8	8	8	8	10	8	8	10	12	12	10	10	12
Spacing	mm	55	55	55	55	55	45	55	45	45	55	60	55	45	45	55
Distance from anchor plate F	mm	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Minimum outer dimensions B × B	mm	190	190	190	190	190	190	190	190	190	190	220	200	190	190	190
Centre spacing and edge distance																
Minimum centre spacing a_c, b_c	mm	210	210	210	210	205	210	210	210	210	205	235	215	210	210	205
Minimum edge distance a'_e, b'_e	mm	95	95	95	95	95	95	95	95	95	95	110	100	95	95	95

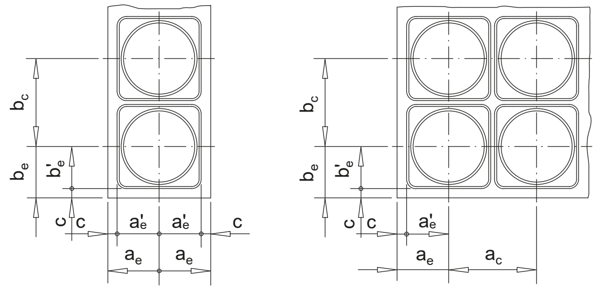
[1]....Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1 860 MPa may also be used.

OIB Member of EOTA

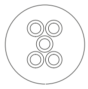
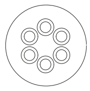
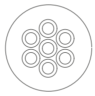
Stressing and fixed anchorage / coupler



Centre spacing and edge distance



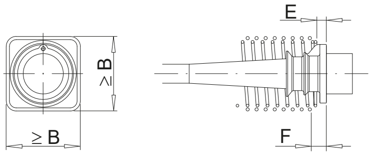
$a_e = a'_e + c$
$b_e = b'_e + c$
c … Concrete cover

BBR VT CONA CMI BT		0506					0606					0706				
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]																
Tendon																
Cross-sectional area A_p	mm²	750					900					1 050				
Char. value of maximum force F_{pk}	kN	1 395					1 674					1 953				
Char. value of 0.1% proof force $F_{p0.1}$	kN	1 230					1 476					1 722				
Max. prestressing force $0.90 \cdot F_{p0.1}$	kN	1 107					1 328					1 550				
Max. overstressing force $0.95 \cdot F_{p0.1}$	kN	1 169					1 402					1 636				
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance																
Minimum concrete strength																
Cube $f_{cm, 0, cube, 150}$	**MPa**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**
Cylinder $f_{cm, 0, cylinder, \varnothing 150}$	**MPa**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**
Helix																
Outer diameter	mm	200	195	195	195	195	200	200	195	195	195	230	200	200	200	200
Bar diameter	mm	10	10	10	10	10	10	10	10	10	10	12	12	12	12	12
Length approximately	mm	230	205	205	245	230	253	230	205	245	230	254	256	231	231	231
Pitch	mm	45	50	50	60	50	45	50	50	60	50	45	50	50	50	50
Number of pitches	—	6	5	5	5	5	6	5	5	5	5	6	6	5	5	5
Distance E	mm	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Additional reinforcement																
Number of stirrups	mm	4	4	4	3	4	5	4	5	3	4	5	4	4	4	4
Bar diameter [2]	mm	12	12	12	12	12	12	12	12	12	12	14	14	12	14	14
Spacing	mm	55	50	50	65	50	50	55	45	65	50	55	60	55	55	55
Distance from anchor plate F	mm	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
Minimum outer dimensions B × B	mm	250	230	230	230	230	270	250	230	230	230	290	270	240	240	240
Centre spacing and edge distance																
Minimum centre spacing a_c, b_c	mm	265	250	250	250	250	290	265	250	250	250	310	285	260	255	255
Minimum edge distance a'_e, b'_e	mm	125	115	115	115	115	135	125	115	115	115	145	135	120	120	120

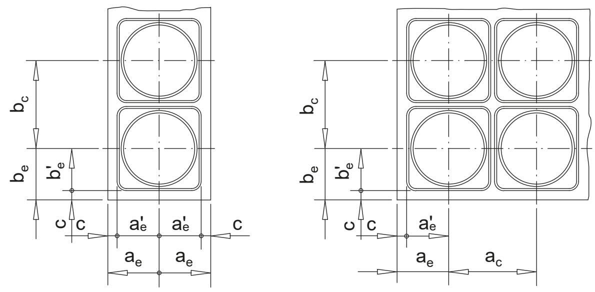
[1]....Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1 860 MPa may also be used.
[2]....Bar diameter of 14 mm can be replaced by 16 mm.

Member of EOTA

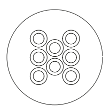
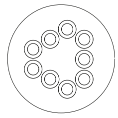
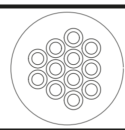
Stressing and fixed anchorage / coupler



Centre spacing and edge distance

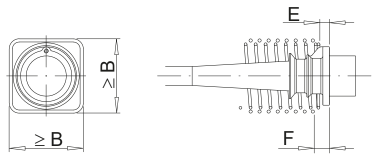


$a_e = a'_e + c$
$b_e = b'_e + c$
c … Concrete cover

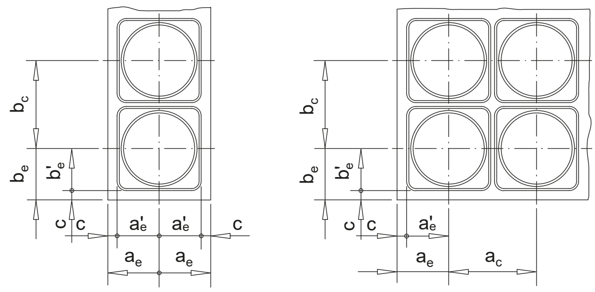
BBR VT CONA CMI BT		0806					0906					1206				
Strand arrangement																
7-wire prestressing steel strand – Nominal diameter **15.7 mm** … Nominal cross-sectional area **150 mm²** Maximum characteristic tensile strength **1 860 MPa** [1)]																
Tendon																
Cross-sectional area A_p	mm^2	1 200					1 350					1 800				
Char. value of maximum force F_{pk}	kN	2 232					2 511					3 348				
Char. value of 0.1% proof force $F_{p0.1}$	kN	1 968					2 214					2 952				
Max. prestressing force $0.90 \cdot F_{p0.1}$	kN	1 771					1 993					2 657				
Max. overstressing force $0.95 \cdot F_{p0.1}$	kN	1 870					2 103					2 804				
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance																
Minimum concrete strength																
Cube $f_{cm, 0, cube, 150}$	**MPa**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**
Cylinder $f_{cm, 0, cylinder, \varnothing 150}$	**MPa**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**
Helix																
Outer diameter	mm	270	230	225	220	220	280	260	255	250	250	330	280	275	260	250
Bar diameter [2)]	mm	14	12	12	12	12	14	12	12	12	12	14	14	14	14	14
Length approximately	mm	282	256	231	256	256	282	281	281	281	281	332	332	332	332	282
Pitch	mm	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Number of pitches	—	6	6	5	6	6	6	6	6	6	6	7	7	7	7	6
Distance E	mm	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Additional reinforcement																
Number of stirrups	mm	4	6	5	4	5	5	5	5	4	5	7	6	5	5	6
Bar diameter [2)]	mm	12	12	12	14	14	12	14	12	14	14	12	14	16	16	14
Spacing	mm	70	45	50	55	50	60	55	55	65	55	60	55	70	70	50
Distance from anchor plate F	mm	33	33	33	33	33	35	35	35	35	35	35	35	35	35	35
Minimum outer dimensions B × B	mm	310	290	260	260	260	330	300	290	290	290	390	350	320	310	290
Centre spacing and edge distance																
Minimum centre spacing a_c, b_c	mm	330	305	280	275	275	350	320	310	310	310	405	370	340	325	310
Minimum edge distance a'_e, b'_e	mm	155	145	130	130	130	165	150	145	145	145	195	175	160	155	145

[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)]....Bar diameter of 14 mm can be replaced by 16 mm.

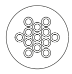
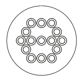
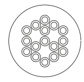
Stressing and fixed anchorage / coupler



Centre spacing and edge distance

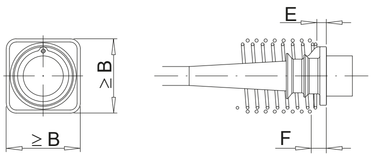


$a_e = a'_e + c$
$b_e = b'_e + c$
c … Concrete cover

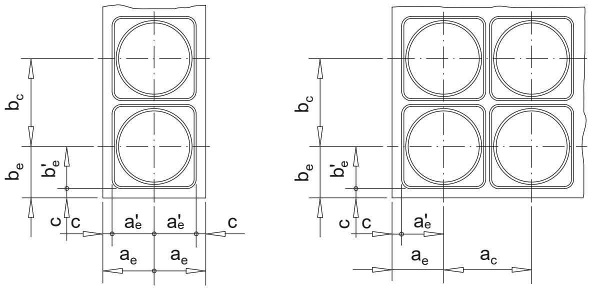
BBR VT CONA CMI BT			1306					1506					1606				
Strand arrangement																	
7-wire prestressing steel strand – Nominal diameter **15.7 mm** … Nominal cross-sectional area **150 mm²** Maximum characteristic tensile strength **1 860 MPa** 1)																	
Tendon																	
Cross-sectional area	A_p	mm²	1 950					2 250					2 400				
Char. value of maximum force	F_{pk}	kN	3 627					4 185					4 464				
Char. value of 0.1% proof force	$F_{p0.1}$	kN	3 198					3 690					3 936				
Max. prestressing force	$0.90 \cdot F_{p0.1}$	kN	2 878					3 321					3 542				
Max. overstressing force	$0.95 \cdot F_{p0.1}$	kN	3 038					3 506					3 739				
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance																	
Minimum concrete strength																	
Cube	$f_{cm, 0, cube, 150}$	**MPa**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**
Cylinder	$f_{cm, 0, cylinder, \varnothing 150}$	**MPa**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**
Helix																	
Outer diameter		mm	375	330	300	280	270	375	330	315	305	305	375	330	320	310	305
Bar diameter 2)		mm	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Length approximately		mm	382	357	382	332	282	432	432	382	332	332	432	432	432	382	332
Pitch		mm	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Number of pitches		—	8	8	8	7	6	9	9	8	7	7	9	9	9	8	7
Distance	E	mm	23	23	23	23	23	27	27	27	27	27	27	27	27	27	27
Additional reinforcement																	
Number of stirrups		mm	7	6	6	6	7	7	6	5	6	5	7	6	5	6	6
Bar diameter 2)		mm	12	14	14	14	14	14	16	16	16	16	14	16	16	16	16
Spacing		mm	55	60	55	60	45	60	65	65	55	60	60	65	65	60	60
Distance from anchor plate	F	mm	40	40	40	40	40	42	42	42	42	42	42	42	42	42	42
Minimum outer dimensions	B × B	mm	410	370	340	320	310	440	400	360	350	350	450	410	370	360	350
Centre spacing and edge distance																	
Minimum centre spacing	a_c, b_c	mm	425	390	355	340	325	455	415	380	365	365	470	430	390	375	365
Minimum edge distance	a'_e, b'_e	mm	205	185	170	160	155	220	200	180	175	175	225	205	185	180	175

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)....Bar diameter of 14 mm can be replaced by 16 mm.

Stressing and fixed anchorage / coupler



Centre spacing and edge distance



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

BBR VT CONA CMI BT		1906					2206					2406				
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)]																
Tendon																
Cross-sectional area A_p	mm²	2 850					3 300					3 600				
Char. value of maximum force F_{pk}	kN	5 301					6 138					6 696				
Char. value of 0.1 % proof force $F_{p0.1}$	kN	4 674					5 412					5 904				
Max. prestressing force $0.90 \cdot F_{p0.1}$	kN	4 207					4 871					5 314				
Max. overstressing force $0.95 \cdot F_{p0.1}$	kN	4 440					5 141					5 609				
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance																
Minimum concrete strength																
Cube $f_{cm, 0, cube, 150}$	**MPa**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**
Cylinder $f_{cm, 0, cylinder, \varnothing 150}$	**MPa**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**
Helix																
Outer diameter	mm	420	360	360	330	325	475	420	390	360	340	475	430	410	360	360
Bar diameter [2)]	mm	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Length approximately	mm	457	457	432	432	382	482	482	432	432	382	532	532	482	482	432
Pitch	mm	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Number of pitches	—	10	10	9	9	8	10	10	9	9	8	11	11	10	10	9
Distance E	mm	27	27	27	27	27	31	31	31	31	31	32	32	32	32	32
Additional reinforcement																
Number of stirrups	mm	7	7	7	7	7	6	7	8	7	8	7	7	7	7	8
Bar diameter	mm	16	16	16	16	16	20	20	20	20	16	20	20	20	20	20
Spacing	mm	65	65	65	65	60	80	75	65	65	50	80	80	70	65	55
Distance from anchor plate F	mm	42	42	42	42	42	46	46	46	46	46	47	47	47	47	47
Minimum outer dimensions B × B	mm	490	450	410	390	370	530	480	440	420	400	560	510	460	440	420
Centre spacing and edge distance																
Minimum centre spacing a_c, b_c	mm	510	465	425	410	390	550	500	460	440	420	575	525	480	460	435
Minimum edge distance a'_e, b'_e	mm	245	225	205	195	185	265	240	220	210	200	280	255	230	220	210

[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)]....Bar diameter of 14 mm can be replaced by 16 mm.

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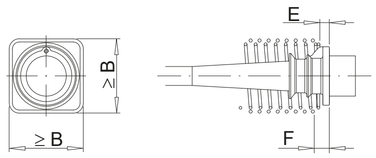
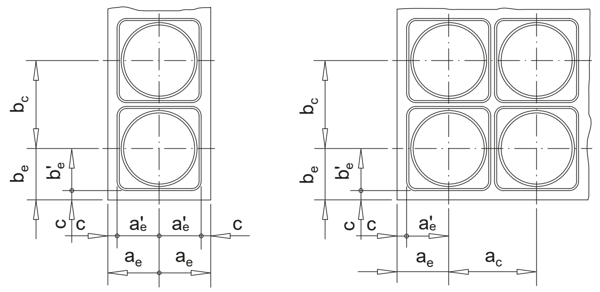
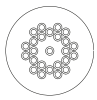
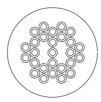
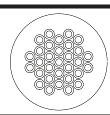
Stressing and fixed anchorage / coupler



Centre spacing and edge distance



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

BBR VT CONA CMI BT	2506	2706	3106
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)]

Tendon

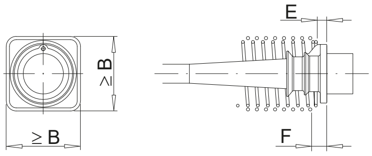
			2506	2706	3106
Cross-sectional area	A_p	mm²	3 750	4 050	4 650
Char. value of maximum force	F_{pk}	kN	6 975	7 533	8 649
Char. value of 0.1% proof force	$F_{p0.1}$	kN	6 150	6 642	7 626
Max. prestressing force	$0.90 \cdot F_{p0.1}$	kN	5 535	5 978	6 863
Max. overstressing force	$0.95 \cdot F_{p0.1}$	kN	5 843	6 310	7 245

Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance

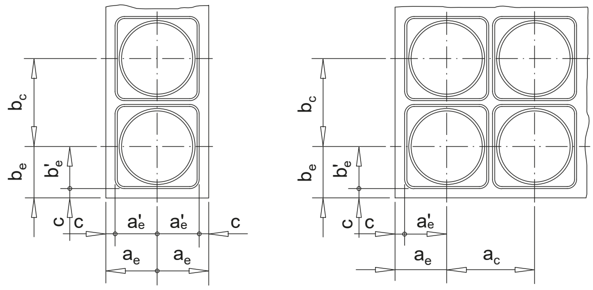
			2506					2706					3106				
Minimum concrete strength																	
Cube	$f_{cm, 0, cube, 150}$	**MPa**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**
Cylinder	$f_{cm, 0, cylinder, \varnothing 150}$	**MPa**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**
Helix																	
Outer diameter		mm	520	430	420	390	380	520	475	440	420	390	560	520	475	430	430
Bar diameter [2)]		mm	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Length approximately		mm	532	532	482	482	432	532	532	482	482	432	532	532	582	482	432
Pitch		mm	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Number of pitches		—	11	11	10	10	9	11	11	10	10	9	11	11	12	10	9
Distance	E	mm	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Additional reinforcement																	
Number of stirrups		mm	7	6	7	7	7	8	7	7	8	8	9	8	8	8	8
Bar diameter		mm	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Spacing		mm	80	90	70	60	60	80	80	75	60	60	80	75	70	65	60
Distance from anchor plate	F	mm	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Minimum outer dimensions	B × B	mm	570	520	470	450	430	590	540	490	470	440	630	580	530	500	480
Centre spacing and edge distance																	
Minimum centre spacing	a_c, b_c	mm	590	535	485	465	450	610	555	505	485	460	650	595	545	520	495
Minimum edge distance	a'_e, b'_e	mm	285	260	235	225	215	295	270	245	235	220	315	290	265	250	240

[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)]....Bar diameter of 14 mm can be replaced by 16 mm.

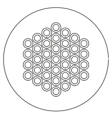
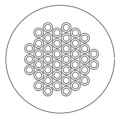
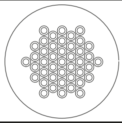
Stressing and fixed anchorage / coupler



Centre spacing and edge distance

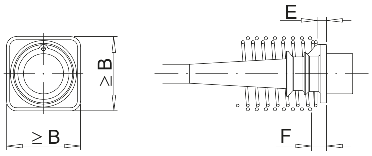


$a_e = a'_e + c$
$b_e = b'_e + c$
c … Concrete cover

BBR VT CONA CMI BT		3706					4206					4306				
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)]																
Tendon																
Cross-sectional area A_p	mm²	5 550					6 300					6 450				
Char. value of maximum force F_{pk}	kN	10 323					11 718					11 997				
Char. value of 0.1% proof force $F_{p0.1}$	kN	9 102					10 332					10 578				
Max. prestressing force $0.90 \cdot F_{p0.1}$	kN	8 192					9 299					9 520				
Max. overstressing force $0.95 \cdot F_{p0.1}$	kN	8 647					9 815					10 049				
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance																
Minimum concrete strength																
Cube $f_{cm, 0, cube, 150}$	**MPa**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**
Cylinder $f_{cm, 0, cylinder, \varnothing 150}$	**MPa**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**
Helix																
Outer diameter	mm	—	580	580	580	580	—	630	630	630	630	—	670	670	670	670
Bar diameter	mm	—	16	16	16	16	—	16	16	16	16	—	16	16	16	16
Length approximately	mm	—	533	533	533	533	—	583	583	583	583	—	583	583	583	583
Pitch	mm	—	50	50	50	50	—	50	50	50	50	—	50	50	50	50
Number of pitches	—	—	11	11	11	11	—	12	12	12	12	—	12	12	12	12
Distance E	mm	—	40	40	40	40	—	45	45	45	45	—	45	45	45	45
Additional reinforcement																
Number of stirrups	mm	—	9	9	9	9	—	10	10	10	10	—	10	10	10	10
Bar diameter	mm	—	20	20	20	20	—	20	20	20	20	—	20	20	20	20
Spacing	mm	—	70	70	70	70	—	70	70	70	70	—	70	70	70	70
Distance from anchor plate F	mm	—	50	50	50	50	—	55	55	55	55	—	55	55	55	55
Minimum outer dimensions B × B	mm	—	660	660	660	660	—	720	720	720	720	—	740	740	740	740
Centre spacing and edge distance																
Minimum centre spacing a_c, b_c	mm	—	680	680	680	680	—	735	735	735	735	—	755	755	755	755
Minimum edge distance a'_e, b'_e	mm	—	330	330	330	330	—	360	360	360	360	—	370	370	370	370

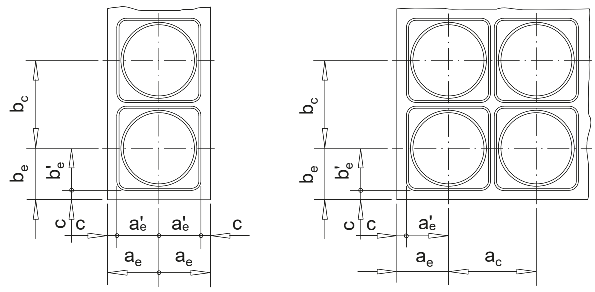
[1)]....Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1 860 MPa may also be used.

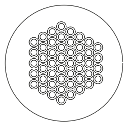
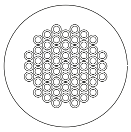
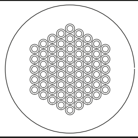
Stressing and fixed anchorage / coupler



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

Centre spacing and edge distance

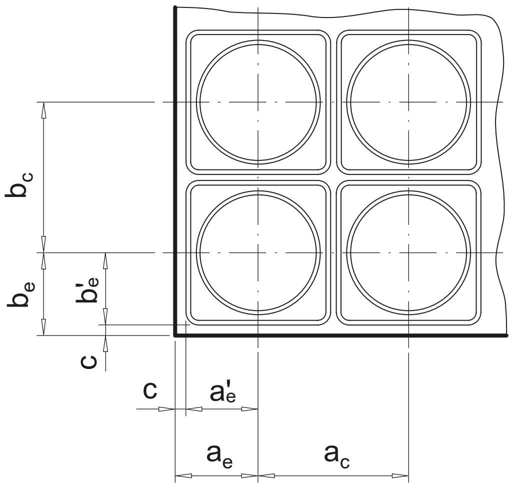


BBR VT CONA CMI BT		4806					5506					6106				
Strand arrangement																
7-wire prestressing steel strand – Nominal diameter **15.7 mm** … Nominal cross-sectional area **150 mm²** Maximum characteristic tensile strength **1 860 MPa** [1]																
Tendon																
Cross-sectional area A_p	mm²	7 200					8 250					9 150				
Char. value of maximum force F_{pk}	kN	13 392					15 345					17 019				
Char. value of 0.1% proof force $F_{p0.1}$	kN	11 808					13 530					15 006				
Max. prestressing force $0.90 \cdot F_{p0.1}$	kN	10 627					12 177					13 505				
Max. overstressing force $0.95 \cdot F_{p0.1}$	kN	11 218					12 854					14 256				
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance																
Minimum concrete strength																
Cube $f_{cm,\,0,\,cube,\,150}$	**MPa**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**	**23**	**28**	**34**	**38**	**43**
Cylinder $f_{cm,\,0,\,cylinder,\,\varnothing 150}$	**MPa**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**	**19**	**23**	**28**	**31**	**35**
Helix																
Outer diameter	mm	—	710	710	710	710	—	780	780	780	780	—	850	850	850	850
Bar diameter	mm	—	16	16	16	16	—	20	20	20	20	—	20	20	20	20
Length approximately	mm	—	633	633	633	633	—	760	760	760	760	—	790	790	790	790
Pitch	mm	—	50	50	50	50	—	60	60	60	60	—	60	60	60	60
Number of pitches	—	—	13	13	13	13	—	13	13	13	13	—	14	14	14	14
Distance E	mm	—	45	45	45	45	—	50	50	50	50	—	55	55	55	55
Additional reinforcement																
Number of stirrups	mm	—	11	11	11	11	—	11	11	11	11	—	12	12	12	12
Bar diameter	mm	—	20	20	20	20	—	20	20	20	20	—	20	20	20	20
Spacing	mm	—	70	70	70	70	—	75	75	75	75	—	75	75	75	75
Distance from anchor plate F	mm	—	55	55	55	55	—	55	55	55	55	—	60	60	60	60
Minimum outer dimensions $B \times B$	mm	—	790	790	790	790	—	860	860	860	860	—	920	920	920	920
Centre spacing and edge distance																
Minimum centre spacing a_c, b_c	mm	—	805	805	805	805	—	875	875	875	875	—	940	940	940	940
Minimum edge distance a'_e, b'_e	mm	—	395	395	395	395	—	430	430	430	430	—	460	460	460	460

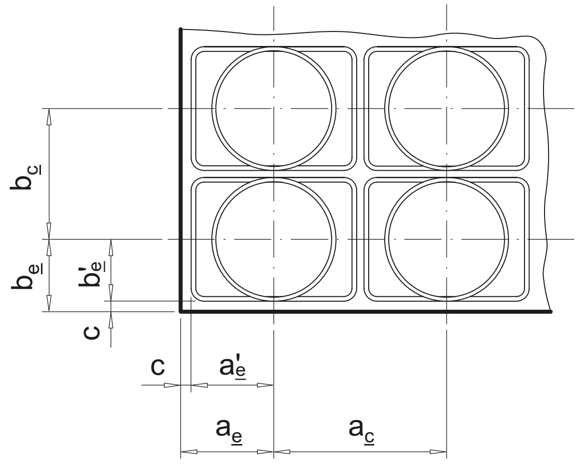
[1]....Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1 860 MPa may also be used.

BBR CONA CMI BT	**Internal Post-tensioning System** Minimum concrete strength – Helix – Additional reinforcement – Centre spacing and edge distance	**Annex 24** of European Technical Assessment **ETA-09/0286** of 19.09.2018

Centre spacing and edge distance



a_c, b_c
a_e, b_e



$a_{\underline{c}} \geq b_{\underline{c}}$
$a_{\underline{e}} \geq b_{\underline{e}}$

Modification of centre spacing and edge distance are in accordance with the Clauses 1.8 and 2.2.3.5.

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

$$a_{\underline{c}} \geq \frac{A_c}{b_{\underline{c}}}$$

$$A_c = a_c \cdot b_c \leq a_{\underline{c}} \cdot b_{\underline{c}}$$

Corresponding edge distances

$$a_{\underline{e}} = \frac{a_{\underline{c}}}{2} - 10\ \text{mm} + c \qquad \text{and} \qquad b_{\underline{e}} = \frac{b_{\underline{c}}}{2} - 10\ \text{mm} + c$$

c..... Concrete cover

1) .... Except the dimensions of helix, the outer dimensions of the additional reinforcement are adjusted accordingly. Further modifications of reinforcement are in accordance with Clause 2.2.3.5.

1) Preparatory work

The components of the prestressing kit are stored so as to avoid any damage or corrosion.

2) Anchorage recesses

Adequate space to accommodate and to use the prestressing jack is ensured, see also the Clauses 1.2.6 and 2.2.3.3.

3) Fastening the bearing trumplates

Four holes are provided to fasten the bearing trumplates to the formwork. The trumpet is screwed into the bearing trumplate. The helix is either welded to the bearing trumplate by means of radial bars, see also Clause 2.2.4.6, or positioned by fastening it to the existing reinforcement.

4) Placing of the sheaths

The sheaths are placed on supports with spacing according to Clause 1.6 and minimum radii of curvature according to Clause 1.9. The sheaths are jointed in a leak-proof way. The sheaths are supported such that any movement is prevented.

The same applies for prefabricated tendons.

5) Installation of tensile elements (prestressing steel)

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

6) Installation of the inaccessible fixed anchorages

After passing the strands through the anchor head, they are anchored individually in the cones by means of ring wedges. After assembling the wedges are secured with springs or a wedge retaining plate. An alternative is pre-locking each individual strand with ~ $0.5 \cdot F_{pk}$ and applying a wedge retaining plate.

7) Installation of fixed coupler anchor head 2.BA

The function of the fixed coupler is to connect two tendons, whereas the first tendon is stressed before the second tendon is installed and stressed.

The coupling is achieved by pushing the strands into the already tensioned coupler anchor head K, side 2.BA (outer pitch circle), whereby the strands are marked to check the correct depth of penetration.

The coupler anchor head H, 2.BA is assembled with ring wedges and a wedge retaining plate. It is connected to the already tensioned coupler anchor head H, 1.BA by means of a threaded coupler sleeve.

8) Assembly of movable coupler

The movable coupler serves to lengthen unstressed tendons. The axial movement during stressing is ensured by a sheathing box suitable to the expected elongation at the position of the coupler.

The assembly of the coupler anchor head is performed in accordance with Point 7) and Clause 1.2.5. The transverse forces at the end of the trumpet are covered by steel deflector rings.

9) Checking the tendons before concreting

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

10) Assembly of anchor head/coupler anchor head 1.BA

After passing the strands through the anchor head, they are anchored individually in the cones by means of ring wedges. The same applies for the coupler anchor head in case of fixed couplers in the first construction stage.

11) Prestressing

At the time of stressing the mean concrete compressive strength is at least according to Table 6 and the provisions of Clause 1.10. Stressing and possible wedging is carried out with a suitable prestressing jack and in accordance with Clause 2.2.4.2.

The elongation of the tendon and the prestressing forces is checked and recorded systematically during the stressing operation.

Restressing the tendons is allowed in accordance with Clause 2.2.4.3.

12) Grouting the tendons

The grout is injected through the inlet holes until it escapes from the outlet tubes with the same consistency. All vents and grouting inlets are sealed immediately after grouting, see also Clause 2.2.4.5.1.

Grease or wax are injected in accordance with Clause 2.2.4.5.2 and the recommendations of the supplier.

More detailed information on installation can be obtained from the ETA holder.

Seven-wire strands according to prEN 10138-3 [1)]

Steel name			Y1770S7	Y1860S7	Y1770S7	Y1860S7
Tensile strength	R_m	MPa	1 770	1 860	1 770	1 860
Diameter	d	mm	15.3	15.3	15.7	15.7
Nominal cross-sectional area	A_p	mm²	140	140	150	150
Nominal mass per metre	M	kg/m	1.093		1.172	
Permitted deviation from nominal mass		%	± 2			
Characteristic value of maximum force	F_{pk}	kN	248	260	266	279
Maximum value of maximum force	$F_{m, max}$	kN	285	299	306	321
Characteristic value of 0.1% proof force [2)]	$F_{p0.1}$	kN	218	229	234	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 is multiplied by 0.98.
3) Standard value

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Contents of the prescribed test plan

Subject / type of control		Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Bearing trumplate	Material	Checking [1]	[2]	100 %	continuous
	Detailed dimensions	Testing	[2]	3 %, ≥ 2 specimens	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	bulk			
Anchor head, Coupler anchor head, Coupler sleeve	Material	Checking [1]	[2]	100 %	continuous
	Detailed dimensions	Testing	[2]	5 %, ≥ 2 specimens	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	full			
Ring wedge	Material	Checking [1]	[2]	100 %	continuous
	Treatment, hardness	Testing	[2]	0.5 %, ≥ 2 specimens	continuous
	Detailed dimensions	Testing	[2]	5 %, ≥ 2 specimens	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	full			
Strand	Material	Checking	[2], [4]	100 %	continuous
	Dimension	Testing	[2]	1 sample	each coil or every 7 tons [5]
	Visual inspection	Checking	[2]	1 sample	
Steel strip duct	Material	Checking [6]	[2]	100 %	continuous
	Dimension	Testing	[2]	3 %, ≥ 2 specimens	continuous
	Traceability	full			
Cement, admixtures, additions of filling materials as per EN 447	Material	Checking [6]	[2]	100 %	continuous
	Traceability	full			

1) Checking by means of an inspection report 3.1 according to EN 10204.
2) Conformity with the specifications of the component
3) Successful visual inspection does not need to be documented.
4) Checking of relevant certificate as long as the basis of "CE"-marking is not available.
5) Maximum between a coil and 7 tons is taken into account
6) Checking of relevant certificate, CE marking and declaration of performance or, if basis for CE marking is not available, certificate of supplier

Traceability full	Full traceability of each component to its raw material.
Material	Defined according to technical specification deposited by the supplier
Detailed dimension	Measuring of all the dimensions and angles according to the specification given in the test plan
Visual inspection	Main dimensions, correct marking and labelling, surface, corrosion, coating, etc.
Treatment, hardness	Surface hardness, core hardness and treatment depth

Audit testing

Subject / type of control		Test or control method	Criteria, if any	Minimum number of samples [1]	Minimum frequency of control
Bearing trumplate	Material	Checking and testing, hardness and chemical [2]	[3]	1	1/year
	Detailed dimensions	Testing	[3]	1	1/year
	Visual inspection	Checking	[3]	1	1/year
Anchor head, Coupler anchor head, Coupler sleeve	Material	Checking and testing, hardness and chemical [2]	[3]	1	1/year
	Detailed dimensions	Testing	[3]	1	1/year
	Visual inspection	Checking	[3]	1	1/year
Ring wedge	Material	Checking and testing, hardness and chemical [2]	[3]	2	1/year
	Treatment, hardness	Checking and testing, hardness profile	[3]	2	1/year
	Detailed dimensions	Testing	[3]	1	1/year
	Main dimensions, surface hardness	Testing	[3]	5	1/year
	Visual inspection	Checking	[3]	5	1/year
Single tensile element test		According to EAD 160004-00-0301, Annex C.7		1 series	1/year

[1] If the kits comprise different kinds of anchor heads e.g. with different materials, different shape, different wedges, etc., then the number of samples are understood as per kind.

[2] Testing of hardness and checking of chemical composition by means of an inspection report 3.1 according to EN 10204.

[3] Conformity with the specifications of the components

Material	Defined according to technical specification deposited by the ETA holder at the Notified body
Detailed dimension	Measuring of all the dimensions and angles according to the specification given in the test plan
Visual inspection	Main dimensions, correct marking and labelling, surface, corrosion, coating, etc.
Treatment, hardness	Surface hardness, core hardness and treatment depth

№	Essential Characteristic	Clause	Intended use Line № according to Clause 2.1, Table 8		
			1	2	3
1	Resistance to static load	3.2.1.1	+	+	+
2	Resistance to fatigue	3.2.1.2	+	+	+
3	Load transfer to the structure	3.2.1.3	+	+	+
4	Friction coefficient	3.2.1.4	+	+	+
5	Deviation, deflection (limits) for internal bonded and internal unbonded tendon	3.2.1.5	+	+	+
6	Assessment of assembly	3.2.1.6	+	+	+
7	Corrosion protection	3.2.1.7	+	+	+
8	Reaction to fire	3.2.2.1	+	+	+
9	Content, emission and/or release of dangerous substances	3.2.3.1	+	+	+
10	Resistance to static load under cryogenic conditions for applications with anchorage/ coupling outside the possible cryogenic zone	3.2.4.1	—	—	+

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.

Reference documents

European Assessment Documents

EAD 160004-00-0301	Post-Tensioning Kits for Prestressing of Structures
EAD 160027-00-0301	Special filling products for post-tensioning kits

Eurocodes

Eurocode 2	Eurocode 2: Design of concrete structures
Eurocode 3	Eurocode 3: Design of steel structures
Eurocode 6	Eurocode 6: Design of masonry structures

Standards

EN 206+A1, 11.2016	Concrete – Specification, performance, production and conformity
EN 445, 10.2007	Grout for prestressing tendons – Test methods
EN 446, 10.2007	Grout for prestressing tendons – Grouting procedures
EN 447, 10.2007	Grout for prestressing tendons – Basic requirements
EN 523, 08.2003	Steel strip sheaths for prestressing tendons – Terminology, requirements, quality control
EN 1561, 10.2011	Founding – Grey cast irons
EN 1563, 12.2011	Founding – Spheroidal graphite cast irons
EN 10025-2, 11.2004 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 10210-1, 04.2006	Hot finished structural hollow sections of non-alloy and fine grain steels – Part 1: Technical delivery conditions
EN 10216-1, 12.2013	Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 1: Non-alloy steel tubes with specified room temperature properties
EN 10217-1, 05.2002 EN 10217-1/A1, 01.2005	Welded steel tubes for pressure purposes – Technical delivery conditions – Part 1: Non-alloy steel tubes with specified room temperature properties
EN 10219-1, 04.2006	Cold formed welded structural hollow sections of non-alloy and fine grain steels – Part 1: Technical delivery conditions
EN 10255+A1, 04.2007	Non-Alloy steel tubes suitable for welding and threading – Technical delivery conditions

EN 10270-1, 10.2011	Steel wire for mechanical springs – Part 1: Patented cold drawn unalloyed steel wire
EN 10277-2, 03.2008	Bright steel products – Technical delivery conditions – Part 2: Steels for general engineering purposes
EN 10305-5, 01.2010	Steel tubes for precision applications – Technical delivery conditions – Part 5: Welded cold sized square and rectangular tubes
EN ISO 17855-1, 10.2014	Plastics – Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specifications
EN ISO 19069-1, 03.2015	Plastics – Polypropylene (PP) moulding and extrusion materials – Part 1: Designation system and basis for specifications
prEN 10138-3, 09.2000	Prestressing steels – Part 3: Strand
prEN 10138-3, 08.2009	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
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 posttensioning 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

Certificate of constancy of performance
0432-CPR-00299-1.4 (EN)

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 CMI BT – Internal Post-tensioning System with 02 to 61 Strands

Bonded or unbonded post-tensioning kits for prestressing of structures with strands

placed on the market under the name or trade mark of

BBR VT International Ltd
Ringstrasse 2
8603 Schwerzenbach (ZH) / Switzerland

and produced in the manufacturing plant(s)

BBR VT International Ltd
Ringstrasse 2
8603 Schwerzenbach (ZH) / Switzerland

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

ETA-09/0286, issued on 19.09.2018

and

EAD 160004-00-0301

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 30.07.2010 and will remain valid until 20.09.2023 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, 21.09.2018

by order

Dipl.-Ing. Hönig
Head of Certification Body (Dep. 21)

Materialprüfungsamt Nordrhein-Westfalen MPA NRW 10

This Certificate consists of 1 page.

This Certificate replaces the Certificate no. 0432-CPD-11 9181-1.4/2 dated 30.06.2013.

DAkkS Deutsche Akkreditierungsstelle D-ZE-11142-01-01

The original of this document was issued in German language.
In case of doubt only the German version is valid.

second copy

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