European Technical Approval
ETA – 09/0287

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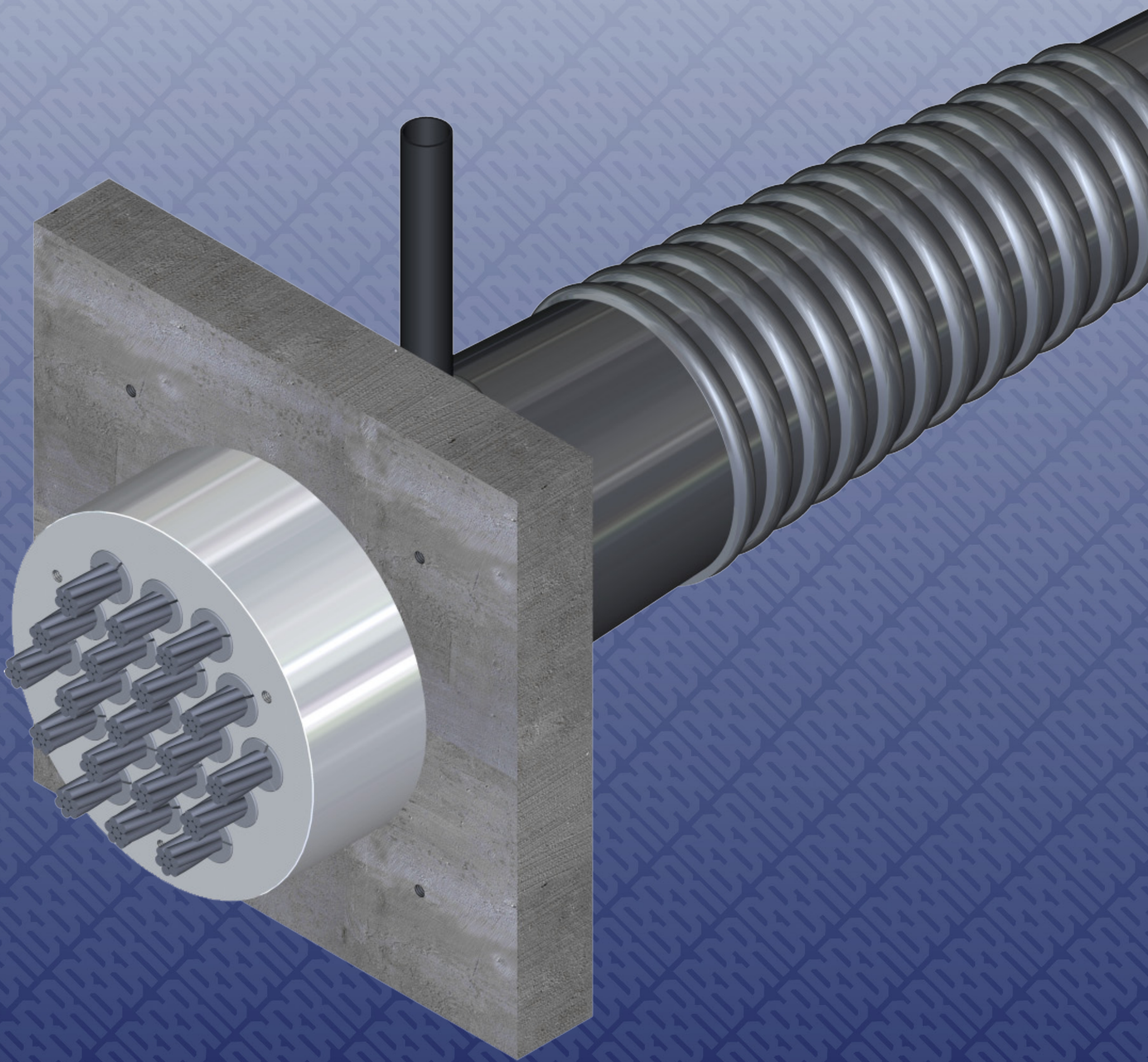

BBR VT CONA CMI SP

Internal Post-tensioning System with 01 to 61 Strands

A Global Network of Experts
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0432

ETA-09/0287
BBR VT CONA CMI SP
Internal Post-tensioning System with 01 to 61 Strands

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

0432-CPD-11 9181-1.5/2
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Responsible BBR PT Specialist Company

CE	The delivery note accompanying components of the BBR VT CONA CMI SP Post-tensioning System will contain the CE marking.
BBR Company Year – PT Specialist Company – www.bbrnetwork.com	Assembly and installation of BBR VT CONA CMI SP tendons must only be carried out by qualified BBR PT Specialist Companies. Find the local BBR PT Specialist Company by visiting the BBR Network website www.bbrnetwork.com.
EOTA	European Organisation for Technical Approvals Europäische Organisation für Technische Zulassungen Organisation Européenne pour l'Agrément technique
ETAG 013	Guideline for European Technical Approval of Post-tensioning Kits for Prestressing of Structures
CWA 14646	Requirements for the installation of post-tensioning kits for prestressing of structures and qualification of the specialist company and its personnel
BBR E-TRACE 2	BBR E-Trace is the trading and quality assurance platform of the BBR Network linking the Holder of Approval, BBR VT International Ltd, BBR PT Specialist Companies and the BBR Manufacturing Plant. Along with the established BBR Factory Production Control, BBR E-Trace provides effective supply chain management including installation, delivery notes and highest quality standards, as well as full traceability of components.

Authorised and notified according to Article 10 of the Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products

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European technical approval ETA-09/0287

English translation, the original version is in German

Handelsbezeichnung *Trade name*	**BBR VT CONA CMI SP – Internes Spannverfahren mit 01 bis 61 Litzen** *BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands*
Zulassungsinhaber *Holder of approval*	**BBR VT International Ltd. Bahnstrasse 23 8603 Schwerzenbach (ZH) Switzerland**
Zulassungsgegenstand und Verwendungszweck *Generic type and use of construction product*	**Litzen-Spannverfahren, intern, im Verbund und ohne Verbund, für das Vorspannen von Tragwerken** *Post-tensioning kit for internal prestressing of structures with internal bonded and unbonded strands*
Geltungsdauer vom *Validity from*	**30.06.2013**
bis zum *to*	**29.06.2018**
Herstellwerk *Manufacturing plant*	**BBR VT International Ltd. Bahnstrasse 23 8603 Schwerzenbach (ZH) Switzerland**
Diese Europäische technische Zulassung umfasst *This European technical approval contains*	**56 Seiten einschließlich 34 Anhängen** *56 Pages including 34 Annexes*
Diese Europäische technische Zulassung ersetzt *This European technical approval replaces*	**ETA-09/0287 mit Geltungsdauer vom 29.09.2010 bis zum 16.05.2015** *ETA-09/0287 with validity from 29.09.2010 to 16.05.2015*

European Organisation for Technical Approvals
Europäische Organisation für Technische Zulassungen
Organisation Européenne pour l’Agrément Technique

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Table of contents

EUROPEAN TECHNICAL APPROVAL ETA-09/0287 1
TABLE OF CONTENTS 2
I LEGAL BASES AND GENERAL CONDITIONS 5
II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL 6
1 DEFINITION OF PRODUCT AND INTENDED USE 6
1.1 Definition of product 6
1.2 Intended use 7
2 CHARACTERISTICS OF THE PRODUCT AND METHODS OF VERIFICATION 7
PT SYSTEM 7
2.1 Designation and range of the anchorages and couplers 7
2.1.1 Designation 7
2.1.2 Anchorage 8
2.1.2.1 General 8
2.1.2.2 Restressable and exchangeable tendon 8
2.1.3 Fixed and stressing coupler 8
2.1.3.1 General 8
2.1.3.2 Single plane coupler (FK, SK) 8
2.1.3.3 Sleeve coupler (FH, SH) 8
2.1.4 Movable coupler (BK, BH) 8
2.1.5 Layout of the anchorage recesses 8
2.2 Designation and range of the tendons 9
2.2.1 Designation 9
2.2.2 Range 9
2.2.2.1 CONA CMI SP n06-140 9
2.2.2.2 CONA CMI SP n06-150 9
2.3 Ducts 10
2.3.1 Use of ducts 10
2.3.2 Degree of filling 10
2.3.3 Round steel strip sheaths 10
2.3.4 Flat corrugated steel ducts 10
2.3.5 Pre-bent smooth round steel ducts 10
2.3.6 Plastic sheaths 10
2.4 Minimum radii of curvature 11
2.5 Support of tendons 11
2.6 Friction losses 11
2.7 Slip at anchorages and couplers 12
2.8 Concrete strength at time of stressing 13
2.9 Centre spacing and edge distance of anchorages 13
COMPONENTS 14
2.10 Strands 14
2.11 Anchorages and couplers 14
2.11.1 Anchor heads 14
2.11.2 Square plates 14
2.11.3 Trumpets 15
2.11.4 Coupler anchor heads type K, H 15
2.11.5 Ring wedges 15
2.11.6 Helix and additional reinforcement 15
2.11.7 Protection caps 15

2.11.8 Material properties 15
2.12 Permanent corrosion protection 16
2.13 Dangerous substances 16
2.14 Methods of verification 16
2.15 Identification 16

3 EVALUATION OF CONFORMITY AND CE MARKING 16
3.1 Attestation of conformity system 16
3.2 Responsibilities 17
3.2.1 Tasks for the manufacturer – factory production control 17
3.2.2 Tasks of the approved body 18
3.2.2.1 Initial type-testing of the products 18
3.2.2.2 Initial inspection of factory and of factory production control 18
3.2.2.3 Continuous surveillance 18
3.2.2.4 Audit testing of samples taken at the factory 18
3.3 CE marking 18

4 ASSUMPTIONS UNDER WHICH THE FITNESS OF THE PRODUCT FOR THE INTENDED USE WAS FAVOURABLY ASSESSED 18
4.1 Manufacturing 18
4.2 Design 19
4.2.1 General 19
4.2.2 Anchorage recess 19
4.2.3 Reinforcement in the anchorage zone 19
4.2.4 Fatigue resistance 19
4.2.5 Tendons in masonry structures – Load transfer to the structure 19
4.2.6 Maximum prestressing force 19
4.3 Installation 19
4.4 Stressing operation 20
4.5 Restressing 20
4.6 Exchanging tendons 21
4.7 Filling material 21
4.7.1 General 21
4.7.2 Grout 21
4.7.3 Grease and wax 21
4.7.4 Circulating dry air 21
4.7.5 Recordings 21
4.8 Welding 21

5 RECOMMENDATIONS FOR THE MANUFACTURER 22
5.1 Recommendations for packing, transport and storage 22
5.2 Recommendations on installation 22
5.3 Accompanying information 22

ANNEXES 23

ANNEX 1 OVERVIEW ANCHORAGES AND COUPLERS 23
ANNEX 2 ANCHORAGE AND COUPLER CONA CMI SP 0106 24
ANNEX 3 ANCHOR HEADS 25
ANNEX 4 COUPLERS K AND TRUMPETS TYPE K 26
ANNEX 5 COUPLERS H 27
ANNEX 6 SQUARE PLATES AND TRUMPETS TYPE A SP 28

ANNEX 7 WEDGES AND ACCESSORIES 29
ANNEX 8 TENDON RANGES FOR CONA CMI N06-140 30
ANNEX 9 TENDON RANGES FOR CONA CMI N06-150 31
ANNEX 10 MINIMUM RADIUS OF CURVATURE OF FLAT DUCT 32
ANNEX 11 MINIMUM RADIUS OF CURVATURE OF ROUND DUCT FOR $P_{R,\ MAX}$ = 200 KN/M 33
ANNEX 12 MINIMUM RADIUS OF CURVATURE OF ROUND DUCT FOR $P_{R,\ MAX}$ = 140 KN/M 34
ANNEX 13 MINIMUM WALL THICKNESS OF STEEL AND PLASTIC DUCT 35
ANNEX 14 MINIMUM CENTRE SPACING 36
ANNEX 15 MINIMUM EDGE DISTANCE 37
ANNEX 16 MATERIAL CHARACTERISTICS 38
ANNEX 17 CONTENTS OF THE PRESCRIBED TEST PLAN 39
ANNEX 18 AUDIT TESTING 40
ANNEX 19 MAXIMUM PRESTRESSING AND OVERSTRESSING FORCES 41
ANNEX 20 CONSTRUCTION STAGES 42
ANNEX 21 MINIMUM CONCRETE STRENGTH – HELIX – ADDITIONAL REINFORCEMENT – CENTRE AND EDGE DISTANCE – SQUARE PLATE DIMENSIONS 43
ANNEX 22 MINIMUM CONCRETE STRENGTH – HELIX – ADDITIONAL REINFORCEMENT – CENTRE AND EDGE DISTANCE – SQUARE PLATE DIMENSIONS 44
ANNEX 23 MINIMUM CONCRETE STRENGTH – HELIX – ADDITIONAL REINFORCEMENT – CENTRE AND EDGE DISTANCE – SQUARE PLATE DIMENSIONS 45
ANNEX 24 MINIMUM CONCRETE STRENGTH – HELIX – ADDITIONAL REINFORCEMENT – CENTRE AND EDGE DISTANCE – SQUARE PLATE DIMENSIONS 46
ANNEX 25 MINIMUM CONCRETE STRENGTH – HELIX – ADDITIONAL REINFORCEMENT – CENTRE AND EDGE DISTANCE – SQUARE PLATE DIMENSIONS 47
ANNEX 26 MINIMUM CONCRETE STRENGTH – HELIX – ADDITIONAL REINFORCEMENT – CENTRE AND EDGE DISTANCE – SQUARE PLATE DIMENSIONS 48
ANNEX 27 MINIMUM CONCRETE STRENGTH – HELIX – ADDITIONAL REINFORCEMENT – CENTRE AND EDGE DISTANCE – SQUARE PLATE DIMENSIONS 49
ANNEX 28 MINIMUM CONCRETE STRENGTH – HELIX – ADDITIONAL REINFORCEMENT – CENTRE AND EDGE DISTANCE – SQUARE PLATE DIMENSIONS 50
ANNEX 29 MINIMUM CONCRETE STRENGTH – HELIX – ADDITIONAL REINFORCEMENT – CENTRE AND EDGE DISTANCE – SQUARE PLATE DIMENSIONS 51
ANNEX 30 MODIFICATION OF CENTRE SPACING AND EDGE DISTANCE 52
ANNEX 31 DESCRIPTION OF INSTALLATION 53
ANNEX 32 DESCRIPTION OF INSTALLATION 54
ANNEX 33 STRAND SPECIFICATIONS 55
ANNEX 34 REFERENCE DOCUMENTS 56

I LEGAL BASES AND GENERAL CONDITIONS

1 This European technical approval is issued by Österreichisches Institut für Bautechnik in accordance with:

1. Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products[1] – Construction Products Directive (CPD) –, amended by the Council Directive 93/68/EEC of 22 July 1993[2], and Regulation (EC) 1882/2003 of the European Parliament and of the Council of 29 September 2003[3];
2. *dem Salzburger Bauproduktegesetz, LGBl. Nr. 11/1995, in der Fassung LGBl. Nr. 47/1995, LGBl. Nr. 63/1995, LGBl. Nr. 123/1995, LGBl. Nr. 46/2001, LGBl. Nr. 73/2001, LGBl. Nr. 99/2001 und LGBl. Nr. 20/2010*;

   the Salzburg Construction Product Regulation LGBl. № 11/1995, amended by LGBl. № 47/1995, LGBl. № 63/1995, LGBl. № 123/1995, LGBl. № 46/2001, LGBl. № 73/2001, LGBl. № 99/2001, and LGBl. № 20/2010;
3. Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex of Commission Decision 94/23/EC[4];
4. Guideline for European technical approval of Post-Tensioning Kits for Prestressing of Structures, ETAG 013, Edition June 2002.

2 Österreichisches Institut für Bautechnik is authorised to check whether the provisions of this European technical approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European technical approval and for their fitness for the intended use remains with the holder of the European technical approval.

3 This European technical approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on Page 1, or manufacturing plants other than those indicated on Page 1 of this European technical approval.

4 This European technical approval may be withdrawn by Österreichisches Institut für Bautechnik, in particular pursuant to information by the Commission according to Article 5 (1) of Council Directive 89/106/EEC.

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6 The European technical approval is issued by the Approval Body in its official language. This version corresponds to the version circulated within EOTA. Translations into other languages have to be designated as such.

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[1] Official Journal of the European Communities № L 40, 11.02.1989, page 12
[2] Official Journal of the European Communities № L 220, 30.08.1993, page 1
[3] Official Journal of the European Union № L 284, 31.10.2003, page 1
[4] Official Journal of the European Communities № L 17, 20.01.1994, page 34

II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of product and intended use

1.1 Definition of product

The European technical approval (ETA)[5] applies to a kit, the PT system

BBR VT CONA CMI SP –
Internal Post-tensioning System with 01 to 61 Strands,

comprising the following components:

– Tendon

Internal tendons with 01 to 61 tensile elements.

– Tensile element

7-wire prestressing steel strand with nominal diameter 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 strands with ring wedges;

End anchorage

Fixed (passive) anchor or stressing (active) anchor as end anchorage for 01, 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 strands;

Fixed or stressing coupler

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

Sleeve coupler for 01, 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 strands;

Movable coupler

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

Sleeve coupler for 01, 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 strands;

– Square plate for 01, 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 strands;

[5] The European technical approval ETA-09/0287 was firstly issued in 2010 with validity from 17.05.2010, amended in 2010 with validity from 29.09.2010 and replaced in 2013 with validity from 30.06.2013 to 30.06.2013.

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

1.2 Intended use

The PT system is intended to be used for the prestressing of structures.

Use categories according to type of tendon and material of structure:

- Internal bonded tendon for normal weight concrete in concrete and composite structures
- Internal unbonded tendon for normal weight concrete in concrete and composite structures
- For special structures according to Eurocode 2, Eurocode 4 and Eurocode 6

Optional use categories:

- Restressable tendons
- Exchangeable tendons
- Tendon for cryogenic applications with anchorages not exposed to cryogenic conditions

The provisions made in the European technical approval are based on an assumed intended working life of the PT system of 100 years. The indications given on the working life of the PT system cannot be interpreted as a guarantee given by the manufacturer or the Approval Body, but are to be regarded only as a means for selecting the appropriate product in relation to the expected, economically reasonable working life of the construction works.

2 Characteristics of the product and methods of verification

PT system

2.1 Designation and range of the anchorages and couplers

End anchorages can be used as fixed or stressing anchors. Couplers are fixed, stressing or movable. The principal dimensions of anchorages and couplers are given in the Annexes 2 to 7 and 21 to 29.

2.1.1 Designation

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

Fixed (F) or stressing (S) ◄— S

Anchorage ◄— A

Designation of the tendon ◄— CONA CMI SP 1906-150 1860
with information on number, cross-sectional area and characteristic tensile strength of the strands

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

Fixed (F), stressing (S) or movable (B) ◄— F

Coupler anchor head (K or H) ◄— K

Designation of the tendon ◄— CONA CMI SP 1906-150 1860
with information on number, cross-sectional area and characteristic tensile strength of the strands

2.1.2 Anchorage

2.1.2.1 General

The anchor heads of the fixed and stressing anchors are identical. A differentiation is needed for the construction works. The wedges of inaccessible fixed anchors shall be secured with springs and/or a wedge retaining plate. An alternative is pre-locking each individual strand with ~ 0.5 · F_{pk} and applying a wedge retaining plate.

Where

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

2.1.2.2 Restressable and exchangeable tendon

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

2.1.3 Fixed and stressing coupler

2.1.3.1 General

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.

2.1.3.2 Single plane coupler (FK, SK)

The coupling is achieved by means of a coupler anchor head K. The 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 heads of the fixed and stressing anchors. The 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.

2.1.3.3 Sleeve coupler (FH, SH)

The coupler anchor heads H are of the same basic geometry as the anchor heads of the fixed and stressing anchors. Compared to the anchor heads of the fixed and stressing anchors, the coupler anchor heads H are higher and provide an external thread for the coupler sleeve.

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

2.1.4 Movable coupler (BK, BH)

The movable 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 shall be for the expected strain displacement, see Clause 4.3.

The coupler anchor heads and the coupler sleeves of the movable couplers are identical to the coupler heads and the coupler sleeves of the fixed and stressing couplers.

A 100 mm long and at least 3.5 mm thick PE-HD insert shall be 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.

2.1.5 Layout of the anchorage recesses

All anchor heads have to be placed perpendicular to the axis of the tendon, see Annex 20.

The dimensions of the anchorage recesses shall be adapted to the prestressing jacks used. The ETA holder shall save for reference information on the minimum dimensions of the anchorage recesses. The formwork for the anchorage recesses should be slightly conical for ease of removal.

In case of internal anchorages fully embedded in concrete, the recesses shall be 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 exposed anchorages, concrete cover of the anchorage and square plate is not required. However, the exposed surface of the square plate and the cap shall be provided with a corrosion protection.

2.2 Designation and range of the tendons

2.2.1 Designation

Tendon, e.g. CONA CMI SP 19 06-150 1860

- Internal PT ← CONA CMI SP
- Number of strands (01 to 61) ← 19
- Type of strand ← 06
- Cross-sectional area of strands (140 or 150 mm^2) ← 150
- Characteristic tensile strength of strands ← 1860

The tendons comprise 01 to 61 tensile elements, 7-wire prestressing steel strands according to Annex 33.

2.2.2 Range

Prestressing and overstressing forces are given in the corresponding standards and regulations in force at the place of use. The maximum prestressing and overstressing forces are listed in Annex 19.

The tendons consist of 01, 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 strands. By omitting strands in the anchorages and couplers in a radially symmetrically way, also tendons with numbers of strands lying between the numbers given above can be installed. Any unnecessary hole shall either remain undrilled or shall be provided with a short piece of strand and a wedge shall be inserted. For coupler anchor head K the cones of the outer pitch circle, second construction stage, may be equally redistributed if strands are omitted. However, the overall dimensions of the coupler anchor head K shall remain unchanged.

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

2.2.2.1 CONA CMI SP n06-140

7-wire prestressing steel strand

Nominal diameter...15.3 mm

Nominal cross-sectional area.........................140 mm^2

Tendon ranges see Annex 8.

2.2.2.2 CONA CMI SP n06-150

7-wire prestressing steel strand

Nominal diameter...15.7 mm

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

Tendon ranges see Annex 9.

2.3 Ducts

2.3.1 Use of ducts

For bonded tendons corrugated ducts, either in steel or plastic, shall be used.

For special application, such as loop tendons and unbonded tendons, smooth ducts can be used.

2.3.2 Degree of filling

The degree of filling, f, for round ducts shall generally be between 0.35 and 0.50. However, the smaller values of degree of filling, 0.35 to 0.40, shall be 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 2.4. Typical degrees of filling, f, and corresponding minimum radii of curvature, R_{min}, are given in Annexes 10, 11 and 12. The degree of filling is defined as

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

2.3.3 Round steel strip sheaths

Steel strip sheath in conformity with EN 523[6] shall be used. For diameters exceeding EN 523 the requirements shall be met analogous. The degree of filling, f, shall be according to Clause 2.3.2 and the minimum radius of curvature to Clause 2.4.

Annexes 11 and 12 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.

2.3.4 Flat corrugated steel ducts

For tendons with 2, 3, 4 and 5 strands flat ducts may be used, whereas EN 523 applies accordingly. Inner dimensions of the duct and the minimum radii of curvature are defined in Annex 10.

Annex 10 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.

2.3.5 Pre-bent smooth round steel ducts

If permitted at the place of use, smooth steel ducts according to EN 10255, EN 10216-1, EN 10217-1, EN 10219-1 or EN 10305-5 can be used. The degree of filling, f, shall conform to Clause 2.3.2 and the minimum radius of curvature to Clause 2.4. The ducts shall be pre-bent and free of any kinks. The minimum wall thickness of the steel ducts shall meet the requirements of Annex 13.

2.3.6 Plastic sheaths

Corrugated plastic sheaths made of HDPE or PP conforming to ETAG 013, Annex C.3 shall be used. Alternatively smooth plastic ducts according to EN 12201-1 may be used if permitted at the place of use. The degree of filling, f, shall conform to Clause 2.3.2 and the minimum radius of curvature to Clause 2.4.

Annex 13 gives duct diameters, and minimum wall thicknesses for corrugated and smooth plastic ducts according to Clause 2.4. Other internal diameters, wall thicknesses or materials are acceptable according to the respective standards and regulations in force at the place of use.

[6] Standards and other documents referred to in the European technical approval are listed in Annex 34.

2.4 Minimum radii of curvature

The minimum radii of curvature, R_{min}, given in Annexes 10, 11 and 12 correspond to

– a prestressing force of the tendon of $0.85 \cdot F_{p0.1}$

– a nominal diameter of the strand of d = 15.7 mm

– a pressure under the prestressing 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 strands, the calculation of the minimum radius of curvature of the tendon can be carried out using the equation

$$R_{min} = \frac{2 \cdot F_{pm,\,0} \cdot d}{d_i \cdot p_{R,\,max}} \geq 2.0\ \text{m}$$

Where

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

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

d .... m .... Diameter of the prestressing steel

d_i .... m .... Inner duct diameter

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

For tendons with predominantly static loading, reduced minimum radii of curvature can be used. Recommended values for the pressure under the prestressing 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 2.3.2, shall be 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 strands in force at the place of use shall be observed.

2.5 Support of tendons

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

2.6 Friction losses

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

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

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 2

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

k .... rad/m.........Wobble coefficient, see Table 2

x .... m............Distance along the tendon from the point where 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 2: Friction parameters

<table>
<tr><th rowspan="3">Type of duct</th><th colspan="2">Recommended values</th><th colspan="2">Range of values</th></tr>
<tr><th>μ</th><th>k</th><th>μ</th><th>k</th></tr>
<tr><th>rad⁻¹</th><th>rad/m</th><th>rad⁻¹</th><th>rad/m</th></tr>
<tr><td>Steel strip duct</td><td>0.18</td><td rowspan="4">0.005</td><td>0.17 – 0.19</td><td rowspan="4">0.004 – 0.007</td></tr>
<tr><td>Smooth steel duct</td><td>0.18</td><td>0.16 – 0.24</td></tr>
<tr><td>Corrugated plastic duct</td><td>0.12</td><td>0.10 – 0.14</td></tr>
<tr><td>Smooth plastic duct</td><td>0.12</td><td>0.10 – 0.14</td></tr>
</table>

Table 3: Friction losses in anchorages

<table>
<tr><th>Tendon</th><th colspan="3">Friction loss</th></tr>
<tr><td>CONA CMI SP 0206 to 0406</td><td rowspan="4">ΔF_s</td><td rowspan="4">%</td><td>1.2</td></tr>
<tr><td>CONA CMI SP 0506 to 0906</td><td>1.1</td></tr>
<tr><td>CONA CMI SP 1206 to 3106</td><td>0.9</td></tr>
<tr><td>CONA CMI SP 3706 to 6106</td><td>0.8</td></tr>
</table>

Where

ΔF_s .....Friction loss in anchorages and first construction stage of stressing couplers. The loss shall be taken into account for determination of elongation and the prestressing force along the tendon.

Friction in CONA CMI SP 0106 anchorages are low and do not need to be considered in design and execution.

2.7 Slip at anchorages and couplers

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

2.8 Concrete strength at time of stressing

Concrete in conformity with EN 206-1 shall be used. At the time of stressing the mean concrete compressive strength, $f_{cm,\,0}$, shall be at least the value given in Table 4. The concrete test specimen shall be subjected to the same curing conditions as the structure.

For partial prestressing with 30 % of the full prestressing force the actual mean value of the concrete compressive strength shall be 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 EN 1992-1-1.

The helix, additional reinforcement, centre spacing and edge distance corresponding to the concrete compressive strengths shall be taken from Annexes 21 to 29, see also Clauses 2.11.6 and 4.2.3.

Table 4: Compressive strength of concrete

Mean concrete strength		$f_{cm,\,0}$					
Cube strength, $f_{cm,\,0,\,cube}$ 150 mm cube	MPa	26	28	34	38	43	46
Cylinder strength, $f_{cm,\,0,\,cylinder}$ 150 mm cylinder diameter	MPa	21	23	28	31	35	38

2.9 Centre spacing and edge distance of anchorages

In general, spacing and distances shall not be less than the values given in Annexes 14, 15 and 21 to 29.

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 the placing of additional reinforcement shall still be possible, see Annex 30. In this case the spacing in the perpendicular direction shall be increased by the same percentage. The corresponding edge distance is calculated by

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

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

Where

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

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

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

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

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

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

The minimum values for a_c, b_c, a_e and b_e are given in Annexes 14, 15 and 21 to 29, where

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

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

c .... Concrete cover in mm

Components

2.10 Strands

Only 7-wire prestressing steel strands with characteristics according to Table 5 shall be used, see also Annex 33.

Table 5: 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	mm^2	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.

In a single tendon only strands spun in the same direction shall be used.

2.11 Anchorages and couplers

The components of anchorages and couplers shall conform to the specifications given in Annexes 2 to 7 and the technical documentation[7]. Therein the component dimensions, materials and material identification data with tolerances are given.

2.11.1 Anchor heads

The anchor heads are made of steel and contain regularly arranged conical holes drilled in parallel to accommodate prestressing steel strands and wedges. 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 fix protection caps and wedge retaining plates.

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

2.11.2 Square plates

The square plates are flat steel plates and are connected to the trumpets type A SP. In Annexes 21 to 29 the main minimum dimensions are listed. The square plate may be equipped with a drilled grout inlet situated at the interface plane to the anchor head, with a connecting pipe to the trumpet.

[7] The technical documentation of the European technical approval is deposited at Österreichisches Institut für Bautechnik and, in so far as is relevant to the tasks of the approved body involved in the attestation of conformity procedure, is handed over to the approved body.

2.11.3 Trumpets

The trumpets type A SP are manufactured in steel or PE material, having a corrugated or plain surface. An air-vent is situated at the top of the trumpet, where a ventilation or grouting tube can be fitted.

For the larger anchorage types CONA CMI SP 3106 up to 6106 the first part of the trumpet near the square plate shall be made out of steel sheet with a thickness of 3 mm over a minimum length equal to the diameter of the trumpet.

In the case of transition pipes made completely out of steel sheet, a 100 mm long and at least 3.5 mm thick PE-HD insert shall be installed at the deviating point of the strands on the duct side.

2.11.4 Coupler anchor heads type K, H

The coupler anchor heads K for the single plane couplers are made of steel and provide in the inner part, for anchorage of the strands of the first construction stage, the same arrangement of holes as the anchor head for the stressing or fixed anchors. In the outer pitch circle there is an arrangement of holes with an inclination of 7 ° to accommodate the strands of the second construction stage. Wedge retaining plates and cover plates are fixed by means of additional threaded bores.

The coupler anchor heads H for the sleeve coupler are made of steel and have the same basic geometry as the anchor heads of the stressing or fixed anchors. Compared to the anchor heads of the fixed and stressing anchors, the coupler anchor heads H are higher and provide an external thread for the coupler sleeve. At the back of the coupler anchor heads K and H there is a step for ease of centring the coupler anchor head on the square plate.

The coupler sleeve is a steel tube with an inner thread and is provided with ventilation holes.

Ring cushions shall be inserted in coupler head H2.

2.11.5 Ring wedges

The ring wedges are in three pieces, which are held together by spring rings. Two types of ring wedges are used. Within one anchorage or coupler only one type of ring wedge shall be used.

The wedges of inaccessible fixed anchors shall be secured with springs and/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 as per Clause 2.1.2.1.

2.11.6 Helix and additional reinforcement

The helix and the 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 shall be placed in the tendon axis. The dimensions of the helix and the additional reinforcement shall conform to the values specified in Annexes 21 to 29, see also Clause 4.2.3.

If required for a specific project design, the reinforcement given in Annexes 21 to 29 may be modified in accordance with the respective regulations in force at the place of use as well as with the relevant approval of the local authorities and of the ETA holder to provide equivalent performance.

2.11.7 Protection caps

Protection caps are made of steel or plastic. They are provided with air vents and fixed with screws or threaded rods.

2.11.8 Material properties

Information on the materials used for the components are given in Annex 16.

2.12 Permanent corrosion protection

To protect the tendons from corrosion, the ducts, couplers and anchorages have to be completely filled with grout according to EN 447, special grout according to ETAG 013, grease according to ETAG 013, Annex C.4.1, wax according to ETAG 013, Annex C.4.2 or circulating dry air as applicable at the place of use.

Alternative grease or wax may be used if according to the standards and regulations in force at the place of use.

With exposed anchorages, not fully embedded in concrete, an adequate corrosion protection for the exposed parts shall be applied.

2.13 Dangerous substances

The release of dangerous substances is determined according to ETAG 013, Clause 5.3.1. The PT system conforms to the provisions of Guidance Paper H[8] relating to dangerous substances.

A declaration in this respect has been made by the manufacturer.

In addition to the specific clauses relating to dangerous substances in the European technical approval, there may be other requirements applicable to the product falling within their scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements also need to be complied with, when and where they apply.

2.14 Methods of verification

The assessment of the fitness of the "BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands" for its intended use in relation to the requirements for mechanical resistance and stability in the sense of Essential Requirement 1 of the Council Directive 89/106/EEC has been made in conformity to the Guideline for European technical approvals of "Post-Tensioning Kits for Prestressing of Structures", ETAG 013, Edition June 2002.

2.15 Identification

The European technical approval for the "BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands" is issued on the basis of agreed data, deposited at Österreichisches Institut für Bautechnik, which identifies the BBR VT CONA CMI SP Post-tensioning System that has been assessed and judged. Changes to the manufacturing process of the BBR VT CONA CMI SP Post-tensioning System, which could result in this deposited data being incorrect, should be notified to Österreichisches Institut für Bautechnik before the changes are introduced. Österreichisches Institut für Bautechnik will decide whether or not such changes affect the European technical approval and consequently the validity of the CE marking on the basis of the European technical approval and, if so, whether further assessment or alterations to the European technical approval are considered necessary.

3 Evaluation of conformity and CE marking

3.1 Attestation of conformity system

The system of attestation of conformity assigned by the European Commission to this product in accordance with the Council Directive 89/106/EWG of 21 December 1988, Annex III, Section 2, Clause i), referred to as System 1+, provides for

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[8] Guidance Paper H: A harmonised approach relating to dangerous substances under the Construction Products Directive, Rev. September 2002.

Certification of the conformity of the product by an approved certification body on the basis of

(a) Tasks for the manufacturer

(1) Factory production control;

(2) Further testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan[9];

(b) Tasks for the approved body

(3) Initial type-testing of the product;

(4) Initial inspection of factory and of factory production control;

(5) Continuous surveillance, assessment and approval of the factory production control;

(6) Audit testing of samples taken at the factory.

3.2 Responsibilities

3.2.1 Tasks for the manufacturer – factory production control

At the manufacturing plant, the manufacturer shall implement and continuously maintain a factory production control system. All the elements, requirements and provisions adopted by the manufacturer shall be documented systematically in the form of written operating and processing instructions. The factory production control system shall ensure that the product is in conformity with the European technical approval.

Within the framework of factory production control, the manufacturer shall carry out tests and controls in accordance with the prescribed test plan and in accordance with the European technical approval. Details of the extent, nature and frequency of testing and controls to be performed within the framework of the factory production control shall correspond to the prescribed test plan, which forms part of the technical documentation of the European technical approval.

The results of factory production control shall be recorded and evaluated. The records shall include at a minimum the following information.

– Designation of the products and the basic materials;

– Type of check or testing;

– Date of manufacture of the products and date of testing of the products or basic materials or components;

– Results of check and testing and, if appropriate, comparison with requirements;

– Name and signature of the person responsible for the factory production control.

The records of factory production control shall be submitted to the approved body and shall be filed for at least 10 years time. On request, the records shall be presented to Österreichisches Institut für Bautechnik.

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

The basic elements of the prescribed test plan conform to ETAG 013, Annex E.1 and are specified in the quality management plan of the "BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands".

[9] The prescribed test plan has been deposited at Österreichisches Institut für Bautechnik and is handed over only to the approved body involved in the conformity attestation procedure. The prescribed test plan is also referred to as control plan.

3.2.2 Tasks of the approved body

3.2.2.1 Initial type-testing of the products

For initial type-testing the results of the tests performed as part of the assessment for the European technical approval may be used unless there are changes in the manufacturing procedure or factory plant. In such cases, the necessary initial type-testing shall be agreed between Österreichisches Institut für Bautechnik and the approved body involved.

3.2.2.2 Initial inspection of factory and of factory production control

The approved body shall ascertain 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 orderly manufacturing of the PT system according to the specifications given in Section II as well as in the Annexes of the European technical approval.

3.2.2.3 Continuous surveillance

The kit manufacturer shall be inspected at least once a year. Each component manufacturer of the components listed in Annex 18 shall be inspected at least once every five years. It shall be 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 product certification and continuous surveillance shall be made available on demand by the approved body to Österreichisches Institut für Bautechnik. If the provisions of the European technical approval and the prescribed test plan are no longer fulfilled, the certificate of conformity shall be withdrawn and Österreichisches Institut für Bautechnik informed immediately.

3.2.2.4 Audit testing of samples taken at the factory

During surveillance inspection, the approved body shall take samples at the factory of components of the PT system or of individual components, for which the European technical approval has been granted, for independent testing. For the most important components Annex 18 given below summarises the minimum procedures that shall be implemented by the approved body.

3.3 CE marking

The delivery note of the components of the PT system shall contain the CE marking. The symbol "CE" shall be followed by the identification number of the certification body and shall be accompanied by the following information.

– Name or identification mark and address of the manufacturer
– The last two digits of the year in which the CE marking was affixed
– Number of the European technical approval
– Number of the certificate of conformity
– Product identification (trade name)

4 Assumptions under which the fitness of the product for the intended use was favourably assessed

4.1 Manufacturing

"BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands" is manufactured in accordance with the provisions of the European technical approval. Composition and manufacturing process are deposited at Österreichisches Institut für Bautechnik.

4.2 Design

4.2.1 General

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

4.2.2 Anchorage recess

The dimensions of the anchorage recesses are to be adapted to the prestressing jacks used. The ETA holder shall save for reference information on the minimum dimensions of the anchorage recesses and appropriate clearance behind the anchorage.

In case of anchorages fully embedded in concrete, the recesses shall be 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 exposed anchorages concrete cover of the anchorage and square plate is not required. However, the exposed surface of the square plate and the cap shall be provided with a corrosion protection.

4.2.3 Reinforcement in the anchorage zone

Verification of the transfer of the prestressing forces to the structural concrete is not required if the centre spacing and edge distance of the anchorages as well as grade and dimensions of additional reinforcement, see Annexes 21 to 29, 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, the number, cross section and position with respect to the square plates shall remain unchanged.

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

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

If required for a specific project design, the reinforcement given in Annexes 21 to 29 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.

4.2.4 Fatigue resistance

Fatigue resistance of the tendons has been tested with an upper force of $0.65 \cdot F_{pk}$ and a stress range of 80 MPa up to $2 \cdot 10^6$ load cycles.

4.2.5 Tendons in masonry structures – Load transfer to the structure

Load transfer of prestressing force from the anchorages to masonry structures shall be via concrete or steel members designed according to the European technical approval, especially according to Clauses 2.8, 2.9, 2.11.6, and 4.2.3, or Eurocode 3, respectively.

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

4.2.6 Maximum prestressing force

Annex 19 lists the maximum prestressing and overstressing forces.

4.3 Installation

Assembly and installation of tendons shall only be carried out by qualified PT specialist companies with the required resources and experience in the use of multi strand internal post-tensioning systems, see ETAG 013, Annex D.1 and CWA 14646. The respective standards and regulations in force at the place of use shall be considered. The company's PT site manager shall have 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 SP – Internal Post-tensioning System with 01 to 61 Strands".

The tendons may be manufactured on site or in the factory (prefabricated tendons).

To avoid confusion on each site only strands with one nominal diameter shall be used.

The square plate, anchor head and coupler anchor head shall be placed perpendicular to the tendon's axis.

Couplers shall be situated in a straight tendon section.

At the anchorages and couplers the tendon layout shall provide a straight section over a length of at least 250 mm beyond the end of the trumpet.

Before placing the concrete a final check of the installed tendons has to be carried out.

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

In the case of a movable coupler it shall be 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 movable 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.

4.4 Stressing operation

With a mean concrete compressive strength in the anchorage zone according to the values laid down in Annexes 21 to 29 full prestressing may be applied.

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

After releasing the prestressing force from the prestressing jack, the tendon length reduces by the amount of slip at the anchor head.

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

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

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

4.5 Restressing

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

For tendons remaining restressable throughout the working life of the structure, wax or grease shall be used as filling material or circulating dry air shall be used as corrosion protection. Moreover, a strand protrusion at the stressing anchor has to remain with a length compatible with the prestressing jack used.

4.6 Exchanging tendons

Exchange of tendons is permitted.

The specifications for the exchangeable tendons shall be defined during the design phase.

Exchangeable tendons are unbonded.

For exchangeable tendons, wax or grease shall be used as filling material or circulating dry air shall be used as corrosion protection. Moreover, a strand protrusion has to remain at the stressing anchor with a length allowing safe release of the complete prestressing force.

Stressing and fixed anchorages shall be accessible and adequate space has to be provided behind the anchorages.

4.7 Filling material

4.7.1 General

Filling operations shall be executed according to the standards and regulations in force at the place of use.

4.7.2 Grout

Grout shall be 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 shall be applied for long tendons, tendon paths with distinct high points or inclined tendons. All vents and grouting inlets shall be sealed immediately after grouting. In case of couplers K, the second stage holes, wedges and springs shall be checked for cleanness before and immediately after grouting the first construction stage. The standards to be 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 shall be applied for ready mixed grout.

4.7.3 Grease and wax

The specifications in ETAG 013, Annex C.4 and the recommendations of the supplier are relevant for grease and wax.

The filling process with grease and wax shall follow a similar procedure as the one specified for the filling with grout. However, a different filling procedure might be possible if permitted at the place of use.

4.7.4 Circulating dry air

Actively circulating dry air allows for corrosion protection of the 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 shall be observed.

4.7.5 Recordings

The results of the filling operation shall be recorded. The respective standards and regulations in force at the place of use shall be observed.

4.8 Welding

Ducts may be welded.

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

After installation of the strands further welding may not be carried out on the tendons. In case of welding operations near tendons precautionary measures are required to avoid damage.

5 Recommendations for the manufacturer

5.1 Recommendations for packing, transport and storage

During transport of prefabricated tendons a minimum diameter of curvature of

- 1.65 m for tendons up to CONA CMI SP 1206,
- 1.80 m for tendons up to CONA CMI SP 3106,
- 2.00 m for tendons larger than CONA CMI SP 3106 shall be observed.

The ETA holder shall have instructions related to

- Temporary protection of prestressing steels and components in order to prevent corrosion during transportation from the production site to the job site;
- Transportation, storage and handling of the tensile elements and of other components in order to avoid any mechanical, chemical or electrochemical changes;
- Protection of tensile elements and other components from moisture;
- Keeping tensile elements away from areas where welding operations are performed.

5.2 Recommendations on installation

The manufacturer's installation instructions shall be followed, see ETAG 013, Annex D.3. The respective standards and regulations in force at the place of use shall be observed. For the installation see also Annexes 31 and 32.

5.3 Accompanying information

It is the responsibility of the ETA holder to ensure that all necessary information on design and installation is submitted to those responsible for design and execution of the structures executed with "BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands".

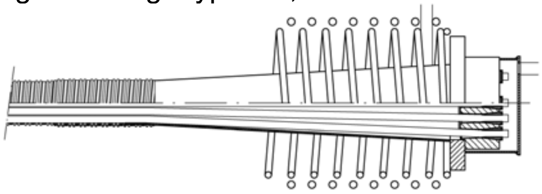
On behalf of Österreichisches Institut für Bautechnik

The original document is signed by:

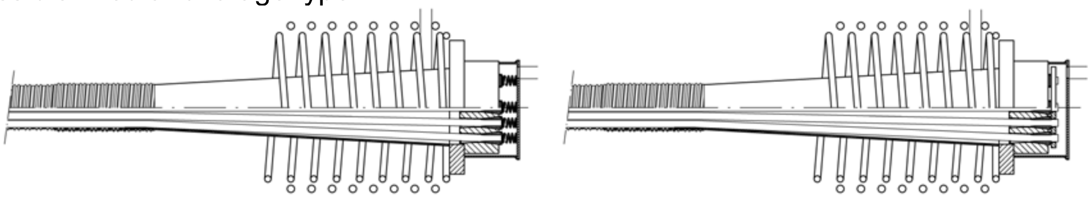
Rainer Mikulits

Managing Director

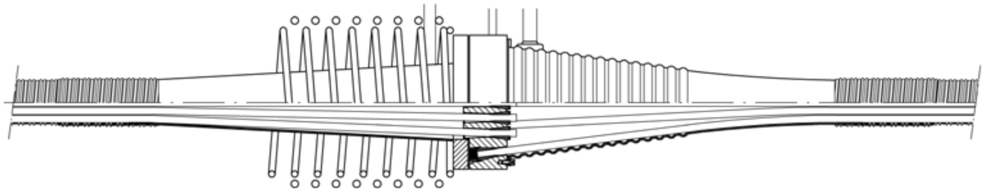
Stressing anchorage type SA, accessible fixed anchorage type FA



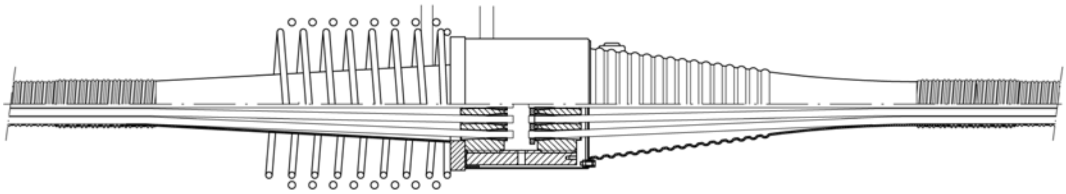
Inaccessible fixed anchorage type FA



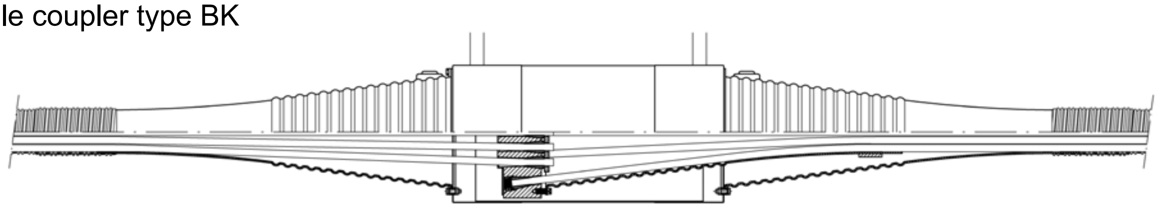
Fixed and stressing coupler type FK, SK



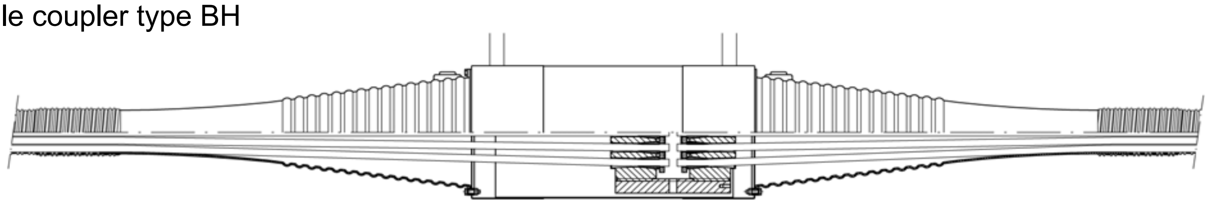
Fixed and stressing coupler type FH, SH



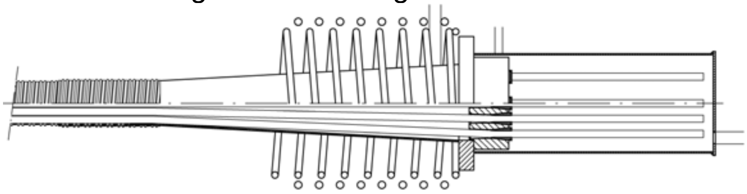
Movable coupler type BK



Movable coupler type BH

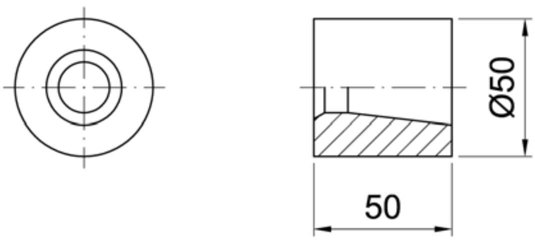


Restressable / exchangeable anchorage

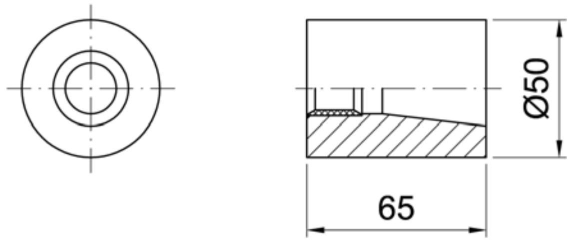


Anchorage CONA CMI SP 0106

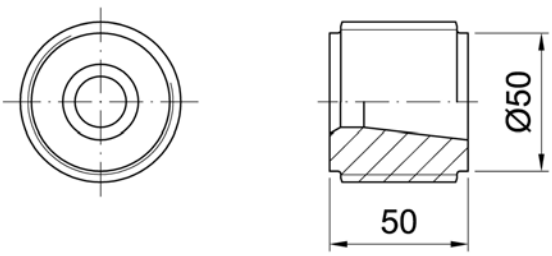
Anchor head A3



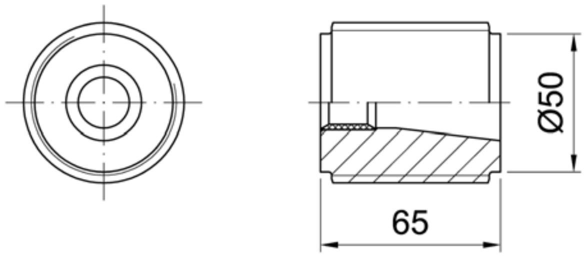
Anchor head A7



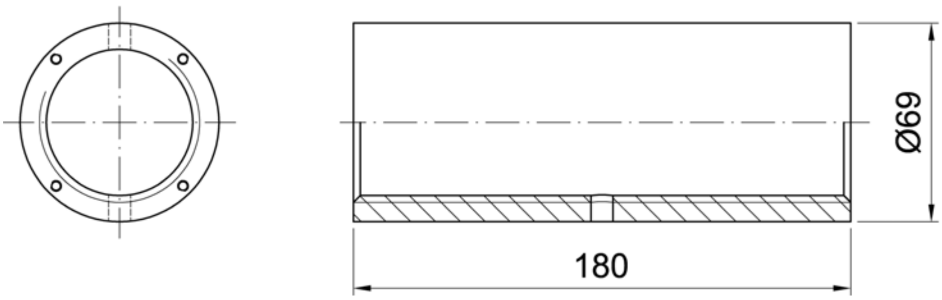
Coupler anchor head H1



Coupler anchor head H2



Coupler sleeve H



Dimensions in mm

CONA CMI SP

Internal Post-tensioning System

Anchorage and coupler CONA CMI SP 0106

Annex 2
of European technical approval
ETA-09/0287

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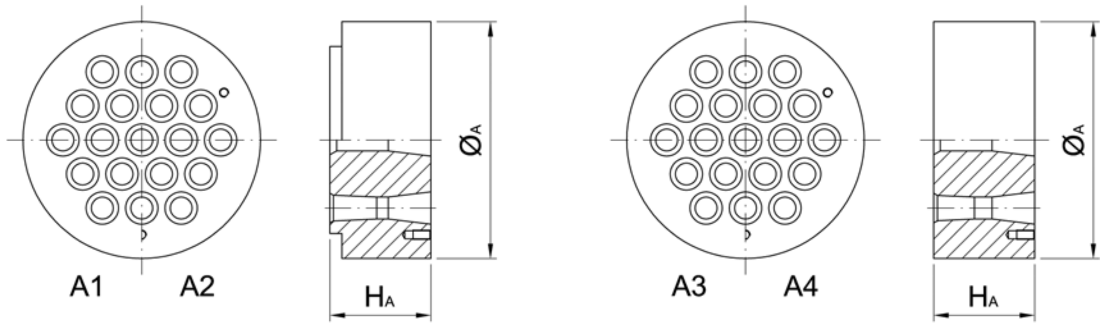
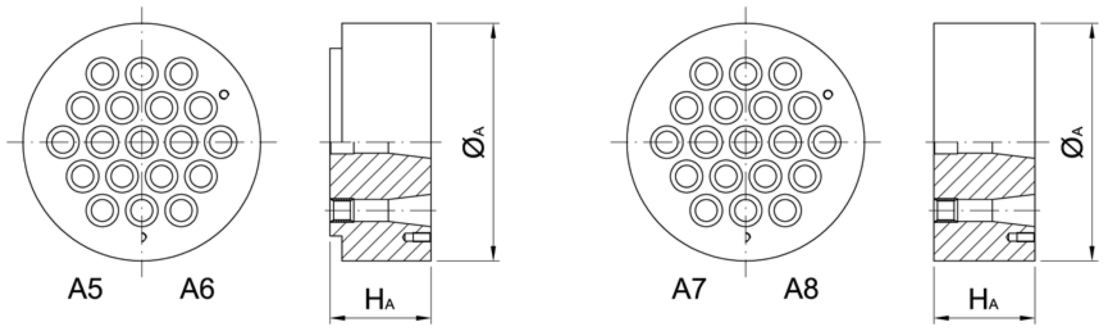
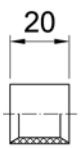
Anchor head A1-A4



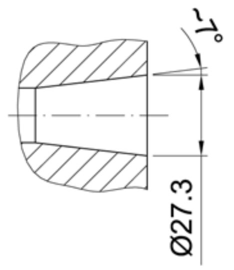
Anchor head A5-A8



Ring cushion
Anchor head A5-A8



Cone

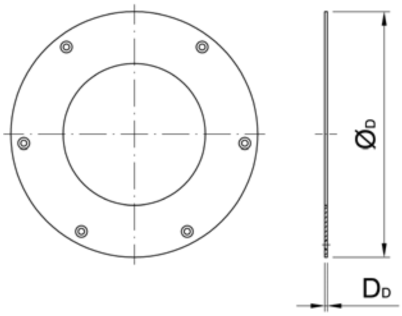


Dimensions in mm

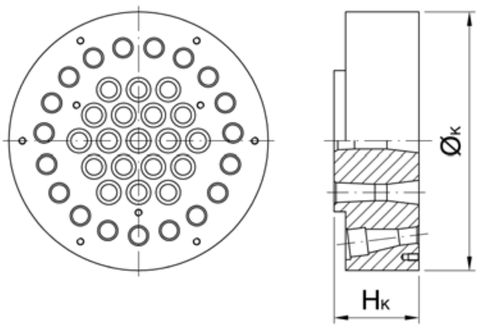
Number of strands			02	03	04	05	06	07	08	09	12	13	15	16
Anchor head														
Nominal diameter	$Ø_A$	mm	90	100	100	130	130	130	150	160	160	180	200	200
Height head A1-A4	H_A	mm	50	50	50	50	55	55	60	60	65	72	75	80
Height head A5-A8	H_A	mm	65	65	65	65	65	65	65	65	70	72	75	80

Number of strands			19	22	24	25	27	31	37	42	43	48	55	61
Anchor head														
Nominal diameter	$Ø_A$	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

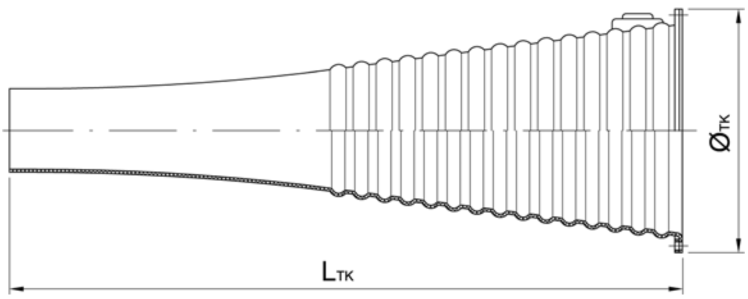
Cover plate



Coupler anchor head K



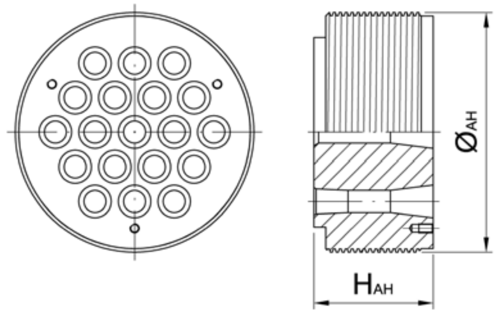
Trumpet type K



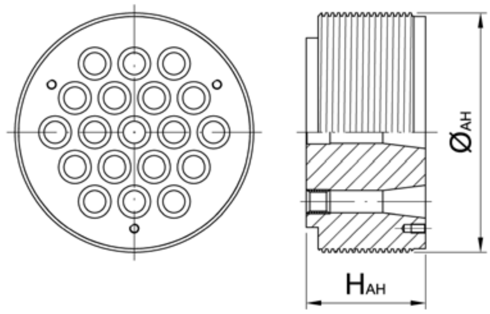
Number of strands			02	03	04	05	06	07	08	09	12
Coupler anchor head K											
Diameter	$Ø_K$	mm	185	185	185	205	205	205	240	240	240
Height	H_K	mm	85	85	85	85	85	85	90	90	90
Cover plate											
Diameter	$Ø_D$	mm	182	182	182	202	202	202	240	240	240
Thickness	D_D	mm	3	3	3	3	3	3	3	3	3
Trumpet type K											
Diameter	$Ø_{TK}$	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 anchor head K											
Diameter	$Ø_K$	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	$Ø_D$	mm	276	276	276	276	306	336	380	380	380
Thickness	D_D	mm	3	3	3	3	5	5	5	5	5
Trumpet type K											
Diameter	$Ø_{TK}$	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

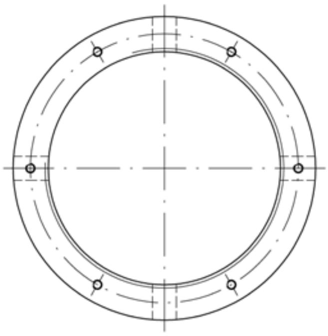
Coupler anchor head H1



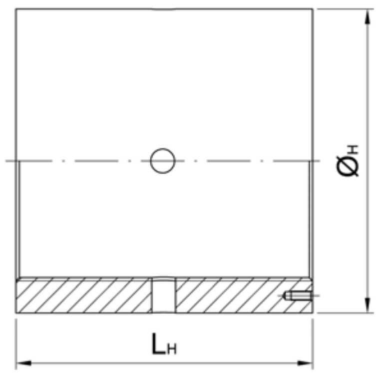
Coupler anchor head H2



Ring cushion
Coupler anchor head H2



Coupler sleeve H

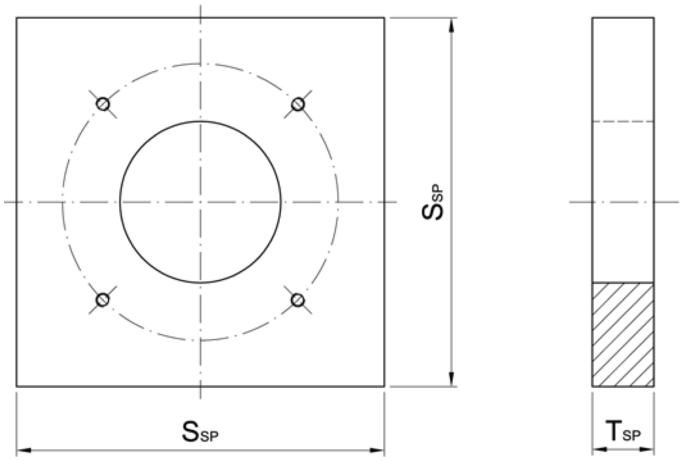


Dimensions in mm

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	111	121	130	160	164	167	189	200	210	230	256	256
Length sleeve	L_H	mm	180	180	180	180	190	200	200	210	230	230	240	250

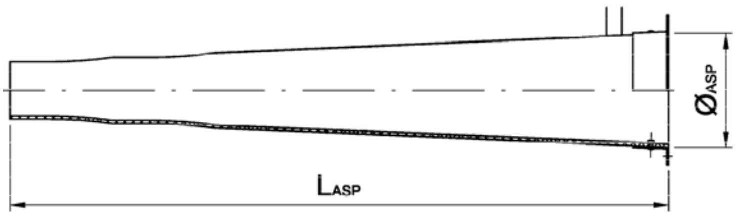
Number of strands			19	22	24	25	27	31	37	42	43	48	55	61
Coupler anchor heads H1 and H2														
Nominal diameter	$\varnothing_{AH}$	mm	200	225	240	255	255	255	285	300	320	325	335	365
Height head H1	H_{AH}	mm	95	100	100	100	105	115	—	—	—	—	—	—
Height head H2	H_{AH}	mm	95	100	100	100	105	115	125	135	135	145	160	160
Coupler sleeve H														
Minimum diameter	$\varnothing_H$	mm	266	293	309	324	327	335	370	392	410	422	440	472
Length sleeve	L_H	mm	270	270	280	280	300	320	340	360	360	380	410	410

Square plate

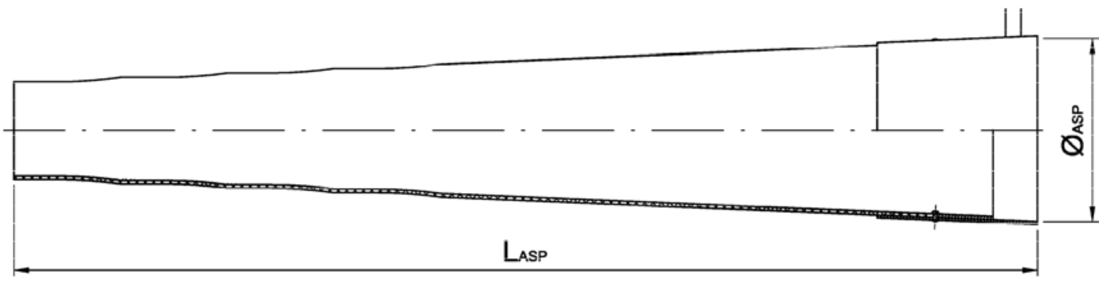


Minimum dimensions see the Annexes 21 to 29.

Trumpet type A SP 0206 – 2406



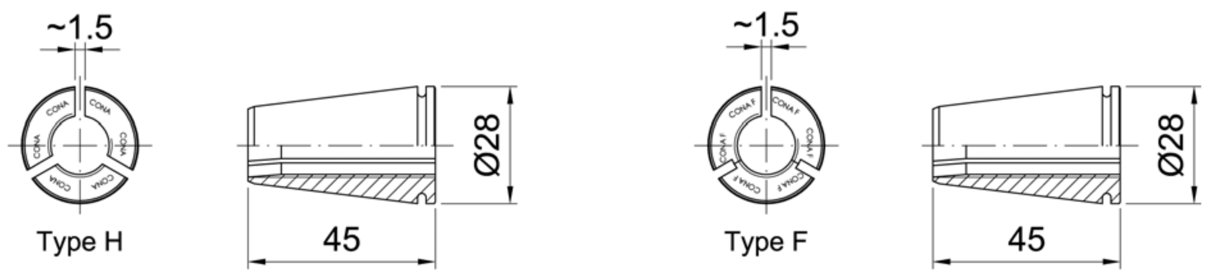
Trumpet type A SP 2506 – 6106



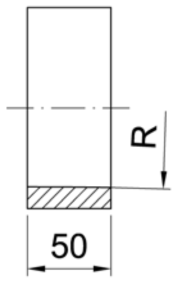
Number of strands			02	03	04	05	06	07	08	09	12	13	15	16
Trumpet type A SP														
Diameter	$Ø_{ASP}$	mm	70	70	70	90	90	90	112	127	127	142	160	160
Length	L_{ASP}	mm	421	421	421	401	401	401	655	739	739	794	894	894

Number of strands			19	22	24	25	27	31	37	42	43	48	55	61
Trumpet type A SP														
Diameter	$Ø_{ASP}$	mm	160	180	195	210	210	210	230	245	270	270	270	305
Length	L_{ASP}	mm	894	1 017	1 196	1 150	1 150	1 150	1 270	1 315	1 506	1 506	1 506	1 684

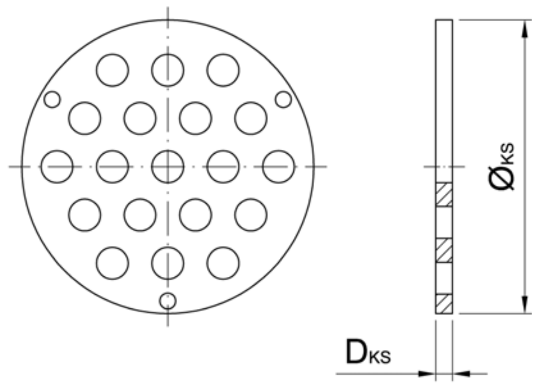
Wedges



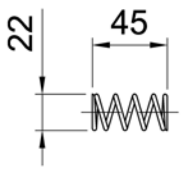
Tension ring



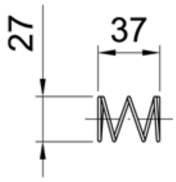
Wedge retaining plate KS



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	$Ø_{KS}$	mm	65	73	75	103	103	103	130	145	145	145	175	175
Thickness	D_{KS}	mm	5	5	5	5	5	5	8	8	8	10	10	10

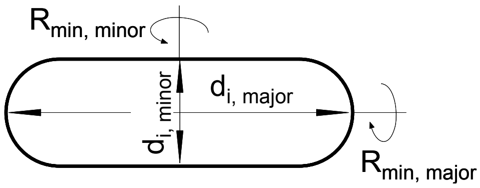
Number of strands			19	22	24	25	27	31	37	42	43	48	55	61
Wedge retaining plate KS														
Diameter	$Ø_{KS}$	mm	175	182	210	210	210	210	240	275	275	275	310	310
Thickness	D_{KS}	mm	10	10	10	10	10	10	12	12	12	12	12	12

CONA CMI SP 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}
—	mm^2	kg/m	kN	kN
01	140	1.1	248	260
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 SP 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}
—	mm²	kg/m	kN	kN
01	150	1.2	266	279
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

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Inner diameter of round 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
01	35	2.0	—	—	—	—	—	—
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 round 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
01	35	2.0	—	—	—	—	—	—
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

Steel ducts, minimum wall thickness, t_{min}

Number of strands	Wall thickness
n	t_{min}
—	mm
01 – 13	1.5
15 – 25	2.0
27 – 37	2.5
42 – 61	3.0

Plastic ducts, minimum wall thickness, t_{min}

	Corrugated plastic ducts up to $p_{R,\,max}$ = 200 kN/m		Smooth plastic ducts up to $p_{R,\,max}$ = 350 kN/m		
Number of strands	Internal diameter	Wall thickness	Outer diameter [1)]	Internal diameter	Wall thickness
n	d_i	t_{min}	d_o	d_i	t_{min}
—	mm	mm	mm	mm	mm
01 – 04	50	2.0	63	57.0	3.0
05 – 07	60	2.0	75	67.8	3.6
08 – 09	75	2.5	90	81.4	4.3
10 – 12	75	2.5	90	81.4	4.3
13 – 15	85	2.5	110	99.4	5.3
16 – 19	100	3.0	125	113.0	6.0
20 – 22	100	3.0	125	113.0	6.0
23 – 24	115	3.5	140	126.6	6.7
25 – 27	115	3.5	140	126.6	6.7
28 – 31	130	4.0	160	144.6	7.7
32 – 37	130	4.0	160	144.6	7.7
38 – 43	145	4.5	180	162.8	8.6
44 – 48	145	4.5	180	162.8	8.6
49 – 55	150	5.0	200	180.8	9.6
56 – 61	160	5.5	225	203.4	10.8

[1)] Not to be applied adjacent to the trumpet at the anchorage or coupler.

Minimum centre spacing of tendon anchorages

Tendon		Minimum centre spacing $a_c = b_c$					
$f_{cm, 0, cube, 150}$	MPa	26	28	34	38	43	46
$f_{cm, 0, cylinder, \varnothing 150}$	MPa	21	23	28	31	35	38
CONA CMI SP 0106	mm	120	115	105	100	95	95
CONA CMI SP 0206	mm	170	165	150	145	135	135
CONA CMI SP 0306	mm	205	200	185	175	170	165
CONA CMI SP 0406	mm	235	230	210	200	190	185
CONA CMI SP 0506	mm	265	255	240	225	215	210
CONA CMI SP 0606	mm	290	280	260	245	230	225
CONA CMI SP 0706	mm	315	300	280	270	255	245
CONA CMI SP 0806	mm	335	320	300	285	270	260
CONA CMI SP 0906	mm	355	340	315	300	285	275
CONA CMI SP 1206	mm	410	395	365	345	330	320
CONA CMI SP 1306	mm	425	410	380	360	340	330
CONA CMI SP 1506	mm	455	440	410	390	370	360
CONA CMI SP 1606	mm	470	455	420	400	380	370
CONA CMI SP 1906	mm	510	490	455	435	415	405
CONA CMI SP 2206	mm	550	530	490	465	445	435
CONA CMI SP 2406	mm	575	550	515	485	465	455
CONA CMI SP 2506	mm	585	565	520	495	470	460
CONA CMI SP 2706	mm	605	585	540	515	490	480
CONA CMI SP 3106	mm	650	625	580	555	535	520
CONA CMI SP 3706	mm	715	715	715	715	715	715
CONA CMI SP 4206	mm	765	765	765	765	765	765
CONA CMI SP 4306	mm	775	775	775	775	775	775
CONA CMI SP 4806	mm	830	830	830	830	830	830
CONA CMI SP 5506	mm	905	905	905	905	905	905
CONA CMI SP 6106	mm	960	960	960	960	960	960

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Minimum edge distance of tendon anchorages

Tendon		Minimum centre spacing $a_c = b_c$					
$f_{cm, 0, cube, 150}$	MPa	26	28	34	38	43	46
$f_{cm, 0, cylinder, \varnothing 150}$	MPa	21	23	28	31	35	38
CONA CMI SP 0106	mm	50 + c	50 + c	45 + c	40 + c	40 + c	40 + c
CONA CMI SP 0206	mm	75 + c	75 + c	65 + c	65 + c	60 + c	60 + c
CONA CMI SP 0306	mm	95 + c	90 + c	85 + c	80 + c	75 + c	75 + c
CONA CMI SP 0406	mm	110 + c	105 + c	95 + c	90 + c	85 + c	85 + c
CONA CMI SP 0506	mm	125 + c	120 + c	110 + c	105 + c	100 + c	95 + c
CONA CMI SP 0606	mm	135 + c	130 + c	120 + c	115 + c	105 + c	105 + c
CONA CMI SP 0706	mm	150 + c	140 + c	130 + c	125 + c	120 + c	115 + c
CONA CMI SP 0806	mm	160 + c	150 + c	140 + c	135 + c	125 + c	120 + c
CONA CMI SP 0906	mm	170 + c	160 + c	150 + c	140 + c	135 + c	130 + c
CONA CMI SP 1206	mm	195 + c	190 + c	175 + c	165 + c	155 + c	150 + c
CONA CMI SP 1306	mm	205 + c	195 + c	180 + c	170 + c	160 + c	155 + c
CONA CMI SP 1506	mm	220 + c	210 + c	195 + c	185 + c	175 + c	170 + c
CONA CMI SP 1606	mm	225 + c	220 + c	200 + c	190 + c	180 + c	175 + c
CONA CMI SP 1906	mm	245 + c	235 + c	220 + c	210 + c	200 + c	195 + c
CONA CMI SP 2206	mm	265 + c	255 + c	235 + c	225 + c	215 + c	210 + c
CONA CMI SP 2406	mm	280 + c	265 + c	250 + c	235 + c	225 + c	220 + c
CONA CMI SP 2506	mm	285 + c	275 + c	250 + c	240 + c	225 + c	220 + c
CONA CMI SP 2706	mm	295 + c	285 + c	260 + c	250 + c	235 + c	230 + c
CONA CMI SP 3106	mm	315 + c	305 + c	280 + c	270 + c	260 + c	250 + c
CONA CMI SP 3706	mm	350 + c	350 + c	350 + c	350 + c	350 + c	350 + c
CONA CMI SP 4206	mm	375 + c	375 + c	375 + c	375 + c	375 + c	375 + c
CONA CMI SP 4306	mm	380 + c	380 + c	380 + c	380 + c	380 + c	380 + c
CONA CMI SP 4806	mm	405 + c	405 + c	405 + c	405 + c	405 + c	405 + c
CONA CMI SP 5506	mm	445 + c	445 + c	445 + c	445 + c	445 + c	445 + c
CONA CMI SP 6106	mm	470 + c	470 + c	470 + c	470 + c	470 + c	470 + c

c .... Concrete cover in mm

Material characteristics

Component	Standard / Specification
Anchor head A CONA CMI SP 0106 to 6106	EN 10083-1 EN 10083-2
Coupler anchor head K CONA CMI SP 0206 to 3106	EN 10083-1 EN 10083-2
Coupler anchor head H CONA CMI SP 0106 to 6106	EN 10083-1 EN 10083-2
Square plate CONA CMI SP 0106 to 6106	EN 10025-2
Coupler sleeve H CONA CMI SP 0106 to 6106	EN 10210-1
Wedge retaining plate, cover plate KS CONA CMI SP 0106 to 6106	EN 10025-2
Trumpet Type A, Type K	EN ISO 1872-1
Tension ring B	EN 10210-1
Ring wedge – Type H Ring wedge – Type F	EN 10277-2 EN 10084
Spring Type A, Type 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 ETAG 013, Annex C.3

Contents of the prescribed test plan

Component	Item	Test / Check	Traceability	Minimum frequency	Documentation
Square plate	Material	Check	Bulk	100 %	"2.2" [8]
	Detailed dimensions	Test		3 % ≥ 2 specimens	Yes
	Visual inspection [3]	Check		100 %	No
Anchor head and coupler anchor head	Material	Check	Full	100 %	"3.1" [1]
	Detailed dimensions [2]	Test		5 % ≥ 2 specimens	Yes
	Visual inspection [3), 4]	Check		100 %	No
Ring wedge	Material	Check	Full	100 %	"3.1" [1]
	Treatment, hardness [5), 6]	Test		0.5 % ≥ 2 specimens	Yes
	Detailed dimensions [2]	Test		5 % ≥ 2 specimens	Yes
	Visual inspection [3), 7]	Check		100 %	No
Coupler sleeve	Material	Check	Full	100 %	"3.1" [1]
	Detailed dimensions	Test		5 % ≥ 2 specimens	Yes
	Visual inspection [3]	Check		100 %	No
Steel strip sheath	Material	Check	"CE"	100 %	"CE"
	Visual inspection [3]	Check		100 %	No
Steel duct	Material	Check	Bulk	100 %	"2.2" [8]
	Visual inspection [3]	Check		100 %	No
Strand	Material	Check	Full	100 %	"CE" [9]
	Diameter	Test		Each coil	No
	Visual inspection [3]	Check		Each coil	No
Constituents of filling material as per EN 447	Cement	Check	Full	100 %	"CE" [10]
	Admixtures, additions	Check	Bulk	100 %	"CE" [10]
Plastic duct, ETAG 013, Annex C.3	Material	Check	Full	100 %	"CE" [10]

1) "3.1": Inspection certificate type "3.1" according to EN 10204
2) Other dimensions than [4]
3) Visual inspections include e.g.: Main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, smoothness, corrosion, coating etc., as detailed in the prescribed test plan.
4) Dimensions: All conical bores of the anchor heads and coupler anchor heads regarding angle, diameter and surface condition, thread dimensions of all anchor heads and coupler anchor heads.
5) Geometrical properties
6) Surface hardness
7) Teeth, cone surface
8) "2.2": Test report "2.2" according to EN 10204
9) If the basis for CE marking of prestressing steel is not available, an approval or certificate according to the respective standards and regulations in force at the place of use shall accompany each delivery.
10) If the basis for CE marking of constituents of filling materials and of plastic ducts is not available, an approval or certificate according to the respective standards and regulations in force at the place of use shall accompany each delivery.

Full: Full traceability of each component to its raw materials.
Bulk: Traceability of each delivery of components to a defined point.

Audit testing

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

[1] Visual inspection means, e.g.: main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, smoothness, corrosion protection, corrosion, coating etc., as given in the prescribed test plan.

[2] All samples shall be randomly selected and clearly identified.

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 SP							
		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	01	196	206	211	221	207	218	222	234
	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 EN 1992-1-1. The actual values shall be taken from the standards and regulations in force at the place of use. Conformity with the stabilisation and crack width criteria in the load transfer test has been verified to a load level of $0.80 \cdot F_{pk}$.

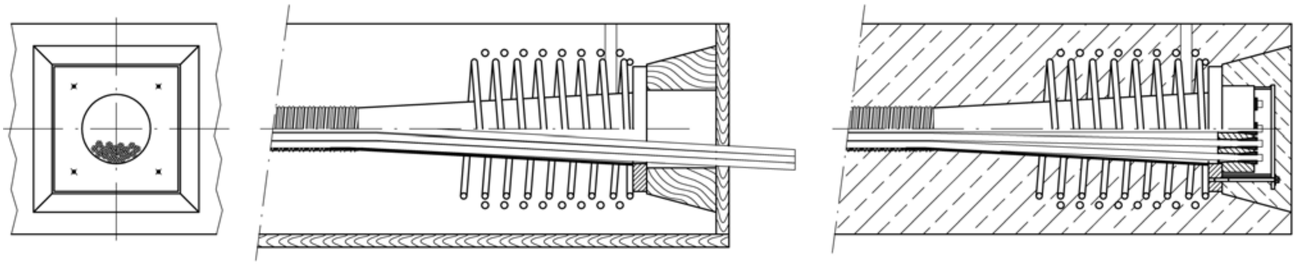
2) Overstressing is permitted if the force in the prestressing jack can be measured to an accuracy of ± 5 % of the final value of the prestressing force.

Where

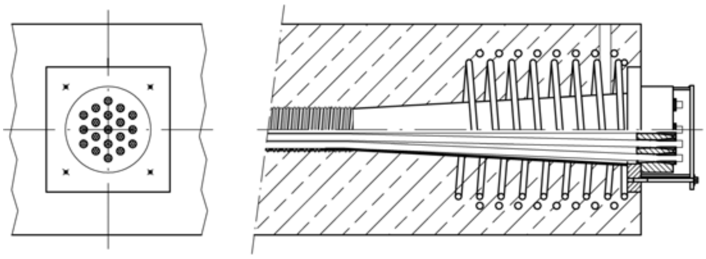
F_{pk}...... Characteristic value of maximum force of tendon

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

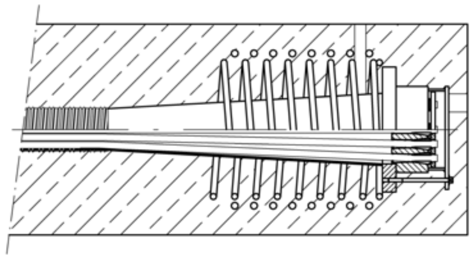
Recessed stressing anchorage type SA



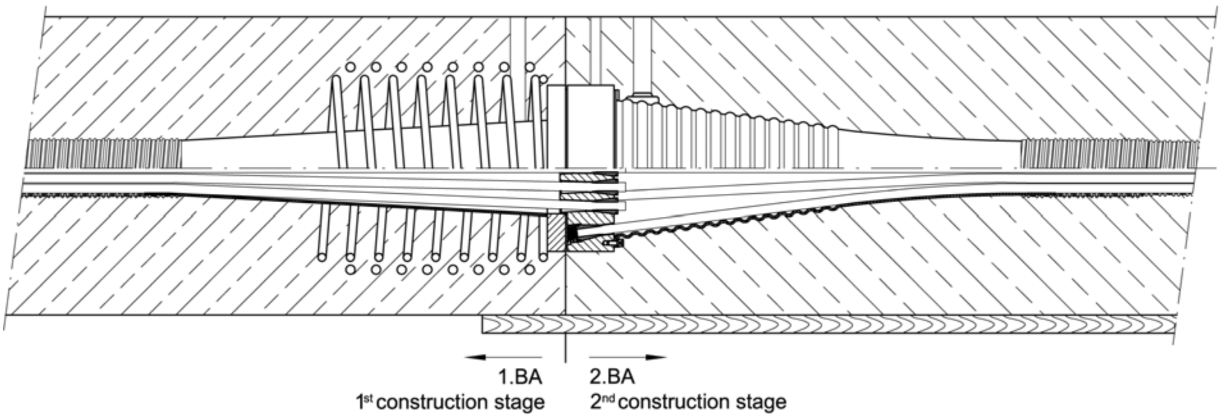
Exposed stressing anchorage type SA



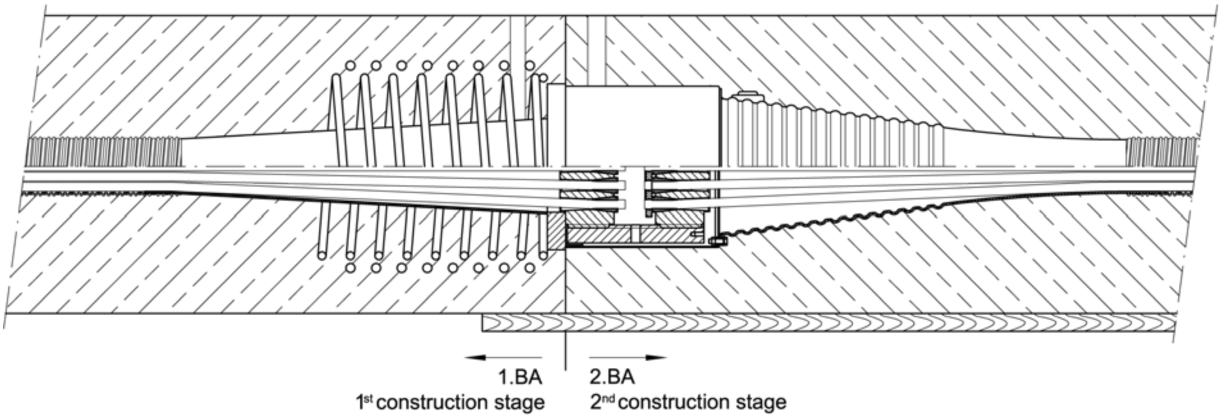
Fixed anchorage type FA



Fixed and stressing coupler type FK, SK



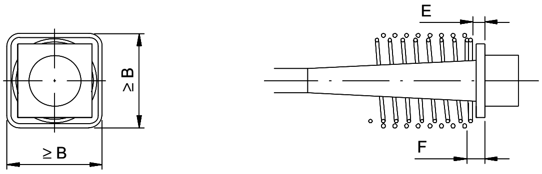
Fixed and stressing coupler type FH, SH



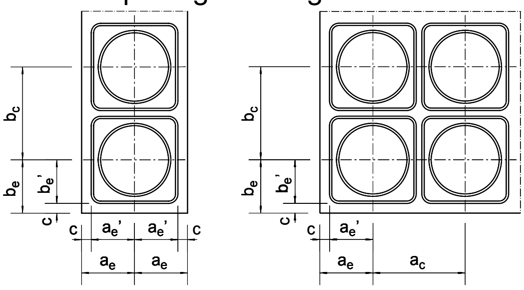
CONA CMI SP	**Internal Post-tensioning System** Construction stages	Annex 20 of European technical approval ETA-09/0287

OIB Member of EOTA

Stressing and fixed anchorage / coupler



Centre spacing and edge distance



$a_e = a_e' + c$

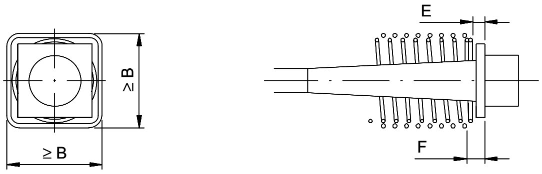
$b_e = b_e' + c$

BBR VT CONA CMI SP			0106					
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	150					
Char. value of maximum force	F_{pk}	kN	279					
Char. value of 0.1 % proof force	$F_{p0.1}$	kN	246					
Maximum prestressing force	$0.90 \cdot F_{p0.1}$	kN	221					
Maximum overstressing force	$0.95 \cdot F_{p0.1}$	kN	234					
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance / Square plate dimensions								
Minimum concrete strength								
Cube	$f_{cm, 0, cube, 150}$	**MPa**	**26**	**28**	**34**	**38**	**43**	**46**
Cylinder	$f_{cm, 0, cylinder, Ø 150}$	**MPa**	**21**	**23**	**28**	**31**	**35**	**38**
Helix, ribbed reinforcing steel, R_e ≥ 500 MPa								
Outer diameter		mm	100	100	75	75	75	75
Bar diameter		mm	10	10	10	8	8	8
Length approximately		mm	100	100	78	76	76	76
Pitch		mm	45	45	45	45	45	45
Number of pitches		—	3	3	2.5	2.5	2.5	2.5
Distance	E	mm	20	20	20	20	20	20
Additional reinforcement, ribbed reinforcing steel, R_e ≥ 500 MPa								
Number of stirrups		mm	2	2	2	2	2	2
Bar diameter		mm	6	6	6	6	6	6
Spacing		mm	80	75	70	65	60	60
Distance from anchor plate	F	mm	40	40	40	40	40	40
Minimum outer dimensions	B × B	mm	100	95	85	80	75	75
Centre spacing and edge distance								
Minimum centre spacing	a_c, b_c	mm	120	115	105	100	95	95
Minimum edge distance	a_e', b_c'	mm	50	50	45	40	40	40
Square plate dimensions [2)]								
Side length	S_{SP}	mm	80	80	80	80	80	80
Thickness	T_{SP}	mm	20	20	20	20	20	20

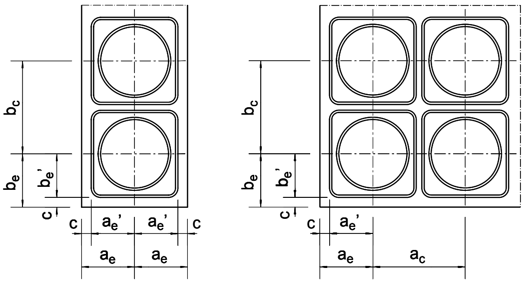
c......Concrete cover
[1)]......Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1 860 MPa may also be used.
[2)]......The square plate dimensions are minimum values, therefore larger or thicker plates may be used.

BBR CONA CMI SP	**Internal Post-tensioning System** Minimum concrete strength Helix – Additional reinforcement Centre and edge distance – Square plate dimensions	Annex 21 of European technical approval ETA-09/0287

Stressing and fixed anchorage / coupler

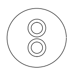
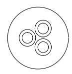
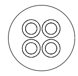


Centre spacing and edge distance



$a_e = a_e' + c$

$b_e = b_e' + c$

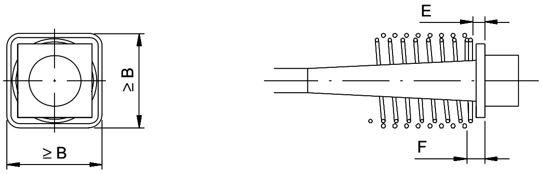
BBR VT CONA CMI SP			0206						0306						0406					
Strand arrangement																				
7-wire prestressing steel strand Nominal diameter **15.7 mm** … Nominal cross-sectional area **150 mm²** … Maximum characteristic tensile strength **1860 MPa** [1)]																				
Tendon																				
Cross-sectional area	A_p	mm²	300						450						600					
Char. value of maximum force	F_{pk}	kN	558						837						1116					
Char. value of 0.1 % proof force	$F_{p0.1}$	kN	492						738						984					
Maximum prestressing force	$0.90 \cdot F_{p0.1}$	kN	443						664						886					
Maximum overstressing force	$0.95 \cdot F_{p0.1}$	kN	467						701						935					
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance / Square plate dimensions																				
Minimum concrete strength																				
Cube	$f_{cm, 0, cube, 150}$	**MPa**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**
Cylinder	$f_{cm, 0, cylinder, Ø 150}$	**MPa**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**
Helix, ribbed reinforcing steel, R_e ≥ 500 MPa																				
Outer diameter		mm	130	130	100	100	100	100	165	160	130	130	120	120	195	190	165	150	145	140
Bar diameter		mm	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Length approximately		mm	145	145	123	123	123	123	168	168	145	145	145	145	190	190	168	168	168	168
Pitch		mm	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Number of pitches		—	4	4	3.5	3.5	3.5	3.5	4.5	4.5	4	4	4	4	5	5	4.5	4.5	4.5	4.5
Distance	E	mm	20	20	20	20	20	20	20	20	20	20	20	20	25	25	25	25	25	25
Additional reinforcement, ribbed reinforcing steel, R_e ≥ 500 MPa																				
Number of stirrups		mm	2	2	3	3	2	2	3	3	6	5	5	5	4	3	5	4	4	4
Bar diameter		mm	6	6	6	6	6	6	10	10	8	8	8	8	10	10	10	10	10	10
Spacing		mm	110	110	60	55	90	90	80	80	30	35	35	35	65	90	45	55	50	50
Distance from anchor plate	F	mm	40	40	40	40	40	40	40	40	40	40	40	40	45	45	45	45	45	45
Minimum outer dimensions	B × B	mm	150	145	130	125	115	115	185	180	165	155	150	145	215	210	190	180	170	165
Centre spacing and edge distance																				
Minimum centre spacing	a_c, b_c	mm	170	165	150	145	135	135	205	200	185	175	170	165	235	230	210	200	190	185
Minimum edge distance	a_e', b_c'	mm	75	75	65	65	60	60	95	90	85	80	75	75	110	105	95	90	85	85
Square plate dimensions [2)]																				
Side length	S_{SP}	mm	140	140	140	140	135	135	145	145	145	140	140	140	155	155	155	155	150	150
Thickness	T_{SP}	mm	20	20	20	20	20	20	20	20	20	20	20	20	25	25	25	25	25	25

c......Concrete cover
[1)]......Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1860 MPa may also be used.
[2)]......The square plate dimensions are minimum values, therefore larger or thicker plates may be used.

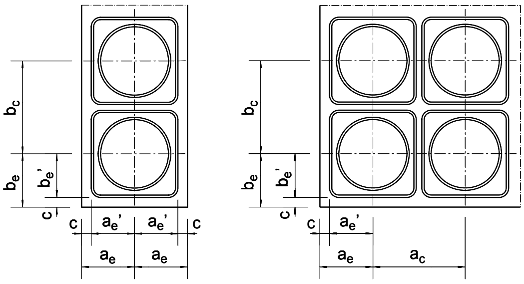
CONA CMI SP	**Internal Post-tensioning System** Minimum concrete strength Helix – Additional reinforcement Centre and edge distance – Square plate dimensions	Annex 22 of European technical approval ETA-09/0287

OIB Member of EOTA

Stressing and fixed anchorage / coupler

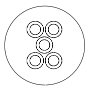
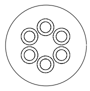
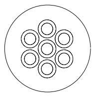


Centre spacing and edge distance



$a_e = a_e' + c$

$b_e = b_e' + c$

BBR VT CONA CMI SP		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 **1860 MPa** 1)																			
Tendon																			
Cross-sectional area A_p	mm^2	750						900						1050					
Char. value of maximum force F_{pk}	kN	1395						1674						1953					
Char. value of 0.1 % proof force $F_{p0.1}$	kN	1230						1476						1722					
Maximum prestressing force $0.90 \cdot F_{p0.1}$	kN	1107						1328						1550					
Maximum overstressing force $0.95 \cdot F_{p0.1}$	kN	1169						1402						1636					
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance / Square plate dimensions																			
Minimum concrete strength																			
Cube $f_{cm, 0, cube, 150}$	**MPa**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**
Cylinder $f_{cm, 0, cylinder, ø 150}$	**MPa**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**
Helix, ribbed reinforcing steel, $R_e \geq 500$ MPa																			
Outer diameter	mm	215	200	185	170	160	160	250	230	210	180	175	175	260	255	220	210	195	190
Bar diameter	mm	10	10	10	10	10	10	10	10	12	12	12	12	10	10	12	12	12	12
Length approximately	mm	235	213	210	185	185	185	235	235	212	212	187	187	258	258	237	237	212	212
Pitch	mm	45	45	50	50	50	50	45	45	50	50	50	50	45	45	50	50	50	50
Number of pitches	—	6	5.5	5	4.5	4.5	4.5	6	6	5	5	4.5	4.5	6.5	6.5	5.5	5.5	5	5
Distance E	mm	30	30	30	30	30	30	35	35	35	35	35	35	35	35	35	35	35	35
Additional reinforcement, ribbed reinforcing steel, $R_e \geq 500$ MPa																			
Number of stirrups	mm	2	2	5	4	4	3	3	2	4	3	3	3	5	4	5	5	5	4
Bar diameter	mm	12	12	10	10	10	12	12	12	12	12	12	12	12	12	12	12	12	12
Spacing	mm	175	170	50	60	60	80	115	185	70	95	90	90	70	85	60	60	55	70
Distance from anchor plate F	mm	50	50	50	50	50	50	55	55	55	55	55	55	55	55	55	55	55	55
Minimum outer dimensions B × B	mm	245	235	220	205	195	190	270	260	240	225	210	205	295	280	260	250	235	225
Centre spacing and edge distance																			
Minimum centre spacing a_c, b_c	mm	265	255	240	225	215	210	290	280	260	245	230	225	315	300	280	270	255	245
Minimum edge distance a_e', b_c'	mm	125	120	110	105	100	95	135	130	120	115	105	105	150	140	130	125	120	115
Square plate dimensions 2)																			
Side length S_{SP}	mm	185	185	185	185	180	180	190	190	190	190	185	185	205	205	205	200	195	195
Thickness T_{SP}	mm	30	30	30	30	30	30	35	35	35	35	35	35	35	35	35	35	35	35

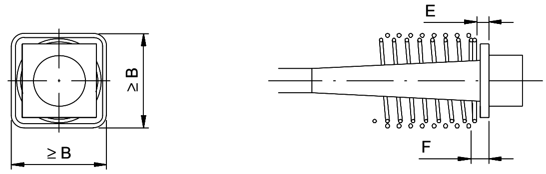
c......Concrete cover

1)......Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1860 MPa may also be used.

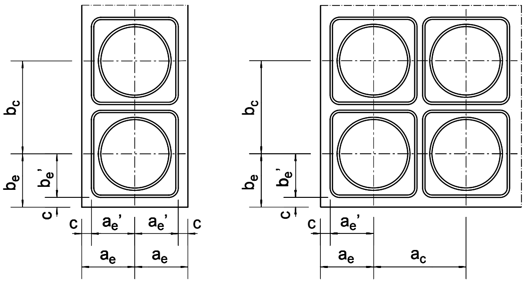
2)......The square plate dimensions are minimum values, therefore larger or thicker plates may be used.

BBR CONA CMI SP	**Internal Post-tensioning System** Minimum concrete strength Helix – Additional reinforcement Centre and edge distance – Square plate dimensions	Annex 23 of European technical approval ETA-09/0287

Stressing and fixed anchorage / coupler

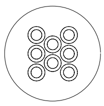
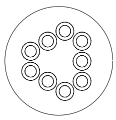
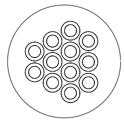


Centre spacing and edge distance



$a_e = a_e' + c$

$b_e = b_e' + c$

BBR VT CONA CMI SP			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 **1860 MPa** [1]																				
Tendon																				
Cross-sectional area	A_p	mm²	1200						1350						1800					
Char. value of maximum force	F_{pk}	kN	2232						2511						3348					
Char. value of 0.1 % proof force	$F_{p0.1}$	kN	1968						2214						2952					
Maximum prestressing force	$0.90 \cdot F_{p0.1}$	kN	1771						1993						2657					
Maximum overstressing force	$0.95 \cdot F_{p0.1}$	kN	1870						2103						2804					
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance / Square plate dimensions																				
Minimum concrete strength																				
Cube	$f_{cm, 0, cube, 150}$	**MPa**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**
Cylinder	$f_{cm, 0, cylinder, Ø 150}$	**MPa**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**
Helix, ribbed reinforcing steel, $R_e \geq 500$ MPa																				
Outer diameter		mm	280	270	230	215	205	200	295	280	240	225	215	215	325	320	290	280	270	260
Bar diameter [3]		mm	10	10	12	12	12	12	10	10	10	10	12	12	12	12	12	14	14	14
Length approximately		mm	280	258	237	237	237	212	280	280	260	260	262	212	327	327	312	289	289	239
Pitch		mm	45	45	50	50	50	50	45	45	50	50	50	50	45	45	50	50	50	50
Number of pitches		—	7	6.5	5.5	5.5	5.5	5	7	7	6	6	6	5	8	8	7	6.5	6.5	5.5
Distance	E	mm	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Additional reinforcement, ribbed reinforcing steel, $R_e \geq 500$ MPa																				
Number of stirrups		mm	5	4	3	3	3	3	5	4	4	4	3	4	7	6	7	6	6	6
Bar diameter [3]		mm	12	12	16	16	16	16	12	12	16	16	16	16	14	14	16	16	16	16
Spacing		mm	70	90	120	110	105	100	75	75	90	85	110	75	55	55	55	60	60	55
Distance from anchor plate	F	mm	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
Minimum outer dimensions	B × B	mm	315	300	280	265	250	240	330	320	295	280	265	255	385	375	345	325	310	300
Centre spacing and edge distance																				
Minimum centre spacing	a_c, b_c	mm	335	320	300	285	270	260	355	340	315	300	285	275	410	395	365	345	330	320
Minimum edge distance	a_e', b_c'	mm	160	150	140	135	125	120	170	160	150	140	135	130	195	190	175	165	155	150
Square plate dimensions [2]																				
Side length	S_{SP}	mm	225	225	225	220	215	215	255	255	250	245	240	240	265	265	265	260	255	250
Thickness	T_{SP}	mm	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35

c......Concrete cover

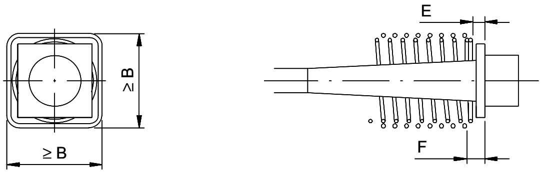
[1]......Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1860 MPa may also be used.

[2]......The square plate dimensions are minimum values, therefore larger or thicker plates may be used.

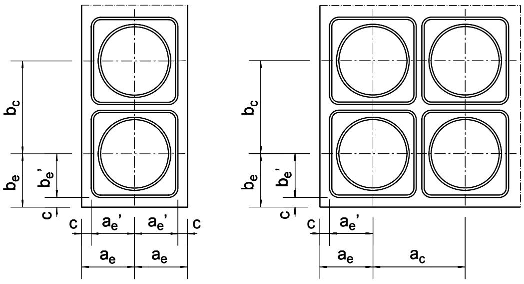
[3]......Bar diameter of 14 mm can be replaced by 16 mm.

Member of EOTA

Stressing and fixed anchorage / coupler

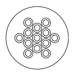
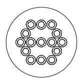
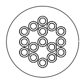


Centre spacing and edge distance



$a_e = a_e' + c$

$b_e = b_e' + c$

BBR VT CONA CMI SP			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 **1860 MPa** [1)]																				
Tendon																				
Cross-sectional area	A_p	mm²	1950						2250						2400					
Char. value of maximum force	F_{pk}	kN	3627						4185						4464					
Char. value of 0.1 % proof force	$F_{p0.1}$	kN	3198						3690						3936					
Maximum prestressing force	$0.90 \cdot F_{p0.1}$	kN	2878						3321						3542					
Maximum overstressing force	$0.95 \cdot F_{p0.1}$	kN	3038						3506						3739					
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance / Square plate dimensions																				
Minimum concrete strength																				
Cube	$f_{cm, 0, cube, 150}$	**MPa**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**
Cylinder	$f_{cm, 0, cylinder, Ø 150}$	**MPa**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**
Helix, ribbed reinforcing steel, R_e ≥ 500 MPa																				
Outer diameter		mm	340	330	305	290	280	270	370	350	325	300	290	280	390	370	340	330	310	310
Bar diameter [3)]		mm	12	12	12	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Length approximately		mm	350	327	312	314	289	264	389	364	339	339	314	289	389	389	364	339	339	289
Pitch		mm	45	45	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Number of pitches		—	8.5	8	7	7	6.5	6	8.5	8	7.5	7.5	7	6.5	8.5	8.5	8	7.5	7.5	6.5
Distance	E	mm	40	40	40	40	40	40	45	45	45	45	45	45	45	45	45	45	45	45
Additional reinforcement, ribbed reinforcing steel, R_e ≥ 500 MPa																				
Number of stirrups		mm	7	6	6	6	6	6	7	6	6	6	6	6	7	6	7	6	6	7
Bar diameter [3)]		mm	14	14	16	16	16	16	14	14	16	16	16	16	14	14	16	16	16	16
Spacing		mm	65	65	65	65	60	60	70	70	70	70	65	65	70	70	60	70	65	55
Distance from anchor plate	F	mm	60	60	60	60	60	60	65	65	65	65	65	65	65	65	65	65	65	65
Minimum outer dimensions	B × B	mm	405	390	360	340	320	310	435	420	390	370	350	340	450	435	400	380	360	350
Centre spacing and edge distance																				
Minimum centre spacing	a_c, b_c	mm	425	410	380	360	340	330	455	440	410	390	370	360	470	455	420	400	380	370
Minimum edge distance	a_e', b_c'	mm	205	195	180	170	160	155	220	210	195	185	175	170	225	220	200	190	180	175
Square plate dimensions [2)]																				
Side length	S_{SP}	mm	285	285	280	275	270	270	320	320	315	310	305	300	330	330	325	320	315	305
Thickness	T_{SP}	mm	40	40	40	40	40	40	45	45	45	45	45	45	45	45	45	45	45	45

c......Concrete cover

1)......Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1860 MPa may also be used.

2)......The square plate dimensions are minimum values, therefore larger or thicker plates may be used.

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

CONA CMI SP

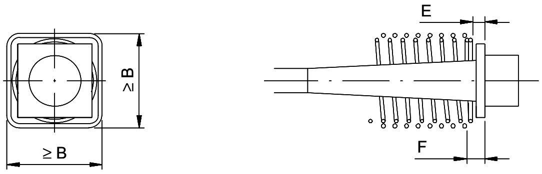
Internal Post-tensioning System

Minimum concrete strength
Helix – Additional reinforcement
Centre and edge distance – Square plate dimensions

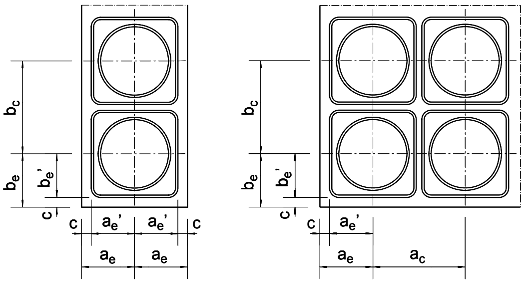
Annex 25
of European technical approval
ETA-09/0287

Member of EOTA

Stressing and fixed anchorage / coupler

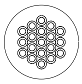
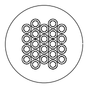
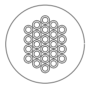


Centre spacing and edge distance



$a_e = a_e' + c$

$b_e = b_e' + c$

BBR VT CONA CMI SP			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 **1860 MPa** [1]																				
Tendon																				
Cross-sectional area	A_p	mm²	2850						3300						3600					
Char. value of maximum force	F_{pk}	kN	5301						6138						6696					
Char. value of 0.1 % proof force	$F_{p0.1}$	kN	4674						5412						5904					
Maximum prestressing force	$0.90 \cdot F_{p0.1}$	kN	4207						4871						5314					
Maximum overstressing force	$0.95 \cdot F_{p0.1}$	kN	4440						5141						5609					
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance / Square plate dimensions																				
Minimum concrete strength																				
Cube	$f_{cm, 0, cube, 150}$	**MPa**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**
Cylinder	$f_{cm, 0, cylinder, Ø 150}$	**MPa**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**
Helix, ribbed reinforcing steel, $R_e \geq 500$ MPa																				
Outer diameter		mm	435	410	380	350	340	340	460	430	400	360	350	350	480	460	410	370	360	360
Bar diameter		mm	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Length approximately		mm	391	391	391	366	341	291	441	441	416	391	366	316	466	441	416	416	391	341
Pitch		mm	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Number of pitches		—	8.5	8.5	8.5	8	7.5	6.5	9.5	9.5	9	8.5	8	7	10	9.5	9	9	8.5	7.5
Distance	E	mm	50	50	50	45	45	45	55	55	55	55	55	55	55	55	55	55	55	55
Additional reinforcement, ribbed reinforcing steel, $R_e \geq 500$ MPa																				
Number of stirrups		mm	7	6	9	8	7	7	7	6	9	8	8	7	7	6	9	8	8	7
Bar diameter [3]		mm	14	16	16	16	16	16	16	16	16	16	16	16	20	20	20	20	20	20
Spacing		mm	70	85	50	55	60	55	80	80	55	60	55	55	90	100	70	70	70	80
Distance from anchor plate	F	mm	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
Minimum outer dimensions	B × B	mm	490	470	435	415	395	385	530	510	470	445	425	415	550	530	495	465	445	435
Centre spacing and edge distance																				
Minimum centre spacing	a_c, b_c	mm	510	490	455	435	415	405	550	530	490	465	445	435	575	550	515	485	465	455
Minimum edge distance	a_e', b_c'	mm	245	235	220	210	200	195	265	255	235	225	215	210	280	265	250	235	225	220
Square plate dimensions [2]																				
Side length	S_{SP}	mm	340	340	335	325	320	310	370	370	365	355	345	345	390	390	385	375	370	370
Thickness	T_{SP}	mm	50	50	50	45	45	45	55	55	55	55	55	55	55	55	55	55	55	55

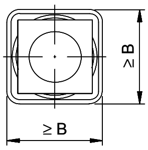
c......Concrete cover

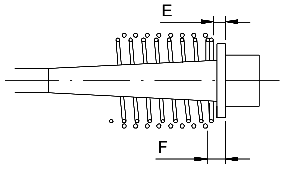
[1]......Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1860 MPa may also be used.

[2]......The square plate dimensions are minimum values, therefore larger or thicker plates may be used.

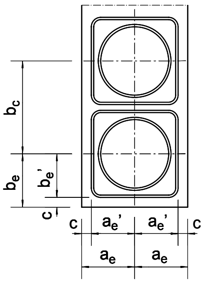
[3]......Bar diameter of 14 mm can be replaced by 16 mm.

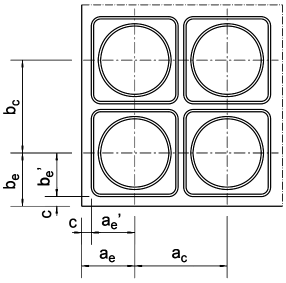
Stressing and fixed anchorage / coupler





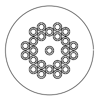
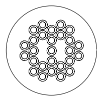
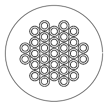
Centre spacing and edge distance





$a_e = a_e' + c$

$b_e = b_e' + c$

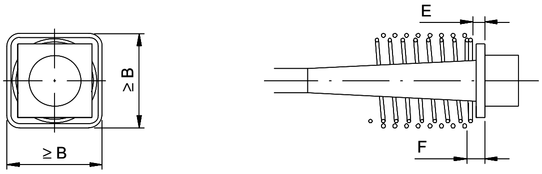
BBR VT CONA CMI SP		2506						2706						3106					
Strand arrangement																			
7-wire prestressing steel strand Nominal diameter **15.7 mm** … Nominal cross-sectional area **150 mm²** … Maximum characteristic tensile strength **1 860 MPa** [1]																			
Tendon																			
Cross-sectional area A_p	mm^2	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					
Maximum prestressing force $0.90 \cdot F_{p0.1}$	kN	5 535						5 978						6 863					
Maximum 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 / Square plate dimensions																			
Minimum concrete strength																			
Cube $f_{cm, 0, cube, 150}$	**MPa**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**
Cylinder $f_{cm, 0, cylinder, ø 150}$	**MPa**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**
Helix, ribbed reinforcing steel, R_e ≥ 500 MPa																			
Outer diameter	mm	500	480	420	380	370	370	520	500	450	400	390	380	560	540	480	430	430	430
Bar diameter	mm	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Length approximately	mm	466	466	441	441	391	366	491	491	441	441	416	391	516	516	466	466	416	391
Pitch	mm	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Number of pitches	—	10	10	9.5	9.5	8.5	8	10.5	10.5	9.5	9.5	9	8.5	11	11	10	10	9	8.5
Distance E	mm	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Additional reinforcement, ribbed reinforcing steel, R_e ≥ 500 MPa																			
Number of stirrups	mm	7	6	9	8	8	6	6	5	7	6	6	6	8	7	10	9	8	8
Bar diameter	mm	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Spacing	mm	100	100	70	70	70	80	100	100	80	90	85	70	80	95	60	65	70	65
Distance from anchor plate F	mm	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Minimum outer dimensions B × B	mm	565	545	500	475	450	440	585	565	520	495	470	460	630	605	560	535	515	500
Centre spacing and edge distance																			
Minimum centre spacing a_c, b_c	mm	585	565	520	495	470	460	605	585	540	515	490	480	650	625	580	555	535	520
Minimum edge distance a_e', b_c'	mm	285	275	250	240	225	220	295	285	260	250	235	230	315	305	280	270	260	250
Square plate dimensions [2]																			
Side length S_{SP}	mm	405	405	405	395	385	385	415	415	410	400	395	395	440	440	435	425	420	415
Thickness T_{SP}	mm	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60

c......Concrete cover

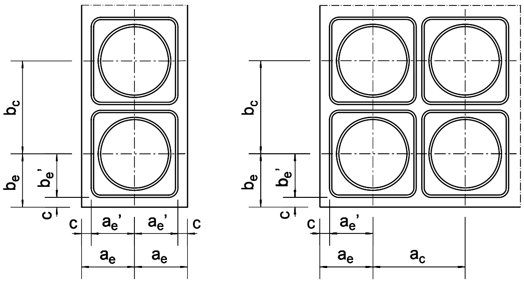
[1]......Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1 860 MPa may also be used.

[2]......The square plate dimensions are minimum values, therefore larger or thicker plates may be used.

Stressing and fixed anchorage / coupler

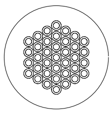
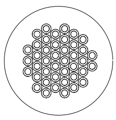
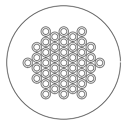


Centre spacing and edge distance



$a_e = a_e' + c$

$b_e = b_e' + c$

BBR VT CONA CMI SP	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 **1860 MPa** [1)]

Tendon

			3706	4206	4306
Cross-sectional area	A_p	mm^2	5550	6300	6450
Char. value of maximum force	F_{pk}	kN	10323	11718	11997
Char. value of 0.1 % proof force	$F_{p0.1}$	kN	9102	10332	10578
Maximum prestressing force	$0.90 \cdot F_{p0.1}$	kN	8192	9299	9520
Maximum overstressing force	$0.95 \cdot F_{p0.1}$	kN	8647	9815	10049

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

			3706						4206						4306					
Minimum concrete strength																				
Cube	$f_{cm, 0, cube, 150}$	**MPa**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**
Cylinder	$f_{cm, 0, cylinder, Ø 150}$	**MPa**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**
Helix, ribbed reinforcing steel, $R_e \geq 500$ MPa																				
Outer diameter		mm	620	620	620	620	620	620	660	660	660	660	660	660	670	670	670	670	670	670
Bar diameter		mm	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Length approximately		mm	566	566	566	566	566	566	616	616	616	616	616	616	666	666	666	666	666	666
Pitch		mm	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Number of pitches		—	12	12	12	12	12	12	13	13	13	13	13	13	14	14	14	14	14	14
Distance	E	mm	70	70	70	70	70	70	75	75	75	75	75	75	75	75	75	75	75	75
Additional reinforcement, ribbed reinforcing steel, $R_e \geq 500$ MPa																				
Number of stirrups		mm	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Bar diameter		mm	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Spacing		mm	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
Distance from anchor plate	F	mm	90	90	90	90	90	90	95	95	95	95	95	95	95	95	95	95	95	95
Minimum outer dimensions	B × B	mm	695	695	695	695	695	695	745	745	745	745	745	745	755	755	755	755	755	755
Centre spacing and edge distance																				
Minimum centre spacing	a_c, b_c	mm	715	715	715	715	715	715	765	765	765	765	765	765	775	775	775	775	775	775
Minimum edge distance	a_e', b_e'	mm	350	350	350	350	350	350	375	375	375	375	375	375	380	380	380	380	380	380
Square plate dimensions [2)]																				
Side length	S_{SP}	mm	480	480	480	480	480	480	510	510	510	510	510	510	520	520	520	520	520	520
Thickness	T_{SP}	mm	70	70	70	70	70	70	75	75	75	75	75	75	75	75	75	75	75	75

c......Concrete cover

1)......Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1860 MPa may also be used.

2)......The square plate dimensions are minimum values, therefore larger or thicker plates may be used.

CONA CMI SP

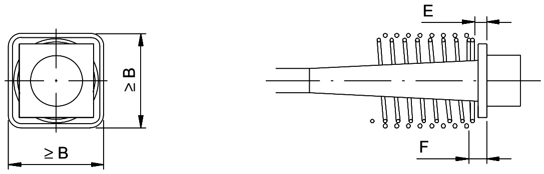
Internal Post-tensioning System

Minimum concrete strength
Helix – Additional reinforcement
Centre and edge distance – Square plate dimensions

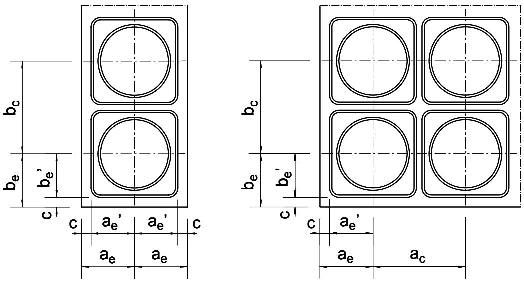
Annex 28
of European technical approval
ETA-09/0287

OIB Member of EOTA

Stressing and fixed anchorage / coupler

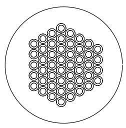
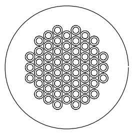
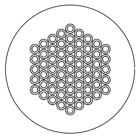


Centre spacing and edge distance



$a_e = a_e' + c$

$b_e = b_e' + c$

BBR VT CONA CMI SP			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 **1860 MPa** 1)																				
Tendon																				
Cross-sectional area	A_p	mm²	7200						8250						9150					
Char. value of maximum force	F_{pk}	kN	13392						15345						17019					
Char. value of 0.1 % proof force	$F_{p0.1}$	kN	11808						13530						15006					
Maximum prestressing force	$0.90 \cdot F_{p0.1}$	kN	10627						12177						13505					
Maximum overstressing force	$0.95 \cdot F_{p0.1}$	kN	11218						12854						14256					
Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance / Square plate dimensions																				
Minimum concrete strength																				
Cube	$f_{cm, 0, cube, 150}$	**MPa**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**	**26**	**28**	**34**	**38**	**43**	**46**
Cylinder	$f_{cm, 0, cylinder, ø 150}$	**MPa**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**	**21**	**23**	**28**	**31**	**35**	**38**
Helix, ribbed reinforcing steel, $R_e \geq 500$ MPa																				
Outer diameter		mm	720	720	720	720	720	720	790	790	790	790	790	790	860	860	860	860	860	860
Bar diameter		mm	20	20	20	20	20	20	25	25	25	25	25	25	25	25	25	25	25	25
Length approximately		mm	860	860	860	860	860	860	940	940	940	940	940	940	985	985	985	985	985	985
Pitch		mm	60	60	60	60	60	60	70	70	70	70	70	70	60	60	60	60	60	60
Number of pitches		—	15	15	15	15	15	15	14	14	14	14	14	14	17	17	17	17	17	17
Distance	E	mm	80	80	80	80	80	80	90	90	90	90	90	90	90	90	90	90	90	90
Additional reinforcement, ribbed reinforcing steel, $R_e \geq 500$ MPa																				
Number of stirrups		mm	11	11	11	11	11	11	12	12	12	12	12	12	13	13	13	13	13	13
Bar diameter		mm	20	20	20	20	20	20	16	16	16	16	16	16	16	16	16	16	16	16
Spacing		mm	75	75	75	75	75	75	70	70	70	70	70	70	70	70	70	70	70	70
Distance from anchor plate	F	mm	100	100	100	100	100	100	110	110	110	110	110	110	110	110	110	110	110	110
Minimum outer dimensions	B × B	mm	810	810	810	810	810	810	885	885	885	885	885	885	940	940	940	940	940	940
Centre spacing and edge distance																				
Minimum centre spacing	a_c, b_c	mm	830	830	830	830	830	830	905	905	905	905	905	905	960	960	960	960	960	960
Minimum edge distance	a_e', b_c'	mm	405	405	405	405	405	405	445	445	445	445	445	445	470	470	470	470	470	470
Square plate dimensions 2)																				
Side length	S_{SP}	mm	550	550	550	550	550	550	595	595	595	595	595	595	620	620	620	620	620	620
Thickness	T_{SP}	mm	80	80	80	80	80	80	90	90	90	90	90	90	90	90	90	90	90	90

c......Concrete cover

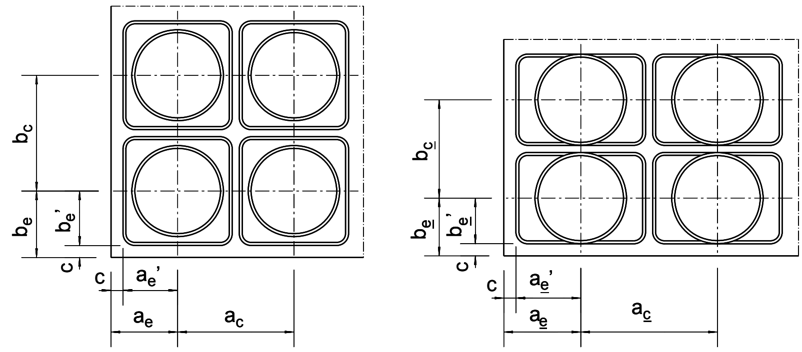
1)......Prestressing steel strand with nominal diameter of 15.3 mm, cross-sectional area of 140 mm² or with characteristic tensile strength below 1860 MPa may also be used.

2)......The square plate dimensions are minimum values, therefore larger or thicker plates may be used.

BBR CONA CMI SP	**Internal Post-tensioning System** Minimum concrete strength Helix – Additional reinforcement Centre and edge distance – Square plate dimensions	Annex 29 of European technical approval ETA-09/0287

Member of EOTA

Centre spacing and edge distance



$a_c = b_c$

$a_e = b_e$

$a_{\underline{c}} > b_{\underline{c}}$

$a_{\underline{e}} > b_{\underline{e}}$

Modification of centre spacing and edge distance shall be in accordance with the Clause 2.9.

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

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

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

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) .... The outer dimensions of the additional reinforcement shall be adjusted accordingly. Further modifications of reinforcement have to be in accordance with Clause 4.2.3.

BBR CONA CMI SP	**Internal Post-tensioning System** Modification of centre spacing and edge distance	Annex 30 of European technical approval ETA-09/0287

Installation

1) Preparatory work

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

2) Anchorage recesses

Adequate space to accommodate and to use the prestressing jack shall be ensured (see also Clauses 2.1.5 and 4.2.2).

3) Fixing the square plates

Four holes are provided to fix the square plates to the formwork. The helix is either welded to the square plates by means of radial bars (see also Clause 4.8) or positioned by fixing it to the existing reinforcement.

4) Placing of the sheaths

The sheaths are placed on supports with spacing according to Clause 2.5 and minimum radii of curvature according to Clause 2.4. The sheaths have to be jointed in a leak-proof way. The sheaths shall be 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 have to be 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 2.1.4. The transverse forces at the end of the trumpet are covered by steel deflector rings (tension rings).

9) Checking the tendons before concreting

Before concreting the structure the fixation and position of the entire tendon have to be checked and corrected if necessary. The sheaths shall be 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 shall be at least according to Table 4 and the provisions of Clause 2.8. The stressing and possible wedging has to be carried out with a suitable prestressing jack and in accordance with Clause 4.4.

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

Restressing the tendons is allowed in accordance with Clause 4.5.

12) Grouting the tendons

The grout shall be injected through the inlet holes until it escapes from the outlet tubes with the same consistency. All vents and grouting inlets shall be sealed immediately after grouting (see also Clause 4.7).

Grease or wax has to be injected in accordance with ETAG 013 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	mm^2	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 valid at the place of use may also be used.
2) For strands according to prEN 10138-3, 09.2000, the value shall be multiplied by 0.98.
3) Standard value

Reference documents

Guideline for European technical approval

ETAG 013, 06.2002	Guideline for European technical approval of Post-Tensioning Kits for Prestressing of Structures

Standards

EN 206-1, 12.2000 EN 206-1/A1, 07.2004 EN 206-1/A2, 06.2005	Concrete - Part 1: 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 1992-1-1, 12.2004 EN 1992-1-1/AC, 11.2010	Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings
EN 1993-series	Eurocode 3: Design of steel structures
EN 1994-series	Eurocode 4: Design of composite steel and concrete structures
EN 1996-series	Eurocode 6: Design of masonry structures
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, 05.2002 EN 10216-1/A1, 03.2004	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 and cold sized square and rectangular tubes
EN 12201-1, 03.2003	Plastic piping system for water supply - polyethylene (PE) - Part 1: General
EN ISO 1872-1, 05.1999	Plastics - Polyethylene (PE) 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

MATERIALPRÜFUNGSAMT NORDRHEIN-WESTFALEN

EC Certificate of Conformity
0432-CPD-11 9181-1.5/2

In compliance with Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products (the Construction Products Directive or CPD), as later amended, it has been stated that the construction product

BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands

Post-tensioning kit for internal prestressing of structures with internal bonded and un-bonded strands

placed on the market by

BBR VT International Ltd
Bahnstraße 23
CH-8603 Schwerzenbach (ZH)
SWITZERLAND

and produced in the factory

BBR VT International Ltd
Bahnstraße 23
CH-8603 Schwerzenbach (ZH)
SWITZERLAND

is submitted by the manufacturer to a factory production control and to the further testing of samples taken at the factory in accordance with a prescribed test plan and that the notified body No. 0432 – MPA NRW – has performed the initial type-testing for the relevant characteristics of the product, the initial inspection of the factory and of the factory production control and performs the continuous surveillance, assessment and approval of the factory production control and an audit-testing of samples taken at the factory, on the market or at the construction site.

This certificate attests that all provisions concerning the attestation of conformity and the performances described in the ETA

ETA-09/0287 from 30-06-2013

were applied and that the product fulfils all the prescribed requirements.

This certificate was first issued on 30-07-2010 and remains valid as long as the conditions laid down in the harmonised technical specification in reference or the manufacturing conditions in the factory or the FPC itself are not modified significantly and latest on 29-06-2018.

Dortmund, 30-06-2013

Materialprüfungsamt MPA NRW 10 Nordrhein-Westfalen

Dipl.-Ing. Gödecker
Head of Certification Body

This Certificate replaces the Certificate no. 11 9181-1.5/1 dated 30-07-2010.

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

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