

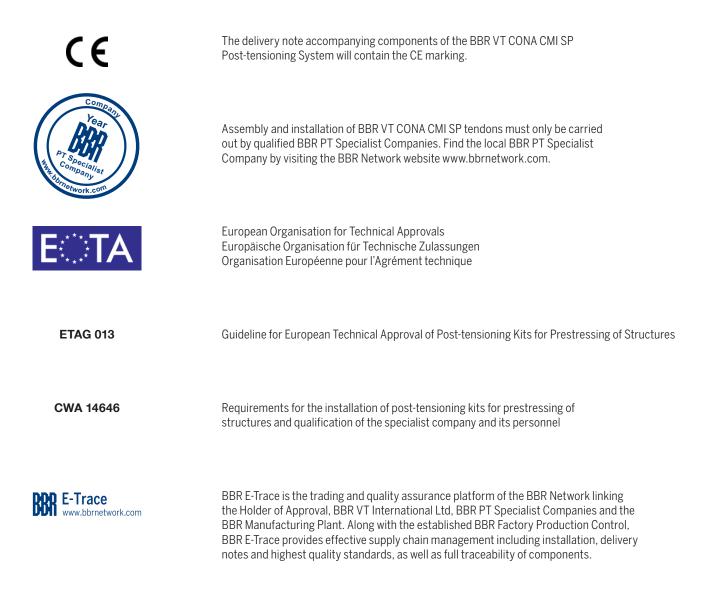
European Technical Assessment ETA – 09/0287

BR VT CONA CMI SP inal Post-tensioning System with 01 to 61 Strands G

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European Technical Assessment

ETA-09/0287 of 19.09.2018

General part

Technical Assessment Body issuing the European Technical Assessment

Trade name of the construction product

Product family to which the construction product belongs

Manufacturer

Manufacturing plant

This European Technical Assessment contains

This European Technical Assessment is issued in accordance with Regulation (EU) № 305/2011, on the basis of

This European Technical Assessment replaces

Österreichisches Institut für Bautechnik (OIB) Austrian Institute of Construction Engineering

BBR VT CONA CMI SP – Internal Posttensioning System with 01 to 61 Strands

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

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

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62 pages including Annexes 1 to 35, which form an integral part of this assessment.

EAD 160004-00-0301, European Assessment Document for Post-Tensioning Kits for Prestressing of Structures.

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Remarks

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Specific parts

1 Technical description of the product

1.1 General

The European Technical Assessment¹ – ETA – 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, see Annex 1, Annex 2, Annex 3, Annex 4, Annex 5, Annex 6, and Annex 7.

- Tendon

Internal tendon with 01 to 61 tensile elements

- Tensile element

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

Nominal diameter	Nominal cross-sectional area	Maximum characteristic tensile strength	
mm	mm²	МРа	
15.3	140	1 860	
15.7	150		

Table 1 Tensile elements

NOTE 1 MPa = 1 N/mm²

- Anchorage and coupler

Anchorage of the prestressing steel strands with ring wedges

End anchorage

Fixed (passive) anchor or stressing (active) anchor as end anchorage, FA or SA, for tendons with 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 prestressing steel strands

ETA-09/0287 was firstly issued in 2010 as European technical approval with validity from 17.05.2010, amended in 2010 with validity from 29.09.2010, extended in 2013 with validity from 30.06.2013, and converted in 2018 to European Technical Assessment ETA-09/0287 of 19.09.2018.



Fixed or stressing coupler

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

Sleeve coupler, FH or SH, for tendons with 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 prestressing steel strands

Moveable coupler

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

Sleeve coupler, BH, for tendons with 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 prestressing steel strands

- Square plate for tendons with 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 prestressing steel strands
- Helix and additional reinforcement in the region of the anchorage
- Corrosion protection for tensile elements, anchorages, and couplers

PT system

1.2 Designation and range of anchorages and couplers

1.2.1 General

End anchorages can be fixed or stressing anchorages. Couplers are fixed, stressing, or moveable. The principal dimensions of anchorages and couplers are given in Annex 2, Annex 3, Annex 4, Annex 5, Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26.

1.2.2 Designation

	End anchorage e.g.	<u>S A CONA CMI SP 1906-150 1860</u>
	Fixed (F) or stressing (S) -	
	Anchorage 🔫	
	Designation of the tendon – with information on number, cross-sectional a prestressing steel strands	area, and characteristic tensile strength of
	Coupler e.g.	<u>F K CONA CMI SP 1906-150 1860</u>
	Fixed (F), stressing (S) or moveable (B) -	
	Coupler anchor head (K or H) 	
	Designation of the tendon with information on number, cross-sectional a prestressing steel strands	area, and characteristic tensile strength of
1.2.3	Anchorage, FA or SA	

1.2.3.1 General

Anchorage of prestressing steel strands is achieved by wedges and anchor heads, see Annex 1, Annex 2, Annex 3, and Annex 7. The anchor heads of the fixed and stressing anchorage are identical. A differentiation is needed for the construction works.



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

Where

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

1.2.3.2 Restressable and exchangeable tendon

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

1.2.4 Fixed and stressing coupler

1.2.4.1 General

Anchorage of prestressing steel strands is achieved by wedges and coupler anchor heads, see Annex 1, Annex 2, Annex 4, Annex 5, and Annex 7.

1.2.4.2 Single plane coupler, FK or SK

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

1.2.4.3 Sleeve coupler, FH or SH

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

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

1.2.5 Moveable coupler, BK or BH

Anchorage of prestressing steel strands is achieved by wedges and coupler anchor heads, see Annex 1, Annex 2, Annex 4, Annex 5, and Annex 7. The moveable coupler is either a single plane coupler or a sleeve coupler in a coupler sheathing made of steel or plastic. Length and position of the coupler sheathing are for the expected elongation displacement, see Clause 2.2.4.

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

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



1.2.6 Layout of the anchorage recess

All bearing trumplates, anchor heads, and coupler anchor heads are placed perpendicular to the axis of the tendon, see Annex 17.

The dimensions of the anchorage recess are adapted to the prestressing jacks used. The ETA holder saves for reference information on the minimum dimensions of the anchorage recess.

The formwork for the anchorage recess should be slightly conical for ease of removal. In case of an internal anchorage fully embedded in concrete, the recess is designed so as to permit a reinforced concrete cover with the required dimensions and in any case with a thickness of at least 20 mm. In case of an exposed anchorage, see Annex 17, concrete cover on anchorage and square plate is not required. However, the exposed surfaces of square plate and steel cap are provided with corrosion protection.

1.3 Designation and range of the tendons

1.3.1 Designation

Tendon e.g.	<u>CONA CMI SP 19 06-150 1860</u>
Internal PT -	I _
Number of prestressing steel strands (02 to 61)	◀────┘│││
Prestressing steel strand -	
Cross-sectional area of prestressing steel strand	ls (140 or 150 mm²) 🚤
Characteristic tensile strength of the prestressing	g steel strands 🔫

The tendons comprise 01 to 61 tensile elements, 7-wire prestressing steel strands according to Annex 30.

1.3.2 Range

1.3.2.1 General

Prestressing and overstressing forces are given in the corresponding standards and regulations in force at the place of use. The maximum prestressing and overstressing forces according to Eurocode 2 are listed in Annex 16.

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

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

1.3.2.2 CONA CMI SP n06-140

7-wire prestressing steel strand

Nominal diameter 15.3	mm
Nominal cross-sectional area140	mm ²
Maximum characteristic tensile strength1860	MPa
Annex 8 lists the available tendon range for CONA CMI SP n0	6-140.



1.3.2.3 CONA CMI SP n06-150

7-wire prestressing steel strand

Nominal diameter 15.7	mm
Nominal cross-sectional area150	mm ²
Maximum characteristic tensile strength1860	MPa
Annex 9 lists the available tendon range for CONA CMI SP n0	6-150.

1.4 Duct

1.4.1 Use of duct

For a bonded tendon a corrugated steel duct is used.

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

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

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

 $\label{eq:table2} \begin{tabular}{c} \textbf{Table 2} & Steel ducts, minimum wall thickness, t_{min} \end{tabular}$

Table 3	Plastic ducts, minimum wall thickness, t _{min}
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Number of	Corrugated plastic duct		Smooth plastic duct	
strands	Maximum degree of filling	Minimum wall thickness	Maximum degree of filling	Minimum wall thickness
n	f	t _{min}	f	t _{min}
		mm	—	mm
02–04	0.3	2.0	0.25	3.0
05–07	0.4	2.0	0.3	3.6
08–12	0.4	2.5	0.35	4.3
13–15	0.4	2.5	0.35	5.3
16–22	0.4	3.0	0.35	6.0
23–27	0.4	3.5	0.35	6.7
28–37	0.4	4.0	0.35	7.7
38–48	0.45	4.5	0.35	8.6
49–55	0.45	5.0	0.35	9.6
56–61	0.45	5.5	0.35	10.8



1.4.2 Degree of filling

The degree of filling, f, for a circular duct is generally between 0.35 and 0.50. However, the smaller values of degree of filling, 0.35 to 0.40, are used for long tendons or if the tensile elements are installed after concreting. The minimum radius of curvature can be defined with the equation given in Clause 1.9. Typical degrees of filling, f, and corresponding minimum radii of curvature, R_{min} , are given in Annex 10, Annex 11, and Annex 12. The degree of filling is defined as

f = <u>cross-sectional area of prestressing steel</u>

cross-sectional area of inner diameter of sheath

1.4.3 Circular steel strip sheath

Steel strip sheath in conformity with EN 523², with minimum wall thicknesses according to Table 2, is used. For diameters exceeding EN 523 the requirements are met analogous. The degree of filling, f, is according to Clause 1.4.2 and the minimum radius of curvature to Clause 1.9.

Annex 11 and Annex 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.

1.4.4 Flat corrugated steel duct

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

1.4.5 Pre-bent smooth circular steel duct

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

1.5 Friction losses

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

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

Where

 F_xkNPrestressing force at a distance x along the tendon

 F_0kN....Prestressing force at x = 0 m

 μ rad⁻¹ Friction coefficient, see Table 4

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

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

² Standards and other documents referred to in the European Technical Assessment are listed in Annex 34 and Annex 35.



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

NOTE 1 1 rad = 1 m/m = 1

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

	Recommen	ided values	Range o	of values
Duct	μ	k	μ	k
	rad ⁻¹	rad/m	rad ⁻¹	rad/m
Steel strip duct	0.18		0.17–0.19	
Smooth steel duct	0.18	0.005	0.16–0.24	0.004–0.007
Corrugated plastic duct	0.12	0.005	0.10–0.14	0.004-0.007
Smooth plastic duct	0.12		0.10–0.14	

Table 4 Friction parameters

Friction loss in stressing anchorage and stressing coupler first construction stage are given in Table 5. The loss is taken into account for determination of elongation and prestressing force along the tendon. Friction in CONA CMI SP 0106 anchorage is low and does not need to be considered in design and execution.

Tendon		Frictio	on loss
CONA CMI BT 0206 to 0406			1.2
CONA CMI BT 0506 to 0906		%	1.1
CONA CMI BT 1206 to 3106	ΔFs	70	0.9
CONA CMI BT 3706 to 6106			0.8

Table 5 Frict	ion losses in	anchorages
---------------	---------------	------------

Where

 $\Delta F_{s}.....$ %......Friction loss in stressing anchorage and first construction stage of stressing coupler.

1.6 Support of tendon

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

1.7 Slip at anchorage and coupler

Slip at stressing and fixed anchorages and at fixed and stressing couplers, first and second construction stages, is 6 mm. Slip at moveable couplers is twice this amount. At the stressing anchorage and at the first construction stage of the stressing couplers, slip is 4 mm, provided a



prestressing jack with a wedging system and a wedging force of around 25 kN per prestressing steel strand is used.

1.8 Centre spacing and edge distance for the anchorage

In general, spacing and distances are not less than given in Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26, see also Annex 13 and Annex 14.

However, a reduction of up to 15 % of the centre spacing of tendon anchorages in one direction is permitted, but should not be less than the outside diameter of the helix and placing of additional reinforcement still is possible, see Annex 27. In this case, spacing in the perpendicular direction is increased by the same percentage. The corresponding edge distance is calculated by

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

Where

ac, ac......mm....... Centre spacing before and after modification

- b_c, b_c.....mm.........Centre spacing in the direction perpendicular to a_c before and after modification
- ae, ae.....mm........ Edge distance before and after modification
- b_e, b_e.....mm........Edge distance in the direction perpendicular to a_e before and after modification

c Concrete cover

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

The minimum values for a_c , b_c , a_e , and b_e are given in Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26.

1.9 Minimum radii of curvature

The minimum radii of curvature of the tendon, $R_{\text{min}},$ given in Annex 10, Annex 11, and Annex 12 correspond to

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

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

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

Where

R _{min} m	. Minimum radius of curvature
F _{p0.1} kN	. Characteristic force at 0.1 % proof force of one single prestressing steel strand, see Annex 30
F _{pm, 0} kN	. Prestressing force of the tendon
dmm.	. Nominal diameter of the prestressing steel strand



di.....m......Nominal inner duct diameter

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

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

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

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

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

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

1.10 Concrete strength at time of stressing

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

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

Helix, additional reinforcement, centre spacing and edge distance corresponding to the concrete compressive strengths are taken from Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26, see also the Clauses 1.12.7 and 2.2.3.5.

Mean concrete strength				f cr	n, 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

Table 6	Compressive	strength	of concrete
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Where

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

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

Components

1.11 Prestressing steel strands

Only 7-wire prestressing steel strands with characteristics according to Table 7 are used, see also Annex 30.

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

In the course of preparing the European Technical Assessment, no characteristic has been assessed for prestressing steel strands. In execution, a suitable prestressing steel strand that



conforms to Annex 30 and is according to the standards and regulations in force at the place of use is taken.

Maximum characteristic tensile strength ¹⁾	\mathbf{f}_{pk}	MPa	18	60
Nominal diameter	d	mm	15.3	15.7
Nominal cross-sectional area	Ap	mm ²	140	150
Mass of prestressing steel	Μ	kg/m	1.093	1.172

Table 7Prestressing steel strands

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

1.12 Anchorage and coupler

1.12.1 General

The components of anchorage and coupler are in conformity with the specifications given in Annex 2, Annex 3, Annex 4, Annex 5, Annex 6, and Annex 7 and the technical file³. Therein the component dimensions, materials and material identification data with tolerances are given.

1.12.2 Anchor head

The anchor head, A1 to A8, is made of steel and provides regularly arranged conical holes drilled in parallel to accommodate prestressing steel strands and wedges, see Annex 2 and Annex 3. The back exits of the bore holes are provided with bell mouth openings or plastic ring cushions. In addition, threaded bores may be provided to attach a protection cap and springs A, see Annex 1 and Annex 7, and wedge retaining plate KS, see Annex 1 and Annex 7.

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

1.12.3 Square plate

The square plate is a flat steel plate and are connected to the trumpet A SP, see Annex 6. In Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26 the main minimum dimensions of the square plate 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.

1.12.4 Trumpet

The conical trumpet A SP, see Annex 6, and conical trumpet K, see Annex 4, is manufactured either in steel or PE, 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 a larger anchorage, CONA CMI SP 3106 up to 6106, the first part of the trumpet A SP adjacent to the square plate is made of steel sheet with a thickness of 3 mm over a minimum length equal to the diameter of the trumpet.

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

The conical trumpet made of PE may have either a corrugated or a plain surface. At the ductside end there is a radius for the deviation of the prestressing steel strands and a smooth

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



surface, to ensure a good transition to the duct. The opposite end is connected to the square plate or coupler anchor head K.

1.12.5 Coupler anchor head

The coupler anchor head K, see Annex 4, for the single plane coupler is made of steel and provides in the inner part, for anchorage of the prestressing steel strands of the first construction stage, the same arrangement of holes as the anchor head for the stressing or fixed anchorage. In the outer pitch circle there is an arrangement of holes with an inclination of 7 ° to accommodate the prestressing steel strands of the second construction stage. At the back of coupler anchor head K there is a step for ease of centring the coupler anchor head on the bearing trumplate. Wedge retaining plate KS, see Annex 7, and springs K, see Annex 7, with cover plate K, see Annex 4, are fastened by means of additional threaded bores.

The coupler anchor heads H1 or H2 for the sleeve coupler are made of steel and have the same basic geometry as the anchor head of the stressing or fixed anchorage, see Annex 2 and Annex 5. Compared to the anchor head of the stressing and fixed anchorage, the coupler anchor head H is higher and provide an external thread for the coupler sleeve. At the back of the coupler anchor head H1 and H2 there is a step for ease of centring the coupler anchor head on the bearing trumplate. Wedge retaining plate KS, see Annex 7, is fastened by means of additional threaded bores.

The coupler sleeve H is a steel tube, see Annex 2 and Annex 5, with an inner thread and is provided with ventilation holes.

Ring cushions, see Annex 5, are inserted in coupler anchor head H2.

1.12.6 Ring wedge

The ring wedge, see Annex 7, is in three pieces. Two different ring wedges are used.

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

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

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

1.12.7 Helix and additional reinforcement

Helix and additional reinforcement are made of ribbed reinforcing steel. The end of the helix on the anchorage side is welded to the following turn. The helix is placed in the tendon axis. Dimensions of helix and additional reinforcement conforms to the values specified in Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26, see also Clause 2.2.3.5.

If required for a specific project design, the reinforcement given in Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26 may be modified in accordance with the respective regulations in force at the place of use as well as with the relevant approval of the local authority and of the ETA holder to provide equivalent performance.

1.12.8 Protection cap

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

1.12.9 Material specifications

Annex 15 lists the material standards or specifications of the components.



1.13 Permanent corrosion protection

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

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

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

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

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

2.1 Intended uses

The BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands is intended to be used for the prestressing of structures. The specific intended uses are listed in Table 8.

Line №	Use category						
Use categories according to tendon configuration and material of structure							
1	Internal bonded tendon for concrete and composite structures						
2	Internal unbonded tendon for concrete and composite structures						
Optional	Optional use category						
3	Internal tendon for cryogenic applications with anchorage outside the possible cryogenic zone						

Table 8Intended uses

2.2 Assumptions

2.2.1 General

Concerning product packaging, transport, storage, maintenance, replacement, and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on transport, storage, maintenance, replacement, and repair of the product as he considers necessary.



2.2.2 Packaging, transport and storage

Advice on packaging, transport, and storage includes.

- During transport of prefabricated tendons, a minimum diameter of curvature of
 - 1.65 m for tendons up to CONA CMI SP 1206,
 - 1.80 m for tendons up to CONA CMI SP 3106,
 - 2.00 m for tendons larger than CONA CMI SP 3106, of prestressing steel strand is observed.
- Temporary protection of prestressing steel and components in order to prevent corrosion during transport from production site to job site
- Transportation, storage and handling of prestressing steel and other components in a manner as to avoid damage by mechanical or chemical impact
- Protection of prestressing steel and other components from moisture
- Keeping tensile elements separate from areas where welding operations are performed

2.2.3 Design

2.2.3.1 General

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

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

2.2.3.2 Fixed and stressing coupler

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

2.2.3.3 Anchorage Recess

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

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

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

2.2.3.4 Maximum prestressing forces

Prestressing and overstressing forces are specified in the respective standards and regulations in force at the place of use. Annex 16 lists the maximum possible prestressing and overstressing forces according to Eurocode 2.

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

Centre spacing, edge distance, helix, and additional reinforcement given in Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26 are adopted, see Clause 1.8.

Verification of transfer of prestressing forces to structural concrete is not required if centre spacing and edge distance of anchorages and couplers as well as grade and dimensions of



additional reinforcement, see Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26, are conformed to. In the case of grouped anchorages, the additional reinforcement of the individual anchorages can be combined, provided appropriate anchorage is ensured. However, number, cross-sectional area and position with respect to the square plates remain unchanged.

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

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

If required for a specific project design, the reinforcement given in Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26 may be modified in accordance with the respective regulations in force at the place of use as well as with the relevant approval of the local authority and of the ETA holder to provide equivalent performance.

2.2.3.6 Tendons in masonry structures – load transfer to the structure

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

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

2.2.4 Installation

2.2.4.1 General

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

Assembly and installation of tendons is only carried out by qualified PT specialist companies with the required resources and experience in the use of multi strand internal post-tensioning systems, see CWA 14646. The respective standards and regulations in force at the place of use are considered. The company's PT site manager has a certificate, stating that she or he has been trained by the ETA holder and that she or he possesses the necessary qualifications and experience with the "BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands".

The sequence of work steps for installation of anchorage, fixed and moveable coupler is described in Annex 28 and Annex 29.

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

Square plate, anchor head, and coupler anchor head are placed perpendicular to the tendon's axis, see Annex 17. Couplers are situated in a straight tendon section. At the anchorages and couplers the tendon layout provides a straight section over a length of at least 250 mm beyond the end of the trumpet. In case of tendons with a minimum or reduced radius of curvature after the trumpet, the following minimum straight lengths after the end of trumpet are recommended.

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



Where

f..... Degree of filling

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

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

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

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

2.2.4.2 Stressing operation

With a mean concrete compressive strength in the anchorage zone according to the values laid down in Annex 18, Annex 19, Annex 20, Annex 21, Annex 22, Annex 23, Annex 24, Annex 25, and Annex 26 full prestressing may be applied.

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

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

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

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

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

2.2.4.3 Restressing

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

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

2.2.4.4 Exchanging tendons

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

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

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

2.2.4.5 Filling operations

2.2.4.5.1 Grouting

Grout is injected through the inlet holes until it escapes from the outlet tubes with the same consistency. To avoid voids in the hardened grout special measures are applied for long tendons, tendon paths with distinct high points, or inclined tendons. All vents, grouting inlets,



and protection caps are sealed immediately after grouting. In case of couplers K, the second stage holes, wedges and springs are checked for cleanness before and immediately after grouting the first construction stage.

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

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

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

2.2.4.5.3 Circulating dry air

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

2.2.4.5.4 Filling records

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

2.2.4.6 Welding

Ducts may be welded.

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

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

2.3 Assumed working life

The European Technical Assessment is based on an assumed working life of the BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands of 100 years, provided that the BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands is subject to appropriate installation, use, and maintenance, see Clause 2.2. These provisions are based upon the current state of the art and the available knowledge and experience.

In normal use conditions, the real working life may be considerably longer without major degradation affecting the basic requirements for construction works⁴.

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



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

3.1 Essential characteristics

The performances of the BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands for the essential characteristics are given in Table 9 and Table 10. In Annex 33 the combinations of essential characteristics and corresponding intended uses are listed.

Nº	Essential characteristic	Product performance
nten Tł	BR VT CONA CMI SP – Internal Post-tensionir ded use	ng System with 01 to 61 Strands estressing of structures, Clause 2.1, Table 8, line
	Basic requirement for construction work	s 1: Mechanical resistance and stability
1	Resistance to static load	See Clause 3.2.1.1.
2	Resistance to fatigue	See Clause 3.2.1.2.
3	Load transfer to the structure	See Clause 3.2.1.3.
4	Friction coefficient	See Clause 3.2.1.4.
5	Deviation, deflection (limits) for internal bonded and internal unbonded tendon	See Clause 3.2.1.5.
6	Assessment of assembly	See Clause 3.2.1.6.
7	Corrosion protection	See Clause 3.2.1.7.
	Basic requirement for construction	on works 2: Safety in case of fire
8	Reaction to fire	See Clause 3.2.2.1.
	Basic requirement for construction works	3: Hygiene, health and the environment
9	Content, emission and/or release of dangerous substances	See Clause 3.2.3.1.
	Basic requirement for construction we	orks 4: Safety and accessibility in use
	Not relevant. No characteristic assessed.	
	Basic requirement for construction	works 5: Protection against noise
_	Not relevant. No characteristic assessed.	
	Basic requirement for construction work	s 6: Energy economy and heat retention
	Not relevant. No characteristic assessed.	
	Basic requirement for construction works	7: Sustainable use of natural resources
	No characteristic assessed.	



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

N⁰	Additional essential characteristic	Product performance
Optic Tł №	BR VT CONA CMI SP – Internal Post-tensionin onal use category ne PT system is intended to be used for the p	ng System with 01 to 61 Strands prestressing of structures, Clause 2.1, Table 8, line is with anchorage outside the possible cryogenic
	Basic requirement for construction work	s 1: Mechanical resistance and stability
10	Resistance to static load under cryogenic conditions for applications with anchorage/coupling outside the possible	See Clause 3.2.4.1.

3.2 Product performance

cryogenic zone

3.2.1 Mechanical resistance and stability

3.2.1.1 Resistance to static load

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.1. The characteristic values of maximum force, F_{pk} , of the tendon for prestressing steel strands according to Annex 30 are listed in Annex 8 and Annex 9.

3.2.1.2 Resistance to fatigue

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.2. The characteristic values of maximum force, F_{pk} , of the tendon for prestressing steel strands according to Annex 30 are listed in Annex 8 and Annex 9.

3.2.1.3 Load transfer to the structure

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.3. The characteristic values of maximum force, F_{pk} , of the tendon for prestressing steel strands according Annex 30 are listed in Annex 8 and Annex 9.

3.2.1.4 Friction coefficient

For friction losses including friction coefficient see Clause 1.5.

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

For minimum radii of curvature see Clause 1.9.

3.2.1.6 Assessment of assembly

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

3.2.1.7 Corrosion protection

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

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3.2.2 Safety in case of fire

3.2.2.1 Reaction to fire

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

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

- 3.2.3 Hygiene, health and the environment
- 3.2.3.1 Content, emission and/or release of dangerous substances

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

SVOC and VOC

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

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

- Leachable substances

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

- 3.2.4 Mechanical resistance and stability
- 3.2.4.1 Resistance to static load under cryogenic conditions for applications with anchorage/coupling outside the possible cryogenic zone

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.8. The characteristic values of maximum force, F_{pk} , of the tendon for prestressing steel strands according to Annex 30 are listed in Annex 8 and Annex 9.

3.3 Assessment methods

The assessment of the essential characteristics in Clause 3.1 of the BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands for the intended uses and in relation to the requirements for mechanical resistance and stability, safety in case of fire, and for hygiene, health and the environment in the sense of the basic requirements for construction works Nº 1, 2, and 3 of Regulation (EU) Nº 305/2011 has been made in accordance with Annex A of EAD 160004-00-0301, Post-tensioning kits for prestressing of structures, for

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

3.4 Identification

The European Technical Assessment for the BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands is issued on the basis of agreed data⁵ that identify the assessed product. Changes to materials, to composition, or to characteristics of the product, or to the production process could result in these deposited data being incorrect. Österreichisches Institut für Bautechnik should be notified before the changes are introduced, as an amendment of the European Technical Assessment is possibly necessary.

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



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

4.1 System of assessment and verification of constancy of performance

According to Commission Decision 98/456/EC the system of assessment and verification of constancy of performance to be applied to the BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands is System 1+. System 1+ is detailed in Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, Annex, point 1.1., and provides for the following items.

- (a) The manufacturer shall carry out
 - (i) factory production control;
 - (ii) further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan⁶.
- (b) The notified product certification body shall decide on the issuing, restriction, suspension, or withdrawal of the certificate of constancy of performance of the construction product on the basis of the outcome of the following assessments and verifications carried out by that body
 - an assessment of the performance of the construction product carried out on the basis of testing (including sampling), calculation, tabulated values, or descriptive documentation of the product;
 - (ii) initial inspection of the manufacturing plant and of factory production control;
 - (iii) continuing surveillance, assessment, and evaluation of factory production control;
 - (iv) audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities.

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

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

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

5.1 Tasks for the manufacturer

5.1.1 Factory production control

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

- Control of the incoming materials

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

- Inspection and testing

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

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



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

All tests are performed according to written procedures with suitable calibrated measuring devices. All results of inspections, tests, and checks are recorded in a consistent and systematic way. The basic elements of the prescribed test plan are given in Annex 31, conform to EAD 160004-00-0301, Table 3, and are specified in the quality management plan of the BBR VT CONA CMI SP – Internal Post-tensioning System with 01 to 61 Strands.

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

- Control of non-conforming products

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

- Complaints

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

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

At least once a year the manufacturer audits the manufacturers of the components given in Annex 32.

5.1.2 Declaration of performance

The manufacturer is responsible for preparing the declaration of performance. When all the criteria of the assessment and verification of constancy of performance are met, including the certificate of constancy of performance issued by the notified product certification body, the manufacturer draws up the declaration of performance. Essential characteristics to be included in the declaration of performance for the corresponding intended use are given in Table 9 and Table 10. In Annex 33 the combinations of essential characteristics and corresponding intended uses are listed.

5.2 Tasks for the notified product certification body

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

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

5.2.2 Continuing surveillance, assessment and evaluation of factory production control

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



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

Each manufacturer of the components given in Annex 32 is audited at least once in five years. It is verified that the system of factory production control and the specified manufacturing process are maintained, taking account of the prescribed test plan.

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

5.2.3 Audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities

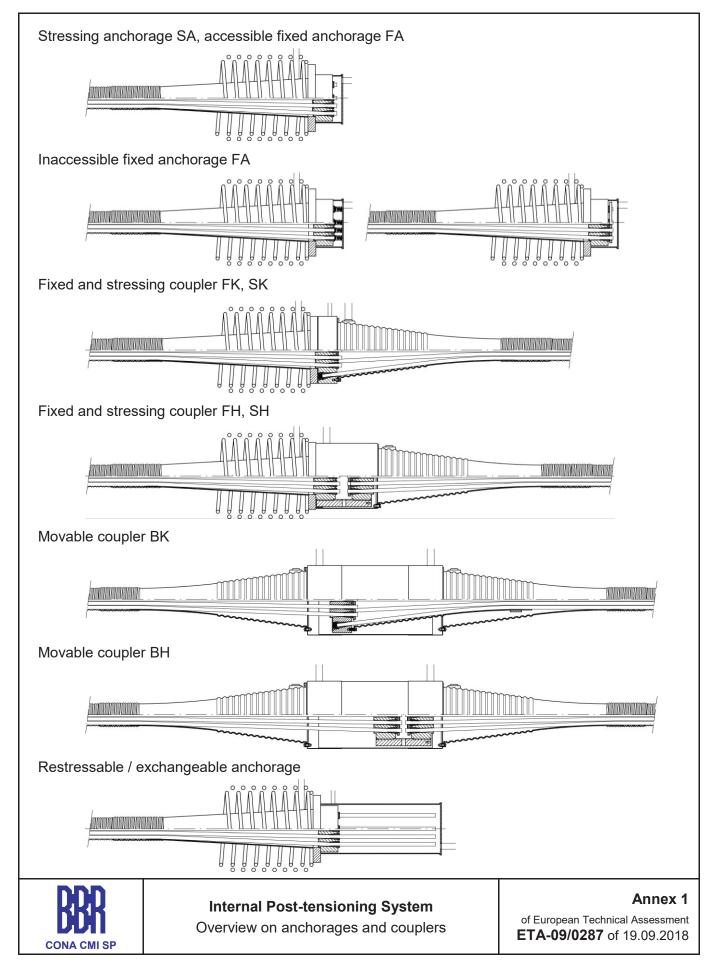
During surveillance inspection, the notified product certification body takes samples of components of the PT system for independent testing. Audit-testing is conducted at least once a year by the notified product certification body. For the most important components, Annex 32 summarises the minimum procedures. Annex 32 conforms to EAD 160004-00-0301, Table 4. In particular, at least once a year, the notified product certification body also carries out one single tensile element test series according to EAD 160004-00-0301, Annex C.7 and Clause 3.3.4 on specimens taken from the manufacturing plant or at the manufacturer's storage facility.

Issued in Vienna on 19 September 2018 by Österreichisches Institut für Bautechnik

The original document is signed by

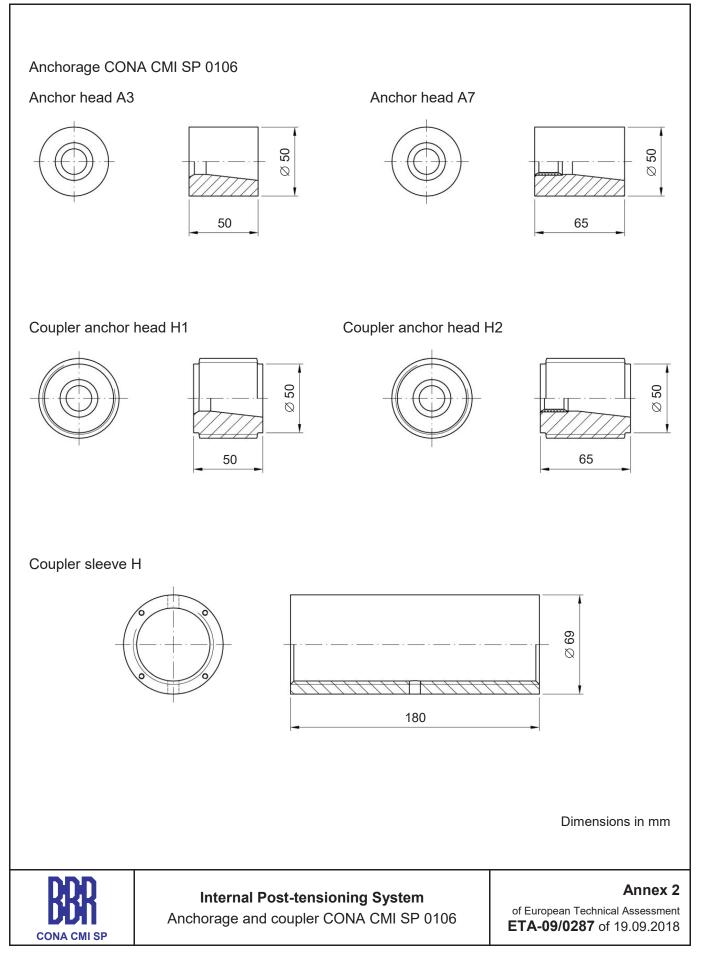
Rainer Mikulits Managing Director



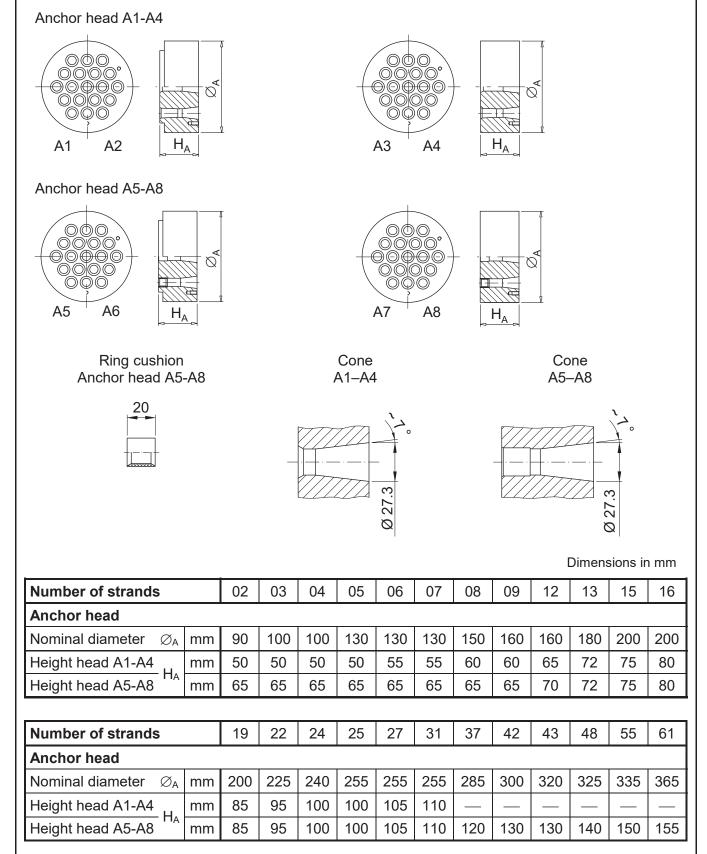


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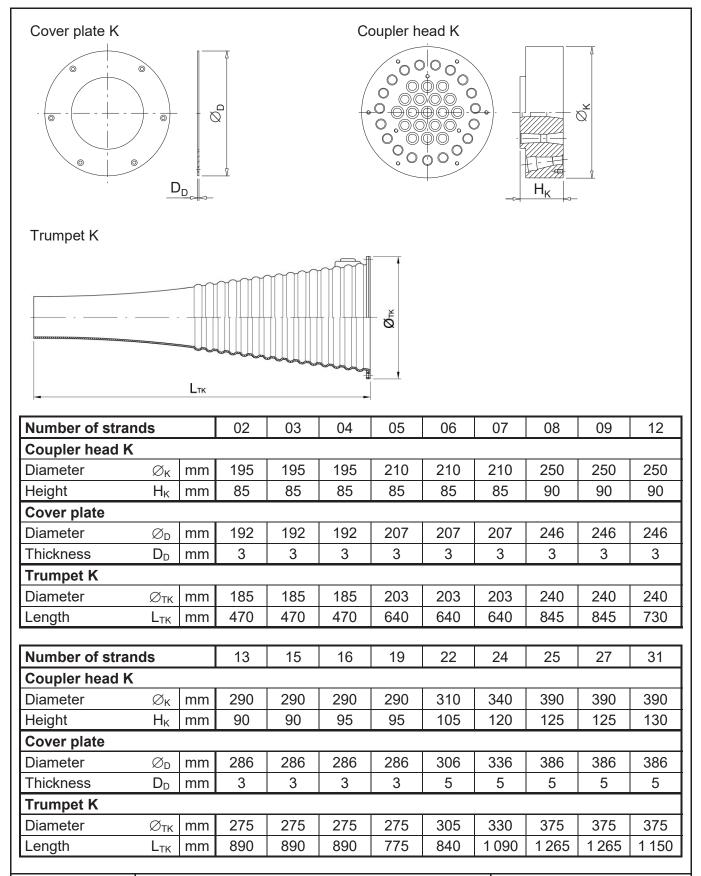






Annex 3







Internal Post-tensioning System

Coupler K and trumpet K

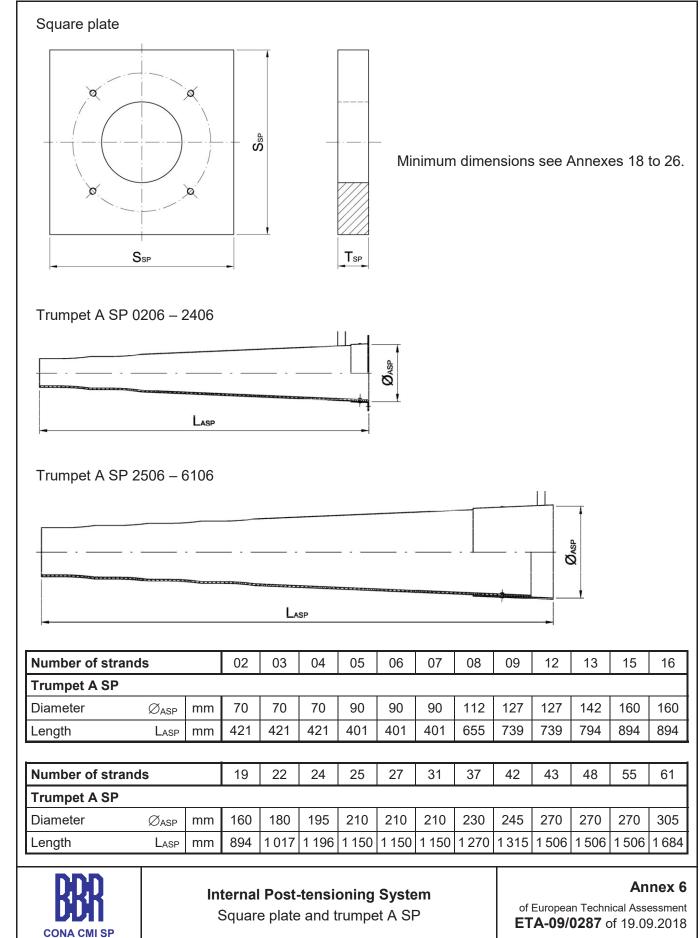
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Annex 4

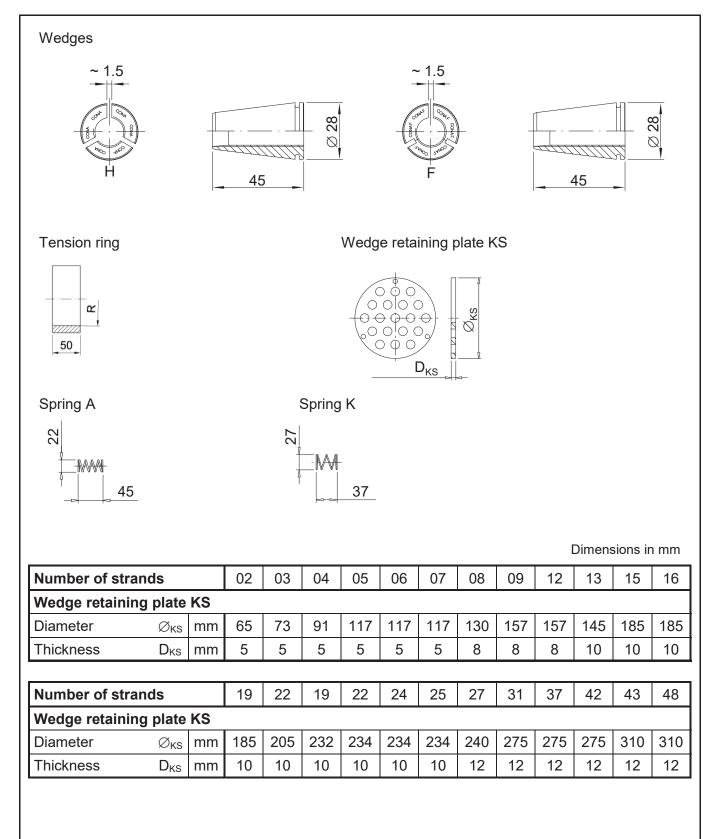


Coupler head H1						Сс	oupler	head	H2					
	• •		H _{AH}	© AH					0000		H _{AH}	Carl		
Ring cu Coupler h		12						Couple	er slee	eve H				
											-0-		HØ HØ	
									/////			<u> </u>	<u>V</u>	
											L _H			
											I	Dimens	sions ir	n mm
Number of strand	ds		02	03	04	05	06	07	08	09	12	13	15	
Coupler anchor h		H1 a				00	00	01	00	00				l In
Nominal diameter		r	90										1	16
Height head H1			90	95	100	130	130	130	150	160	160	180	200	200
n eigint neau i i i		mm	90 50	95 50	100 55	130 55	130 60	130 65	150 65	160 70	160 80	180 80	200 80	
Height head H2	- H _{AH}	mm mm												200
			50	50	55	55	60	65	65	70	80	80	80	200 85
Height head H2		mm	50	50	55	55	60	65	65	70	80	80	80	200 85 85
Height head H2 Coupler sleeve H		mm mm	50 65	50 65	55 65	55 65	60 65	65 65	65 65	70 70	80 80	80 80	80 80	200 85 85 259
Height head H2 Coupler sleeve H Minimum diameter Length sleeve	r Ø _н L _н	mm mm	50 65 114 180	50 65 124 180	55 65 133 180	55 65 163 180	60 65 167 190	65 65 170 200	65 65 192 200	70 70 203 210	80 80 213 230	80 80 233 230	80 80 259 240	200 85 85 259 250
Height head H2 Coupler sleeve H Minimum diameter Length sleeve Number of stranc	r Ø _н L _н	mm mm mm	50 65 114 180 19	50 65 124 180 22	55 65 133	55 65 163	60 65 167	65 65 170	65 65 192	70 70 203	80 80 213	80 80 233	80 80 259	200 85 85 259
Height head H2 Coupler sleeve H Minimum diameter Length sleeve Number of strand Coupler anchor h	r _{Øн} L _н ds neads	mm mm H1 a	50 65 114 180 19 nd H2	50 65 124 180 22	55 65 133 180 24	55 65 163 180 25	60 65 167 190 27	65 65 170 200 31	65 65 192 200 37	70 70 203 210 42	80 80 213 230 43	80 80 233 230 48	80 80 259 240 55	200 85 85 259 250 61
Height head H2 Coupler sleeve H Minimum diameter Length sleeve Number of strand Coupler anchor h Nominal diameter	r _{Øн} L _н ds neads	mm mm H1 a mm	50 65 114 180 19 nd H2 200	50 65 124 180 22 225	55 65 133 180 24 240	55 65 163 180 25 255	60 65 167 190 27 255	65 65 170 200 31 255	65 65 192 200	70 70 203 210	80 80 213 230	80 80 233 230	80 80 259 240	200 85 85 259 250 61
Height head H2 Coupler sleeve H Minimum diameter Length sleeve Number of strand Coupler anchor h Nominal diameter Height head H1	r _{Øн} L _н ds neads	mm mm H1 a mm mm	50 65 114 180 19 nd H2 200 95	50 65 124 180 22 225 100	55 65 133 180 24 240 100	55 65 163 180 25 255 100	60 65 167 190 27 255 105	65 65 170 200 31 255 115	65 65 192 200 37 285 	70 70 203 210 42 300 	80 80 213 230 43 320 —	80 80 233 230 48 325 —	80 80 259 240 55 335 —	200 85 85 259 250 61 365
Height head H2 Coupler sleeve H Minimum diameter Length sleeve Number of strand Coupler anchor h Nominal diameter Height head H1 Height head H2	r Ø _H L _H ds Deads Ø _{AH}	mm mm H1 a mm	50 65 114 180 19 nd H2 200	50 65 124 180 22 225	55 65 133 180 24 240	55 65 163 180 25 255	60 65 167 190 27 255	65 65 170 200 31 255	65 65 192 200 37	70 70 203 210 42	80 80 213 230 43	80 80 233 230 48	80 80 259 240 55	200 85 85 259 250 61 365
Height head H2 Coupler sleeve H Minimum diameter Length sleeve Number of strand Coupler anchor h Nominal diameter Height head H1 Height head H2 Coupler sleeve H	r Ø _H L _H ds meads Ø _{AH} - Н _{AH}	mm mm H1 a mm mm	50 65 114 180 19 nd H2 200 95 95	50 65 124 180 22 225 100 100	55 65 133 180 24 240 100 100	55 65 163 180 25 255 100 100	60 65 167 190 27 255 105 105	65 65 170 200 31 255 115 115	65 65 192 200 37 285 125	70 70 203 210 42 300 135	80 80 213 230 43 320 135	80 80 233 230 48 325 145	80 80 259 240 55 335 160	200 85 85 259 250 61 365 160
Height head H2 Coupler sleeve H Minimum diameter Length sleeve Number of strand Coupler anchor h Nominal diameter Height head H1 Height head H2 Coupler sleeve H Minimum diameter	r Ø _H Lн ds neads Øан - Нан I r Ø _H	mm mm H1 a mm mm mm	50 65 114 180 19 nd H2 200 95 95 269	50 65 124 180 22 225 100 100 296	55 65 133 180 24 240 100 100 312	55 65 163 180 25 255 100 100 327	60 65 167 190 27 255 105 105 330	65 65 170 200 31 255 115 115 338	65 65 192 200 37 285 — 125 373	70 70 203 210 42 300 135 395	80 80 213 230 43 320 135 413	80 80 233 230 48 325 145 425	80 80 259 240 55 335 160 443	200 85 85 259 250 61 365 160 475
Height head H2 Coupler sleeve H Minimum diameter Length sleeve Number of strand Coupler anchor h Nominal diameter Height head H1 Height head H2 Coupler sleeve H	r Ø _H L _H ds meads Ø _{AH} - Н _{AH}	mm mm H1 a mm mm	50 65 114 180 19 nd H2 200 95 95	50 65 124 180 22 225 100 100	55 65 133 180 24 240 100 100	55 65 163 180 25 255 100 100	60 65 167 190 27 255 105 105	65 65 170 200 31 255 115 115	65 65 192 200 37 285 125	70 70 203 210 42 300 135	80 80 213 230 43 320 135	80 80 233 230 48 325 145	80 80 259 240 55 335 160	200 85 85 259 250











Internal Post-tensioning System

Wedges and accessories

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Annex 7



CONA CMI SP n06-140

Number of	Nominal cross-sectional	Nominal mass of		stic value of rce of tendon		
strands	area of prestressing steel	prestressing steel	f _{pk} = 1 770 MPa	f _{pk} = 1 860 MPa		
n	Ap	М	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	4712	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 4 16	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		



Internal Post-tensioning System

Tendon ranges for CONA CMI SP n06-140

Annex 8

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CONA CMI SP n06-150

Number of	Nominal cross-sectional	Nominal mass of prestressing steel		stic value of rce of tendon
strands	strands area of prestressing steel pre n A _p		f _{pk} = 1 770 MPa	f _{pk} = 1 860 MPa
n	Ap	М	F _{pk}	F _{pk}
	mm ²	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



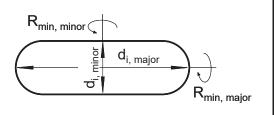
Internal Post-tensioning System

Tendon ranges for CONA CMI SP n06-150

Annex 9

of European Technical Assessment **ETA-09/0287** of 19.09.2018





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 din	nensions	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 $p_{\text{R,}\,\text{max}}$ = 140 kN/m

Number of strands	Inner din	nensions	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 diamo p _{R, max} = 200		circular o	duct, d _i ,	and mini	mum rad	lius of cu	urvature,	R_{min} , for
Number of strands	f ≈ (0.35	f≈	0.40	f≈	0.45	f≈	0.50
n	di	R _{min}	di	R _{min}	di	R _{min}	di	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



Internal Post-tensioning System

Annex 11

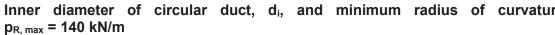
Minimum radius of curvature of circular duct for $p_{R, max} = 200 \text{ kN/m}$

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Inner diame p _{R, max} = 140		circular o	luct, d _i ,	and mini	mum rad	lius of cu	urvature,	R_{min} , for
Number of strands	f ≈ (0.35	f≈	0.40	f≈	0.45	f≈	0.50
n	di	R_{min}	di	R _{min}	di	R _{min}	di	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



Internal Post-tensioning System

Annex 12

Minimum radius of curvature of circular duct for $p_{R, max} = 140 \text{ kN/m}$

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Minimum centre spacing of tendon anchorages

Tendon			Minim	num centre	e spacing a	$a_c = b_c$	
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



Internal Post-tensioning System

Minimum centre spacing

Annex 13

of European Technical Assessment **ETA-09/0287** of 19.09.2018



Minimum edge distance of tendon anchorages

Tendon			Minim	ium centre	e spacing a	g 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 +	
CONA CMI SP 0706	mm	150 + c	140 + c	130 + c	125 + c	120 + c	115 +	
CONA CMI SP 0806	mm	160 + c	150 + c	140 + c	135 + c	125 + c	120 +	
CONA CMI SP 0906	mm	170 + c	160 + c	150 + c	140 + c	135 + c	130 +	
CONA CMI SP 1206	mm	195 + c	190 + c	175 + c	165 + c	155 + c	150 +	
CONA CMI SP 1306	mm	205 + c	195 + c	180 + c	170 + c	160 + c	155 +	
CONA CMI SP 1506	mm	220 + c	210 + c	195 + c	185 + c	175 + c	170 +	
CONA CMI SP 1606	mm	225 + c	220 + c	200 + c	190 + c	180 + c	175 +	
CONA CMI SP 1906	mm	245 + c	235 + c	220 + c	210 + c	200 + c	195 +	
CONA CMI SP 2206	mm	265 + c	255 + c	235 + c	225 + c	215 + c	210 +	
CONA CMI SP 2406	mm	280 + c	265 + c	250 + c	235 + c	225 + c	220 +	
CONA CMI SP 2506	mm	285 + c	275 + c	250 + c	240 + c	225 + c	220 +	
CONA CMI SP 2706	mm	295 + c	285 + c	260 + c	250 + c	235 + c	230 +	
CONA CMI SP 3106	mm	315 + c	305 + c	280 + c	270 + c	260 + c	250 +	
CONA CMI SP 3706	mm	350 + c	350 + c	350 + c	350 + c	350 + c	350 +	
CONA CMI SP 4206	mm	375 + c	375 + c	375 + c	375 + c	375 + c	375 +	
CONA CMI SP 4306	mm	380 + c	380 + c	380 + c	380 + c	380 + c	380 +	
CONA CMI SP 4806	mm	405 + c	405 + c	405 + c	405 + c	405 + c	405 +	
CONA CMI SP 5506	mm	445 + c	445 + c	445 + c	445 + c	445 + c	445 +	
CONA CMI SP 6106	mm	470 + c	470 + c	470 + c	470 + c	470 + c	470 +	

c..... Concrete cover in mm



Internal Post-tensioning System

Minimum edge distance

Annex 14

of European Technical Assessment **ETA-09/0287** of 19.09.2018



Material specifications

	1
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 A and K	EN ISO 17855-1
Ring cushion	EN ISO 17855-1 EN ISO 19069-1
Tension ring B	EN 10210-1
Ring wedge H and F	EN 10277-2 EN 10084
Spring A and K	EN 10270-1
Helix	Ribbed reinforcing steel $R_e \ge 500 \text{ MPa}$
Additional reinforcement, stirrups	Ribbed reinforcing steel $R_e \geq 500 \mbox{ MPa}$
Sheaths	EN 523

CONA CMI SP

Internal Post-tensioning System Material specifications Annex 15



Maximum prestr	essing	and over	stressinę	g forces						
		Maxim		tressing fo F _{p0.1}	orce ¹⁾	Maximur	n overstr 0.95 ·	essing for F _{p0.1}	rce ^{1), 2)}	
					CONA	CMI SP				
Designation	n	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	
	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 0 3 1	1 053	1 107	1 036	1 088	1 1 1 2	1 169	
	06	1 177	1 2 37	1 264	1 328	1 243	1 305	1 334	1 402	
	07	1 373	1 4 4 3	1 474	1 550	1 450	1 523	1 556	1 636	
	08	1 570	1 649	1 685	1771	1 657	1 740	1778	1 870	
	09	1 766	1 855	1 895	1 993	1 864	1 958	2 001	2 103	
	12	2 354	2 4 7 3	2 527	2 657	2 485	2611	2 668	2 804	
	13	2 551	2 6 7 9	2738	2878	2 692	2 828	2 890	3 0 3 8	
n	15	2943	3 0 9 2	3 159	3 321	3 107	3 263	3 335	3 506	
Number	16	3 1 3 9	3 298	3 370	3 542	3 314	3 481	3 557	3739	
of strands	19	3 7 2 8	3916	4 001	4 207	3 935	4 133	4 224	4 4 4 0	
	22	4 316	4 534	4 633	4 871	4 556	4 786	4 891	5 141	
	24	4 709	4 946	5 054	5314	4 970	5 221	5 335	5 609	
	25	4 905	5 153	5 265	5 535	5 178	5 4 3 9	5 558	5843	
	27	5 297	5 565	5 686	5978	5 592	5 874	6 002	6310	
	31	6 082	6 389	6 529	6 863	6 4 2 0	6 7 4 4	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	9815	
	43	8 4 3 7	8 862	9 0 5 6	9 520	8 905	9 355	9 559	10 049	
	48	9418	9 893	10 109	10 627	9 941	10 442	10 670	11218	
	55	10 791	11 336	11 583	12 177	11 391	11 965	12 227	12 854	
	61	11 968	12 572	12 847	13 505	12 633	13 271	13 560	14 256	

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

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

Where

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

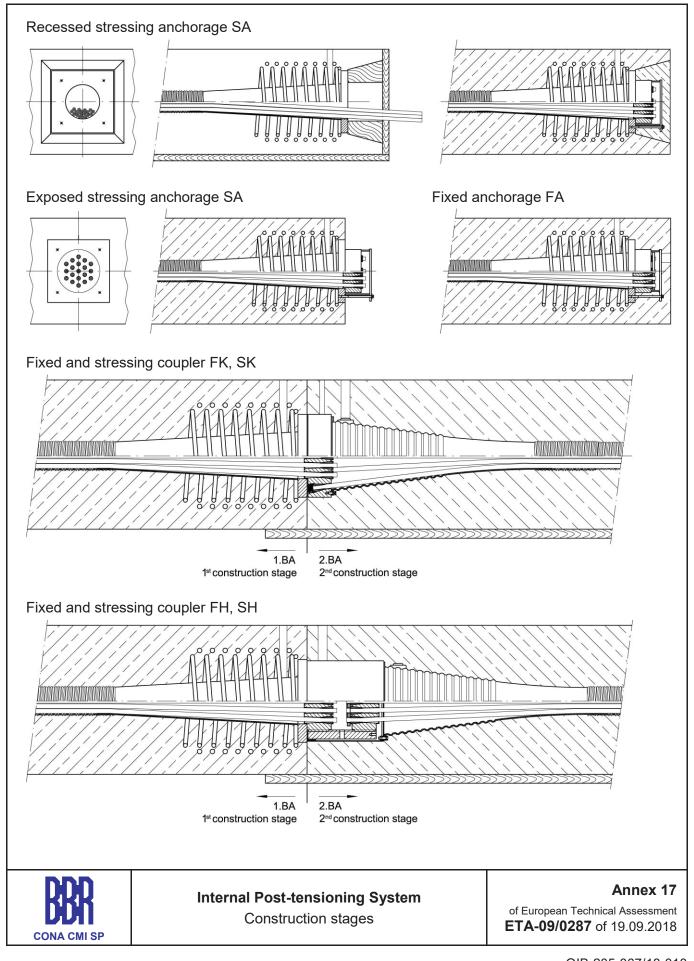


Internal Post-tensioning System

Maximum prestressing and overstressing forces

Annex 16





OIB-205-067/18-010



Stressing and	fixed anchorage / couple	er C	Centre	spa	acino	g an	d ec	lge d	distance	9
	$ \begin{array}{c} \underline{E} \\ \underline{I} \\ \underline$	- 				c				
	BBR VT CONA CMI SP			i —			0106			1
							0			
	Strand arrangement						(\bigcirc)			4
	7-wire prestressing stee sectional area 150 mm ²	I strand – Nomina Maximum chara	l diame acteristi	eter 1 c ten	5.7 m sile s	treng	. Nom th 18	ninal o 60 M	pross- Pa ¹⁾	
		Tendo	n							1
	Cross-sectional area	Ap	mm ²				150			1
	Char. value of maximum force	F	kN				279			4
	Char. value of 0.1 % proof for		kN				246			-
	Maximum prestressing force	$0.90\cdot F_{p0.1}$	kN				221			4
	Maximum overstressing force	$0.95 \cdot F_{p0.1}$	kN				234			
	Minimum concre Centre spacing a Minimum concrete strength	and edge distance								-
	Cube	f cm, 0, cube, 150	MPa	26	28	34	38	43	46	-
	Cylinder	f cm, 0, cylinder, \emptyset 150	MPa	21	23	28	31	35	38	1
	Helix, ribbed reinforcing ste		1				1			
	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	1
	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, r	ibbed reinforcing	steel,	R₀≥	500 N	/IPa				
	Number of stirrups		mm	2	2	2	2	2	2]
	Bar diameter		mm	6	6	6	6	6	6	1
	Spacing		mm	80	75	70	65	60	60	4
	Distance from anchor plate	F	mm	40	40	40	40	40	40	4
	Minimum outer dimensions	$B\timesB$	mm	100	95	85	80	75	75	4
	Centre spacing and edge di		1							4
	Minimum centre spacing	a _c , b _c	mm		115	105		95	95	-
	Minimum edge distance	a' _e , b' _e	mm	50	50	45	40	40	40	4
	Square plate dimensions ²⁾			00	00	00	00	00	00	4
	Side length	S _{SP}	mm	80	80	80	80	80	80	4
	Thickness	T _{SP}	mm	20	20	20	20	20	20	
1 860 MPa may a	el strand with nominal diameter of lso be used. dimensions are minimum values, th						י wiln	Unafa	ACLEMSLIC [6	ะกอแต อเเตเญเก มิย์ไป/

Internal Post-tensioning System

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

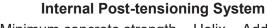
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CONA CMI SP



Stressing and fixed	ancho	rade	م / د	nun	٥r			Ce	ntre	sna	ocina	g an	d er	lae (dista	nce				
Stressing and liked		aye	-	Jupi				Ce	nue	spe		y an	u ec	iye i	JISIC		,			
	<u> </u>		b _e =	a'e + b'e + Cor	⊦c	e co	ver	- - - -					2	pe -						
BBR VT CONA CMI SP			<u> </u>		02	06					03	06					04	06		
Strand arrangement						3)					0	8)					8	8)		
Nominal diameter 15	.7 mm	Nom	inal c				stress rea 15					charad	cterist	ic ten	sile s	treng	th 18	60 MF	Pa ¹⁾	
							Ten	don												
Cross-sectional area	A _p	mm ²			30	00					45	50					60	00		
Char. value of maximum for		kN			5	58					83	37					11	16		
Char. value of 0.1 % proof force	F _{p0.1}	kN			49	92					73	38					98	34		
Max. prestressing force 0.	$90 \cdot F_{p0.1}$	kN			44	43					66	64					88	36		
Maximum overstressing 0.	$95 \cdot F_{p0.1}$	kN			46	67					70)1					93	35		
Minimum concrete stre	ength / H	elix /	Addit	ional	roint	Force														
						orcei	ment /	/ Cen	tre sp	pacin	g and	d edg	e dist	ance	/ Sqı	uare j	plate	dime	nsion	าร
Minimum concrete streng	gth					orce	ment	/ Cen	tre sp	oacin	g and	d edg	e dist	ance	/ Sqı	uare	olate	dime	nsion	າຣ
	gth 0, cube, 150	MPa		28	34	38	ment / 43	/ Cen 46	tre sp 26	pacin 28	g and 34	d edg 38	e dist 43	ance 46	/ Sqi 26	uare 28	olate 34	dime 38	nsion 43	1S
Cube f _{cm,}	0, cube, 150		26		1	1									-	1	1			4
Cube f _{cm} Cylinder f _{cm, 0, cyl}	0, cube, 150 inder, Ø 150	MPa	26 21	28 23	34	38	43	46	26	28	34	38	43	46	26	28	34	38	43	4
Cube f _{cm,}	0, cube, 150 inder, Ø 150	MPa	26 21	28 23	34 28	38	43 35	46	26	28	34 28	38	43	46	26	28	34	38	43	4
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing	0, cube, 150 inder, Ø 150	MPa ≥ 500	26 21 MPa	28 23	34 28	38 31	43 35	46 38	26 21	28 23	34 28	38 31	43 35	46 38	26 21	28 23	34 28	38 31	43 35	4 3
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter	0, cube, 150 inder, Ø 150	MPa ≥ 500 mm	26 21 MPa 130	28 23 130	34 28 100 10	38 31 100	43 35 100 10	46 38 100	26 21 165	28 23 160	34 28 130 10	38 31 130	43 35 120	46 38 120	26 21 195	28 23 190	34 28 165	38 31 150	43 35 145	4 3 14
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Length approximately Pitch	0, cube, 150 inder, Ø 150	MPa ≥ 500 mm mm	26 21 MPa 130 10	28 23 130 10	34 28 100 10 123 45	38 31 100 10	43 35 100 10 123 45	46 38 100 100 123 45	26 21 165 10 168 45	28 23 160 10 168 45	34 28 130 10 145 45	38 31 130 10	43 35 120 10	46 38 120 10	26 21 195 10 190 45	28 23 190 10 190 45	34 28 165 10 168 45	38 31 150 10 168 45	43 35 145 10 168 45	4 3 14 16 4
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Length approximately Pitch Number of pitches	0, cube, 150 inder, ∅ 150 steel, R e	MPa ≥ 500 mm mm mm	26 21 MPa 130 10 145 45 4	28 23 130 10 145 45 4	34 28 100 10 123 45 3.5	38 31 100 10 123 45 3.5	43 35 100 10 123 45 3.5	46 38 100 10 123 45 3.5	26 21 165 10 168 45 4.5	28 23 160 10 168 45 4.5	34 28 130 10 145 45 4	38 31 130 10 145 45 4	43 35 120 10 145 45 4	46 38 120 10 145 45 4	26 21 195 10 190 45 5	28 23 190 10 190 45 5	34 28 165 10 168 45 4.5	38 31 150 10 168 45 4.5	43 35 145 10 168 45 4.5	4 3 14 16 4
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Length approximately Pitch	0, cube, 150 inder, Ø 150	MPa ≥ 500 mm mm mm	26 21 MPa 130 10 145 45	28 23 130 10 145 45	34 28 100 10 123 45	38 31 100 100 123 45	43 35 100 10 123 45	46 38 100 100 123 45	26 21 165 10 168 45	28 23 160 10 168 45	34 28 130 10 145 45	38 31 130 10 145 45	43 35 120 10 145 45	46 38 120 10 145 45	26 21 195 10 190 45	28 23 190 10 190 45	34 28 165 10 168 45	38 31 150 10 168 45	43 35 145 10 168 45	4 3 14 16 4
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement	0, cube, 150 inder, ∅ 150 steel, R e	MPa ≥ 500 mm mm mm mm mm	26 21 130 10 145 45 4 20 rcing	28 23 130 10 145 45 4 20	34 28 100 10 123 45 3.5 20 I, R _e 2	38 31 100 10 123 45 3.5 20	43 35 100 10 123 45 3.5 20	46 38 100 10 123 45 3.5	26 21 165 10 168 45 4.5 20	28 23 160 10 168 45 4.5	34 28 130 10 145 45 4	38 31 130 10 145 45 4	43 35 120 10 145 45 4 20	46 38 120 10 145 45 4	26 21 195 10 190 45 5	28 23 190 10 190 45 5	34 28 165 10 168 45 4.5 25	38 31 150 10 168 45 4.5	43 35 145 10 168 45 4.5	4 3 14 16 4
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement Number of stirrups	0, cube, 150 inder, ∅ 150 steel, R e	MPa ≥ 500 mm mm mm mm mm	26 21 130 145 45 4 20 rcing 2	28 23 130 10 145 45 4 20 stee 2	34 28 100 10 123 45 3.5 20 I, R _e 3	38 31 100 10 123 45 3.5 20 ≥ 500 3	 43 35 100 10 123 45 3.5 20 MPa 2 	46 38 100 10 123 45 3.5 20 2	26 21 165 10 168 45 4.5 20 3	28 23 160 10 168 45 4.5 20 3	34 28 130 10 145 45 4 20	38 31 130 10 145 45 4 20 5	43 35 120 10 145 45 4 20 5	46 38 120 10 145 45 4 20 5	26 21 195 10 190 45 5 25 4	28 23 190 10 190 45 5 25 3	34 28 165 10 168 45 4.5 25 5	38 31 150 10 168 45 4.5 25 4	43 35 145 10 168 45 4.5 25	4 3 12 16 4 4. 2
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement Number of stirrups Bar diameter	0, cube, 150 inder, ∅ 150 steel, R e	MPa ≥ 500 mm mm mm mm mm reinfo mm mm	26 21 130 10 145 45 4 20 rcing 2 6	28 23 130 10 145 45 4 20 stee 2 6	34 28 100 10 123 45 3.5 20 1, R 3 6	38 31 100 10 123 45 3.5 20 ≥ 500 3 6	43 35 100 10 123 45 3.5 20 MPa 2 6	46 38 100 123 45 3.5 20 2 6	26 21 165 10 168 45 4.5 20 3 10	28 23 160 10 168 45 4.5 20 3 10	34 28 130 10 145 45 4 20 6 8	38 31 130 10 145 45 4 20 5 8	43 35 120 10 145 45 4 20 5 8	46 38 120 10 145 45 4 20 5 8	26 21 195 10 190 45 5 25 25 4 10	28 23 190 10 190 45 5 25 3 10	34 28 165 10 168 45 4.5 25 5 10	38 31 150 10 168 45 4.5 25 4.5 25	43 35 145 10 168 45 4.5 25 4.5 25	4 3 14 16 4 4. 2 2
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement Number of stirrups Bar diameter Spacing	0, cube, 150 inder, ∅ 150 steel, R _e E t, ribbed	MPa ≥ 500 mm mm mm mm reinfo mm mm mm	26 21 130 10 145 45 4 20 rcing 2 6 110	28 23 130 10 145 45 4 20 stee 2 6 110	34 28 100 10 123 45 3.5 20 3.5 20 3 6 6 60	38 31 100 10 123 45 3.5 20 ≥ 500 3 6 55	43 35 100 10 123 45 3.5 20 MPa 2 6 90	46 38 100 10 123 45 3.5 20 20 2 6 90	26 21 165 10 168 45 4.5 20 3 3 10 80	28 23 160 10 168 4.5 20 3 3 10 80	34 28 130 10 145 45 4 20 6 8 30	38 31 130 10 145 45 4 20 5 8 35	43 35 120 10 145 45 4 20 5 8 35	46 38 120 10 145 45 4 20 5 8 35	26 21 195 10 190 45 5 25 25 4 10 65	28 23 190 10 190 45 5 25 3 10 90	34 28 165 10 168 45 4.5 25 5 10 45	38 31 150 10 168 45 4.5 25 25 4 10 55	43 35 145 10 168 4.5 25 25 4.5 25 4 10 50	4 3 14 16 4 4 2 4 1 5
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement Number of stirrups Bar diameter Spacing Distance from anchor plate	0, cube, 150 inder, Ø 150 steel, R e E :, ribbed ⇒ F	MPa ≥ 500 mm mm mm mm mm mm mm mm mm mm	26 21 130 10 145 45 4 20 rcing 2 6 110 40	28 23 130 10 145 4 20 20 stee 2 6 110 40	34 28 100 10 123 45 3.5 20 3.5 3.6 60 40	38 31 100 10 123 45 3.5 20 ≥ 500 3 6 55 40	43 35 100 123 45 3.5 20 MPa 2 6 90 40	46 38 100 10 123 45 3.5 20 2 6 90 40	26 21 165 10 168 4.5 20 3 3 10 80 40	28 23 160 10 168 4.5 20 3 3 10 80 40	34 28 130 10 145 45 4 20 6 8 300 40	38 31 130 10 145 45 4 20 5 8 35 40	 43 35 120 10 145 45 4 20 5 8 35 40 	46 38 120 10 145 45 4 20 5 8 35 40	26 21 195 10 190 45 5 25 25 4 10 65 45	28 23 190 10 190 45 5 25 3 10 90 45	34 28 165 10 168 45 4.5 25 5 10 45 45	38 31 150 10 168 45 4.5 25 4 10 55 45	43 35 145 10 168 45 4.5 25 25 4.5 25 4.5 25 4 50 45	4 3 14 1 4 4 2 2 4 1 5 4
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Distance Additional reinforcement Number of stirrups Bar diameter Distance Additional reinforcement Spacing Distance from anchor plate Minimum outer dimensions	0, cube, 150 inder, Ø 150 steel, R e E c, ribbed ⇒ F S B × B	MPa ≥ 500 mm mm mm mm mm mm mm mm mm	26 21 130 10 145 45 4 20 rcing 2 6 110	28 23 130 10 145 45 4 20 stee 2 6 110	34 28 100 10 123 45 3.5 20 3 6 6 60	38 31 100 10 123 45 3.5 20 ≥ 500 3 6 55	43 35 100 123 45 3.5 20 MPa 2 6 90 40	46 38 100 10 123 45 3.5 20 20 2 6 90	26 21 165 10 168 45 4.5 20 3 3 10 80	28 23 160 10 168 4.5 20 3 3 10 80	34 28 130 10 145 45 4 20 6 8 30	38 31 130 10 145 45 4 20 5 8 35	43 35 120 10 145 45 4 20 5 8 35	46 38 120 10 145 45 4 20 5 8 35	26 21 195 10 190 45 5 25 25 4 10 65	28 23 190 10 190 45 5 25 3 10 90 45	34 28 165 10 168 45 4.5 25 5 10 45	38 31 150 10 168 45 4.5 25 25 4 10 55	43 35 145 10 168 4.5 25 25 4.5 25 4 10 50	4 3 14 16 4 2 2 1 5 4
Cube fcm, Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement Number of stirrups Bar diameter Spacing Distance from anchor plate Minimum outer dimensions	0, cube, 150 inder, Ø 150 steel, R e E c, ribbed ⇒ F S B × B e distance	MPa ≥ 5000 mm mm mm mm mm mm mm mm mm mm a	26 21 130 10 145 45 4 20 rcing 2 6 110 40 150	28 23 130 10 145 45 4 20 stee 2 6 110 40 145	34 28 100 10 123 45 3.5 20 3.5 20 9 1, R e 3 6 6 60 40 130	38 31 100 10 123 45 3.5 20 2 55 40 125	43 35 100 123 45 3.5 20 MPa 2 6 90 40 115	46 38 100 10 123 45 3.5 20 2 6 90 40 115	26 21 165 10 168 45 4.5 20 3 3 10 80 40 185	28 23 160 10 168 4.5 20 3 3 10 80 40 180	34 28 130 10 145 45 4 20 6 8 30 40 165	38 31 130 10 145 45 4 20 5 8 35 40 155	43 35 120 10 145 45 4 20 5 8 355 40 150	46 38 120 10 145 45 4 20 5 8 35 40 145	26 21 195 10 190 45 5 25 25 4 10 65 45 215	28 23 190 10 190 45 5 25 3 10 90 45 210	34 28 165 10 168 45 4.5 25 5 10 45 45 190	38 31 150 10 168 45 4.5 25 4 10 55 45 180 10	43 35 145 10 168 45 25 4 10 50 45 170	4 3 12 1 4 4 2 2 1 5 4 16
Cube fcm, 0, cyl Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement Number of stirrups Bar diameter Spacing Distance from anchor plate Minimum outer dimensions Centre spacing and edge Minimum centre spacing	0, cube, 150 inder, ∅ 150 steel, R e E c, ribbed E B × B e distanc (a _c , b _c	MPa ≥ 500 mm mm mm mm mm mm mm mm mm mm mm	26 21 130 10 145 45 4 20 2 6 110 40 150	28 23 130 10 145 45 4 20 stee 2 6 110 40 145 165	34 28 100 10 123 45 3.5 20 5 20 8 1, R , 2 6 6 60 40 130 150	38 31 100 10 123 45 3.5 20 ≥ 500 3 6 55 40 125 145	43 35 100 123 45 3.5 20 MPa 2 6 90 40 115	46 38 100 123 45 3.5 20 2 6 90 40 115 135	26 21 165 10 168 45 4.5 20 3 3 10 80 40 185 205	28 23 160 10 168 45 4.5 20 3 10 80 40 180 200	34 34 28 30 30 145 4 20 6 8 30 40 165 1855 305 305 305 305	38 31 130 10 145 45 4 20 5 8 35 40 155 175	43 35 120 10 145 45 4 20 5 8 355 40 150 1770	46 38 120 10 145 45 4 20 5 8 35 40 145 165	26 21 195 10 190 45 5 25 25 4 10 65 45 215 235	28 23 190 10 190 45 5 25 3 10 90 45 210 230	34 28 165 10 168 45 4.5 25 5 10 45 45 190 210	38 31 150 10 168 4.5 4.5 25 4 10 55 45 180 200	43 35 145 10 168 45 25 4 10 50 45 170 170 190	4 3 14 1 4 4 2 2 1 5 4 16 18
Cube fcm, 0, cyl Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement Number of stirrups Bar diameter Spacing Distance from anchor plate Minimum outer dimensions Centre spacing and edge Minimum centre spacing Minimum edge distance Minimum edge distance	0, cube, 150 inder, ∅ 150 steel, R e E c, ribbed e F c B × B d distance a _c , b _c a' _c , b' _e	MPa ≥ 500 mm mm mm mm mm mm mm mm mm mm mm	26 21 130 10 145 45 4 20 rcing 2 6 110 40 150	28 23 130 10 145 45 4 20 stee 2 6 110 40 145	34 28 100 10 123 45 3.5 20 3.5 20 9 1, R e 3 6 6 60 40 130	38 31 100 10 123 45 3.5 20 2 55 40 125	43 35 100 123 45 3.5 20 MPa 2 6 90 40 115	46 38 100 10 123 45 3.5 20 2 6 90 40 115	26 21 165 10 168 45 4.5 20 3 3 10 80 40 185	28 23 160 10 168 4.5 20 3 3 10 80 40 180	34 28 130 10 145 45 4 20 6 8 30 40 165	38 31 130 10 145 45 4 20 5 8 35 40 155	43 35 120 10 145 45 4 20 5 8 355 40 150	46 38 120 10 145 45 4 20 5 8 35 40 145	26 21 195 10 190 45 5 25 25 4 10 65 45 215	28 23 190 10 190 45 25 25 3 10 90 45 210 230	34 28 165 10 168 45 4.5 25 5 10 45 45 190	38 31 150 10 168 45 4.5 25 4 10 55 45 180 10	43 35 145 10 168 45 25 4 10 50 45 170	4 3 14 1 4 4 2 2 1 5 4 16 18
Cube fcm, 0, cyl Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement Number of stirrups Bar diameter Spacing Distance from anchor plate Minimum outer dimensions Centre spacing and edge Minimum centre spacing Minimum edge distance Square plate dimensions	0, cube, 150 inder, ∅ 150 steel, R e E c , ribbed c c c c c c c c	MPa ≥ 500 mm mm mm mm mm mm mm mm mm	26 21 MPa 130 10 145 45 4 20 2 6 110 40 150 170 75	28 23 130 10 145 45 4 20 stee 2 6 110 40 145 75	34 28 100 10 123 45 3.5 20 4, R ₀ 3 6 60 40 130 55	38 31 100 10 123 45 3.5 20 ≥ 500 3 6 55 40 125 145 65	43 35 100 123 45 3.5 20 MPa 2 6 90 40 115 60	46 38 100 10 123 45 3.5 20 2 6 90 40 115 135 60	26 21 165 10 168 45 4.5 20 3 10 80 40 185 205 95	28 23 160 10 45 4.5 20 3 10 80 40 180 200 90	34 28 130 10 145 45 4 20 6 8 30 40 165 85	38 31 130 10 145 45 4 20 5 8 35 40 155 80	43 35 120 10 145 45 4 20 5 8 355 40 150 1700 75	46 38 120 10 145 45 4 20 5 8 35 40 145 165 75	26 21 195 10 45 5 25 25 4 10 65 45 215 235 110	28 23 190 10 190 45 5 25 3 10 90 45 210 230 105	34 34 28 165 10 168 4.5 25 10 5 10 4.5 4.5 190 210 95 95 10	38 31 150 10 168 45 45 25 4 10 55 45 180 90	43 35 145 10 168 45 25 25 4.5 25 4 10 50 45 170 85	4 3 14 16 4 4 2 2 4 1 5 4 16 5 4 16 8
Cube fcm, 0, cyl Cylinder fcm, 0, cyl Helix, ribbed reinforcing Outer diameter Bar diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcement Number of stirrups Bar diameter Spacing Distance from anchor plate Minimum outer dimensions Centre spacing and edge Minimum centre spacing Minimum edge distance Minimum edge distance	0, cube, 150 inder, ∅ 150 steel, R e E c, ribbed e F c B × B d distance a _c , b _c a' _c , b' _e	MPa ≥ 500 mm mm mm mm mm mm mm mm mm mm mm	26 21 130 10 145 45 4 20 2 6 110 40 150	28 23 130 10 145 45 4 20 stee 2 6 110 40 145 165	34 28 100 10 123 45 3.5 20 5 20 8 1, R , 2 6 6 60 40 130 150	38 31 100 10 123 45 3.5 20 ≥ 500 3 6 55 40 125 145	43 35 100 123 45 3.5 20 MPa 2 6 90 40 115 60	46 38 100 123 45 3.5 20 2 6 90 40 115 135	26 21 165 10 168 45 4.5 20 3 3 10 80 40 185 205	28 23 160 10 168 45 4.5 20 3 10 80 40 180 200	34 28 130 10 145 45 4 20 6 8 30 40 165 85	38 31 130 10 145 45 4 20 5 8 35 40 155 175	43 35 120 10 145 45 4 20 5 8 355 40 150 1770	46 38 120 10 145 45 4 20 5 8 35 40 145 165	26 21 195 10 190 45 5 25 25 4 10 65 45 215 235	28 23 190 10 190 45 5 25 3 10 90 45 210 230	34 28 165 10 168 45 4.5 25 5 10 45 45 190 210	38 31 150 10 168 4.5 4.5 25 4 10 55 45 180 200	43 35 145 10 168 45 25 4 10 50 45 170 170 190	4 3 14 16 4 4 2 4 1 5



Annex 19



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

of European Technical Assessment ETA-09/0287 of 19.09.2018



	ixed ancho	orage îî 	E	oupl	- - - c - c	e co	ver	Ce م						° q I						
BBR VT CONA CMI S	SP		 		05	06					06	06					07	06		
Strand arrangement																		38)		
					7_wir	nros	stress	sina a	tool	stran	d									
Nominal diamete	er 15.7 mm	. Nom	inal c									harac	cterist	ic ten	sile s	trena	th 18	60 MI	Pa ¹⁾	
					_ = = = = = =									0/1						
			-				Ten	don												
Cross-sectional area	Ap	mm ²			75	50					90	0					10	50		
Char. value of maximu	P	kN			13	95					16	74					19	53		
Char. value of 0.1 % p force	proof F _{p0.1}	kN			12	30					14	76					17	22		
Maxi. prestressing for	ce 0.90 · F _{p0.1}	kN			11	07					13	28					15	50		
U		r	1																	-
Maximum overstressir	ng $0.95 \cdot F_{p0.1}$	kN			11	69					14	02					16	36		
Maximum overstressir force	^{ng} 0.95 · F _{p0.1}	kN			11	69					14	02					16	36		
Maximum overstressir			Addit	tional			ment	/ Cen	tre s	pacin			e dist	tance	/ Sqi	uare	-		nsior	IS
Maximum overstressir force	e strength / H trength	lelix /		tional			ment	/ Cen	tre s	pacin			e dist	tance	/ Sqı	uare	-		nsior	IS
Maximum overstressir force Minimum concrete	e strength / H	lelix /		tional 28			ment 43	/ Cen 46	tre s _i 26	pacin 28			e dist 43	tance 46	/ Sqi 26	uare 28	-		nsior 43	
Maximum overstressir force Minimum concrete Minimum concrete s Cube	e strength / H trength f _{cm, 0, cube, 150}	elix / MPa	26		reinf	orcei					g and	l edg					plate	dime		4
Maximum overstressir force Minimum concrete Minimum concrete s Cube	e strength / H trength f _{cm, 0, cube, 150} n, 0, cylinder, Ø 150	elix / MPa MPa	26 21	28 23	reinf	orcei 38	43	46	26	28	g and 34	l edg 38	43	46	26	28	plate 34	dime 38	43	4
Maximum overstressir force Minimum concrete Minimum concrete s Cube Cylinder f _{cm}	e strength / H trength f _{cm, 0, cube, 150} n, 0, cylinder, Ø 150	elix / MPa MPa ≥ 500	26 21	28 23	reinf 34 28	orcei 38 31	43	46 38	26 21	28	g and 34 28	l edg 38	43 35	46 38	26 21	28	plate 34 28	dime 38 31	43	4
Maximum overstressir force Minimum concrete Minimum concrete s Cube Cylinder f _{cm} Helix, ribbed reinforce	e strength / H trength f _{cm, 0, cube, 150} n, 0, cylinder, Ø 150	elix / MPa MPa ≥ 500	26 21 MPa 215 10	28 23 200 10	reint 34 28 185 10	38 31 170 10	43 35 160 10	46 38 160 10	26 21 250 10	28 23 230 10	g and 34 28 210 12	38 31 180 12	43 35 175 12	46 38 175 12	26 21 260 10	28 23 255 10	34 28 220 12	dime 38 31 210 12	43 35 195 12	4 3
Maximum overstressir force Minimum concrete Minimum concrete s Cube Cylinder f _{cm} Helix, ribbed reinforce Outer diameter	e strength / H trength fcm, 0, cube, 150 n, 0, cylinder, Ø 150 cing steel, R _e	lelix / MPa MPa ≥ 500	26 21 MPa 215 10	28 23 200	reint 34 28 185 10	38 31 170 10	43 35 160 10	46 38 160	26 21 250 10	28 23 230 10	g and 34 28 210 12	38 31 180 12	43 35 175 12	46 38 175 12	26 21 260 10	28 23 255 10	34 28 220	dime 38 31 210 12	43 35 195	4 3
Maximum overstressir force Minimum concrete Minimum concrete s Cube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter	e strength / H trength fcm, 0, cube, 150 n, 0, cylinder, Ø 150 cing steel, R _e	lelix / MPa MPa ≥ 500 mm mm	26 21 MPa 215 10	28 23 200 10	reint 34 28 185 10	38 31 170 10	43 35 160 10	46 38 160 10	26 21 250 10	28 23 230 10	g and 34 28 210 12	38 31 180 12	43 35 175 12	46 38 175 12	26 21 260 10	28 23 255 10	34 28 220 12	dime 38 31 210 12	43 35 195 12	4 3 19
Maximum overstressir force Minimum concrete Minimum concrete Scube Cylinder Helix, ribbed reinford Outer diameter Bar diameter Length approximately	e strength / H trength fcm, 0, cube, 150 n, 0, cylinder, Ø 150 cing steel, R _e	elix / MPa MPa ≥ 500 mm mm	26 21 MPa 215 10 235	28 23 200 10 213 45 5.5	reint 34 28 185 10 210 50 5	38 31 170 10 185	43 35 160 10 185 50 4.5	46 38 160 10 185	26 21 250 10 235 45 6	28 23 230 10 235	g and 34 28 210 12 212	38 31 180 12 212 50 5	43 35 175 12 187	46 38 175 12 187	26 21 260 10 258 45 6.5	28 23 255 10 258	34 28 220 12 237	dime 38 31 210 12 237	43 35 195 12 212	4 3 19 2 5 5
Maximum overstressir force Minimum concrete Sube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch	e strength / H trength fcm, 0, cube, 150 n, 0, cylinder, Ø 150 cing steel, R _e	elix / MPa MPa ≥ 500 mm mm	26 21 215 10 235 45	28 23 200 10 213 45	reint 34 28 185 10 210 50	38 31 170 10 185 50	43 35 160 10 185 50	46 38 160 10 185 50	26 21 250 10 235 45	28 23 230 10 235 45	g and 34 28 210 12 212 50	38 31 180 12 212 50	43 35 175 12 187 50	46 38 175 12 187 50	26 21 260 10 258 45	28 23 255 10 258 45	34 28 220 12 237 50	dime 38 31 210 12 237 50	43 35 195 12 212 50	4 3 1(1 2 ⁻ 5
Maximum overstressir force Minimum concrete Sube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches	e strength / H trength fcm, 0, cube, 150 n, 0, cylinder, Ø 150 cing steel, Re	elix / MPa MPa ≥ 500 mm mm mm mm mm	26 21 215 10 235 45 6 30	28 23 200 10 213 45 5.5 30	reint 34 28 185 10 210 50 5 30	38 31 170 10 185 50 4.5 30	43 35 160 10 185 50 4.5 30	46 38 160 10 185 50 4.5	26 21 250 10 235 45 6	28 230 230 235 45 6	g and 34 28 210 12 212 50 5	38 31 180 12 212 50 5	43 35 175 12 187 50 4.5	46 38 175 12 187 50 4.5	26 21 260 10 258 45 6.5	28 235 10 258 45 6.5	34 28 220 12 237 50 5.5	dime 38 31 210 12 237 50 5.5	43 35 195 12 212 50 5	4 3 1(1 2 ⁻ 5
Maximum overstressir force Minimum concrete Minimum concrete s Cube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance	e strength / H trength fcm, 0, cube, 150 n, 0, cylinder, Ø 150 cing steel, Re	elix / MPa MPa ≥ 500 mm mm mm mm mm	26 21 215 10 235 45 6 30	28 23 200 10 213 45 5.5 30	reint 34 28 185 10 210 50 5 30	38 31 170 10 185 50 4.5 30	43 35 160 10 185 50 4.5 30	46 38 160 10 185 50 4.5 30	26 21 250 10 235 45 6 35 35	28 23 230 10 235 45 6 35 35	34 28 210 12 212 212 50 5 35	1 edg 38 31 180 12 212 50 5 35 35	43 35 175 12 187 50 4.5 35 35	46 38 175 12 187 50 4.5 35 35	26 21 260 10 258 45 6.5 35 5	28 235 10 258 45 6.5 35	34 28 220 12 237 50 5.5 35 35	dime 38 31 210 12 237 50 5.5 35 5	43 35 195 12 212 50 5 35 35	4 3 1 2 5 4 3
Maximum overstressir force Minimum concrete Sube Cube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer	e strength / H trength fcm, 0, cube, 150 n, 0, cylinder, Ø 150 cing steel, Re	lelix / MPa MPa ≥ 500 mm mm mm mm mm reinfo	26 21 215 10 235 45 6 30 rcing 2 12	28 23 200 10 213 45 5.5 30 stee	reinf 34 28 185 10 210 50 5 30 I, R e	38 31 170 10 185 50 4.5 30 ≥ 500	 43 35 160 10 185 50 4.5 30 MPa 	46 38 160 10 185 50 4.5 30	26 21 250 10 235 45 6 35 35 312	28 230 10 235 45 6 35 35	g and 34 28 210 12 212 50 5 35 35 4 12	1 edg 38 31 180 12 212 50 5 35 3 12	43 35 175 12 187 50 4.5 35 35 3 12	46 38 175 12 187 50 4.5 35	260 21 260 10 258 45 6.5 35	28 235 10 258 45 6.5 35 42 12	34 28 220 12 237 50 5.5 35	dime 38 31 210 12 237 50 5.5 35	43 35 195 12 212 50 5 35 35 5 12	4 3 1 2 5 5 3
Maximum overstressir force Minimum concrete Sube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer Number of stirrups Bar diameter Spacing	e strength / H trength fcm, 0, cube, 150 n, 0, cylinder, Ø 150 cing steel, Re E ment, ribbed	lelix / MPa MPa ≥ 500 mm mm mm mm mm reinfo	26 21 215 10 235 45 6 30 rcing 2 12 175	28 23 200 10 213 45 5.5 30 stee 2 12 170	reinf 34 28 185 10 210 50 5 30 I, R ₆ 5 10 50	38 31 170 10 185 50 4.5 30 ≥ 500 4 10 60	43 35 160 10 185 50 4.5 30 MPa 4 10 60	46 38 160 10 185 50 4.5 30 30 31 2 80	26 21 250 10 235 45 6 35 35 3 12 115	28 23 230 10 235 45 6 35 35 2 2 12 185	g and 34 28 210 12 212 50 5 35 35 4 12 70	1 edg 38 31 180 12 212 50 5 35 3 12 95	43 35 175 12 187 50 4.5 35 35 35 32 90	46 38 175 12 187 50 4.5 35 35 35 32 90	26 21 260 10 258 45 6.5 35 35 5 12 70	28 23 255 10 258 45 6.5 35 35 4 12 85	34 28 2200 12 237 50 5.5 35 5 12 60	dime 38 31 210 12 237 50 5.5 35 5 12 60	43 35 195 12 212 50 5 35 35 5 12 55	4 3 1 2 1 5 3 3 2 1 7
Maximum overstressir force Minimum concrete Sube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer Number of stirrups Bar diameter Spacing Distance from anchor	e strength / H trength fcm, 0, cube, 150 cing steel, Re E ment, ribbed	elix / MPa MPa MPa 500 mm mm mm mm mm mm mm mm mm	26 21 215 10 235 45 6 30 9 7 cring 2 12 175 50	28 23 200 10 213 45 5.5 30 stee 2 12 170 50	reinf 34 28 185 10 210 50 5 30 1, Re 2 5 10 50 50	38 31 170 10 185 50 4.5 30 ≥ 500 4 10 60 50 50	43 35 160 10 185 50 4.5 30 MPa 4 10 60 50	46 38 160 10 185 50 4.5 30 30 3 12 80 50	26 21 250 10 235 45 6 35 35 312 115 55	28 23 230 10 235 45 6 35 35 2 12 12 185 55	g and 34 28 210 12 212 50 5 35 35 4 12 70 55	I edg 38 31 180 12 212 50 5 35 3 12 95 55	43 35 175 12 187 50 4.5 35 35 35 32 90 55	46 38 175 12 187 50 4.5 35 35 35 32 90 55	26 21 260 10 258 45 6.5 35 35 5 12 70 55	28 23 255 10 258 45 6.5 35 35 4 12 85 55	34 28 220 12 237 50 5.5 35 5 12 60 55	dime 38 31 210 12 237 50 5.5 35 5 12 60 55	43 35 195 12 212 50 5 35 5 12 55 55	4 3 19 1 21 5 € 3 3 2 4 7 5
Maximum overstressir force Minimum concrete Scube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer Number of stirrups Bar diameter Spacing Distance from anchor Minimum outer dimension	e strength / H trength fcm, 0, cube, 150 cing steel, Re E ment, ribbed plate F sions B × B	elix / MPa MPa 2 5000 mm mm mm mm mm mm mm mm mm mm mm	26 21 215 10 235 45 6 30 rcing 2 12 175	28 23 200 10 213 45 5.5 30 stee 2 12 170	reinf 34 28 185 10 210 50 5 30 I, R ₆ 5 10 50	38 31 170 10 185 50 4.5 30 ≥ 500 4 10 60	43 35 160 10 185 50 4.5 30 MPa 4 10 60	46 38 160 10 185 50 4.5 30 30 31 2 80	26 21 250 10 235 45 6 35 35 3 12 115	28 23 230 10 235 45 6 35 35 2 2 12 185	g and 34 28 210 12 212 50 5 35 35 4 12 70	1 edg 38 31 180 12 212 50 5 35 3 12 95	43 35 175 12 187 50 4.5 35 35 35 32 90	46 38 175 12 187 50 4.5 35 35 35 32 90	26 21 260 10 258 45 6.5 35 35 5 12 70	28 23 255 10 258 45 6.5 35 35 4 12 85	34 28 2200 12 237 50 5.5 35 5 12 60	dime 38 31 210 12 237 50 5.5 35 5 12 60	43 35 195 12 212 50 5 35 35 5 12 55	4 3 19 2 5 5 3 3 2 1 7 5
Maximum overstressir force Minimum concrete Sube Cube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer Number of stirrups Bar diameter Spacing Distance from anchor Minimum outer dimensi	e strength / H trength fcm, 0, cube, 150 cing steel, Re E ment, ribbed plate F sions B × B edge distanc	elix / MPa MPa 2 5000 mm mm mm mm mm mm mm mm mm mm mm	26 21 215 10 235 45 6 30 rcing 2 12 175 50 245	28 23 200 10 213 45 5.5 30 stee 2 12 170 50 235	rein1 34 28 185 10 210 50 5 30 5 5 10 50 50 50 220	Solution 38 31 170 10 185 50 4.5 30 ≥ 500 4 10 60 50 205	43 35 160 10 185 50 4.5 30 MPa 4 10 60 50 195	46 38 160 10 185 50 4.5 30 3 12 80 50 190	26 21 250 10 235 45 6 35 35 3 12 115 55 270	28 23 230 10 235 45 6 35 25 260	g and 34 28 210 12 212 50 5 5 35 4 12 70 55 240	I edg 38 31 180 12 212 50 5 31 12 95 55 225	43 35 175 12 187 50 4.5 35 35 3 12 90 55 210	46 38 175 12 187 50 4.5 35 35 3 12 90 55 205	26 21 260 10 258 45 6.5 35 5 12 70 55 295	28 23 255 10 258 45 6.5 35 35 4 12 85 55 280	34 28 220 12 237 50 5.5 35 12 60 55 260	dime 38 31 210 12 237 50 5.5 35 5 12 60 55 250	43 35 195 12 212 50 5 35 35 235 235	4 3 1 2 5 4 3 7 5 2 2
Maximum overstressir force Minimum concrete Sube Cube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer Number of stirrups Bar diameter Spacing Distance from anchor Minimum outer dimense Centre spacing and of	e strength / H trength fcm, 0, cube, 150 cing steel, Re E ment, ribbed plate F sions B × B edge distanc ing a _c , b _c	elix / MPa MPa MPa 2 5000 mm mm mm mm mm mm mm mm mm	26 21 MPa 215 10 235 45 6 30 2 12 175 50 245	28 23 200 10 213 45 5.5 30 stee 2 12 170 50 235	reinf 34 28 185 10 210 50 5 30 5 10 50 50 220 240	50rcei 38 31 170 10 185 50 4.5 30 25 225 225	43 35 160 10 185 50 4.5 30 MPa 4 10 60 50 195 215	46 38 160 10 185 50 4.5 30 3 12 80 50 190 210	26 21 250 10 235 45 6 35 35 31 21 115 55 270 290	28 230 10 235 45 6 35 20 12 185 55 260 280	g and 34 28 210 12 212 50 5 35 35 4 12 70 55 240 260	I edg 38 31 180 12 212 50 5 33 12 95 55 2225 245	43 35 175 12 187 50 4.5 35 35 32 210 230	46 38 175 12 187 50 4.5 35 35 35 205 205 225	260 21 258 45 6.5 35 70 55 295 315	28 23 255 10 258 45 6.5 35 35 4 12 85 55 280 300	Jate 34 28 220 12 237 50 5.5 35 5 12 60 55 260 280	dime 38 31 210 12 237 50 5.5 35 5 12 60 55 250 2270	43 35 195 212 212 50 5 35 35 235 235 2255	4 3 19 19 5 5 3 3 1 7 5 22 24
Maximum overstressir force Minimum concrete Sube Cube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer Number of stirrups Bar diameter Spacing Distance from anchor Minimum outer dimensi Centre spacing and of Minimum centre spaci Minimum edge distance	e strength / H trength fcm, 0, cube, 150 cing steel, Re E ment, ribbed plate F sions B × B edge distanc ing a _c , b _c	elix / / MPa MPa 2 5000 mm mm mm mm mm mm mm mm mm mm e	26 21 215 10 235 45 6 30 rcing 2 12 175 50 245	28 23 200 10 213 45 5.5 30 stee 2 12 170 50 235	rein1 34 28 185 10 210 50 5 30 5 5 10 50 50 50 220	Solution 38 31 170 10 185 50 4.5 30 ≥ 500 4 10 60 50 205	43 35 160 10 185 50 4.5 30 MPa 4 10 60 50 195	46 38 160 10 185 50 4.5 30 3 12 80 50 190	26 21 250 10 235 45 6 35 35 3 12 115 55 270	28 23 230 10 235 45 6 35 25 260	g and 34 28 210 12 212 50 5 5 35 4 12 70 55 240	1 edg 38 31 180 12 212 50 5 33 12 95 55 225	43 35 175 12 187 50 4.5 35 35 32 210 230	46 38 175 12 187 50 4.5 35 35 3 12 90 55 205	260 21 258 45 6.5 35 70 55 295 315	28 23 255 10 258 45 6.5 35 35 4 12 85 55 280	Jate 34 28 220 12 237 50 5.5 35 5 12 60 55 260 280	dime 38 31 210 12 237 50 5.5 35 5 12 60 55 250 2270	43 35 195 12 212 50 5 35 35 55 235	4 3 1 2 5 3 3 1 7 5 22 24
Maximum overstressir force Minimum concrete Sube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer Number of stirrups Bar diameter Spacing Distance from anchor Minimum outer dimens Centre spacing and Minimum centre spaci Minimum edge distance	e strength / H trength fcm, 0, cube, 150 cing steel, R_e E ment, ribbed plate F sions B × B edge distanc ing a_c, b_c ce a_e^l, b_e^l sions 2)	elix / MPa MPa MPa 500 mm mm mm mm mm mm mm mm mm	26 21 MPa 215 10 235 45 6 30 2 12 175 50 245 265 125	28 23 200 10 213 45 5.5 30 stee 2 12 170 50 235 255 120	rein1 34 28 185 10 210 50 5 30 5 30 5 5 10 50 50 220 240 110	5000000000000000000000000000000000000	43 35 160 10 185 50 4.5 30 MPa 4 10 60 50 195 215 100	46 38 160 10 185 50 4.5 30 3 12 80 50 190 210 95	26 21 250 10 235 45 6 35 3 12 115 55 270 290 135	28 230 10 235 45 6 355 260 280 130	g and 34 28 210 12 212 50 5 35 35 4 12 70 55 240 260 120	I edg 38 31 180 12 212 50 5 35 3 12 95 555 2255 2455 115	43 35 175 12 187 50 4.5 35 35 3 12 90 55 210 230 105	46 38 175 12 187 50 4.5 35 35 3 205 205 205 205 205	26 21 258 45 6.5 35 5 12 70 55 295 315 150	28 23 255 10 258 45 6.5 35 35 4 12 85 55 280 300 140	34 28 220 12 237 50 5.5 35 5 12 60 55 260 280 130	dime 38 31 210 12 237 50 5.5 35 5 12 60 55 250 270 125	43 35 195 12 212 50 5 35 35 55 235 2255 120	4 3 1 2 5 4 3 3 2 2 2 1 7 5 2 2 2 1 7
Maximum overstressir force Minimum concrete Sube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer Number of stirrups Bar diameter Spacing Distance from anchor Minimum outer dimens Centre spacing and of Minimum edge distand Square plate dimens Side length	e strength / H trength fcm, 0, cube, 150 cing steel, Re E ment, ribbed plate F sions B × B edge distanc cing a _c , b _c ce a _e , b' _e Sions ²	elix / MPa MPa MPa S S S S S S S S S S S S S	26 21 MPa 215 10 235 45 6 30 7 cring 2 12 175 50 245 265 125	28 23 200 10 213 45 5.5 30 stee 2 12 12 170 50 235 255 120	rein1 34 28 185 10 210 50 50 50 50 220 240 110	500 38 31 170 10 185 50 4.5 30 ≥ 500 4 10 60 50 205 225 105 185	43 35 160 10 185 50 4.5 30 MPa 4 10 60 50 195 215 100 180	46 38 160 10 185 50 4.5 30 4.5 30 3 12 80 50 190 210 95 210 95	26 21 250 10 235 45 6 35 3 12 115 55 270 290 135 190	28 230 10 235 45 6 355 260 280 130 130	g and 34 28 210 12 212 50 5 35 35 4 12 70 55 240 260 120 120	I edg 38 31 180 12 212 50 5 35 3 12 95 55 225 245 115 190	43 35 175 12 187 50 4.5 35 35 312 90 55 210 230 105 230 105	46 38 175 12 187 50 4.5 35 35 35 35 205 205 205 205 225 105 185	260 21 258 45 6.5 35 5 12 70 55 295 315 150 205	28 23 255 10 258 45 6.5 35 35 4 12 85 55 280 300 140 205	34 28 220 12 237 50 5.5 35 5 12 60 55 260 280 130	dime 38 31 210 12 237 50 5.5 35 35 5 12 60 55 250 2200 2200	43 35 195 12 212 50 5 35 35 55 235 235 2255 120 255 120	4 3 19 1 21 5 4 3 3 22 11 7 5 22 11
Maximum overstressir force Minimum concrete Sube Cylinder f _{cm} Helix, ribbed reinford Outer diameter Bar diameter Length approximately Pitch Number of pitches Distance Additional reinforcer Number of stirrups Bar diameter Spacing Distance from anchor Minimum outer dimens Centre spacing and Minimum centre spaci Minimum edge distance	e strength / H trength fcm, 0, cube, 150 cing steel, R_e E ment, ribbed plate F sions $B \times B$ edge distanc ing a_c, b_c ce a'_e, b'_e Sions 2) Ssp Tsp	elix / MPa MPa MPa S S S S S S S S S S S S S	26 21 215 10 235 45 6 30 22 12 175 50 245 245 245 245 125 30	28 23 200 10 213 45 5.5 30 stee 2 12 170 50 235 120 185 30	rein1 34 28 185 10 210 50 5 30 5 5 30 5 0 50 50 220 220 240 110 185 30	500 38 31 170 10 185 50 4.5 30 ≥ 500 4 10 60 50 205 105 185 30 225 105	43 35 160 10 185 50 4.5 30 MPa 4 10 60 50 195 215 100 180 30	46 38 160 10 185 50 4.5 30 30 3 12 80 50 190 210 95 210 95	26 21 250 10 235 45 6 35 35 312 115 55 270 290 135 190 35	28 230 10 235 45 6 35 260 280 130 280 130 190 35	g and 34 28 210 12 212 50 5 35 35 4 12 70 55 240 260 120 190 35	I edg 38 31 180 12 212 50 5 33 12 95 55 225 245 115 190 35	43 35 175 12 187 50 4.5 35 35 210 55 210 230 105 185 35	46 38 175 12 187 50 4.5 35 35 205 205 205 205 105 185 35	26 21 260 10 258 45 6.5 35 35 295 315 150 205 35	28 23 255 10 258 45 6.5 35 35 280 4 12 85 55 55 280 300 140 205 35	34 28 220 12 237 50 5.5 35 12 60 55 260 280 130 205 35	dime 38 31 210 12 237 50 5.5 35 250 255 250 2270 125 2200 35	43 35 195 12 212 50 5 35 35 235 235 235 2255 120 195 35	4 3 19 1 2 1 5 5 3 3 2 2 1 1 7 5 22 1 1 1 9 3

Minimum concrete strength – Helix – Additional

reinforcement - Centre spacing and edge distance

Square plate dimensions

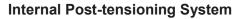


of European Technical Assessment

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Stressing and fixed anchorage / coupler Centre spacing and edge distance													edge	tanc	е					
	+	 	E F be = C	b' _e +	с	cove	er	be bo				c	<u>ء</u> ء							
BBR VT CONA CMI SP					08	06					09	06					12	06		
Strand arrangement											60)			(88)	
Nominal diameter 15.7	mm	Nom	inal c			e pres nal ar						charao	cterist	ic ten	isile s	treng	th 18	60 MF	Pa ¹⁾	
								don												
Cross sectional area	٨	mm2			4.0	000	ren	uon			4.0	250		i			4.0	200		
Cross-sectional area Char. value of maximum force	1	mm ² kN				200					13 25							300 348		
Char. value of 0.1 % proof	е _{Fpk} F _{p0.1}	kN kN				.32)68					25							952		
force									ļ											
force Max prestressing force 0.90	L.E.A.	kΝ			17	71					1 0	103								
Max. prestressing force 0.90 Maximum overstressing 0.95 force	i · F _{p0.1}	kN kN elix /	Addit	ional	18	71 70 force	ment	/ Cen	tre sp	pacin	21		e dist	tance	/ Sqi	uare j	28	657 804 dime	nsior	IS
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strengt Minimum concrete strengt Cube f _{cm, 0, o}	5 · F _{p0.1} gth / H h cube, 150	kN elix /	26	ional 28 23	18	370	ment 43 35	/ Cen 46 38	tre sı 26 21	28 23	21	03	e dist 43 35	tance 46 38	26 21	uare 28 23	28	304	nsior 43 35	46
Max. prestressing force 0.90 Maximum overstressing orce 0.95 Minimum concrete strength Minimum concrete strength Cube $f_{cm, 0, c}$ Cylinder $f_{cm, 0, c}$	j · F _{p0.1} gth / H h cube, 150 er, ∅ 150	kN elix / MPa MPa	26 21	28	1 8 rein1 34	370 force	43	46	26	28	2 1 g and 34	03 d edg 38	43	46	26	28	2 8 olate 34	304 dime 38	43	46
Max. prestressing force 0.90 Maximum overstressing 0.95 force Minimum concrete strengt Minimum concrete strengt Cube fcm, 0, c Cylinder fcm, 0, cylinde Helix, ribbed reinforcing state	j · F _{p0.1} gth / H h cube, 150 er, ∅ 150	kN elix / MPa MPa ≥ 500	26 21 MPa	28 23	18 reinf 34 28	370 force 38 31	43 35	46 38	26 21	28 23	21 g and 34 28	03 d edg 38 31	43 35	46 38	26 21	28 23	28 olate 34 28	304 dime 38 31	43 35	46 38
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strength Cube fcm, 0, c Cylinder fcm, 0, cylinder Helix, ribbed reinforcing ster Outer diameter	j · F _{p0.1} gth / H h cube, 150 er, ∅ 150	kN elix / / MPa MPa ≥ 500	26 21 MPa 280	28 23 270	18 reint 34 28	570 forcer 38 31 215	43 35 205	46 38 200	26 21 295	28 23 280	2 1 g and 34 28 240	03 d edg 38 31 225	43 35 215	46 38 215	26 21 325	28 23 320	28 olate 34 28	304 dime 38 31 280	43 35 270	46 38 260
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strength Cube $f_{cm, 0, cv}$ Cylinder $f_{cm, 0, cv}$ Helix, ribbed reinforcing stered Outer diameter Bar diameter 2	j · F _{p0.1} gth / H h cube, 150 er, ∅ 150	kN elix / MPa MPa ≥ 500	26 21 MPa 280 10	28 23 270 10	18 reint 34 28 230 12	570 forcel 38 31 215 12	43 35 205 12	46 38 200 12	26 21 295 10	28 23 280 10	2 1 g and 34 28 240 10	03 d edg 38 31 225 10	43 35 215 12	46 38 215 12	26 21 325 12	28 23 320 12	2 8 olate 34 28 290 12	304 dime 38 31 280 14	43 35 270 14	46 38 260 14
Max. prestressing force 0.90 Maximum overstressing 0.95 force Minimum concrete strength Minimum concrete strength Cube fcm, 0, c Cylinder fcm, 0, cylinder Helix, ribbed reinforcing stered Outer diameter	j · F _{p0.1} gth / H h cube, 150 er, ∅ 150	kN elix / . MPa MPa ≥ 500 mm mm	26 21 MPa 280	28 23 270	18 reint 34 28	570 forcer 38 31 215	43 35 205	46 38 200	26 21 295	28 23 280	2 1 g and 34 28 240	03 d edg 38 31 225	43 35 215	46 38 215	26 21 325	28 23 320	28 olate 34 28	304 dime 38 31 280	43 35 270	46 38 260 14 239 50
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strength Minimum concrete strength Cube $f_{cm, 0, c}$ Cylinder $f_{cm, 0, cylinder}$ Helix, ribbed reinforcing ster Outer diameter Bar diameter $^{2)}$ Length approximately	j · F _{p0.1} gth / H h cube, 150 er, ∅ 150	kN elix / MPa MPa ≥ 500 mm mm mm	26 21 MPa 280 10 280	28 23 270 10 258	1 8 reinf 34 28 230 12 237	570 forcer 38 31 215 12 237	43 35 205 12 237	46 38 200 12 212	26 21 295 10 280	28 23 280 10 280	2 1 g and 34 28 240 10 260	03 d edg 38 31 225 10 260	43 35 215 12 262	46 38 215 12 212	26 21 325 12 327	28 23 320 12 327	2 8 olate 34 28 290 12 312	304 dime 38 31 280 14 289	43 35 270 14 289	46 38 260 14 239 50
Max. prestressing force0.90Maximum overstressing force0.95Minimum concrete strengthCube $f_{cm, 0, c}$ Cylinder $f_{cm, 0, c}$ Helix, ribbed reinforcing steeOuter diameterBar diameter $^{2)}$ Length approximatelyPitch	j · F _{p0.1} gth / H h cube, 150 er, ∅ 150	kN elix / MPa MPa ≥ 500 mm mm mm	26 21 MPa 280 10 280 45	28 23 270 10 258 45	1 8 reint 34 28 230 12 237 50	370 forcel 38 31 215 12 237 50	43 35 205 12 237 50	46 38 200 12 212 50	26 21 295 10 280 45	28 23 280 10 280 45	2 1 g and 34 28 240 10 260 50	03 d edg 38 31 225 10 260 50	43 35 215 12 262 50	46 38 215 12 212 50	26 21 325 12 327 45	28 23 320 12 327 45	2 8 olate 34 28 290 12 312 50	304 dime 38 31 280 14 289 50	43 35 270 14 289 50	46 38 260 14 239 50 5.5
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strengt Minimum concrete strengt Cube $f_{cm, 0, c}$ Cylinder $f_{cm, 0, c}$ Helix, ribbed reinforcing stee Outer diameter Bar diameter $^{2)}$ Length approximately Pitch Number of pitches	j - F _{p0.1} gth / H h cube, 150 eel, R _e E	kN elix / / MPa ≥ 500 mm mm mm mm mm mm	26 21 280 10 280 45 7 35	28 23 270 10 258 45 6.5 35	1 8 rein1 34 28 230 12 237 50 5.5 35	570 507 Cel 38 31 215 12 237 50 5.5 35	43 35 205 12 237 50 5.5 35	46 38 200 12 212 50 50	26 21 295 10 280 45 7	28 23 280 10 280 45 7	2 1 g and 34 28 240 10 260 50 6	03 38 31 225 10 260 50 6	43 35 215 12 262 50 6	46 38 215 12 212 50 50	26 21 325 12 327 45 8	28 23 320 12 327 45 8	2 8 34 290 12 312 50 7	304 dime 38 31 280 14 289 50 6.5	43 35 270 14 289 50 6.5	46 38 260 14 239 50 5.5
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strength Cube $f_{cm, 0, c}$ Cylinder $f_{cm, 0, c}$ Helix, ribbed reinforcing ster Outer diameter Bar diameter $^{2)}$ Length approximately Pitch Number of pitches Distance	j - F _{p0.1} gth / H h cube, 150 eel, R _e E	kN elix / / MPa ≥ 500 mm mm mm mm mm mm	26 21 280 10 280 45 7 35	28 23 270 10 258 45 6.5 35	1 8 rein1 34 28 230 12 237 50 5.5 35	570 507 Cel 38 31 215 12 237 50 5.5 35	43 35 205 12 237 50 5.5 35	46 38 200 12 212 50 50	26 21 295 10 280 45 7	28 23 280 10 280 45 7	2 1 g and 34 28 240 10 260 50 6	03 38 31 225 10 260 50 6	43 35 215 12 262 50 6	46 38 215 12 212 50 50	26 21 325 12 327 45 8	28 23 320 12 327 45 8	2 8 34 290 12 312 50 7	304 dime 38 31 280 14 289 50 6.5	43 35 270 14 289 50 6.5	46 38 260 14 239 50 5.5
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strengt Cube fcm, 0, cylinde Cylinder fcm, 0, cylinde Helix, ribbed reinforcing ster Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, r	j - F _{p0.1} gth / H h cube, 150 eel, R _e E	kN elix / MPa MPa ≥ 500 mm mm mm mm reinfo	26 21 280 10 280 45 7 35 rcing	28 23 270 10 258 45 6.5 35 stee	18 reinf 34 28 230 12 237 50 5.5 35 35 35	370 5orce 38 31 215 12 237 50 5.5 35 ≥ 500	 43 35 205 12 237 50 5.5 35 MPa 	46 38 200 12 212 50 5 35	295 295 10 280 45 7 35	28 23 280 10 280 45 7 35	21 g and 34 28 240 10 260 50 6 35	03 38 31 2225 10 260 50 6 35	43 35 215 12 262 50 6 35	46 38 215 12 212 50 5 35	26 21 325 12 327 45 8 35	28 23 320 12 327 45 8 35	28 34 28 290 12 312 50 7 35	304 dime 38 31 2800 14 289 50 6.5 35 35	43 35 270 14 289 50 6.5 35	46 38 260 14 239 50 5.5 35 35 6
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strengt Minimum concrete strengt Cube fcm, 0, cylinde Cylinder fcm, 0, cylinde Helix, ribbed reinforcing ste Outer diameter 2 Length approximately Pitch Number of pitches Distance Additional reinforcement, ri Number of stirrups	j - F _{p0.1} gth / H h cube, 150 eel, R _e E	kN elix / MPa MPa ≥ 500 mm mm mm mm mm reinfo mm	26 21 280 10 280 45 7 35 rcing 5	28 23 270 10 258 45 6.5 35 35 stee 4	18 reint 34 230 12 237 50 5.5 35 35 35 35 35	370 forcer 38 31 215 12 237 50 5.5 35 ≥ 500 3	43 35 205 12 237 50 5.5 35 MPa 3	46 38 200 12 212 50 5 35 35	26 21 295 10 280 45 7 35	280 280 10 280 45 7 35	2 1 g and 34 28 240 10 260 50 6 35 4	03 38 31 2225 10 260 50 6 35 4	43 35 215 12 262 50 6 35 3	46 38 215 12 212 50 5 35 35	26 21 325 12 327 45 8 35 7	28 23 320 12 327 45 8 35 6	28 34 28 290 12 312 50 7 35 7	dime 38 31 280 14 289 50 6.5 35 6	43 35 270 14 289 50 6.5 35	46 38 260 14 230 5.0 5.0 5.0 5.0 6 16
Max. prestressing force 0.90 Maximum overstressing force 0.95 Minimum concrete strength Cube fcm, 0, cylinde Cylinder fcm, 0, cylinde Helix, ribbed reinforcing ster Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ri Number of stirrups Bar diameter ²⁾	j - F _{p0.1} gth / H h cube, 150 eel, R _e E	kN elix / MPa MPa ≥ 500 mm mm mm mm mm reinfo mm mm	26 21 280 10 280 45 7 35 rcing 5 12	28 23 270 10 258 45 6.5 35 35 stee 4 12	18 rein1 34 28 230 12 237 50 5.5 35 35 35 35 35 16	370 507Cel 38 31 215 12 237 50 5.5 35 ≥ 500 3 16	43 35 205 12 237 50 5.5 35 MPa 3 16	46 38 200 12 212 50 5 35 35 35	26 21 295 10 280 45 7 35 35 5 12	28 23 280 10 280 45 7 35 35	21 g and 34 28 240 10 260 50 6 35 4 16	03 38 31 2225 10 260 50 6 35 4 16	43 35 215 12 262 50 6 35 35 316	46 38 215 12 212 50 5 35 35 4 16	26 21 325 12 327 45 8 35 35 7 14	28 23 320 12 327 45 8 35 35 6 14	2 8 34 28 290 12 312 50 7 35 7 16	adime dime 38 31 280 14 289 50 6.5 35 6 16	43 35 270 14 289 50 6.5 35 6 6 16 60 55	46 38 260 14 239 50 5.5 35
Max. prestressing force 0.90 Maximum overstressing 0.95 0.95 force 0.95 Minimum concrete strengt 0.95 Minimum concrete strengt 0.95 Cube fcm, 0, cline Cylinder fcm, 0, cline Helix, ribbed reinforcing stee 0 Outer diameter 0 Bar diameter 2) 1 Length approximately 1 Pitch 1 Number of pitches 1 Distance 1 Additional reinforcement, ri 1 Number of stirrups 1 Bar diameter 2) 2 Distance 1 Distance from anchor plate 1	i - F _{p0.1} gth / H h cube, 150 er, Ø 150 eel, R _e E ibbed i	kN elix / MPa MPa 2 5000 mm mm mm mm mm mm mm mm mm	26 21 280 10 280 45 7 35 rcing 5 12 70	28 23 270 10 258 45 6.5 35 stee 4 12 90	18 rein1 34 230 12 237 50 5.5 35 35 1, R _e 2 3 16 120	570 507Cel 38 31 215 12 237 50 5.5 35 ≥ 500 3 16 110	43 35 205 12 237 50 5.5 35 MPa 3 16 105	46 38 200 12 212 50 5 35 35 35 35 31 6 100	295 10 280 45 7 35 5 12 75	28 23 280 10 280 45 7 355 4 12 75	21 g and 34 28 240 10 260 50 6 35 4 16 90	03 38 31 2225 10 260 50 6 35 4 16 85	43 35 215 12 262 50 6 35 35 3 16 110	46 38 215 12 212 50 5 35 35 4 16 75	26 21 325 12 327 45 8 35 7 14 55	28 23 320 12 327 45 8 35 35 6 14 55 55	28 34 28 290 12 312 50 7 35 7 16 55	dime 38 31 280 14 289 50 6.5 35 6 16 60 55	43 35 270 14 289 50 6.5 35 6 16 60	46 38 260 14 230 5.5 355 6 16 555
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strengt Cube fcm, 0, cl Cube fcm, 0, cl Cylinder fcm, 0, cl Helix, ribbed reinforcing ste Outer diameter Bar diameter 2) Length approximately Pitch Number of pitches Distance Additional reinforcement, ri Number of stirrups Bar diameter 2) Spacing Distance from anchor plate	$F = \frac{F}{B \times B}$	kN elix / MPa MPa ≥ 5000 mm mm mm mm mm mm mm mm mm mm mm	26 21 MPa 280 10 280 45 7 35 7 5 12 70 55	28 23 270 10 258 45 6.5 35 stee 4 12 90 55	18 rein1 34 230 12 237 50 5.5 35 1, R ₆ : 3 16 120 55	570 507Cel 38 31 215 12 237 50 5.5 35 ≥ 500 3 16 110 55	43 35 205 12 237 50 5.5 35 MPa 3 16 105 55	46 38 200 12 212 50 5 35 35 35 31 6 100 55	26 21 295 10 280 45 7 35 5 12 75 55	28 23 280 10 280 45 7 35 35 4 12 75 55	2 1 g and 34 28 240 10 260 50 6 35 35 4 16 90 55 295	03 38 31 2225 10 260 50 6 355 4 16 85 55	43 35 215 12 262 50 6 35 35 3 16 110 55	46 38 215 12 212 50 5 35 35 4 16 75 55	26 21 325 12 327 45 8 35 7 14 55 55	28 23 320 12 327 45 8 35 35 6 14 55 55	2 8 34 29 0 12 312 50 7 35 7 16 55 55	dime 38 31 280 14 289 50 6.5 35 6 16 60 55	43 35 270 14 289 50 6.5 35 6 6 16 60 55	46 38 260 14 230 5.5 355 6 16 555
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strengt Minimum concrete strengt Cube fcm, 0, or Cylinder fcm, 0, or Helix, ribbed reinforcing ste Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ri Number of stirrups Bar diameter ²⁾ Spacing Distance from anchor plate Minimum outer dimensions Centre spacing and edge di Minimum centre spacing	$F = B \times B$	kN elix / MPa MPa ≥ 5000 mm mm mm mm mm mm mm mm mm mm mm	26 21 MPa 280 45 7 35 5 12 70 55 315 335	28 23 270 10 258 45 6.5 35 stee 4 12 90 55 300 320	18 reint 34 28 230 12 237 50 5.5 35 35 16 120 55 280 300	370 38 31 215 12 237 50 5.5 35 250 3 16 110 55 265 285	43 35 205 12 237 50 5.5 35 MPa 3 16 105 55 250 250	46 38 2000 12 212 50 5 35 35 35 35 35 30 16 100 555 2400 260	26 21 295 10 280 45 7 35 35 35 330 335	28 23 280 45 7 35 35 4 12 75 55 320 340	2 1 g and 34 28 240 10 260 50 6 35 4 16 90 55 295 315	03 38 31 2225 10 260 50 6 35 4 16 85 55 280 300	43 35 215 12 262 50 6 35 35 3 16 110 55 265 285	46 38 215 12 212 50 5 35 35 4 16 75 55 255 255	26 21 325 12 327 45 8 35 7 14 55 55 385 410	28 23 320 12 327 45 8 35 6 14 55 55 375 395	2 8 34 28 290 12 312 50 7 35 7 16 55 345 365	304 dime 38 31 280 14 289 50 6.5 35 6 16 60 55 325 345 345 345 345	43 35 2700 14 2899 500 6.5 35 6 16 600 555 3100 3300	46 38 260 14 233 50 5.5 35 35 6 16 55 55 300 320
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strengt Minimum concrete strengt Cube fcm, 0, cylinde Cylinder fcm, 0, cylinde Helix, ribbed reinforcing ste Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ri Number of stirrups Bar diameter ²⁾ Spacing Distance from anchor plate Minimum outer dimensions Centre spacing and edge di	$F = B \times B$	kN elix / MPa MPa mm mm mm mm mm mm mm mm mm m	26 21 MPa 280 45 7 35 5 12 70 55 315	28 23 270 10 258 45 6.5 35 stee 4 12 90 55 300	18 reinf 34 28 230 12 237 50 5.5 35 1, Re 2 3 16 120 55 280	370 38 31 215 12 237 50 5.5 35 ≥ 500 3 16 110 55 265	43 35 205 12 237 50 5.5 35 MPa 3 16 105 55 250	 46 38 200 12 212 50 5 35 35 36 100 55 240 	26 21 295 10 280 45 7 35 55 55 330	28 23 280 45 7 35 4 12 75 55 320	2 1 g and 34 28 240 10 260 50 6 35 35 4 16 90 55 295	03 38 31 2225 10 260 50 6 35 4 16 85 55 280	43 35 215 12 262 50 6 35 35 3 16 110 55 265	46 38 215 12 212 50 5 35 35 4 16 75 55 255 255	26 21 325 12 327 45 8 35 7 14 55 55 385	28 23 320 12 327 45 8 35 6 14 55 55 375	2 8 34 28 2900 12 312 50 7 355 7 16 555 555 345	304 dime 38 31 2800 14 289 50 6.5 35 6 16 60 55 325	43 35 2700 14 2899 500 6.5 355 6 6 6 6 6 6 0 555 3100	46 38 260 14 233 50 5.5 35 35 6 16 55 55 300 320
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strengt Minimum concrete strengt Cube fcm, 0, or Cylinder fcm, 0, or Helix, ribbed reinforcing ste Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ri Number of stirrups Bar diameter ²⁾ Spacing Distance from anchor plate Minimum outer dimensions Centre spacing and edge di Minimum centre spacing	$F = \frac{F}{a_c, b_c}$	kN elix / MPa MPa ≥ 5000 mm mm mm mm mm mm mm mm mm mm mm mm	26 21 MPa 280 45 7 35 5 12 70 55 315 335 160	28 23 270 10 258 45 6.5 35 stee 4 12 90 55 300 55 300 320 150	18 rein1 34 28 230 12 237 50 5.5 35 35 16 120 55 280 300 140	370 507Cel 38 31 215 12 237 50 5.5 35 ≥ 500 3 16 110 55 265 285 135	43 35 205 12 237 50 5.5 35 MPa 3 16 105 55 250 270 125	46 38 2000 12 2122 50 5 355 35 35 36 100 55 240 2600 120	26 21 295 10 280 45 7 35 35 35 330 335	28 23 280 45 7 35 35 4 12 75 55 320 340	2 1 g and 34 28 240 10 260 50 6 35 4 16 90 55 295 315 150	03 38 31 2225 10 260 50 6 355 4 16 85 555 280 3000 140	43 35 215 12 262 50 6 35 3 16 110 55 265 285 135	 46 38 215 12 212 50 5 35 4 16 75 55 255 255 130 	26 21 325 12 327 45 8 35 7 14 55 55 385 385	28 23 320 12 327 45 8 35 35 55 375 395 190	2 8 34 28 290 12 312 50 7 35 7 16 55 345 365	304 dime 38 31 280 14 289 50 6.5 35 6 16 60 55 325 345 345 345 345	43 35 2700 14 2899 500 6.5 355 60 55 3100 33300 1555	46 38 260 14 239 50 5.5 35 35 6 16 55 55 300 320 150
Max. prestressing force 0.90 Maximum overstressing 0.95 force 0.95 Minimum concrete strengt Minimum concrete strengt Cube fcm, 0, cylinde Cylinder fcm, 0, cylinde Helix, ribbed reinforcing ste Outer diameter 2 Bar diameter 2 Length approximately Pitch Number of pitches Distance Additional reinforcement, ri Number of stirrups Bar diameter 2 Spacing Distance from anchor plate Minimum outer dimensions Centre spacing and edge di Minimum centre spacing Minimum edge distance	i · $F_{p0.1}$ gth / H h cube, 150 eel, Re eel, Re ibbbed F B × B istance a_{c}, b_{c}	kN elix / MPa MPa ≥ 5000 mm mm mm mm mm mm mm mm mm mm mm mm	26 21 MPa 280 45 7 35 5 12 70 55 315 335	28 23 270 10 258 45 6.5 35 stee 4 12 90 55 300 320	18 reint 34 28 230 12 237 50 5.5 35 35 16 120 55 280 300	570 507Cel 38 31 215 12 237 50 5.5 35 ≥ 500 3 16 110 55 265 285 135	43 35 205 12 237 50 5.5 35 MPa 3 16 105 55 250 250	46 38 2000 12 2122 50 5 355 35 35 36 100 55 240 2600 120	26 21 295 10 280 45 7 35 35 35 330 335	28 23 280 45 7 35 35 4 12 75 55 320 340 160	2 1 g and 34 28 240 10 260 50 6 35 4 16 90 55 295 315	03 38 31 2225 10 260 50 6 35 4 16 85 55 280 300	43 35 215 12 262 50 6 35 35 3 16 110 55 265 285	 46 38 215 12 212 50 5 35 4 16 75 55 255 255 130 	26 21 325 12 327 45 8 35 7 14 55 55 385 385	28 23 320 12 327 45 8 35 6 14 55 55 375 395	2 8 34 28 290 12 312 50 7 35 7 16 55 345 365	304 dime 38 31 2800 14 289 50 6.5 35 6 16 60 55 325 345 165	43 35 2700 14 2899 500 6.5 35 6 16 600 555 3100 3300	46 38 260 14 233 50 5.5 35 6 16 55 55 300 320



Annex 21



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



Stressing and fixed and	hora	ge /	/ cc	oupl	er			Ce	entre	spa	acin	g an	d ec	dge (dista	ance	;			
		b) _e =	a'e + D'e + Cor	- c	e co	ver	pe P					<u>c</u>	pe pe						
BBR VT CONA CMI SP		Т			13	06					15	606					16	06		
Strand arrangement																				
Nominal diameter 15.7 mn	ı N	omina	ial cr				stress rea 15					chara	cterist	tic ten	sile s	treng	th 18	60 MI	Pa ¹⁾	
Cross sostianal area	<u>م</u>	2			10	50	Ten	idon			0.0	050		i			0.4	100		_
	A _p m [≂] _{pk} k)50)27						250 185						100 164		
Char value of 0.1.9/ proof	_{0.1} К					98						690						936		
Max. prestressing force 0.90 · F	_{0.1} k	١			28	878					33	321					35	542		
Maximum overstressing	_{0.1} k	۷			30	38					35	506					37	'39		
Maximum overstressing 0.95 · F force			dditi	ional			ment	/ Cen	tre s	pacin			e dis	tance	/ Sqi	uare			nsior	ıs
Maximum overstressing 0.95 · F force Minimum concrete strength			ddit	ional			ment	/ Cen	tre s	pacin			e dis	tance	/ Sqi	uare			nsior	ıs
Maximum overstressing force Minimum concrete strength Minimum concrete strength	/ Heli	(/ Ac	ddit 26	ional 28			ment 43	/ Cen 46	tre s _i 26	pacin 28			e dist 43	tance 46	/ Sqi 26	uare 28			nsior 43	1
Maximum overstressing force 0.95 · F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube} ,	/ Heli	(/ Ao Pa 2			rein	force	1				g and	d edg					plate	dime		4
Maximum overstressing 0.95 · F force Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube,} Cylinder f _{cm, 0, cylinder, Ø}	/ Heli 150 M	a / Ao Pa 2 Pa 2	26 21	28	reint	force	43	46	26	28	g and 34	d edg 38	43	46	26	28	olate 34	dime 38	43	4
Maximum overstressing force 0.95 ⋅ F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube,} Cylinder f _{cm, 0, cylinder, Ø} Helix, ribbed reinforcing steel,	/ Heli 150 M	2 / A0 2a 2 2a 2 00 N	26 21 MPa	28	reint	force 38 31	43	46 38	26	28 23	g and 34 28	d edg 38	43	46 38	26 21	28	olate 34	dime 38	43 35	4
Maximum overstressing force 0.95 · F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube,} Cylinder f _{cm, 0, cylinder, Ø} Helix, ribbed reinforcing steel, Outer diameter	/ Heli ₁₅₀ M ₁₅₀ M R _e ≥ \$	2 / A 2 a	26 21 MPa 340 12	28 23 330 12	rein 34 28 305 12	force 38 31 290 14	43 35	46 38 270 14	26 21 370 14	28 23 350 14	g and 34 28 325 14	38 31 300 14	43 35 290 14	46 38 280 14	26 21	28 23 370 14	34 28 340 14	dime 38 31	43 35	3
Maximum overstressing force 0.95 · F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube,} Cylinder f _{cm, 0, cylinder, Ø} Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately	/ Heli 150 M 150 M R _e ≥ \$ m	2 / A 2 a 3 a 1 a	26 21 MPa 340 12 350	28 23 330 12 327	rein 34 28 305 12 312	38 31 290 14 314	43 35 280 14 289	46 38 270 14 264	26 21 370 14 389	28 23 350 14 364	34 28 325 14 339	38 31 300 14 339	43 35 290 14 314	46 38 280 14 289	26 21 390 14 389	28 23 370 14 389	34 28 340 14 364	dime 38 31 330 14 339	43 35 310 14 339	2 3 2
Maximum overstressing 0.95 · F force 0.95 · F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube,} Cylinder f _{cm, 0, cylinder, Ø} Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately	/ Heli 150 M 150 M R _e ≥ 4 m m m	2 A C A C A C A C A C A C A C A C A C A	26 21 MPa 340 12 350 45	28 23 330 12	rein 34 28 305 12	force 38 31 290 14	43 35 280 14	46 38 270 14	26 21 370 14	28 23 350 14	g and 34 28 325 14	38 31 300 14	43 35 290 14 314 50	46 38 280 14	26 21 390 14	28 23 370 14	34 28 340 14	dime 38 31 330 14	43 35 310 14 339 50	4 3 3 1 2 5
Maximum overstressing $0.95 \cdot F$ force $0.95 \cdot F$ Minimum concrete strength Minimum concrete strength Cube $f_{cm, 0, cube,}$ Cylinder $f_{cm, 0, cylinder, \emptyset}$ Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches	/ Heli: 150 M 150 M R _e ≥ 9 m m m m	2 / A 2 a	26 21 MPa 340 12 350 45 8.5	28 23 330 12 327 45 8	reint 34 28 305 12 312 50 7	force 38 31 290 14 314 50 7	43 35 280 14 289 50 6.5	46 38 270 14 264 50 6	26 21 370 14 389 50 8.5	28 23 350 14 364 50 8	g and 34 28 325 14 339 50 7.5	38 31 300 14 339 50 7.5	43 35 290 14 314 50 7	46 38 280 14 289 50 6.5	26 21 390 14 389 50 8.5	28 23 370 14 389 50 8.5	34 340 14 364 50 8	dime 38 31 330 14 339 50 7.5	43 35 310 14 339 50 7.5	3 3 1 2 5
Maximum overstressing $0.95 \cdot F$ force $0.95 \cdot F$ Minimum concrete strength Minimum concrete strength Cube $f_{cm, 0, cube,}$ Cylinder $f_{cm, 0, cylinder, \emptyset}$ Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches	/ Heli 150 M 150 M R _e ≥ 4 m m m	2 / A 2 a	26 21 MPa 340 12 350 45	28 23 330 12 327 45	reint 34 28 305 12 312 50	50 38 31 290 14 314 50	43 35 280 14 289 50	46 38 270 14 264 50	26 21 370 14 389 50	28 23 350 14 364 50	g and 34 28 325 14 339 50	38 31 300 14 339 50	43 35 290 14 314 50	46 38 280 14 289 50	26 21 390 14 389 50	28 23 370 14 389 50	34 28 340 14 364 50	dime 38 31 330 14 339 50	43 35 310 14 339 50	3 2 5
Maximum overstressing 0.95 · F force 0.95 · F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube,} Cylinder f _{cm, 0, cylinder, Ø} Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb	/ Heli: 150 M 150 M R _e ≥ m m m m m m m m m	a A Pa 2	26 21 340 12 350 45 8.5 40 cing	28 23 330 12 327 45 8 40 stee	reint 34 28 305 12 312 50 7 40 I, R _e	38 31 290 14 314 50 7 40 ≥ 500	 43 35 280 14 289 50 6.5 40 MPa 	 46 38 270 14 264 50 6 40 	26 21 370 14 389 50 8.5 45	28 23 350 14 364 50 8 45	34 28 325 14 339 50 7.5 45	38 31 300 14 339 50 7.5 45	43 35 290 14 314 50 7 45	 46 38 280 14 289 50 6.5 45 	26 21 390 14 389 50 8.5 45	28 23 370 14 389 50 8.5 45	34 28 340 14 364 50 8 45	dime 38 31 330 14 339 50 7.5 45	43 35 310 14 339 50 7.5 45	2 3 1 2 5 6 2
Maximum overstressing force 0.95 · F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube} , Cylinder f _{cm, 0, cylinder, Ø} Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups	/ Heli: 150 M 150 M R _e ≥ m m m m m m m m m	2a 2 2a 2	26 21 MPa 340 12 350 45 8.5 40 cing 7	28 23 330 12 327 45 8 40 stee 6	reint 34 28 305 12 312 312 50 7 40 I, R_e 6	38 31 2900 14 314 50 7 40 ≥ 5000 6	43 35 280 14 289 50 6.5 40 MPa 6	46 38 270 14 264 50 6 40	26 21 370 14 389 50 8.5 45 7	28 23 350 14 364 50 8 45 45	g and 34 28 325 14 339 50 7.5 45	38 31 300 14 339 50 7.5 45	43 35 290 14 314 50 7 45 6	46 38 280 14 289 50 6.5 45	26 21 390 14 389 50 8.5 45 7	28 23 370 14 389 50 8.5 45 6	34 28 340 14 364 50 8 45 7	dime 38 31 330 14 339 50 7.5 45 6	43 35 310 14 339 50 7.5 45	2 2 4 2
Maximum overstressing force 0.95 ⋅ F Minimum concrete strength Minimum concrete strength Cube fcm, 0, cube, Cylinder fcm, 0, cylinder, Ø Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²⁾	/ Helii 150 M 150 M	a 2 Pa 3	26 21 MPa 340 12 350 45 8.5 40 cing 7 14	28 23 330 12 327 45 8 40 stee 6 14	reint 34 28 305 12 312 50 7 40 I, R ,	5 orce 38 31 2900 14 314 500 7 400 ≥ 500 6 16	43 35 280 14 289 50 6.5 40 MPa 6 16	46 38 270 14 264 50 6 40 6 16	26 21 370 14 389 50 8.5 45 7 14	28 23 350 14 364 50 8 45 45 6 14	g and 34 28 325 14 339 50 7.5 45 6 16	d edg 38 31 300 14 339 50 7.5 45 6 16	43 35 290 14 314 50 7 45 45 6 16	46 38 280 14 289 50 6.5 45 45 6 16	26 21 390 14 389 50 8.5 45 7 14	28 23 370 14 389 50 8.5 45 45 6 14	34 28 3400 14 364 500 8 455 7 16	dime 38 31 330 14 339 50 7.5 45 6 16	43 35 310 14 339 50 7.5 45 45 6 16	2 3 1 2 5 6 2
Maximum overstressing force 0.95 · F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube,} Cylinder f _{cm, 0, cylinder, Ø} Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²⁾ Spacing	/ Heli 150 M 150 M 150 M Re≥ { 0 m m m m c E m m c m m m m m m m m m m m m m	A Pa 2	26 21 MPa 340 12 350 45 8.5 40 7 7 14 65	28 23 330 12 327 45 8 40 stee 6 14 65	reint 34 28 305 12 312 312 50 7 40 I, R. 6 16 65	force 38 31 2900 14 314 500 7 40 ≥ 6 16 65	43 35 280 14 289 50 6.5 40 MPa 6 16 60	46 38 270 14 264 50 6 40 6 16 60	26 21 370 14 389 50 8.5 45 45 7 14 70	28 23 350 14 364 50 8 45 45 6 14 70	g and 34 28 325 14 339 50 7.5 45 6 16 70	ad edg 38 31 300 14 339 50 7.5 45 6 16 70 70	43 35 2900 14 314 500 7 455 6 16 65	46 38 280 14 289 50 6.5 45 45 6 16 65	26 21 390 14 389 50 8.5 45 7 7 14 70	28 23 370 14 389 50 8.5 45 45 6 14 70	34 28 340 14 364 50 8 45 7 16 60	dime 38 31 330 14 339 50 7.5 45 45 6 16 70	43 35 310 14 339 50 7.5 45 6 16 65	
Maximum overstressing 0.95 · F force Minimum concrete strength Minimum concrete strength Cube fcm, 0, cube, Cylinder fcm, 0, cylinder, Ø Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²) Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²) Spacing Distance from anchor plate	/ Heli 150 M 150 M 150 M Re 2 f m m m m c m m m m m m m f m	(/ Ac 2a 2 2a 2	26 21 340 12 350 45 8.5 40 7 7 14 65 60	28 23 330 12 327 45 8 40 stee 6 14 65 60	reint 34 28 305 12 312 312 50 7 40 1, R, 6 16 65 60	5orce 38 31 2900 14 314 500 7 400 ≥ 500 6 16 65 60	43 35 280 14 289 50 6.5 40 MPa 6 16 60 60	46 38 270 14 264 50 6 40 6 16 60 60	26 21 370 14 389 50 8.5 45 7 14 70 65	28 23 350 14 364 50 8 45 45 6 14 70 65	g and 34 28 325 14 339 50 7.5 45 6 16 70 65	ad edg 38 31 300 14 339 50 7.5 45 6 16 70 65	43 35 2900 14 314 50 7 45 6 16 65	46 38 2800 14 2899 50 6.5 45 6 16 65 65	26 21 390 14 389 50 8.5 45 7 14 70 65	28 23 370 14 389 50 8.5 45 45 6 14 70 65	34 28 340 14 364 50 8 45 7 16 60 65	dime 38 31 330 14 339 50 7.5 45 45 6 16 70 65	43 35 310 14 339 50 7.5 45 6 16 65	
Maximum overstressing force 0.95 · F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube} , Cylinder f _{cm, 0, cylinder, ∅} Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²⁾ Spacing Distance from anchor plate Minimum outer dimensions B >	/ Heli: 150 M 150 M 150 M Re ≥ ! m m m m m m m m m m m m m	(/ Ac 2a 2 2a 2	26 21 340 12 350 45 8.5 40 7 7 14 65 60	28 23 330 12 327 45 8 40 stee 6 14 65	reint 34 28 305 12 312 312 50 7 40 I, R. 6 16 65	force 38 31 2900 14 314 500 7 40 ≥ 6 16 65	43 35 280 14 289 50 6.5 40 MPa 6 16 60	46 38 270 14 264 50 6 40 6 16 60	26 21 370 14 389 50 8.5 45 45 7 14 70	28 23 350 14 364 50 8 45 6 14 70	g and 34 28 325 14 339 50 7.5 45 6 16 70	ad edg 38 31 300 14 339 50 7.5 45 6 16 70 70	43 35 2900 14 314 500 7 455 6 16 65	46 38 280 14 289 50 6.5 45 45 6 16 65	26 21 390 14 389 50 8.5 45 7 7 14 70	28 23 370 14 389 50 8.5 45 45 6 14 70	34 28 340 14 364 50 8 45 7 16 60 65	dime 38 31 330 14 339 50 7.5 45 45 6 16 70	43 35 310 14 339 50 7.5 45 6 16 65	
Maximum overstressing 0.95 · F force 0.95 · F Minimum concrete strength Minimum concrete strength Cube f _{cm, 0, cube} , Cylinder f _{cm, 0, cylinder, Ø} Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²⁾ Spacing Distance from anchor plate Minimum outer dimensions B > Centre spacing and edge dista	/ Heli: 150 M 150 M Re ≥ t m m m m c m m m m m m m m m m m m m	a 2 a 2 base 2 base 2 base 2 base 2 base 3 m 3 m 3 m 2 m 4 m 4	26 21 340 12 350 45 8.5 40 7 14 65 60 405	28 23 330 12 327 45 8 40 stee 6 14 65 60 390	reint 34 28 305 12 312 50 7 40 7 6 16 65 60 360	50rce 38 31 290 14 314 50 7 40 ≥ 500 6 16 65 60 340	43 35 280 14 289 50 6.5 40 MPa 6 16 60 320	46 38 270 14 264 50 6 40 6 16 60 60 310	26 21 370 14 389 50 8.5 45 7 14 70 65 435	28 23 350 14 364 50 8 45 6 14 70 65 420	g and 34 28 325 14 339 50 7.5 45 6 16 70 65 390	ad edg 38 31 300 14 339 50 7.5 45 6 16 70 65 370	43 35 2900 14 314 500 7 455 665 655 3500	46 38 280 14 289 50 6.5 45 65 65 340	26 21 390 14 389 50 8.5 45 7 14 70 65 450	28 23 370 14 389 50 8.5 45 6 14 70 65 435	34 28 340 14 364 50 8 45 7 16 60 65 400	dime 38 31 330 14 339 50 7.5 45 6 16 70 65 380	43 35 310 14 339 50 7.5 45 6 6 6 5 65 360	3 3 1 2 5 6 2 1 1 5 6 3
Maximum overstressing force 0.95 ⋅ F Minimum concrete strength Minimum concrete strength Cube fcm, 0, cube, Cylinder fcm, 0, cylinder, Ø Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²⁾ Spacing Distance from anchor plate Minimum outer dimensions B > Centre spacing and edge dista Minimum centre spacing ac,	/ Heli: 150 M 150 M Re ≥ t m m m m c m c m m c m m m c m m m c m m m m c m m m c m m m m m m m m m m m m m m	a 2 a 2 a 2 b 2 a 2 b 3 m 3 m 3 m 2 m 2 m 4 m 4	26 21 340 12 350 45 8.5 40 7 14 65 60 405	28 23 330 12 327 45 8 40 stee 6 14 65 60 390 390	reint 34 28 305 12 312 50 7 40 1, R , 2 6 16 65 60 360 380	force 38 31 290 14 314 50 7 40 ≥ 6 16 65 60 340 360	43 35 280 14 289 50 6.5 40 MPa 6 16 60 320 340	46 38 270 14 264 50 6 40 6 16 60 310 330	26 21 370 14 389 50 8.5 45 7 14 70 65 435	28 23 350 14 364 50 8 45 6 14 70 65 420	g and 34 28 325 14 339 50 7.5 45 6 16 70 65 390 410	ad edg 38 31 300 14 339 50 7.5 45 6 16 70 65 370 390	43 35 290 14 314 50 7 45 6 16 65 350 350 370	46 38 280 14 289 50 6.5 45 6 6 16 65 340 360	26 21 390 14 389 50 8.5 45 7 14 70 65 450 470	28 23 370 14 389 50 8.5 45 45 45 435	34 28 340 14 364 50 8 45 7 16 60 65 400 420	dime 38 31 330 14 339 50 7.5 45 7.5 45 6 16 70 65 380 400	43 35 310 14 339 50 7.5 45 6 16 65 360 380	3 1 2 5 6 2 1 5 6 2 7 1 5 6 2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
Maximum overstressing 0.95 · F force Minimum concrete strength Minimum concrete strength Cube fcm, 0, cube, Cylinder fcm, 0, cylinder, Ø Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²⁾ Spacing Distance from anchor plate Minimum outer dimensions B > Centre spacing and edge distata Minimum centre spacing ac, Minimum edge distance a/e,	/ Heli: 150 M 150 M Re ≥ t m m m m c m m c m m m m m m m m m m m m m	a 2 a 2 a 2 b 2 a 2 b 3 m 3 m 3 m 2 m 2 m 4 m 4	26 21 340 12 350 45 8.5 40 7 14 65 60 405	28 23 330 12 327 45 8 40 stee 6 14 65 60 390	reint 34 28 305 12 312 50 7 40 7 6 16 65 60 360	50rce 38 31 290 14 314 50 7 40 ≥ 500 6 16 65 60 340	43 35 280 14 289 50 6.5 40 MPa 6 16 60 320	46 38 270 14 264 50 6 40 6 16 60 60 310	26 21 370 14 389 50 8.5 45 7 14 70 65 435	28 23 350 14 364 50 8 45 6 14 70 65 420	g and 34 28 325 14 339 50 7.5 45 6 16 70 65 390	ad edg 38 31 300 14 339 50 7.5 45 6 16 70 65 370 390	43 35 290 14 314 50 7 45 6 16 65 350 350 370	46 38 280 14 289 50 6.5 45 6 6 16 65 340 360	26 21 390 14 389 50 8.5 45 7 14 70 65 450	28 23 370 14 389 50 8.5 45 6 14 70 65 435	34 28 340 14 364 50 8 45 7 16 60 65 400 420	dime 38 31 330 14 339 50 7.5 45 6 16 70 65 380	43 35 310 14 339 50 7.5 45 6 16 65 360 380	
Maximum overstressing force 0.95 ⋅ F Minimum concrete strength Minimum concrete strength Cube fcm, 0, cube, Cylinder fcm, 0, cylinder, Ø Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²⁾ Spacing Distance from anchor plate Minimum outer dimensions B > Centre spacing and edge distata Minimum centre spacing ac, Minimum edge distance a'e, Square plate dimensions ³ 3	/ Heli: 150 M 150 M R _e ≥ t m m m m c m m m m m c F m m m m m m m m m m m m m	x / Ac Pa 2	26 21 MPa 340 12 350 45 8.5 40 cing 7 14 65 60 405 425 205	28 23 330 12 327 45 8 40 stee 6 14 65 60 390 390 410 195	reinit 34 28 305 12 312 50 7 40 1, R.e. 6 16 65 60 360 380 180	5orce 38 31 2900 14 314 500 7 400 ≥ 5000 6 16 65 600 3400 3600 1700	43 35 280 14 289 50 6.5 40 MPa 6 16 60 320 340 160	46 38 270 14 264 50 6 40 6 16 60 310 330 155	26 21 370 14 389 50 8.5 45 7 14 70 65 435 435 220	28 23 350 14 50 8 45 6 14 70 65 420 440 210	g and 34 28 325 14 339 50 7.5 45 6 16 70 65 390 410 195	d edg 38 31 300 14 339 50 7.5 45 6 16 70 65 370 390 185 390	43 35 2900 14 314 500 7 455 66 166 65 65 3500 3700 1755	46 38 280 14 289 50 6.5 16 65 340 360 170	26 21 390 14 389 50 8.5 45 7 14 70 65 450 470 225	28 23 370 14 389 50 8.5 45 6 14 70 65 435 435 220	34 28 340 14 364 50 8 45 7 16 60 65 400 2200	dime 38 31 330 14 339 50 7.5 45 45 6 16 70 65 380 400 190	43 35 310 14 339 50 7.5 45 6 16 65 360 380 180	2 3 1 2 5 6 2 1 1 5 6 2 1 1 5 6 2 1 1 5 6 2 1 1 5 6 2 1 1 5 6 2 1 1 1 5 6 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Maximum overstressing force $0.95 \cdot F$ Minimum concrete strength Minimum concrete strength Cube $f_{cm, 0, cube,}$ Cylinder $f_{cm, 0, cylinder, \emptyset}$ Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²⁾ Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²⁾ Spacing Distance from anchor plate Minimum outer dimensions B > Centre spacing and edge distata Minimum centre spacing a, Minimum edge distance a'a, Square plate dimensions ³⁾ Side length	/ Heli: 150 M 150 M R _e ≥ t m m m m m c m m m c m m m m m m m m m m m m m	x / Ac Pa 2	26 21 MPa 340 12 350 45 8.5 40 cing 7 14 65 60 405 425 205	28 23 330 12 327 45 8 40 stee 6 14 65 60 390 410 195 285	rein1 34 28 305 12 312 312 312 312 312 50 7 40 15 6 6 16 65 60 360 380 180 280	force 38 31 290 14 314 50 7 40 ≥ 500 6 16 65 60 340 360 170 275	43 35 280 14 289 50 6.5 40 MPa 6 16 60 320 340 160 270	46 38 270 14 264 50 6 40 6 16 60 310 330 330 155 270	26 21 370 14 389 50 8.5 45 7 14 70 65 435 435 220 320	28 23 350 14 50 8 45 6 14 70 65 420 440 210 320	g and 34 28 325 14 3399 50 7.5 45 6 16 16 70 65 390 410 195 315	d edg 38 31 300 14 339 50 7.5 45 6 16 70 65 370 390 185 310	43 35 2900 14 314 50 7 45 6 16 65 350 3700 305	46 38 280 14 289 50 6.5 45 6 6 6 5 65 340 360 170 300	26 21 390 14 389 50 8.5 45 7 14 70 65 450 450 470 225 330	28 23 370 14 389 50 8.5 45 45 45 435 435 435 220	34 28 340 14 364 50 8 45 7 16 60 65 400 200 325	dime 38 31 330 14 339 50 7.5 45 45 6 16 70 65 380 400 190	43 35 310 14 339 50 7.5 45 45 6 6 6 5 65 360 380 180 315	4 3 1 28 5 6 4 1 5 6 3 3 3 1 1 30
Maximum overstressing force 0.95 ⋅ F Minimum concrete strength Minimum concrete strength Cube fcm, 0, cube, Cylinder fcm, 0, cylinder, Ø Helix, ribbed reinforcing steel, Outer diameter Bar diameter ²) Length approximately Pitch Number of pitches Distance Additional reinforcement, ribb Number of stirrups Bar diameter ²) Spacing Distance from anchor plate Minimum outer dimensions B > Centre spacing and edge dista Minimum centre spacing ac, Minimum edge distance a'e, Square plate dimensions ³ Side length	/ Heli: 150 M 150 M 150 M R _e ≥ § m m m m m m c m m m m m m m c m m m m m m m m m m m m m	x / Ac Pa 2 M 2 M 4 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 2 M 3 M 3 M 3 M 3 M 3 M 3 <t< td=""><td>26 21 340 12 350 45 8.5 40 7 14 65 60 405 405 405 405 2285 40</td><td>28 23 330 12 327 45 8 40 stee 6 14 65 60 390 410 195 285 40</td><td>reint 34 28 305 12 312 50 7 40 I, R, 3 6 16 65 60 380 380 180 2880 40</td><td>force 38 31 290 14 314 50 7 40 ≥ 500 6 16 65 60 340 360 170 275 40</td><td>43 35 280 14 289 50 6.5 40 MPa 6 16 60 320 340 160 270 40</td><td>46 38 270 14 264 50 6 40 6 40 310 330 155 270 40</td><td>26 21 370 14 389 50 8.5 45 45 455 435 435 220 320 45</td><td>28 23 350 14 364 50 8 45 45 420 440 210 320 45</td><td>g and 34 28 325 14 339 50 7.5 45 6 16 70 65 390 410 195 315 45</td><td>d edg 38 311 300 14 339 50 7.5 45 6 16 70 65 370 390 185 310 45</td><td>43 35 2900 14 314 50 7 45 6 16 65 350 3700 175 3005 45</td><td>46 38 280 14 289 50 6.5 45 45 65 340 360 170 300 45</td><td>26 21 390 14 389 50 8.5 45 7 14 70 65 450 450 225 330 45</td><td>28 23 370 14 389 50 8.5 45 45 455 220 330 45</td><td>34 38 340 14 364 50 8 45 7 16 60 65 400 420 200 3225 45</td><td>dime 38 31 330 14 339 50 7.5 45 7.5 45 6 16 70 65 380 400 190 320 45</td><td>43 35 310 14 339 50 7.5 45 6 16 65 360 380 180 3315 45</td><td>4 3 1 2 5 6 4 1 5 6 3 3 1 3 1 3 1 3 1 3 1 3 1 3</td></t<>	26 21 340 12 350 45 8.5 40 7 14 65 60 405 405 405 405 2285 40	28 23 330 12 327 45 8 40 stee 6 14 65 60 390 410 195 285 40	reint 34 28 305 12 312 50 7 40 I , R , 3 6 16 65 60 380 380 180 2880 40	force 38 31 290 14 314 50 7 40 ≥ 500 6 16 65 60 340 360 170 275 40	43 35 280 14 289 50 6.5 40 MPa 6 16 60 320 340 160 270 40	46 38 270 14 264 50 6 40 6 40 310 330 155 270 40	26 21 370 14 389 50 8.5 45 45 455 435 435 220 320 45	28 23 350 14 364 50 8 45 45 420 440 210 320 45	g and 34 28 325 14 339 50 7.5 45 6 16 70 65 390 410 195 315 45	d edg 38 311 300 14 339 50 7.5 45 6 16 70 65 370 390 185 310 45	43 35 2900 14 314 50 7 45 6 16 65 350 3700 175 3005 45	46 38 280 14 289 50 6.5 45 45 65 340 360 170 300 45	26 21 390 14 389 50 8.5 45 7 14 70 65 450 450 225 330 45	28 23 370 14 389 50 8.5 45 45 455 220 330 45	34 38 340 14 364 50 8 45 7 16 60 65 400 420 200 3225 45	dime 38 31 330 14 339 50 7.5 45 7.5 45 6 16 70 65 380 400 190 320 45	43 35 310 14 339 50 7.5 45 6 16 65 360 380 180 3315 45	4 3 1 2 5 6 4 1 5 6 3 3 1 3 1 3 1 3 1 3 1 3 1 3

Internal Post-tensioning System

BBR CONA CMI SP

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

Annex 22



Cylinderf_{cm, 0, cylinder, $\oslash 150$ MPa2123283135382123283135382123283135382123Helix, ribbed reinforcing steel, $R_e \geq 50$ MPa203803503403403404604304003603503504804Outer diametermm4354103803503403404604304003603503504804Bar diametermm1610101010Length approximatelymm3013913913913663412914414414163913663164664Number of pitches8.58.58.58.7.55.55.55.55.55.55.55.55.55.55.55.5 <th< th=""><th>rength 1</th><th>2400 th 1860</th><th></th><th></th><th></th></th<>	rength 1	2400 th 1860				
Strand arrangement 7-wire prestressing steel strand Nominal diameter 15.7 mm Nominal cross-sectional area 150 mm ² Maximum characteristic tensile strated Tendon Cross-sectional area A ₀ mm ² 2850 3 300 Cross-sectional area A ₀ mm ² 2850 3 300 Char. value of maximum force F_{pk} kN 5 3300 Char. value of 0.1 % proof $F_{p0.1}$ kN 4 674 5 412 Max. prestressing force 0.90 · $F_{p0.1}$ kN 4 4871 Maximum corecte strength / Helix / Additional reinforcement / Centre spacing and edge distance / Squat Minimum concrete strength MPa 26 28 34 38 43 43 46 2 80 7 Minimum concrete strength KN 4400 5 5 5 5 5 5 6 2 8 4 4 4 6 3 3 3	rength 1					
T-wire prestressing steel strand Nominal diameter 15.7 mm Nominal cross-sectional area 150 mm ² Maximum characteristic tensile street Tendon Cross-sectional area A_p mm ² 2850 3 300 Char. value of maximum force F_{pk} KN 5301 6 138 Char. value of 0.1 % proof Fp.1 KN 4 4674 5412 Max. prestressing force $0.90 \cdot F_{p0.1}$ KN 4440 5141 Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance / Squat MPa 26 28 34 38 43 MPa 26 28 34 38 43 46 2 MPa 26 28 34 38 43 46 2 MPa 26 28 34 38 <th c<="" th=""><th></th><th>th 1860</th><th></th><th></th><th></th></th>	<th></th> <th>th 1860</th> <th></th> <th></th> <th></th>		th 1860			
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Minimum concrete strength / Helix / Additional reinforcement / Centre spacing and edge distance / Squata Minimum concrete strength Cube f _{cm, 0, cube, 150} MPa 26 28 34 38 21 23 28 34 38 21 23 28 34 38 21 23 28 34 38 21 23 28 34 38 21 23 28 21 23 28 21 23 28 21 23 28 21 23 28 21 23 28 24 24 24 24 24 24 24 24 24 24 24 24 24 24 <th co<="" td=""><td></td><td>5 60</td><td></td><td></td><td></td></th>	<td></td> <td>5 60</td> <td></td> <td></td> <td></td>		5 60			
Outer diametermm4354103803503403404604304003603503504804Bar diametermm16 <th>28 34</th> <th>34</th> <th>38</th> <th>43 35</th> <th>46 38</th>	28 34	34	38	43 35	46 38	
Bar diametermm16 <td>I</td> <td>11</td> <td></td> <td></td> <td></td>	I	11				
Length approximately mm 391 391 391 366 341 291 441 441 416 391 366 466 4 Pitch mm 50 55	460 41	410 3	370 3	360	360	
Pitch mm 50 55	16 16	16	16	16	16	
Number of pitches 8.5 8.5 8.5 8 7.5 6.5 9.5 9 8.5 8 7 10 9 Distance E mm 50 50 50 45 45 45 56 55 56 55 56					341	
Distance E mm 50 50 50 45 45 45 56 57				50	50	
Additional reinforcement, ribbed reinforcement, ribbed reinforcement, ribbed Re > 500 MPa Number of stirrups mm 7 6 9 8 7 7 6 9 8 7 7 Bar diameter ³⁾ mm 14 16 <td></td> <td>9</td> <td></td> <td>8.5</td> <td>7.5</td>		9		8.5	7.5	
Number of stirrups mm 7 6 9 8 7 7 6 9 8 8 7 7 Bar diameter ³) mm 14 16 <td>55 55</td> <td>55</td> <td>55</td> <td>55</td> <td>55</td>	55 55	55	55	55	55	
Bar diameter ³⁾ mm 14 16						
Spacing mm 70 85 50 55 60 55 80 80 55 60 55 90 1		9	8	8 20	7 20	
				20 70	20 80	
Distance from anchor plate F mm 75 75 75 75 75 75 75 75 75 75 75 75 75				75	75	
					435	
Centre spacing and edge distance		<u> </u>				
		515 4	485 4	465	455	
Minimum edge distance a'e, b'e mm 245 235 220 210 200 195 265 235 235 225 215 210 280 2	550 51	250 2	235 2	225	220	
Square plate dimensions ²⁾		<u> </u>				
		385 3	375 3	370	370	
$ T_{\text{SP}} \ \text{mm} \ 50 \ 50 \ 50 \ 45 \ 45 \ 45 \ 55 \ 55$	265 25	55	55	55	55	



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

Internal Post-tensioning System

Annex 23

of European Technical Assessment **ETA-09/0287** of 19.09.2018



Saboonig	and fixed ancho	orage	e / c	oupl	er			Ce	entre	spa	acin	g an	d ec	lge (dista	ance				
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BBR VT CON	A CMI SP				25	06					27	06					31	06		
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Nominal	diameter 15.7 mm	Nom	inal c				stres					hara	cterist	tic ten	sile s	trena	h 18	50 MF	Da ¹⁾	
Normina		. NOM		1033-	300110					VIAAII	num	Jiaia	5101131		15110 5	licing		50 101	u	
0	-1				0.7	150	Ten	don			4.0	50					1.0	50		
Cross-sectiona	al area A_p maximum force F_{pk}	mm ² kN			-	750 975						50 33					46			
Char. value of force	pit	kN				50						42					76			
	sing force 0.90 · F _{p0.1}	kN			55	535					59	78					68	63		
Maximum ove	rstressing 0.95 · F _{p0.1}					343						10					72			
Cube	ncrete strength f _{cm, 0, cube, 150}	MPa	26	28	34	38	43				24	38	10				0.4			
Cylinder							-	46	26	28	34		43	46	26	28	34	38	43	-
	$f_{cm, 0, cylinder, \emptyset 150}$	1	21	23	28	31	45 35	46 38	26 21	28 23	34 28	31	43 35	46 38	26 21	28 23	34 28	38 31	43 35	-
Helix, ribbed	reinforcing steel, R	≥ 500	21) MPa	23 1		31	35	38	21	23	28	31	35	38	21	23	28	31	35	3
Helix, ribbed Outer diamete	reinforcing steel, R	≥ 50(mm	21) MPa 500	23 480	420	31 380	35 370	38 370	21 520	23 500	28 450	31 400	35 390	38 380	21 560	23 540	28 480	31 430	35 430	3
Helix, ribbed Outer diamete Bar diameter	reinforcing steel, R	≥ 50(mm mm	21 MP a 500 16	23 480 16	420 16	31 380 16	35 370 16	38 370 16	21 520 16	23 500 16	28 450 16	31 400 16	35 390 16	38 380 16	21 560 16	23 540 16	28 480 16	31 430 16	35 430 16	3 4: 1
Helix, ribbed Outer diamete Bar diameter Length approx	reinforcing steel, R	≥ 50(mm mm mm	21 MPa 500 16 466	23 480 16 466	420 16 441	31 380 16 441	35 370 16 391	38 370 16 366	21 520 16 491	23 500 16 491	28 450 16 441	31 400 16 441	35 390 16 416	38 380 16 391	21 560 16 516	23 540 16 516	28 480 16 466	31 430 16 466	35 430 16 416	3 4 1 3
Helix, ribbed Outer diamete Bar diameter	reinforcing steel, R.	≥ 50(mm mm	21 MP a 500 16	23 480 16	420 16	31 380 16	35 370 16	38 370 16	21 520 16 491 50	23 500 16	28 450 16	31 400 16	35 390 16	38 380 16	21 560 16	23 540 16	28 480 16	31 430 16	35 430 16	3 4: 1 3: 5
Helix, ribbed Outer diamete Bar diameter Length approx Pitch	reinforcing steel, R.	≥ 50(mm mm mm	21 500 16 466 50	23 480 16 466 50	420 16 441 50	31 380 16 441 50	35 370 16 391 50	38 370 16 366 50	21 520 16 491 50	23 500 16 491 50	28 450 16 441 50	31 400 16 441 50	35 390 16 416 50	38 0 16 391 50	21 560 16 516 50	23 540 16 516 50	28 480 16 466 50	31 430 16 466 50	35 430 16 416 50	3 4 1 3 5 8
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance	reinforcing steel, R _e r kimately ches	≥ 500 mm mm mm mm mm	21 500 16 466 50 10 60	23 480 16 466 50 10 60	420 16 441 50 9.5 60	31 380 16 441 50 9.5 60	35 370 16 391 50 8.5 60	38 370 16 366 50 8	21 520 16 491 50 10.5	23 500 16 491 50 10.5	28 450 16 441 50 9.5	31 400 16 441 50 9.5	35 390 16 416 50 9	38 380 16 391 50 8.5	21 560 16 516 50 11	23 540 16 516 50 11	28 480 16 466 50 10	31 430 16 466 50 10	35 430 16 416 50 9	3 4 1 3 5 8
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei	reinforcing steel, R ar imately ches E inforcement, ribbed	≥ 500 mm mm mm mm mm	21 500 16 466 50 10 60	23 480 16 466 50 10 60	420 16 441 50 9.5 60	31 380 16 441 50 9.5 60	35 370 16 391 50 8.5 60	38 370 16 366 50 8	21 520 16 491 50 10.5	23 500 16 491 50 10.5	28 450 16 441 50 9.5	31 400 16 441 50 9.5	35 390 16 416 50 9	38 380 16 391 50 8.5	21 560 16 516 50 11	23 540 16 516 50 11	28 480 16 466 50 10	31 430 16 466 50 10	35 430 16 416 50 9	3 4 3 5 8 6
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance	reinforcing steel, R ar imately ches E inforcement, ribbed	≥ 50(mm mm mm mm mm	21 500 16 466 50 10 60 rcing	23 480 16 466 50 10 60 stee	420 16 441 50 9.5 60 I, R e	31 380 16 441 50 9.5 60 ≥ 500	35 370 16 391 50 8.5 60 MPa	38 370 16 366 50 8 60	21 520 16 491 50 10.5 60	23 500 16 491 50 10.5 60	28 450 16 441 50 9.5 60	31 400 16 441 50 9.5 60	35 390 16 416 50 9 60	38 380 16 391 50 8.5 60	21 560 16 516 50 11 60	23 540 16 516 50 11 60	28 480 16 466 50 10 60	31 430 16 466 50 10 60	35 430 16 416 50 9 60	3 4: 1 3: 5 8 6
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir	reinforcing steel, R ar imately ches E inforcement, ribbed	≥ 500 mm mm mm mm mm reinfo mm	21 500 16 466 50 10 60 rcing 7	23 480 16 466 50 10 60 stee 6	420 16 441 50 9.5 60 I, R ,	31 380 16 441 50 9.5 60 ≥ 500 8	35 370 16 391 50 8.5 60 MPa 8	370 16 366 50 8 60	21 520 16 491 50 10.5 60	23 500 16 491 50 10.5 60 5	28 450 16 441 50 9.5 60 7	31 400 16 441 50 9.5 60	35 390 16 416 50 9 60	38 0 16 391 50 8.5 60	21 560 16 516 50 11 60	23 540 16 516 50 11 60 7	28 480 16 466 50 10 60 10	31 430 16 466 50 10 60 9	35 430 16 416 50 9 60 8	3 4 1 3 5 8 6
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter	reinforcing steel, R ar dimately ches E inforcement, ribbed rups	≥ 500 mm mm mm mm mm reinfo mm	21 500 16 466 50 10 60 rcing 7 20	23 480 16 466 50 10 60 stee 6 20	420 16 441 50 9.5 60 I, R , 2 9 20	31 380 16 441 50 9.5 60 ≥ 500 8 20	370 16 391 50 8.5 60 MPa 8 20	370 16 366 50 8 60 6 20	21 520 16 491 50 10.5 60 60 20	23 500 16 491 50 10.5 60 5 20	28 450 16 441 50 9.5 60 7 20	31 400 16 441 50 9.5 60 60 20	35 390 16 416 50 9 60 60 20	380 16 391 50 8.5 60 6 20	21 560 16 516 50 11 60 8 20	23 540 516 50 11 60 7 20	28 480 16 466 50 10 60 10 20	31 430 16 466 50 10 60 9 20	 35 430 16 416 50 9 60 8 20 	3 4 1 3 5 8 6
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter Spacing	reinforcing steel, R, er dimately ches E inforcement, ribbed rups anchor plate F	≥ 500 mm mm mm mm mm reinfo mm mm	21 500 16 466 50 10 60 rcing 7 20 100	23 480 16 466 50 10 60 stee 6 20 100	420 16 441 50 9.5 60 I, R e 9 20 70	31 380 16 441 50 9.5 60 ≥ 500 8 20 70	370 16 391 50 8.5 60 MPa 8 20 70	370 16 366 50 8 60 6 20 80	21 520 16 491 50 10.5 60 6 20 100	23 500 16 491 50 10.5 60 5 20 100	28 450 16 441 50 9.5 60 7 20 80	31 400 16 441 50 9.5 60 60 60 20 90	35 390 16 416 50 9 60 60 85	38 0 16 391 50 8.5 60 6 20 70	21 560 16 516 50 11 60 8 20 80	23 540 16 516 50 11 60 7 20 95	28 480 16 466 50 10 60 10 20 60	 31 430 16 466 50 10 60 9 20 65 	 35 430 16 416 50 9 60 8 20 70 	3 4: 1 3: 5 8 6 2 2 6 8
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter Spacing Distance from Minimum oute	reinforcing steel, R ar dimately ches E inforcement, ribbed rups anchor plate F r dimensions B × B ng and edge distanc	≥ 500 mm mm mm mm mm mm mm mm mm mm mm e	21 500 16 466 50 10 60 7 20 100 80 565	23 480 16 466 50 10 60 545 80 545	420 16 441 50 9.5 60 9 20 70 80 500	31 380 16 441 50 9.5 60 8 20 70 80 475	35 370 16 391 50 8.5 60 MPa 8 20 70 80 450	370 16 366 50 8 60 6 20 80 80 80 440	21 520 16 491 500 10.5 60 6 20 100 80 585	23 500 16 491 50 10.5 60 5 20 100 80 565	28 450 16 441 50 9.5 60 7 20 80 80 80 520	31 4000 16 4411 500 9.5 60 60 60 80 80 80 80	390 16 416 50 9 60 60 85 80 470	380 16 391 50 8.5 60 6 20 70 80 460	21 560 16 516 50 11 60 8 8 20 80 80 80 80 630	23 540 16 516 50 11 60 7 20 95 80 605	28 480 16 466 50 10 60 20 60 80 560	31 4300 16 466 500 10 60 9 20 65 80 5335	35 430 16 416 50 9 60 8 20 70 80 515	3 4: 1 3: 5 8 6 7 2 6 8 50
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter Spacing Distance from Minimum oute Centre spacin Minimum cent	reinforcing steel, R imately ches E inforcement, ribbed rups anchor plate F r dimensions B × B ng and edge distanc re spacing a _c , b _c	≥ 500 mm mm mm mm mm mm mm mm mm mm mm e mm	21 500 16 466 50 10 60 7 20 100 80 565 585	23 480 16 466 50 10 60 545 545 565	420 16 441 50 9.5 60 I, R , 9 20 70 80 500	31 380 16 441 50 9.5 60 8 20 70 80 475 495	35 370 16 391 50 8.5 60 MPa 8 20 70 80 450	370 16 366 50 8 6 20 80 80 80 80 440	21 520 16 491 500 10.5 60 200 100 800 585 605	23 500 16 491 50 10.5 60 5 20 100 80 565 585	28 450 16 441 50 9.5 60 7 20 80 80 80 520 520	31 4000 16 4411 500 9.5 60 60 20 900 800 4995 515	390 16 416 50 9 60 85 80 470 490	380 16 391 50 8.5 60 6 20 70 80 460	21 5600 16 516 500 11 600 80 80 80 80 800 800 800 800 800 800	23 540 16 516 50 11 60 7 20 95 80 605 625	28 480 16 50 10 60 20 60 80 560 580	31 4300 16 4666 500 100 600 600 600 605 800 5335	35 4300 16 416 50 9 60 60 8 8 20 70 80 515 535	3 4: 1 3: 5 8 6 2 6 8 5: 5:
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter Spacing Distance from Minimum oute Centre spacer Minimum cent Minimum edge	reinforcing steel, R imately ches E inforcement, ribbed rups anchor plate F r dimensions B × B ng and edge distanc re spacing a _c , b _c e distance a' _e , b' _e	≥ 500 mm mm mm mm mm mm mm mm mm mm mm e mm	21 500 16 466 50 10 60 7 20 100 80 565	23 480 16 466 50 10 60 545 80 545	420 16 441 50 9.5 60 9 20 70 80 500	31 380 16 441 50 9.5 60 8 20 70 80 475	35 370 16 391 50 8.5 60 MPa 8 20 70 80 450	370 16 366 50 8 60 6 20 80 80 80 440	21 520 16 491 500 10.5 60 200 100 800 585 605	23 500 16 491 50 10.5 60 5 20 100 80 565 585	28 450 16 441 50 9.5 60 7 20 80 80 80 520	31 4000 16 4411 500 9.5 60 60 60 80 80 80 80	390 16 416 50 9 60 60 85 80 470	380 16 391 50 8.5 60 6 20 70 80 460	21 5600 16 516 500 11 600 80 80 80 80 6300	23 540 16 516 50 11 60 7 20 95 80 605	28 480 16 466 50 10 60 20 60 80 560	31 4300 16 4666 500 100 600 9 200 655 800 5535	35 430 16 416 50 9 60 8 20 70 80 515	3 4: 1 3: 5 8 6 2 6 8 5: 5:
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter Spacing Distance from Minimum oute Centre spacir Minimum cent Minimum edge Square plate	reinforcing steel, R dimately ches E inforcement, ribbed rups anchor plate F or dimensions B × B ng and edge distance re spacing a _c , b _c e distance a' _e , b' _e dimensions ²	≥ 500 mm mm mm mm mm mm mm mm mm mm mm mm	21 500 16 466 50 10 60 7 20 100 80 565 585 285	23 480 16 466 50 10 60 5 stee 6 20 100 80 545 565 275	420 16 441 50 9.5 60 9 20 70 80 500 520 250	31 380 16 441 50 9.5 60 ≥ 500 8 20 70 80 475 240	35 370 16 391 50 8.5 60 MPa 8 20 70 80 450 450	38 370 16 366 50 8 60 20 80 80 4400 220	21 520 16 491 50 10.5 60 20 100 80 585 295	23 500 16 491 50 10.5 60 55 20 100 80 565 585 285	28 450 16 441 9.5 60 7 20 80 80 520 540 260	31 400 16 441 50 9.5 60 80 495 515 250	35 390 16 416 50 9 60 80 420 85 80 470 225	38 380 16 391 50 8.5 60 20 70 80 460 230	21 560 16 516 50 11 60 80 80 80 630 630 315	23 540 16 516 50 11 60 7 20 95 80 605 80 605	28 480 16 466 50 10 60 80 580 280	31 430 16 466 50 10 60 80 535 555 270	35 4300 16 416 50 9 600 8 20 70 80 515 535 2600	3 4: 1 3: 5 8 6 2 6 8 5 2 5 2 5 2
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter Spacing Distance from Minimum oute Centre spacir Minimum cent Minimum edge Square plate Side length	reinforcing steel, R _e r imately ches E inforcement, ribbed rups anchor plate F r dimensions B × B ng and edge distance re spacing a _c , b _c e distance a' _e , b' _e dimensions 2) S _{SP}	≥ 500 mm mm mm mm mm mm mm mm mm mm mm mm m	21 500 16 466 50 10 60 7 20 100 80 565 585 285 285	23 480 16 466 50 10 60 3 stee 6 20 100 80 545 565 275 405	420 16 441 50 9.5 60 9 20 70 80 500 520 250 405	31 380 16 441 50 9.5 60 8 20 70 80 475 495 240 395	35 370 16 391 50 8.5 60 MPa 8 20 70 80 450 450 470 225 385	38 370 16 366 50 8 60 20 80 400 220 385	21 520 16 491 50 10.5 60 20 100 80 585 605 295 605 295	23 500 16 491 50 10.5 60 50 20 100 80 565 585 285 285 415	28 450 16 441 9.5 60 7 20 80 80 520 540 260 410	31 400 16 441 50 9.5 60 80 495 515 250 400	35 390 16 416 50 9 60 6 20 85 80 470 235 395	380 380 16 391 50 8.5 60 20 70 80 460 230 395	21 560 16 516 50 11 60 80 80 80 630 630 315 440	23 540 16 516 50 11 60 7 20 95 80 605 80 605 625 305	28 480 16 466 50 10 60 20 60 80 560 580 280 435	31 430 16 466 50 10 60 9 20 65 80 535 555 270 425	35 4300 16 416 50 9 600 8 8 20 70 80 515 535 2600 420	3 4: 1 3: 5 8 6 2 6 8 5 2 5 2 5 2 4
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter Spacing Distance from Minimum oute Centre spacir Minimum cent Minimum edge Square plate Side length Thickness	reinforcing steel, Ra imately ches E inforcement, ribbed rups anchor plate F r dimensions B × B ng and edge distanc re spacing a _c , b _c e distance a' _e , b' _e dimensions ²) S _{SP} T _{SP}	≥ 500 mm mm mm mm mm mm mm mm mm mm mm mm m	21 500 16 466 50 10 60 7 20 100 80 565 585 285 285 285 60	23 480 16 466 50 10 60 20 100 80 545 565 275 405 60	420 16 441 50 9.5 60 9 20 70 80 500 500 520 250 405 60	31 380 16 441 50 9.5 60 ≥ 500 8 20 70 80 475 240 395 60	35 370 16 391 50 8.5 60 MPa 8 20 70 80 450 450 225 385 60	38 370 16 366 50 8 60 20 80 80 440 220 385 60	21 520 16 491 50 10.5 60 80 585 205 295 415 60	23 500 16 491 50 10.5 60 50 50 50 50 50 50 50 50 50 50 50 50 50	28 450 16 441 50 9.5 60 7 20 80 80 80 520 540 260 410 60	31 400 16 441 50 9.5 60 80 80 495 515 250 400 60	35 390 16 416 50 9 60 85 80 470 235 395 60	38 380 16 391 50 8.5 60 70 80 460 230 3995 60	21 560 16 516 50 11 60 80 80 80 630 315 440 60	23 540 16 516 50 11 60 7 20 95 80 605 625 305 440 60	28 480 16 466 50 10 60 20 60 80 580 280 280 435 60	31 430 16 50 10 60 9 20 65 80 5355 555 270 425 60	35 430 16 416 50 9 60 8 8 20 70 80 515 535 260 420 60	3 4 1 3 5 8 6 2 6 8 5 2 6 8 5 2 9 6 8 5 2 9 6 8 5 2 9 6 8 5 2 9 6 8 5 2 9 6 8 5 7 9 8 6 8 5 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter Spacing Distance from Minimum outer Centre spacin Minimum cent Minimum cent Minimum edge Square plate Side length Thickness	reinforcing steel, Ra inforcement, ribbed rups anchor plate F in dimensions B × B ng and edge distanc re spacing a _c , b _c e distance a' _e , b' _e dimensions ²) S _{SP} T _{SP} steel strand with nomina	≥ 500 mm mm mm mm mm mm mm mm mm mm mm mm i diam	21 500 16 466 50 10 60 7 20 100 80 565 585 285 585 60 405 60	23 480 16 466 50 10 60 50 50 50 50 50 50 50 50 50 50 50 50 50	420 16 441 50 9.5 60 1, R 9 20 70 80 520 250 405 60 nm, cr	31 380 16 441 50 9.5 60 ≥ 500 8 20 70 80 475 240 395 60 	35 370 16 391 50 8.5 60 MPa 8 20 70 80 450 450 470 225 385 60	38 370 16 366 50 8 60 20 80 80 440 220 385 60 385 60	21 520 16 491 50 10.5 60 20 100 80 585 295 605 295 415 60 0f 140	23 500 16 491 50 10.5 60 55 20 100 80 565 585 285 415 60 mm ²	28 450 16 441 50 9.5 60 7 20 80 80 520 540 260 260 410 60 or witt	31 400 16 441 50 9.5 60 80 80 495 515 250 400 60	35 390 16 416 50 9 60 85 80 470 235 395 60	38 380 16 391 50 8.5 60 70 80 460 230 3995 60	21 560 16 516 50 11 60 80 80 80 630 315 440 60	23 540 16 516 50 11 60 7 20 95 80 605 625 305 440 60	28 480 16 466 50 10 60 20 60 80 580 280 280 435 60	31 430 16 50 10 60 9 20 65 80 5355 555 270 425 60	35 430 16 416 50 9 60 8 8 20 70 80 515 535 260 420 60	3 4 3 5 8 6 8 6 8 5 2 6 8 5 2 5 2 5 2 5 2 5 2 5 2 5 2 5 2 5 2 5
Helix, ribbed Outer diameter Bar diameter Length approx Pitch Number of pitc Distance Additional rei Number of stir Bar diameter Spacing Distance from Minimum oute Centre spacin Minimum cent Minimum cent Minimum edge Square plate Side length Thickness	reinforcing steel, R dimately ches E inforcement, ribbed rups anchor plate F r dimensions B × B ng and edge distance re spacing a _c , b _c distance a' _e , b' _e dimensions ²) S _{SP} T _{SP} steel strand with nomina	≥ 500 mm mm mm mm mm mm mm mm mm mm mm mm m	21 500 16 466 50 10 60 7 20 100 80 565 285 285 285 405 60 eter of ralues	23 480 16 466 50 10 60 3 stee 6 20 100 80 545 275 565 275 405 60 15.3 i , there	420 16 441 50 9.5 60 9 20 70 80 500 520 250 405 60 nm, cr	31 380 16 441 50 9.5 60 8 20 70 80 475 240 395 60 000000000000000000000000000000000	35 370 16 391 50 8.5 60 MPa 8 20 70 80 450 450 470 225 385 60	38 370 16 366 50 8 60 20 80 80 440 220 385 60 385 60 al area	21 520 16 491 50 10.5 60 60 585 605 295 605 295 415 60 60 585 00 140 60 585	23 500 16 491 50 10.5 60 55 20 100 80 565 585 285 415 60 100mm ² / be us	28 450 16 441 50 9.5 60 7 20 80 80 520 540 260 260 410 60 or witt	31 400 16 441 50 9.5 60 80 80 495 515 250 400 60	35 390 16 416 50 9 60 85 80 470 235 395 60	38 380 16 391 50 8.5 60 70 80 460 230 3995 60	21 560 16 516 50 11 60 80 80 80 630 315 440 60	23 540 16 516 50 11 60 7 20 95 80 605 625 305 440 60	28 480 16 466 50 10 60 20 60 80 580 280 280 435 60	31 430 16 466 50 10 60 9 20 65 80 535 555 270 425 60 1860	35 430 16 416 50 9 60 8 8 20 70 80 515 535 260 420 60	

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CONA CMI SP

reinforcement – Centre spacing and edge distance Square plate dimensions **ETA-09/0287** of 19.09.2018

CONA CMI SP



Stressing and fixed anch	orage	e/c	oupl	ler			Ce	entre	e spa	acin	g an	d ec	lge	dista	ance	;			
	<u> </u>	a _e = b _e =			e co	ver	- Pe					2	be bo						
BBR VT CONA CMI SP				37	06					42	06					43	06		
Strand arrangement))			(00000 00000000000000000000000000000000)	
Nominal diameter 15.7 mm .	Nom	inal c	ross-	7-wir sectio	e pre nal a	stres rea 1	sing s 50 mr	steel : n²	stran Maxir	d num d	chara	cteris	tic ter	isile s	treng	th 18	60 MF	Pa ¹⁾	
						Ter	don												
Cross-sectional area A	mm ²			55	50	. 01				63	800					64	50		
Char. value of maximum force F_{pl}	-				323						718					-	997		
Char. value of 0.1 % proof force $F_{p0.7}$					02						332						578		
Max. prestressing force $0.90 \cdot F_{p0.2}$	kN			81	92					92	99			-		95	520		
Maximum overstressing $0.95 \cdot F_{p0.7}$	kN				647						315			-			049		
Minimum concrete strength / I Minimum concrete strength Cube f _{cm, 0, cube, 150}			tional 28	reint	force 38	ment 43	/ Cer 46	ntre s 26	pacin 28	g and 34	d edg 38	e dis 43	tance 46	26 / Sq	uare 28	plate 34	dime 38	nsior 43	15 46
Cylinder f _{cm, 0, cylinder, Ø 150}		21	23	28	31	35	38	21	23	28	31	35	38	21	23	28	31	35	38
Helix, ribbed reinforcing steel, R		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	-	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	mm	70	70	70	70	70	70	75	75	75	75	75	75	75	75	75	75	75	75
Additional reinforcement, ribbed		orcino	, stee	l, R.	≥ 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 distand	e																		
Minimum centre spacing a _c , b _c		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 _{SF}	mm	480	480	480	480	480	480	510	510	510	510	510	510	520	520	520	520	520	520
Thickness T _{SF}		70	70	70	70	70	70	75	75	75	75	75	75	75	75	75	75	75	75
 Prestressing steel strand with nomin also be used. The square plate dimensions are mi 											n chara	acteris	tic ten	sile st	rength	below	1860	MPaı	nay

Internal Post-tensioning System

Annex 25

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

CONA CMI SP

Page 53 of European Technical Assessment ETA-09/0287 of 19.09.2018,
eplaces European technical approval ETA-09/0287
vith validity from 30.06.2013 to 29.06.2018



Stressing and fixed ancho	orage	e / c	oup	ler			Ce	entre	spa	acing	g an	d ec	dge (dista	ance				
	a _e = a' _e + c b _e = b' _e + c c Concrete co																		
BBR VT CONA CMI SP				48	06					55	06					61	06		
Strand arrangement			(
Nominal diameter 15.7 mm	. Nom	iinal c						steel s n²			charao	cterist	tic ten	isile s	trengt	h 18	60 MF	'a 1)	
						Ten	don												-
Cross-sectional area A _p	mm ²			72	200					82	50					91	50		
Char. value of maximum force F_{pk}	kN				392						345						019		-
Char. value of 0.1 % proof force Fp0.1	kN			118	808					13	530					15	006		
Max. prestressing force $0.90 \cdot F_{p0.1}$	kN			100	627					12	177					13	505		
Maximum overstressing $0.95 \cdot F_{p0.1}$	kN			112	218					128	354					14	256		
Minimum concrete strength / H Minimum concrete strength				1		r													
Cube f _{cm, 0, cube, 150}			28 23	34 28	38 31	43 35	46 38	26 21	28 23	34 28	38 31	43 35	46 38	26 21	28	34	38 31	43 35	46 38
Cylinder f _{cm, 0, cylinder, Ø 150}				20	51	35	30	21	23	20	31	30	30	21	23	28	51	35	30
Helix, ribbed reinforcing steel, Re Outer diameter		720	720	720	720	720	720	790	790	790	790	790	790	860	860	860	860	860	860
Bar diameter	mm mm	20	20	20	20	20	20	790 25	25	790 25	790 25	790 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	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			stee	I, Re	_ ≥ 500										. 1				-
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
$Minimum \ outer \ dimensions B \times B$	mm	810	810	810	810	810	810	885	885	885	885	885	885	940	940	940	940	940	940
Centre spacing and edge distanc	е																		
Minimum centre spacing a _c , b _c	mm	830	830	830	830		830	905	905	905		905		960	960	960	960	960	960
Minimum edge distance a' _e , b' _e	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}		550	550	550	550	550	550		595	595	595	595		620	620	620	620	620	620
Thickness T _{SP}		80	80	80	80	80	80	90	90	90	90	90	90	90	90	90	90	90	90
 ¹⁾ Prestressing steel strand with nomina also be used. ²⁾ The square plate dimensions are min 											n chara	acteris	tic ten	sile sti	ength	below	1860	MPa r	nay
	Int	orna		oct t	long	ion	ina	Sve	tom										

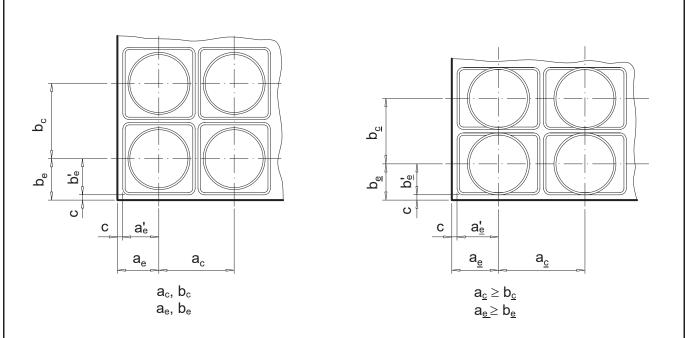
Internal Post-tensioning System

Annex 26

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



Centre spacing and edge distance



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

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

$$\begin{array}{lll} \mathbf{a}_{\underline{c}} & \geq \frac{\mathbf{A}_{c}}{\mathbf{b}_{\underline{c}}} \\ \\ \mathbf{A}_{c} & = \mathbf{a}_{c} \cdot \mathbf{b}_{c} & \leq & \mathbf{a}_{\underline{c}} \cdot \mathbf{b}_{\underline{c}} \end{array}$$

Corresponding edge distances

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

c..... Concrete cover

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



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Modification of centre spacing and edge distance

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1) Preparatory work

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

2) Anchorage recesses

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

3) Fastening the square plates

Four holes are provided to fasten the square plates to the formwork. The helix is either welded to the square plate by means of radial bars, see also Clause 2.2.4.6, or positioned by fastening it to the existing reinforcement.

4) Placing of the sheaths

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

The same applies for prefabricated tendons.

5) Installation of tensile elements (prestressing steel)

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

6) Installation of the inaccessible fixed anchorages

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

7) Installation of fixed coupler anchor head 2.BA

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

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

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

8) Assembly of movable coupler

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

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

9) Checking the tendons before concreting

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



Internal Post-tensioning System Description of installation Annex 28



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

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

11) Prestressing

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

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

Restressing the tendons is allowed in accordance with Clause 2.2.4.3.

12) Grouting the tendons

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

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

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



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Seven-wire	strands	accordin	g to prEN 1	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	Ap	mm²	140	140	150	150
Nominal mass per metre	М	kg/m	1.0)93	1.1	72
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, $L_0 \ge 500 \text{ mm}$	A _{gt}	%		3	.5	
Modulus of elasticity	Ep	MPa		195 ()00 ³⁾	

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

³⁾ Standard value



Prestressing steel strand specifications

Annex 30



Contents of the prescribed test plan

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

¹⁾ Checking by means of at least a test report 2.2 according to EN 10204.

 $^{\mbox{\tiny 2)}}$ Conformity with the specifications of the component

3) Successful visual inspection does not need to be documented.

- 4) Checking by means of an inspection report 3.1 according to EN 10204.
- 5) Checking of relevant certificate as long as the basis of "CE"-marking is not available.
- ⁶⁾ Maximum between a coil and 7 tons is taken into account

7) Checking of relevant certificate, CE marking and declaration of performance or, if basis for CE marking is not available, certificate of supplier

- Traceability full Full traceability of each component to its raw material.
 - Defined according to technical specification deposited by the supplier

Material Detailed dimension Measuring of all the dimensions and angles according to the specification given in the test plan Main dimensions, correct marking and labelling, surface, corrosion, coating, etc. Visual inspection Treatment, hardness Surface hardness, core hardness and treatment depth



Internal Post-tensioning System

Contents of the prescribed test plan

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Audit testing

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

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

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

³⁾ Conformity with the specifications of the components

Material Defined according to technical specification deposited by the ETA holder at the Notified body

Detailed dimension Measuring of all the dimensions and angles according to the specification given in the test plan

Visual inspectionMain dimensions, correct marking and labelling, surface, corrosion, coating, etc.Treatment, hardnessSurface hardness, core hardness and treatment depth



Internal Post-tensioning System Audit testing



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

Key

+.....Essential characteristic relevant for the intended use

-------Essential characteristic not relevant for the intended use

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



Internal Post-tensioning System

Essential characteristics for the intended uses

Annex 33



Reference documents European Assessment Documents EAD 160004-00-0301 Post-Tensioning Kits for Prestressing of Structures EAD 160027-00-0301 Special filling products for post-tensioning kits **Eurocodes** Eurocode 2 Eurocode 2: Design of concrete structures Eurocode 3 Eurocode 3: Design of steel structures Eurocode 6 Eurocode 6: Design of masonry structures Standards Concrete – Specification, performance, production and conformity EN 206+A1, 11.2016 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 Steel strip sheaths for prestressing tendons - Terminology, EN 523, 08.2003 requirements, quality control Hot rolled products of structural steels – Part 2: Technical delivery EN 10025-2, 11.2004 conditions for non-alloy structural steels EN 10025-2/AC, 06.2005 EN 10083-1, 08.2006 Steels for quenching and tempering – Part 1: General technical delivery conditions Steels for guenching and tempering – Part 2: Technical delivery EN 10083-2, 08.2006 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 Hot finished structural hollow sections of non-alloy and fine grain EN 10210-1, 04.2006 steels – Part 1: Technical delivery conditions EN 10216-1, 12.2013 Seamless steel tubes for pressure purposes – Technical delivery conditions - Part 1: Non-alloy steel tubes with specified room temperature properties EN 10217-1, 05.2002 Welded steel tubes for pressure purposes - Technical delivery conditions - Part 1: Non-alloy steel tubes with specified room EN 10217-1/A1, 01.2005 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



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EN 10277-2, 03.2008	Bright steel products – Technical delivery conditions – Part 2: Steels for general engineering purposes
EN 10305-5, 01.2010	Steel tubes for precision applications – Technical delivery conditions – Part 5: Welded cold sized square and rectangular tubes
EN ISO 17855-1, 10.2014	Plastics – Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specifications
EN ISO 19069-1, 03.2015	Plastics – Polypropylene (PP) moulding and extrusion materials – Part 1: Designation system and basis for specifications
prEN 10138-3, 09.2000	Prestressing steels – Part 3: Strand
prEN 10138-3, 08.2009	Prestressing steels – Part 3: Strand
CWA 14646, 01.2003	Requirements for the installation of post-tensioning kits for prestressing of structures and qualification of the specialist company and its personnel
98/456/EC	Commission decision 98/456/EC of 3 July 1998 on the procedure for attesting the conformity of construction products pursuant to Article 20 (2) of Council Directive 89/106/EEC as regards posttensioning kits for the prestressing of structures, Official Journal of the European Communities L 201 of 17 July 1998, p. 112
305/2011	Regulation (EU) № 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 88 of 4 April 2011, p. 5, amended by Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, OJ L 157 of 27.05.2014, p. 76 and Commission Delegated Regulation (EU) № 574/2014 of 21 February 2014, OJ L 159 of 28.05.2014, p. 41
568/2014	Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014 amending Annex V to Regulation (EU) № 305/2011 of the European Parliament and of the Council as regards the assessment and verification of constancy of performance of construction products, OJ L 157 of 27.05.2014, p. 76



Annex 35





Materialprüfungsamt Nordrhein-Westfalen

Prüfen · Überwachen · Zertifizieren

Certificate of constancy of performance 0432-CPR-00299-1.5 (EN)

Version 02

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

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

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

placed on the market under the name or trade mark of

BBR VT International Ltd

Ringstr. 2

CH-8603 Schwerzenbach / Schweiz / Switzerland

and produced in the manufacturing plant(s)

BBR VT International Ltd

Ringstr. 2

CH-8603 Schwerzenbach / Schweiz

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

ETA-09/0287, issued on 19.09.2018

and

EAD 160004-00-0301

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

constancy of performance of the construction product.

This certificate was first issued on 30.07.2010 and will remain valid until 11.10.2028 as long as neither the ETA, the EAD, the construction product, the AVCP methods nor the manufacturing conditions in the plant are modified significantly, unless suspended or withdrawn by the notified product certification body.

Dortmund, 12.10.2023	by order Dipl. Hng. Becker Head of Certification Body (Dep. 21)
This Certificate consists of 1 page.	Morarhein-We ⁸
This Certificate replaces the Certificate no. 0432-CPR-0 dated 21.09.2018, Version 01.	0299-1.5
The original of this document was issued in German lang In case of doubt only the German version is valid.	

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