MK4 | Innovative Solutions

FORTEC

Post-Tensioning Slabs

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1. Introduction

The Post-Tensioning Slabs for the building industry have been used with success in many countries since the 70's. Nonetheless, in spite of being a tested technique with a high number of finished Jobs and very common in many countries, it has a reduced acceptance in others where it is reserved exclusively to single buildings.

Nowadays, the cast in-situ construction of slabs using post-tensioning systems, is an alternative that should be seriously considered. The increasing cost of materials, construction equipment, labor and transport demands the maximum optimization of resources. It also involves the use of high quality techniques, save material costs and are fast in execution.

The Post-Tensioning method lightens the structure, allows the reduction of slab thickness and allows to release the formwork in record time and it even guaranties a higher durability.

MeKano4 System for Post-Tensioning Slabs

MeKano4, the international company, designs, produces and installs Post-Tensioning System created specially for buildings, which have been used in projects as varied as:

- Office Buildings
- Hospitals
- Hotels
- Housing
- Schools
- Theaters
- Churches
- Sport centers
- Parking lots
- Silos
- Slabs on ground
- Setting tanks

The Mekano4 System for Post – Tensioning slabs is characterized basically by the following:

- Preliminary study of reinforcement, strand and concrete quantities and slab thickness.
- Supply of Post-Tensioning materials according to the European assessment document and national standards.
- Possibilities to offer design of the slab.
- Technical assistance during the design phase and during the execution Works.
- Wide range of live ends, dead ends and couplers.
- Use of bonded and unbonded tendons with metallic or plastic, ducts and grease fill with wax or grout.
- Light equipment of unitary stressing jacks with automatic wedge setting.
- Special designs for Jobs and singular details.
- Supply specialized technicians and equipment for the Post-Tensioning Works.

2. Slab Post-tensioning Tendons

Strand Properties

STRAND GRADE 1860 Pa LOW RELAXATION ACCORDING TO EN10138-3 EURO NORM

NOMINAL DIAMETER (mm)	NOMINAL AREA (mm^2)	NOMINAL MASS (g/m)	MINIMUM BREAKING LOAD Fpk (kN)	F YIELD (kN)	STRESSING LOAD (1) F (kN)
12,5	93	726	173	149	123
12,7	100	781	186	160	139
15,2	140	1.095	260	224	195
15,7	150	1.172	279	240	209

Note(1) 75% Fpk according to EURO NORM
Note(2): All types of strand can be supplied for bonded and unbonded tendons.

Tendon Properties

UNBONDED		ANCHORANGES	STRAND Ø 15,7 mm. Y 1860 S 7		
Type	Nº of Strands	Live Ends	Stressing Force Fo (kN)	Nominal Area Ap (mm2)	Nominal Mass (Kg/m)
1/0,6"	1	MUNB 1/06”	209	150	1,3
2/0,6"	2	WWS2/0,6” UNB	418	300	2,6
3/0,6"	3	WWS3/0,6” UNB	627	450	3,9
4/0,6"	4	WWS4/0,6” UNB	836	600	5,2

BONDED 0,6”		ANCHORANGES	STRAND Ø 15,7 mm. Y 1860 S 7		
Type	Nº of Strands	Live Ends	Stressing Force Fo (kN)	Nominal Area Ap (mm2)	Nominal Mass (Kg/m)
1/0,6”	1	MADH 0,6”	209	150	1,3
2/0,6”	2	WW2/0,6”	419	300	2,3
3/0,6”	3	WW3/0,6”	628	450	3,5
4/0,6”	4	WW4/0,6”	837	600	4,7
5/0,6”	5	ML/0,6” AW	1.047	750	5,9

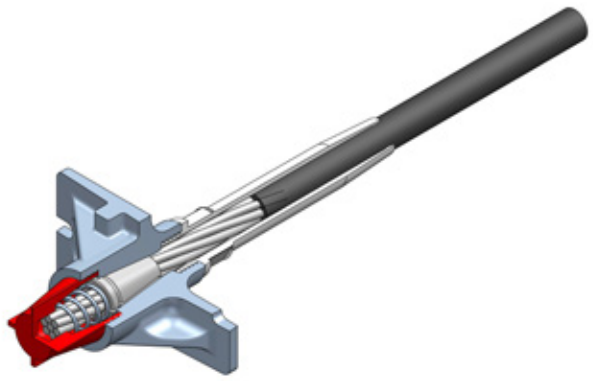
BONDED 0,5”		ANCHORANGES	STRAND Ø 12,7 mm. Y 1860 S 7		
Type	Nº of Strands	Live Ends	Stressing Force Fo (kN)	Nominal Area Ap (mm2)	Nominal Mass (Kg/m)
3/05”	3	WW3/05”	419	300	2,3
4/05”	4	WW4/05”	558	400	3,1
5/05”	5	WW5/05”	698	500	3,9

FRICTION RATES		μ (rad^{-1})	k (rad/m)
Bonded Tendons	Rate Usual Calculation Rate	0.14 - 0.19 0.14	0.005 - 0.010 0.010
Unbonded Tendons	Rate Usual Calculation Rate	0,05 - 0,07 0,07	0,0003 - 0,0007 0,0007

3. Post-tensioning slab with mono strand anchorage

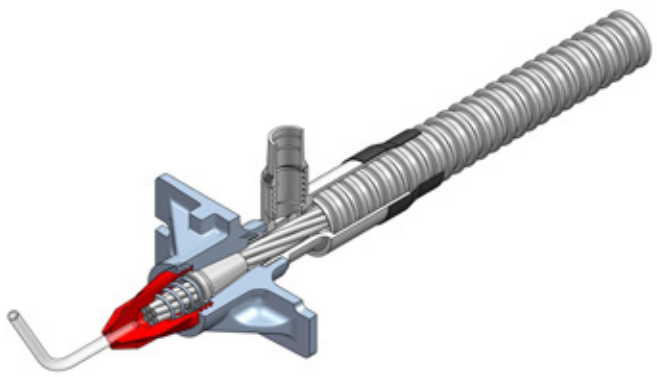
Unbonded Anchorage MUNB 1/0,6”

The MK4 unbonded mono-strand system uses 15,2 mm or 15,7 mm (0,6” - 0,62”) diameter strand and a live end anchorage MUNB 1/0.6” which can also be used as a passive anchorage by incorporating a seal cap and a spring. The strands feature a factory applied corrosion protection system consisting of grease encasement in a polyethylene sheath.



Bonded Anchorage MADM 0,6”

For every day more used bonded solution in building slab’s, MK4 offers two possible options for the unitary anchorage: the Bonded Anchorage MADH 0,6”. For this system the inhibition of the corrosion is achieved by the injection of the grouting.

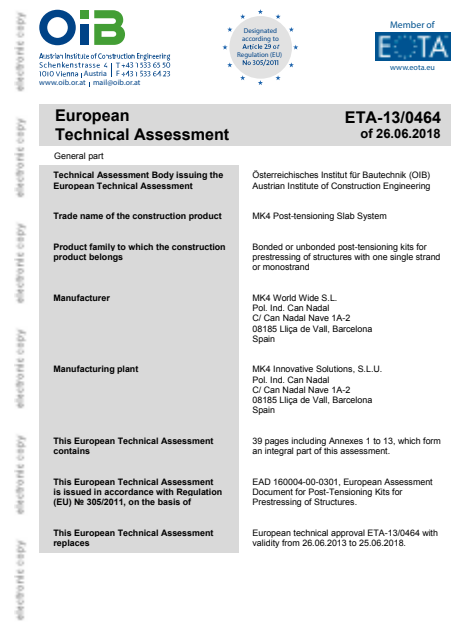


Encapsulated unbonded anchorage 1/0,6”

To ensure maximum durability for post-tension structures MK4 has developed an encapsulation system to protect the tendons from water and any other corrosions agents. Our encapsulated anchorages are protected with an external layer of plastic keeping the openings for the stressing jack.

• On the tendon side, there is a plastic transition piece that threads with the back of the anchor encapsulation. This plastic transition is watertight and is designed to have no voids where water might accumulate.

• On the stressing side, after the stressing of the wedge, a cap filled with grease is threaded too to assure the total encapsulation. .



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Designated according to Article 29 of Regulation (EU) No 305/2011

Member of EOTA
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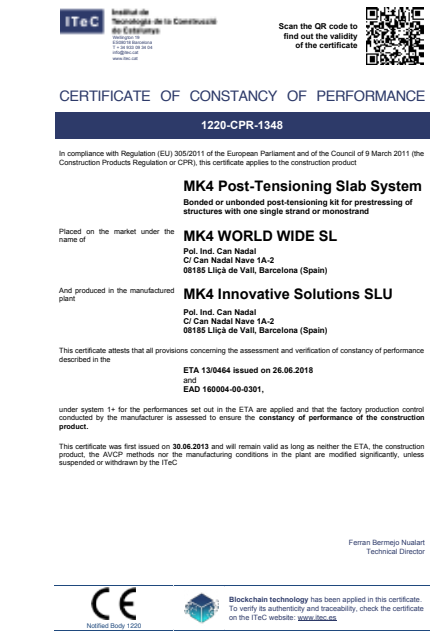
European Technical Assessment **ETA-13/0464 of 26.06.2018**

General part

Technical Assessment Body issuing the European Technical Assessment	Österreichisches Institut für Bautechnik (OIB) Austrian Institute of Construction Engineering
Trade name of the construction product	MK4 Post-tensioning Slab System
Product family to which the construction product belongs	Bonded or unbonded post-tensioning kits for prestressing of structures with one single strand or monostrand
Manufacturer	MK4 World Wide S.L. Pol. Ind. Can Nadal C/ Can Nadal Nave 1A-2 08185 Lliça de Vall, Barcelona Spain
Manufacturing plant	MK4 Innovative Solutions, S.L.U. Pol. Ind. Can Nadal C/ Can Nadal Nave 1A-2 08185 Lliça de Vall, Barcelona Spain
This European Technical Assessment contains	39 pages including Annexes 1 to 13, which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with Regulation (EU) № 305/2011, on the basis of	EAD 160004-00-0301, European Assessment Document for Post-Tensioning Kits for Prestressing of Structures.
This European Technical Assessment replaces	European technical approval ETA-13/0464 with validity from 26.06.2013 to 25.06.2018.



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Scan the QR code to find out the validity of the certificate

CERTIFICATE OF CONSTANCY OF PERFORMANCE

1220-CPR-1348

In compliance with Regulation (EU) 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

MK4 Post-Tensioning Slab System
Bonded or unbonded post-tensioning kit for prestressing of structures with one single strand or monostrand

Placed on the market under the name of
MK4 WORLD WIDE SL
Pol. Ind. Can Nadal
C/ Can Nadal Nave 1A-2
08185 Lliçà de Vall, Barcelona (Spain)

And produced in the manufactured plant
MK4 Innovative Solutions SLU
Pol. Ind. Can Nadal
C/ Can Nadal Nave 1A-2
08185 Lliçà de Vall, Barcelona (Spain)

This certificate attests that all provisions concerning the assessment and verification of constancy of performance described in the
ETA 13/0464 issued on 26.06.2018
and
EAD 160004-00-0301,

under system 1+ for the performances 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.**

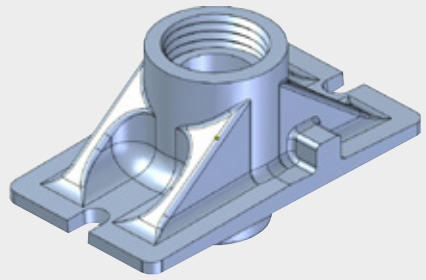
This certificate was first issued on **30.06.2013** and will remain valid as long as neither the ETA, the construction product, the AVCP methods nor the manufacturing conditions in the plant are modified significantly, unless suspended or withdrawn by the ITeC

Ferran Bermejo Nualart
Technical Director

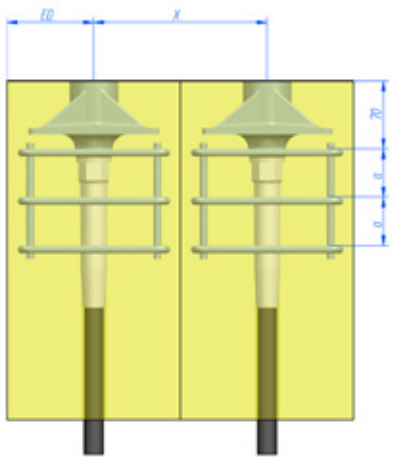
CE Notified Body 1220

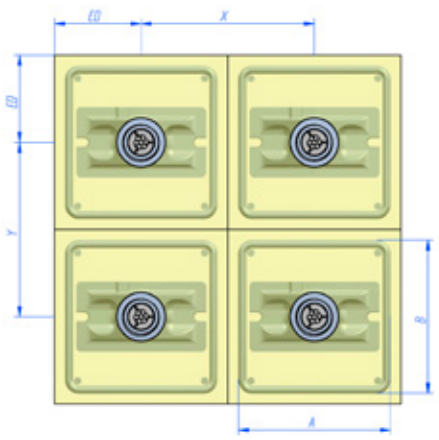
Blockchain technology has been applied in this certificate. To verify its authenticity and traceability, check the certificate on the ITeC website: www.itec.es

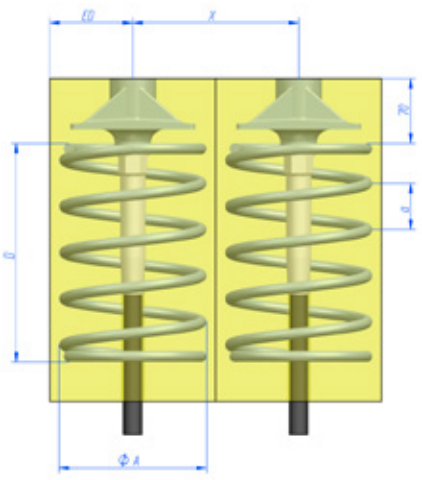
4. Anchorage zone reinforcement (stir-rubs & spiral)

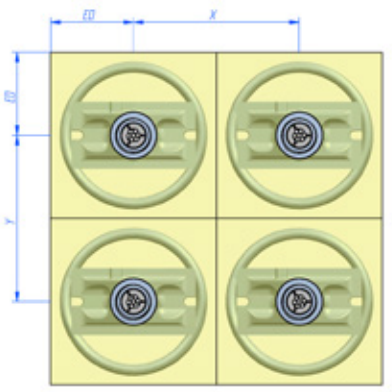
MINIMUN CONCRETE STRENGTH, ADDITIONAL REINFORCEMENT, DETAILS ON DIMENSIONS						
Tendon		1/0.6”				
Number of strands	n	1				
Anchorage						
MUNB 0,6” and MADH 0,6”	C	135				
	C’	72,5				
	h	79				
MINIMUM CONCRETRE STRENGTH AT TIME OF STRESSING, CYLINDER / CUBE						
ADDITIONAL REINFORCEMENT		STIRRUPS		SPIRALS		
Minimum concretre strength in MPa	$f_{cm},0$	25/20	30/25	25/20	30/25	
CENTRE SPACING AND EDGE DISTANCE						
Centre spacing	X	180	155	180	155	
Centre spacing	Y	180	135	145	145	
Edge distance [1]	ED	ED = CD/2+concrete cover -10				
Ribbed reinforcing steel, Re > 500 Mpa						
Bar Diameter	Æ	8	8	8	8	
Outer dimensions	A - Æ A	160	135	160	135	
	B	160	115	-	-	
Number of stirrups	n	3	4	-	-	
Spacing	a	50	60	50	45	
Number of pitches	n	-	-	5	4	
Length Spiral	D	-	-	230	163	

1) Values of edge distance are based on a concrete cover 30 mm.
For different concrete covers the edges distance is calculated to:
ED = CD / 2 + concrete cover= 10 mm









5. Post Tensioning slab with flat anchorage.

MK4 has developed an innovative Post-Tensioning anchorage, specifically for flat slabs. This new anchorage system is called Wedge Wedge System, its acronyms are: WWS and can be used for bonded and unbonded tendons.

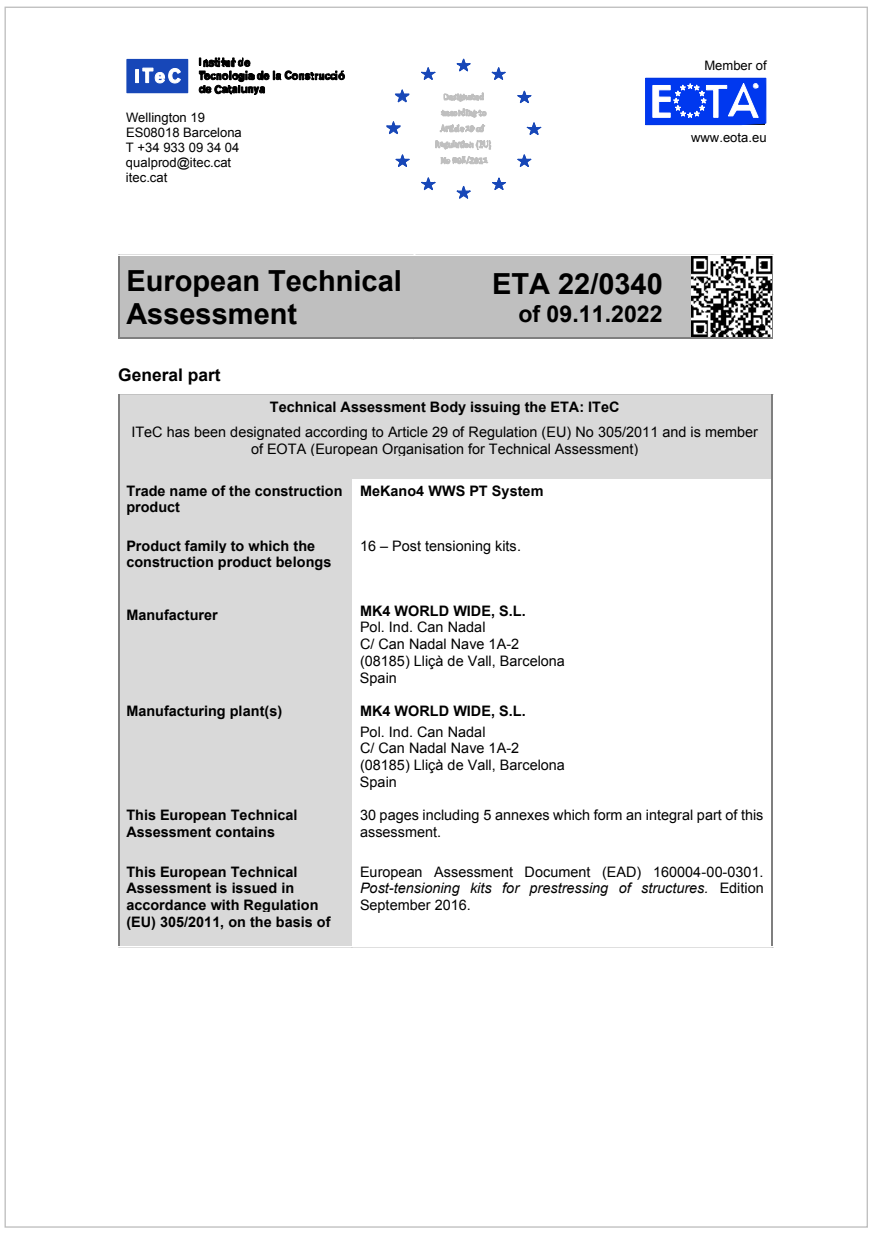
The denomination of different types is WWS n-.di, where n is number of strands and di it is the nominal diameter of the strands in inches.

We have the following types:

WWS 2-.62 | WWS 3-.62 | WWS 4-.62 | WWS 2-.60 | WWS 3-.60 | WWS 4-.60 | WWS 3-.51 | WWS4-.51 | WWS 5-.51 | WWS 3-0.49 | WWS 4-0.49 | WWS 5-0.49 |

Our target is to provide better solutions to the requirements of the post tensioning flats slabs, with the innovation geometry of a new flat anchorage Wedge Wedge System.

MK4 is an ISO 9001:2015 Certification registered Company and our Systems comply with the requirements: EAD 160004-00-0301 EAD 160027-00-0301 and UK CARE Certification. This anchorage system, WWS is designed under Nationals (CE) & International standards.



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European Technical Assessment **ETA 22/0340 of 09.11.2022**

General part

Technical Assessment Body issuing the ETA: ITeC ITeC has been designated according to Article 29 of Regulation (EU) No 305/2011 and is member of EOTA (European Organisation for Technical Assessment)	
Trade name of the construction product	**MeKano4 WWS PT System**
Product family to which the construction product belongs	16 – Post tensioning kits.
Manufacturer	**MK4 WORLD WIDE, S.L.** Pol. Ind. Can Nadal C/ Can Nadal Nave 1A-2 (08185) Lliçà de Vall, Barcelona Spain
Manufacturing plant(s)	**MK4 WORLD WIDE, S.L.** Pol. Ind. Can Nadal C/ Can Nadal Nave 1A-2 (08185) Lliçà de Vall, Barcelona Spain
This European Technical Assessment contains	30 pages including 5 annexes which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with Regulation (EU) 305/2011, on the basis of	European Assessment Document (EAD) 160004-00-0301. *Post-tensioning kits for prestressing of structures*. Edition September 2016.

6. The innovative WWS n-di Systems.

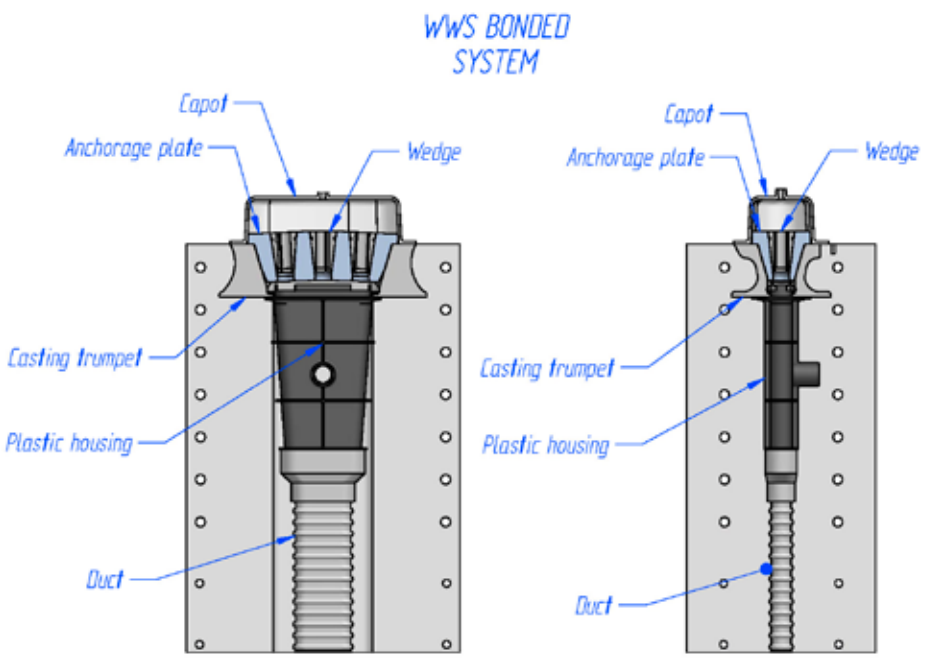
The components of new flat anchorage system, Wedge Wedge System, are:

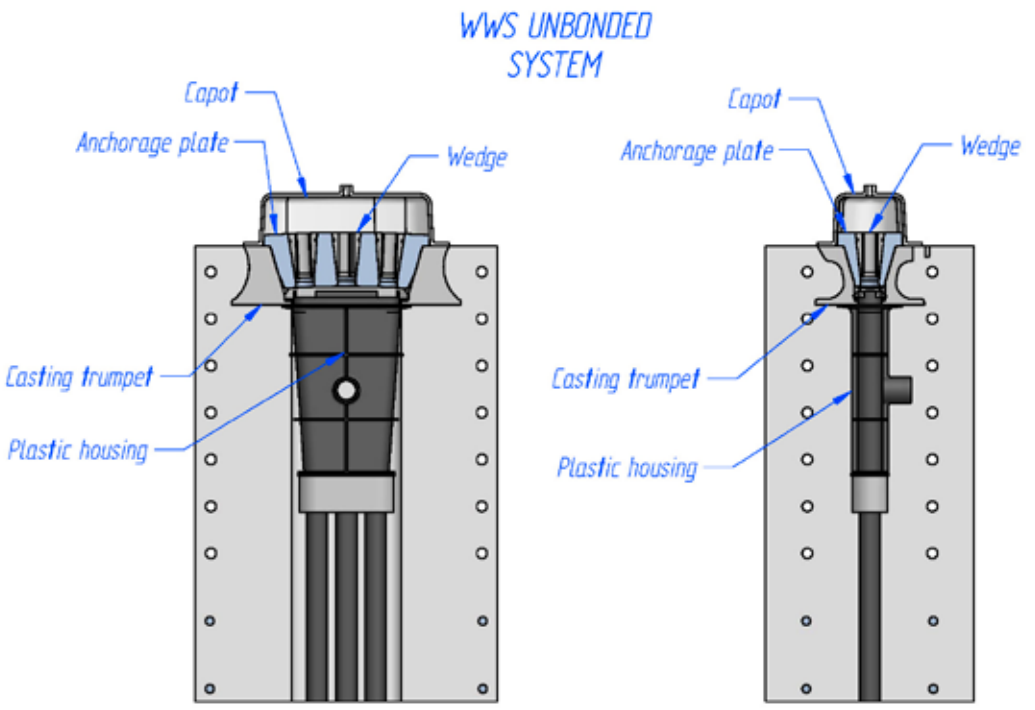
→ **Wedges**
→ **Anchor Head**
→ **Bearing Plate**
→ **Plastic housing (Plastic deviation cone)**
→ **Duct (in the bonded and unbonded)**
→ **Transition Thimble (unbonded)**

Where the anchor head is embedded inside the bearing plate, like a big wedge, thus becoming all one piece (Anchor head/ bearing plate).

Therefore it forms a monolithic working system of the whole, where the strand, anchor head and wedges assembly are like a double wedge (Wedge-Wedge).

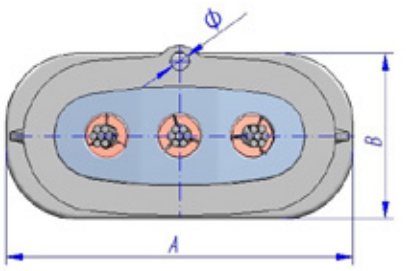
The mechanical behavior of this anchorage system, is like a single block, thus offering the advantages of a more compact efficient system and at the same time the practicality of assembling a set of components. Thus facilitating the installation in the job site.

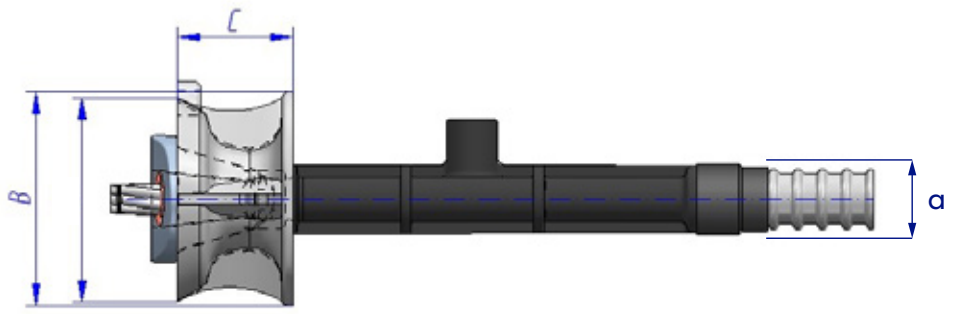


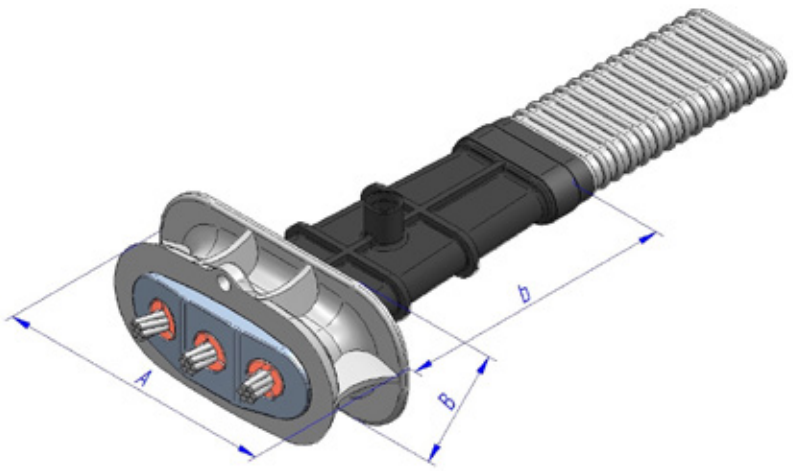


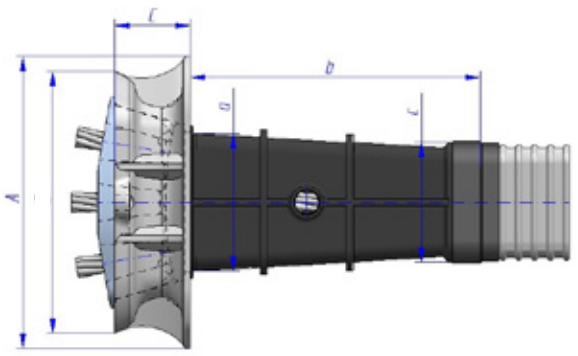
7. General Denomination

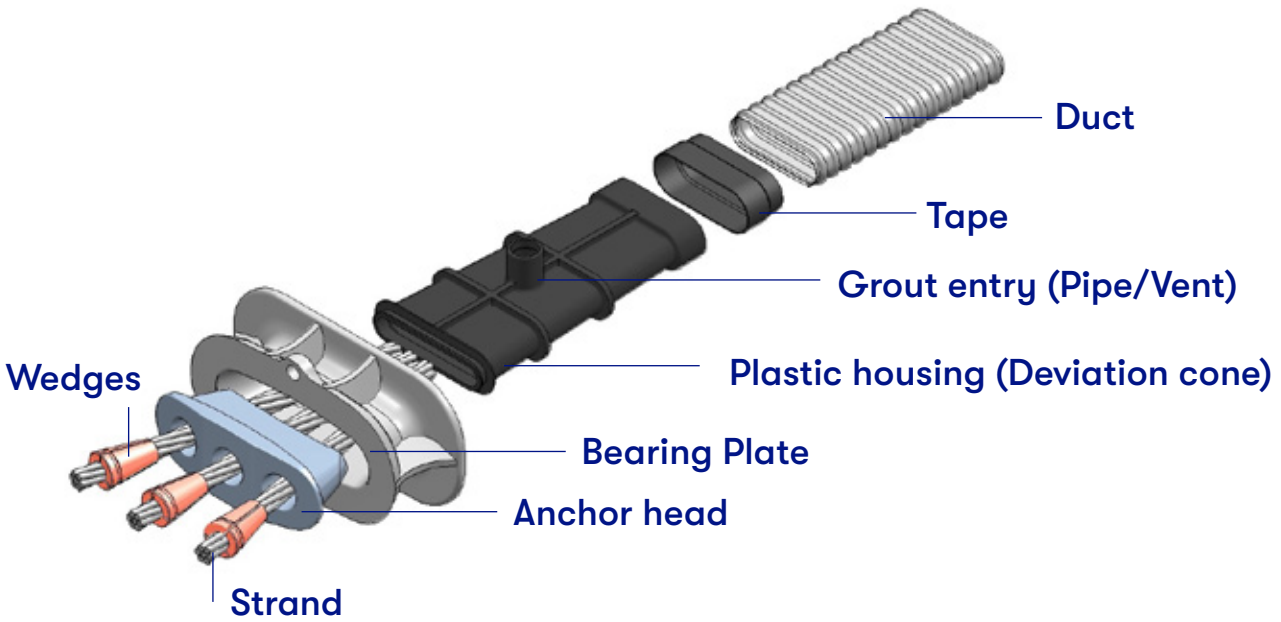
General Denomination						Dimension mm					
						Casting Trumpet			Plastic Housing		
Strand Size	Anchorage Type	Tendon Type	N° Strand	Casting Trumpet	Plastic Housing	A	B	C	a	b	c
12,7 / 12,9 mm (0,5”)	WWWS 3-50	30.5”	3	T050	A050	170	95	49	30	150	69
	WWWS 4-50	40.5”	4	T080	A080	220	105	56	30	200	86
	WWWS 5-50	50.5”	5	T112	A112	260	110	57	30	250	98
15,2 / 15,7 mm (0,6”)	WWWS 2-62	20.6”	2	T050	A050	170	95	50	30	150	69
	WWWS 3-62	30.6”	3	T080	A080	220	105	56	30	200	86
	WWWS 4-62	40.6”	4	T112	A112	260	110	58	30	250	98





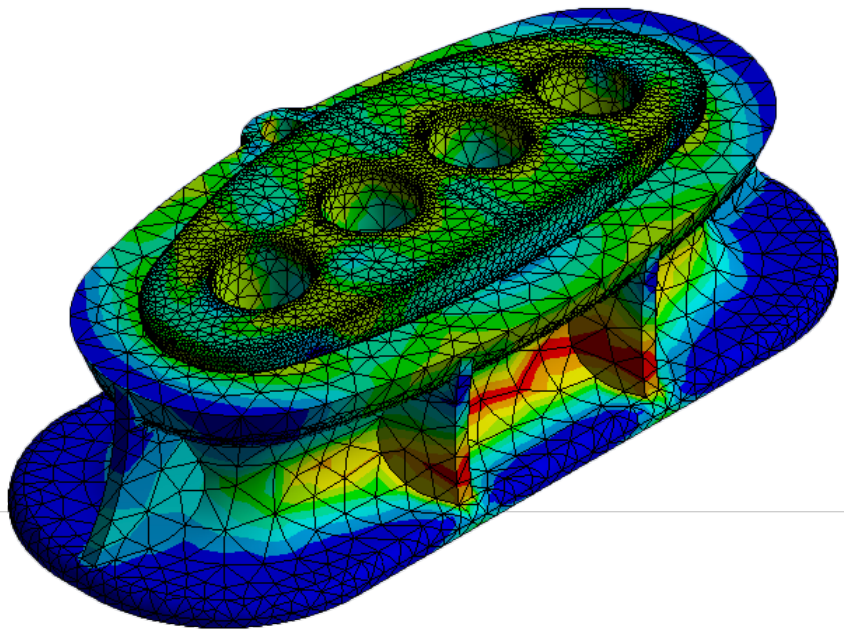


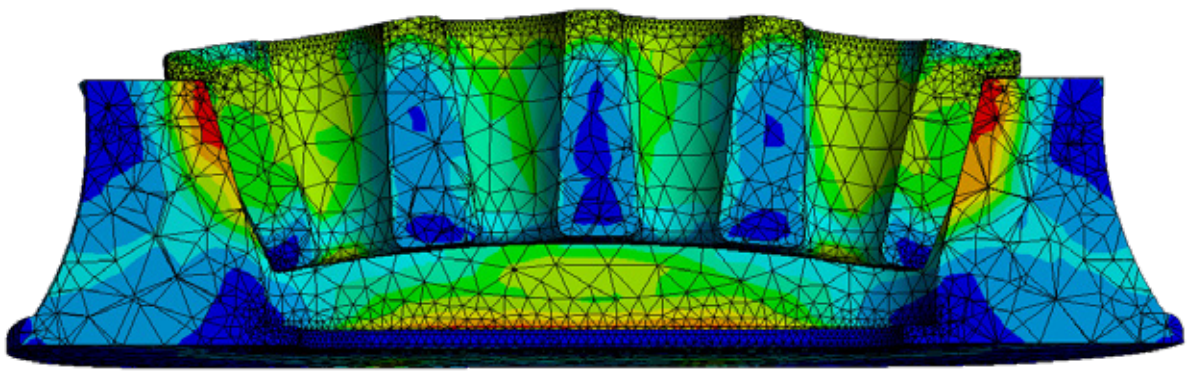




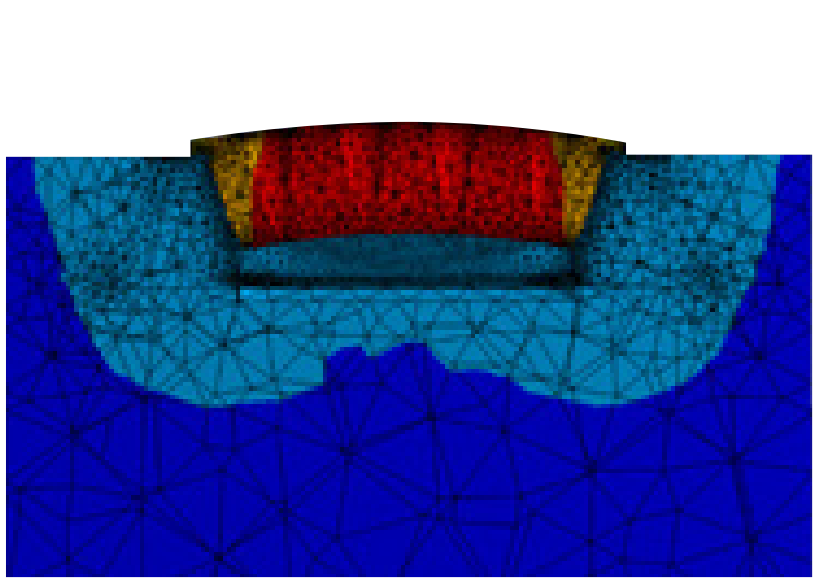
8. 3D FEM
(Finite element modeling)

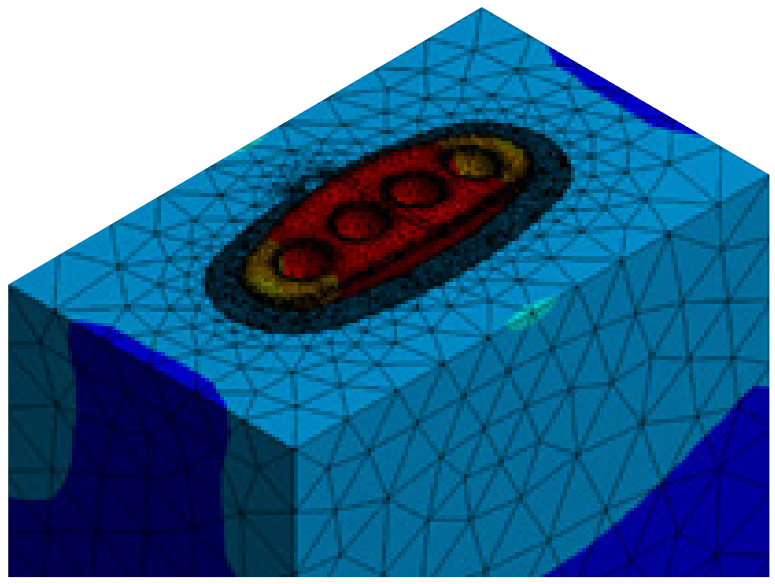
Anchorage plate Trumpet interaction
Ultimate Load on the anchorage.



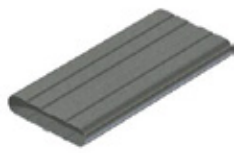
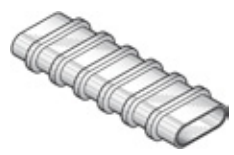


Model of the load distribution between concete and anchorage





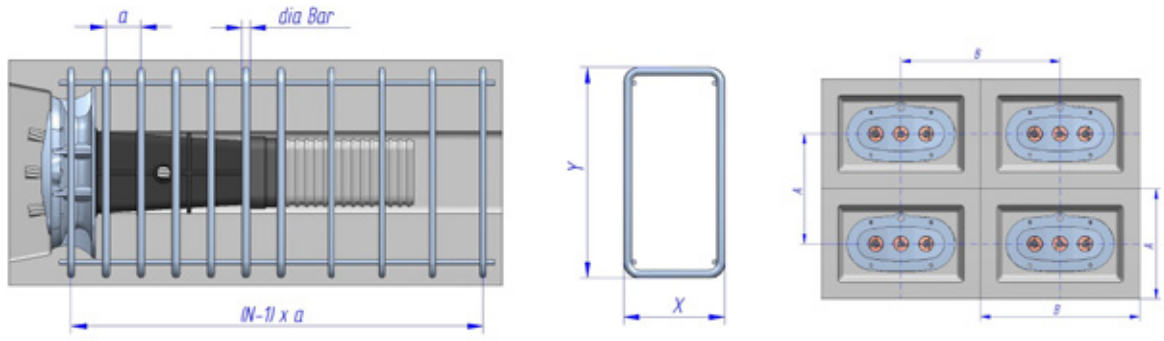
9. Flat Ducts for bonded tendons

TYPE			
T050	21x45	19x43	26x49
T080	21x58	19x70	26x77
T112	21x70	19x70	26x77

10. Anchorage zone reinforcement

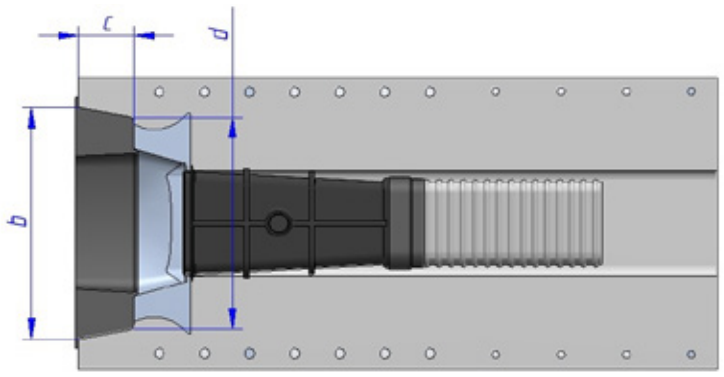
Type of concrete C 30/37 [MPa]							
Type of trumpet	Anchorage Spacing		Reinforcement dimension				
	A	B	X	Y	N	a	φ
T050	160	200	140	180	6	50	8
T080	180	280	160	260	7	55	10
T112	200	330	180	310	8	60	12
Type of concrete C 25/30 [MPa]							
T050	160	210	140	190	6	40	8
T080	180	290	160	270	8	45	10
T112	200	360	180	340	10	55	12
Type of concrete C 20/25 [MPa]							
T050	160	220	140	200	8	30	8
T080	180	310	170	290	9	35	10
T112	200	380	180	360	13	45	12

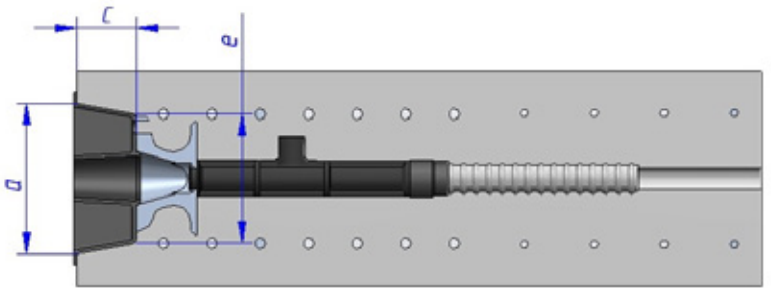
The flat slabs system requires anti-bursting reinforcement to ensure the forces generated during stressing are confined. A and B are minimum distance all dimension in mm.
For values of fcm,o between C 30/37 and C 20/25, A and B can be determined by straight line interpolation.

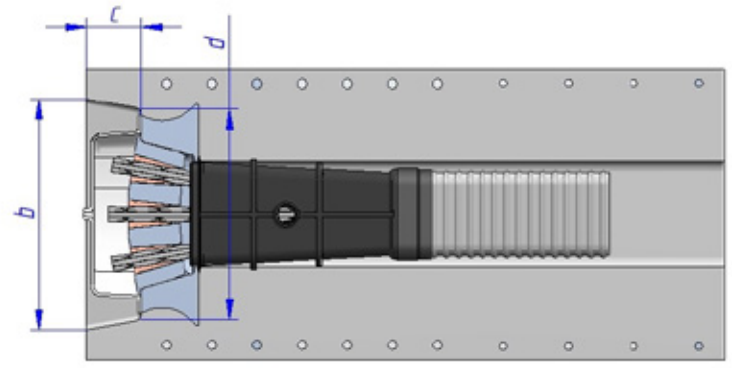


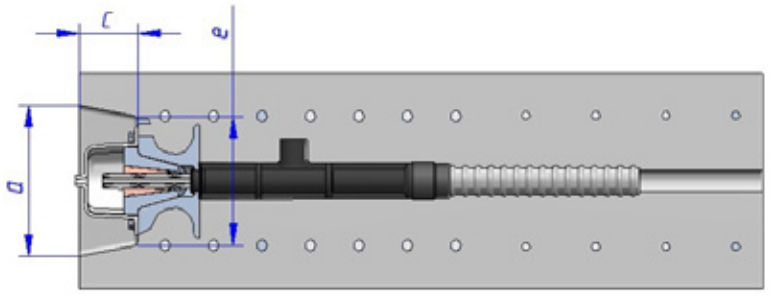
11. Dimensions of Pocket Former

Type of trumpet	Dimensions Pocket Former				
in mm	a	b	c	d	e
T050	200	125	72	180	165
T080	250	140	72	230	120
T112	290	150	72	270	130









12. Conceptual Post-tensioning Designs

POST-TENSIONING SLAB - ONE WAY SLAB

Sector Type (1) - Corner with same Spans

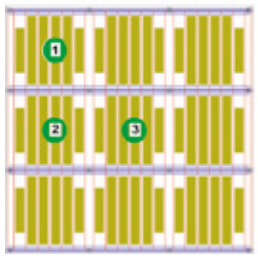
SPAN	LOAD: SW + 5 kN/m²			LOAD: SW + 10 kN/m²			LOAD: SW + 20 kN/m²		
(m)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)
5	20	7,0	2,4	25	9,0	3,5	30	12,0	4,7
7	25	8,0	2,4	30	11,0	3,5	35	13,0	4,7
10	30	9,0	3,5	35	12,0	4,7	40	14,0	5,9
13	35	11,0	4,7	40	13,0	5,9	45	15,0	7,1
15	40	15,0	5,9	45	16,0	7,1	50	18,0	7,1

Sector Type (2) and (3) – Edge and Center with same Spans

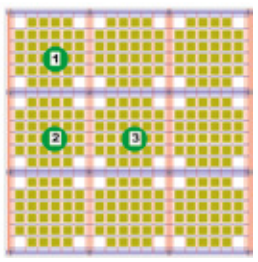
SPAN	LOAD: SW + 5 kN/m²			LOAD: SW + 10 kN/m²			LOAD: SW + 20 kN/m²		
(m)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)
5	15	7,0	2,4	20	9,0	3,5	25	11,0	4,7
8	20	8,0	2,4	25	11,0	3,5	30	12,0	4,7
10	25	9,0	3,5	30	12,0	4,7	35	13,0	5,9
13	30	10,0	4,7	35	12,0	5,9	40	15,0	7,1
15	35	14,0	5,9	40	15,0	7,1	45	17,0	7,1

Note: In the chart of the one way slab the reinforcement of the beams is not included

One Way



Two Ways



POST-TENSIONING SLAB - TWO WAY SLABS

Sector Type (1) - Corner with same Spans

SPAN	LOAD: SW + 5 kN/m²			LOAD: SW + 10 kN/m²			LOAD: SW + 20 kN/m²		
(m)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)
5	18	10,0	4,8	24	13,0	7,0	29	14,0	9,4
8	24	13,0	4,8	28	16,0	7,0	33	16,0	9,4
10	28	16,0	7,0	32	19,0	9,4	37	19,0	11,8
13	32	19,0	9,4	36	21,0	11,8	41	22,0	14,2
15	36	22,0	11,8	40	24,0	14,2	45	25,0	14,2

Sector Type (2) - Edge with same Spans

SPAN	LOAD: SW + 5 kN/m²			LOAD: SW + 10 kN/m²			LOAD: SW + 20 kN/m²		
(m)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)
5	17	10,0	4,8	20	13,0	7,0	23	14,0	9,4
8	22	12,0	4,8	24	15,0	7,0	27	15,0	9,4
10	26	15,0	7,0	28	18,0	9,4	31	18,0	11,8
13	30	18,0	9,4	33	20,0	11,8	38	21,0	14,2
15	34	21,0	11,8	37	23,0	14,2	42	24,0	14,2

Sector Type (3) - Center with same Spans

SPAN	LOAD: SW + 5 kN/m²			LOAD: SW + 10 kN/m²			LOAD: SW + 20 kN/m²		
(m)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)	Thickness (cm)	Reinforcement (Kg/m²)	PT Stands (Kg/m²)
5	16	10,0	4,8	19	12,0	7,0	21	12,0	9,4
8	20	11,0	4,8	22	14,0	7,0	25	14,0	9,4
10	25	14,0	7,0	26	17,0	9,4	29	17,0	11,8
13	29	17,0	9,4	31	19,0	11,8	35	20,0	14,2
15	32	20,0	11,8	35	22,0	14,2	40	23,0	14,2

Note: The quantities on all these charts are intended to give an approximate range of the amounts.
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