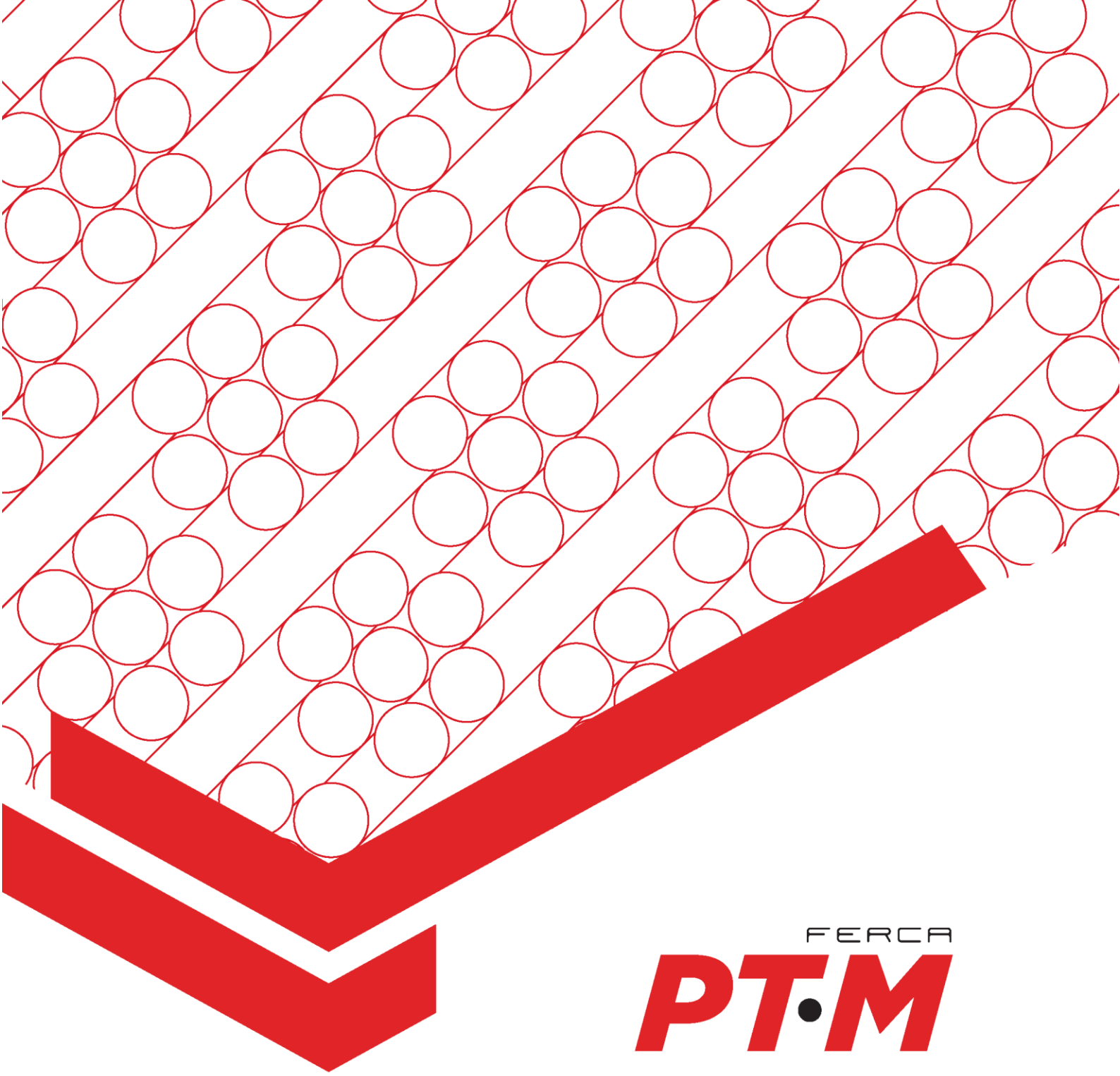


FERCA PT·M

PTM TECHNICAL MANUAL

RSF – Post-Tension Systems for Slabs

FERCA

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Technical Manual – PTM System – *Post-Tensioning System for RSF Slabs*

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INTRODUCTION TO THE PTM - RSF SYSTEM

The RSF Rudloff StrongForce International system was developed to create an integrated range of prestressing solutions for bridges and civil structures, geotechnical works and buildings, positioning the system as a key player in a highly demanding and competitive international market. Built on intensive research and experience in producing anchorages and specialised construction equipment, and backed by a group with a strong background in the steel sector, RSF Rudloff StrongForce International today operates in areas such as:

- Prestressing for bridges and civil structures;
- Prestressing for buildings;
- Geotechnical ground consolidation systems;
- Hydraulic equipment for pulling, pushing, injection or production lines;
- Bearings and expansion joints for bridges;
- Industrial floor slabs.

With an experienced technical department dedicated to the design and production of the system's various components and accessories, its own manufacturing and testing facilities, and a wide range of equipment, anchorages and accessories, the RSF SLAB PT system stands as a complete solution to meet market requirements.



The RSF RUDLOFF STRONGFORCE system is certified by the European Organisation for Technical Assessment (EOTA) under certificate ETA 22/0120 (European Technical Assessment), covering unbonded monostrand prestressing and bonded flat anchorages for 2/3/4/5 strands, guaranteeing its quality and suitability for use in the widest range of situations and configurations.

The RSF Slab Post-tensioning System holds Certificate of Constancy of Performance No. 1220-CPR-2252, issued under Regulation (EU) 305/2011.

This "Procedures Manual", produced by FERCA, is intended to complement the information contained in the system's certifications, providing greater clarity for those involved at design or construction stage regarding the system's composition, the procedures for each application phase, the production structure, and the risks associated with each activity — while also enabling closer oversight of the entire production process, from the application design through to our final activity reports.

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WHO IS RSF?

RSF (Rudloff StrongForce International) is the result of a strategic joint venture between Brazil's Rudloff Industrial and Australia's StrongForce, with the resulting company operating under the name Rudloff StrongForce International LLC, headquartered in Dubai, United Arab Emirates. Rudloff Industrial was founded in São Paulo, Brazil, in 1960 — although its founder had already produced Brazil's first prestressed beam back in 1954 — and over more than six decades has specialised in post-tensioning and the manufacture of structural systems and components. StrongForce, for its part, was founded in 1989 in Queensland, Australia, and has spent more than thirty years designing and building post-tensioning solutions and structural strengthening systems. This union gave rise to RSF, a company specialising in the study, design and production of anchorage systems and equipment for on-site installation, continually growing its knowledge base through ongoing investment in the sector. Serving clients since 1965, RSF now operates in more than 60 countries across all six continents, with over 600 civil engineering structures, more than 850 wind turbine towers and more than 26 million square metres of building works completed — giving it a strong presence in both its home markets and internationally.



RSF SYSTEMS

RSF's multistrand post-tensioning systems, designed for bridges, viaducts and large structures, hold European Technical Assessment ETA 22/0119, under which they carry CE marking in accordance with the ETAG 013 guideline and its corresponding EAD. The RSF Multistrand system is an internal bonded, internal unbonded or external post-tensioning system with 4 to 37 strands, available in 0.5″ and 0.6″ strand sizes, and comprising active anchorages (AN), passive anchorages (PS) and couplers (CO). It is designed for bridge box girders and beams (precast or cast in situ), piers and transition tables, building beams, as well as containment structures such as tanks, reservoirs and silos.

RSF's post-tensioning systems for slabs and floors — the RSF Slab system — are designed for monostrand use in bonded or unbonded systems and hold European Technical Assessment ETA 22/0120, covering configurations of 1 to 5 strands. RSF offers unbonded monostrand in 0.5″ and 0.6″, and encapsulated monostrand anchorages, which bring full corrosion protection to the market.

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In short, the company's goal has been to offer its clients more effective, durable and sustainable products, backed by European-certified systems (EOTA) and compliant with the leading international codes and standards applicable to building, civil infrastructure and geotechnical projects.





In the field of systems for geotechnical works, RSF offers strand and bar ground anchor systems for temporary and permanent applications, used to stabilise infrastructure and improve ground conditions. RSF's ground anchor systems comply with European standard EN 1537 ("Execution of special geotechnical work – Ground anchors"). The company distinguishes between soil anchors and rock anchors, covering applications ranging from excavation support (sheet-pile walls, diaphragm walls, concrete retaining walls) to resisting uplift forces, as well as stabilising eccentric foundations, natural or excavated slopes, dams and bridge foundations, and anchoring wind turbine towers. In rock anchors, the free length can remain unbonded, allowing the anchor to be checked and re-tensioned at any time, provided adequate corrosion protection is maintained for the anchor head and the free length.



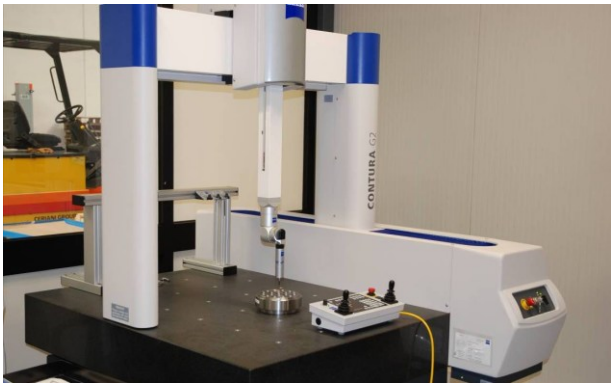
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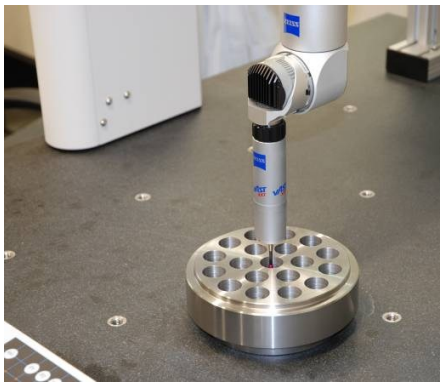
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RSF QUALITY

A product can be understood as the sum of the processes, resources and knowledge behind it, so its quality level is intrinsically linked to the organisation's excellence across every aspect and to the investment directed at pursuing these goals.

Achieving a high level of quality in its products and services is now central to the company's strategy: RSF operates under ISO 9001 (quality), ISO 14001 (environment) and ISO 45001 (occupational health and safety) certifications, and Rudloff has implemented an Integrated Management System certified to ISO 9001. The company applies rigorous quality control procedures (QA/QC) and maintains an ongoing commitment to high manufacturing standards.







RUDLOFF
STRONGFORCE

In addition, whenever required, RSF provides OEM services, manufacturing products to clients' exact specifications, and makes available a qualified technical team of engineers and specialists who provide support throughout the entire supply chain — including equipment maintenance and after-sales technical support — ensuring the quality standard demanded of every part produced.

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WHY USE POST-TENSIONING

Over the last decade, architecture has taken on a central role in real-estate investment, driving many of the features that set projects apart and representing a key factor in their success. This shift is rooted in society itself, which today values not only the comfort and functionality of space but also the image and social standing they convey. This change in paradigm has brought a profound shift in how structures are designed: enabling the architect's creative vision now often carries more weight than strictly technical-economic criteria. By making slender, daring structures possible, prestressing fits today's demands perfectly, and its use in buildings has become increasingly common — a trend expected to keep growing.

The use of prestressing systems also significantly improves a structure's quality across the board — not only in construction processes, but also in durability and performance.



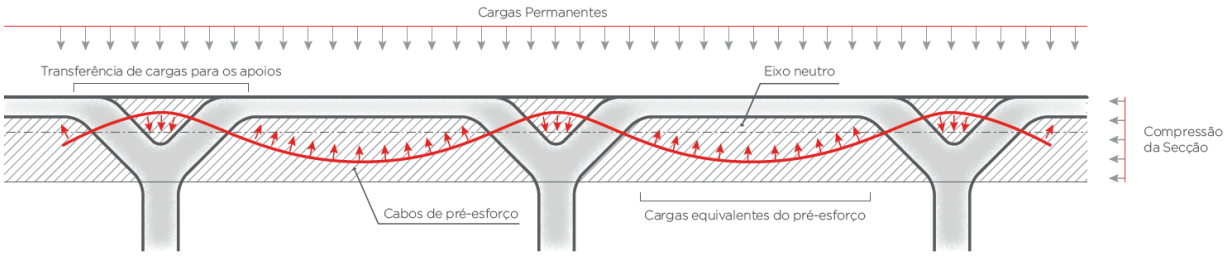
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PRINCIPLES

Originally developed to achieve large spans in bridges and civil structures, prestressing systems — later applied to buildings — represent an innovation in structural design by introducing an active element within the structural members.

Made up of high-strength steel strands, prestressing tendons are installed inside the slab and fixed at their ends in anchorages, then stressed using hydraulic equipment developed for the purpose. Thanks to their curvature in both elevation and plan, once stressed, the tendons impose balancing loads on the slab section that counteract the effects of gravity loads. The equivalent loads created in this way partially balance the design loads and generate an overall compression in the slab section, allowing for reduced passive reinforcement, the elimination of joints, and a greater contribution from the concrete section to the slab's overall strength.



SYSTEMS

Prestressing systems are essentially classified according to their bond with the concrete and are therefore referred to as bonded or unbonded systems; within each of these, we can further distinguish between monostrand and multistrand applications.

In unbonded systems, the steel is supplied inside a plastic sheath with no subsequent grouting, whereas in bonded systems the steel strand is fed into a duct that is later filled with cement grout, giving it full bond with the surrounding concrete section.

In terms of use, unbonded monostrand systems are typically the most common choice for slender elements such as building slabs, while bonded multistrand systems are more commonly used in bridges and, more generally, larger structural elements.

Self-sheathed monostrand is an unbonded system commonly used in buildings, where each prestressing tendon consists of a single strand encased in a polyethylene sheath filled with a lubricating compound. This system allows for greater eccentricities, lower friction losses and more flexible tendon layouts.

Multistrand with a flat or circular duct is a bonded system in which the prestressing tendon is made up of several uncoated strands fed into a metal duct, which is later filled with a suitable cement grout. This system allows the full strength of the prestressing steel to be mobilized at the Ultimate Limit State.

The PTM-RSF SLAB PT system uses both the RSF-MT4 bonded flat-duct system and the RSF-MO unbonded system.

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ADVANTAGES

The advantages of using prestressing systems span structural considerations — spans, slenderness and performance — as well as economic and environmental benefits.

Structural Behaviour

- Increased clear spans,
- Fewer columns;
- Reduced structure self-weight;
- Thinner slabs;
- Better control of deflection;
- Improved punching shear resistance;
- Fewer or no joints;
- Improved seismic behaviour;
- Improved shrinkage behaviour;

Economy

- Reduced concrete and steel consumption;
- Savings on vertical elements and foundations;
- Commercial value added by the large open spaces created;
- More parking spaces per m^2;

Sustainability

- Reduced CO_2 emissions;
- Greater efficiency in the use of natural resources.



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STEEL

Prestressing reinforcement consists of 7-wire strands characterised by high strength and low relaxation coefficients. Prestressing steels are generally classified as standard (T15), super (T15S) and compact (T15C), corresponding to cross-sectional areas of 140, 150 and 165 mm² respectively. For further information, refer to European standard EN 10138.

All anchorage systems manufactured by RSF RUDLOFF STRONGFORCE are certified by European Technical Assessment for all three types of steel available on the market.





Diameter	Standard	Steel Type	Nominal Diameter	Nominal Area	Mass	Breaking Force P_{tk}	Elastic Limit at 1% Pt0.1k	Relaxation 1000 h	
			mm	mm²	g/m	kN	kN	%	%
0.6" / T15	EN 10138	Standard	15.2	140	1095	260	230	2.5	4.5
0.6" / T15S	EN 10138	Super	15.7	150	1170	279	248	2.5	4.5
0.6" / T15C	EN 10138	Compact	15.2	165	1290	300	264	2.5	4.5
			Modulus of Elasticity = 195 +/- 10 kN/mm²						

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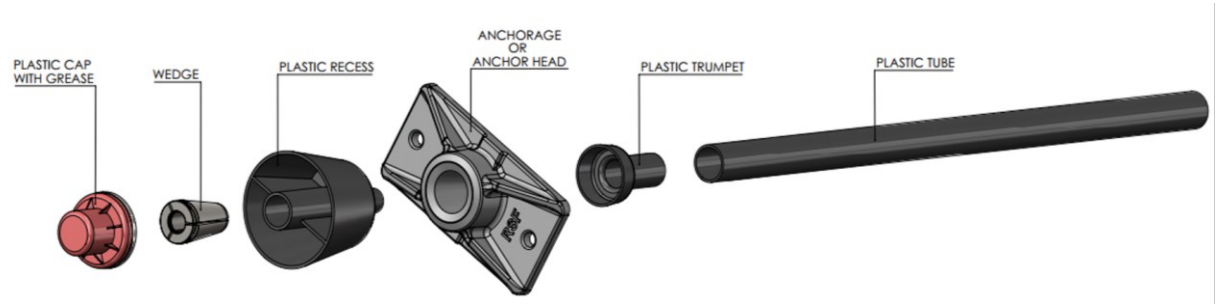
RSF-MO SYSTEM - ANCHORAGES FOR MONOSTRAND TENDONS

RSF RUDLOFF STRONGFORCE tendon anchorages are manufactured for both bonded and unbonded use, and are shipped to site complete with all the accessories needed for installation, with production carried out in accordance with the ETAG 013 Assessment Guideline.

The "MO" tendon anchorage series consists of the following components: an anchor head in C40-45 steel to UNI EN 10083-2, wedges in 16NiCrS4Pb steel to UNI EN 10277-4, and an H.D.P.E. connector to UNI EN ISO 1872-1, linking the anchor head to the strand.

The anchorage is designed for use with T15, T15S and T15C steel classes and is certified under ETA 22/0120 for monostrand systems.

Active anchorages for the unbonded "MO" system are supplied with a connecting tube fitted to the self-sheathed strand at the rear of the anchorage, preventing bond with the steel after concreting, and are designed to accept the formwork element that creates the recess needed for stressing.



Passive anchorages are essentially identical to active anchorages, except that their wedges are pre-seated before the tendons are installed, during the assembly preparation stage. Pre-seating is carried out using hydraulically powered equipment, namely a hydraulic ram and an auxiliary metal table.

The anchorages are designed to secure the steel firmly inside them, as well as to fix them to the formwork panel, ensuring correct positioning throughout every stage of the process.

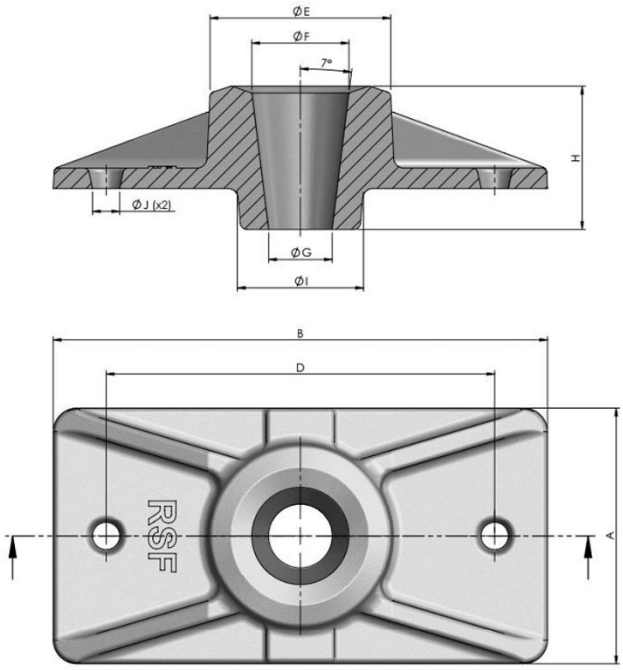
The most common anchorages used for monostrand applications are those designated MO, for both the active and passive ends; this anchorage configuration allows for quick, effective use with an enhanced level of protection against corrosion.

When used in unbonded systems, the "MO" anchorage is supplied with a connecting tube fitted to the self-sheathed strand at the rear, preventing bond with the steel after concreting, together with a cap filled with lubricating grease and a compression spring that allows the wedges to be activated manually, without pre-seating the anchorage.

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ANCHORAGE CONFIGURATION - MO SYSTEM



Dimensions (mm)	1Ø 15.2/15.7
A	75
B	145
D	114
ØE	53
ØF	28.5
ØG	18.7
H	42
ØI	37
ØJ	8

MO anchorage dimensions

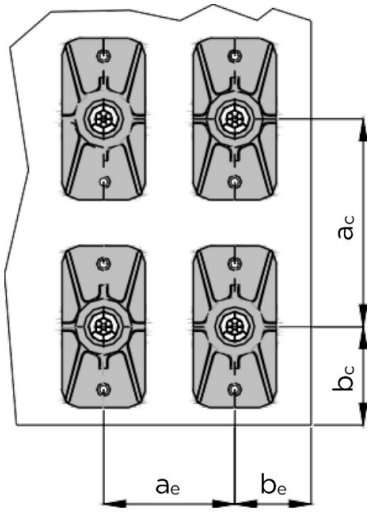
Characteristic Tensile Strength and Prestressing Force of the RSF MO Post-Tensioning System							
Designation	Number of Strands	Nominal Cross-Sectional Area	Nominal Mass	Characteristic Value of Maximum Force	Force at 0.1% of the Conventional Elastic Limit	Maximum Prestressing Force	Maximum Overstressing Force
	n	A_p	M	F_{pk}	Fp 0.1	0.9·Fp 0.1	0.95·Fp 0.1
		mm²	kg/m	kN	kN	kN	kN
1 Ø15.2	1	140	1.126	260	239	215.10	227.05
1 Ø15.7	1	150	1.172	279	246	221.40	233.70

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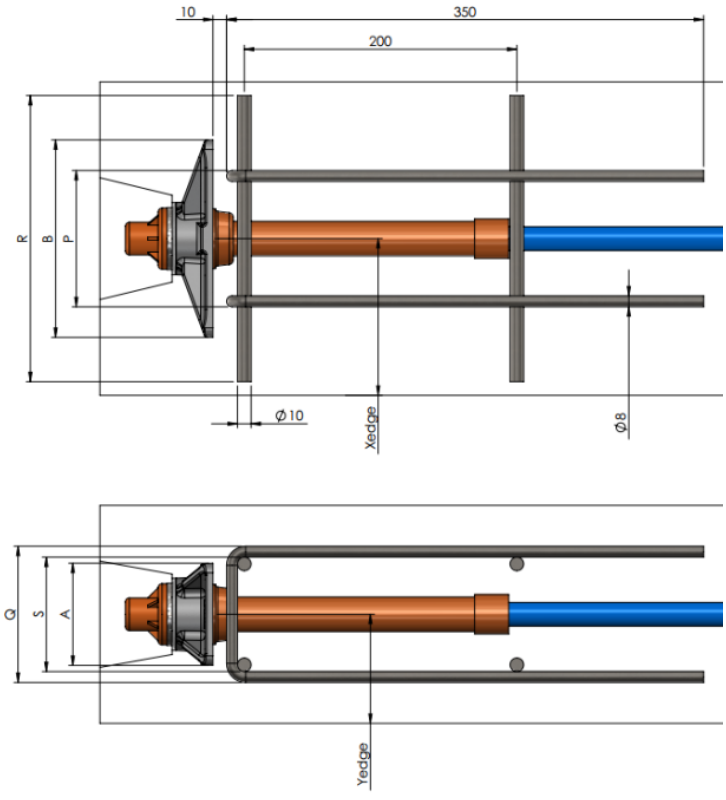
EDGE AND SPACING DISTANCES BETWEEN ANCHORAGES - MO SYSTEM

The dimensions shown refer to C20/25 concrete and may be reduced in accordance with ETA 22/0120.



Between Anchorages	a_c [mm]	196
	a_e [mm]	136

To Edge	b_c [mm]	113
	b_e [mm]	83



Dimensions (mm)	1 Ø15.2 / Ø15.7
A	75
B	145
P	101
Q	100
R	210
S	84

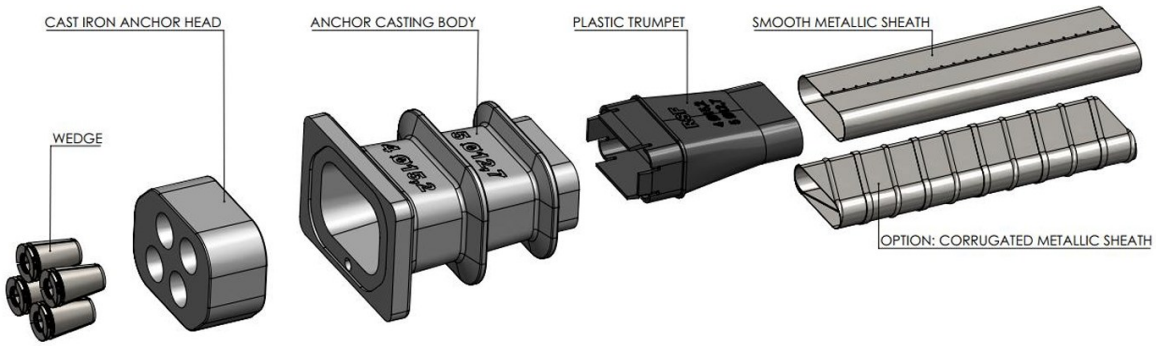
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RSF MT4 SYSTEM - ANCHORAGES FOR FLAT-DUCT TENDONS

RSF RUDLOFF STRONGFORCE's "MT4" system was designed to fully comply with the ETAG 013 guideline and holds European Technical Assessment ETA 22/0120. The system comprises an anchor head, wedges, and metal and plastic trumpets. Finite element simulations combined with laboratory testing enabled the design of a compact anchorage compliant with ETAG 013.

The metal trumpets on the "MT" series anchorages have a flat face for seating the anchor head, connection holes for the grouting cap and formwork, and a corrugated grouting port for fitting the injection tube. They are made of EN-GJS 500-7 EN-JS-1050 steel, giving them high load resistance. They are weldable, ensuring the highest level of safety during installation. The strands are seated in the anchor head, made of C40-45 steel to UNI EN10083/1, fitted with conical holes shaped to match the retaining wedges, which are manufactured from 16NiCr4Pb nickel steel to UNI EN 10277-4.



The connection between the anchorage and the ducts is made using an H.D.P.E. plastic cone, which ensures the correct deviation of the strands and minimises losses. All metal trumpets have threaded holes to allow fixing to the formwork using threaded rod or bolts.

In general, the anchorages are made up of:

1. Three-part wedges
2. Cast iron anchor block
3. Anchor casting body
4. Plastic transition trumpet
5. Accessory elements.

Characteristic Tensile Strength and Prestressing Force of the RSF Post-Tensioning System							
Designation	Number of Strands	Nominal Cross-Sectional Area	Nominal Mass	Characteristic Value of Maximum Force	Force at 0.1% of the Conventional Elastic Limit	Maximum Prestressing Force	Maximum Overstressing Force
	n	A_p	M	F_{pk}	Fp 0.1	0.9·Fp 0.1	0.95·Fp 0.1
		mm²	kg/m	kN	kN	kN	kN
2 Ø15.2	2	280	2.252	532	478	430.20	454.10
2 Ø15.7	2	300	2.344	558	492	442.80	467.40
4 Ø15.2	4	560	4.504	1,064	956	860.40	908.20
4 Ø15.7	4	600	4.688	1,116	984	885.60	934.80

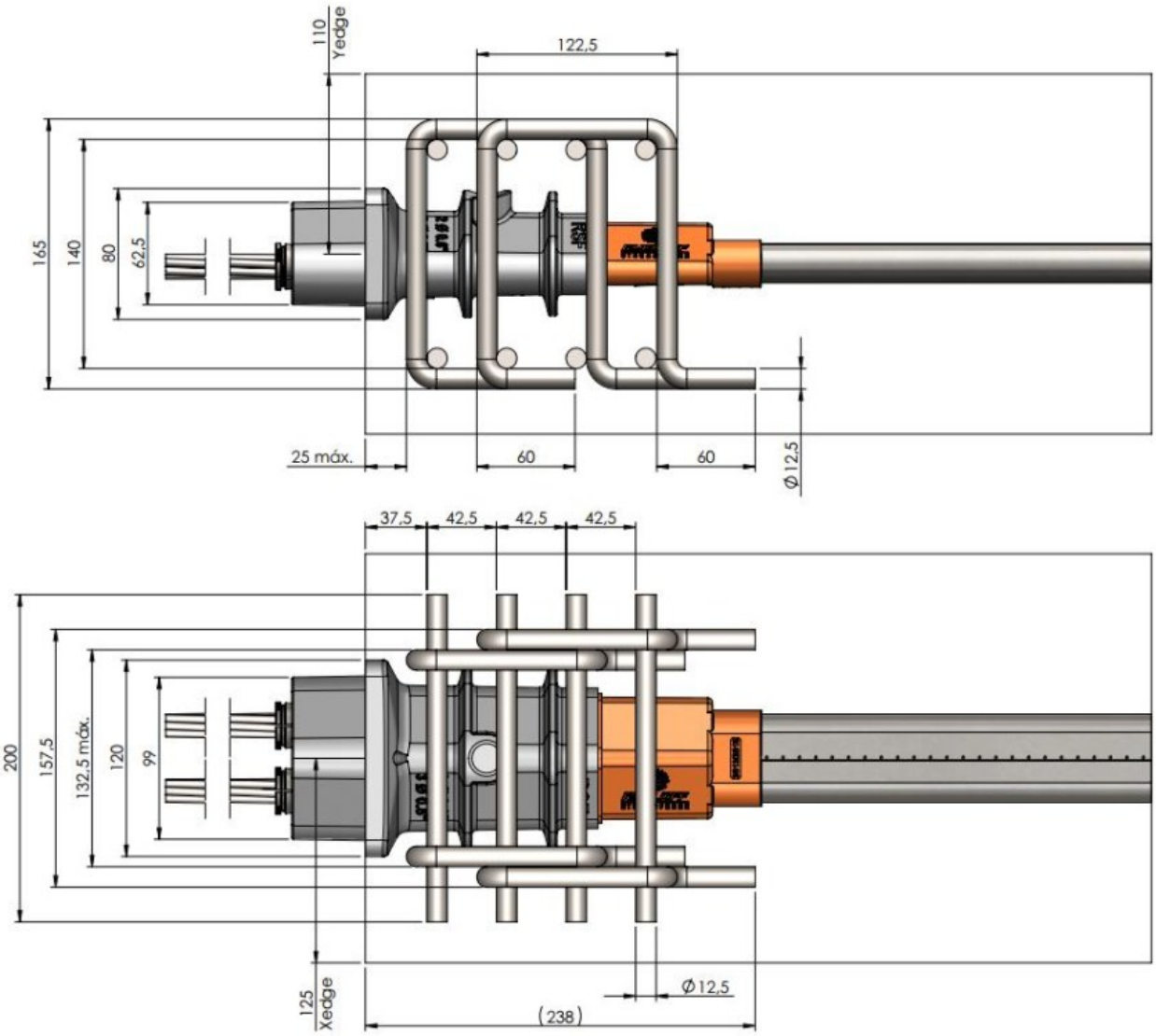
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ANCHORAGE CONFIGURATION - MT SYSTEM

RSF "MT" anchorages have the following dimensions:

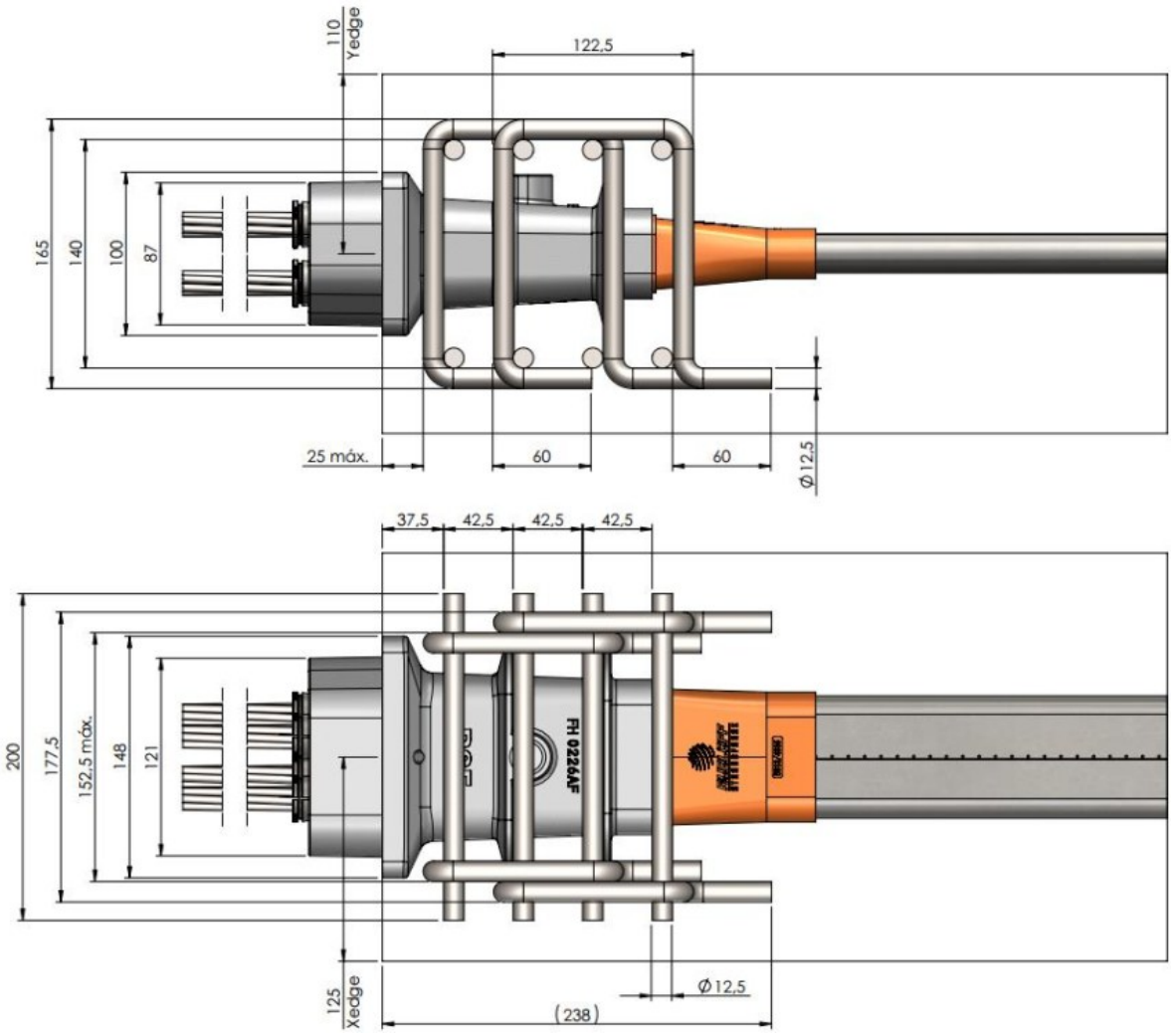
For 2-tendon anchorages:



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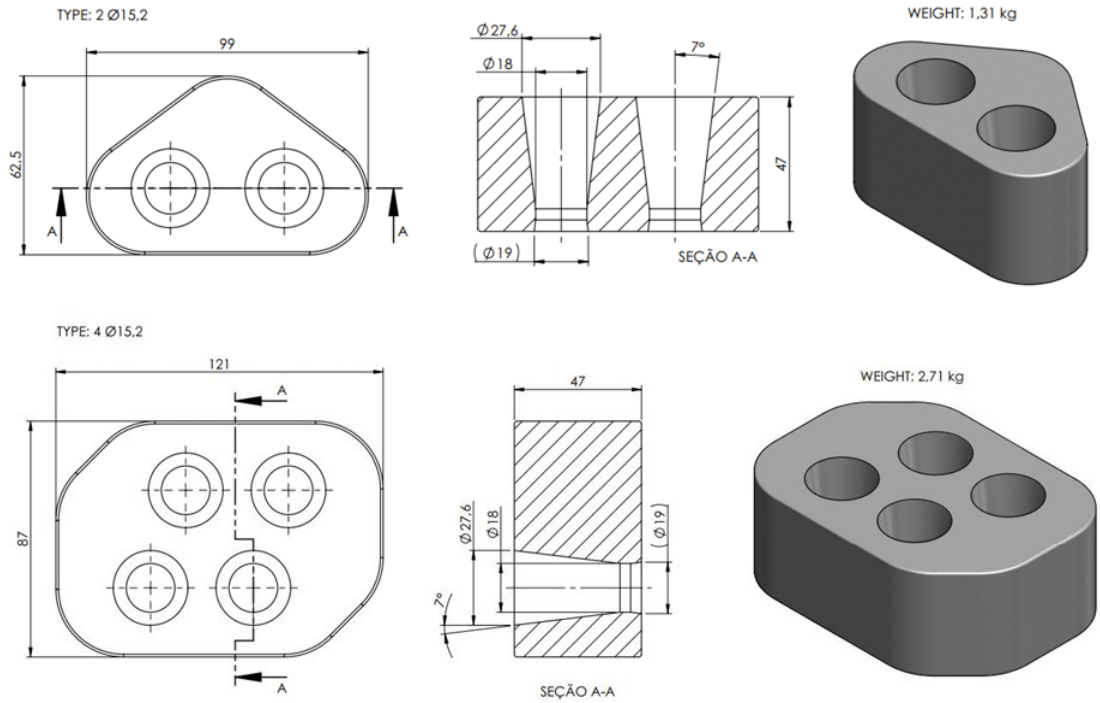
For 4-tendon anchorages:



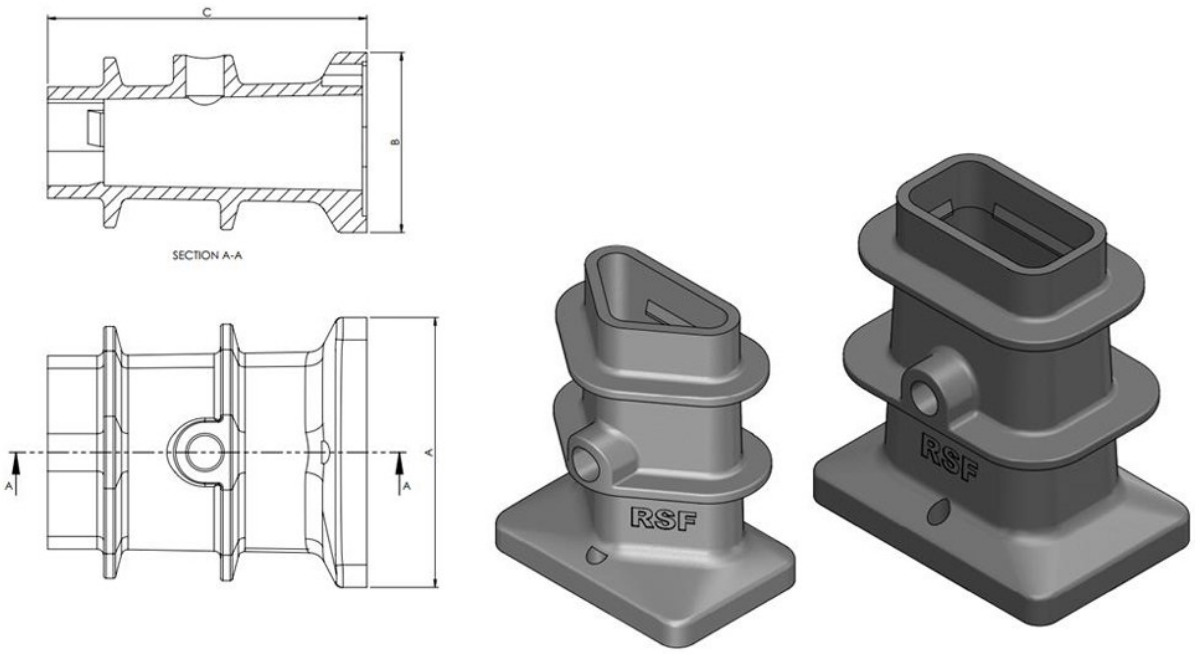
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BEARING PLATES



ANCHOR BLOCK



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Dimensions and Weight	2Ø 15.2	4Ø 15.2/15.7
	3Ø 12.7	5Ø 12.7
A (mm)	120	148
B (mm)	80	100
C (mm)	142	165
Mass (kg)	2.23	3.56

Bearing plate dimensions

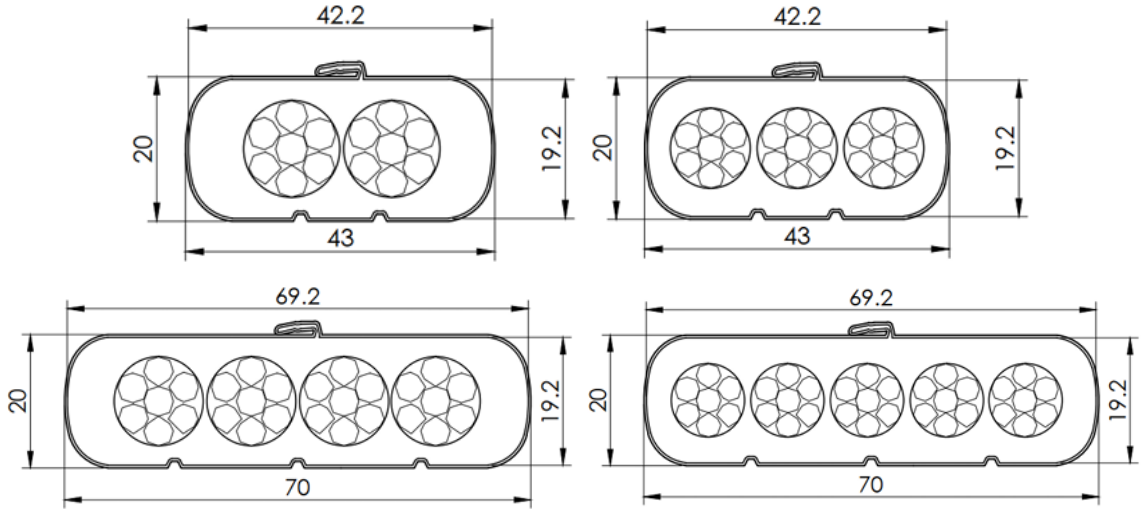
DUCTS

Metal ducts are available in a flat cross-section.

They are made of pressed steel sheet to EN 10139 – 1999 and may be galvanised. Metal duct sections are approximately 6.0 m long.



Metal ducts provide good secondary corrosion protection and ensure good bond between the tendons and the concrete. Primary corrosion protection is provided by the alkalinity of the grout and the concrete itself, while secondary protection comes from the duct and the protective barrier it forms around the tendon. The dimensions of the flat ducts are shown in the following illustrations:



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FLAT POLYETHYLENE DUCT "SPE"







SPE-78x25x2 mm polyethylene ducts are manufactured from H.D.P.E. in accordance with FIB specifications, in sections ranging from 5.8 m to 11.8 m in length. They are blue and fitted with a heat-shrink sleeve at each joint. SPE ducts are available in the following form:

- Corrugated SPE, with a wall thickness of 2.00 mm.

Connections between polyethylene ducts are made using heat-shrink sleeves and must be fitted by trained personnel in accordance with the assembly instructions.

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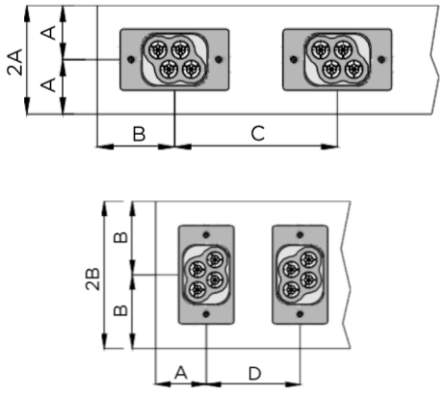
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EDGE AND SPACING DISTANCES BETWEEN ANCHORAGES - MT SYSTEM

In accordance with ETA 22/0120, the minimum edge and spacing distances to be observed for each tendon type in the MT system are set out below. These values depend on the minimum concrete strength at the time the prestressing force is applied (fcm,0) and on the number of strands and must be respected to ensure correct force transfer to the concrete and to prevent cracking in the anchorage zone.

Tendon		2 Ø15.2/Ø15.7	4 Ø15.2/Ø15.7
Number of Strands	n	2	4
Minimum Concrete Strength at the Time of Stressing			
Minimum concrete strength in MPa	$f_{cm,0}$	C20/25	
Centre Spacing and Edge Distance			
Centre spacing	X_{centre} / Y_{centre}	250 / 250	278 / 278
Edge distance in concrete beams	$X_{edge,\ beam}$ / $Y_{edge,\ beam}$	125 / 115	125 / 115
Edge distances in concrete slabs	$X_{edge,\ slab}$ / $Y_{edge,\ slab}$	125 / 110	125 / 110

In summary:



Between Anchorages	C [mm]	278
	D [mm]	278
To Edge	A [mm]	115
	B [mm]	125

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ACCESSORIES

VENT BASE FOR THE RSF-MT SYSTEM





Positioning vents on corrugated ducts ensures the correct removal of trapped air during grouting. They must be installed at every point along the tendon where air pockets could potentially form. The vent is made of a flexible material, allowing it to be used with ducts of all diameters.

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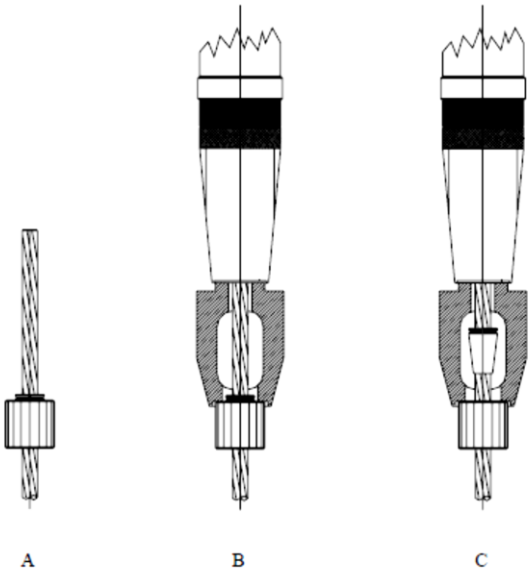
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DE-ANCHORING TABLE

De-anchoring tables allow the tension to be released from the tendons for their replacement, or for wedge replacement, across the full range of RSF anchorages, and are compatible with monostrand stressing equipment.







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EQUIPMENT

PTM STRESSING JACK FOR MO AND MT4 SYSTEMS

Monostrand stressing is carried out using the PAUL TENSA SM 240 kN jack, a hydraulically powered monostrand jack fitted with a spring-loaded internal gripping claw. It applies a stressing force of up to 240 kN (245 kN friction-free, at 520 bar) and is designed for stressing monostrand anchorages as well as for the individual stressing of strands within multistrand tendons. It is available with piston strokes of 100, 200, 300 and 500 mm — shorter strokes allow for a more compact jack — and is normally used with NG50 hydraulic power packs, with manual or electric control.

Model	Piston stroke (mm)	Overall length (mm)	Piston area (cm^2)	Stressing force (kN)	Weight (kg)
TENSA SM 240 – 200 mm	200	688	47.13	240	25



HYDRAULIC PUMPS

Paul NG50 (PT)



The NG50 is a hydraulic power pack (pumping unit) made by PAUL, the leading German manufacturer of prestressing and post-tensioning equipment. It supplies the hydraulic power that drives stressing jacks, cylinders and related equipment used in the production of prestressed concrete elements. It is a compact, simple-to-operate unit that can run with manual or electric control, at a working pressure of 420 bar.

In essence: it is typically driven by a three-phase electric motor, although AC, pneumatic and petrol-driven versions also exist; control is via a manual hydraulic valve, with the option of additional electric controls for assembly functions. The pump is a radial-piston type mounted on the motor flange, with a return filter for oil purification, and the complete station comprises the base unit, power pack, pressure gauge, hydraulic couplings and interconnecting cable.

The main features of this hydraulic pump are summarised below:

- Power: 5.5 kW

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- Weight: 110 kg
- Control: pushbutton panel
- Functions: stressing-seating-return
- Max. stressing pressure: 620 bar.
- Max. seating pressure: 150 bar.
- Max. return pressure: 150 bar.
- Dimensions: 1350x740x1060 mm
- Hydraulic hoses: three

GROUTING PUMP FOR THE MT4 SYSTEM

For grouting, FERCA uses the Hänny IC 310. This equipment is a compact grouting unit from the Swiss manufacturer Hänny AG, combining a mixer, agitator and pump in a single assembly — preparing and pumping cement grout (or bentonite suspensions) for grouting anchorages, ground nails, prestressing tendons and related applications, reaching pressures of up to 100 bar and a flow rate of around 2 m³/h.



Specifications	Unit	Hänny IC310E
Weight	**kg**	625
Dimensions	**mm**	1600x780x1600
Mixer	**l**	100
Mixing time	**s**	40”
Agitator	**l**	150
Max. grouting pressure	**Bar**	100
Max. grouting capacity	**m³/h**	2.0
Mixer power	**kW**	10.5

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INDUSTRIAL FLOOR SLABS

The post-tensioning system normally used for slabs can also be used to build industrial floor slabs, allowing the flooring sector to benefit from the advantages this technology offers. The loads applied to the floor by the high-strength steel tendons translate into compressive forces transmitted throughout the structure, preventing deformation and cracking of the floor. This makes it possible to partially replace traditional concrete reinforcement with self-sheathed monostrand tendons, or tendons in a duct sized for a single bare strand.



Bonded post-tensioning

This system is used when the floor layout needs to be modified repeatedly, since it is even possible to section both the floor and the tendons themselves at a later stage, without losing the post-tensioning force.

Unbonded post-tensioning

As the simplest method to install in the floor, the self-sheathed polyethylene tendon provides adequate corrosion protection.

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The strands are placed in the slab and fixed to the formwork as specified in the design; they are generally laid out parallel to one another to ensure a uniform distribution of compression, although the application design must define:

- Tendon layout in plan and elevation,
- Tendon type
- Pulling force, losses and final prestressing force,



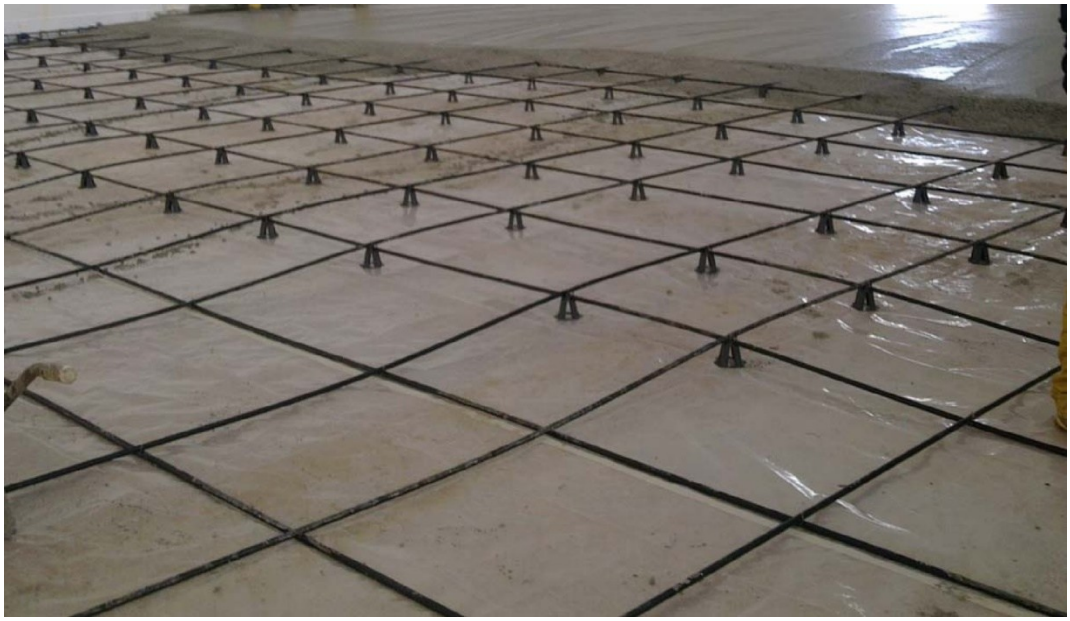
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Horizontal movements can occur during stressing and even throughout the floor's service life, so it is essential to keep the floor structure separated from other structural elements, avoiding any restraint that could limit the floor's proper functioning; compressible materials should therefore be used in the joints created.



In a correctly designed floor, the only passive reinforcement to consider is that needed to ensure the correct support of the tendons, at the slab edge and in the reinforcement of the perimeter zones where the tendon anchorages are located, where any cracking resulting from force concentration must be prevented.



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ADVANTAGES OF POST-TENSIONED FLOOR SLAB

The advantages of using prestressing systems in industrial floor slabs are intrinsically linked to the state of compression resulting from tendon stressing and to the speed of the process, and can be summarised as follows:

- Elimination of joints
- Elimination of cracks
- Greater comfort in use
- Lower maintenance costs
- Improved aesthetic finish
- Reduced floor thickness
- Faster construction



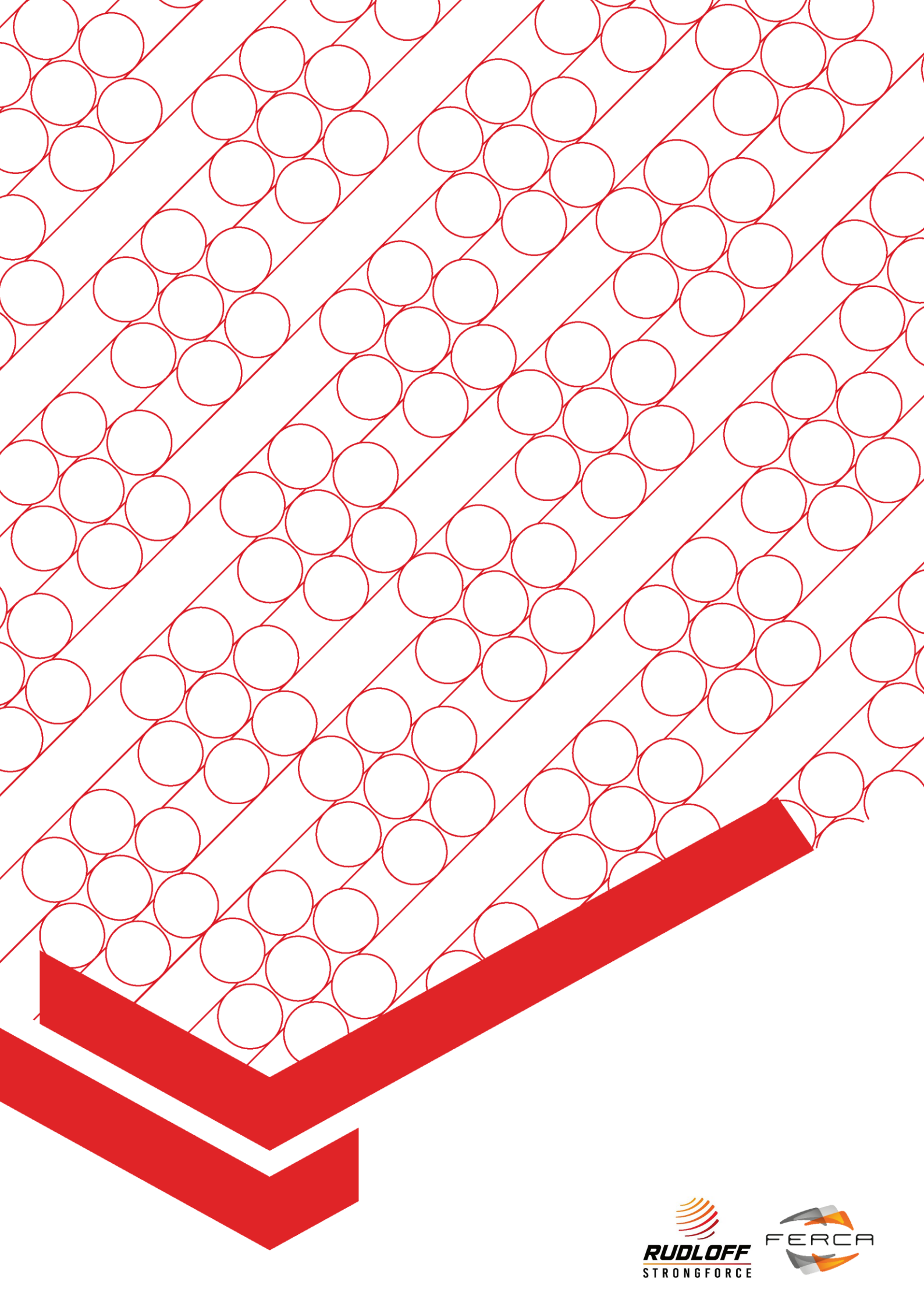






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