INŞAAT TEKNİK DEĞERLENDİRME VE BİLİMSEL ARAŞTIRMA KURUMU
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European Technical Assessment

ETA 15/0507
of 20/05/2022

General Part

Technical Assessment Body issuing the ETA:	**İTBAK İnşaat Teknik Değerlendirme Araştırma ve Belgelendirme AŞ.** Mustafa Kemal Mah. 2123. Cadde Cepa Ofis Nó:2-D Daire 901-902 Çankaya 06530 Ankara TÜRKİYE Tel: +90 312 285 63 80
Trade name of the construction product	**SARE post- tension systems Type ACT and PSV**
Product family to which the construction product belongs	Post-tensioning kit for prestressing of structures with internal bonded strands
Manufacturer	**Sare Makina Yapı Ürünleri İnşaat Tük. Mal. Taah. San. ve Tic. Ltd. Şti.** Merkez Mah.Çavuşbaşı Caddesi No: 42 Kat:3 Daire 5 Çekmeköy İstanbul TÜRKİYE
Manufacturing plant(s)	Dudullu OSB İmes Sanayi Sitesi A Blok 103. Sokak No:15 İstanbul TÜRKİYE
This European Technical Assessment contains	26 pages including 7 Annexes which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of	European Assessment Document (EAD) 160004-00-03.01 "Post-Tensioning Kits for Prestressing of Structures" edition September 2016

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

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Specific parts

1. Technical description of the product

1.1. Description of the construction product

The European Technical Assessment (ETA) applies to a kit, the PT system, **SARE post- tension systems Type ACT and PSV** post tensioning system, comprising the following, see Annex 1.1, Annex 1.2 and Annex 2.

- Tendon
  Internal bonded tendon with 4 to 31 tensile elements.
- Tensile element
  7-wire prestressing steel strand with nominal diameter and maximum characteristic tensile strength as given in Table 1.

Table 1: Tensile elements

Nominal diameter	Nominal cross-section area	Nominal Maximum characteristic tensile strength
(mm)	(mm^2)	(MPa)
15.7	150	1860

- Details of the tested post tensioning systems as given in Table 2.

Table 2: Details of the tested post tensioning systems

Specimen Type	Model No	Anchor Head	Iron Block	Trumpet	Wedges
1	AG-7	AH-7A	Nu.D-71B	Nu.D-7T	Nu.D-06W
2	AG-15	AH-15A	Nu.D-151B	Nu.D-15T	Nu.D-06W
3	AG-31	AH-31A	Nu.D-31B	Nu.D-31T	Nu.D-06W

- Anchorage
  Prestressing steel strand anchored by wedges
  End anchorage, stressing (active) and fixed (passive) anchor with wedges, anchor head, and bearing plate.
- Bursting reinforcement
- Corrosion protection for tensile elements and anchorages

1.2. PT system

1.2.1. Designation and range of anchorages

1.2.1.1. Designation

Each type of anchorage is defined as per the following example, where the three parameters shown below give full information about the product:

Anchorage type:

SARE

AG-15-06

Type of anchorage — Number of strands — Diameter of strand

1.2.1.2. Range

Each single parameter can change according to the following options:

Type of anchorage : AG (Active Group) – PG (Passive Group)

Number of strands: 4 – 7 – 9 – 12 – 15 – 19 – 22 – 27 – 31

1.2.2. Friction coefficient

For calculation of loss of prestressing force due to friction, Coulomb's law applies. Friction losses are calculated as:

$$\Delta P\mu = Pmax^* \left(1 - e^{-\mu^*(\varphi + k^* x)}\right)$$

Where
ΔPμ is the losses of prestressing force along the tendon path due to friction
Pmax is the prestressing force at x=0m
x is the curvilinear abscissa along the tendon path (with x=0 where P=Pmax)
φ is the sum of the total angular deviation of the tendon between abscissas 0 and x
μ is the friction coefficient between duct or pipe and tendon
k is the wobble coefficient

Table 3: Friction Coefficient EN 1992-1

Friction Coefficient(μ) and Wobble Coefficient (k) – EN 1992-1		
Corrugated Steel Circular Duct	$\mu(rad^{-1})$	k(rad/m)
	0,19	0,005

1.2.3. Deviation deflection limits

Deviation deflection limits were calculated according to the equation given in EAD 1600004- 00-0031 Clause 2.2.5. Calculation results are given in Table 4.

Table 4: Deviation deflection limits

Strand Y1860 S7 Ap=150 mm², d_{strand} 15.75mm					
Number of strands	Fm0 (kN)	dduct,i(mm)	Minimum radius of curvature (m)		
			pr,max=130kN/m	pr,max=150kN/m	pr,max=230kN/m
4	984	53.7	4.44	3.85	2.51
7	1722	61.2	6.82	5.91	3.85
9	2214	75.3	7.12	6.17	4.03
12	2952	86.4	8.28	7.18	4.68
15	3690	95.4	9.37	8.12	5.30
19	4674	99.7	11.36	9.84	6.42
22	5412	115.2	11.38	9.87	6.43
27	6642	120.4	13.37	11.58	7.56
31	7626	125.4	14.74	12.77	8.33

1.2.4. Assessment of assembly

Installation Tolerances:
The systems that the manufacturer requests to be included in the ETA Certificate, all consist of 4-7-9-12-15-19-22-27-31 strand groups.

Each group consists of a Strand, Wedge, Anchor Head, Iron Block and a Trumpet.

The Galvanized Duct, which is not included in the group, but must have dimensional compatibility with the group components, has also been taken into the tolerance assessment.

Accordingly, taking into account the manufacturer's statement and successful past experiences in the industry, the tolerance values are as follows;
Strand : The declared diameter size is max +/- 0.1%.

Wedge : The angle of the tapered (conical) slot where the Anchor Head will sit, in order to hold the weight load is max +/- 1.0%.

Anchor Head 1 : The angle of the conical holes located on the surface of the Anchor Head where the post-tensioning will be done and where the Wedge will be sitting is max +/- 1.0%,

Anchor Head 2 : The diameter of the hole where the Anchor Head will sit on the Iron Block is max +/- 2%,

Iron Block 1 : The diameter of the middle space where the Anchor Head will sit is max +/- 2%,

Iron Block 2: The diameter of the tooth housing where the Trumpet will be mounted on to the moving apparatus is max +/- 1%,

Trumpet 1 : The diameter of the housing above the tooth where the trumpet will be mounted on the Iron Block on the moving apparatus is max +/- 1%.

Trumpet 2 : The diameter of the back hole into which the Galvanized Duct will enter the trumpet is max +/- 2% of the value given in the manufacturer data sheets.
Galvanized Duct : According to the selected model to be used, the difference in the tolerance values given in the manufacturer data sheets can only be in a max +/- 5% range.
The sensitivity of the PT system to wear/contamination may be considered moderate. For this reason, the products are protected in the crate and/or packaging provided by the manufacturer for them until the assembly stage begins.

The process of the easy and reliable placement and compression of the concrete around the anchors is directly related to the workability and density of the concrete as well as the casting method used. Tests for determination the concrete class measuring the concrete grade and predicted workability are implemented and checked before each concrete casting process is done. In some areas/cases where a precision check and application is not possible, all gaps are totally and completely filled using a vibrator during casting. Where necessary, the internal parts of the concrete are X-rayed with special equipment before the post-tensioning process is performed.

PT kit elements are resistant to all extreme environmental conditions, provided that these conditions are of a natural origin (extreme wet, dry, hot, cold, etc.) due to their structure and the material used when being manufactured.

As long as the kit elements are installed correctly, it allows for monitoring the tensioning, load and elongation during the post-tensioning process.

All of the PT Kits are of Multi-Strand nature. For this reason, the post-tensioning process is performed using Multi-Strand Jacks. As long as all the equipment is installed correctly, simultaneous tensioning can be carried out by all the tensioning equipment at the same time, without any problems.

Because of the nature of the PT Equipment and provided that there are no design errors in the beam, there will be nothing that will prevent the beams from stretching (partially or completely) during any steps of the post-tensioning process.

In order to distribute the tensile force evenly and to a reasonable degree between all the components of the post-tensioning equipment, each strand is prestressed one by one to the predetermined low tensile load levels, by means of a Mono Jack before the actual multistressing process begins. In this way, tensile force can be distributed evenly among all the strands prior to starting the post-tensioning process itself.

The Anchor Head serves as an anti-corrosion protection for the parts of the Wedge and Pre-Tensioning Steel Strands that are outside the beam and come into contact with air. After all these parts have been tensioned and the grout is injected into the galvanized duct, they must all be completely protected against corrosion. (If the time between the tensioning process and the injection process takes too long, be sure to take extra precautions in order to protect all the parts mentioned above against corrosion). This is done by attaching a 'cap' made of steel or plastic to the bearing plate using screws. The following are some points to be considered when taking the precautions that must be performed in order to protect against corrosion the Anchor Head parts that are in contact with air. Make absolutely sure that the entire Anchor Head is shut tightly with a lid, Check to be absolutely sure that the lid is fastened tightly to the bearing plate using screws, so as not to cause even the slightest leak. Be absolutely sure that the application of the filler material, which will protect the Anchor Head from corrosion as well as the parts left exposed to the outside air, is applied through the injection hole located at the front of the lid. After the injection process is completed, the injection hole located on the lid must be tightly shut, so as not to cause even the slightest leak. In cases where the working area does not allow the use of a 'Protection Cap', the anchoring components in contact with the air must be closed off completely by using temporary moulds to be made there at the site and the grout application process must be carried out very quickly, without losing any time. In both cases, it must be checked carefully that the injected grout filler material used,is in an ample amount, making absolutely sure that it covers the ends of the tendons.

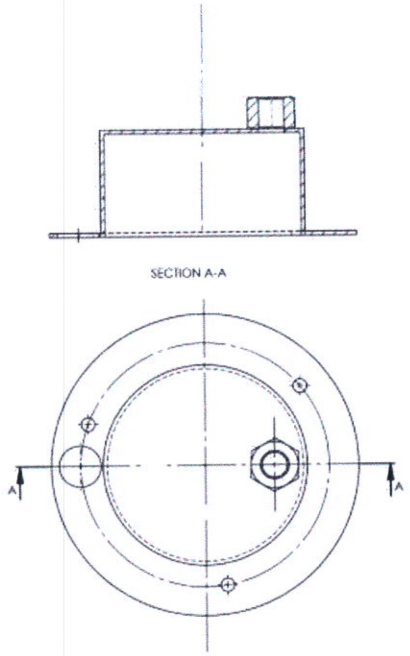


Figure 1: Grouting Cap

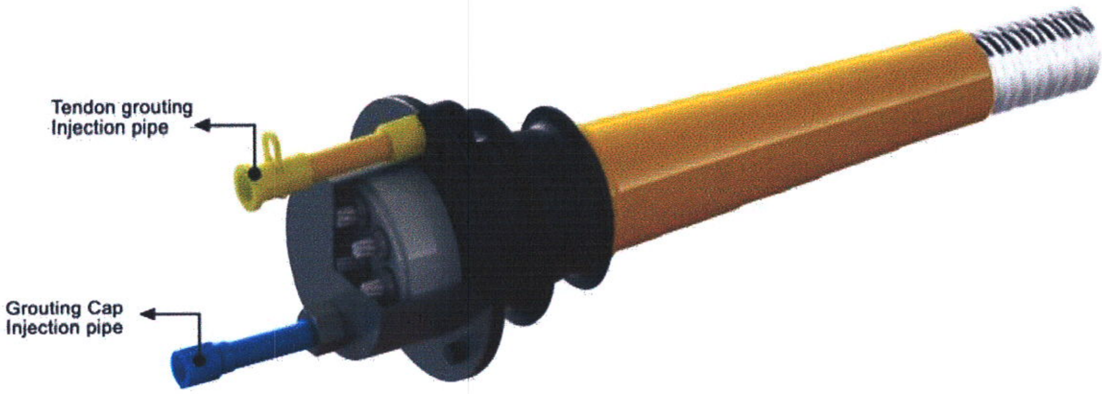


Figure 2: Grouting injection inputs

The evaluation given in the clause covers all assembling, mounting and filling activities envisaged for PT kits in light of the procedures to be followed, their applicability and reliability, the specified values, assumptions and the methodology used. These evaluations have been made according to successful past experiences and are within the limits foreseen in the industry for comparable PT systems applications. In addition, adequate general provisions, methods and actions are provided concerning the connection of the individual components of the system, as well as the anchoring methods for the coupling of components and auxiliary sealing, stretching and insertion of the proper components and equipment that are disposed in the beam channel and to provide adequate protection against the danger of corrosion and ensure its durability in proper application and safety where applicable. . Fire response class (for components or materials that are sensitive to fire and combustion) connecting and fixating applications with materials such as steel, cast iron, stainless steel, cement or substances containing mineral and/or chemical ingredients used in binding mortar, as specified in and in accordance with 96/603/EC (edited form) that meet the conditions in the specifications mentioned above, are considered to be of a "Class A1 Performance". All the above materials are within the scope and fulfilment of the purpose described in this clause. These materials are accepted that the performance requirements are fulfilled on the basis of their characteristic reactions to fires of a Class A1 nature and therefore, do not need to be tested before use. In short, the materials mentioned above are all accepted that their performance requirements against fires are fulfilled.
Therefore, the performances of all these components are Class A1.

Content, distribution and/or exposure of hazardous substances

Taking into account the evaluation made and the manufacturer's statement of conditions of use as described in the EAD-160004-00-0301, page:45, Clause 2.2.36 and quoted below, it has been evaluated that materials used are not subject to any of the classes mentioned below. The intended purpose of our products and equipment, in given extrusion (release) scenarios and in the intended use with hazardous substances are as follows:

IA1 : Products that are in direct contact with indoor air.
IA2 : Products that are in indirect contact with indoor air (for example, coated products), but have a possible effect on indoor air.
S/W1 : Products that are in direct contact with soil, groundwater and surface water.
S/W2 : Products that are in indirect contact with soil, groundwater and surface waters

1.3. Components

1.3.1. Tubes and trumpets

Tubes and trumpets are positioned between the sheath and the anchorage and guarantee proper protection to the strand. They are made of H.D.P.E. and they are able to keep stability when high temperatures are reached during the injection process.

1.3.2. Bursting reinforcement

Bursting reinforcement shall be placed exactly in the tendon axis. Helical steel and additional stirrups can be combined.

1.3.3. Bearing plates

Bearing Plates are made according to EN 1563. They are designed with a shape able to transmit prestressing forces from anchor head to concrete. Circular bearing plates shall be used for 4 to 31 strands. An air vent is provided and in order to guarantee a suitable ventilation a tube must be fitted to these air-vent.

1.3.4. Anchor heads

Anchor head, manufactured by closed die forging made by steel C40-45 according to EN ISO 683-1 and have conical hole drilled in circular arrangement to accommodate strands and wedges.
Additionally, passive anchorage have threaded holes to fix the retaining plate and cylindrical seating for retaining springs.

1.3.5. Wedges

Wedges type T15 are made of case hardening steel 16NiCrS4+Pb according to EN 10277. Only one type of wedge is used. The 3 segments of the wedges, hold together by a spring ring are 43 mm long and have 60°-tooth. In case of passive anchorages wedges are kept in place by springs and a retaining plate. Further characteristic value of the wedges see Annex 1.

1.3.6. Ducts

Cylindrical steel ducts with a corrugated profile are made of galvanized steel sheets conforming to EN 523 and these are tested according to EN 524-1, EN 524-2, EN 524-3, EN 524-4 and EN 524-5 for determining the characteristics of it.

1.3.7. Strands

Only 7-wire prestressing steel strands with characteristics according to Table 1 are used, see also Annex 6.

2. Specification of the intended use(s) in accordance with the applicable European Assessment Document

2.1. Intended uses

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

- Internal bonded tendon for concrete and composite structures

2.2. Working life

The European Technical Assessment is based on an assumed working life of the PT system of 100 years, provided that the PT system is subject to appropriate installation, use and maintenance, see Clause 1.2.4 These provisions are based upon the current state of the art and available knowledge and experience.

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 by the Technical Assessment Body, but are regarded only as a means for expressing the expected economically reasonable working life of the product[1].

[1] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works are subject, as well as on the particular conditions of design, execution, use, and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than the assumed working life.

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

3.1 Essential characteristics

The performances of the PT system for the essential characteristics are given in Table 5.

Table 5: Performance of the product in relation to the essential characteristics

Basic requirements for construction works	Essential characteristics	Product Performance
BWR 1	Resistance to static load	Clause 3.2.1.1
	Resistance to fatigue	Clause 3.2.1.2
	Load transfer to the structure	Clause 3.2.1.3
	Friction coefficient	Clause 3.2.1.4
	Deviation, deflection (limits) for internal bonded and internal unbonded tendon	Clause 3.2.1.5
	Assessment of assembly	Clause 3.2.1.6
	Corrosion protection	Clause 3.2.1.7
BWR 2	Reaction to fire	Clause 3.2.2.1
BWR 3	Content, emmision, and/or release of dangerous substances	Clause 3.2.3
BWR 4	Not relevant. No characteristic assessed.	
BWR 5	Not relevant. No characteristic assessed.	
BWR 6	Not relevant. No characteristic assessed.	
BWR 7	Not relevant. No characteristic assessed.	

3.2 Performance of the product

3.2.1 Mechanical resistance and stability

3.2.1.1 Resistance to static load

The PT system as described in this 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 with prestressing steel strands according to Annex 6 are listed in Annex 3.1 to 3.3.

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 with prestressing steel strands according to Annex 6 are listed in Annex 4.

Fatigue resistance of anchorages was tested and verified with an upper force of 65%. $F_{pk,}$, a fatigue stress range of 80 Mpa, and 2.10^6 load cycles.

3.2.1.3 Load transfer to structure

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-03.01, Clause 2.2.3. The characteristic values of maximum force, F_{pk} , of the tendon with prestressing steel strands according to Annex 6 are listed in Annex 5.1 to Annex 5.3.

The concrete classes used for test beams are C20/25 and C40/50. Compressive strength of concretes determined in the (150x150x150) mm cube shaped specimens are shown in Table 6.

Table 6: Compressive strength test results concrete specimens after 28 days

Concrete Class*	Compressive Strength (MPa)			
	1	2	3	Average
C 20/25	26,8	27,6	27,3	27,2
C 40/50	51,6	50,3	51,4	51,1

Note : * the concrete classification is made according to EN 206 + A2.

The fulfilment of the stabilization criteria and the requirements for crack widths in the load transfer test were verified up to 1.1 F_{pk}.

3.2.1.4 Friction coefficient

For friction losses including friction coefficient see Clause 1.2.2.

3.2.1.5 Deviation, deflection (limits) for internal bonded tendon

For minimum radii of curvature see Clause 1.2.3.

3.2.1.6 Assessment of assembly

The PT system as described in this ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.7. See Clause 1.2.4.

3.2.1.7 Corrosion protection

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

3.2.2 Safety in case of fire

3.2.2.1 Reaction to fire

The performance of components made of steel or cast iron s Class A1 without testing. The performance of components of other materials has not been assessed.

3.2.2.2 Hygiene, health, and the environment

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.

3.3 Assessment methods

The assessment of the essential characteristics in Clause 3.1 of the PT system, 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

- Internal bonded tendon,

3.4 Identification

The European Technical Assessment for the **SARE post- tension systems Type ACT and PSV** is issued on the basis of agreed data 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. ITBAK should be notified before the changes are introduced, as an amendment of the European Technical Assessment is possibly necessary.

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

According to the decision 98/456/EC, the system of assessment and verification of constancy of performance to be applied to SARE post- tension systems Type ACT and PSV is System 1+. (see Annex point 1.1 of Regulation (EU) No 568/2014)[1]

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

Technical details necessary for the implementation of the AVCP system are laid down in in the control plan deposited by the Technical Assessment Body: Constructional Technical Evaluation and Scientific Research and Certification İnc. (ITBAK).

The notified product certification body shall visit the factory at least once a year for surveillance of the manufacturer.

Issued in Ankara on 20.05.2022

By

Board Member of İTBAK

Hakan ERGİN

and

General Manager of İTBAK

Ertuğrul CANKI

Annexes

PT Systems Detail

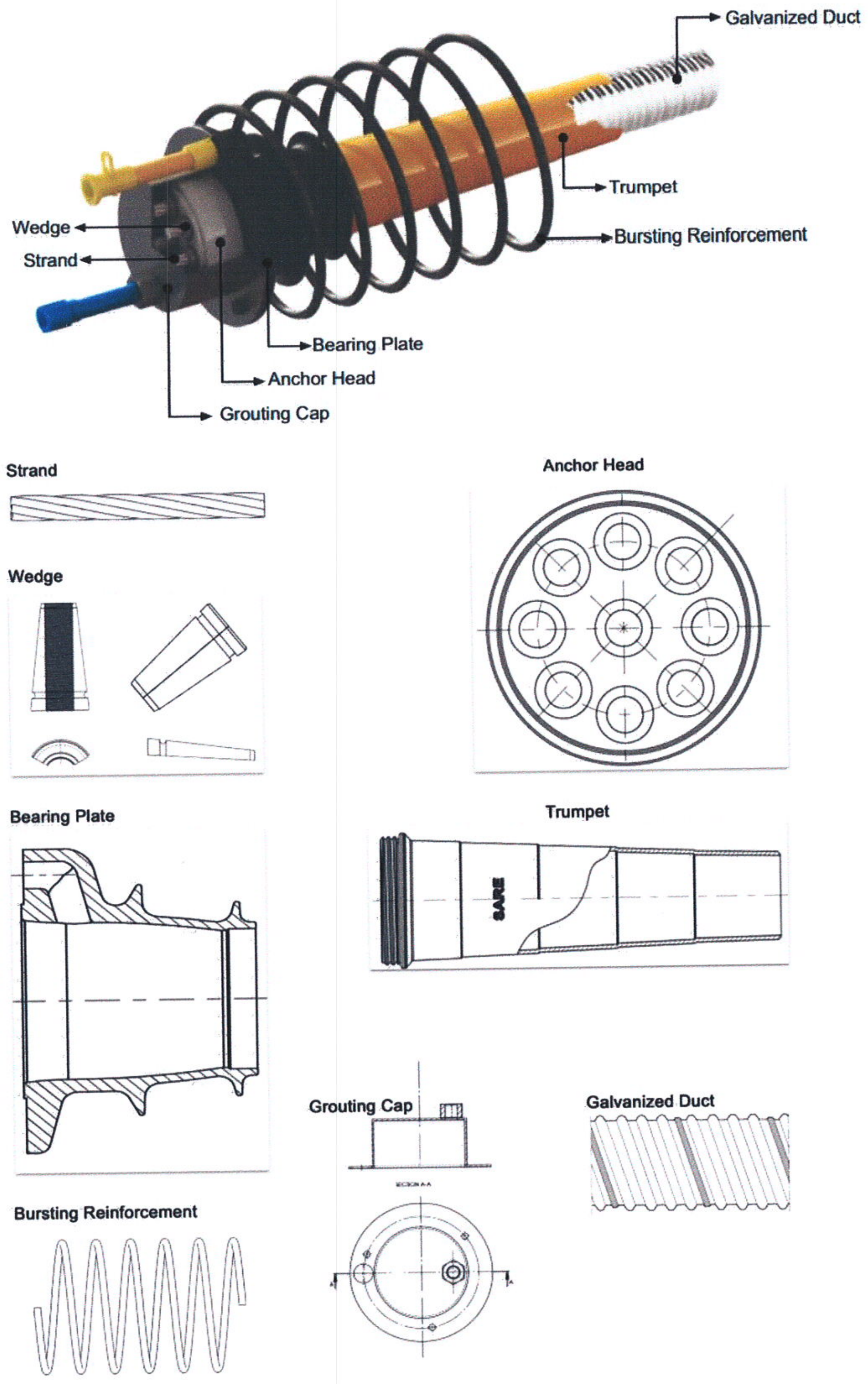


Figure 3: Active Type PT System

SARE post- tension systems Type ACT and PSV	**Annex 1.1** to ETA 15/0507

PT Systems Detail

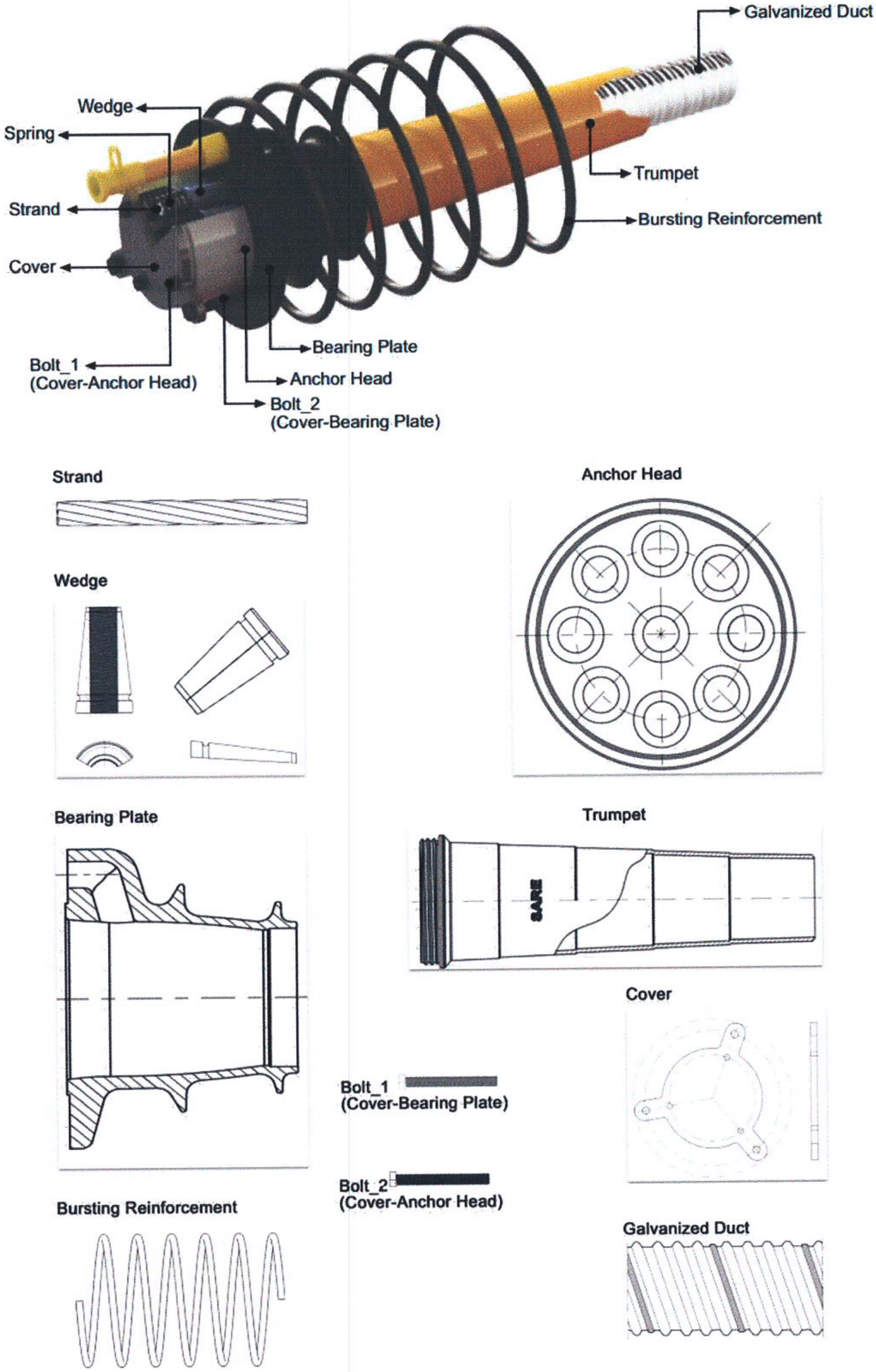
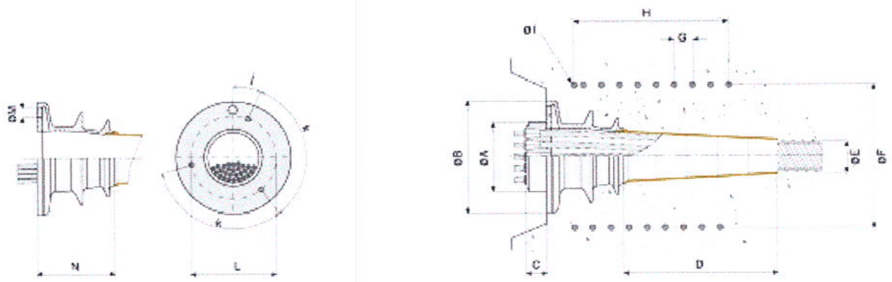


Figure 4:Passive Type PT System

Active Type Models

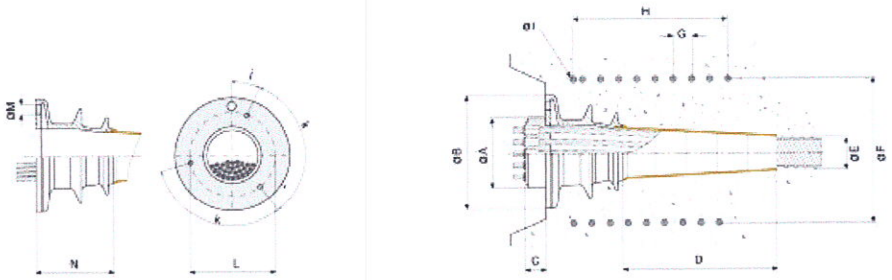


Model No		AG-4	AG-7	AG-9	AG-12	AG-15
Number of strands		4	7	9	12	15
Strand arrangement						
ANCHOR HEAD						
A	Ø (mm)	Ø105	Ø123	Ø146	Ø157	Ø175
B	Ø (mm)	Ø175	Ø200	Ø235	Ø256	Ø290
C	mm	48	49	52	59	67
TRUMPET						
D	mm	308	334	372	386	403
GALVANIZED DUCT						
E	Ø (mm)	Ø50	Ø60	Ø75	Ø85	Ø95
Internal Dia.	Ø (mm)	Ø45	Ø55	Ø70	Ø80	Ø90
HELIX						
F	Ø (mm)	Ø170	Ø220	Ø250	Ø310	Ø350
G	mm	50	60	60	60	65
H	mm	300	360	360	420	455
I	Ø (mm)	Ø10	Ø12	Ø12	Ø14	Ø14
BEARING PLATE						
J	Ø (mm)	90°	30°	20°	20°	20°
K	Ø (mm)	180	120°	120°	120°	120°
L	mm	Ø124	Ø145	Ø190	Ø203	Ø235
M	mm	G 3/4"	G 3/4"	G 3/4"	G 3/4"	G 3/4"
N	Ø (mm)	110	131	160	169	193

Table 7 : The description of the system components AG -4, AG -7, AG- 9, AG- 12, AG-15

SARE post- tension systems Type ACT and PSV	**Annex 2.1** to ETA 15/0507

Active Type Models



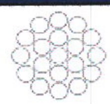
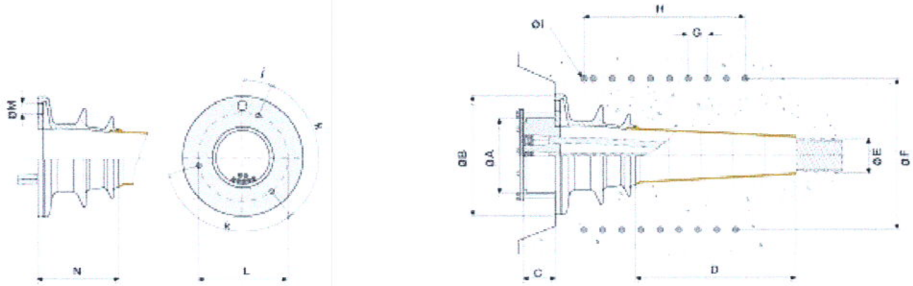
Model No		AG-19	AG-22	AG-27	AG-31
Number of strands		19	22	27	31
Strand arrangement					
ANCHOR HEAD					
A	Ø (mm)	Ø197	Ø227	Ø246	Ø266
B	Ø (mm)	Ø321	Ø344	Ø372	Ø396
C	mm	72	77	82	105
TRUMPET					
D	mm	431	414	472	617
GALVANIZED DUCT					
E	Ø (mm)	Ø100	Ø115	Ø120	Ø125
Internal Dia.	Ø (mm)	Ø95	Ø110	Ø115	Ø120
HELIX					
F	Ø (mm)	Ø400	Ø430	Ø470	Ø640
G	mm	70	70	80	80
H	mm	490	560	640	640
I	Ø (mm)	Ø16	Ø16	Ø20	Ø20
BEARING PLATE					
J	Ø (mm)	20°	20°	15°	15°
K	Ø (mm)	120°	120°	120°	120°
L	mm	Ø118.5	Ø290	Ø325	Ø350
M	mm	G 3/4"	G 1"	G 1"	G 1"
N	Ø (mm)	204	243	262	376

Table 8 : The description of the system components AG -19, AG -22, AG- 27, AG- 31

Passive Type Models

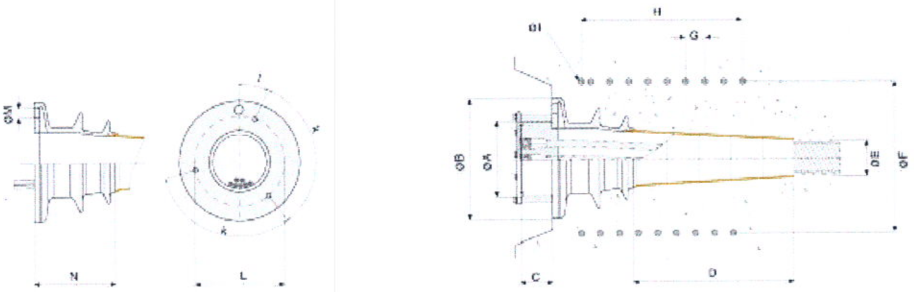


Model No		PG-4	PG-7	PG-9	PG-12	PG-15
Number of strands		4	7	9	12	15
Strand arrangement						
ANCHOR HEAD						
A	Ø (mm)	Ø105	Ø123	Ø146	Ø157	Ø175
B	Ø (mm)	Ø175	Ø200	Ø235	Ø256	Ø290
C	mm	80	80	80	80	80
TRUMPET						
D	mm	308	334	372	386	403
GALVANIZED DUCT						
E	Ø (mm)	Ø50	Ø60	Ø75	Ø85	Ø95
Internal Dia.	Ø (mm)	Ø45	Ø55	Ø70	Ø80	Ø90
HELIX						
F	Ø (mm)	Ø170	Ø220	Ø250	Ø310	Ø350
G	mm	50	60	60	60	65
H	mm	300	360	360	420	455
I	Ø (mm)	Ø10	Ø12	Ø12	Ø14	Ø14
BEARING PLATE						
J	Ø (mm)	90°	30°	20°	20°	20°
K	Ø (mm)	180	120°	120°	120°	120°
L	mm	Ø124	Ø145	Ø190	Ø203	Ø235
M	mm	G 3/4"	G 3/4"	G 3/4"	G 3/4"	G 3/4"
N	Ø (mm)	110	131	160	169	193

Table 9 : The description of the system components PG -4, PG -7, PG- 9, PG- 12, PG-15

SARE post- tension systems Type ACT and PSV	Annex 2.3 to ETA 15/0507

Passive Type Models



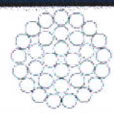
Model No		PG-19	PG-22	PG-27	PG-31
Number of strands		19	22	27	31
Strand arrangement					
ANCHOR HEAD					
A	Ø (mm)	Ø197	Ø227	Ø246	Ø266
B	Ø (mm)	Ø321	Ø344	Ø372	Ø396
C	mm	91	96	105	114
TRUMPET					
D	mm	431	414	472	617
GALVANIZED DUCT					
E	Ø (mm)	Ø100	Ø115	Ø120	Ø125
Internal Dia.	Ø (mm)	Ø95	Ø110	Ø115	Ø120
HELIX					
F	Ø (mm)	Ø400	Ø430	Ø470	Ø640
G	mm	70	70	80	80
H	mm	490	560	640	640
I	Ø (mm)	Ø16	Ø16	Ø20	Ø20
BEARING PLATE					
J	Ø (mm)	20°	20°	15°	15°
K	Ø (mm)	120°	120°	120°	120°
L	mm	Ø118.5	Ø290	Ø325	Ø350
M	mm	G 3/4"	G 1"	G 1"	G 1"
N	Ø (mm)	204	243	262	376

Table 10 : The description of the system components PG -19, PG -22, PG- 27, PG- 31

SARE post- tension systems Type ACT and PSV	**Annex 2.4** to ETA 15/0507

Resistance to Static Load Test Results

Resistance to static load test is according to the EAD-160004-00-0301 Annex C2. Anchor head, wedges, tensile element of the post tensioning system were mounted on the concrete beam. Test specimens were selected according to the EAD-160004-00-0301 Clause 2.2.1, Fpk≤10500kN and three different sizes. Tendon was stressed at one end with producer equipment within the steps of 20%, 40%, 60% and 80% of characteristic tensile strength of the tensile elements. Load was applied with a constant rate of 100 MPa/min during testing. Load was measured with a pressure transmitter sensor which have an uncertainty within the 1% and load was maintained with a tolerance of 2%. Displacement transducers have an uncertainty within the 0.5%. Load was held at 80% of characteristic tensile strength of the tensile elements for one hour. Resistance to static load test results are shown in Table 11. Displacement measurement points are shown with Figure 66. Load displacement relations are given Figure 7 to Figure 11.

Table11: Resistance to static load test results

Number of tensile element	7	7	15	15	31	31
Applied load on tensile elements (kN)	1856	1856	3976	3976	8217	8217
Elongation(%)	2,98	2,96	2.96	3,14	2,98	3,33
Wedge displacement anchor 1 (mm)	3,94	4,98	3.36	5,01	2,6	4,95
Wire displacement anchor 1 (mm)	4,8	5,56	4.48	5,11	3,41	5,26
Wedge displacement anchor 2 (mm)	4,13	4,73	3.88	5,26	3,25	4,99
Wire displacement anchor 2 (mm)	4,56	5,28	4.37	5,37	4,02	5,39

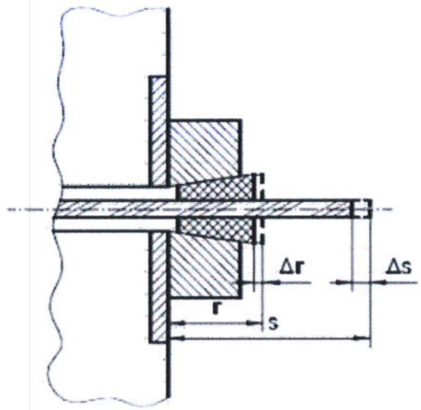


Figure 5: Displacement measurement points

Resistance to static load

Annex 3.1 to
ETA 15/0507

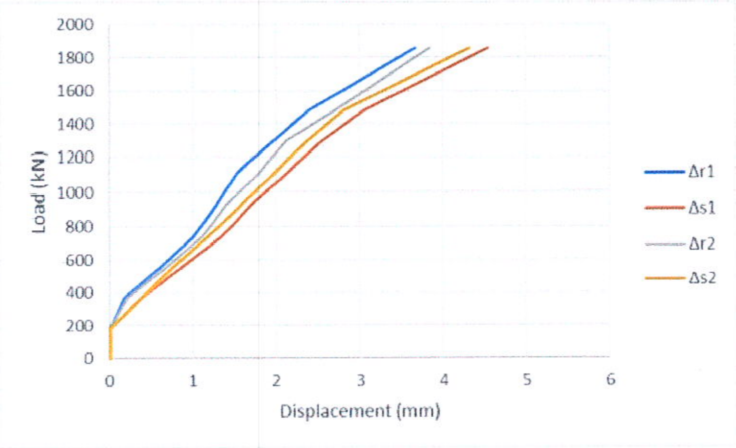


Figure 6 : Load displacement relations of AG-7 first specimen

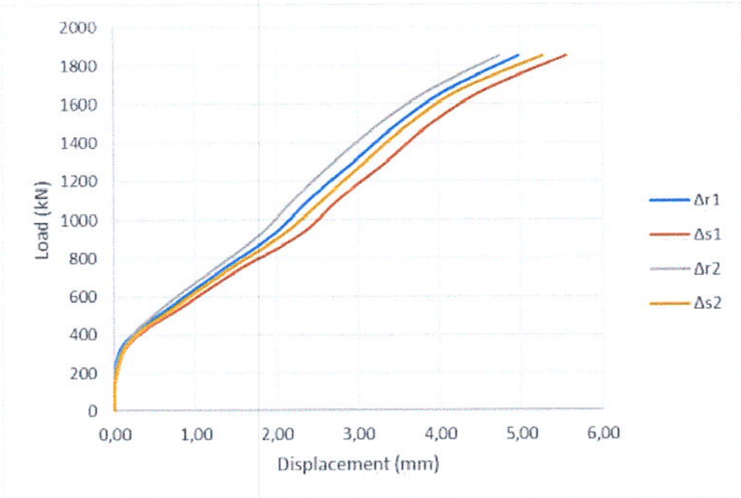


Figure 7 : Load displacement relations of AG-7 second specimen

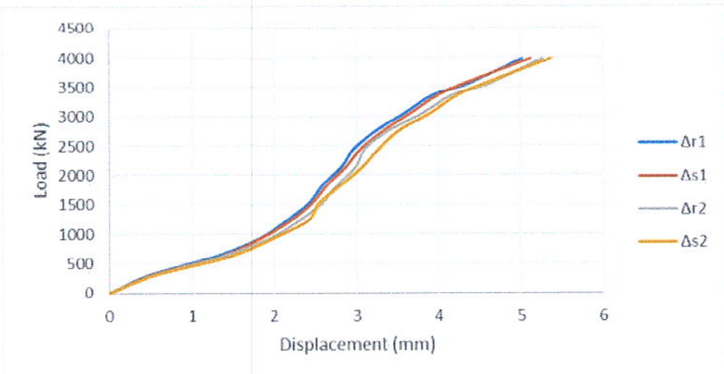


Figure 8: Load displacement relations of AG-15 first specimen

Resistance to static load	**Annex 3.2 to** ETA 15/0507

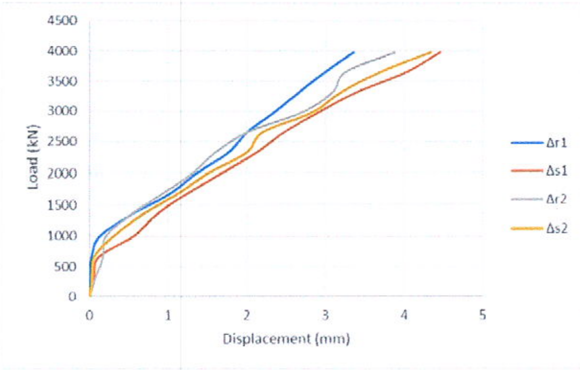


Figure 9: Load displacement relations of AG-15 second specimen

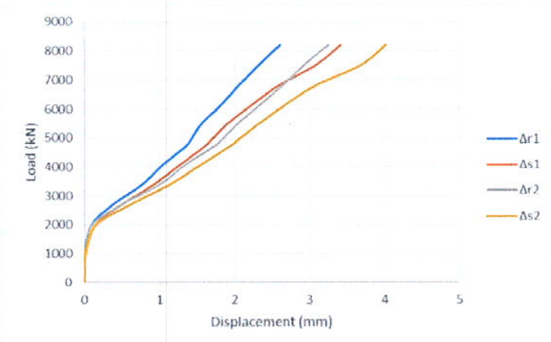


Figure 10: Load displacement relations of AG-31 first specimen

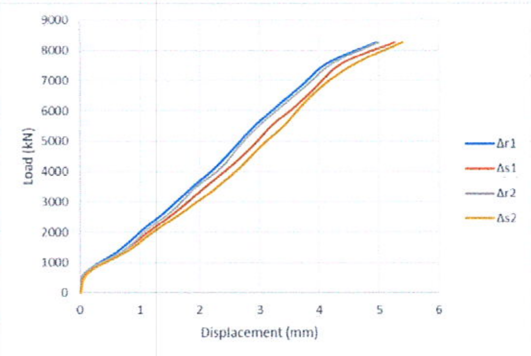


Figure 11: Load displacement relations of AG-31 second specimen

Resistance to static load	**Annex 3.3 to ETA 15/0507**

Resistance to Fatigue Test Results

According to the EAD-160004-00-0301 document if the number of the tensile element are higher than 12, reduction is allowed which is described in C.3.1.1. Test was performed on with an upper load of 65% of the characteristic strength of the tensile elements. Range of loads was maintained constant throughout the testing, at a level of corresponding to 80 MPa stress amplitude corresponding to the upper load. Before testing each wire were checked to the load was evenly distributed to all tensile elements of the tendon. 2.000.000 cycles were performed on the specimens. The load was the applied at frequency of 8 Hz. Nominal diameters of the tensile elements were 15,7mm and cross section area of 150mm^2 . During the fatigue load test using an upper load of 65% F_{pk} no wire breaks occurred. The components showed no visible fatigue damages or deformations. At the demounted tensile elements, no wire breaks were noticed. All wedges were taken out of their holes. At the demounted wedges, no damage have been determined. In the fatigue test all specimens achieved the required 2 million cycles without failure. The relative displacement between anchorage components and tensile elements were stabilized during the tests. Test results are given in Table 12.

Table 12: Resistance to fatigue test results

Number of tensile element		7	9	13	13
Upper stress of tensile elements (MPa)		1209	1209	1209	1209
Upper load of tensile elements (kN)		1269	1632	2358	2358
Lower stress of tensile elements (MPa)		1129	1129	1129	1129
Lower load of tensile elements (kN)		1185	1524	2202	2202
İnitial	**Wedge displacement anchor 1 at upper stress (mm)**	3,15	3,65	2,63	2,96
	Wire displacement anchor 1 at upper stress (mm)	3,33	3,85	2,89	3,24
	Wedge displacement anchor 2 at upper stress (mm)	3,26	3,39	3,25	3,73
	Wire displacement anchor 2 at upper stress (mm)	3,41	3,52	3,63	3,99
After 10.000 cycles	**Wedge displacement anchor 1 at upper stress (mm)**	3,18	3,70	2,64	2,96
	Wire displacement anchor 1 at upper stress (mm)	3,41	3,87	2,93	3,04
	Wedge displacement anchor 2 at upper stress (mm)	3,29	3,44	3,27	3,77
	Wire displacement anchor 2 at upper stress (mm)	3,47	3,58	3,71	4,14
After 2.000.000 cycles	**Wedge displacement anchor 1 at upper stress (mm)**	3,19	3,7	2,65	2,99
	Wire displacement anchor 1 at upper stress (mm)	3,44	3,92	3,04	3,12
	Wedge displacement anchor 2 at upper stress (mm)	3,30	3,45	3,27	3,77
	Wire displacement anchor 2 at upper stress (mm)	3,51	3,63	3,82	4,21

Resistance to fatigue	**Annex 4 to** ETA 15/0507

Load Transfer to Structure Test Result

Load transfer to structure test results on C20/25 and C40/50 concrete are shown in Table 9. Strain values on C20/25 and C40/50 concrete are shown in Table 10. There were no visual deformation or breakage were determined at the end of the tests.

Acceptance criteria for the load transfer to structure test given below and also given in EAD 160004-00-0301 were all satisfied.

- Crack widths max w:
  - Upon the first attainment of upper load of 80% of tensile element characteristic strength not more than 0.15mm.
  - Upon the last attainment of lower load of 12% of tensile element characteristic strength not more than 0.15mm.
  - Upon the last attainment of upper load of 80% of tensile element characteristic strength not more than 0.25mm.
- Mechanical anchorages have a measured ultimate force at least: $F_u \geq 1.1\ F_{pk}$

Load transfer to structure test	**Annex 5.1 to** ETA 15/0507

Table 13: Load transfer to structure test results on C20/25 and C40/50 concrete

Number of tensile element		7	15	31	31	7	15	31	31
Concrete class		C20/25				C40/50			
F_{pk}(kN)		1953	4185	8649	8649	1953	4185	8649	8649
F_u(kN)		2481	5570	11036	11226	2503	5432	11250	11298
$f_{cme\ cube}$(MPa)		23.1				47.2			
$f_{cm0\ cube}$(MPa)		25.4				49.3			
Upper load of cyclic phase (kN)		1562	3348	6919	6919	1562	3348	6919	6919
Lower load of cyclic phase (kN)		234	502	1038	1038	234	502	1038	1038
Maximum crack width at first attainment of upper load (mm)		0,05	0,08	0,08	0,09	0,01	0,02	0,03	0,05
Maximum crack width at last attainment of lower load (mm)		0,08	0,09	0,10	0,10	0,02	0,03	0,04	0,06
Maximum crack width at last attainment of upper load (mm)		0,10	0,10	0,10	0,11	0,03	0,04	0,06	0,07
Strains on concrete face 1	ε_{t1}	0,0009	0,0009	0,0012	0,0013	0,0006	0,0008	0,0011	0,0010
	ε_{t2}	0,0010	0,0011	0,0009	0,0011	0,0010	0,0011	0,0011	0,0009
	ε_v	0,0008	0,0006	0,0008	0,0008	0,0003	0,0003	0,0002	0,0003
Strains on concrete face 2	ε_{t1}	0,0008	0,0010	0,0011	0,0009	0,0008	0,0090	0,0014	0,0011
	ε_{t2}	0,0011	0,0009	0,0011	0,0008	0,0009	0,0013	0,0017	0,0014
	ε_v	0,0005	0,0005	0,0006	0,0006	0,0004	0,0002	0,0003	0,0004

Load transfer to structure test	Annex 5.2 to ETA 15/0507

Table 14: Strain values on C20/25 and C40/50 concrete

Number of Tensile Element	Face	Strain	Strains at first, sixth and tenth cycles						Stabilization criteria
			C20/25			C40/50			$\varepsilon_v - \varepsilon_{v-4} \leq 1/3 (\varepsilon_{v-4} - \varepsilon_0)$
			ε_0	ε_6	ε_{10}	ε_0	ε_6	ε_{10}	
7	1	ε_{t1}	0,00019	0,00074	0,00091	0,00023	0,00058	0,00063	
		ε_{t2}	0,00032	0,00085	0,00098	0,00042	0,00084	0,00096	
		ε_v	0,00015	0,00074	0,00082	0,00016	0,00031	0,00034	
7	2	ε_{t1}	0,00031	0,00076	0,00081	0,00042	0,00076	0,00084	
		ε_{t2}	0,00029	0,00095	0,00106	0,00028	0,00084	0,00091	
		ε_v	0,00011	0,00045	0,00052	0,00016	0,00038	0,00042	
15	1	ε_{t1}	0,00022	0,00076	0,00093	0,00032	0,00074	0,00082	
		ε_{t2}	0,00032	0,00096	0,00111	0,00041	0,00094	0,00108	
		ε_v	0,00022	0,00058	0,00064	0,00016	0,00031	0,00034	
15	2	ε_{t1}	0,00031	0,00086	0,00102	0,00032	0,00082	0,00094	
		ε_{t2}	0,00027	0,00084	0,00091	0,00056	0,00117	0,00127	
		ε_v	0,00011	0,00048	0,00052	0,00008	0,00021	0,00024	Satisfied
31	1	ε_{t1}	0,00028	0,00099	0,00118	0,00036	0,00099	0,0011	
		ε_{t2}	0,00027	0,00081	0,00094	0,00037	0,00094	0,00111	
		ε_v	0,00024	0,00074	0,00083	0,00004	0,0002	0,00022	
31	2	ε_{t1}	0,00023	0,00096	0,00108	0,00037	0,001245	0,00141	
		ε_{t2}	0,00032	0,00094	0,00106	0,00042	0,00143	0,00166	
		ε_v	0,00021	0,00058	0,00063	0,00011	0,00029	0,00032	
31	1	ε_{t1}	0,00043	0,00117	0,00125	0,00038	0,00084	0,00096	
		ε_{t2}	0,00041	0,00096	0,00106	0,00028	0,00071	0,00084	
		ε_v	0,00036	0,00072	0,00082	0,00011	0,00028	0,00031	
31	2	ε_{t1}	0,00029	0,00084	0,00091	0,00021	0,00093	0,00108	
		ε_{t2}	0,00024	0,00076	0,00084	0,00047	0,00126	0,00135	
		ε_v	0,00027	0,00058	0,00064	0,00013	0,00037	0,00044	

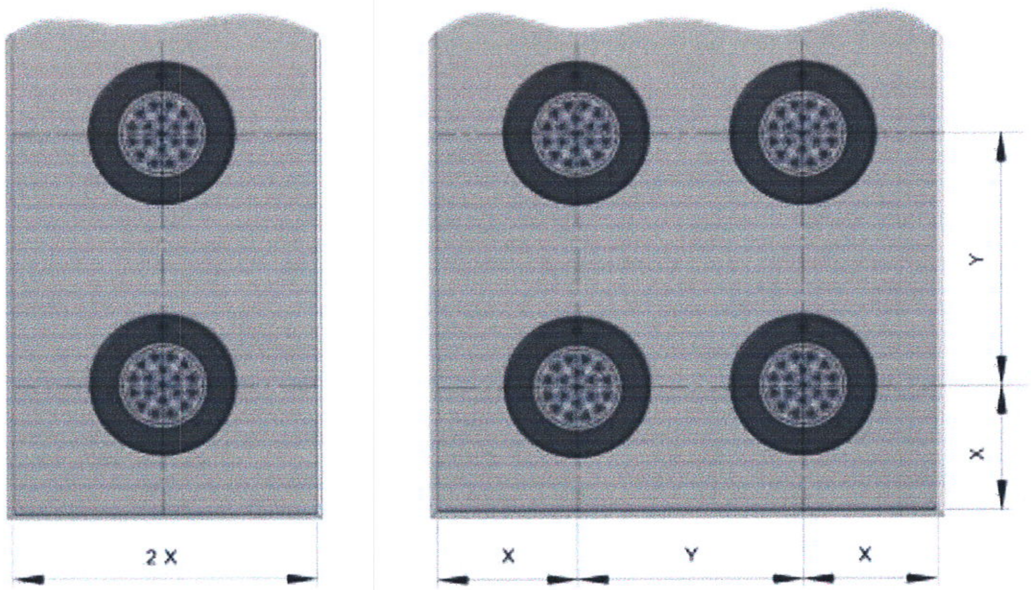
Load transfer to structure test	Annex 5.3 to ETA 15/0507

Table 15: Characteristics of prestressing steel strands

Declaration of manufacturer according to pr EN 10138-3	
0,62" – 7 Wire PC Strand -Prestressed Concrete Strand	
Steel name	Y1860S7
Nominal diameter	15.7
Nominal Cross Sectional Area(mm^2)	150
Tensile strength	1860
Characteristic value of maximum force Fm kN	279
Maximum value of maximum force Fm kN	321
Characteristic value of 0,1% proof force F p0,1	240

Prestressing steel strand specifications	**Annex 6 to** ETA 15/0507

Table 16: Edge distances



Minimum centres spacing. Y (mm)				Minimum edges distance X (mm)			
Number of strands	$f_{cmi,cube}$			Number of strands	$f_{cmi,cube}$		
	25 MPa	35 MPa	45 Mpa		25 MPa	35 MPa	45MPa
4	270	250	230	4	130	125	120
7	320	335	295	7	155	175	155
9	345	370	320	9	170	190	165
12	400	430	380	12	195	220	195
15	445	480	430	15	220	245	220
19	500	545	485	19	245	280	250
22	540	585	520	22	265	300	265
27	600	650	580	27	295	330	295
31	690	710	630	31	345	360	320

Edge Distances	**Annex 7 to** ETA 15/0507

Reference Documents

EAD 160004-00-0301 "POST-TENSIONING KITS FOR PRESTRESSING OF STRUCTURES" edition September 2016

EN 1992-1 Eurocode 2:Design of concrete structures - Part 1-1: General rules and rules for buildings

EN 1563:2011 Founding - Spheroidal graphite cast irons

EN ISO 683-1 Heat-treatable steels, alloy steels and free-cutting steels - Part 1: Non-alloy steels for quenching and tempering

EN 10277 Bright steel products - Technical delivery conditions

EN 206+A2 Concrete - Specification, performance, production and conformity

EN 523 Steel strip sheaths for prestressing tendons - Terminology, requirements, quality control

EN 524-1 Steel strip sheaths for prestressing tendons-Test methods-Test methods-Part 1:Determination of shape and dimensions

EN 524-2 Steel strip sheaths for prestressing tendons-Test methods-Part 2:Determination of flexural behaviour

EN 524-3 Steel strip sheaths for prestressing tendons-Test methods-Part 3:To-and-fro bending test

EN 524-4 Steel strip sheaths for prestressing tendons - Test methods - Part 4:Determination of lateral load resistance

EN 524-5 Steel strip sheaths for prestressing tendons-Test methods-Part 5:Determination of tensile load resistance

ISO 6892-1 Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2019)

GÖKPINAR M., GÜLER F., YORULMAZ B., PEKMEZCİ B.Y., 2020, EAD 160004-00-0301 Post Tensioning Kit Test Report, TICEM ILERI YAPI TEKNOLOJILERI, İSTANBUL

GÖKPINAR M., GÜLER F., YORULMAZ B., PEKMEZCİ B.Y., 2020, EN 523 "STEEL STRİP SHEATS", TICEM ILERI YAPI TEKNOLOJILERI, İSTANBUL

MENTE R., BAYRAK A., 2021, '0,62" - 7 Wire PC Strand – Prestressed Concrete Strand N2104041-01/03', MATİL Malzeme Test ve İnovasyon Laboratuvar A.Ş., İSTANBUL