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European Technical Assessment

ETA-05/0122 of 09.12.2019

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	SAS – Post-tensioning bar tendon system
Product family to which the construction product belongs	Bonded, unbonded, and external post-tensioning kits for prestressing of structures with bars, diameter 17.5 to 47 mm
Manufacturer	Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Ainring-Hammerau Germany
Manufacturing plant	Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Ainring-Hammerau Germany
This European Technical Assessment contains	78 pages including Annexes 1 to 47, 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.
This European Technical Assessment replaces	European Technical Assessment ETA-05/0122 of 27.06.2018.

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Table of contents

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Specific parts

1 Technical description of the product

1.1 General

The European Technical Assessment[1] – ETA – applies to a kit, the

SAS – Post-tensioning bar tendon system,

comprising the following components.

- Tendon
  - Bonded bar tendon
  - Unbonded bar tendon with free tendon duct
  - Unbonded bar tendon without free tendon duct
  - External bar tendon
- Tensile element

  Tensile element is a hot rolled bar of prestressing steel, with nominal diameters and nominal tensile strength as given in Table 1 – Prestressing steel bar. The prestressing steel bar is either a plain bar or ribs are hot rolled along the entire length of the bar, providing a continuous thread – Thread bar.
- Anchorage and coupling

  Thread bar and plain bar anchored by domed anchor nut

  Stressing and fixed anchor with anchor plate as solid plate, square, solid plate, rectangular, solid plate, rectangular, small, or QR-plate and with domed anchor nut

  Fixed and movable coupling with coupler or transition coupler
- Additional reinforcement in the anchorage zone
- Temporary and permanent corrosion protection systems for prestressing steel bar, anchorage, and coupling

[1] ETA-05/0122 was firstly issued in 2005 as European technical approval with validity from 15.12.2005, extended in 2010 with validity from 15.12.2010, amended in 2013 with validity from 30.06.2013, converted 2018 to European Technical Assessment ETA-05/0122 of 27.06.2018, and amended in 2019 to ETA-05/0122 of 09.12.2019.

Table 1 Tensile elements

Nominal bar diameter	mm	17.5	26.5	32	36	40	47
Thread bar – WR							
Designation	—	18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR
Nominal tensile strength R_m	N/mm^2	1 050					
Plain bar – WS							
Designation	—	—	—	32 WS	36 WS	—	—
Nominal tensile strength R_m	N/mm^2	1 050					

NOTE 1 N/mm^2 = 1 MPa

PT system

1.2 Anchorage and coupling

1.2.1 Designation and range

The components of anchorage and coupling are designated by the first two digits of the nominal bar diameter in mm, followed by "WR" for thread bar or "WS" for plain bar, and a number allocated to the respective component, e.g. anchor plate, nut, or coupler. An overview of the various components is given in Annex 1.

NOTE The designation for the nominal diameter of 17.5 mm is 18 and for a nominal diameter of 26.5 mm is 26.5.

The range of available prestressing steel bars is given in Table 1. Characteristic values of maximum force of the bar tendon are listed in Annex 39.

1.2.2 Stressing anchor

The stressing anchor comprises anchor plate and domed anchor nut, see Annex 9 for bonded bar tendon and Annex 19 for unbonded and external bar tendon. Whether a domed anchor nut without grout slot or with grout slots is installed, depends on the applied corrosion protection system. The stressing anchor can also be used as a fixed anchor

At the anchorage, the tendon layout provides a straight section over a length of at least 0.3 m ahead the end of the anchor plate.

1.2.3 Fixed anchor

The fixed anchor comprises anchor plate and domed anchor nut, see Annex 9 for bonded bar tendon and Annex 19 for unbonded and external bar tendon. Whether a domed anchor nut without or with grout slots is installed depends on the applied corrosion protection system.

For a fixed anchor embedded in concrete, the domed anchor nut is tack welded perpendicularly onto the anchor plate at the manufacturing plant.

At the anchorage, the tendon layout provides a straight section over a length of at least 0.3 m ahead the end of the anchor plate.

1.2.4 Movable coupling

1.2.4.1 General

Movable coupling connects two bar tendons prior to stressing. With cold bent prestressing steel bars, the coupling is installed in a straight tendon sections, ensuring a straight length of at least 0.3 m at both sides.

1.2.4.2 Movable coupling D

Movable coupling D for bonded, unbonded, and external bar tendon connects two prestressing steel prestressing steel bars by means of a coupler prior to stressing. Both prestressing steel bars are stressed simultaneously, see Annex 10 and Annex 17 for bonded bar tendon, and Annex 20, Annex 23, and Annex 34 for unbonded and external bar tendon.

1.2.4.3 Movable couplings G

Movable coupling G for bonded bar tendon enables the direct connection of a prestressing steel bar to the stressing anchor of an already stressed but still ungrouted bar tendon, see Annex 17. The prestressing steel bars are stressed simultaneously.

1.2.5 Fixed coupling with grout cap

The fixed coupling with grout cap is for bonded bar tendon and connects a 2nd prestressing steel bar with an already stressed 1st prestressing steel bar, see Annex 18. The already stressed 1st prestressing steel bar is anchored in the same way as a stressing anchor.

With cold bent prestressing steel bars, the coupling is installed in a straight tendon sections, ensuring a straight length of at least 0.3 m at both sides.

1.3 Range and designation of bar tendons

Prestressing and overstressing forces are specified in the respective standards and regulations in force at the place of use. Annex 40 lists the maximum prestressing and overstressing forces of the bar tendon according to Eurocode 2, i.e. the maximum prestressing force applied to a bar tendon does not exceed $P_{max} = \min \begin{cases} 0.90 \cdot F_{p0.1} \\ 0.8 \cdot F_{pk} \end{cases}$. Overstressing with $P_{max,\,o} = 0.95 \cdot F_{p0.1}$ is only permitted if the force in the prestressing jack can be measured to an accuracy of ± 5 % of the final value of the overstressing force.

Initial prestressing force, P_{m0}, immediately after stressing and anchoring does not exceed the forces as specified in Eurocode 2.

Where

$F_{p0.1}$.......kN ....Characteristic 0.1 % proof force of the prestressing steel bar, i.e. $F_{p0.1} = f_{p0.1} \cdot S_n$, see Annex 39

F_{pk}.........kN ....Characteristic maximum force of the prestressing steel bar, i.e. $F_{pk} = f_{pk} \cdot S_n$, see Annex 39

$f_{p0.1}$........kN ....Characteristic 0.1 % proof stress of the prestressing steel bar, see Annex 39

f_{pk}..........kN ....Characteristic tensile strength of the prestressing steel bar, see Annex 39

S_n........ mm^2............Nominal cross-sectional area of the prestressing steel bar, see Annex 38

P_{m0}........kN ....Initial prestressing force immediately after stressing and anchoring

P_{max}.......kN ....Maxiumum prestressing force

$P_{max,\,o}$ ....kN ....Maximum overstressing force

The designations of the bar tendons are given in Annex 40.

1.4 Friction losses

Friction losses are considered for bonded bar tendons. Unbonded and external bar tendons are straight tendons only and losses of prestressing force due to friction generally do not need to be taken into account.

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

$$P_x = P_0 \cdot e^{-\mu \cdot (\alpha + k \cdot x)}$$

Where

P_x..........kN.............Prestressing force at a distance x from the stressing anchor along the bar tendon

P_0..........kN.............Prestressing force at the distance x = 0 m

μ......... rad^{-1}...........Friction coefficient, $\mu = 0.50\ rad^{-1}$ for thread bars and $\mu = 0.25\ rad^{-1}$ for plain bars in steel strip ducts

θ.......... rad............Sum of the angular deviations over a distance x, irrespective of direction or sign

k........ rad/m...........Coefficient of unintentional angular deviation, $k = 8.7 \cdot 10^{-3}$ rad/m, corresponding to a wobble coefficient of $\beta = 0.5$ °/m

x........... m..............Distance along the bar tendon from the point where the prestressing force is equal to P_0

NOTE 1 rad = 1 m/m = 1

If longitudinal vibrations are applied to thread bars during stressing operations, the friction coefficient μ may be decreased to a reduced friction coefficient $_{red}\mu$. The longitudinal vibrations may be applied upon attainment of the overstressing force. The reduced friction coefficient due to application of longitudinal vibrations is calculated by the following equation.

$$_{red}\mu = \mu \cdot \frac{\alpha + \beta \cdot l}{60} \leq \mu$$

Where

$_{red}\mu$...... rad^{-1}...........Reduced friction coefficient

μ......... rad^{-1}...........Friction coefficient, $\mu = 0.50\ rad^{-1}$ for thread bars in steel strip ducts

α........... °..............Sum of the angular displacements over the bar tendon length, irrespective of direction or sign

β.......... °/m............Wobble coefficient, $\beta = 0.5$ °/m

l............ m..............Tendon length

NOTE 1 rad = 1 m/m = 1

If longitudinal vibrations are applied to plain bars in steel strip ducts and the tendon length does not exceed 30 m, the reduced friction coefficient is $_{red}\mu = 0.15\ rad^{-1}$.

Friction losses in anchorages are low and do not need to be taken into consideration in design and execution.

1.5 Slip at anchorages and couplings

Slip at anchorages and couplings is considered in design of the structure. Annex 41 specifies the slip values, taken into account for determining prestressing force and tendon elongation. After three cycles, comprising stressing and transfer of prestressing force to anchorage, reduced slip can be applied at the stressing anchor, see Annex 41. At each cycle, the anchor nut is firmly tightened prior to releasing the prestressing jack.

1.6 Centre and edge distances, concrete cover

Centre and edge distances of the anchorage given in Annex 11, Annex 12, Annex 13, Annex 14, Annex 15, Annex 16, Annex 21, and Annex 22 for an unbonded and external bar tendon are adopted. They depend on the actual mean cylinder compressive strength, $f_{cm,\,0,\,cyl}$, of concrete at time of stressing.

Centre and edge distances of the anchorage given in the Annexes may be reduced in one direction by up to 15 %, but are not smaller than the dimensions of the anchor plate and placing of additional reinforcement is still possible. In case of a reduction of the distances in one direction, the centre and edge distances in the perpendicular direction are increased by the same percentage, in order to keep the same concrete area in the anchorage zone.

Concrete cover of the bar tendon is in no case less than 20 mm and not smaller than concrete cover of reinforcement in the same cross section. Concrete cover of the anchorage should be at least 20 mm. The respective standards and regulations on concrete cover in force at the place of use are considered.

1.7 Strength of concrete

Concrete according to EN 206[2] is used.

At the time of transmission of full prestressing force to the structural concrete, the actual mean cylinder compressive strength of concrete, $f_{cm,\,0,\,cyl}$, at least as given in Annex 11, Annex 12, Annex 13, Annex 14, Annex 15, Annex 16, Annex 21, and Annex 22. The actual mean compressive strength, $f_{cm,\,0,\,cyl}$, is verified by means specimens, which are cured under the same conditions as the structure.

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

1.8 Reinforcement in the anchorage zone

Steel grade and dimensions of additional reinforcement specified in Annex 14, Annex 15, Annex 16, and Annex 22 are conformed to. The position of the additional reinforcement, centric to the tendon axis, is ensured by appropriate means.

If required for a specific project design, the reinforcement given in Annex 14, Annex 15, Annex 16, and Annex 22 may be modified in accordance with the respective regulations in force at the place of use as well as with the relevant approval of the local authority and of the ETA holder to provide equivalent performance.

1.9 Support of ducts

The ducts are secured in their positions. Spacing of duct support is up to 2.5 m.

1.10 Radius of curvature

The minimum elastic radius of curvature, min R_{el}, not requiring cold bending, as well as the minimum cold bent radius of curvature, min R_{kv}, are listed in Annex 42. Thereby, the maximum prestressing forces given in Annex 40 are applicable.

The radius of curvature, R, may be less than the minimum elastic radius of curvature, min R_{el}, see Annex 42. In this case, the prestressing steel bars are cold bent. Cold bending may also be required for larger radius, if the prestressing steel bar is not adapting itself to the intended curvatures, e.g. for very short bar tendon or horizontal tendon layout. Cold bent radius of curvature, R_{kv}, less than the minimum cold bent radius of curvature, min R_{kv}, see Annex 42, may only be applied if their serviceability has been verified specifically.

[2] Standards and other documents referred to in the European Technical Assessment are listed in Annex 46 and Annex 47.

If the prestressing steel bar is cold bent, the working modulus A to determine tendon elongation is applied.

– $A = 195\,000\ \text{N/mm}^2$ where .... $500 \cdot d \leq R_{kv}$
– $A = 185\,000\ \text{N/mm}^2$ where .... $200 \cdot d \leq R_{kv} \leq 500 \cdot d$ for thread bar
– $A = 185\,000\ \text{N/mm}^2$ where .... $150 \cdot d \leq R_{kv} \leq 500 \cdot d$ for plain bar

For cold bending, only equipment that produces a uniform curvature and does not damage the prestressing steel bar, e.g. by friction marks etc., is used.

Components

1.11 Prestressing steel bar

The characteristics of the prestressing steel bar are given in Annex 38 and Annex 39.

The prestressing steel bar is either a thread bar or a plain bar, with circular cross section and hot rolled of prestressing steel Y1050H according to prEN 10138-4.

In the course of preparing the European Technical Assessment, no characteristic has been assessed for the prestressing steel bar. In execution, a suitable prestressing steel bar that conforms to Annex 38 and Annex 39 and is according to the standards and regulations in force at the place of use is taken.

1.11.1 Thread bar

Nominal diameters of thread bar are 17.5, 26.5, 32, 36, 40 and 47 mm. The thread bar features continuous hot rolled ribs, providing a right-handed thread along the entire length of the prestressing steel bar.

1.11.2 Plain bar

Nominal diameters of the plain bar are 32 and 36 mm. At both ends, the plain bar is provided with a special cold rolled thread.

1.12 Anchorage and coupling

1.12.1 General

Specifications of anchorage components are given in the Annexes and the technical file[3] of the European Technical Assessment. Therein the components' dimensions, materials, and material identification data with tolerances are specified.

1.12.2 Anchor plate

The anchor plate is made of steel. Following anchor plates are available.

– Solid plate, square according to Annex 3 for bonded, unbonded, and external bar tendon
– Solid plate, rectangular according to Annex 4 for bonded, unbonded, and external bar tendon
– Solid plate, rectangular, small according to Annex 5 for bonded bar tendon
– QR-plate according to Annex 6 for bonded bar tendon

All anchor plates provide a conical bore.

In the manufacturing plant, a connection tube is welded watertight on the anchor plate for unbonded and external bar tendon. A connection tube is not required for stressing anchor and accessible fixed anchor, if the anchor plate is placed on a precast concrete structure.

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

1.12.3 Domed anchor nut

The domed anchor nut is made of steel. The available domed anchor nuts are, see Annex 2.

- Domed anchor nut with grout slots
- Domed anchor nut without grout slot

Whether a domed anchor nut without grout slot or with grout slots is installed depends on the applied corrosion protection system. For stressing anchor in bonded bar tendon, in general the domed anchor nut with grout slots is used, to facilitate injection and ventilation through the grout slots. For a fixed anchor embedded in concrete, the domed anchor nut is tack welded perpendicularly onto the anchor plate at the manufacturing plant.

1.12.4 Coupler

The couplers are made of steel. Following couplers are available.

- Coupler according to Annex 7
- Coupler L according to Annex 7, to joint two thread bars with angular cut ends
- Transition coupler according to Annex 8 enables jointing of thread bar with plain bar of the same nominal diameter.

1.13 Additional reinforcement

Steel grade, ribbed reinforcing steel, $R_e \geq 500$ N/mm^2, and dimensions, see Annex 14, Annex 15, and Annex 16 for bonded bar tendon, and Annex 22 for unbonded and external bar tendon, of the additional reinforcement are adopted.

The position of the additional reinforcement, centric to the tendon axis, is ensured by appropriate means.

1.14 Duct

1.14.1 Bonded bar tendon

Steel strip sheath in accordance with EN 523 is used. Alternatively, corrugated plastic ducts may be installed for straight bar tendons, if permitted at the place of use.

In general, the prestressing steel bars are provided with ducts prior to installation. Steel strip sheath are coupled with duct sleeves C in accordance with EN 523. Around the coupling, a steel strip coupler tube in accordance with EN 523 is used.

1.14.2 Unbonded and external bar tendon

The dimensions given in Annex 24, Annex 25, Annex 26, Annex 27, Annex 28, Annex 30, Annex 31, Annex 32, and Annex 33 are standard dimensions. The minimum nominal wall thickness of PE-tubes is 2 mm and of steel tubes is 2 mm, For mechanical protection of corrosion protection measures according to Annex 27, Annex 30, and Annex 31, minimum nominal wall thickness of PE-tubes is 1 mm. Steel tubes and PE-tubes conform to Annex 37. To compensate tolerances, the wall thicknesses of the tubes may be increased.

If steel tubes are used for permanent corrosion protection of bar tendons that are grouted prior to installation, see Annex 25, only steel tubes with a length of maximum 12 m and without weld joints are used. On the inner and outer surface, the steel tubes are provided with corrosion protection.

1.15 Temporary corrosion protection

1.15.1 General

The bonded bar tendon is grouted and thereby, in general, provided with permanent corrosion protection.

Unbonded bar tendon with free tendon duct and external bar tendon are provided either with a permanent or temporary corrosion protection. Unbonded bar tendon without free tendon duct is, similar to bonded bar tendon, provided with permanent corrosion protection only.

For bar tendons with temporary corrosion protection, the exposed steel parts other than prestressing steel do not need to be protected, if not subjected to particular corrosive environment or if not required for aesthetic reasons.

1.15.2 Unbonded bar tendons with free tendon duct and external bar tendons

The prestressing steel bar is provided with corrosion protection coating in accordance with EN ISO 12944-5, with a thickness of at least 200 µm, and is installed within a smooth PE-tube in conformity to Annex 24 and with a wall thickness according to Clause 1.14.2. At the anchorage, the void between connection tube and prestressing steel bar is filled with corrosion protection filling material and insertion and overlapping depths are observed, see Annex 24.

For unbonded bar tendons with free tendon duct, the bar tendon duct always is dry. This is attained by appropriate measures.

1.16 Permanent corrosion protection

1.16.1 General

For bar tendon with permanent corrosion protection, corrosion protection of anchorages, steel tubes as well as all other exposed steel parts is attained as follows.

- All exposed or outside surfaces of steel parts, e.g. connection tubes, anchorage components and caps, insufficiently covered with concrete are protected against corrosion.
  - In general, one of the protection systems in accordance with EN ISO 12944-5 is applied. Surfaces are prepared in accordance with EN ISO 12944-4. For execution of the corrosion protection, EN ISO 12944-7 is observed.
  - As an alternative, anchor plates and caps exposed to corrosivity categories C1 to C3 according to EN ISO 14713-1 are hot dip galvanised according to EN 1461. Mean coating thickness of hot dip galvanised coating is appropriate to the corrosivity categories and the assumed working life. In EN ISO 14713-1, guide values for coating thickness are specified.

    NOTE Corrosion protection by hot dip galvanising relies on coating deterioration of the hot dip galvanised coating in the course of time. However, local corrosive exposure may cause substantially intensified coating deterioration and a clearly reduced time of protection by the hot dip galvanised coating. Where such local corrosive exposure is possible, evaluation of the corrosion protection taken them into account in.
- For PE-tubes, corrosion protection measures are not required.

End anchorages and couplings are completely provided with corrosion protection. All joints and connections are carefully sealed with the prescribed material. The given insertion and overlapping depths are observed, see Annex 9, Annex 24, Annex 25, Annex 26, Annex 27, Annex 28, Annex 30, Annex 31, Annex 32, and Annex 33.

Corrosion protection filling material is in general injected in the voids of ducts, anchorages, and couplings. Alternatively, the corrosion protection filling material may also be applied as corrosion protection tape that comprises a flexible carrier, coated with corrosion protection filling material. The corrosion protection tape is wrapped wrinkle free with overlap on prestressing steel bar, anchor nut, and coupling. After wrapping, the tape is smoothed to ensure a tight and continuous corrosion protection layer.

1.16.2 Bonded bar tendon

A grout cap with port for grouting or venting is attached at the stressing anchor with sealing ring and hex nut. The bonded bar tendon is grouted from grout cap at stressing anchor to end of the duct at fixed anchor. Thereby permanent corrosion protection, continuously along the full tendon length is established. Directly behind and within the fixed anchor embedded in concrete, prestressing steel bar and anchorage components are protected by the structural concrete, see Annex 9. The coupling placed in a coupler tube is grouted together with the duct in one operation, see Annex 10, Annex 17, and Annex 18.

1.16.3 Unbonded bar tendons with free tendon duct and external bar tendons

Three corrosion protection systems are available.

– Corrosion protection system with grout

  The prestressing steel bar is sheathed with a PE-tube or steel tube and centred with spacers at a distance of ≤ 1 m. Alternatively, a PE-cord is wound helically around the prestressing steel bar. The gap between prestressing steel bar and PE-tube is grouted in accordance with EN 446. Thickness of grout is at least 5 mm. Grouting can be performed prior to tendon installation or after stressing, see Annex 25 and Annex 26.

  The length of a grouted section with PE-tubes does not exceed 50 m. For bar tendons with a length exceeding 50 m, additional grouting inlets are installed.

  Steel tubes with a length of maximum 12 m and without weld joints are used. On the inner and outer surface, the steel tubes are provided with corrosion protection.

– Corrosion protection system with corrosion protection filling material

  A smooth PE-tube with a nominal wall thickness of $t_{nom} \geq 2$ mm is slipped over the prestressing steel bar. Spacers with a distance of maximum 1 m along the prestressing steel bar ensure a cover of corrosion protection filling material of at least 5 mm. The corrosion protection filling material is injected into the void between prestressing steel bar and PE-tube through the inlet of the cap, see Annex 28.

– Corrosion protection system according to Annex 27

  The corrosion protection is applied according to defined procedures, in line with the standards and regulations in force at the place of use.

For unbonded bar tendons with free tendon duct, the bar tendon duct always is dry. This is attained by appropriate measures.

1.16.4 Unbonded bar tendons without free tendon duct

Two corrosion protection systems are available.

– Corrosion protection system with corrosion protection filling material, see Annex 32 and Annex 33

  A smooth PE-tube with a nominal wall thickness of $t_{nom} \geq 2$ mm is slipped over the prestressing steel bar. Spacers with a distance of maximum 1 m along the prestressing steel bar ensure a cover of corrosion protection filling material of at least 5 mm. The corrosion protection filling material is injected into the void between prestressing steel bar and PE-tube through the inlet of the cap.

– Corrosion protection system according to Annex 30 and Annex 31

  The corrosion protection is applied according to defined procedures, in line with the standards and regulations in force at the place of use.

Directly behind and within the fixed anchor embedded in concrete, the prestressing steel bar is protected by the structural concrete.

1.16.5 Anchorage

All anchor plates including connection tubes, if not sufficiently covered with concrete, are protected on their exposed surfaces according to Clause 1.16.1.

The void between connection tube and prestressing steel bar is filled with corrosion protection filling material. To ensure correct filling, in case of accessible fixed anchors the corrosion protection filling material penetrates through the domed anchor nut during threading on the anchorage and in case of stressing anchor after stressing. Otherwise additional corrosion protection filling material is injected.

NOTE With a bar tendon grouted after stressing or injected with corrosion protection filling material, the void between connection tube and prestressing steel bar is injected together with the duct.

If not already provided with corrosion protection during grouting or injecting, the domed anchor nut is protected against corrosion with a cap, filled with corrosion protection filling material or grout, see Annex 35.

Following caps are available.

– PE-cap, for anchorage subjected to only low mechanical stress or without mechanical stress

– Steel cap, for high mechanical stress, thickness $t \geq 4$ mm or $t \geq 3$ mm, are deep-drawn or similar cold formed.

PE-cap and steel cap can be used as injection caps.

1.16.6 Couplings

The coupling is sheathed with a coupler tube, see Annex 17, Annex 18, Annex 20, Annex 23, Annex 29, and Annex 34. The void is injected with grout in accordance with EN 446 or a corrosion protection filling material simultaneously with the duct or individually for each coupling. For grouting and filling operations inlets and vents are installed if required.

1.16.7 Materials for corrosion protection

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

1.17 Material specifications of the components

Material specifications of the components are given in Annex 37.

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

2.1 Intended uses

The PT system SAS – Post-tensioning bar tendon system is intended to be used for the prestressing of structures. The specific intended uses are listed in Table 2.

Table 2 Intended uses

Line №	Use category
Use category according to tendon configuration and material of structure	
1	Internal bonded tendon for concrete and composite structures
2	Internal unbonded tendon for concrete and composite structures
3	External tendon for concrete and composite structures with a tendon path situated outside the cross section of the structure or member but inside its envelope

2.2 Assumptions

2.2.1 General

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

2.2.2 Packaging, transport, and storage

Advice on packaging, transport, and storage includes.

– Temporary protection of prestressing steel bars and components in order to prevent corrosion during transportation from the production site to the job site

– Transportation, storage, and handling of the prestressing steel bars and components in a manner as to avoid damage by mechanical or chemical impact

– Protection of prestressing steel bars and components from moisture

– Shielding of prestressing steel bars where welding operations are performed

2.2.3 Design

2.2.3.1 General

Advice on design includes the following items.

Design of the structure permits correct installation and stressing of bar tendons and correct application of the corrosion protection, in particular grouting and filling with corrosion protection filling material.

Design and reinforcement of the anchorage zone permits correct placing and compacting of concrete.

Unbonded and external bar tendons are with straight tendon paths only.

Diameters of couplers are larger than internal diameters of ducts at anchorages.

Verification of transfer of prestressing forces to structural concrete is not required if concrete strength at time of stressing, centre spacing and edge distance of bar tendons, as well as grade and dimensions of additional reinforcement, see Annex 11, Annex 12, Annex 13, Annex 14, Annex 15, Annex 16, Annex 21, and Annex 22 are conformed to. The forces outside the area of the additional reinforcement are verified and, if necessary, covered by appropriate reinforcement. Reinforcement of the structure is not employed as additional reinforcement. Reinforcement exceeding the required reinforcement of the structure may be used as additional reinforcement if appropriate placing is possible.

Centre spacing and edge distance of anchorages given in see Annex 11, Annex 12, Annex 13, Annex 14, Annex 15, Annex 16, Annex 21, and Annex 22 may be reduced in one direction by up to 15 %, but not smaller than the outside dimensions of the anchor plates and placing of additional reinforcement is still possible. In case of a reduction of the spacing in one direction, centre spacing and edge distance in the perpendicular direction are increased by the same percentage.

If required for a specific project design, the reinforcement given in Annex 14, Annex 15, Annex 16, and Annex 22 may be modified in accordance with the respective regulations in force at the place of use as well as with the relevant approval of the local authority and of the ETA holder to provide equivalent performance.

2.2.3.2 Fixed couplings

The fixed coupling is for a bonded bar tendon only. Under all possible load combinations, the prestressing force at the 2nd construction stage is at no time higher than at the 1st construction stage, neither during construction nor in the final state.

2.2.3.3 Increased losses of prestressing forces at couplings

For verification of crack width limitation and for verification of stress range, increased losses of prestressing force at the fixed coupling due to creep and shrinkage of the concrete are considered. In the areas of the fixed coupling, the determined loss of prestressing force of bar tendon without influence of coupling is multiplied by the factor 1.5.

NOTE For movable coupling, increased losses of prestressing forces need not to be taken into consideration.

2.2.3.4 Movable coupling

The length of the coupler tube and its position relative to the coupling permit an unimpeded movement of the coupler in the coupler tube along a length of max $\begin{cases} 1.2 \cdot \Delta L \\ \Delta L + 40\ \text{mm} \end{cases}$, where ΔL in mm as the symbol for the expected displacement, left and right, of the coupler during stressing, see Annex 17 and Annex 23.

2.2.3.5 Safeguard against bursting out of the prestressing steel bar

Prevention of bursting out of the prestressing steel bar in case of a bar failure of unbonded and external bar tendons is ensured by appropriate measures, see examples of Annex 36. The safeguard devices are designed based on the expected impact force or energy.

2.2.3.6 Tendon in steel, masonry, and timber structures

Post-tensioning kits are primarily used in structures made of concrete. They can, however, be used with other structural materials, i.e. in steel, masonry, and timber structures. However, there is no particular assessment in EAD 160004-00-0301 for these applications.

2.2.3.7 Unbonded and external bar tendon in steel and timber structures

Load transfer of stressing force from the anchorage to the steel or timber structure is via steel member, designed according to Eurocode 3.

The steel member has dimensions as to permit a force of $1.1 \cdot F_{pk}$ being transferred into the steel or timber structure. The verification is according to Eurocode 3 or Eurocode 5 respectively, as well as to the standards and regulations in force at the place of use.

2.2.3.8 Bonded, unbonded, and external bar tendon in masonry structures

Load transfer of stressing force from the anchorage to the masonry structure is via concrete or steel member, designed according to the European Technical Assessment, especially according to the Clauses 1.6, 1.7, and 1.8, or Eurocode 3 respectively.

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

2.2.4 Installation

2.2.4.1 General

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

Assembly and installation of bar tendons is only carried out by qualified PT specialist companies with the required resources and experience in the use of bar post-tensioning systems, see CWA 14646. The company's PT site manager has a certificate, stating that she or he has been trained by the ETA holder and that she or he possesses the necessary qualifications and experience with the “SAS – Post-tensioning bar tendon system”.

2.2.4.2 Tendon handing

During installation, careful handling of bar tendons is ensured.

- Bonded bar tendon and bar tendon without free tendon duct are installed prior to concreting.
- Tendon with free tendon duct and external bar tendon are usually installed after placing of concrete.

Before concreting, a final examination of the installed bar tendons is performed. Damages to ducts are repaired immediately or reported to the responsible person.

If surface water or dirt can enter at the anchorage prior to grouting, a protective cap, provided with a sealing ring is fastened onto the anchorage with screws, see Annex 35. Alternatively, a plastic protection cap according to Annex 35 can be attached.

2.2.4.3 Welding at anchorages

The domed anchor nut may be tack welded onto the anchor plate only at the manufacturing plant.

After installation of the bar tendon, no further welding operations are performed at anchorages and immediate to the bar tendon.

2.2.4.4 Installation of bonded bar tendon

2.2.4.4.1 Duct installation

In general, the prestressing steel bars are provided with ducts prior to installation. bar tendons are installed with high accuracy on supports, see Clause 1.9.

The sheathing consists of ducts with duct sleeves C. On-site assembling considers the following items.

- All joints of the connecting elements, e.g. duct sleeves and ducts, are sealed using a chloride-free adhesive tape.
- In fastening the ducts, avoid damage by compression.
- The vent and grout connections are installed tension proof.
- The sheathing of the coupling is secured in its position as to avoid unintentional displacement.
- If confusion is likely, the grout hoses are clearly marked, e.g. by number plates.
- Prior to concrete placing, the sheathing is checked for damages.

2.2.4.4.2 Stressing anchor

The stressing anchor comprises anchor plate and in general domed anchor nut with grout slots, see Annex 9. The individual components of the stressing anchor are delivered to the construction site and assembled on the prestressing steel bar.

The stressing anchor can also be used as a fixed anchor. In that case, a domed anchor nut without grout slot or with grout slots can be used.

On-site assembly comprises the following steps.

- The anchor plate, i.e. solid plate, square, solid plate, rectangular, solid plate, rectangular, small, or QR-plate, is fastened onto the formwork on site. If required, a recess form is installed.

- Firstly, the steel strip duct is placed into the connection tube, the latter is welded on the back face of the anchor plate – either solid plate, square, rectangular, rectangular, small, or QR-plate – and the joint connection tube to duct is sealed with adhesive tape.
- The domed anchor nut is fastened tightly.

2.2.4.4.3 Fixed anchor

On-site assembly comprises the following steps, see Annex 9.

- A plastic end cap or vent cap is threaded onto the prestressing steel bar, into the duct sleeve C, and, if required, sealed with chloride-free adhesive tape.
- The fixed anchor, comprising anchor plate and domed anchor nut, tack welded perpendicularly onto the anchor plate, is threaded onto the prestressing steel bar. The fixed anchor is firmly secured in its position as to avoid unfastening.

2.2.4.5 Installation of unbonded and external bar tendon

2.2.4.5.1 General

For a bar tendon with free tendon duct and an external bar tendon, the prestressing steel bar is usually provided with one anchorage prior to installation. The other anchorage is installed on the structure.

For a bar tendon without free tendon duct, both anchorages are usually installed on the prestressing steel bar prior to installation.

2.2.4.5.2 Installation of prestressing steel bar

Careful handling is required to avoid damage of the applied corrosion protection. For unbonded bar tendon with free tendon duct the prestressing steel bar with applied corrosion protection is lifted for insertion into the structure, in order to prevent the tube from rubbing on the concrete edge at the beginning of the tendon duct. If required, an auxiliary insertion device is applied. Corrosion protected steel tubes are inserted, protected by a PE-tube, which is subsequently withdrawn.

2.2.4.5.3 Stressing and fixed anchor

On-site assembly comprises the following steps.

- The bearing surface of the anchor plate is perpendicular to the tendon axis. If required, a compensating layer is applied.
- During installation, corrosion protection filling material is applied at anchor plate and connection tube.
- Corrosion protection is applied according to the Clauses 2.2.4.9.3 and 2.2.4.10.2.

For bar tendons without free tendon duct, anchor plates without or with connection tubes are used at the fixed anchors. Within an embedded fixed anchor, the domed anchor nut can be tack welded perpendicularly onto the anchor plate.

2.2.4.6 Coupling installation

The coupling is shown in Annex 10, Annex 17, Annex 18, Annex 20, Annex 23, Annex 29, and Annex 34.

On-site assembling comprises the following steps.

- Prior to installation, the thread bar or the thread of the plain bar is marked to enable control of engagement length of the prestressing steel bar in the coupler.
- If the coupling is secured by an adhesive, installation is performed once the adhesive is sufficiently set and hardened. Alternative to gluing, the coupling can be secured with nuts, see Annex 20, Annex 23, Annex 29, and Annex 34.

- The correct position of the coupler in the coupler tube with regard to direction and amount of displacement during stressing is checked prior to final assembly of the coupler tube.
- The coupler tube at the coupler is sealed with a chloride-free adhesive tape.
- Corrosion protection is applied according to the Clauses 2.2.4.8.3, 2.2.4.9.4, and 2.2.4.10.3.

2.2.4.7 Stressing and stressing records

2.2.4.7.1 Stressing

Upon attainment of the required mean cylinder compressive strength, $f_{cm,\,0,\,cyl}$, of concrete in the anchorage zone, the maximum prestressing force may be applied, see the Annex 40.

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

Stressing comprises the following steps.

- The pull rod coupler is threaded halfway onto the prestressing steel bar.
- A hydraulic jack is positioned, resting on the anchor plate and connected to the prestressing steel bar.
- The prestressing steel bar is stressed.
- During stressing, the domed anchor nut is continuously tightened. The revolutions of the nut are counted, whereof the elongation can be determined. The force is monitored using manometer readings. The difference in length of the bar protrusion before and after stressing is determined as well.
- The measurement results are recorded in the stressing record.
- For grouted bar tendons with steel tubes and with free tendon duct, the prestressing force is firstly increased to the maximum overstressing force and subsequently completely relaxed. Then the final prestressing force is applied.
- If longitudinal vibrations are applied, they are applied after overstressing force is attained, e.g. by strokes onto the front face of the prestressing steel bar.
- Until grouting, the prestressing force, if required, can be checked and corrected at any time.
- Straight bar tendons are stressed from one end. For curved bar tendons, stressing from both ends can be advisable in particular to avoid higher losses of prestressing forces due to friction.

The domed anchor nut features grout slots to permit penetration of grout from cap into duct or out of duct into cap during grouting.

Re-stressing of the bar tendons prior to final cutting of thread bar protrusions or grouting is permitted.

2.2.4.7.2 Stressing records

All stressing operations are recorded for each bar tendon. In general, the required prestressing force is applied. The elongation is measured and compared with the calculated value.

2.2.4.7.3 Stressing equipment, space requirements and safety-at-work

For stressing, hydraulic jacks are used. Information about the stressing equipment has been submitted to Österreichisches Institut für Bautechnik.

To stress the bar tendons, clearance of approximately 1 m directly behind the anchorage is ensured. The ETA holder keeps available more detailed information on the prestressing jacks used and the required space for handling and stressing.

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

2.2.4.8 Grouting of bonded bar tendon

2.2.4.8.1 General

Grout according to EN 447, special grout according to EAD 160027-00-0301, or ready-mixed grout with an adequate composition according to standards and regulations in force at the place of use is applied.

Grout establishes both, bond between prestressing steel bar and structure and corrosion protection of prestressing steel bar and anchorage.

2.2.4.8.2 Grouting

Following stressing, the grout is injected into the void between prestressing steel bar and duct. For the grouting procedure, EN 446 applies. To ensure correct filling the voids, the following items are considered in addition to EN 446.

– For bar tendon lengths exceeding 50 m, additional grouting inlets are installed.
– For tendon paths with distinct high points, special post-grouting procedures are performed to avoid voids in the hardened grout. The design of the structure already considers the required measures.
– Only mixing and grouting equipment as permitted by the ETA holder is used.
– Grouting speed is between 5 and 15 m/min.
– All vents and grouting inlets are sealed immediately after grouting to prevent escaping of grout from the duct. To ensure the duct is correctly filled up to the domed anchor nut at the stressing anchor as well as at the fixed anchor not embedded in concrete, grout penetrates through the grout slots of the domed anchor nut. Only then the vents are closed, e.g. with plugs.
– Obstructed, ungrouted ducts are immediately reported to the responsible PT site manager.
– All grouting operations are recorded in detail in an injection data sheet.

2.2.4.8.3 Coupling

The coupling is sheathed with a coupler tube and at both end with transition pieces or end piece made of PE or steel. The joints between tube and transition pieces or end piece are sealed with heat-shrinking sleeve or chloride-free adhesive tape, see Annex 17 and Annex 18. Inlets and vents are installed where required.

The movable coupling is grouted together with the duct in one operation.

With the fixed coupling, a toroidal sealing ring is inserted between grout cap and coupler tube end piece and tightened with a flat hex nut. The prestressing steel bar at the toroidal sealing ring, the flat hex nut, and the grout cap, see Annex 18, is provided with corrosion protection filling material that does not affect the toroidal sealing ring.

2.2.4.9 Permanent corrosion protection of unbonded bar tendon with free tendon duct and external bar tendon

2.2.4.9.1 Corrosion protection with grout

The prestressing steel bar is sheathed with a PE-tube or steel tube and centred using spacers at a distance of ≤ 1 m, see Annex 25 and Annex 26. The gap between prestressing steel bar and PE-tube or steel tube is injected with grout according to Clause 2.2.4.8. Cover of grout on the prestressing steel bar is ≥ 5 mm. Grouting can be performed

- prior to tendon installation with thread bar, see Annex 25 or
- after stressing with plain bar and thread bar, see Annex 26.

For grouting prior to installation, see Annex 25, an end cap or vent cap is installed at both ends of the sheathing. The steel tube is without weld joints and the length does not exceed 12 m. On the inner surface, the steel tube is coated with a corrosion preventing material that is set and hardened prior to inserting the prestressing steel bar.

The sheathed prestressing steel bar is supported in a slightly inclined position, vibration-free and shielded from direct sunlight until the cement grout has sufficiently set and hardened. The grout is injected through the lower end cap.

After grouting, end cap or vent cap is cut and the protruding prestressing steel bar is carefully cleaned from grout.

For grouting after stressing, see Annex 26, a domed anchor nut with grout slots is used. Grout is injected, as for bonded bar tendons according to Clause 2.2.4.8.2, through the grout slots of the domed anchor nut using a grout cap. Post-grouting is usually required, particularly if the inclination of the bar tendon is greater than 30 °.

The length of a grouted section with PE-tube does not exceed 50 m. For bar tendon with a length of more than 50 m, additional grouting inlets are installed. The steel tube is without weld joints and the length does not exceed 12 m. The internal and external surfaces of the steel tube are provided with corrosion protection coating.

Obstructed bar tendon that cannot be completely grouted, is immediately reported to the responsible PT site manager.

2.2.4.9.2 Corrosion protection system with corrosion protection filling material

Corrosion protection is attained by filling the void between prestressing steel bar and PE-tube with corrosion protection filling material, see Annex 28.

A smooth PE-tube according to EN 12201-1 with a nominal wall thickness of $t_{nom} \geq 2$ mm is slipped over the prestressing steel bar. Spacers with a distance of ≤ 1 m along the prestressing steel bar ensure a cover of corrosion protection filling material on the prestressing steel bar of ≥ 5 mm. Alternatively to spacers, a PE cord is wounded helically around the bar.

The corrosion protection filling material is injected into the void between prestressing steel bar and PE-tube through the inlet at the cap until it escapes through the vent hoses or at the vents of the anchorage. To ensure complete filling of the bar tendon it is verified that the corrosion protection filling material escapes through all vents and, if accessible, penetrates through the anchor nut. Viscosity of the corrosion protection filling material is checked after it has passed through the bar tendon.

Immediately after finalising the filling procedure, all vents and inlets are properly sealed with caps to prevent loss of corrosion protection filling material and prevent ingress of water.

All filling operations are recorded in detail.

An obstructed bar tendon that cannot be completely filled, is immediately reported to the responsible PT site manager.

Alternatively, the tendon can be filled with corrosion protection filling material at the manufacturing plant. End caps or vent caps or heat shrinking sleeves with appropriate vent hoses are applied. After filling is completed, end caps or vent caps or vent hoses are cut and the duct is sealed during transport with a chloride free adhesive tape.

2.2.4.9.3 Anchorage

All anchor plates including connection tubes, if not sufficiently covered with concrete, are coated on their exposed surfaces, see Clause 1.16.1. For temporary corrosion protection, this may only be required for aesthetic reasons.

The void between connection tube and prestressing steel bar is filled with corrosion protection filling material.

For filling the gap between prestressing steel bar and connection tube, the connection tube is filled with corrosion protection filling material prior to slipping on the anchorage. To ensure correct filling, in case of accessible fixed anchors the corrosion protection filling material penetrates through the domed anchor nut during threading on the anchorage and in case of stressing anchor after stressing. Otherwise additional corrosion protection filling material is injected.

Alternatively, the void between prestressing steel bar and connection tube is filled with corrosion protection filling material through an injection hole, sealed afterwards by the protection cap.

In a grouted bar tendon and a bar tendon with corrosion protection filling material the anchorage is filled together with the duct in one operation.

Prestressing steel bar and domed anchor nut are protected against corrosion with caps, filled with corrosion protection filling material or grout, see Annex 26, Annex 28, and Annex 35.

Alternatively, the corrosion protection filling material may also be applied as corrosion protection tape that comprises a flexible carrier, coated with corrosion protection filling material, see Clause 1.16.1.

Following caps are available.

- Grout cap, for grouting after stressing and injecting corrosion protection filling material, see Annex 26 and Annex 28
- PE cap, for an application without or with only low mechanical stress, see Annex 35
- Steel cap, for an application with high mechanical stress, with wall thickness $t \geq 4$ mm or $t \geq 3$ mm for deep-drawn or similar cold formed caps, see Annex 35

PE cap and steel cap according to Annex 35 can be used as injection caps for grouting or injecting corrosion protection filling material.

2.2.4.9.4 Couplings

The coupling is sheathed with a coupler tube made of steel, with a wall thickness of at least $t = 2$ mm, or PE, with a wall thickness of at least $t = 2$ mm. The joint coupler tube to duct is sealed with a heat shrinking sleeve, see Annex 29.

Grout or corrosion protection filling material is injected into the coupling. For grouting or injecting corrosion protection filling material, inlets and vents are installed where required.

2.2.4.10 Permanent corrosion protection of unbonded bar tendon without free tendon duct

2.2.4.10.1 Corrosion protection system with corrosion protection filling material

Corrosion protection is attained by filling the void between prestressing steel bar and PE-tube with corrosion protection filling material, see Annex 32 and Annex 33.

A smooth PE-tube according to EN 12201-1 with a nominal wall thickness of $t_{nom} \geq 2$ mm is slipped over the prestressing steel bar. Spacers with a distance of ≤ 1 m along the prestressing steel bar ensure a cover of corrosion protection filling material on the prestressing steel bar of ≥ 5 mm.

Filling is performed according to Clause 2.2.4.9.2.

Directly behind and within the fixed anchor embedded in concrete, the prestressing steel bar is protected by the structural concrete, see Annex 32 and Annex 33.

2.2.4.10.2 Anchorage

Corrosion protection of the anchorage is established according to Clause 2.2.4.9.3.

2.2.4.10.3 Couplings

The coupling is sheathed with a duct in accordance with EN 523, see Annex 34. The joint coupler duct to duct is sealed with a heat shrinking sleeve, see Annex 34.

The coupling is injected with corrosion protection filling material, inlets and vents are installed where required.

2.3 Assumed working life

The European Technical Assessment is based on an assumed working life of the SAS – Post-tensioning bar tendon system of 2 years for temporary corrosion protection and 100 years for permanent corrosion protection, provided that the SAS – Post-tensioning bar tendon system is subject to appropriate installation, use, and maintenance, see Clause 2.2.

In normal use conditions, the real working life may be considerably longer without major degradation affecting the basic requirements for construction works[4].

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

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

3.1 Essential characteristics

The performances of SAS – Post-tensioning bar tendon system for the essential characteristics are given in Table 3.

Table 3 Essential characteristics and performances of the product

№	Essential characteristic	Product performance
Basic requirement for construction works 1: Mechanical resistance and stability		
1	Resistance to static load	See Clause 3.2.1.1.
2	Resistance to fatigue	See Clause 3.2.1.2.
3	Load transfer to the structure	See Clause 3.2.1.3.
4	Friction coefficient	See Clause 3.2.1.4.
5	Deviation, deflection (limits) for internal bonded and unbonded tendon	See Clause 3.2.1.5.

4 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.

№	Essential characteristic	Product performance
6	Deviation, deflection (limits) for external tendon	See Clause 3.2.1.6.
7	Assessment of assembly	See Clause 3.2.1.7.
8	Corrosion protection	See Clause 3.2.1.8.
Basic requirement for construction works 2: Safety in case of fire		
9	Reaction to fire	See Clause 3.2.2.1.
Basic requirement for construction works 3: Hygiene, health, and the environment		
10	Content, emission, and/or release of dangerous substances	See Clause 3.2.3.1.
Basic requirement for construction works 4: Safety and accessibility in use		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 5: Protection against noise		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 6: Energy economy and heat retention		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 7: Sustainable use of natural resources		
—	No characteristic assessed.	—

3.2 Product performance

3.2.1 Mechanical resistance and stability

3.2.1.1 Resistance to static load

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.1. The characteristic values of maximum force, F_{pk}, of the bar tendon with prestressing steel bars according to Annex 38 and Annex 39 are listed in Annex 39.

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 bar tendon with prestressing steel bars according to Annex 38 and Annex 39 are listed in Annex 39.

Fatigue resistance of anchorages and couplings was tested and verified with an upper force of $0.65 \cdot F_{pk}$, a fatigue stress range of 80 N/mm^2, and $2 \cdot 10^6$ load cycles.

3.2.1.3 Load transfer to the structure

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.3. The characteristic values of maximum force, F_{pk}, of the bar tendon with prestressing steel bars according to Annex 38 and Annex 39 are listed in Annex 39.

Conformity with the stabilisation and crack width criteria specified for the load transfer test was verified to a force level of 0.80 · F_{pk}.

3.2.1.4 Friction coefficient

For friction losses including friction coefficient see Clause 1.4.

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

For minimum radii of curvature see Clause 1.10, i.e. straight tendon for unbonded bar tendon.

3.2.1.6 Deviation, deflection (limits) for external tendon

For minimum radii of curvature see Clause 1.10, i.e. straight tendon.

3.2.1.7 Assessment of assembly

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

3.2.1.8 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 is Class A1 without testing.

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

3.2.3 Hygiene, health, and the environment

3.2.3.1 Content, emission and/or release of dangerous substances

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

– SVOC and VOC

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

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

– Leachable substances

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

3.3 Assessment methods

The assessment of the essential characteristics in Clause 3.1 of SAS – Post-tensioning bar tendon 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 № 1, 2, and 3 of Regulation (EU) № 305/2011, has been made in accordance with Annex A of EAD 160004-00-0301, Post-tensioning kits for prestressing of structures, for

– Item 1, Internal bonded tendon
– Item 4, Internal unbonded tendon
– Item 5, External tendon

3.4 Identification

The European Technical Assessment for SAS – Post-tensioning bar tendon system is issued on the basis of agreed data that identify the assessed product[5]. Changes to materials, to composition, or to characteristics of the product, or to the production process could result in these deposited data being incorrect. Österreichisches Institut für Bautechnik should be notified before the changes are introduced, as an amendment of the European Technical Assessment is possibly necessary.

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

4.1 System of assessment and verification of constancy of performance

According to Commission Decision 98/456/EC, the system of assessment and verification of constancy of performance to be applied to SAS – Post-tensioning bar tendon system is System 1+. System 1+ is detailed in Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, Annex, point 1.1, and provides for the following items.

(a) The manufacturer shall carry out

- (i) factory production control;
- (ii) further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan[6].

(b) The notified product certification body shall decide on the issuing, restriction, suspension, or withdrawal of the certificate of constancy of performance of the construction product on the basis of the outcome of the following assessments and verifications carried out by that body

- (i) an assessment of the performance of the construction product carried out on the basis of testing (including sampling), calculation, tabulated values, or descriptive documentation of the product;
- (ii) initial inspection of the manufacturing plant and of factory production control;
- (iii) continuing surveillance, assessment, and evaluation of factory production control;
- (iv) audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities.

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

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

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

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

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

5.1 Tasks for the manufacturer

5.1.1 Factory production control

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

– Control of the incoming materials

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

– Inspection and testing

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

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

All tests are performed according to written procedures with suitable calibrated measuring devices. All results of inspections, tests, and checks are recorded in a consistent and systematic way. The basic elements of the prescribed test plan are given in Annex 43, conform to EAD 160004-00-0301, Table 3, and are specified in the quality management plan of the SAS – Post-tensioning bar tendon system.

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

– Control of non-conforming products

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

– Complaints

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

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

At least once a year the manufacturer audits the manufacturers of the components given in Annex 44.

5.1.2 Declaration of performance

The manufacturer is responsible for preparing the declaration of performance. When all the criteria of the assessment and verification of constancy of performance are met, including the certificate of constancy of performance issued by the notified product certification body, the manufacturer draws up the declaration of performance. Essential characteristics included in the declaration of performance for the corresponding intended use are given in Table 3. In Annex 45 the combinations of essential characteristics and corresponding intended uses are listed.

5.2 Tasks for the notified product certification body

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

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

5.2.2 Continuing surveillance, assessment, and evaluation of factory production control

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

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

Each manufacturer of the components given in Annex 44 is audited at least once in five years. It is verified that the system of factory production control and the specified manufacturing process are maintained, taking account of the prescribed test plan.

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

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

During surveillance inspection, the notified product certification body takes samples of components of the PT system for independent testing. Audit-testing is conducted at least once a year by the notified product certification body. For the most important components, Annex 44 summarises the minimum procedures. Annex 44 conforms to EAD 160004-00-0301, Table 4. In particular, at least once a year, the notified product certification body also carries out one single tensile element test series according to EAD 160004-00-0301, Annex C.7 and Clause 3.3.4 on specimens taken from the manufacturing plant or at the manufacturer’s storage facility.

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The original document is signed by

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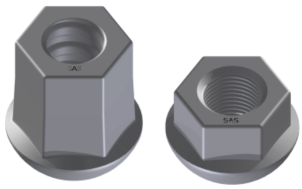
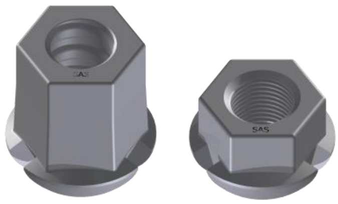
Managing Director

Member of EOTA

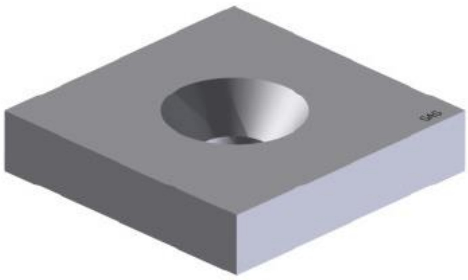
Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bar tendon, bonded, unbonded, and external tendon Components – Anchorage and coupling	**Annex 1** of European Technical Assessment **ETA-05/0122** of 09.12.2019



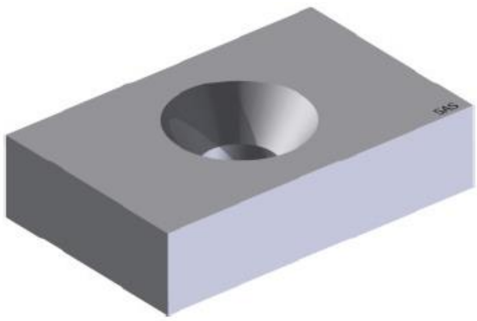
Domed anchor nut
WR/WS 2001



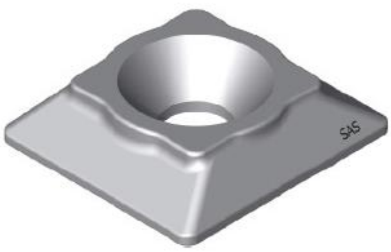
Domed anchor nut with grout slots
WR/WS 2099



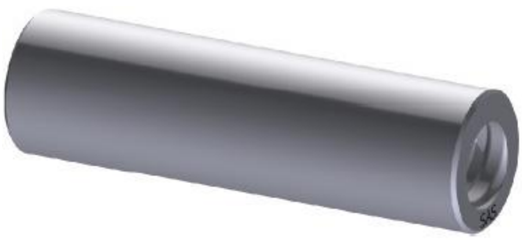
Solid plate, square
WR/WS 2011



Solid plate, rectangular WR/WS 2012,
Solid plate, rectangular, small WR/WS 2076

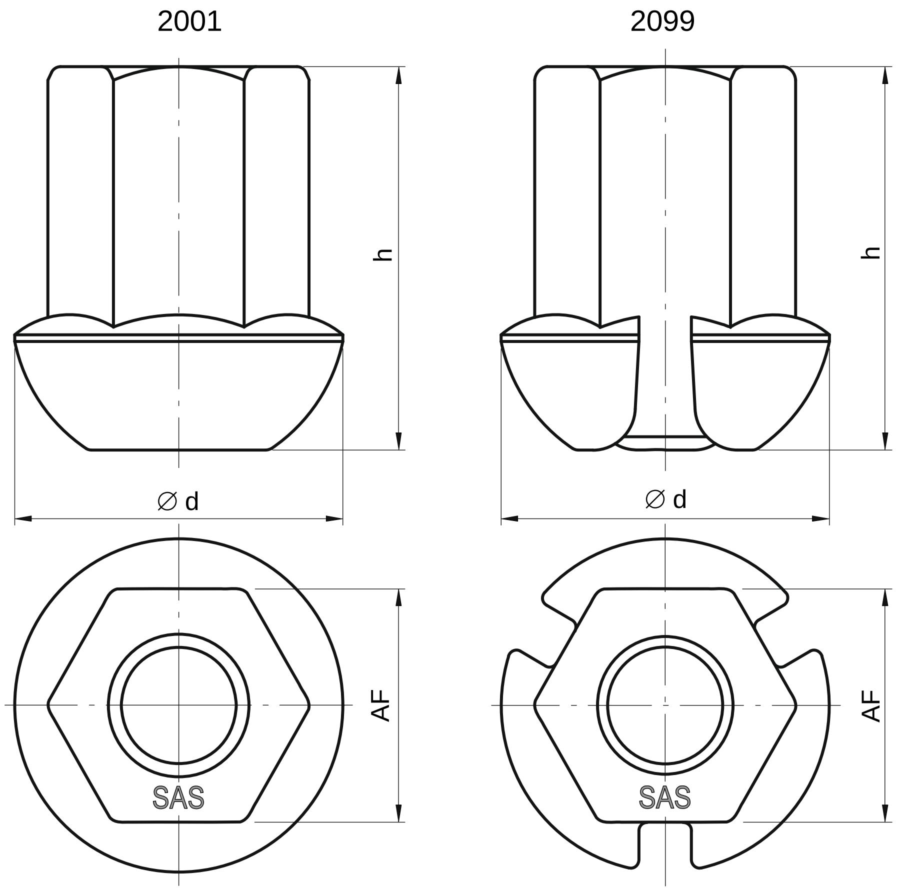


QR-plate
WR/WS 2074



Coupler WR/WS 3003,
Coupler, long WR 3303
Transition coupler WR/WS 3004

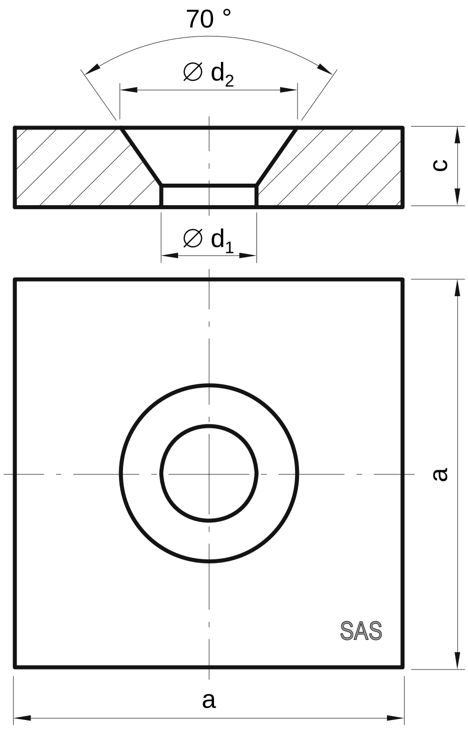
Domed anchor nut WR/WS 2001 / Domed anchor nut with grout slots WR/WS 2099



Prestressing steel bar	Designation	AF	∅ d	L
	—	mm	mm	mm
Thread bar	18 WR	36	50	55
	26.5 WR	50	72	75
	32 WR	60	80	90
	36 WR	65	90	100
	40 WR	70	100	115
	47 WR	80	110	135
Plain bar	32 WS	55	72	46
	36 WS	65	90	60

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bar tendon, bonded, unbonded, and external tendon Solid plate, square WR/WS 2011	**Annex 3** of European Technical Assessment **ETA-05/0122** of 09.12.2019

Solid plate, square WR/WS 2011



Prestressing steel bar	Designation	a	c	∅ d_1	∅ d_2
	—	mm	mm	mm	mm
Thread bar	18 WR	110	30	28	45
	26.5 WR	150	35	39	72
	32 WR	180	40	45	82
	36 WR	200	45	49	92
	40 WR	220	45	54	100
	47 WR	260	50	64	110
Plain bar	32 WS	180	40	45	72
	36 WS	200	45	49	92

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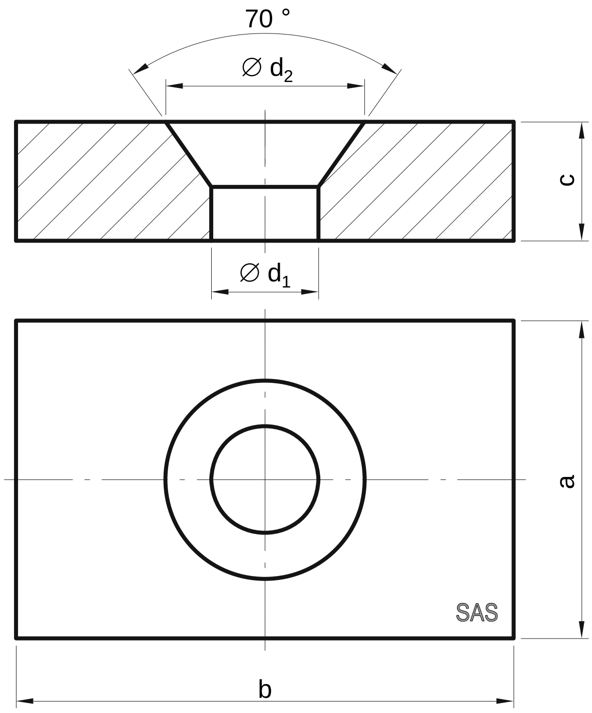
Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

SAS – Post tensioning bar tendon system
SAS-PT bar tendon, bonded, unbonded, and external tendon

Solid plate, rectangular WR/WS 2012

Annex 4
of European Technical Assessment
ETA-05/0122 of 09.12.2019

Solid plate, rectangular WR/WS 2012



Prestressing steel bar	Designation	a	b	c	∅ d_1	∅ d_2
	—	mm	mm	mm	mm	mm
Thread bar	18 WR	100	130	30	28	45
	26.5 WR	130	150	35	39	72
	32 WR	140	180	40	45	82
	36 WR	150	220	50	49	92
	40 WR	160	250	60	54	100
	47 WR	200	280	60	64	110
Plain bar	32 WS	140	180	40	45	72
	36 WS	150	220	50	49	92

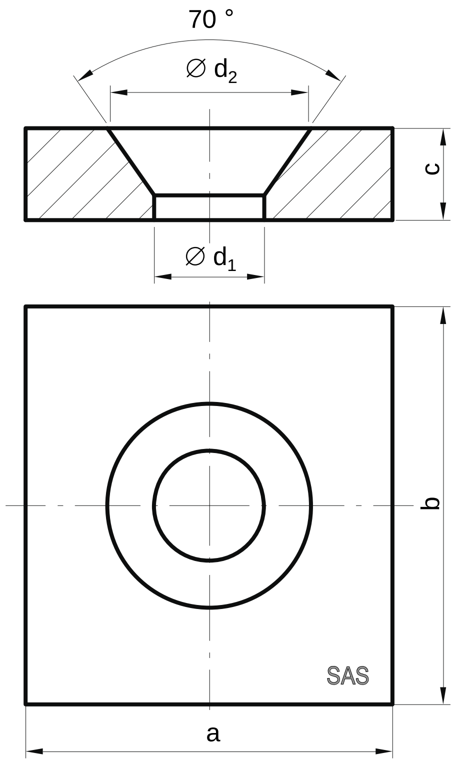
Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

SAS – Post tensioning bar tendon system
SAS-PT bounded bar tendon

Solid plate, rectangular, small
WR/WS 2076

Annex 5
of European Technical Assessment
ETA-05/0122 of 09.12.2019

Solid plate, rectangular, small WR/WS 2076



Prestressing steel bar	Designation	a	b	c	∅ d_1	∅ d_2
	—	mm	mm	mm	mm	mm
Thread bar	18 WR	80	90	25	28	45
	26.5 WR	120	130	30	39	72
	32 WR	140	165	35	45	82
	36 WR	160	180	40	49	92
	40 WR	180	195	45	54	100
	47 WR	210	235	55	64	110
Plain bar	32 WS	140	165	35	45	72
	36 WS	160	180	40	49	92

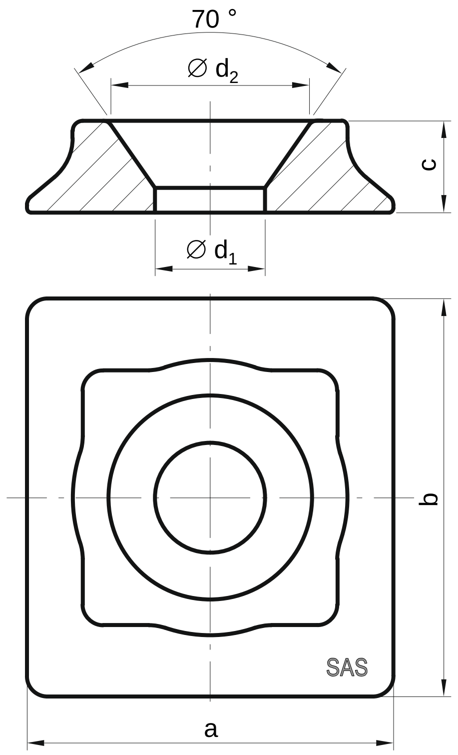
Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

SAS – Post tensioning bar tendon system
SAS-PT bounded bar tendon

QR plate WR/WS 2074

Annex 6
of European Technical Assessment
ETA-05/0122 of 09.12.2019

QR-plate WR/WS 2074



Prestressing steel bar	Designation	a	b	c	∅ d_1	∅ d_2
	—	mm	mm	mm	mm	mm
Thread bar	26.5 WR	120	130	30	39	72
	32 WR	140	165	35	45	82
	36 WR	160	180	40	49	92
	40 WR	180	195	45	54	100
Plain bar	32 WS	140	165	35	45	82
	36 WS	160	180	40	49	92

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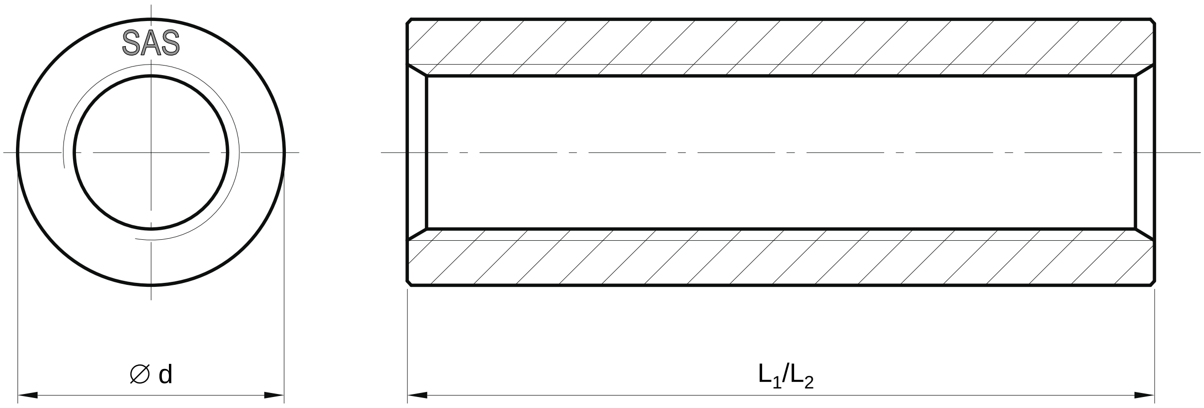
Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

SAS – Post tensioning bar tendon system
SAS-PT bar tendon, bonded, unbonded, and external tendon

Coupler WR/WS 3003
Coupler, long WR 3303

Annex 7
of European Technical Assessment
ETA-05/0122 of 09.12.2019

Coupler WR/WS 3003, Coupler, long WR 3303



L_1...... Length of coupler WR/WS 3003
L_2...... Length of coupler, long WR 3303 for unbonded bar tendon with angular cut thread bars

Prestressing steel bar	Designation	∅ d	L_1	L_2
	—	mm	mm	mm
Thread bar	18 WR	36	100	115
	26.5 WR	50	170	195
	32 WR	60	200	230
	36 WR	68	210	245
	40 WR	70	245	285
	47 WR	83	270	—
Plain bar	32 WS	60	110	—
	36 WS	68	160	—

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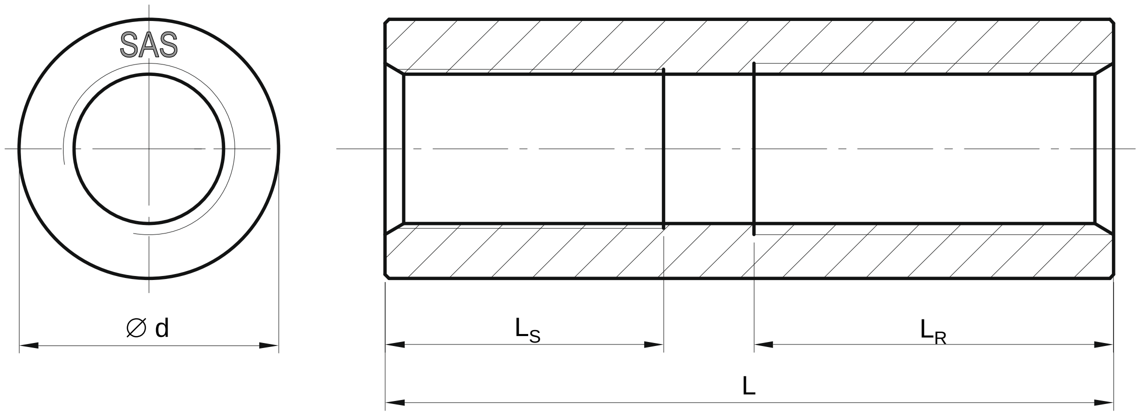
Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bar tendon, bonded, unbonded, and external tendon Transition coupler WR/WS 3004	**Annex 8** of European Technical Assessment **ETA-05/0122** of 09.12.2019

Transition coupler WR/WS 3004



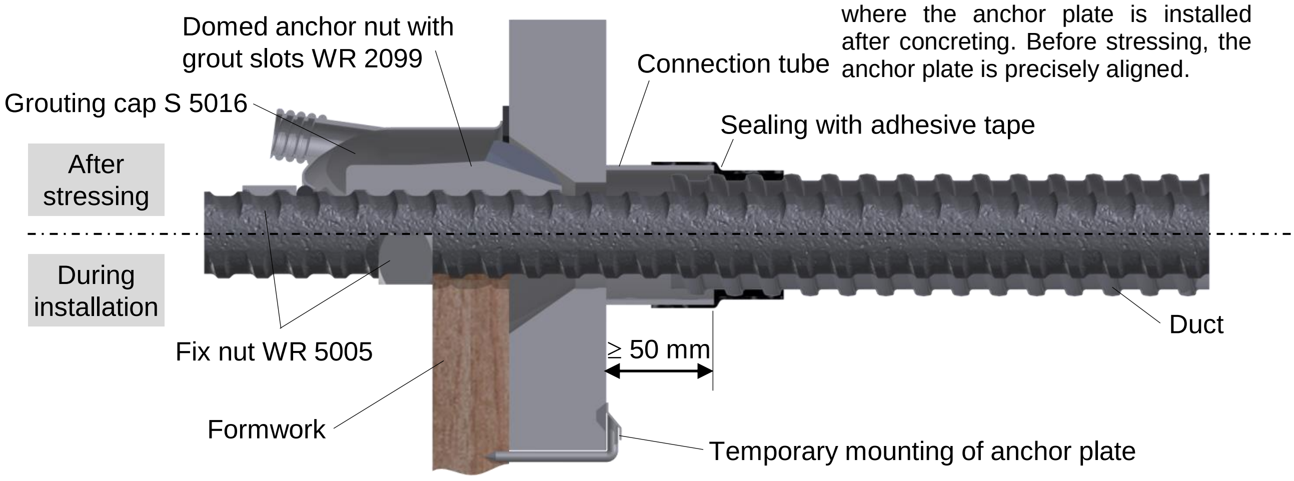
L_R .... length of thread for thread bar
L_S .... length of thread for plain bar

Prestressing steel bar	Designation	∅ d	L	L_R	L_S
	—	mm	mm	mm	mm
Thread bar	32 WR/WS	60	200	100	55
Plain bar	36 WR/WS	68	210	105	80

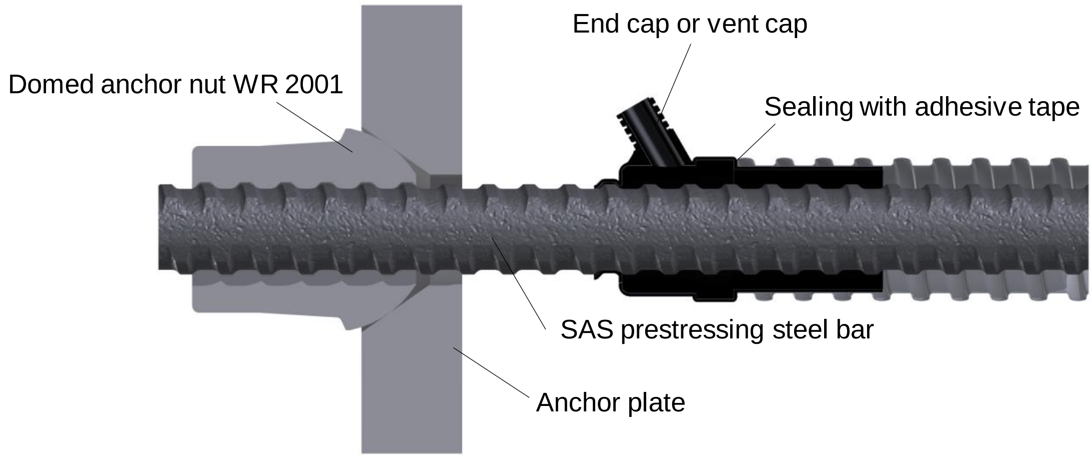
SAH Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bonded bar tendon Stressing and fixed anchor Thread bar, plain bar analogue	**Annex 9** of European Technical Assessment **ETA-05/0122** of 09.12.2019

Stressing anchor and fixed anchor, accessible on both anchorages

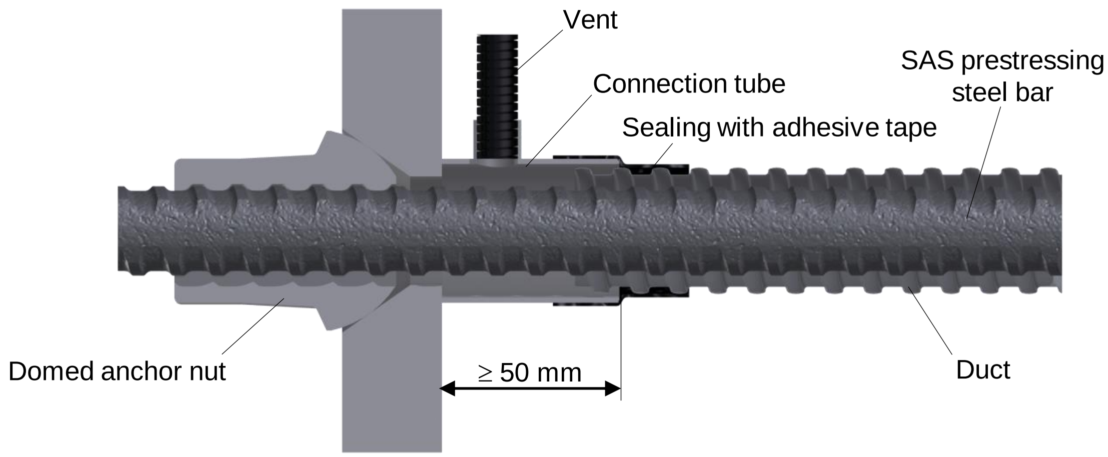
The connection tube is not required where the anchor plate is installed after concreting. Before stressing, the anchor plate is precisely aligned.



Fixed anchor, embedded in concrete



Stressing anchor and fixed anchor



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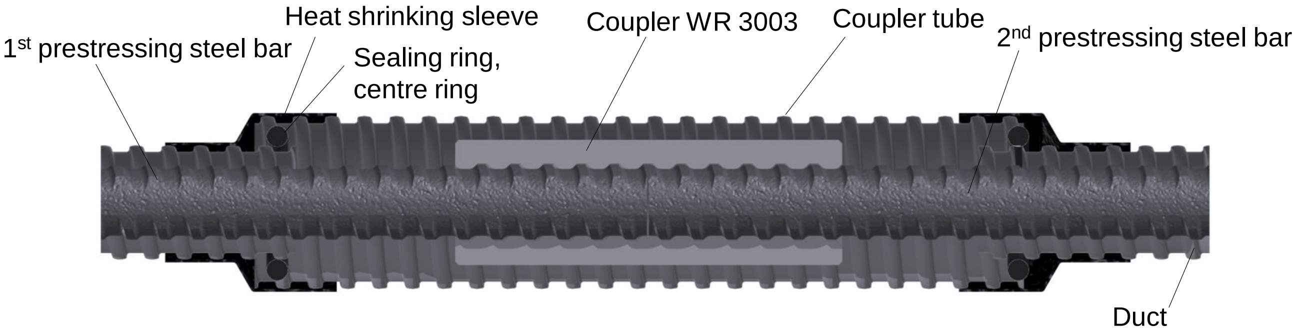
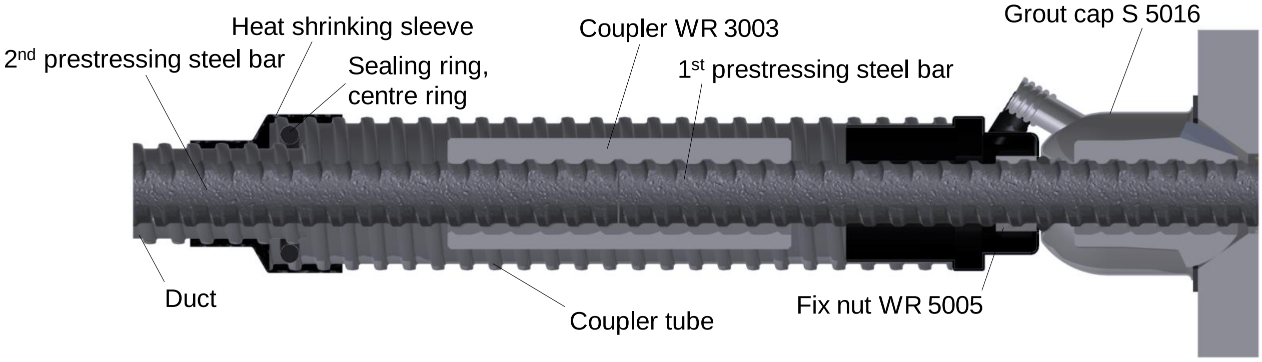
Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bonded bar tendon Movable and fixed coupling Thread bar, plain bar analogue	**Annex 10** of European Technical Assessment **ETA-05/0122** of 09.12.2019

Movable coupling D



Fixed coupling with grout cap

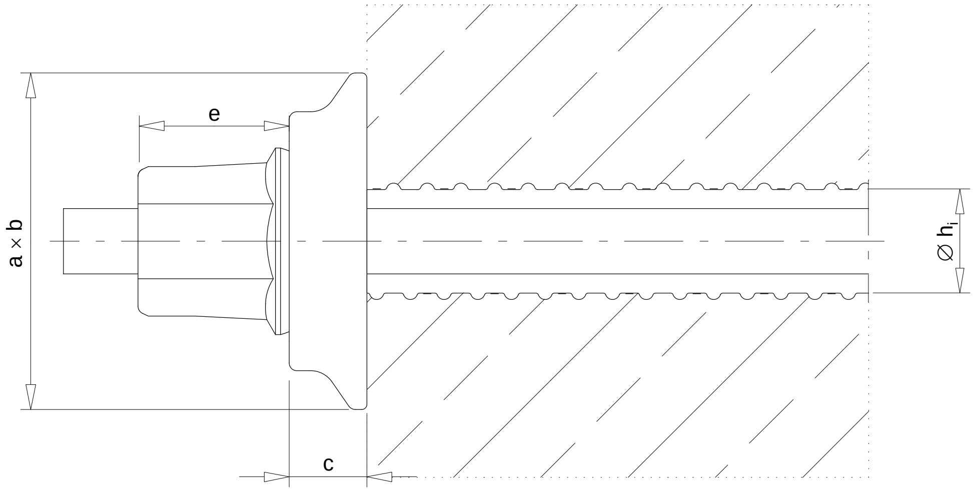


Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

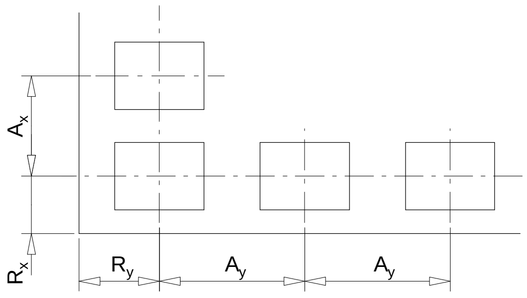
SAS – Post tensioning bar tendon system
SAS-PT bonded bar tendon

Stressing and fixed anchor
QR-plate WR/WS 2074 without additional reinforcement – Centre and edge distances

Annex 11
of European Technical Assessment
ETA-05/0122 of 09.12.2019



Designation		26.5 WR	32 WR/WS		36 WR/WS		40 WR
Dimensions	a	120	140		160		180
	b	130	165		180		195
	c	30	35		40		45
	~ e	60	32 WR	32 WS	36 WR	36 WS	90
			70	25	76	36	
	$\varnothing\ h_{i,\ min}$	35	40		45		50
	$\varnothing\ h_{i,\ max}$	40	45		50		55
Min. actual concrete strength $f_{cm,\ 0,\ cyl}$ at stressing in N/mm²		30	30		30		30
Centre distance	A_x [1)]	230	260		280		320
Centre distance	A_y [1)]	250	300		340		360
Edge distance	R_x, R_y [1)]	0.5 · centre distance + concrete cover – 10 mm					



1) Minimum centre and edge distance

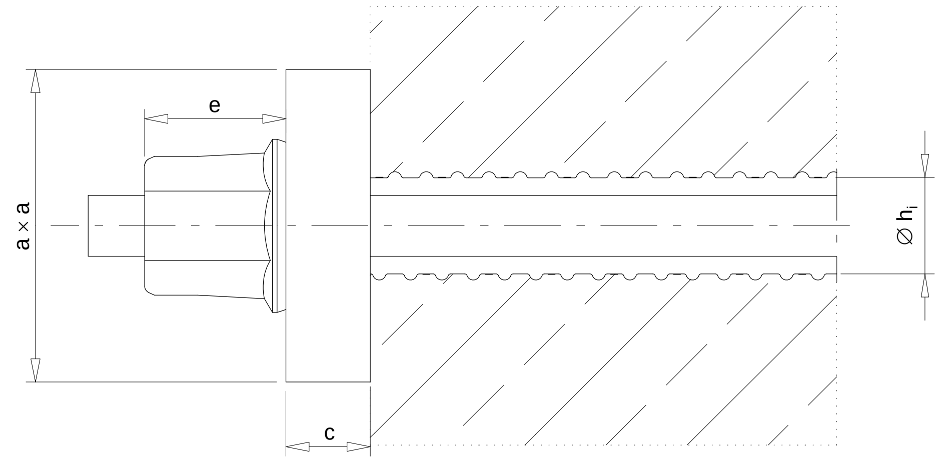
Dimensions in mm

Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

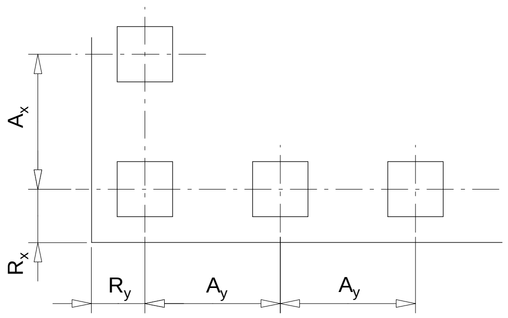
SAS – Post tensioning bar tendon system
SAS-PT bonded bar tendon

Stressing and fixed anchor – Solid plate, square WR/WS 2011 without additional reinforcement – Centre and edge distances

Annex 12
of European Technical Assessment
ETA-05/0122 of 09.12.2019



Designation		18 WR	26.5 WR	32 WR/WS		36 WR/WS		40 WR	47 WR
Dimensions	a	110	150	180		200		220	260
	c	30	35	40		45		45	50
	~ e	46	60	32 WR	32 WS	36 WR	36 WS	90	108
				70	30	76	36		
	$\varnothing\ h_{i,\ min}$	25	35	40		45		50	60
	$\varnothing\ h_{i,\ max}$	35	40	45		50		55	70
Min. actual concrete strength $f_{cm,\ 0,\ cyl}$ at stressing in N/mm²		20	20	20		20		20	20
Centre distance	A_x, A_y [1)]	155	280	340		380		420	500
Edge distance	R_x, R_y [1)]	0.5 · centre distance + concrete cover – 10 mm							



[1)] Minimum centre and edge distance

Dimensions in mm

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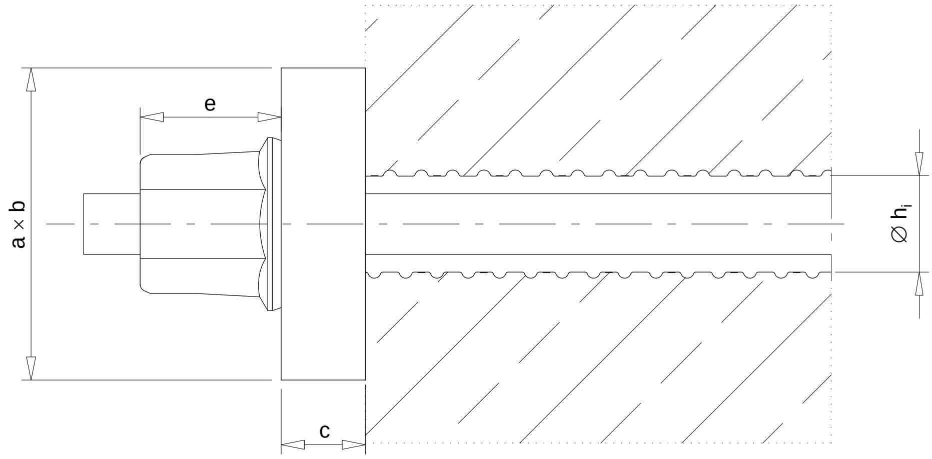
Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

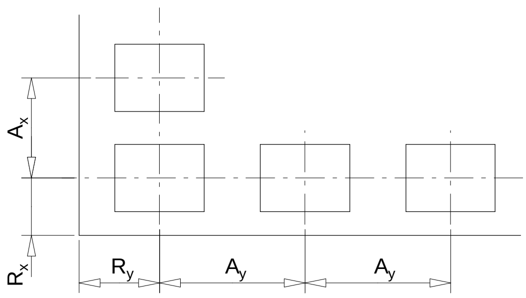
SAS – Post tensioning bar tendon system
SAS-PT bonded bar tendon

Stressing and fixed anchor – Solid plate, rectangular, small WR/WS 2076 without add. reinforcement – Centre and edge distances

Annex 13
of European Technical Assessment
ETA-05/0122 of 09.12.2019



Designation		18 WR	26.5 WR	32 WR/WS		36 WR/WS		40 WR	47 WR
Dimensions	A	80	120	140		160		180	210
	b	90	130	165		180		195	235
	c	25	30	35		40		45	55
	~ e	46	60	32 WR	32 WS	36 WR	36 WS	90	108
				70	30	76	36		
	∅ $h_{i,\,min}$	25	35	40		45		50	60
	∅ $h_{i,\,max}$	35	40	45		50		55	70
Min. actual concrete strength $f_{cm,\,0,\,cyl}$ at stressing in N/mm²		30	30	30		30		30	30
Centre distance A_x 1)		150	230	260		280		320	380
Centre distance A_y 1)		160	250	300		340		360	420
Edge distance R_x, R_y 1)		0.5 · centre distance + concrete cover – 10 mm							

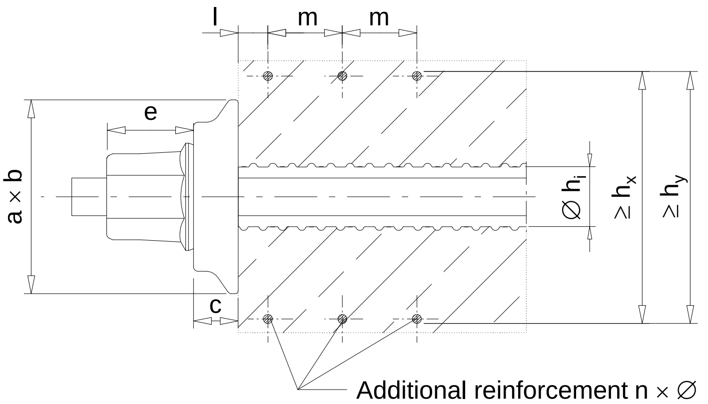


1) Minimum centre and edge distance

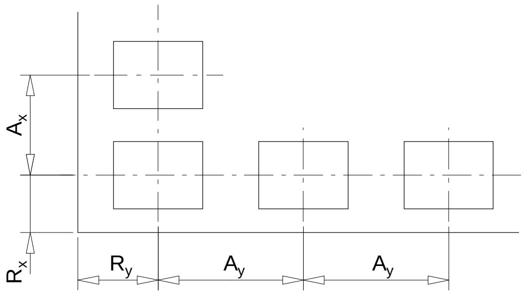
Dimensions in mm

OIB Member of EOTA

SAH Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bonded bar tendon Stressing and fixed anchor – QR-plate WR/WS 2074 with additional reinforcement Centre and edge distances	**Annex 14** of European Technical Assessment **ETA-05/0122** of 09.12.2019



Additional reinforcement n × ∅



Designation		26.5 WR			32 WR/WS			36 WR/WS			40 WR		
Dimensions	a	120			140			160			180		
	b	130			165			180			195		
	c	30			35			40			45		
	~ e	60			32 WR		32 WS	36 WR		36 WS	90		
					70		25	76		36			
	$\varnothing\ h_{i,\ min}$	35			40			45			50		
	$\varnothing\ h_{i,\ max}$	40			45			50			55		
Min. actual concrete strength $f_{cm,\ 0,\ cyl}$ at stressing in N/mm²		20	30	40	20	30	40	20	30	40	20	30	40
Centre distance	A_x [1)]	190	160	140	230	200	170	260	220	190	280	250	220
Centre distance	A_y [1)]	210	180	150	250	220	190	280	250	220	320	280	240
Edge distance	R_x, R_y [1)]	0.5 · centre distance + concrete cover – 10 mm											
Additional reinforcement	n	4	4	3	5	4	3	4	4	3	4	4	3
	∅	10	10	10	10	10	10	10	10	10	10	10	10
	m	50	50	60	50	60	60	60	60	60	60	60	60
	l	40	40	40	40	40	40	40	40	40	40	40	40
	h_x	170	140	120	210	180	150	240	200	170	260	230	200
	h_y	190	160	130	230	200	170	260	230	200	300	260	220

Additional reinforcement as stirrups or orthogonal reinforcement. Orthogonal reinforcement is properly anchored.

[1)] Minimum centre and edge distance

Dimensions in mm

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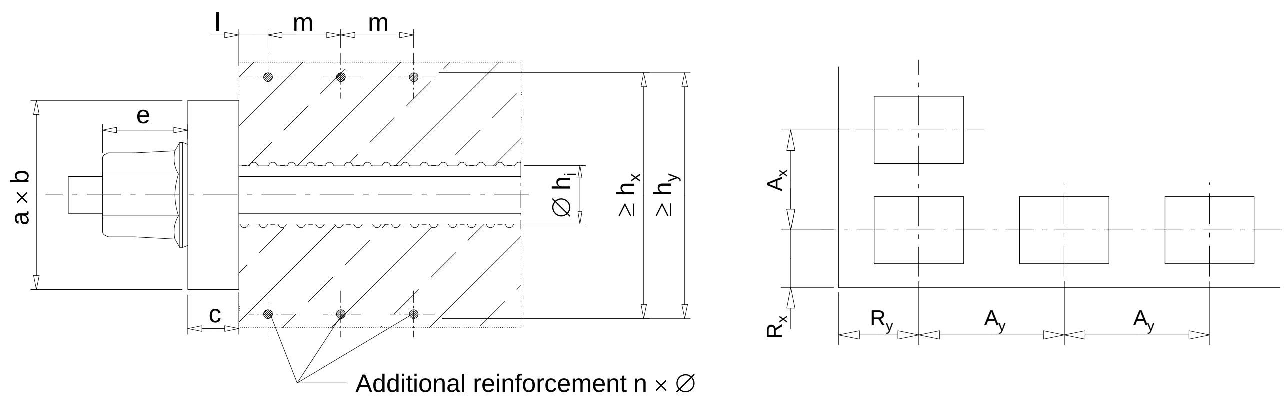
Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bonded bar tendon Stressing and fixed anchor – Solid plate, rectangular WR/WS 2012 with additional reinforcement – Centre and edge distances	**Annex 15** of European Technical Assessment **ETA-05/0122** of 09.12.2019



Designation		18 WR			26.5 WR			32 WR/WS			36 WR/WS			40 WR			47 WR		
Anchor plate		WR 2012																	
Dimensions	a	100			130			140			150			160			200		
	b	130			150			180			220			250			280		
	c	30			35			40			50			60			60		
	~ e	46			60			32 WR	32 WS		36 WR	36 WS		90			108		
								70	30		76	36							
	∅ $h_{i,\,min}$	25			35			40			45			50			60		
	∅ $h_{i,\,max}$	35			40			45			50			55			70		
Min. actual concrete strength $f_{cm,\,0,\,cyl}$ at stressing in N/mm²		20	30	40	20	30	40	20	30	40	20	30	40	20	30	40	20	30	40
Centre distance	A_x 1)	130	120	120	180	160	150	210	190	180	230	210	180	260	220	200	290	260	220
Centre distance	A_y 1)	150	150	150	240	190	160	300	230	190	340	260	240	380	320	270	440	370	300
Edge distance R_x, R_y 1)		0.5 · centre distance + concrete cover – 10 mm																	
Additional reinforcement	n	4	4	4	4	3	3	5	4	4	5	4	4	6	5	5	5	5	5
	∅	10	10	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	m	30	30	30	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	l	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	35	35	35
	h_x	110	100	100	160	140	130	190	170	160	210	190	160	240	200	180	270	240	200
	h_y	130	130	130	220	170	140	280	210	170	320	240	220	360	300	250	420	350	280

Additional reinforcement as stirrups or orthogonal reinforcement. Orthogonal reinforcement is properly anchored.

1) Minimum centre and edge distance

Dimensions in mm

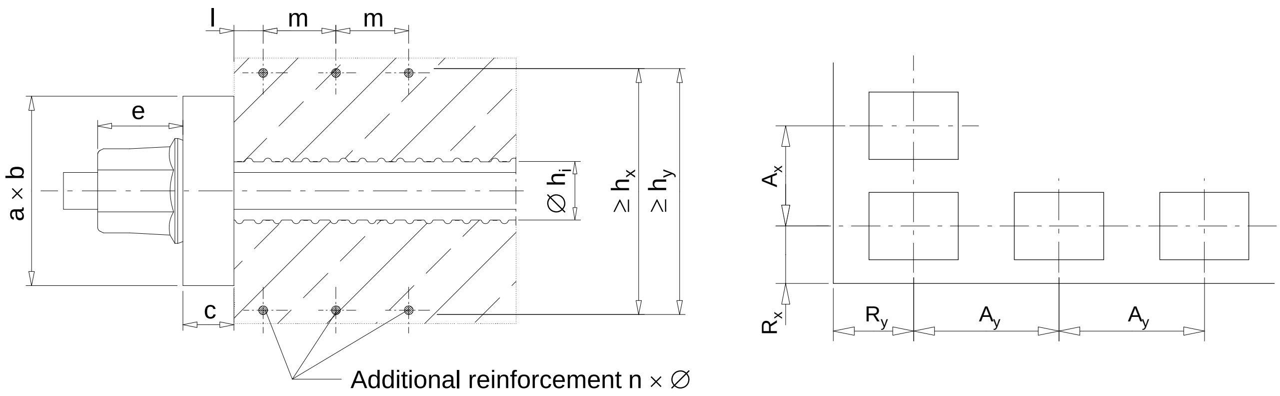
OIB Member of EOTA

SAH Stahlwerk Annahütte
Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

SAS – Post tensioning bar tendon system
SAS-PT bonded bar tendon

Stressing and fixed anchor – Solid plate, rectangular, small WR/WS 2076 with add. reinforcement – Centre and edge distances

Annex 16
of European Technical Assessment
ETA-05/0122 of 09.12.2019



Designation		18 WR			26.5 WR			32 WR/WS			36 WR/WS			40 WR			47 WR		
Dimensions	a	80			120			140			160			180			210		
	b	90			130			165			180			195			235		
	c	25			30			35			40			45			55		
	~ e	46			60			32 WR	32WS		36 WR	36WS		90			108		
								70	30		76	36							
	∅ $h_{i,\,min}$	25			35			40			45			50			60		
	∅ $h_{i,\,max}$	35			40			45			50			55			70		
Min. actual concrete strength $f_{cm,\,0,\,cyl}$ at stressing in N/mm²		20	30	40	20	30	40	20	30	40	20	30	40	20	30	40	20	30	40
Centre distance	A_x 1)	130	110	100	190	160	140	230	200	170	260	220	190	280	250	220	320	290	240
Centre distance	A_y 1)	140	120	105	210	180	150	250	220	190	280	250	220	320	280	240	370	330	270
Edge distance	R_x, R_y 1)	0.5 · centre distance + concrete cover – 10 mm																	
Additional reinforcement	n	3	3	3	4	4	3	5	4	3	4	4	3	4	4	3	4	4	3
	∅	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	m	50	50	50	50	50	60	50	60	60	60	60	60	60	60	60	60	60	60
	l	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
	h_x	110	90	80	170	140	120	210	180	150	240	200	170	260	230	200	300	270	220
	h_y	120	100	85	190	160	130	230	200	170	260	230	200	300	260	220	350	310	250

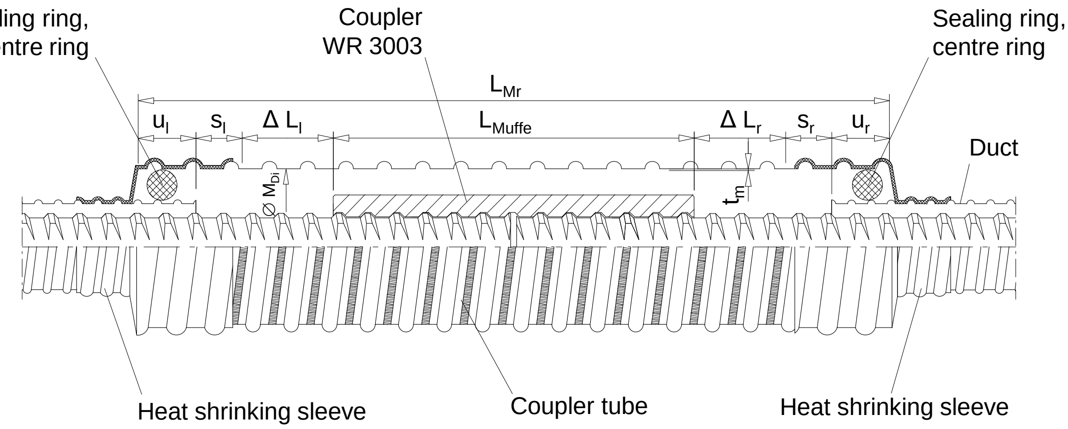
Additional reinforcement as stirrups or orthogonal reinforcement. Orthogonal reinforcement is properly anchored.

1) Minimum centre and edge distance

Dimensions in mm

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bonded bar tendon Movable coupling	**Annex 17** of European Technical Assessment **ETA-05/0122** of 09.12.2019

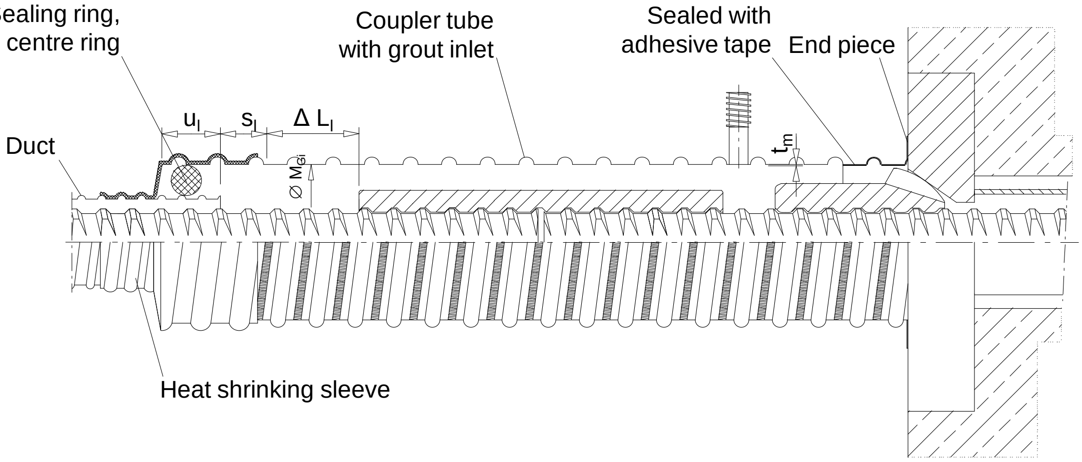
Movable coupling D



$L_{Mr} = L_{Muffe} + \Delta L_l + \Delta L_r + s_l + s_r + u_l + u_r$

L_{Mr} ....Length of coupler tube
L_{Muffe} ....Length of coupler/transition coupler
ΔL_l, ΔL_r........Displacement of coupler on left and right respectively
s_l, s_r.............Safety clearance, $0.2 \cdot \Delta L \geq 40$ mm
u_l, u_r ....Coupler tube protrusion on left and right respectively

Movable coupling G

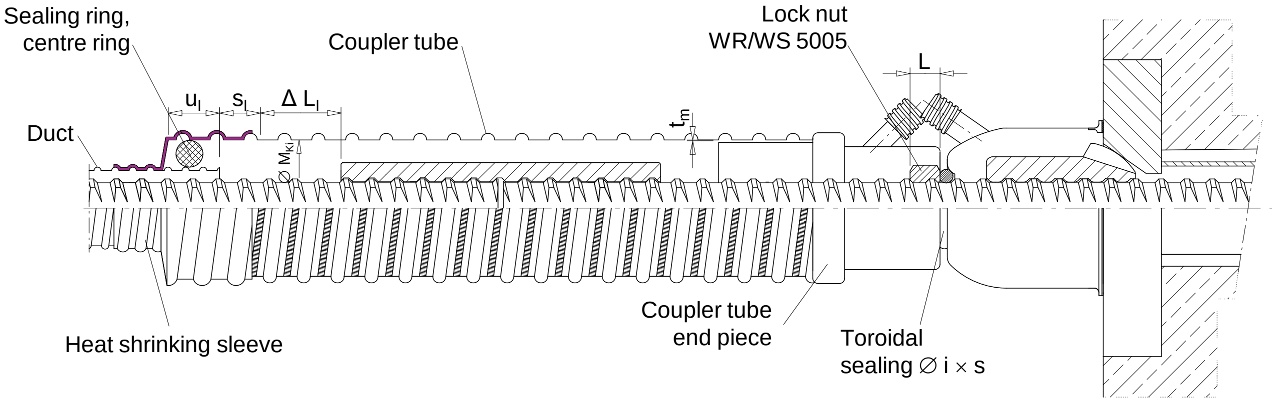


Designation		18 WR	26.5 WR	32 WR/WS	36 WR/WS	40 WR	47 WR
Coupler tube							
For coupling D	min. $\varnothing M_{Di}$	50	65	75	85	85	110
For coupling G	min. $\varnothing M_{Gi}$	65	90	110	110	120	130
Thickness of the metal sheet	min. t_m	0.3	0.3	0.3	0.3	0.3	0.3

Dimensions in mm

SAH Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bonded bar tendon Fixed coupling	**Annex 18** of European Technical Assessment **ETA-05/0122** of 09.12.2019

Fixed coupling with grout cap



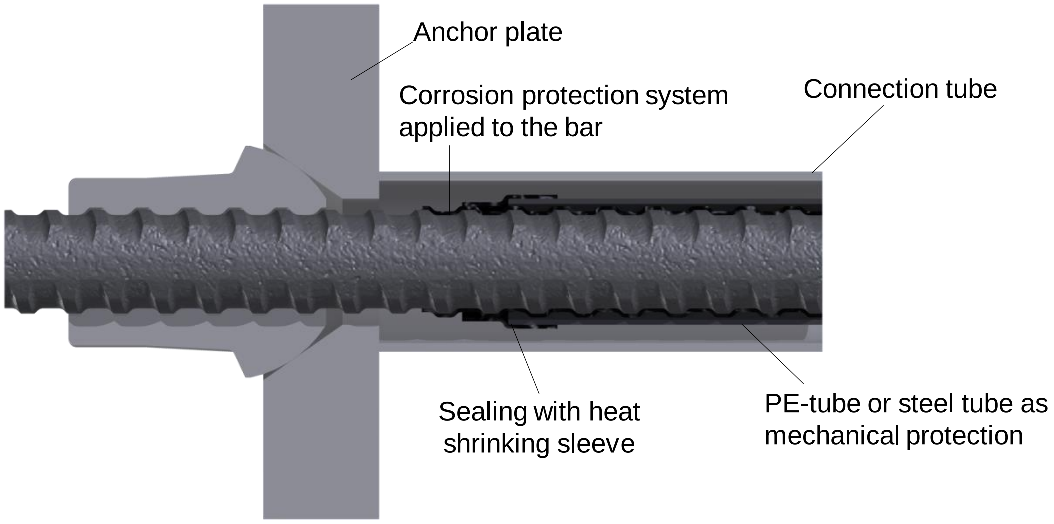
ΔL_l ....Displacement of coupler on left
s_l ....Safety clearance, $0.2 \cdot \Delta L \geq 40$ mm
u_l ....Coupler tube protrusion on left

Designation		18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR	32 WS	36 WS
Coupler tube	min. $\varnothing M_{Ki}$	50	65	75	85	85	110	75	85
Coupler tube, thickness of metal sheet	min. t_m	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Flat hex nut	SW	30	36	41	46	50	60	41	46
	L	22	22	22	25	25	30	15	15
Toroidal sealing	∅ i	14	22	26	30	36	43	26	30
	s	8	8	8	8	8	8	8	8

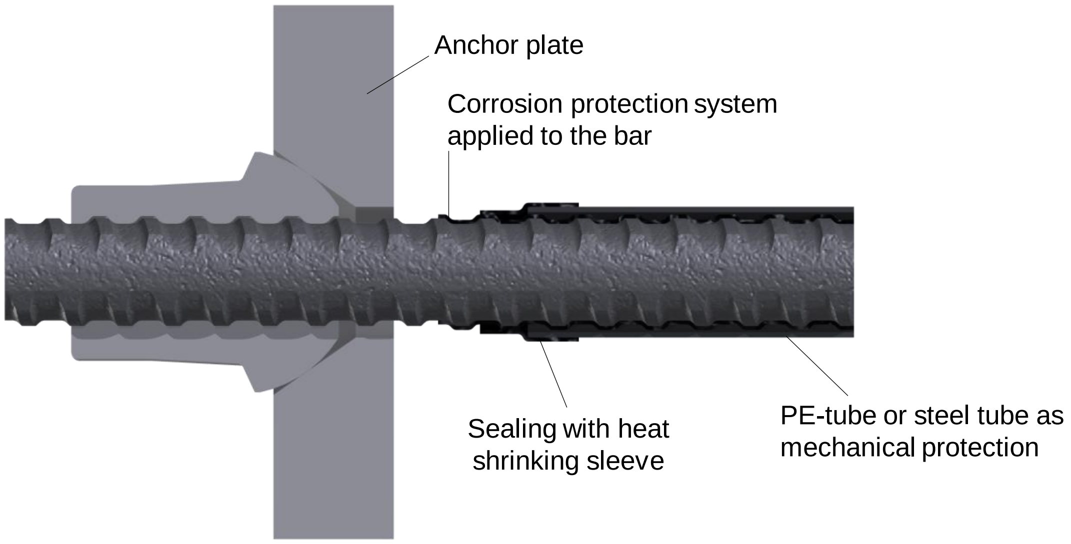
Dimensions in mm

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded and external bar tendon Stressing and fixed anchor Thread bar, plain bar analogue	**Annex 19** of European Technical Assessment **ETA-05/0122** of 09.12.2019

Stressing anchor and fixed anchor, accessible on both anchorages



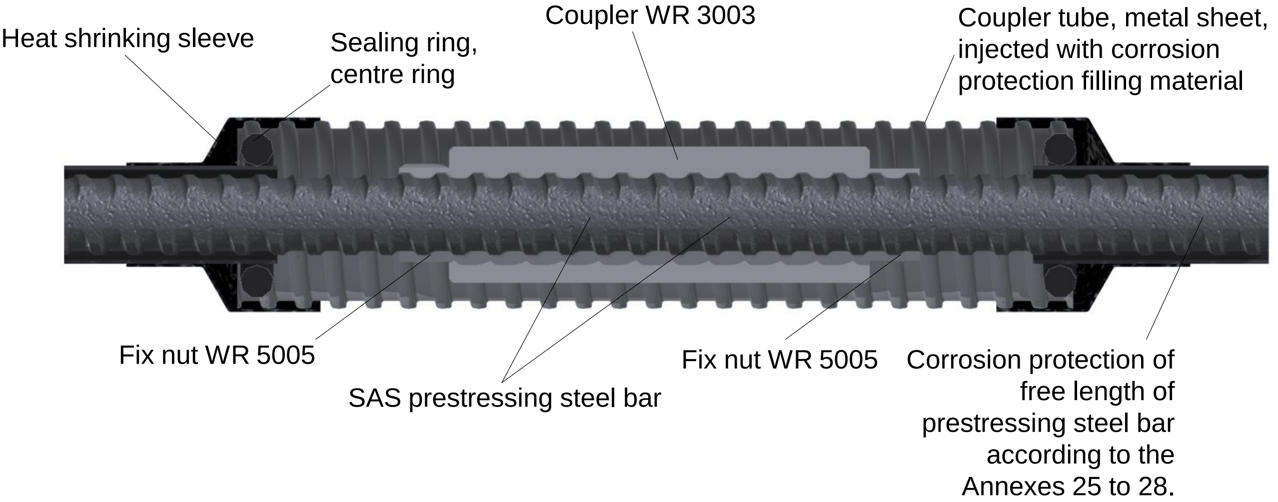
Fixed anchor embedded in concrete



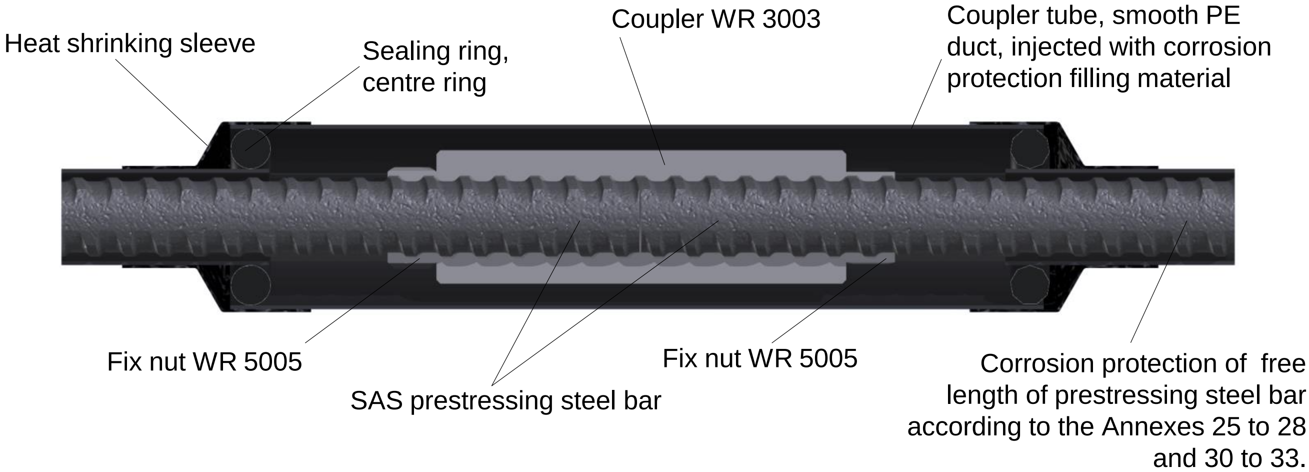
Member of EOTA

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded and external bar tendon Movable coupling Thread bar, plain bar analogue	**Annex 20** of European Technical Assessment **ETA-05/0122** of 09.12.2019

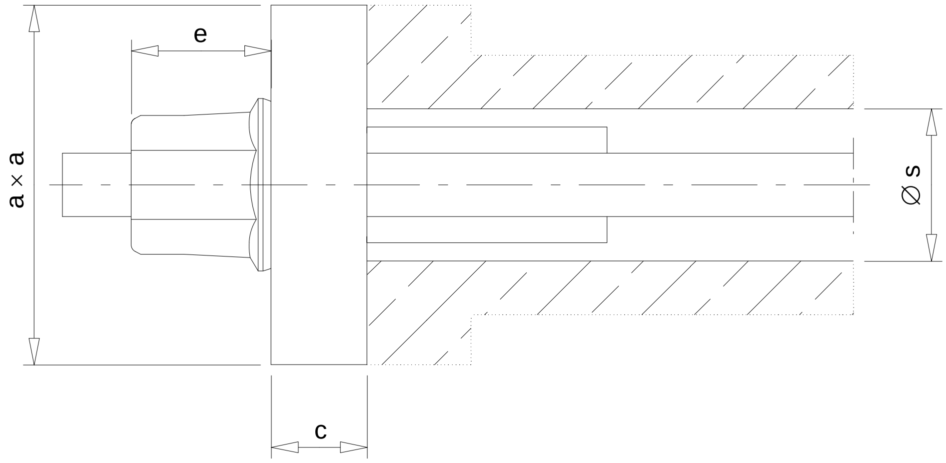
Movable coupling D, unbonded without free tendon duct



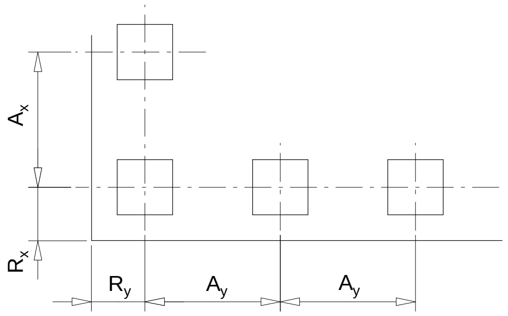
Movable coupling D, unbonded, without and with free tendon duct



Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded and external bar tendon Stressing and fixed anchor – Solid plate, square WR/WS 2011 without additional reinforcement – Centre and edge distance	**Annex 21** of European Technical Assessment **ETA-05/0122** of 09.12.2019



Designation		18 WR	26.5 WR	32 WR/WS	36 WR/WS	40 WR	47 WR
Dimensions	a	110	150	180	200	220	260
	c	30	35	40	45	45	50
	~ e	46	60	70	76	90	108
	max. ∅ s	63.5	63.5	70	76.1	76.1	101.6
Min. actual concrete strength $f_{cm, 0, cyl}$ at stressing in N/mm²		20	20	20	20	20	20
Centre distance A_x, A_y [1)]		200	280	340	380	420	500
Edge distance R_x, R_y [1)]		0.5 · centre distance + concrete cover – 10 mm					

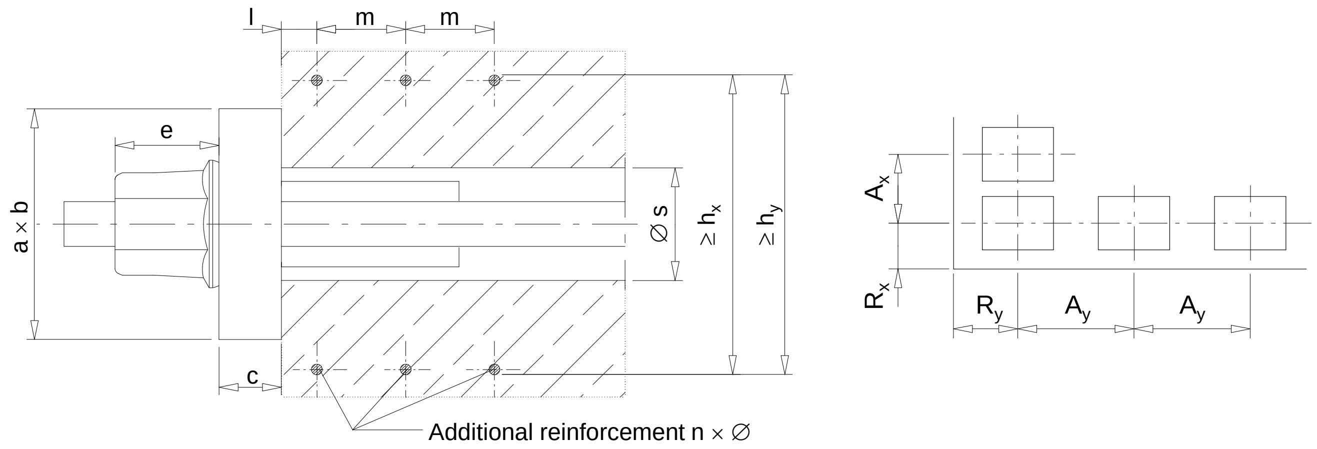


[1)] Minimum centre and edge distance

Dimensions in mm

OiB Member of EOTA

SAH Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded and external bar tendon Stressing and fixed anchor – Solid plate, rectangular WR/WS 2012 with additional reinforcement – Centre and edge distance	**Annex 22** of European Technical Assessment **ETA-05/0122** of 09.12.2019



Designation		18 WR			26.5 WR			32 WR/WS			36 WR/WS			40 WR			47 WR		
Dimensions	a	100			130			140			150			160			200		
	b	130			150			180			220			250			280		
	c	30			35			40			50			60			60		
	~ e	46			60			32 WR: 70	32 WS: 30		36 WR: 76	36 WS: 36		90			108		
	max. ∅ s	63.5			63.5			70			76.1			90			101.6		
Min. actual concrete strength $f_{cm, 0, cyl}$ at stressing in N/mm²		20	30	40	20	30	40	20	30	40	20	30	40	20	30	40	20	30	40
Centre distance	A_x 1)	130	120	120	180	160	150	210	190	180	230	210	180	260	220	200	290	260	220
Centre distance	A_y 1)	160	150	150	240	190	160	300	230	190	340	260	240	380	320	270	440	370	300
Edge distance	R_x, R_y 1)	0.5 · centre distance + concrete cover – 10 mm																	
Additional reinforcement	n	4	4	4	4	3	3	5	4	4	5	4	4	6	5	5	5	5	5
	∅	10	10	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	m	30	30	30	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	l	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	35	35	35
	h_x	110	100	100	160	140	130	190	170	160	210	190	160	240	200	180	270	240	200
	h_y	140	130	130	220	170	140	280	210	170	320	240	220	360	300	250	420	350	280

Additional reinforcement as stirrups or orthogonal reinforcement. Orthogonal reinforcement is properly anchored.

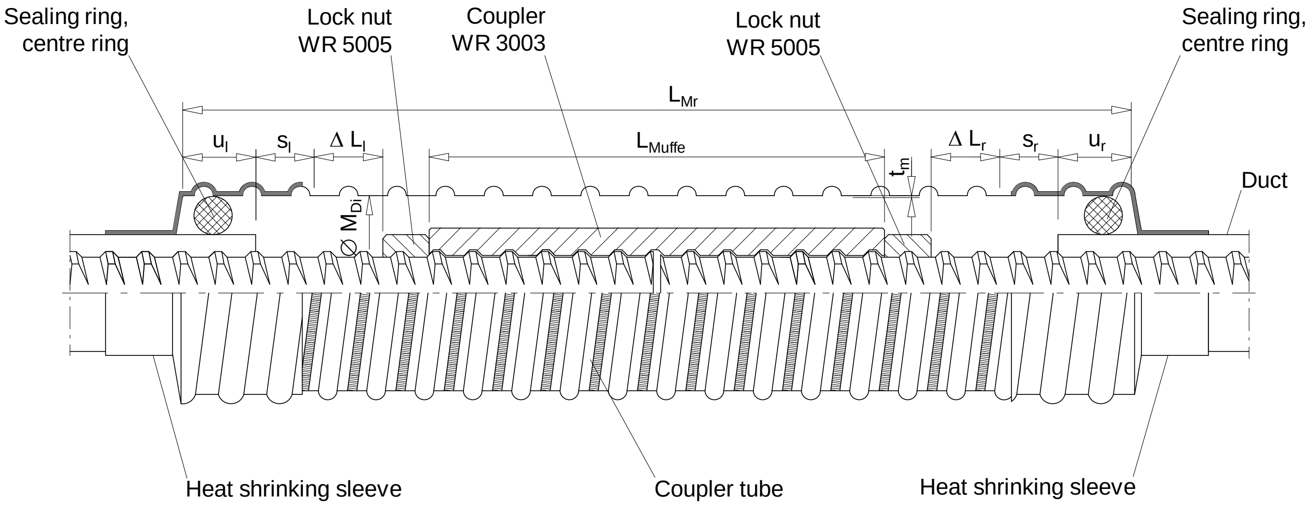
1) Minimum centre and edge distance

Dimensions in mm

OIB Member of EOTA

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded and external bar tendon Movable coupling	**Annex 23** of European Technical Assessment **ETA-05/0122** of 09.12.2019

Movable coupling D



$L_{Mr} = L_{Muffe} + \Delta L_l + \Delta L_r + s_l + s_r + u_l + u_r$

L_{Mr} ....length of coupler tube

L_{Muffe} ....length of coupler/transition coupler

ΔL_l, ΔL_r......movement of coupler on left and right respective

s_l, s_r.............safety cleareance, $0.2 \cdot \Delta L \geq 40$ mm

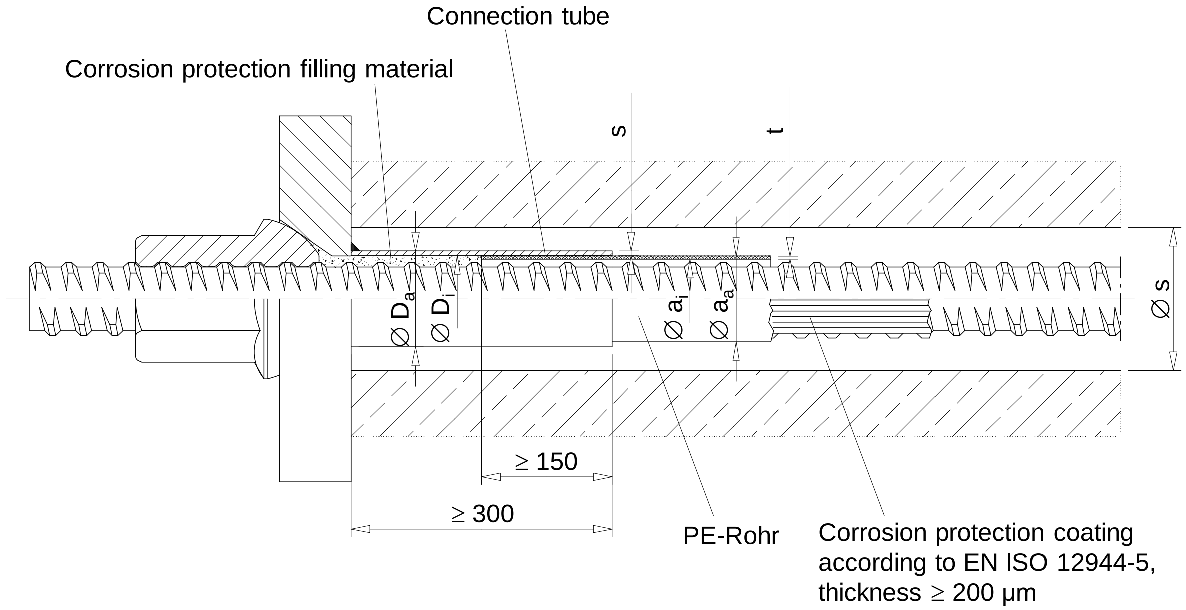
u_l, u_r ....coupler tube protrusion on left and right respective

Designation		18 WR	26.5 WR	32 WR/WS	36 WR/WS	40 WR	47 WR
Coupler tube	min. ∅ M_{Di}	50	65	75	85	85	100
Thickness of the metal sheet	min. t_m	0.3	0.3	0.3	0.3	0.3	0.3

Dimensions in mm

Member of EOTA

SAH Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded and external bar tendon Tendon with free tendon duct Temporary corrosion protection	**Annex 24** of European Technical Assessment **ETA-05/0122** of 09.12.2019

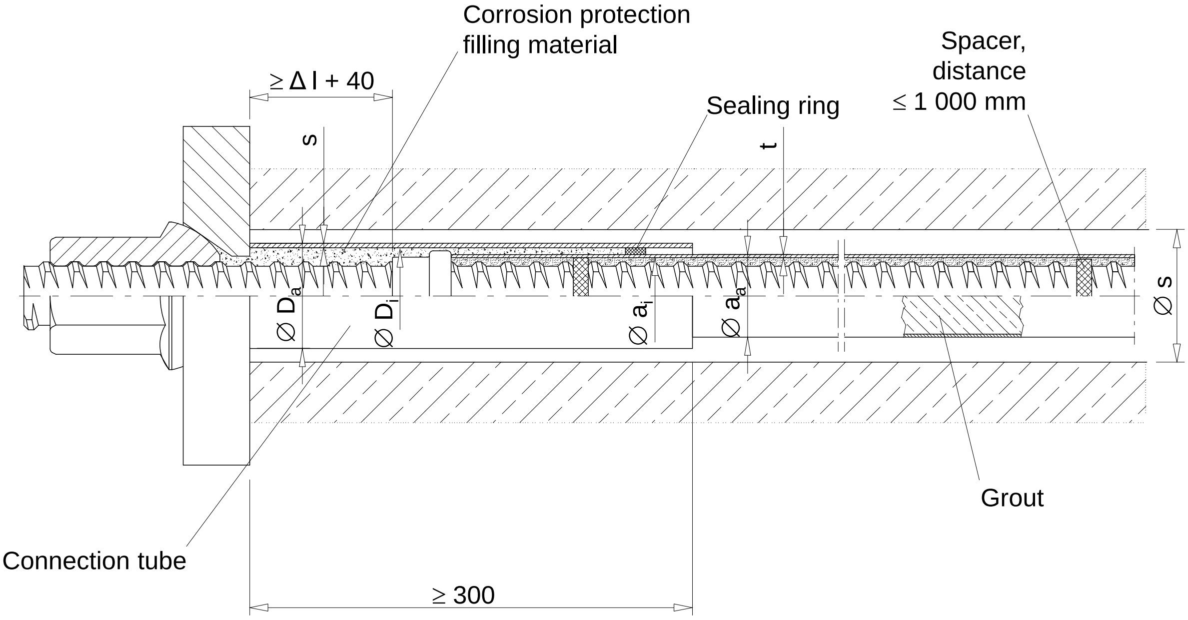


s ≥ 2 mm
t ≥ 2 mm

Designation		18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR	32 WS	36 WS
Connection tube (larger wall thickness permitted)	max. $\varnothing$ D_a	60.3	60.3	63.5	70	76.1	88.9	70	76.1
	min. $\varnothing$ D_i	35	45	55	60	60	70	50	55
PE-tube	max. $\varnothing$ a_a	40	40	50	50	63	63	40	50
	min. $\varnothing$ a_i	29.6	39.8	45.7	50.1	53.9	61.4	42	46
Tendon duct diameter at the anchorage, max.	max. $\varnothing$ s	63.5	63.5	70	76.1	90	101.6	70	76.1

Dimensions in mm

SAH Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded and external bar tendon Tendon with free tendon duct Permanent corrosion protection Grouting before installation	**Annex 25** of European Technical Assessment **ETA-05/0122** of 09.12.2019



s ≥ 2 mm
t ≥ 2 mm

Designation		18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR
Connection tube (larger wall thickness permitted)	max. ∅ D_a	60.3	60.3	63.5	70	76.1	88.9
	min. ∅ D_i	35	45	55	60	60	70
Steel tube	max. ∅ a_a	48.3	48.3	54	63.5	63.5	76.1
	min. ∅ a_i	29.6	39.8	45.7	50.1	53.9	61.4
PE-tube	max. ∅ a_a	50	50	55	63	63	75
	min. ∅ a_i	29.6	39.8	45.7	50.1	53.9	61.4
Tendon duct diameter at the anchorage, max.	max. ∅ s	63.5	63.5	70	76.1	90	101.6

Dimensions in mm

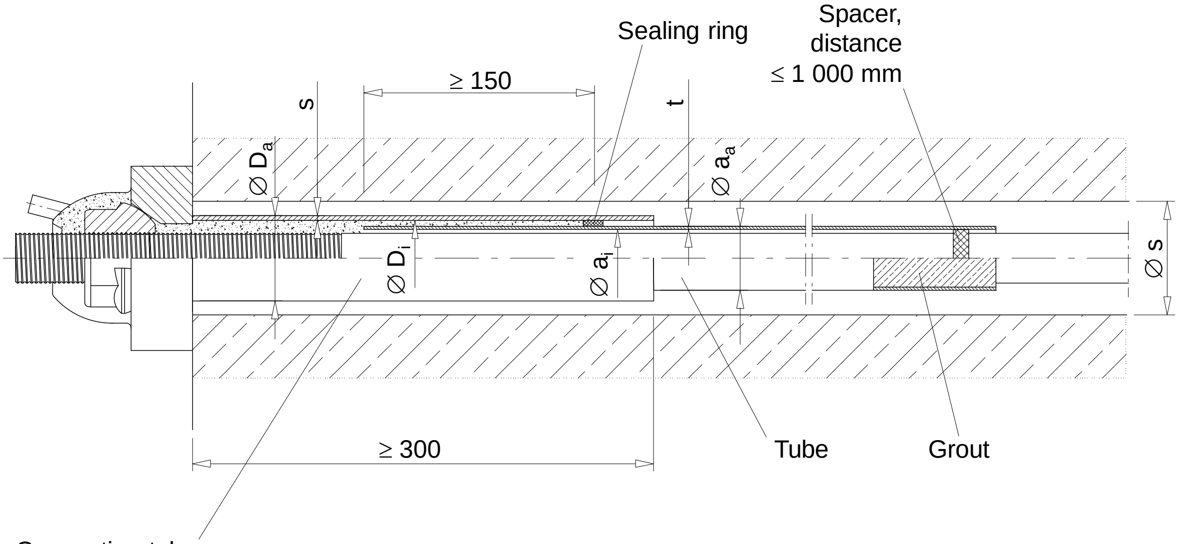
Member of EOTA

Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

SAS – Post tensioning bar tendon system
SAS-PT unbonded and external bar tendon

Tendon with free tendon duct
Permanent corrosion protection
Grouting after stressing

Annex 26
of European Technical Assessment
ETA-05/0122 of 09.12.2019



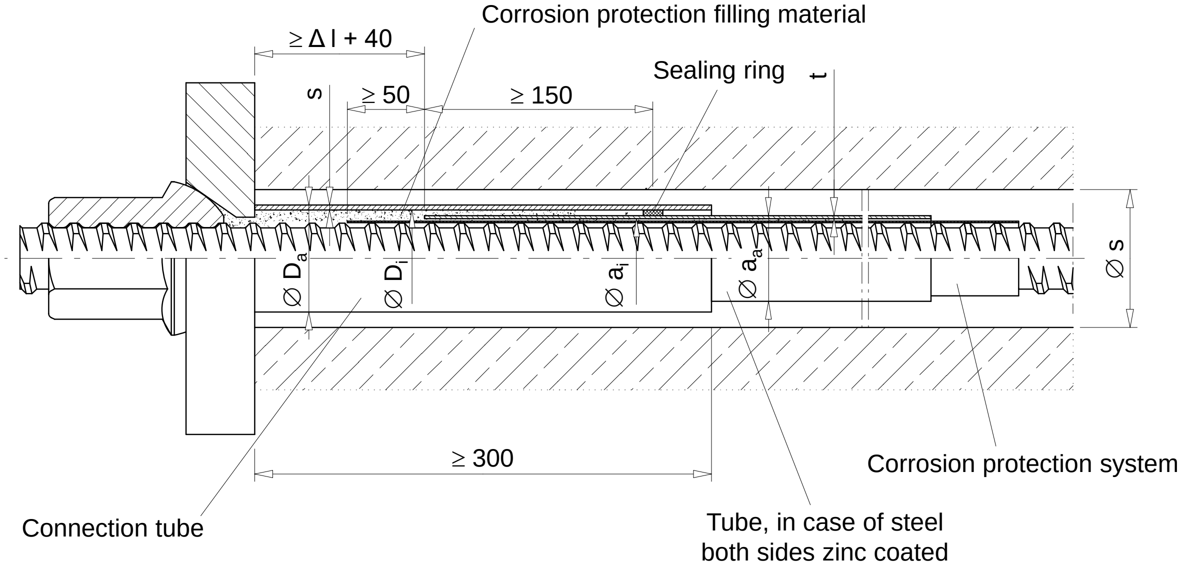
s ≥ 2 mm
t ≥ 2 mm

Designation		18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR	32 WS	36 WS
Connection tube (larger wall thickness permitted)	max. ∅ D_a	60.3	60.3	63.5	70	76.1	88.9	70	76.1
	min. ∅ D_i	35	45	55	60	60	70	50	55
Steel tube	max. ∅ a_a	48.3	48.3	54	63.5	63.5	76.1	63.5	63.5
	min. ∅ a_i	29.6	39.8	45.7	50.1	53.9	61.4	42	46
PE-tube	max. ∅ a_a	50	50	55	63	63	75	55	63
	min. ∅ a_i	29.6	39.8	45.7	50.1	53.9	61.4	42	46
Tendon duct diameter at the anchorage, max.	max. ∅ s	63.5	63.5	70	76.1	90	101.6	70	76.1

Dimensions in mm

Member of EOTA

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded and external bar tendon Tendon with free tendon duct Permanent corrosion protection	**Annex 27** of European Technical Assessment **ETA-05/0122** of 09.12.2019



s ≥ 2 mm
t ≥ 2 mm

Designation		18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR	32 WS	36 WS
Connection tube, larger wall thickness possible	max. ∅ D_a	60.3	60.3	63.5	70	76.1	88.9	70	76.1
	min. ∅ D_i	35	45	55	60	60	70	50	55
Steel tube	max. ∅ a_a	48.3	48.3	54	63.5	63.5	76.1	63.5	63.5
	min. ∅ a_i	29.6	39.8	45.7	50.1	53.9	61.4	42	46
PE-tube	max. ∅ a_a	50	50	55	63	63	75	55	63
	min. ∅ a_i	29.6	39.8	45.7	50.1	53.9	61.4	42	46
Tendon duct diameter at the anchorage, max.	max. ∅ s	63.5	63.5	70	76.1	90	101.6	70	76.1

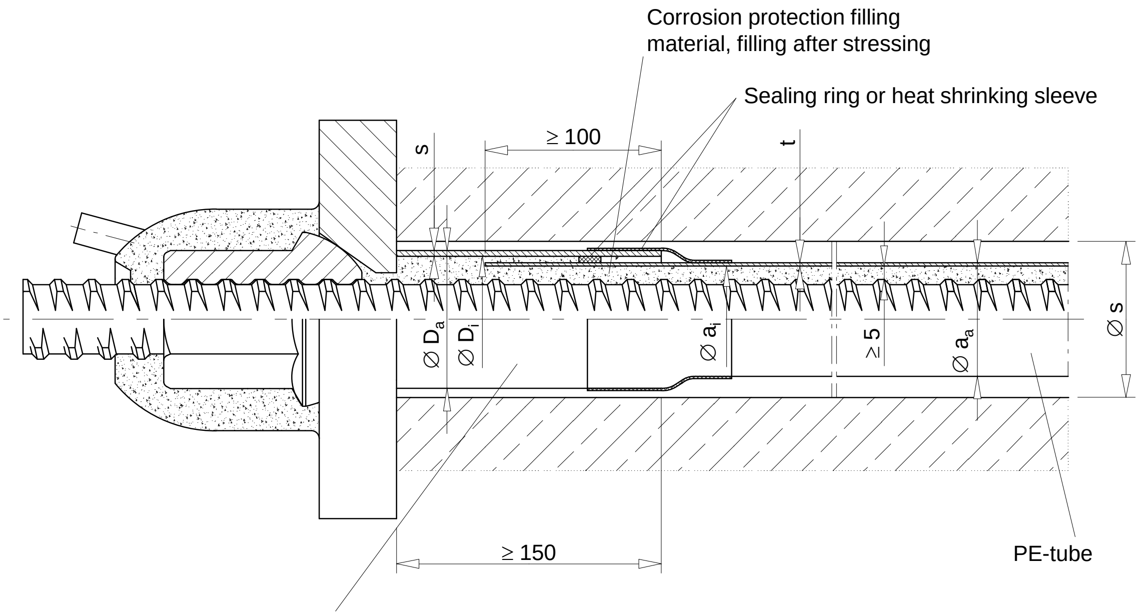
Dimensions in mm

Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

SAS – Post tensioning bar tendon system
SAS-PT unbonded and external bar tendon

Tendon with free tendon duct – Permanent corrosion protection – Corrosion protection filling material applied after stressing

Annex 28
of European Technical Assessment
ETA-05/0122 of 09.12.2019



In case of a prefabricated and pre-injected tendon, the PE-tube is sealed towards the prestressing steel bar by a plastic end cap or a heat shrinking sleeve.

s ≥ 2 mm
t ≥ 2 mm

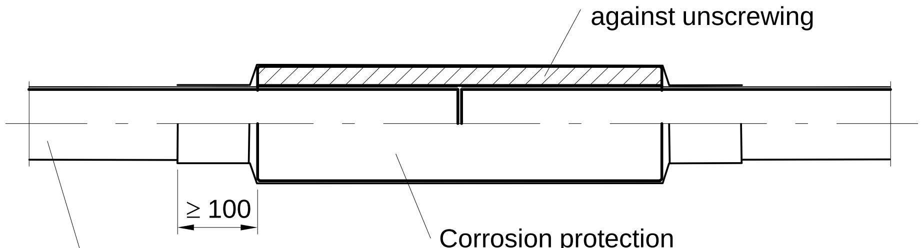
Designation		18 WR	26.5 WR	32 WR/WS	36 WR/WS	40 WR	47 WR
Connection tube, larger wall thickness possible	max. ∅ D_a	60.3	60.3	63.5	70	76.1	88.9
	min. ∅ D_i	35	45	55	60	60	70
PE-tube	max. ∅ a_a	50	50	55	63	63	75
	min. ∅ a_i	29.6	39.8	45.7	50.1	53.9	61.4
Tendon duct diameter at the anchorage, max.	max. ∅ s	63.5	63.5	70	76.1	90	101.6

Dimensions in mm

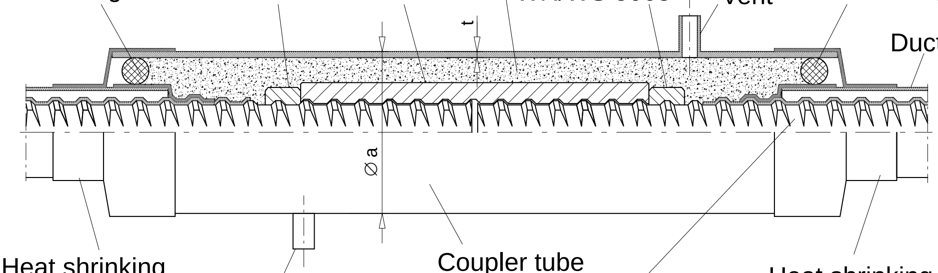
Member of EOTA

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded and external bar tendon Tendon with free tendon duct Corrosion protection Coupling	**Annex 29** of European Technical Assessment **ETA-05/0122** of 09.12.2019

Temporary corrosion protection



Permanent corrosion protection



Apply inlets and vents only when necessary. The outer side of the steel tube is corrosion protected.

Designation		18 WR	26.5 WR	32 WR/WS	36 WR/WS	40 WR	47 WR
Temporary corrosion protection							
Min. tendon duct diameter	∅ s	65	65	75	82	90	100
Permanent corrosion protection							
Coupler tube, steel	min. ∅ a	63	70	80	90	90	100
	min.t	2	2	2	2	2	2
Min. tendon duct diameter	∅ s	70	80	90	100	100	110
Coupler tube, HD-PE	min. ∅ a	63	75	75	90	90	100
	min.t	2	2	2	2.2	2.2	2.2
Min. tendon duct diameter	max. ∅ s	75	85	85	100	100	110

∅ s, not shown

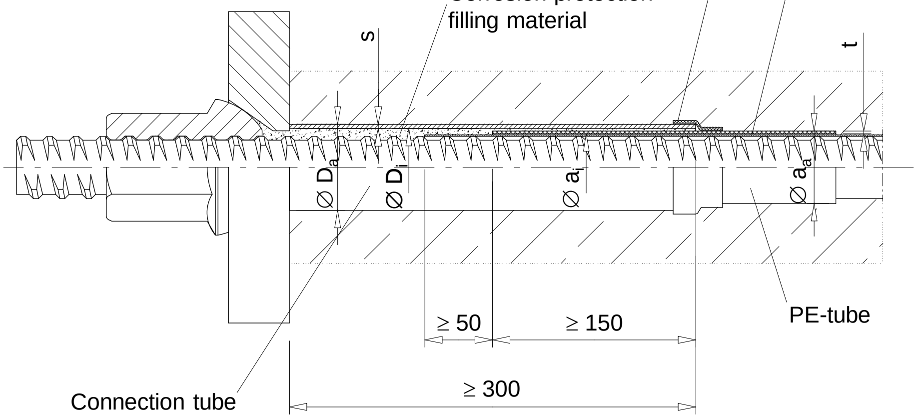
Dimensions in mm

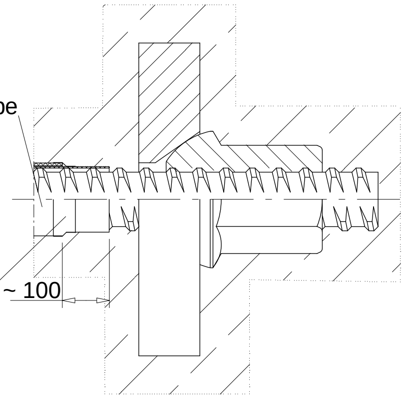
Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

SAS – Post tensioning bar tendon system
SAS-PT unbonded bar tendon

Tendon without free tendon duct
Permanent corrosion protection

Annex 30
of European Technical Assessment
ETA-05/0122 of 09.12.2019



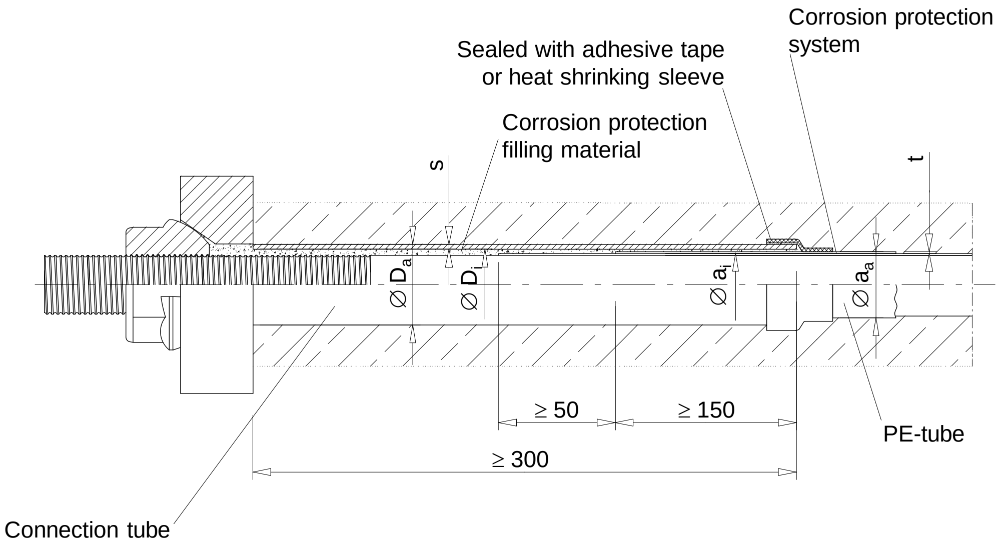


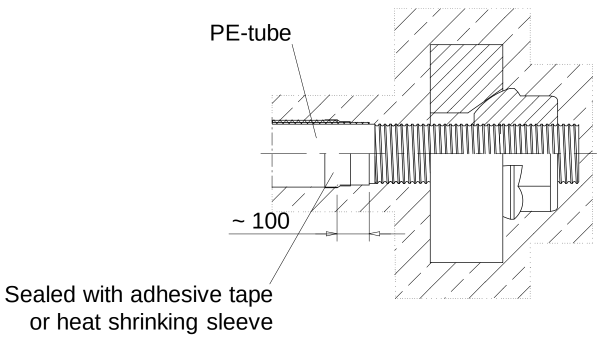
s ≥ 2 mm
t ≥ 2 mm

Designation		18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR
Connection tube (larger wall thickness permitted)	max. ∅ D_a	60.3	60.3	63.5	70	76.1	88.9
	min. ∅ D_i	35	45	55	60	60	70
PE-tube	max. ∅ a_a	50	50	55	63	63	75
	min. ∅ a_i	29.6	39.8	45.7	50.1	53.9	61.4

Dimensions in mm

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded bar tendon Tendon without free tendon duct Permanent corrosion protection	**Annex 31** of European Technical Assessment **ETA-05/0122** of 09.12.2019





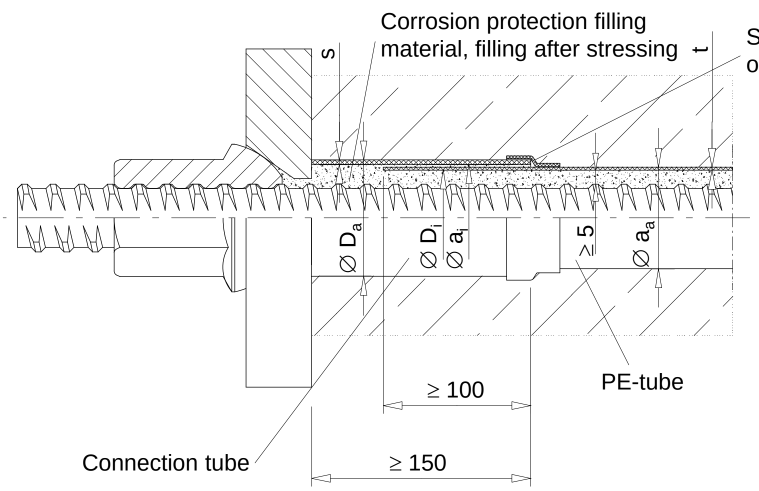
s ≥ 2 mm

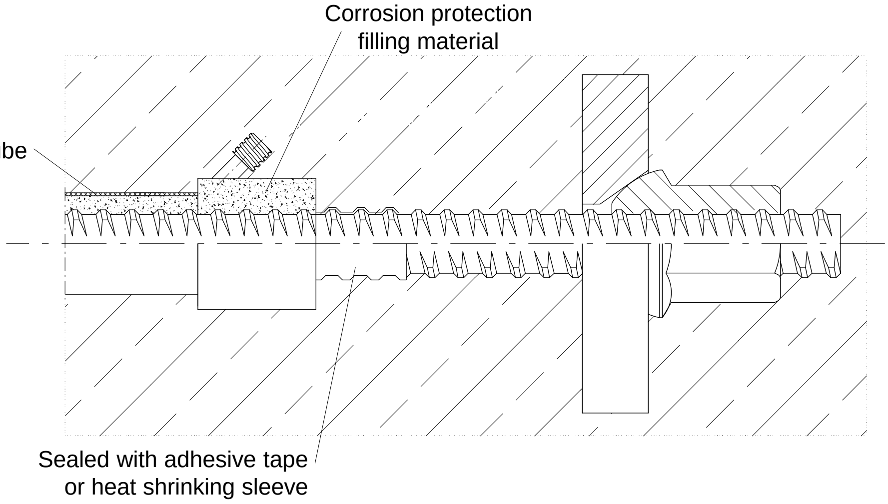
t ≥ 2 mm

Designation		32 WS	36 WS
Connection tube, larger wall thickness permitted	max. ∅ D_a	63.5	70
	min. ∅ D_i	50	55
PE-tube	max. ∅ a_a	55	63
	min. ∅ a_i	42	46

Dimensions in mm

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT unbonded bar tendon Tendon without free tendon duct – Permanent corrosion protection for thread bar – Corrosion protection filling material applied after stressing	**Annex 32** of European Technical Assessment **ETA-05/0122** of 09.12.2019





s ≥ 2 mm

t ≥ 2 mm

Designation		18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR
Connection tube, larger wall thickness permitted	max. ∅ D_a	60.3	60.3	63.5	70	76.1	88.9
	min. ∅ D_i	35	45	55	60	60	70
PE-tube	max. ∅ a_a	50	50	55	63	63	75
	min. ∅ a_i	29.6	39.8	45.7	50.1	53.9	61.4

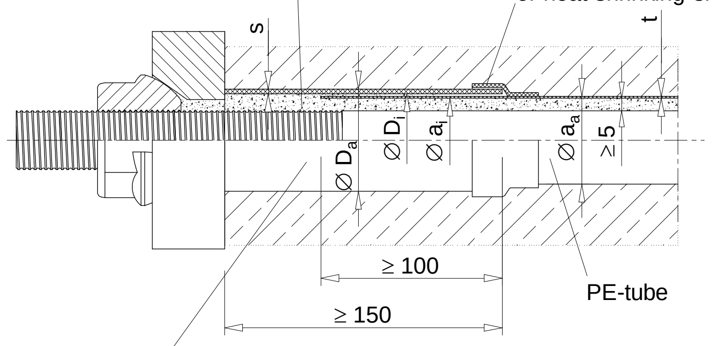
Dimensions in mm

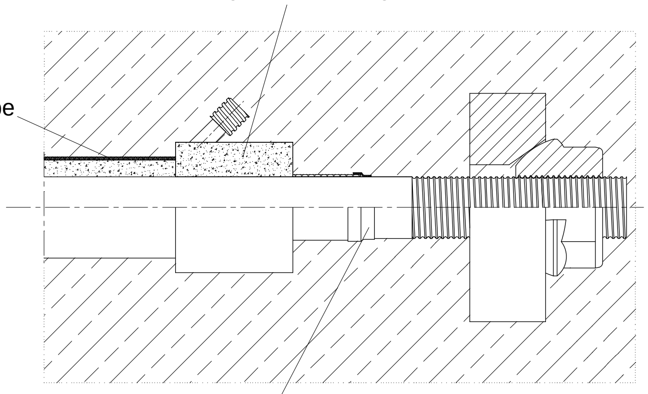
Max Aicher GmbH & Co. KG
83404 Ainring–Hammerau

SAS – Post tensioning bar tendon system
SAS-PT unbonded bar tendon

Tendon without free tendon duct – Permanent corrosion protection for plain bar – Corrosion protection filling material applied after stressing

Annex 33
of European Technical Assessment
ETA-05/0122 of 09.12.2019





s ≥ 2 mm
t ≥ 2 mm

Designation		32 WS	36 WS
Connection tube, larger wall thickness permitted	max. ∅ D_a	63.5	70
	min. ∅ D_i	50	55
PE-tube	max. ∅ a_a	55	63
	min. ∅ a_i	42	46

Dimensions in mm

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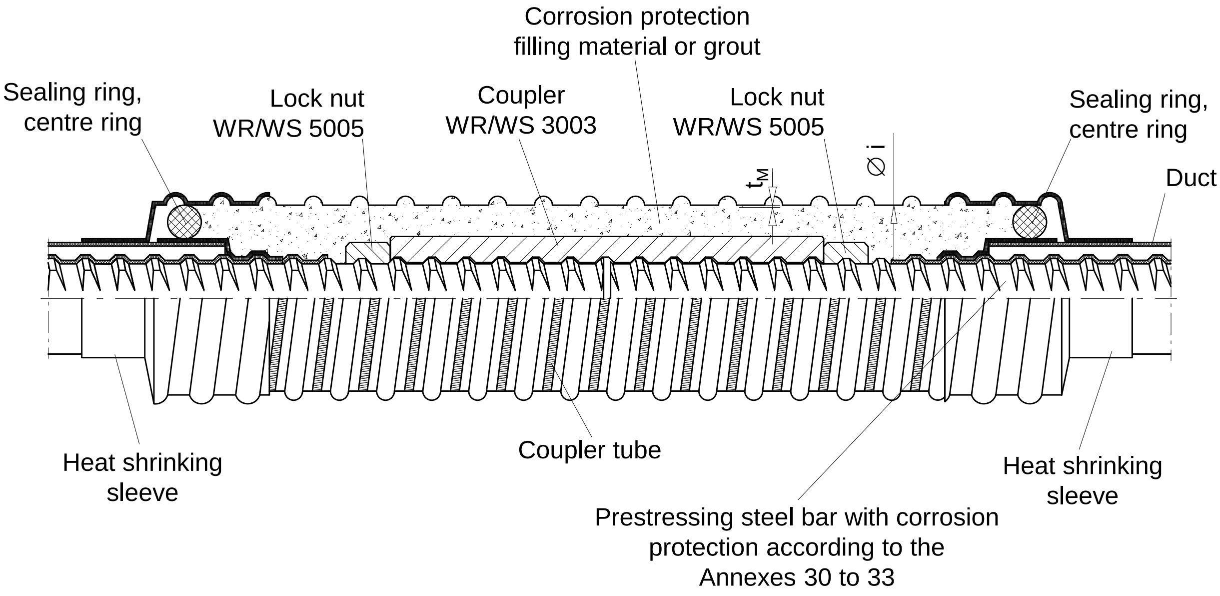
SAS – Post tensioning bar tendon system
SAS-PT unbonded bar tendon

Tendon without free tendon duct
Corrosion protection
Coupling

Annex 34
of European Technical Assessment
ETA-05/0122 of 09.12.2019



Designation		18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR	32 WS	36 WS
Coupler tube, nom. diameter	∅ i	50	65	75	85	85	100	75	85
Coupler tube, sheet thickness	min. t_M	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Dimensions in mm

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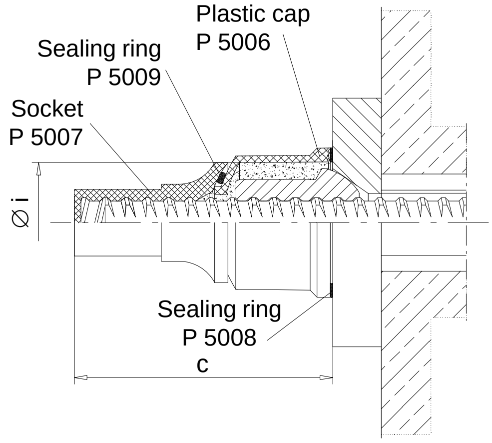
SAS – Post tensioning bar tendon system
SAS-PT bar tendon, bonded, unbonded, and external tendon

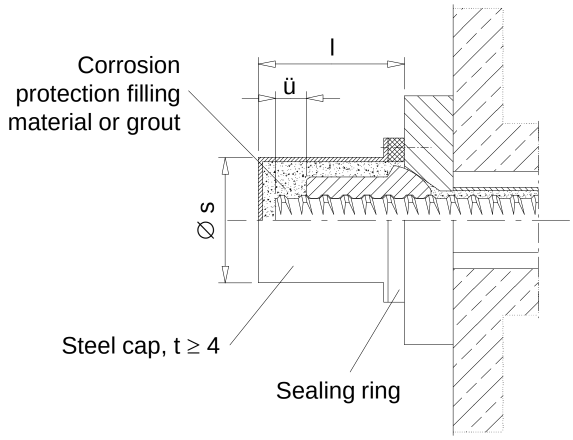
Anchorage – Corrosion protection

Annex 35
of European Technical Assessment
ETA-05/0122 of 09.12.2019

Corrosion protection at low mechanical stresses



Corrosion protection at high mechanical stresses



Designation		18 WR	26.5 WR	32 WR	36 WR	40 WR	47 WR	32 WS	36 WS
In case of low mechanical stresses PE-cap	∅ i	70	90	90	110	110	161	90	110
	c	163	195	195	250	250	293	195	250
In case of high mechanical stresses Steel cap	min. ∅ s	63.5	88.9	95	101.6	114	127	95	101.6
	min. l	105	105	105	115	110	130	55	80

Min. l for a bar projection length of ü = 5 mm

Dimensions in mm

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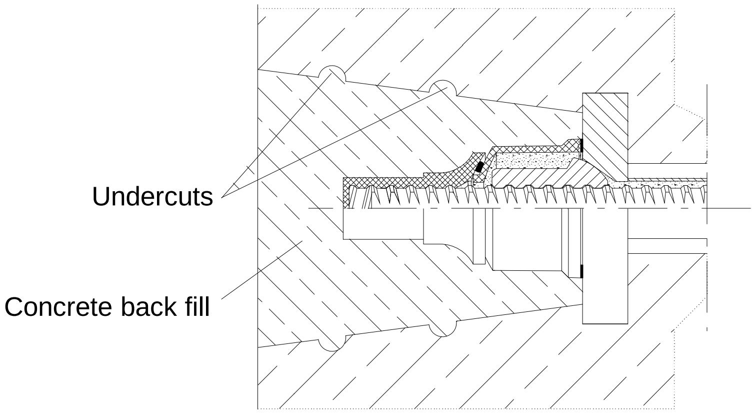
SAS – Post tensioning bar tendon system
SAS-PT unbonded and external bar tendon

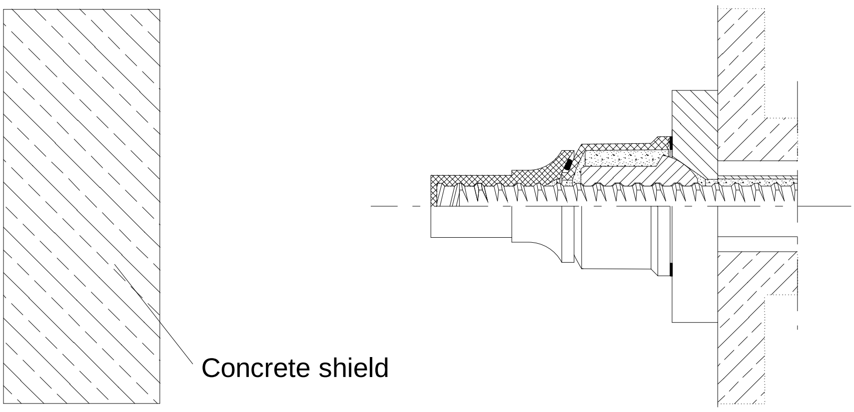
Measures against bursting out of prestressing steel bar – Examples

Annex 36
of European Technical Assessment
ETA-05/0122 of 09.12.2019

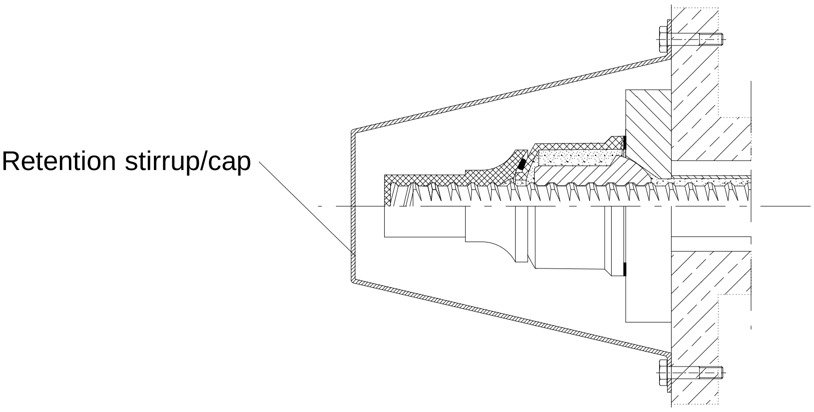
Anchorage with concrete cover



Free anchorage with concrete shield



Free anchorage with retention stirrup/cap



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SAS – Post tensioning bar tendon system
SAS-PT bar tendon, bonded, unbonded, and external tendon

Material specifications

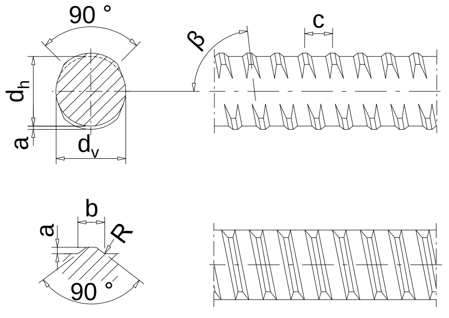
Annex 37
of European Technical Assessment
ETA-05/0122 of 09.12.2019

Material specifications

Component	**Standard / Specification**
Solid plate, square	EN 10025
Solid plate, rectangular	EN 10025
Solid plate, small rectangular	EN 10025
QR-plate	EN ISO 683-1
Domed anchor nut, ∅ 17.5, 26.5, 32, 36 mm	EN 10025
Domed anchor nut, ∅ 40, 47 mm	EN 10293 EN ISO 683-2
Domed anchor nut with grout slots, ∅ 17.5, 26.5, 32, 36, 40, 47 mm	EN 10025
Domed anchor nut with grout slots, ∅ 40, 47 mm	EN 10293 EN ISO 683-2
Coupler, ∅ 17.5	EN 10025
Coupler, ∅ 17.5, 26.5, 32, 36 mm	EN ISO 683-1
Coupler, ∅ 40, 47 mm	Deposited at Österreichisches Institut für Bautechnik
Additional reinforcement	Ribbed reinforcing steel, $R_e \geq 500$ N/mm^2
Steel strip duct, Duct sleeve C, Coupler tube	EN 523 EN 10139
Retaining nut	Deposited at Österreichisches Institut für Bautechnik
Duct sleeve A, duct sleeve B, PE cap, hex nut with washer face, spacer	EN ISO 17855-1
Smooth PE tube	EN 12201-1
Sealing ring, Toroidal sealing ring	Deposited at Österreichisches Institut für Bautechnik
Grout cap	EN 10130
Steel tube	EN 10216, EN 10217, EN 10305

Thread bar, WR, surface configuration and dimensions

Y1050H according to prEN 10138-4

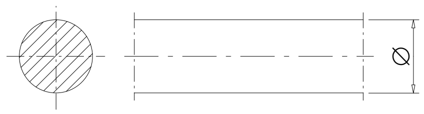


Designation	Nominal diameter	Nominal mass per metre [1]	Nom. cross-sectional area	Core diameter		Depth	Width	Pitch	Gradient	Radius
—	∅	M	S_n	d_h	d_v	min. a	b	c	β	R
—	mm	kg/m	mm²	mm	mm	mm	mm	mm	°	mm
18 WR	17.5	1.96	241	17.4	17.2	1.1	4.1	8	82.5	1.8
26.5 WR	26.5	4.48	552	26.4	25.9	1.7	6.2	13	81.5	2.6
32 WR	32	6.53	804	31.9	31.4	1.9	7.6	16	81.5	3.2
36 WR	36	8.27	1 018	35.9	35.4	2.1	8.7	18	81.5	3.6
40 WR	40	10.21	1 257	39.7	38.9	2.1	9.6	20	81.5	4.0
47 WR	47	14.10	1 735	46.6	45.8	2.4	10.5	21	82.5	4.0

[1] The nominal mass per metre includes 3.5 % non-bearing area of ribs.
Tolerance +3 % / -2 % of nominal mass

Plain bar, WS, dimensions

Y1050H according to prEN 10138-4



Designation	Nominal diameter ∅	Nominal mass per metre [1]	Nominal cross-sectional area
—	mm	kg/m	mm²
32 WS	32	6.31	804
36 WS	36	7.99	1 018

[1] Tolerance +3 % / -2 % of nominal mass

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Mechanical characteristics

<table>
<tr><th colspan="2" rowspan="2">Nominal diameter</th><th rowspan="2">0.1% - proof stress</th><th rowspan="2">Tensile strength</th><th colspan="2">Characteristic</th><th rowspan="2">—</th></tr>
<tr><th>0.1% - proof force</th><th>Maximum force</th></tr>
<tr><td colspan="2">∅</td><td>$R_{p0.1}$
$f_{p0.1}$</td><td>R_m
f_{pk}</td><td>$F_{p0.1}$</td><td>F_{pk}</td><td>α 1)</td></tr>
<tr><td colspan="2">mm</td><td>N/mm²</td><td>N/mm²</td><td>kN</td><td>kN</td><td>%</td></tr>
<tr><td rowspan="2">WR</td><td>17.5</td><td rowspan="6">950</td><td rowspan="6">1 050</td><td>230</td><td>255</td><td rowspan="6">5</td></tr>
<tr><td>26.5</td><td>525</td><td>580</td></tr>
<tr><td rowspan="2">WR
WS</td><td>32</td><td>760</td><td>845</td></tr>
<tr><td>36</td><td>960</td><td>1 070</td></tr>
<tr><td rowspan="2">WR</td><td>40</td><td>1 190</td><td>1 320</td></tr>
<tr><td>47</td><td>1 650</td><td>1 820</td></tr>
</table>

Additional characteristics

<table>
<tr><td>Total elongation at maximum force 2),
calculated as $A_g + \frac{R_{m,\,a}}{E} \cdot 100$</td><td>$A_{gt}$</td><td>%</td><td>5</td><td>5 1)</td></tr>
<tr><td rowspan="3">Force range F_r,
at upper load $F_{up} = 0.70 \cdot F_{m,\,a}$ and
$N = 2 \cdot 10^6$ load cycles</td><td colspan="2">Plain bar</td><td colspan="2">$200\ \text{N/mm}^2 \cdot S_n$</td></tr>
<tr><td rowspan="2">Thread bar</td><td>18–40 WR</td><td colspan="2">$180\ \text{N/mm}^2 \cdot S_n$</td></tr>
<tr><td>47 WR</td><td colspan="2">$120\ \text{N/mm}^2 \cdot S_n$</td></tr>
<tr><td>Isothermal stress relaxation</td><td colspan="4">Losses from an initial force of
$0.70 \cdot F_{m,\,a}$ after 1 000 h ≤ 3 %</td></tr>
</table>

1) Quantile for a statistical probability of $W = 1 - \alpha = 0.95$ (one sided)

2) $E \approx 205\,000$ N/mm² and A_g as plastic extension at maximum force

Maximum prestressing and overstressing forces

Designation	Nominal bar diameter	Nominal cross-sectional area	Maximum prestressing force[1]	Maximum overstressing force[1), 2)]
—	∅	S_n	$0.8 \cdot F_{pk}$	$0.95 \cdot F_{p0.1}$
—	mm	mm²	kN	kN
Thread bar				
18 WR	17.5	241	204	219
26.5 WR	26.5	552	464	499
32 WR	32	804	676	722
36 WR	36	1 018	856	912
40 WR	40	1 257	1 056	1 131
47 WR	47	1 735	1 457	1 566
Plain bar				
32 WS	32	804	676	722
36 WS	36	1 018	856	912

1) The given values are maximum values according to Eurocode 2, i.e. $\min(k_1 \cdot f_{pk},, k_2 \cdot f_{p0.1})$ applies.

$F_{pk} = S_n \cdot f_{pk}$

$F_{p0.1} = S_n \cdot f_{p0.1}$

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

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SAS – Post tensioning bar tendon system
SAS-PT bar tendon, bonded, unbonded, and external tendon

Slip at anchorage and coupling

Annex 41
of European Technical Assessment
ETA-05/0122 of 09.12.2019

Slip at anchorage and coupling

Designation	Anchor plate	Slip at load transfer from prestressing jack to anchorage	Slip, considered for calculation of elongation		
		Stressing anchor	Stressing anchor	Fixed anchor	Coupling
mm	—	mm	mm	mm	mm
Thread bar					
18 WR	Solid plate, square	1.7 [1] 0.2 [2]	1.5	3.2	2.0
	Solid plate, rectangular		1.0	2.7	
	Solid plate, rectangular, small				
26.5 WR 32 WR 36 WR 40 WR	Solid plate, square	1.7 [1] 0.9 [2]	1.5	3.2	
	Solid plate, rectangular		1.0	2.7	
	Solid plate, rectangular, small				
	QR-plate				
47 WR	Solid plate, square	1.4 [1] 0.9 [2]	1.0	2.7	3.0
	Solid plate, rectangular				
	Solid plate, rectangular, small				
Plain bar					
32 WS 36 WS	Solid plate, square	0.7 [1]	1.5	2.2	1.0
	Solid plate, rectangular		1.0	1.7	
	Solid plate, rectangular, small				

[1] Slip at transfer of prestressing force from prestressing jack to anchorage
[2] Slip at transfer of prestressing force from prestressing jack to anchorage after three stressing-transfer-cycles

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SAS – Post tensioning bar tendon system
SAS-PT bar tendon, bonded, unbonded, and external tendon

Minimum elastic and
minimum cold bent radius of curvature

Annex 42
of European Technical Assessment
ETA-05/0122 of 09.12.2019

Minimum elastic and minimum cold bent radius of curvature

Designation	Minimum elastic radius of curvature	Minimum cold bent radius of curvature
—	min R_{el}	min R_{kv}
—	m	m
Thread bar		**200 · d**
18 WR	30	3.5
26.5 WR	40	5.3
32 WR	40	6.4
36 WR	50	7.2
40 WR	60	8.0
47 WR	80	9.4
Plain bar		**150 · d**
32 WS	40	4.8
36 WS	50	5.4

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SAS – Post tensioning bar tendon system
SAS-PT bar tendon, bonded, unbonded, and external tendon

Contents of the prescribed test plan

Annex 43
of European Technical Assessment
ETA-05/0122 of 09.12.2019

Subject / type of control		Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Solid plate, square 2011, Solid plate, rectangular 2012, Solid plate, rectangular, small, 2076	Material	Checking [1]	[2]	100 %	continuous
	Detailed dimensions	Testing	[2]	3 %, ≥ 2 specimens	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	bulk			
QR plate 2074	Material	Checking [4]	[2]	100 %	continuous
	Detailed dimensions	Testing	[2]	3 %, ≥ 2 specimens	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	full			
Domed anchor nut 2001, Domed anchor nut with grout slots 2099, Coupler 3003, Coupler L 3303, Transition coupler 3004	Material	Checking [4]	[2]	100 %	continuous
	Strength	Testing	[2]	0.5 %, ≥ 2 specimens	continuous
	Detailed dimensions	Testing	[2]	5 %, ≥ 2 specimens	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	full			
Thread bar, Plain bar	Material	Checking	[2], [5]	100 %	continuous
	Diameter	Testing	[2]	1 sample	each bundle or every 7 tons [6]
	Visual inspection	Checking	[2]	1 sample	
Rolled-on special thread of plain bar	Thread form [7]	Checking	[2]	100 %	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	full			
Steel strip duct	Material	Checking [8]	[2]	100 %	continuous
	Dimension	Testing	[2]	3 %, ≥ 2 specimens	continuous
	Traceability	full			
Cement, Admixtures, Additions of filling materials as per EN 447	Material	Checking [8]	[2]	100 %	continuous
	Traceability	full			

1) Checking by means of at least a test report 2.2 according to EN 10204.
2) Conformity with the specifications of the component
3) Successful visual inspection does not need to be documented.
4) Checking by means of an inspection report 3.1 according to EN 10204.
5) Checking of relevant certificate as long as the basis of "CE"-marking is not available.
6) Maximum between a bundle and 7 tons is taken into account
7) Dimensions of the rolled-on thread of the plain bar.
8) Checking of relevant certificate, CE marking and declaration of performance or, if basis for CE marking is not available, certificate of supplier

Traceability	full	Full traceability of each component to its raw material.
	bulk	Traceability of each delivery of components to a defined point.
Material		Defined according to technical specification deposited by the supplier
Detailed dimension		Measuring of all the dimensions and angles according to the specification given in the test plan
Visual inspection		Main dimensions, correct marking and labelling, surface, corrosion, coating, etc.
Strength		Determination of strength by means of hardness tests or similar

Max Aicher GmbH & Co. KG
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SAS – Post tensioning bar tendon system
SAS-PT bar tendon, bonded, unbonded, and external tendon

Audit testing

Annex 44
of European Technical Assessment
ETA-05/0122 of 09.12.2019

Subject / type of control		Test or control method	Criteria, if any	Minimum number of samples [1]	Minimum frequency of control
Solid plate, square 2011, Solid plate, rectangular 2012, Solid plate, rectangular, small 2076, QR plate 2074	Material	Checking and testing, hardness and chemical [2]	[3]	1	1/year
	Detailed dimensions	Testing	[3]	1	1/year
	Visual inspection	Checking	[3]	1	1/year
Coupler 3003, Coupler L 3303, Transition coupler 3004, Domed anchor nut 2001, Domed anchor nut with grout slots 2099	Material	Checking and testing, hardness and chemical [2]	[3]	2	1/year
	Strength	Testing	[3]	2	1/year
	Detailed dimensions	Testing	[3]	1	1/year
	Main dimensions, surface hardness	Testing	[3]	5	1/year
	Visual inspection	Checking	[3]	5	1/year
Rolled-on special thread of plain bar	Material	Checking [4]	[3]	2	1/year
	Visual inspection	Checking [5]	[3]	2	1/year
Single tensile element test		According to EAD 160004-00-0301, Annex C.7		3	1/year

[1] If the kits comprise different kinds of anchor heads e.g. with different materials, different shape, different nut, etc., then the number of samples is understood as per kind.

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

[3] Conformity with the specifications of the component

[4] Checking by means of an inspection report 3.1 according to EN 10204.

[5] Main dimensions of thread, gauge testing, surface, smoothness, corrosion, notches.

Material	Defined according to technical specification deposited by the ETA holder at the Notified body
Detailed dimension	Measuring of all dimensions and angles according to the specification given in the test plan
Visual inspection	Main dimensions, correct marking and labelling, surface, corrosion, coating, etc.
Treatment, hardness	Surface hardness, core hardness and treatment depth
Strength	Determination of strength by means of hardness tests or similar

Essential characteristics for the intended uses of the PT system

№	Essential characteristic	Clause	Intended use Line № according to Clause 2.1, Table 2		
			1	2	3
1	Resistance to static load	3.2.1.1	+	+	+
2	Resistance to fatigue	3.2.1.2	+	+	+
3	Load transfer to the structure	3.2.1.3	+	+	+
4	Friction coefficient	3.2.1.4	+	+	+
5	Deviation, deflection (limits) for internal bonded and internal unbonded tendon	3.2.1.5	+	+	—
6	Deviation, deflection (limits) for external tendon	3.2.1.6	—	—	+
7	Assessment of assembly	3.2.1.7	+	+	+
8	Corrosion protection	3.2.1.8	+	+	+
9	Reaction to fire	3.2.2.1	+	+	+
10	Content, emission and/or release of dangerous substances	3.2.3.1	+	+	+

Key
+.........Essential characteristic relevant for the intended use
—.......Essential characteristic not relevant for the intended use

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

Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bar tendon, bonded, unbonded, and external tendon Reference documents	**Annex 46** of European Technical Assessment **ETA-05/0122** of 09.12.2019

Reference documents

European Assessment Document

EAD 160004-00-0301	Post-Tensioning Kits for Prestressing of Structures
EAD 160027-00-0301	Special filling products for post-tensioning kits

Eurocodes

Eurocode 2	Eurocode 2 – Design of concrete structures
Eurocode 3	Eurocode 3 – Design of steel structures
Eurocode 5	Eurocode 5 – Design of timber structures
Eurocode 6	Eurocode 6 – Design of masonry structures

Standards

EN 206+A1, 11.2016	Concrete – Specification, performance, production and conformity
EN 446, 10.2007	Grout for prestressing tendons – Grouting procedures
EN 447, 10.2007	Grout for prestressing tendons – Basic requirements
EN 523, 08.2003	Steel strip sheaths for prestressing tendons – Terminology, requirements, quality control
EN 10025-2, 11.2004	Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels
EN 10130, 12.2006	Cold-rolled low carbon steel flat products for cold forming – Technical delivery conditions
EN 10139, 02.2016	Cold rolled uncoated low carbon steel narrow strip for cold forming – Technical delivery conditions
EN 10204, 10.2004	Metallic products – Types of inspection documents
EN 10216-series, 12.2013	Seamless steel tubes for pressure purposes – Technical delivery conditions – Series
EN 10217-series, 04.2019	Welded steel tubes for pressure purposes – Technical delivery conditions – Series
EN 10293, 01.2015	Steel castings – Steel castings for general engineering uses
EN 10305-series, 03.2016	Steel tubes for precision applications – Technical delivery conditions – Series
EN 12201-1, 09.2011	Plastics piping systems for water supply, and for drainage and sewerage under pressure – Polyethylene (PE) – Part 1: General
EN ISO 683-1, 06.2018	Heat-treatable steels, alloy steels and free-cutting steels – Part 1: Non-alloy steels for quenching and tempering
EN ISO 683-2, 06.2018	Heat-treatable steels, alloy steels and free-cutting steels – Part 2: Alloy steels for quenching and tempering
EN ISO 1461, 05.2009	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods

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Max Aicher GmbH & Co. KG 83404 Ainring–Hammerau	**SAS – Post tensioning bar tendon system** SAS-PT bar tendon, bonded, unbonded, and external tendon Reference documents	**Annex 47** of European Technical Assessment **ETA-05/0122** of 09.12.2019

EN ISO 12944-4, 12.2017	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 4: Types of surface and surface preparation
EN ISO 12944-5, 03.2018	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 5: Protective paint systems
EN ISO 12944-7, 12.2017	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 7: Execution and supervision of paint work
EN ISO 14713-1, 05.2017	Zinc coatings – Guidelines and recommendations for the protection against corrosion of iron and steel in structures – Part 1: General principles of design and corrosion resistance
EN ISO 17855-1, 10.2014	Plastics – Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specifications
prEN 10138-4, 08.2009	Prestressing steels – Part 4: Bars
CWA 14646, 01.2003	Requirements for the installation of post-tensioning kits for prestressing of structures and qualification of the specialist company and its personnel

Other documents

98/456/EC	Commission decision 98/456/EC of 3 July 1998 on the procedure for attesting the conformity of construction products pursuant to Article 20 (2) of Council Directive 89/106/EEC as regards posttensioning kits for the prestressing of structures, Official Journal of the European Communities L 201 of 17 July 1998, p. 112
305/2011	Regulation (EU) № 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 88 of 4 April 2011, p. 5, amended by Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, OJ L 157 of 27.05.2014, p. 76, Commission Delegated Regulation (EU) № 574/2014 of 21 February 2014, OJ L 159 of 28.05.2014, p. 41, and Regulation (EU) 2019/1020 of the European Parliament and of the Council of 20 June 2019, OJ L 169 of 15.06.2019, p. 1
568/2014	Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014 amending Annex V to Regulation (EU) № 305/2011 of the European Parliament and of the Council as regards the assessment and verification of constancy of performance of construction products, OJ L 157 of 27.05.2014, p. 76