Technical and Test Institute
for Construction Prague
Prosecká 811/76a
190 00 Prague
Czech Republic
eota@tzus.cz

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

Member of EOTA
www.eota.eu

Evaluation Report of ETA 17/0222 issued on 13/04/2017

Trade name	**Udarna pričvrsnica TS-8**
Holder of assessment	STRELA d.o.o. Varaždinska ulica, Odv. I/6, Jalkovec 42000 Varaždin HRVATSKA Republic of Croatia
Generic type and use of construction product	Plastic nailed-in anchors for fixing of external thermal insulation composite systems with rendering in concrete and masonry
This Evaluation Report contains:	13 pages

CONTENT:

1 Introduction

The company STRELA d.o.o. has applied for the granting of an European Technical Assessment for the nailed-in anchor Udarna pričvrsnica TS-8 for the fixing of thermal insulation composite systems (ETICS).

The following tests were performed and evaluated in accordance with EAD 330335-00-0604 [1].

The test carried out at the Technický a zkušební ústav stavební Praha, s.p. (Technical and Test Institute for Construction Prague) – laboratory 1018.8 accredited by ČIA (Czech Accreditation Institute).

2 References

[1] EAD 330335-00-0604, "Plastic anchors made of virgin or non-virgin material for fixing of external thermal insulation composite systems with rendering ", Edition June 2016

[2] ETAG 004, "Guideline for European Technical Approval of External Thermal Insulation Composite Systems with Rendering", Edition March 2000

[3] EOTA Technical Report TR 025, “Point thermal transmittance of plastic anchors for ETICS”, Edition May 2016

[4] EOTA Technical Report TR 026, “Plate stiffness of plastic anchors for ETICS”, Edition May 2016

[5] EN 206-1: Concrete – Part 1: Specification, performance, production and conformity, Edition July 2001

[6] EN 771-1: Specifikation for masonry units – Part 1: Clay masonry units

[7] Test reports of the anchors TS-8 (according to the EAD 330335-00-0604), tests carried out by laboratory No. 1018.8 accredited by ČIA (Czech Accreditation Institute)

[8] Test reports of the anchors TS-8 (according to the EAD 330335-00-0604 and ISO 11357-3, EN ISO 3451)

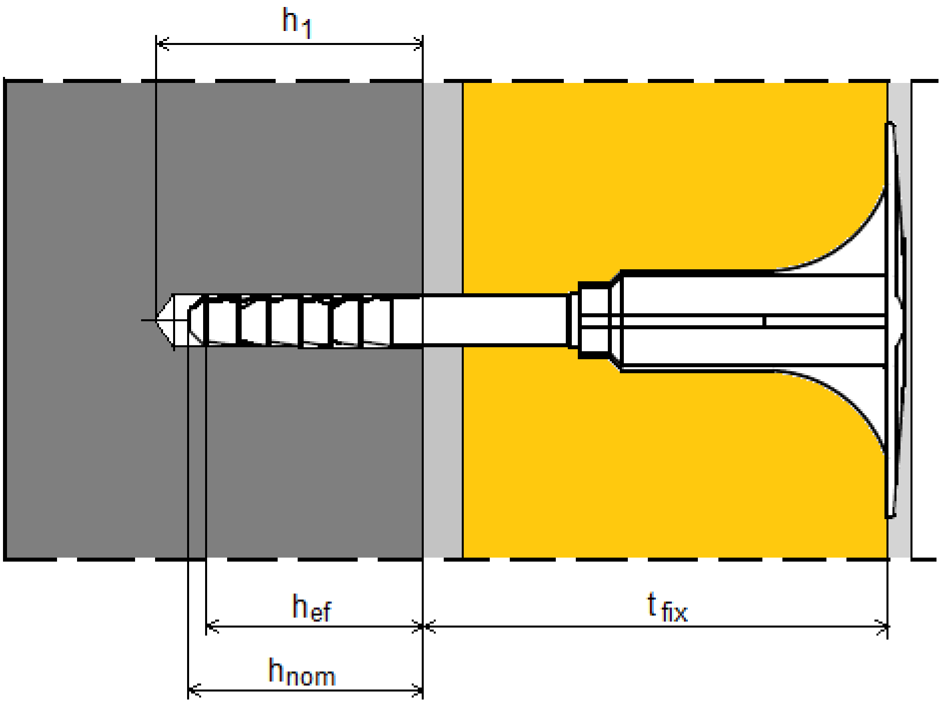
3 Description of product and intended use

3.1 Description of anchor

The anchor TS-8 consists of an anchor sleeve with a plate for fixing the thermal insulation and expansion nail. The anchor is made of polypropylene with accompanying expansion nail of poylamide.

The anchor is expanded by hammering the expansion nail into the anchor sleeve.

Figure 3.1 Anchor TS-8 for the fixing of thermal insulation composite systems (installed)



Legend:

h_1	= depth of drill hole in base material
h_{ef}	= effective embedment depth
h_{nom}	= overall embedment depth in the base material
t_{fix}	= thickness of fixture

The anchor's dimensions correspond to those given in Table 3.1

Table 3.1 Dimensions

Anchor type	Anchor sleeve				Expansion nail	
	h_{ef} [mm]	$Ød_{nom}$ [mm]	L_s [mm]	L_a [mm]	L_n [mm]	Ød [mm]
TS-8-90	45	8,2	52,5	90	90	5
TS-8-110	45	8,2	72,8	110	110	5
TS-8-140	45	8,2	103,3	140	140	5
TS-8-160	45	8,2	122,8	160	160	5
TS-8-180	45	8,2	142,1	180	180	5
TS-8-200	45	8,2	162,0	200	200	5
TS-8-220	45	8,2	182,0	220	220	5
TS-8-260	45	8,2	221,0	260	260	5

3.2 Intended use

The anchor may only be used for the fixing of thermal insulation composite systems according to ETAG 004 [2].

The assumed working life of the anchor for the intended use is at least 25 years.

The anchor is intended to be used in base materials such as walls made of normal weight concrete and masonry walls made of solid clay bricks and vertically perforated clay bricks.

The anchor is intended to be used as multiple fixing only for the anchorage of bonded thermal insulation composite systems for the transmission of wind suction loads.

The anchor is not intended to transmit the dead loads of the thermal insulation composite system and other loads. These loads shall be carried by the bonding of the thermal insulation composite system. Verification of stability for the thermal insulation composite system shall be carried out in accordance with ETAG 004 [2].

3.3 Materials of the anchor

The anchor's materials correspond to those given in Table 3.2.

Table 3.2. Anchor's materials

Designation	Colour	Material
Anchor sleeve / Anchor plate	natural	Polypropylene
Expansion nail	black	Polyamide reinforced with fiberglass

3.4 Anchors marking

The designation of the anchor consists of the identifying mark of the producer, the anchor type, diameter anchor and the length of the anchor sleeve L_a in [mm], e.g. TS-8 - L_a.

Each anchor sleeve is marked with the identifying mark of the producer, the anchor type and the length of the anchor sleeve. The required minimum effective anchorage depth is marked at the anchor sleeve.

3.5 Base material

The anchor TS-8 is intended to be used in normal weight concrete of strength classes C 12/15 to C50/60 according to EN 206-1 [3] and masonry made of solid clay bricks according to EN 771-1 [4] and vertically perforated clay bricks according to ÖNORM 6124 and EN 771-1[4].

Characteristics of basic tested materials are given in the table 3.3.

Table 3.3 Dimensions, mean compressive strengths and bulk densities of the materials investigated

Material	Dimensions L x B x H [mm]	Compressive strength ß [N/mm²]	Bulk density ρ [kg/dm³]
Normal weight concrete C20/25	500 x 500 x 150	30,3	2,32
Normal weight concrete C 50/60	200 x 200 x 150	62,3	2,30
Solid clay bricks	290 x 140 x 65	20,0	1,70
Vertically perforated clay bricks e.g. according to ÖNORM 6124	175 x 372 x 238	15,0	0,90

L - length, B - breadth, H – height

3.6 Installation of the anchors

The anchor may only be used as a fixing unit produced and delivered in series (anchor sleeve and accompanying special nail, packed as a unit). The installation characteristics given in Table 3.4 shall be observed.

Table 3.4 Installation Characteristics

Typ kotvy	Nominal diameter of drill bit d_o [mm]	Cutting diameter of drill bit d_{cut} [mm]	Depth of drill hole $h_1 \geq$ [mm]	Overall embedment depth h_{nom}[mm]
TS-8	9	9,3	50	45

The anchor shall be set at a temperature of at least 0°C.

The drilled hole is realised for concrete and masonry made of solid clay bricks by means of a hammer drill by impact drilling. The drilled hole is realised in vertically perforated clay bricks by means of rotary drilling. Further details for the installation are specified in the installation instructions of the manufacturer.

4 Performed tests

The tests and verifications were performed in accordance with EAD 330335-00-0604 [1].

A summary tests for TS-8 is given in Table 4.1.

Table 4.1: Performed tests for TS-8

	Test (centric tensile tests)	Base material	Test number	Ambient temperature
1	Tests for determining the characteristic resistance	C 20/25	5	normal
		C 50/60	5	
		Solid clay bricks	10	
		Vertically perforated clay bricks e.g. according to ÖNORM 6124	10	
2	Installation safety	C 20/25	5	normal
		Solid clay bricks		
		Vertically perforated clay bricks e.g. according to ÖNORM 6124	5	
3	Influence of drilled hole diameter $d_{cut, min}$ = 9,20 mm $d_{cut, max}$ = 9,40 mm	C 20/25	5/5	normal
		Solid clay bricks	5/5	
		Vertically perforated clay bricks e.g. according to ÖNORM 6124	5/5	
4	Influence of conditioning	not required, since polypropylene		
5	Influence of temperature 0°C 40°C	C 20/25	5/5	Setting at normal temperature, then heating up, 24 h keeping this temperature
		Solid clay bricks	5/5	
		Vertically perforated clay bricks e.g. according to ÖNORM 6124	5/5	
6	Influence of repeated loading	C 20/25	3	normal
		Solid clay bricks	3	
		Vertically perforated clay bricks e.g. according to ÖNORM 6124	3	
7	Influence of relaxation 500 h	C 20/25	5	normal
		Solid clay bricks	5	
		Vertically perforated clay bricks e.g. according to ÖNORM 6124	5	
9	Sustained load tests	not required, since virgin material		

5 Evaluation tests

The 5%-fractile of the ultimate load shall be calculated for a confidence level of 90% by assuming a standard distribution according to EAD 330335-00-0604.

5.1 Tests results

The test results are given in the following Table 5.1 and are documented in [9].

From the test results the mean values of the ultimate loads $N^{t}_{Ru,m}$ the corresponding coefficient of variation **v** ($N^{t}_{Ru,m}$) and the 5%-fractile of the ultimate load N^{t}_{Rk} as well as the mean displacement with maximum load δ ($N^{t}_{Ru,m}$) were determined.

Table 5.1: Tests according to EAD 330335-00-0604 (Table 2.3; category: A, B, C, D and E).

Pos.	Material/test		n	$N^{t}_{Ru,m}$ [kN]	$v(N^{t}_{Ru,m})$ [%]	$\delta(N^{t}_{Ru,m})$ [mm]	$N^{t}_{R,k}$ [kN]	α_{reg}	$\alpha(N^{t}_{Ru,m})$	$\alpha N^{t}_{R,k}$	α/α_{reg}
1a	Concrete C 20/25		5	0,62	5,57	1,93	**0,50**	-			
1b	Concrete C 50/60		5	0,65	2,39	1,81	**0,60**	-			
1c	Solid clay bricks		10	0,63	9,52	2,01	**0,48**	-			
1d	Vertically perforated clay bricks (ÖNORM B 6124)		10	0,42	7,35	3,18	**0,34**	-			
2a	Installation safety (C 20/25)		5	0,68	8,43	2,35	0,48	≥ 0,9	1	0,95	1
2b	Installation safety (vertically perforated clay bricks ÖNORM B 6124)		5	0,38	6,54	2,05	0,30	≥ 0,9	0,92	0,88	0,98
3	Drill diameter (C 20/25):	9,20 mm 9,40 mm	5 5	0,62 0,57	3,58 8,05	2,16 1,46	0,54 0,41	≥ 1,0 ≥ 0,8	0,99 0,92	1 0,82	0,99
4	Conditioning		not relevant, since polypropylene								
5	Temperature influence (C20/25):	0°C 40°C	5	0,73 0,47	7,29 6,18	2,28 2,01	0,55 0,37	≥ 1,0 ≥ 0,8	1 0,76	1 0,74	0,92
6	Repeated loading (C 20/25)		3	0,71	-	-	-	≥ 1,0	1	[1]	1
7	Relaxation 500 h (C 20/25)		5	0,66	5,59	2,28	0,54	≥ 1,0	1	1	1
9	Sustained load tests		not relevant, since virgin material								

[1] not applicable, since number of tests is different and the coefficient of variation is $v \leq 15\%$ (according to EAD 330335-00-0604)

5.1.1 Tests for determining the characteristic resistance

Tests of anchors TS-8 were performed under standard conditions in the base materials subject to the application for assessment.

The results $N^r_{Ru,m}$ and N^r_{Rk} of the reference pull-out tests in materials, which are noted in table 3.3 and 4.1 are used as a basis for the determination of the reduction factors α for the calculation of the characteristic loads in concrete and masonry of solid clay bricks and vertically perforated clay briks (category A, B and C).

The load displacement curves show a continuous increase until load maximum [7].

The failure in solid clay bricks occurred due to rupture of anchor sleeve or anchor pull-out.

The failure in concrete and vertically perforated clay bricks occurred due to anchor pull out.

5.1.2 Tests for the verification of installation suitability

Tests were performed with EPS-block.

After removing the EPS-block any anchor didn't show any crack and/or brakes that influence the performance of the anchor.

The load displacement curves show a continuous increase until load maximum [7].

The failure in concrete and perforated clay bricks occurred due to anchor pull out.

5.1.3 Tests for determining the influence of the drill hole diameter

For these tests the diameter of the drill bit was varied between 9,20 mm and 9,40 mm. The reduction of the diameter of the drill bit caused the same mean failure load but lower 5%-fractile value. The maximum diameter of the drill bit results in a lower mean failure load and 5%-fractile value respectively.

The load displacement curves show a continuous increase until load maximum [7].

The failure occurred due to anchor pull out.

5.1.4 Tests for determining the effect of temperature

Increasing temperature leads in the relevant temperature range of 0°C to 40°C to a decrease in the failure load.
The load displacement curves show a continuous increase until load maximum [7].

At the temperature +40°C the failure occurred due to anchor pull out.

At the temperature 0°C the failure occurred due to rupture of anchor sleeve or anchor pull-out.

5.1.5 Functioning under repeated loading

The lower and upper loads are calculated for anchor for concrete as follows:

$N_{R,K}$ = 500N
F_u = 0,25*$N_{R,K}$ = 0,25•500 N = **125 N**
F_o = 0,60* $N_{R,K}$ = 0,60•600 N = **300 N**

After 100.000 load cycles tension tests were performed for determining the residual resistance. These tests result, in comparison with the results of the short-term tests, lead to same or higher mean pull-out resistances.

The load displacement curves show a continuous increase until load maximum [7].

The failure occurred due to anchor pull out.

5.1.6 Functioning after relaxation 500 h

Pull-out tests under standard conditions in concrete show an increase in the pull-out resistance after 500 h.

The load displacement curves show a continuous increase until load maximum [7].

The failure in occurred due to rupture of anchor sleeve or anchor pull-out.

5.1.7 Verification of the Anchor plate

The load resistance of the anchor plate and the plate stiffness of the anchor TS-8 have been determined in [7]. The test were conducted according to the TR 026 [4].

Anchor type	Diameter of the anchor plate [mm]	Load resistance of the anchor plate [kN]	Plate stiffness [kN/mm]
TS-8	64	1,42	0,6

5.1.8 Thermo Technical Verification

The point transmittance has been determined in [7] according to the TR 025 [3].

For the thermo technical verification the following χ **-** values given in table:

Anchor type	Insulation thickness h_D [mm]	Point thermal transmittance χ [W/K]
TS-8	54 - 215	0

The thermal bridge effect of the anchor is smaller than 0,0005 W/K and can therefore be neglected in the calculation.

6 Assessment of the anchor

6.1 Calculation at the characteristic load

The characteristic load of the anchor on the basis of the 5%-fractile of the performed test series concerned is determined in accordance wlth EAD 330335-00-0604 [1]. The confidence levels 90% by assuming a normal distribution and an unknown standard deviation.

Since none of the performed test series resulted in a failure or pull off of the steel nail, only the characteristic values determined in the pull-out tests are relevant for deriving the characteristic load. The coefficient of variation is for all test series below 20%, hence $\alpha_v = 1$ ([1], equation 6.1).

Table 6.1 shows the reduction factors calculated on the basis of the performed tests, which were used for the determination of the characteristic loads.

Since the number of tests of the test series differs significantly and the coefficient of variation of the performed tests is always v < 15%, a consideration of the reduction factor according to equation 6.2b [1] is not needed.

For the determination of the characteristic loads in materials of category A, B and C the following reduction factors have to be considered, Table 6.1.

Table 6.1: Reduction factors for deriving the characteristic loads of anchor TS-8 in materials of categories A, B and C.

	min$\alpha_{1, line2}$	**min**$\alpha_{1, line 4,5}$	**min**$\alpha_{1, line3,6,7}$	$\alpha_{1, line9}$	***min***α_1
C 20/25	1	0,92	0,99	-	0,92
Solid clay bricks	1	0,92	0,99	-	0,92
Verticaly perforated clay bricks ÖNORM B 6124	0,98	0,92	0,99	-	0,90

The calculation of the characteristic loads of the anchor TS-8 in materials of category A, B and C results in the following values, Table 6.2.

Table 6.2: Calculation of the characteristic loads of anchor TS-8 displacements for N_{RK} /3

Material	$N^t_{Rk} = N_{Rk0}$ [kN]	min α_1	min α_v	$N_{Rk0, rech}$ [kN]	**N_{Rk} [kN]**	**δ for $N_{R,k}/3$ [mm]**
C 12/15	0,50	0,92	-	0,46[1) · 0,7	**0,3**	**0,44**
C 16/20	0,50	0,92	-	0,46	**0,4**	**0,44**
C 50/60	0,60	0,92	-	0,55	**0,4**	**0,44**
Solid clay bricks	0,48	0,92	-	0,44	**0,4**	**0,21**
Verticaly perforated clay bricks ÖNORM B 6124	0,34	0,90	-	0,31	**0,3**	**0,35**

[1)] For C 12/15 a reduction factor of 0.7 according to [1] has to be used.

N^t_{RK} = 5%- fractile of the ultimate load (W = 90%)
$N_{Rk0, rech}$ = calculated characteristic load
N_{RK} = rounded characteristic load

6.2 Base materials

Table 6.3: Base materials

Material	Symbol according to EN	Format: LxBxH [mm]	Compressive strength ß [N/mm²]	Bulk density ρ [kg/dm³]	Remarks	Drill method
Concrete	C 20/25 C 50/60	500x500x150 200x200x150	30,3 62,3	2,32 2.30		Impact drilling
Solid clay bricks		290x140x65	20,0	1,70	Vertically perforation up to 15%	Impact drilling
Vertically perforated clay bricks		175x372x238	15,0	0,90	ÖNORM 6124	Rotary drilling

L - lenght, B - breadth, H – height

6.3 Durability of the expansion nail

The expansion nail is made of polyamide reinforced with fiberglass.

The geometric shape of the head of the nail and the plastic anchor ensures, that after installation no humidity can penetrate into the interior of the anchor sleeve.

6.4 Durability of the plastic sleeve

The material used for the plastic sleeve is polypropylene. The plate is made from polypropylene reinforced with fiberglass The suitability of this plastic material is verified and documented in [8].

It was shown that the used material is resistant to building material-specific media.

The durability against alkalinity is given. The plastic material is unsusceptible to stress cracking. Due to the impact resistance even at low temperatures, kopolymer polypropylene considered suitable for the mechanic loads that occur during anchor setting. No negative influence on the durability of the plastic material used for the plastic sleeve is to be expected from the temperatures occurring in the base material.

Since PP does not absorb any water, no influence is to be expected from the ambient humidity on the durability of the plastic material.

Since UV-exposure can damage the plastic, the plastic sleeve shall be stored in a package impervious to light (according to [1] 6.7.3) and shall be exposed to sunlight after setting for not more than 6 weeks.

The durability of the plastic sleeve is thus sufficiently verified for the intended use.

7 Identification of the anchor

7.1 Expansion nail

Polyamide PA6 is used for the plastic part, which is manufactured in an injection molding process.

Polyamide has the following material characteristics and properties in table 7.1:

a) mechanical properties

Table 7.1: Material properties of the nail

Tensile modulus	[MPa]	dry 9000 / cond 6000
Stress at break	[MPa]	dry 140 / cond 80
Strain at break	[%]	dry 2 / cond 4

7.2 Anchor sleeve

Copolymer polypropylene is used for the plastic part, which is manufactured in an injection molding process.

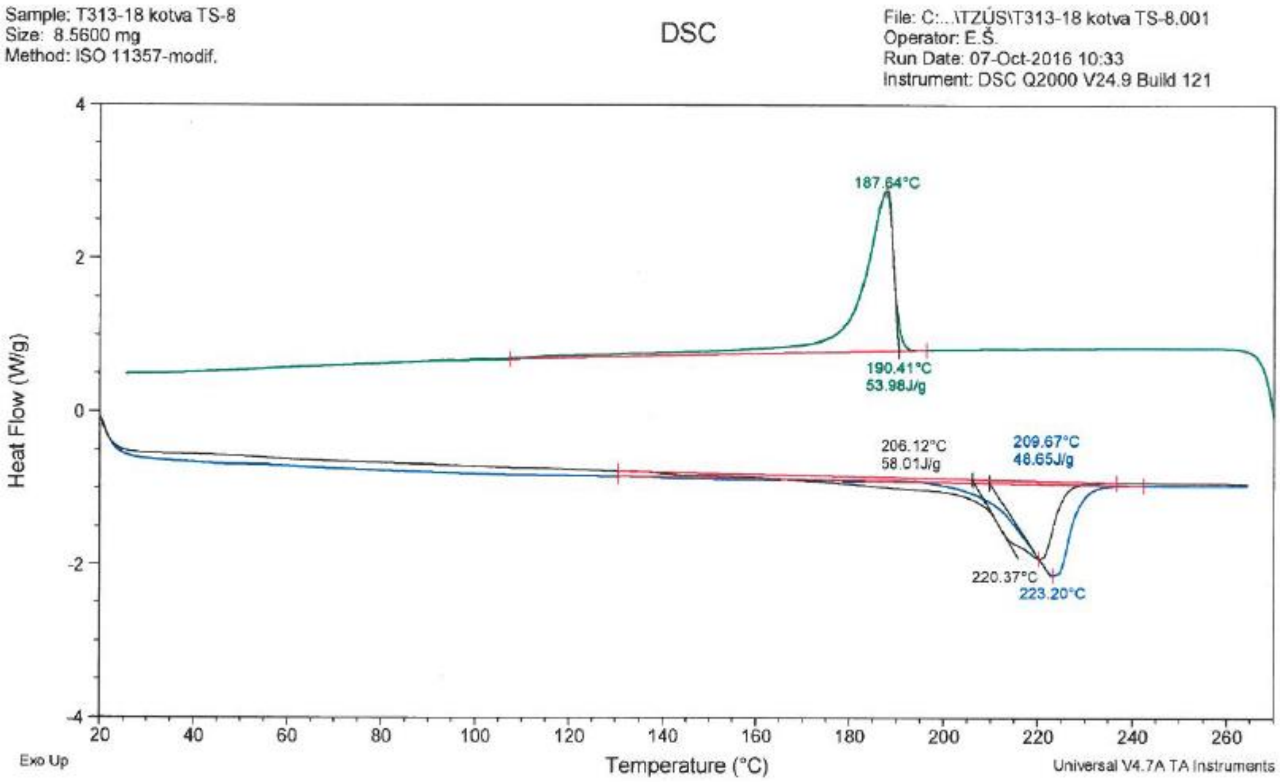
Polypropylene has the following material characteristics and properties in table 7.2:

a) mechanical properties

Table 7.2: Material properties of the sleeve

Flexural modulus	[MPa]	1350
Tensile strength at Yield	[MPa]	27
Tensile strain at Yield	[%]	5

Figure 7.1 The DSC-curves – Expansion nail



8 Summary

The company STRELA d.o.o. applies for an European Technical Assessment for the anchors TS-8. The anchor TS-8 is used for the fixing of bonded thermal insulation composite systems in concrete and masonry of solid clay bricks and vertically perforated clay bricks.

It is confirmed by the tests that the anchor TS-8 can be properly installed in the tested materials.

It could be demonstrated by means of the tests under different influences, that the anchor has a sufficiently high resistance and is recommended for a European Technical Assessment for the fixing of bonded thermal insulation composite systems (ETICS) in concrete and certain masonry types.