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European Assessment Document for

Distance-fixing systems for use in concrete and masonry

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

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1 SCOPE OF THE EAD

1.1 Description of the construction product

This EAD covers the assessment of post-installed anchors placed into pre-drilled holes in concrete, masonry and autoclaved aerated concrete, and anchored by bonding.

The EAD applies to a distance fixing systems, which consists of a cylindrical load-bearing element made of glass-fibre reinforced plastics or metal or reinforced or non-reinforced polyamide with and without a mesh or a sieve sleeve and is used together with the injection mortar. The element has an internal or external thread. The fixing system is placed into a pre-drilled hole perpendicular to the surface (maximum deviation 5°) in concrete, masonry or autoclaved aerated concrete, and anchored by bonding the plastic or metal anchoring element to the sides of the drilled hole by means of mortar (see Figure 1.1.1 to Figure 1.1.2).

This EAD applies to distance fixing systems in which a metal or plastic anchoring element is anchored in the masonry or autoclaved aerated concrete or concrete through an existing façade insulation system and designed to transmit the applied loads.

This EAD applies to an anchoring element used together with a minimum M6 threaded pin including washer and nut made of steel, or with a minimum Ø6 mm screw made of steel.

The bonding material may be manufactured from cementitious mortar, synthetic mortar or a mixture of the two including fillers and/or additives.

The metal parts of the fixing system and the cementitious mortar contain no more then 1,0 % by weight or volume (whichever is lower) of homogeneously distributed organic material.

This EAD applies to fixing systems with a minimum anchorage depth of h_{ef} = 80 mm in masonry and aerated autoclaved concrete and a minimum anchorage depth of h_{ef} = 40 mm in concrete. The maximum anchorage depth is max h_{ef} = h – 30 mm.

This EAD applies to applications where the minimum thickness of the structural element in which the fixing system is installed is at least h_{min} = 115 mm for masonry and aerated autoclaved concrete and h_{min} = 80 mm for concrete.

The product is not covered by a harmonised European standard (hEN).

The product is not fully covered by the following harmonised technical specification: EAD 330076-01-0604 [1] [1] and EAD 330499-02-0601 [2], since these EADs cover only metal injection anchors and are not applicable for the products covered by this EAD without modifications.

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 the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

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.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1 All undated references to standards in this EAD are to be understood as references to the dated versions listed in chapter4.

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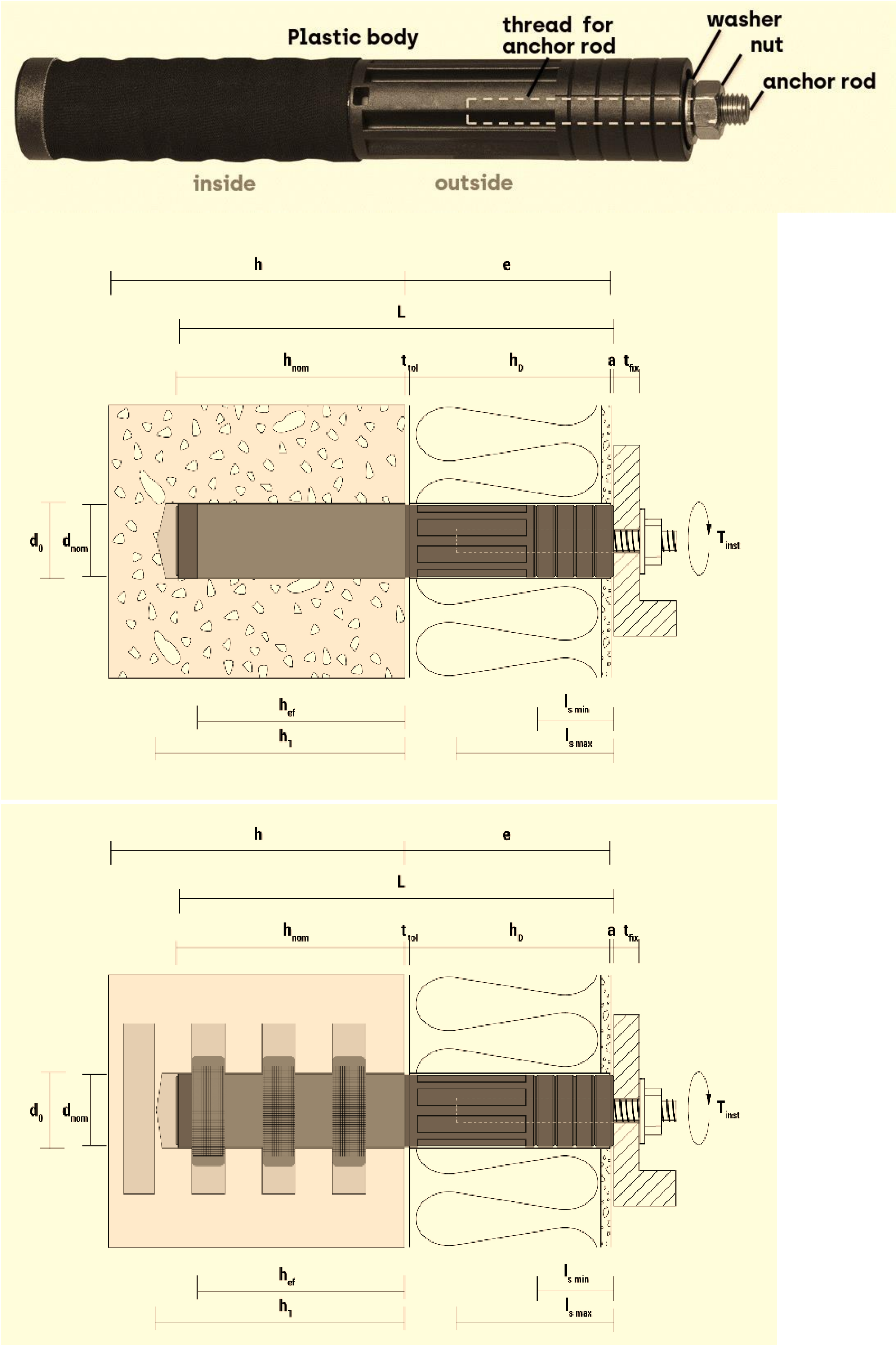

Figure 1.1.1a: Example A Materials and working principle of distance fixing system

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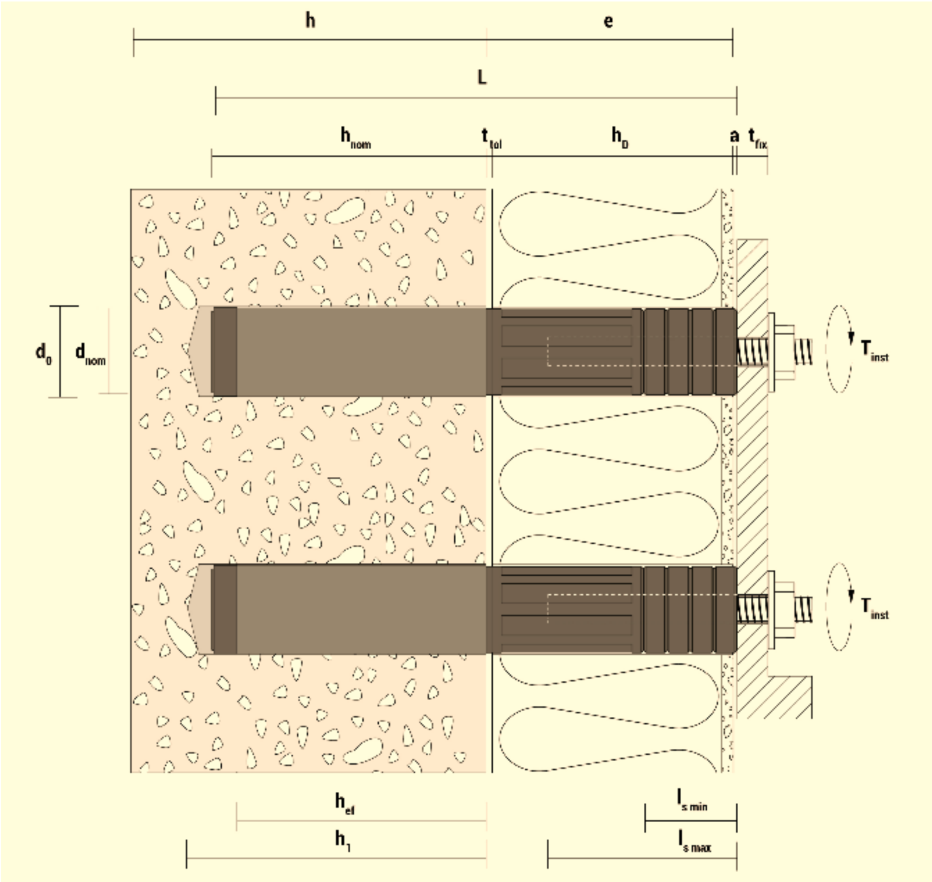

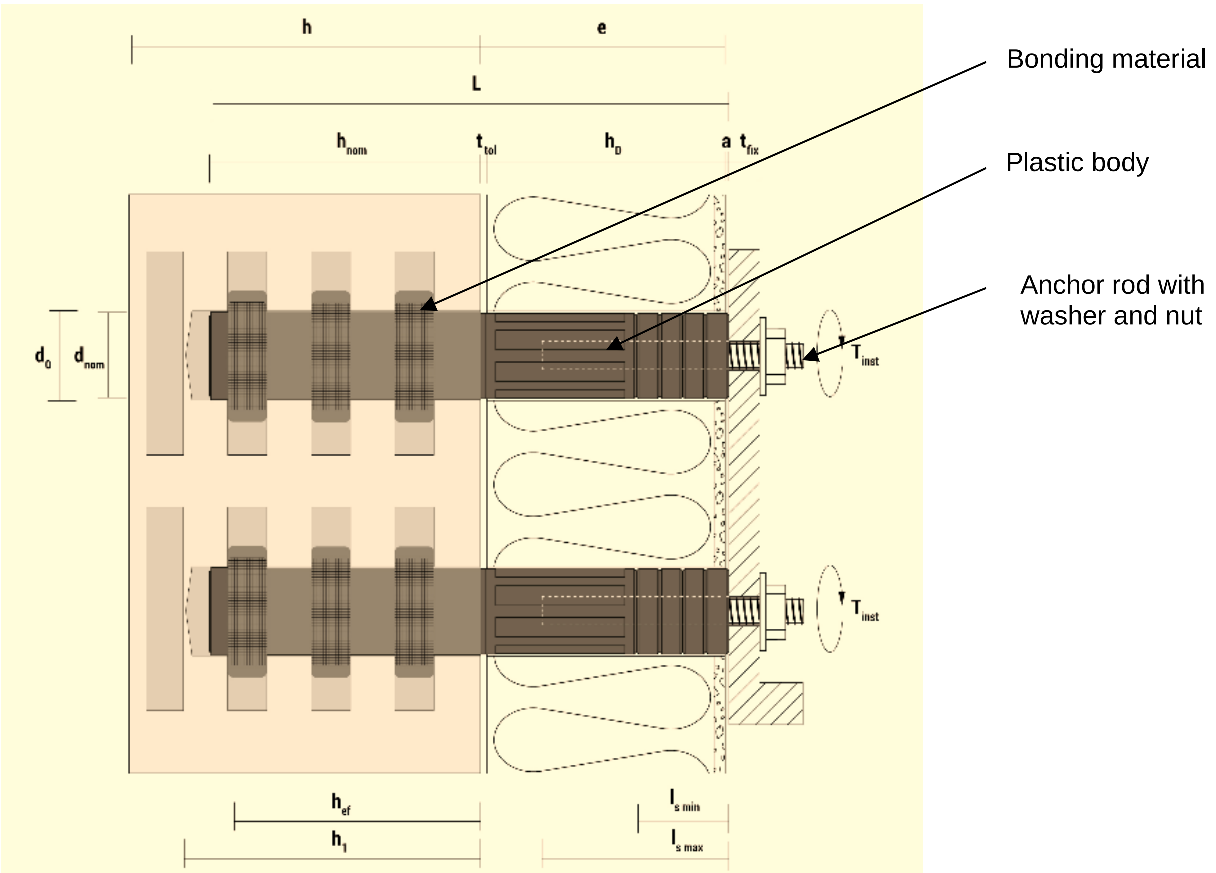

Figure 1.1.1b: Example A Materials and working principle of distance fixing system

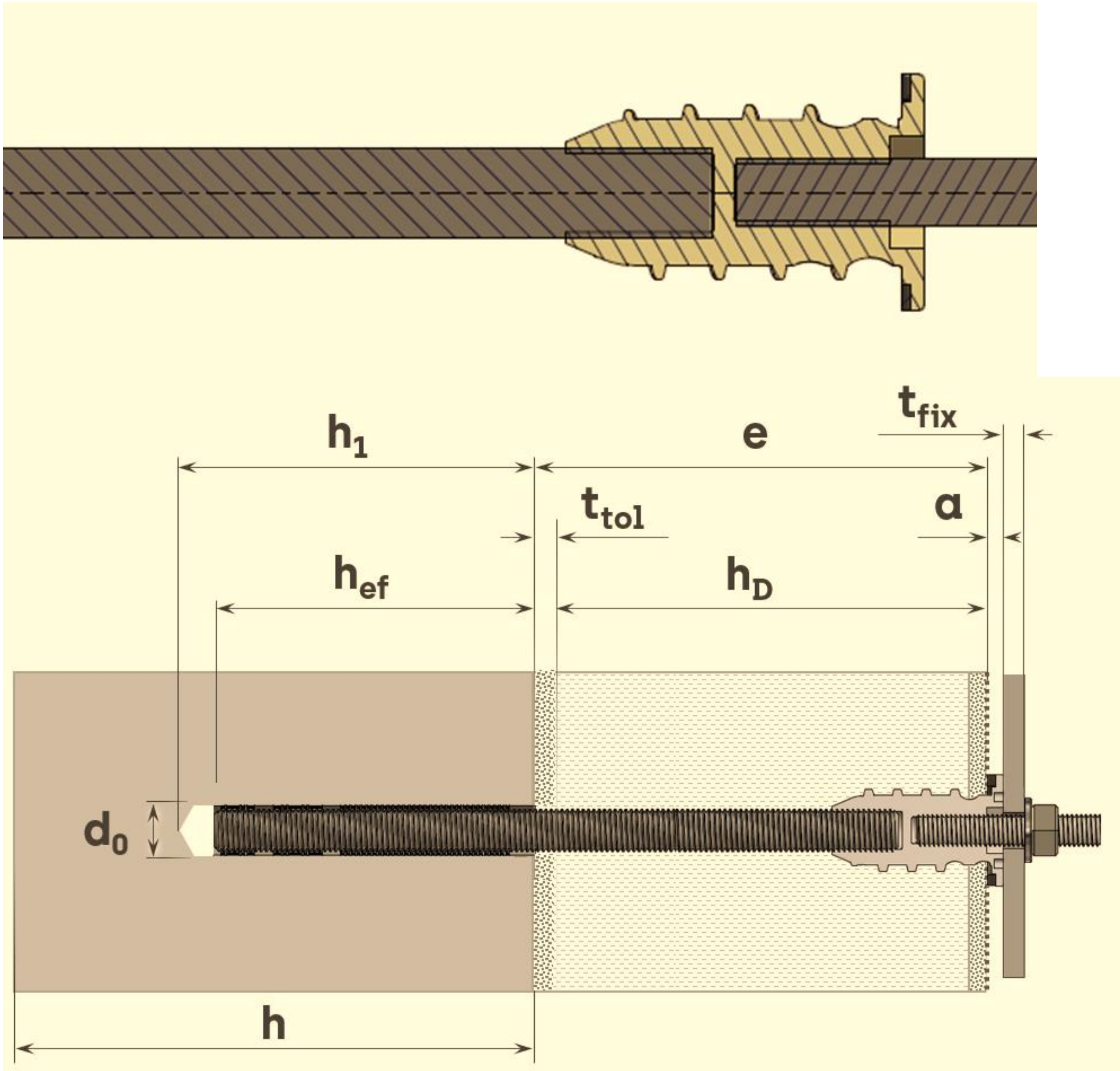

Figure 1.1.2 Example B Materials and working principle of distance fixing system

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The product is intended for fixing heavy-duty fixtures such as awnings, French balconies, canopies, satellite dishes, etc through an insulation layer (e.g., ETICS, other insulation layers) into the loadbearing wall.

The system is used for distance installations in the following insulated or non-insulated base materials:

- cracked and uncracked concrete C12/15 to C90/105 according to EN 206 [5] (base material group a)
- solid masonry bricks (base material group b)
- perforated or hollow bricks (base material group c)
- Uncracked autoclaved aerated concrete (base material group d)

Reference to base material group is given in EAD 330284-00-0604 [6] and EAD 330076-01-0604 [1].

Anchorages subject to: Static or quasi-static loads

Service temperature ranges of the base material (anchorage base) during the working life:

- Temperature range **Ta:** - 40 °C to + 40 °C
  (max short-term temperature + 40 °C and max long-term temperature + 24 °C)
- Temperature range **Tb:** - 40 °C to + 80 °
  (max short-term temperature + 80 °C and max long-term temperature + 50 °C)
- Temperature range **Tc:** on manufacturer's request with - 40 °C to T1
  (short term: T1 > + 40 °C, long term: 0,6 T1 to 1,0 T1)

The minimum and the maximum installation temperature are specified by the manufacturer within the above range.

Conditions in respect of installation and use:

- Condition d/d: Installation and use in dry masonry or concrete
- Condition w/w: Installation and use in wet masonry or concrete

The product is intended for base materials and their installation conditions defined as follows:

- masonry material (clay, calcium silicate, normal weight concrete and lightweight aggregate concrete or autoclaved aerated concrete),
- the specific masonry units including geometry of holes, webs and shells,
- for masonry units according to EN 771-1 to EN 771-5 [7]: mean gross dry density according to EN 772-13 [8] and mean compressive strength according to EN 772-1 [9],
- for joints unfilled with mortar: joint width,
- for joints filled with mortar according to EN 998-2 [10]: mortar class, joint width,
- consideration of plaster or similar materials,
- setting position (wall side or reveal, distance to joints).

Masonry members in which the distance fixing systems are embedded are subject to static or quasi-static actions in tension, shear or combined tension and shear or bending. The distance fixing system are intended to be used in areas with no and very low seismicity as defined in EN 1998-1-1 [11], Clause 4.1. The masonry members are not cracked.

In case of a product use in ETICS, the assessment methods based on the assumption that no particle of ETICS influences the installation (e.g., particles of ETICS insulation material have been removed completely out of the borehole).

For anchors which are intended to be used in structures subject to dry, internal conditions no special corrosion protection is necessary for steel parts. Coatings are only required to prevent corrosion during storage prior to use and to ensure proper function (zinc coating with a minimum thickness of 5 microns).

The intended use regarding other environmental conditions of anchors with components made of stainless steel, results from its corrosion resistance class according (CRC) to EN 1993-1-4 [4], Table A.3 in connection with EN 1993-1-4 [4], Table A.2 and A.1.

Set of essential characteristics presented in this EAD is relevant to intended use of the product and is aimed at providing input data for calculations according to TR 077 [12].

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1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the distance fixing system for the intended use of 50 years when installed in the works. These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[2].

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 when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

1.3 Specific terms used in this EAD

1.3.1 Anchors

c_{cr}	=	edge distance for ensuring the transmission of the characteristic resistance of a single anchor
$s_{cr\perp}$	=	characteristic spacing perpendicular to the bed joint determined of manufacturer
$s_{cr\parallel}$	=	characteristic spacing parallel to the bed joint determined of manufacturer
c_{min}	=	minimum edge distance determined of manufacturer
$s_{min\perp}$	=	minimum spacing perpendicular to the bed joint determined of manufacturer
$s_{min\parallel}$	=	minimum spacing parallel to the bed joint determined of manufacturer
d_o	=	drill hole diameter
d_{nom}	=	outside diameter of anchor
d_n	=	nominal diameter
h	=	thickness of member (wall)
h_{min}	=	minimum thickness of member
h_1	=	depth of drilled hole to deepest point
h_{ef}	=	effective anchorage depth
h_D	=	thickness of insulation material
T_{inst}	=	installation torque moment
max. T_{inst}	=	Maximum installation torque moment
t_{fix}	=	thickness of fixture
L	=	overall anchor length
$L_{Buckling}$	=	length of the possible buckling part
$l_{s\ min}$	=	minimum screw insertion depth determined of manufacturer
$l_{s\ max}$	=	maximum screw insertion depth determined of manufacturer
e	=	distance between surface of base material and surface of ETICs
a	=	distance between ETICS and fixture
t_{tol}	=	thickness of existing plaster / adhesive ETICS

2 The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the 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 referred to above.

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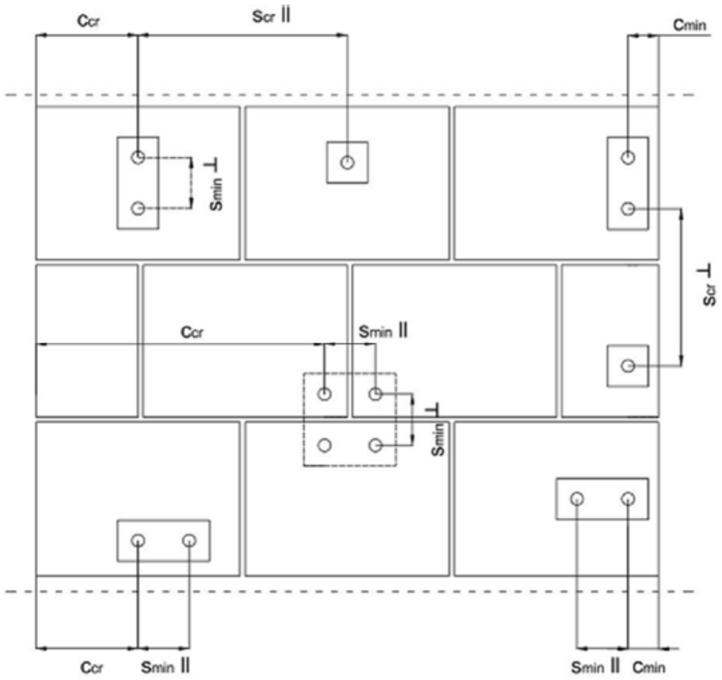

Figure 1.3.1.1Spacing and edge distance

Temperature terms

Service temperature:	Range of ambient temperatures of the base material after installation and during the lifetime of the anchorage.
Short-term temperature:	Temperatures within the service temperature range which vary over short intervals, e.g., day/night cycles and freeze/thaw cycles.
Maximum short-term temperature:	Upper limit of the service temperature range.
Long-term temperature:	Temperature within the service temperature range, which will be approximately constant over significant periods of time. Long-term temperatures will include constant or near constant temperatures, such as those experienced in cold stores or next to heating installations.
Maximum long-term temperature:	Specified by the manufacturer within the range of 0,6 times to 1,0 times the maximum short-term temperature (based on the unit °C).
Normal ambient temperature:	base material temperature 21 °C ± 3 °C (for test conditions only)
Installation temperature:	The temperature range of the base material specified by the manufacturer for installation and during curing of the bonding material.
Curing time:	The minimum time from the end of mixing to the time when the anchor may be torqued or loaded (whichever is longer). The curing time depends on the ambient temperature.

1.3.2 Assessment of tests

F	=	applied load
P	=	pressure load
N	=	tension load
V	=	shear load
P_{Rk}	=	characteristic resistance under pressure load

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$P_{Rk,tk}$	=	characteristic resistance of the plastic part transferring load to failure under pressure loading
$P_{Rk,ca}$	=	characteristic resistance to failure pressure load (buckling of cantilever arm)
$P_{Rk,ca}$ (V)	=	characteristic resistance to failure under combined shear and pressure load (buckling of cantilever arm) as a function of the acting shear load V
N_{Rk}	=	characteristic resistance under tension load
$N_{Rk,tk}$	=	characteristic resistance of the plastic part transferring load to failure under tension loading
V_{Rk}	=	characteristic resistance under shear load
$V_{Rk,tk}$	=	characteristic resistance of the plastic part transferring load to failure under shear loading
$V_{Rk,ca}$	=	characteristic resistance to failure under shear loads acting on the cantilever arm (failure of plastic part transferring load)
$F_{u,b}$	=	ultimate pressure load under buckling of the element
$F_{u,s/p}$	=	ultimate load under combined pressure and shear load of the element
n	=	number of tests of a test series
v	=	coefficient of variation
$\alpha_{pressure}$	=	reduction factor for pressure loads
$\delta(\delta_N, \delta_V)$	=	displacement (movement) of the anchor at the surface of the base material relative to the surface of the base material in direction of the load (tension, shear) outside the failure area. The displacement includes the plastic and base material deformations and a possible anchor slip.
$\delta_{V,ca}$	=	displacements at the end of the cantilever arm under shear loading
$\delta_{V,ca,P+V}$	=	displacements at the end of the cantilever arm under combined shear and pressure load
$\delta_{V,ca,0}$	=	short-term displacements under shear loads acting on the cantilever arm
$\delta_{V,ca,\infty}$	=	long-term displacements under shear loads acting on the cantilever arm
χ	=	point thermal transmittance
h_D	=	thickness of insulating layer
λ_{eq}	=	equivalent thermal conductivity
A_N	=	nominal cross-sectional area
L_N	=	nominal anchor length

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2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of the distance fixing system is assessed in relation to the essential characteristics.

Table 2.1.1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.1	Class
Basic Works Requirement 4: Safety and accessibility in use			
Resistance of the anchor in the base material masonry			
2	Characteristic resistance to pull-out failure or brick breakout failure of a single anchor under tension loading	EAD 330076-01-0604 2.2.2	Level $N_{Rk,p}$, $N_{Rk,b}$ [kN] $N_{Rk,p,c}$, $N_{Rk,b,c}$ [kN], β [-]
3	Characteristic resistance to local brick failure or brick edge failure of a single anchor under shear loading	EAD 330076-01-0604 2.2.3	Level $V_{Rk,b}$ [kN] $V_{Rk,c,II}$, $V_{Rk,c,\perp}$ [kN]
4	Characteristic resistance to brick breakout failure of an anchor group under tension loading	EAD 330076-01-0604 2.2.4	Level N^g_{Rk} [kN], $\alpha_{g,N}$ [-]
5	Characteristic resistance to local brick failure or brick edge failure of an anchor group under shear loading	EAD 330076-01-0604 2.2.5	Level $V^g_{Rk,b}$ [kN] $V^g_{Rk,c,II}$, $V^g_{Rk,c,\perp}$ [kN] $\alpha_{g,V,II}$, $\alpha_{g,V,\perp}$ [-]
6	Edge distances, spacing, member thickness	EAD 330076-01-0604 2.2.6	Level c_{cr}, s_{cr}, c_{min}, $s_{min,II}$, $s_{min,\perp}$, h_{min} [mm]
7	Displacements under tension and shear loading (on the surface of the base material)	EAD 330076-01-0604 2.2.7	Level δ_{N0}, $\delta_{N\infty}$, δ_{V0}, $\delta_{V\infty}$ [mm]
8	Characteristic resistance to brick breakout failure of a single anchor under pressure loading	2.2.2	Level $\alpha_{pressure}$ [-]
Resistance of the anchor in the base material concrete under tension loading			
9	Characteristic resistance to combined pull-out failure or concrete failure under tension loading	EAD 330499-02-0601 2.2.2	Level τ_{Rk} [N/mm²], ψ^0_{sus} [-]
10	Characteristic resistance to concrete cone failure	EAD 330499-02-0601 2.2.3	Level $c_{cr,N}$ [mm] $k_{cr,N}$, $k_{ucr,N}$ [-]
11	Edge distance to prevent splitting under load	EAD 330499-02-0601 2.2.4	Level $c_{cr,sp}$ [mm]
12	Robustness	EAD 330499-02-0601 2.2.5	Level γ_{inst} [-]

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No	Essential characteristic	Assessment method	Type of expression of product performance
13	Minimum edge distance and spacing	EAD 330499-02-0601 2.2.6	Level c_{min}, s_{min}, h_{min} [mm]
14	Displacements under short-term and long-term loading	EAD 330499-02-0601 2.2.10	Level δ_{N0}, $\delta_{N\infty}$ [mm or mm/(N/mm²)] δ_{V0}, $\delta_{V\infty}$ [mm or mm/(N/mm²)]
15	Characteristic resistance to pry-out failure	EAD 330499-02-0601 2.2.8	Level k_8 [-]
16	Characteristic resistance to concrete edge failure	EAD 330499-02-0601 2.2.9	Level d_{nom}, ℓ_f [mm]
Resistance of the plastic part transferring load			
17	Characteristic resistance of the plastic part transferring load to failure under tension loading	2.2.3	Level $N_{Rk,tk}$ [kN]
18	Characteristic resistance of the plastic part transferring load to failure under pressure loading	2.2.4	Level $P_{Rk,tk}$ [kN]
19	Characteristic resistance of the plastic part transferring load to failure under shear loading	2.2.5	Level $V_{Rk,tk}$ [kN]
Resistance of the system with cantilever arm			
20	Characteristic resistance to failure under pressure load and displacement (buckling of cantilever arm)	2.2.6	Level $F_{u,b,m}$ [kN], $P_{Rk,ca}$ [kN]
21	Characteristic resistance to failure under combined shear and pressure load and displacements (buckling of cantilever arm)	2.2.7	Level $F_{u,s/p}$ (Table) or $P_{Rk,ca}$ (V) [kN] as a function of the acting shear load V, $\delta_{V,ca,P+V}$ [mm]
22	Characteristic resistance to failure under shear loads and displacements (failure of plastic part transferring load, cantilever arm)	2.2.8	Level $V_{Rk,ca}$ [kN], $\delta_{V,ca,0}$ [mm], $\delta_{V,ca,\infty}$ [mm]
23	Maximum installation torque moment	2.2.9	Level Max. T_{inst} [Nm]
Aspects of durability			
24	Durability	2.2.10	Description

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2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

2.2.1 Reaction to fire

The metal parts of the fixing system and the cementitious mortar are considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire in accordance with the Decision 1996/603/EC, as amended by Commission Decisions 2000/605/EC and 2003/424/EC, without the need for testing on the basis of it fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

The bonding material (synthetic mortar, cementitious mortar or a mixture of the two including fillers and/or additives) is located between fixing system and the wall of the drilled hole in the end use. The thickness of the mortar layer is about 1 to 2 mm and most of the mortar is material classified class A1 according to EC Decision 96/603/EC. Therefore, it may be assumed that the bonding material (synthetic mortar or a mixture of synthetic mortar and cementitious mortar) in connection with the fixing system in the end use application do not make any contribution to fire growth or to the fully developed fire and they have no influence on the smoke generation.

In the context of the end use application of the fixing system the plastic material embedded in concrete/masonry can be considered to satisfy any reaction to fire requirements. Where the plastic parts are embedded in the cladding/component which is not class A1 the plastic parts can be considered not to influence the reaction to fire class of the cladding/component.

2.2.2 Characteristic resistance to brick breakout failure of a single anchor under pressure loading

For anchor in solid masonry, autoclaved aerated concrete and in hollow or perforated masonry with minimum anchorage depth is in contact with 5 shells (partitions of the brick) at minimum:

$$\alpha_{pressure} = 1{,}0$$

Purpose of the test:

These tests are performed to determine the characteristic resistance under pressure load of a single anchor in a hollow brick. It shall be proved that the maximum pressure load is greater than the maximum tension load ($\alpha_{pressure} = 1{,}0$) or a reduction factor ($\alpha_{pressure} \leq 1{,}0$) is calculated.

For anchor in hollow or perforated masonry where the minimum anchorage depth is in contact with less than 5 shells (partitions of the brick) tests are performed according to Table A.1.1, test series P1 (for resistance not influenced by edge distance) and Table A.1.1, test series P2 (for resistance influenced by minimum edge distance).

Test conditions

Tests shall be performed according to EAD 330076-01-0604 [1], A.2, A.3, A.4, A.5.1 and A.5.2 but applying a pressure force on the anchor instead a tension force (see Figure 2.2.2.1).

The tests shall be carried out with the same hollow bricks and anchor configuration (e.g., size, diameter, setting position) as used for the corresponding tests for resistance to failure under tension loading.

Tests shall be carried out as unconfined tests in all hollow bricks which shall be part of the ETA. The longest lever arm of the fastening element at normal ambient temperature. All anchorage depths shall be proofed.

Tests can be omitted if the fastener is anchored in more than 5 shells of the brick.

Assessment

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If the results of the maximum pressure loads in test series P1 and P2 are smaller than the results of the test series for resistance to failure under tension loading, the tests series P1 and P2 shall be considered for evaluating of the characteristic resistance.

5%-fractiles of converted ultimate loads shall be determined according to EAD 330076-01-0604 [1], B.1 and B.2.

Load/displacement behaviour and α_1 shall be assessed according to EAD 330076-01-0604 [1], B.5.

The reduction factor for the coefficient of variation α_v shall be calculated according to EAD 330076-01-0604 [1], B.4.

The factor for characteristic resistance of single anchors without spacing effects under pressure loading shall be calculated as follows:

$$\alpha_{pressure} = P_{Rk,P1} \cdot \beta / N_{Rk,b} \leq 1{,}0 \quad \text{for } c_{cr} = 1{,}5\, h_{ef} \qquad (2.2.2.1)$$

$$\alpha_{pressure} = P_{Rk,P2} \cdot \beta / N_{Rk,b} \leq 1{,}0 \quad \text{for } c_{min} = c_{min,test} \qquad (2.2.2.2)$$

with:
- $P_{Rk,P1}$ = 5%-fractiles evaluated from the results of tests according to Table A.1.1, test series P1
- $P_{Rk,P2}$ = 5%-fractiles evaluated from the results of tests according to Table A.1.1, test series P2
- β = reduction factor according to EAD 330076-01-0604 [1], 2.2.2, Equation (2.2.2.5) where α_1 and α_v shall be taken from the pressure load tests
- $N_{Rk,b}$ = characteristic resistance to brick breakout failure of a single anchor under tension loading according to EAD 330076-01-0604 [1], 2.2.2

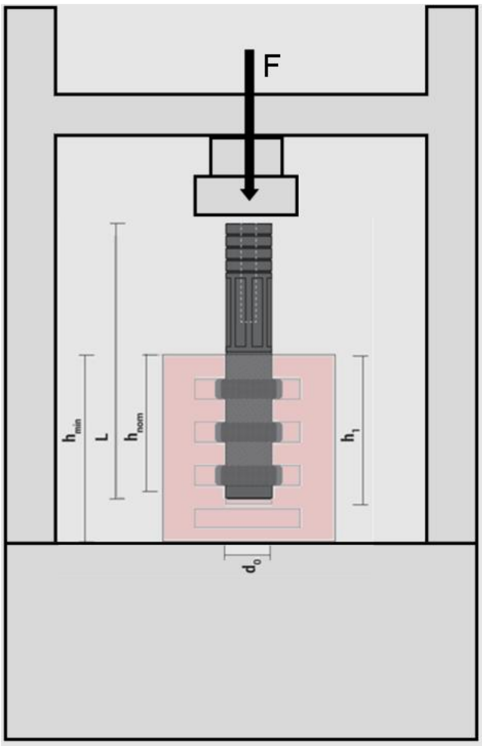

Figure 2.2.2.1. Example of a test rig for maximum pressure loads

2.2.3 Characteristic resistance of the plastic part transferring load to failure under tension loading

The tests shall be performed to show the resistance of the plastic connection or plastic part transferring the load. The test shall be performed applying a tension force on the connection. The plastic part shall be tested installed in the base material or without base material to ensure a failure of the plastic part that transfers the force.

The tests of plastic parts (anchors) installed in base material shall be carried out according to EAD 330499-02-0601 [2], D.3.

The loading device shall be placed over the anchor and the anchor shall be connected to the attachment or the attachment to the threaded rod. The threaded rod shall be passed through the hydraulic cylinder and load cell and fixed to the load cell by a nut via a spherical bearing.

The support nut at the upper end shall be applied.

The displacement transducer shall be fixed in the displacement transducer support and the displacement transducer shall be connected to the head of the dowel using a magnet and wire. Then the displacement transducer holder shall be aligned so that the wire is plumb above the dowel.

The applied load shall be measured using a load cell. The load increase shall be selected so that the failure load is reached in a period of approximately 1 to 3 minutes.

The test setup is shown in Figure 2.2.3.1.

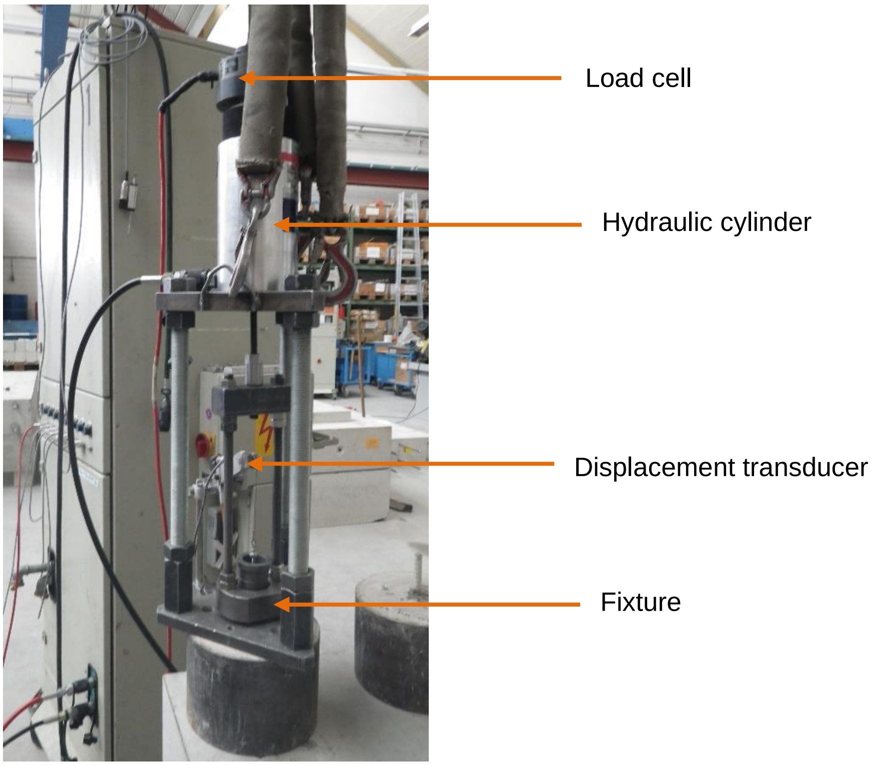

Figure 2.2.3.1 Test setup of the centric tension tests (anchor installed in base material)

The tests of plastic parts (anchors) not installed in base material shall be carried out as follows:

To check the tensile strength of the bond between the plastic part and the steel rod, the rod shall be fixed to the fixture at a length of 100 mm using wedges. The attachment shall be fixed to the clamping base. The connection between the connector and the extractor shall be made by a sleeve and a threaded rod. Two displacement transducers shall be bonded to the sleeve to record the displacement. The applied load and the displacement of the dowel shall be measured continuously and recorded electronically.

The force shall be measured with a load cell. The load increment shall be selected so that the failure load was reached after approximately 1 to 3 minutes from the start of loading.

The test setup is shown in Figure 2.2.3.2.

<u>Resistance under tension loading of the plastic part transferring load (test series TK1) (normal ambient temperature)</u>

The 5% fractile shall be determined according to A.2.

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Resistance for dry and wet condition of the plastic part transferring load (test series TK2)

The tests shall be performed to show the resistance of the plastic connection or plastic part transferring the load for different humidity conditions.

For the tests under dry conditions (TK2a) the plastic parts shall be dried in an oven (drying temperature 80°C), so that the plastic part is dry and the weight does not change anymore (less than 1% of weight difference). After the conditioning the tests shall be performed. The test shall be performed applying a tension force on the connection. The plastic part shall be tested without base material to ensure a failure of the plastic part that transfers the force. The 5% fractile shall be determined according to A.2.

- Determine α according to Equation (A.3.1)
- Determine reduction factor $\alpha_{TK2a} = \alpha / 0{,}8 \leq 1{,}0$

For the tests under wet conditions (TK2b) the plastic parts shall be stored under water, so that the plastic part is saturated, and the weight does not change anymore (less than 1% of weight difference). After the conditioning the tests shall be performed. The test shall be performed applying a tension force on the connection. The plastic part shall be tested without base material to ensure a failure of the plastic part that transfers the force. The 5% fractile shall be determined according to A.2.

- Determine α according to Equation (A.3.1)
- Determine reduction factor $\alpha_{TK2b} = \alpha / 0{,}8 \leq 1{,}0$

Resistance under different temperatures of the plastic part transferring load (test series TK3)

The tests shall be performed to show the resistance of the plastic connection or plastic part transferring the load for maximum long-term temperature (TK3a) and maximum short-term temperature (TK3b) conditions.

For the tests under increased temperature the plastic parts shall be stored in an oven, so that the plastic part has the specified temperature according to the intended use (temperature ranges see clause 1.2.1). After the temperature is reached the tests shall be performed immediately so that the temperature is present at failure. The test shall be performed applying a tension force on the connection. The plastic part shall be tested without base material to ensure a failure of the plastic part that transfers the force. The 5% fractile shall be determined according to A.2.

Maximum long-term temperature:

- Determine α according to Equation (A.3.1)
- Determine reduction factor $\alpha_{TK3a} = \alpha / 1{,}0 \leq 1{,}0$

Maximum short-term temperature:

- Determine α according to Equation (A.3.1), but with reference test series TK3a under long-term temperature instead of test series TK1
- Determine reduction factor $\alpha_{TK3b} = \alpha / 0{,}8 \leq 1{,}0$

For the tests under low temperature (TK3c) the plastic parts shall be stored in a calibrated climatic chamber for at least 12 hours, so that the plastic part has the specified minimum temperature according to the intended use. After the temperature is reached the tests shall be performed immediately so that the temperature is present at failure. The test shall be performed applying a tension force on the connection. The plastic part shall be tested without base material to ensure a failure of the plastic part that transfers the force. The 5% fractile shall be determined according to A.2.

Minimum service temperature:

- Determine α according to Equation (A.3.1)
- Determine reduction factor $\alpha_{TK3c} = \alpha / 1{,}0 \leq 1{,}0$

For polyamide elements, which are intended to be used at minimum temperature -20°C, no tests are required.

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Resistance under sustained load of the plastic part transferring load (test series TK4)

The tests shall be performed to show the resistance of the plastic connection or plastic part transferring the load. The test shall be performed by applying different tension load levels on the connection and measuring the time to failure. At least 10 tests (5 tests per test series TK4a and 5 test series for TK4b, see Table A.1.1) shall be performed at minimum 5 different load levels (e.g., 3 different load levels in series TK4a and 2 different load levels in series TK4b). Input for the calculation of the load level is the result of the tension test TK1. The load levels depend on the product, but can be estimated as 80% to 85%, 70% to 75% and 65% to 70% as a first approximation. Depending on the first load level the other load level can be adapted.

The plastic part shall be tested without base material to ensure a failure of the plastic part that transfers the force. The test shall be performed for ambient (TK4a) and long-term temperature (TK4b). The test results of test series TK4a as a time to failure curve shall be extrapolated to 50 years. The test results of test series TK4b as a time to failure curve shall be extrapolated to 10 years. Examples for extrapolation see Figure 2.2.3.2.

- Determine the reduction factor α_{TK4a} by division of the extrapolated value of tests performed for ambient temperature (TK4a) by the 5%-fractile value of test series TK1

$$\alpha_{TK4a} = \frac{F_{extr\ (TK4a)}}{F_{5\%\ (TK1)}} \qquad (2.2.3.1)$$

with:

$F_{extr\ (TK4a)}$ = extrapolated value of tests performed for ambient temperature to 50 years (TK4a)

$F_{5\%\ (TK1)}$ = 5%-fractile value of test series TK1 according to A.2

- Determine the reduction factor α_{TK4b} by division of the extrapolated value of tests performed for long-term temperature (TK4b) by the 5%-fractile value of test series TK1

$$\alpha_{TK4a} = \frac{F_{extr\ (TK4b)}}{F_{5\%\ (TK1)}} \qquad (2.2.3.2)$$

with:

$F_{extr\ (TK4b)}$ = extrapolated value of tests performed for ambient temperature to 10 years (TK4b)

$F_{5\%\ (TK1)}$ = 5%-fractile value of test series TK1 according to A.2

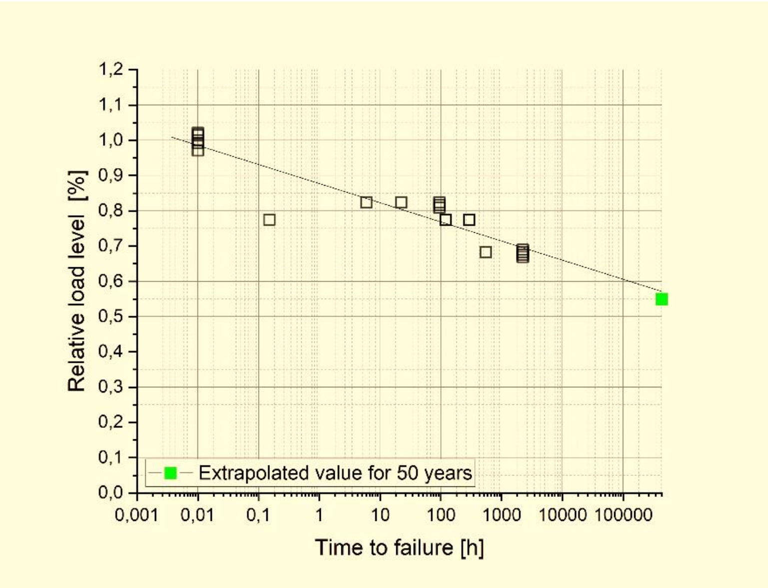

Figure 2.2.3.2 Example for extrapolation of results of test series TK4b

<u>Characteristic resistance</u>

The characteristic resistance shall be calculated as follows:

$$N_{Rk,tk} = N_{Rk,tk1} \cdot \min(\alpha_{TK2a}; \alpha_{TK2b}) \cdot \min(\alpha_{TK3a}; \alpha_{TK3b}; \alpha_{TK3c}) \cdot \min(\alpha_{TK4a}; \alpha_{TK4b}) \quad (2.2.3.3)$$

with: $N_{Rk,tk}$ = characteristic resistance of the plastic part transferring load under tension loading

$N_{Rk,tk1}$ = 5%-fractiles evaluated from results of tests according to Table A.1.1, test series TK1

α_{TKx} = reduction factors for different influences (see above)

2.2.4 Characteristic resistance of the plastic part transferring load to failure under pressure loading

The tests (TK5) shall be performed to show the resistance of the plastic connection or plastic part transferring the load. The test is performed applying a pressure force on the connection. The plastic part shall be tested installed in the base material or without base material to ensure a failure of the plastic part that transfers the force (description of test setup see 2.2.3). The 5% fractile shall be determined according to A.2.

The characteristic resistance shall be calculated as follows:

$$P_{Rk,tk} = P_{Rk,tk5} \cdot \min(\alpha_{TK2a}; \alpha_{TK2b}) \cdot \min(\alpha_{TK3a}; \alpha_{TK3b}; \alpha_{TK3c}) \cdot \min(\alpha_{TK4a}; \alpha_{TK4b}) \quad (2.2.4.1)$$

with: $P_{Rk,tk}$ = characteristic resistance of the plastic part transferring load under pressure loading

$P_{Rk,tk5}$ = 5%-fractiles evaluated from results of tests according to Table A.1.1, test series TK5

α_{TKx} = reduction factors for different influences (see 2.2.3)

2.2.5 Characteristic resistance of the plastic part transferring load to failure under shear loading

The tests (TK6) shall be performed to show the resistance of the plastic connection or plastic part transferring the load. The test is performed applying a shear force on the connection. The plastic part shall be tested installed in the base material or without base material to ensure a failure of the plastic part that transfers the force (see Figure 2.2.5.1).

Tests are static shear tests on anchors in non-cracked concrete of strength class C20/25. The anchor shall be installed according to the manufacturer's instructions. After the mortar cured, the dowel shall be subjected to transverse tension to failure with a lever arm. To measure the displacement in the direction of the force line, a displacement transducer shall be bonded to the concrete slab with its tip in contact with the fixture.

The schematic diagram of the test is shown in Figure.2.2.5.1

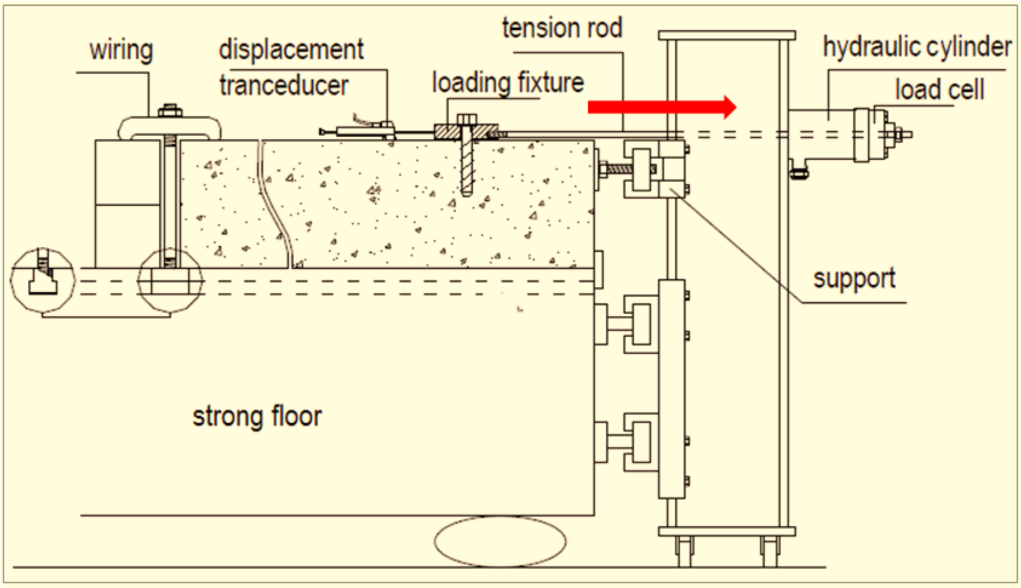

Figure 2.2.5.1 Test setup for shear load tests

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The 5% fractile shall be determined according to A.2.

The characteristic resistance shall be calculated as follows:

$$V_{Rk,tk} = V_{Rk,tk6} \cdot \min(\alpha_{TK2a}; \alpha_{TK2b}) \cdot \min(\alpha_{TK3a}; \alpha_{TK3b}; \alpha_{TK3c}) \cdot \min(\alpha_{TK4a}; \alpha_{TK4b}) \quad (2.2.5.1)$$

with: $V_{Rk,tk}$ = characteristic resistance of the plastic part transferring load under shear loading

$V_{Rk,tk6}$ = 5%-fractiles evaluated from results of tests according to Table A.1.1, test series TK6

α_{TKx} = reduction factors for different influences (see 2.2.3)

2.2.6 Characteristic resistance to failure under pressure load and displacement (buckling of cantilever arm)

<u>Purpose of test:</u>

These tests (B1) shall be performed to determine the failure mode and the capacity under pressure load of single anchor without edge influence.

<u>Test details</u>

Since this is purely a matter of determining the buckling behaviour of the anchor, the test shall be based on the principle of the Euler case 2. The test shall be carried out at a standard temperature of 21 ± 3°C.

The anchor shall be installed with the maximum length of the anchor in accordance with the manufacturer's product installation instruction (MPII). During the pressure test the load shall be applied centric and directly on the head of the anchor. The pressure load F shall be continuously being increased until the anchor fails.

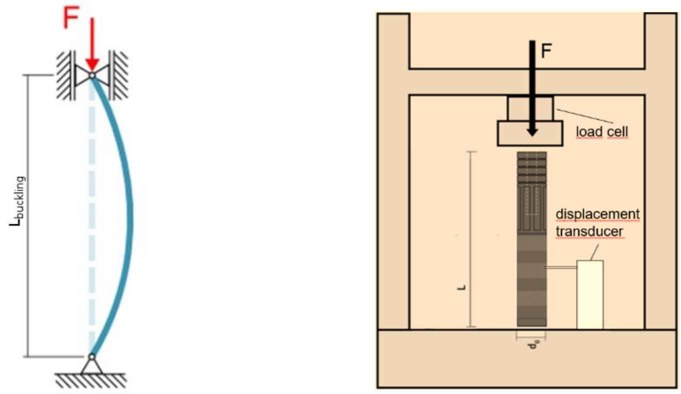

Figure 2.2.6.1: Static principle of the test set-up using Euler Case 2

Tests and measuring equipment shall be performed according to EAD 330499-02-0601 [2], D.3.1.6. Tests shall be performed with maximum length L and the acting load shall be a pressure load F instead of a tension load. The buckling length shall be $L_{buckling} = (e + a + 0{,}5\ d_N + 0{,}5\ t_{fix})$.

In addition, the buckling of the anchor shall be measured. The displacement shall be measured in the area of the maximum deflection to be expected.

After installation, the anchoring element shall be connected to the test rig and loaded to failure with a loading speed according to EAD 330499-02-0601 [2], D.3.2). The displacements of the anchor relative to the surface of the test member shall be measured by the use of an appropriate measuring device, which measure the maximum buckling. The connection between the fixture and the load jack shall be hinged to permit differential anchor displacement to occur.

<u>Assessment</u>

The following assessment shall be made for each anchor size and for each embedment depth:

<u>Failure loads</u>

- Determine the mean value of the failure pressure loads $F_{u,b,m}$ [kN]
- Determine the 5%-fractile value of the failure pressure loads $F_{u,b,5\%}$ [kN] according to A.2.

- Determine the reduction factor α by comparing the results with the comparable tension load series with rqd. α = 1,0 otherwise the tension load shall be limited $F_{u,b,5\%}$ (if no separate resistance to pressure loads is given in the ETA)

Note: If the determined load is smaller than the tension or compression load, this becomes decisive for the further dimensioning.

<u>Load displacement behaviour</u>

- Determine the mean value of the failure pressure loads $F_{u,b,m}$ [kN] of the test series
- Show the pressure load $F_{u,b}$ [kN] and the corresponding buckling. For a given maximum buckling the load $F_{u,b,m}$ [kN] can be assigned for the given clamping (fixing) condition. E.g., the max. buckling shall be less than 10 mm. The maximum load shall be approximately the same as the maximum reference load from the P1 tests

The load $F_{u,b,m}$ [kN] by a buckling of the anchor and the corresponding displacement shall be given in the ETA.

Additional a separate characteristic resistance to pressure loads $P_{Rk,ca} = F_{u,b,5\%}$ [kN] can be given in the ETA.

2.2.7 Characteristic resistance to failure under combined shear and pressure load and displacement (buckling of cantilever arm)

<u>Purpose of the tests:</u>

These tests (B2) shall be performed to know the maximum pressure load for a determined and permanent displacement or for a determined permanent shear load.

<u>Test conditions</u>

The maximum pressure load shall be determined in relation to a permanent displacement or a permanent shear load.

The results shall be given in a Table which include the displacements, the shear load and the maximum pressure load. In order to get the values in a table, at least 3 different loads or displacements are necessary.

For example, the displacements shall be selected reasonably depending on the results from the series V1 “Resistance for shear loading” (for example: in test series V1 δ_m = 20 mm: Displacement 1 = 5 mm Displacement 2 = 10 mm, Displacement 3 = 15 mm).

The test shall be performed without insulation material.

The test shall be carried out according to the following instructions at a standard temperature of 21 ± 3°C.

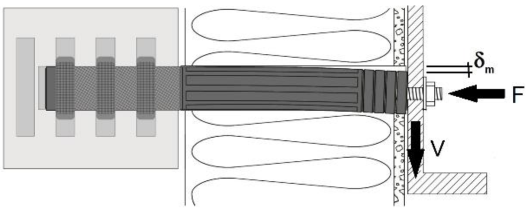

Figure 2.2.7.1: Static principle of the test set-up
(dimensions for different products / intended uses see Figures 1.1.1 to 1.1.4, shear load applied on 0,5 t_{fix})

<u>Test equipment</u>

Tests and measuring equipment shall be performed according to EAD 330499-02-0601 [2], D.3.1.6. Tests shall be performed with cantilever arm and the acting load shall be a pressure load instead of a tension load. Additionally, the system shall be loaded by a permanent shear load (see Figure 2.2.7.1).

In addition, the displacement during shear and pressure load of the anchor shall be measured.

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Test execution

The anchor shall be installed in accordance with the manufacturer's product installation instruction (MPII). Five specimens for each displacement shall be tested. First, apply a shear load V until δ_m = the first selected displacement is reached, keep "δ_m" constant and apply the load F in the speed 20 N/sec. Record -N/-δ_N diagram until failure. The displacement shall be measured at half the thickness of the fixture part, see figure 2.2.8.1. An example for the load/displacement diagram is given in the following Figure.

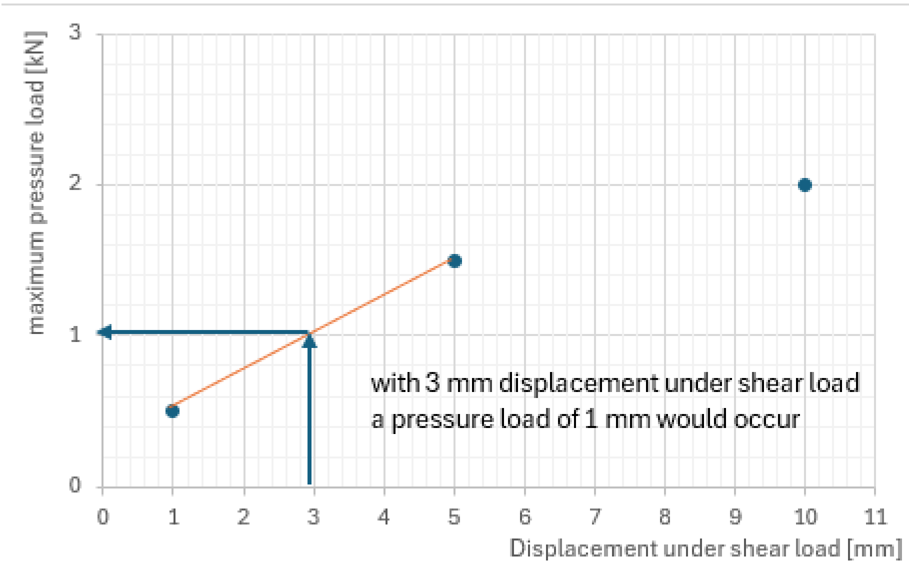

Figure 2.2.7.2: Example of the load/displacement diagram

Assessment

The following assessment shall be made for each anchor size and minimum embedment depth for different lever arms at minimum:

Failure loads

- Determine the mean value of the failure pressure loads $F_{u,m,s/p}$ under combined loads [kN]
- Determine the 5%-fractile value of the failure pressure loads $F_{u,s/p,5\%}$ under combined loads [kN] according to A.2
- Determine the interaction table

Load displacement behaviour

- Determine the mean value of the failure pressure loads $F_{u,m,s/p}$ [kN] of the test series
- Integrate the pressure loads $F_{u,s/p}$ [kN] and the corresponding shear load and their displacements into the interaction table

The result of the investigations shall be finally described in a table. Additionally, the corresponding displacements under shear load shall be given in the Table. For example:

Cantilever arm e+a+0,5 t_{fix} [mm]	Shear load V [kN]	resistance to pressure load $F_{u,s/p,5\%} = P_{Rk,ca}$ (V) [kN]	Displacements under shear and pressure load $\delta_m = \delta_{V,ca,P+V}$ [mm]

2.2.8 Characteristic resistance to failure under shear load and displacements (failure of plastic part transferring load, cantilever arm)

<u>Purpose of the tests</u>

Test series V1 and V2 shall be performed to assess the characteristic resistance to shear loads of the system with a specific cantilever arm (according to the intended use). Test series V1 performed in concrete/AAC is used as reference for test series V3.

The tests V3 shall be performed to check the creep behaviour of the loaded anchor at normal ambient temperature and at maximum long-term temperature in shear load direction and specified sustained load level, e.g., from 12,5%, 25% and 40% of the characteristic resistance of test series V1.

<u>Test condition</u>

Tests V1 and V2 shall be performed according to EAD 330076-01-0601 [1], A.5.3 but applying the shear load on the end of the cantilever arm (e+a) as given in Figures 2.2.8.1 to 2.2.8.3.

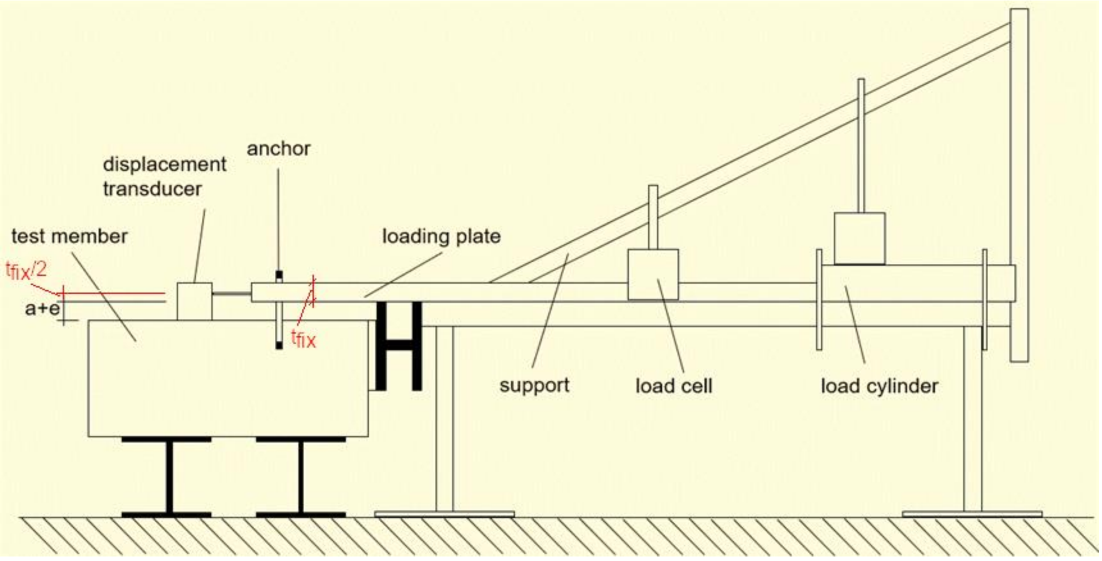

Figure 2.2.8.1: Example of a shear test-setup

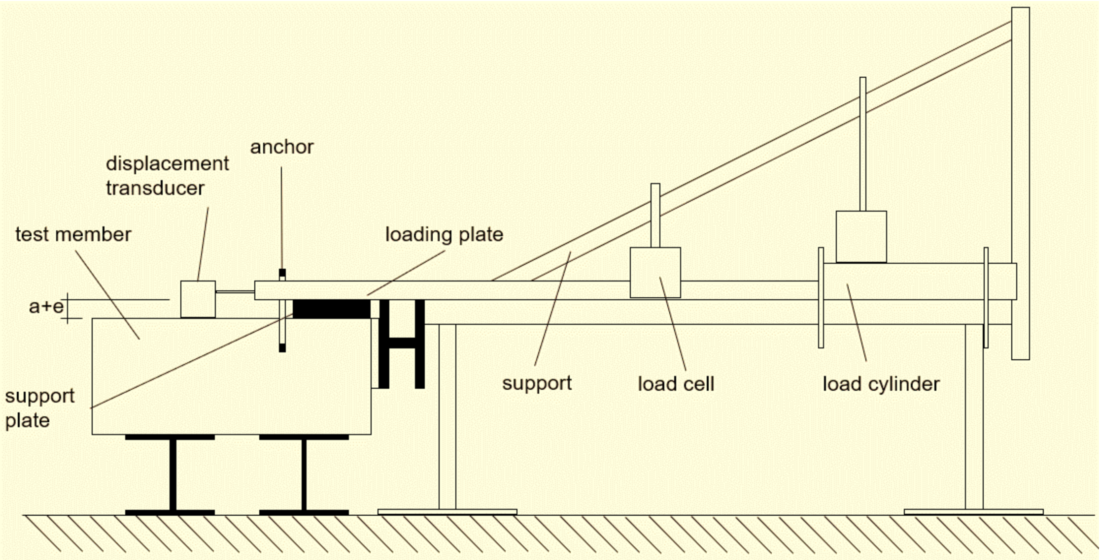

Figure 2.2.8.2: Example of a shear test-setup with support plate

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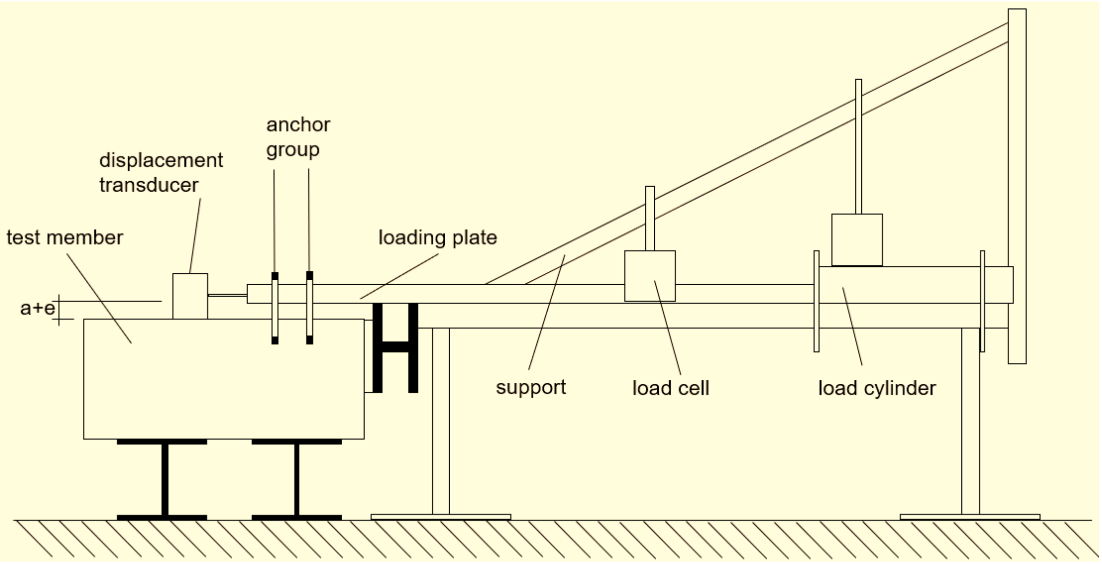

Figure 2.2.8.3: Example of a shear test-setup for double anchor group

Tests V3 shall be carried out as unconfined tests in uncracked concrete C20/25 or AAC with the longest lever arm of the fastening element (according to the intended use).

Tests for products according to example D (metal rod) shall be carried out without base material to ensure a failure of the plastic part that transfers the force. In this case also the reference test V1 shall be performed without base material. Tests for products according to example D (metal rod) shall also be performed with the smallest lever arm of the fastening element to ensure a failure of the plastic part that transfers the force.

Test series V3a shall be performed at normal ambient temperature (T= +21 °C ± 3 °C) for temperature range **Ta**, **Tb** and **Tc.** Test series V3b shall be performed and at maximum long-term temperature for temperature range **Tb** (T = +50°C) and **Tc** (Temperature as specified by the manufacturer).

The distance fixing system shall be installed at normal temperature without insulation material.

For the tests at the maximum long-term temperature (temperature range **Tb** and **Tc**) the test specimens, the loading equipment, the displacement transducers and the installed anchors shall be heated to the maximum long-term temperature at least for 24 hours before loading the anchors.

The anchor shall be then subjected to a shear load V_{sust}, which is kept constant (variation within ± 5 %).

The permanent load V_{sust} shall be applied by e.g., dead loads.

Maintain load at V_{sust} and maintain temperature and measure the displacements until they appear to have stabilized, but at least for 5000 h (in special justified cases the Assessment Body may allow a shorter duration for the sustained load test, but at least for three months).

Temperatures in the room may vary by + 3K due to day/night and seasonal effects but the required test room temperature shall be achieved as a mean over the test period.

The frequency of monitoring displacements shall be chosen so as to demonstrate the characteristics of the anchor. As displacements are greatest in the early stages, the frequency shall be high initially and reduced with time. As an example, the following regime is acceptable:

During first hour:	every 10 minutes
During next 6 hours:	every hour
During next 10 days:	every day
From then on:	every 5-10 days.

Load of the anchor to V_{sust} according to the specified sustained load level, e.g., according to following equation: $V_{sust} = V_{Rk,V1} \bullet 0{,}4$.

To check the remaining load capacity after the sustained load test, unload the anchor, measure the displacement and carry out a shear test immediately after unloading.

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Assessment tests V1 and V2 shear loads on cantilever arm

The basic value of characteristic resistance shall be calculated as follows:

$$V_{Rk,ca,0} = V_{Rk,0} \cdot \min \alpha_1 \cdot \min \alpha_{V,V} \qquad (2.2.8.1)$$

with: $V_{Rk,0}$ = minimum value of $F_{5\%}$ according to A.2, evaluated from the results of test series V1 and V2 according to Table A.1.1

$\min \alpha_1$ = minimum value α_1 according to EAD 330076-01-0604 [1], B.5 reduction factor from the load/displacement behaviour in all tests

$\min \alpha_{V,V}$ = minimum value α_V according to EAD 330076-01-0604 [1], B.4, Equations (9), minimum reduction factor from the coefficient of variation of the ultimate loads in the tests V1 and V2

Assessment tests V3 sustained shear loads on cantilever arm

The displacements measured in the tests shall be extrapolated according to following Equation (Findley approach) to 50 years (tests V3a at normal ambient temperature), or 10 years (tests V3b at maximum long-term temperature. The trend line according to Equation (2.2.8.2) may be constructed with data from not less than the last 20 days and not less than 20 data points of the sustained load test.

The curve fitting shall start with the displacement measured after approximately 100 h (see [6]).

$$s(t) = s_o + a \cdot t^b \qquad (2.2.8.2)$$

with: s_o = initial displacement under the sustained load at t = 0 (measured directly after applying the sustained load)

a, b = constants (tuning factors), evaluated by a regression analysis of the deformations measured during the sustained load tests

Requirements of the tests depending on the intended use

The extrapolated displacements shall be less than the displacements specified by the manufacturer according to the intended use.

If no displacements are specified by the manufacturer, the extrapolated displacements shall be:

- The extrapolated displacement to 50 years shall be a maximum of 10 mm.
- The displacements during 500 hours and 1500 hours shall be less than 3 mm.
- The displacements during 1500 hours and 3000 hours shall be less than 2 mm.
- The displacements during 3000 hours and 5000 hours shall be less than 1 mm.

If the requirement is not fulfilled the tests shall be performed with a reduced load level until the requirements are fulfilled. E.g., the tests shall be performed with a reduced load level according to the following table.

The reduction factor $\alpha_{2,V}$ shall be determined according to the reduced load level. E.g., the reduction factor $\alpha_{2,V}$ shall be determined according to the following table by using series V1 (shear load tests) as reference tests.

Load level [%]	factor $\alpha_{2,V}$ [-]
40	0,40
25	0,25
12,5	0,125

Assessment of characteristic resistance

The characteristic resistance to failure under shear load shall be calculated as follows:

$$V_{Rk,ca} = V_{Rk,ca,0} \cdot \alpha_{2,V} \qquad (2.2.8.3)$$

with: $V_{Rk,ca,0}$ = according to Equation (2.2.8.1)

$\alpha_{2,V}$ = minimum reduction factor from sustained load tests V3a and V3b, see above

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Assessment of displacements

The short-term displacements under shear loading, $\delta_{V,ca,0}$, shall be evaluated from the test results of the shear load tests (Table A.1.1, line V1) for a load level V according to following Equation. The value derived shall correspond to the 95 %-fractile for a confidence level of 90 %.

$$V = V_{Rk,ca} / (\gamma_F \cdot \gamma_M) \quad (2.2.8.4)$$

with:

$V_{Rk,ca}$ = characteristic resistance $V_{Rk,ca}$ according to Equation (2.2.8.3)

γ_F = 1,4

γ_M = 2,5

$$\delta_{V,ca,0} = \delta_{V95\%} = \delta_m \cdot (1 + k_s \cdot cv_F) \quad (2.2.8.5)$$

with: δ_m = mean value of displacements at load level V according to Equation (2.2.8.4) of test series line V1

k_s = statistical factor according to [6]
e.g.: n = 5 tests: k_s = 3,40
n = 10 tests: k_s = 2,57

cv_F = coefficient of variation of displacements measured in test series line V1 at load level V according to Equation (2.2.8.4)

The long-term displacements under shear loading, $\delta_{V,ca,\infty}$, shall be calculated from the results of the sustained load tests (Table A.1.1, line V3) according to the following equation:

$$\delta_{V,ca,\infty} = \delta_{m2} / 2,0 \quad (2.2.8.6)$$

δ_{m2} = mean extrapolated displacement in the sustained load tests for every temperature range (see [6])

2.2.9 Maximum installation torque moment

Test series V4 shall be performed and assessed according to EAD 330076-01-0604 [1], 2.2.8 (maximum torque moment), but for systems with maximum cantilever arm.

The maximum torque moment max. T_{inst} for distance fixing systems anchored in masonry results from the minimum of maximum torque moment according to EAD 330076-01-0604 [1], 2.2.8 (maximum torque moment) without cantilever arm and test series V4 for installation with maximum cantilever arm.

The maximum torque moment max. T_{inst} for distance fixing systems anchored in concrete results from the minimum of maximum torque moment according to EAD 330499-02-0601 [2], 2.2.1.2 without cantilever arm and test series V4 for installation with maximum cantilever arm.

If the threaded rod is removable from the plastic part the functioning of the fixing system at maximum torque moment at minimum rod depth shall be assessed in accordance with EAD 330076-01-0604 [1], 2.2.8 (maximum torque moment).

Purpose of the test:

Tests shall be performed to check the maximum torque moment at minimum metal threaded rod depth. It shall be proved that the maximum torque moment during the installation load is greater than the maximum tension load. It shall be proved that when applying 1,3 times of the max T_{inst}, the thread rod does not turn in the internal plastic thread. In addition, the plastic anchor shall without turn-through in the hole.

It shall be possible to return the metal thread rod at any time without damaging the internal thread.

Tests may be omitted if for structural reasons no torque can be transmitted into the base material or into the connection between bolt and anchor.

Test conditions

The tests shall be carried out with the same hollow bricks and anchor configuration (e.g., size, diameter, setting position) as used for the corresponding tests for resistance to failure under tension loading.

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Tests shall be carried out as unconfined tests in all hollow bricks which shall be part of the ETA. The longest lever arm of the fastening element at normal ambient temperature. The minimal anchorage depths shall be proofed.

The metal threaded rod shall be installed with a screw driver. The torque moment shall be measured with a calibrated torque moment transducer. The torque moment shall be increased until failure of the plastic anchor.

Case 1 (general case):

First, the threaded rod shall be screwed in with the minimum screw-in depth.

If the product has an internal thread on both sides, both threaded rods shall be screwed in with the minimum screw-in depth.

Then apply 1,3 times the installation torque with a nut on the mounting part side.

The following shall be ensured:

- the internal thread is not damaged,

- that the threaded rod can be loosened again.

Case 2 (only for products with internal threads on both sides and a parting line in between)

First, a threaded rod shall be screwed in on the component side and a screw with the minimum screw-in depth shall be screwed in on the attachment side.

Then apply 1,3 times the installation torque on the attachment part side.

It shall be ensured:

- that the intermediate layer is not destroyed by the screw,

- the internal thread is not damaged,

- the screw can be loosened again.

The torque moment shall be measured as a function of time. From the gradient of this curve the maximum value (T_u) can be applied to the plastic anchor.

Assessment

The ratio ξ of the maximum torque moment T_u to the torque moment during installation T_{inst} shall be determined for each test:

$$\xi_i = \frac{T_{u,i}}{T_{inst,i}} \qquad (2.2.10.1)$$

The 5 %-fractile of the ratio for all tests shall be at least 1,3.

If this requirement is not met, the maximum torque moment shall be reduced to a value that meets the requirement.

2.2.10 Durability

The durability of the bonding material shall be assessed in accordance with EAD 330076-01-0604 [1], 2.2.2/9, or EAD 330499-02-0601 [2], 2.2.2.12.

The durability of the fixing system (glass-fibre reinforced plastic element) shall be assessed in accordance with EAD 330284-00-0604 [6], 2.2.10.2.

In case of bonding material with high alkalinity and a fixing system made of glass-fibre reinforced plastic elements (exception polyamide) the durability shall be assessed by chemical compatibility analysis.

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3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Decision 96/582/EC
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The system is 1.

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3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the distance fixing system in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1.

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
		Factory production control (FPC)			
Metal parts					
1	Dimensions (outer diameter, inner diameter, thread length, etc.)	Calliper and/ or gauge	Laid down in control plan	3	Each batch
2	Tensile Load (N_p) or tensile strength (f_{uk}), yield strength (f_{yk})	EN ISO 6892-1 [14], EN ISO 898-1 [15], EN ISO 3506-1 [16]		3	
3	Zinc plating (where relevant)	x-ray measurement according to EN ISO 3497 [17], magnetic method according to EN ISO 2178 [18], Phase-sensitive eddy-current method according to EN ISO 21968 [19]		3	
Plastic parts					
4	Material	DSC according to EN ISO 11357-1 [20]	Tolerance: ± 10 K	2	twice yearly or each batch (The lower control interval is decisive)
5	Density	according to EN ISO 1183-1, -2, -3 [21]	-	2	
6	Only for polyamide (PA) / Viscosity VZ	VZ according to EN ISO 307 [22]	Tolerance: ± 10%	2	
7	Only for polyethylene (PE) and polypropylene (PP)/ Molecular weight	MFR according to EN ISO 1133-1, -2 [23]	Tolerance: MFR ≤ 10: ±1 MFR > 10: ±10%	2	
8	Extrusion of anchor sleeve	visual inspection	Laid down in control plan	one shot of each production lot or shift	To be defined in the control plan
Glass-fibre reinforced elements					
9	Raw materials	Certificates	Laid down in control plan	3	Each manu-facturing batch
10	Fibre content	EN ISO 1172 [13]	Laid down in control plan	3	Each manufacturing batch
11	Cure ratio	EN ISO 11357-5 [29]		1	
12	Density, void content, meter weight	EN ISO 1183-1 [21]		3	5,000 consecutive meter of the connector resp. per 15,000 connectors resp. once per production week
13	Determination of the functional measurements (diameter or width and height, reductions of cross section e.g., rib or dovetail for bond or undercut) of the connectors	Gauge		3	
14	Modulus of elasticity and bending strength	4-point bending test according to ISO 3597-2 [30]		3	
15	Interlaminar shear strength	EN ISO 14130 [31] at 20°C		3	
Injection mortar and sieve sleeve according to EAD 330076-01-0601[1], Table 3.2.1					

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for distance fixing systems are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	The Notified Body will ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the distance fixing systems.	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	According to Control plan	According to Control plan	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control					
2	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in table 3.2.1	According to Control plan	According to Control plan	1/year

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4 REFERENCE DOCUMENTS

[1] EAD 330076-01-0604	Metal injection anchors for use in masonry
[2] EAD 330499-02-0601	Bonded fasteners for use in concrete
[4] EN 1993-1-4:2006 + A1:2015 + A2:2020	Eurocode 3: Design of steel structures – Part 1-4: General rules – Supplementary rules for stainless steels
[5] EN 206:2013 + A1 2016 +A2:2021	Concrete: Specification, performance, production and conformity
[6] EAD 330284-00-0604	Plastic anchors for redundant non-structural systems in concrete and masonry
[7] EN 771-1 to 5:2011 + A1:2015	Specification for masonry units
[8] EN 772-13:2000	Methods of test for masonry units – Part: 13 Determination of net and gross dry density of masonry units (except for natural stone)
[9] EN 772-1:2011 + A1:2015	Methods of test for masonry units – Part 1: Determination of compressive strength
[10] EN 998-2:2016	Specification for mortar for masonry – Part 2: Masonry mortar
[11] EN 1998-1-1:2024	Eurocode 8: Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings
[12] EOTA TR 077:2022-12	Design methods for distance fixing systems
[13] EN ISO 1172:2023	Textile-glass-reinforced plastics - Prepregs, moulding compounds and laminates - Determination of the textile-glass and mineral-filler content; calcination methods (ISO 1172:2023)
[14] EN ISO 6892-1:2019	Metallic materials – Tensile testing – Part 1: Method of test at room temperature (ISO 6892-1:2019)
[15] EN ISO 898-1:2013/AC:2013	Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs with specified property classes – Coarse thread and fine pitch thread (ISO 898-1:2013+Cor1:2013
[16] EN ISO 3506-1:2020	Mechanical properties of corrosion-resistant stainless-steel fasteners – Part 1: Bolts, screws and studs with specified property classes – Coarse pitch thread and fine pitch thread (ISO 3506-1:2020)
[17] EN ISO 3497:2000	Metallic coatings – Measurement of coating thickness – X-ray spectrometric methods (ISO 3497:2000)
[18] EN ISO 2178:2016	Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method (ISO 2178:2016)
[19] EN ISO 21968:2019	Non-magnetic metallic coatings on metallic and non-metallic basis materials – Measurement of coating thickness – Phase-sensitive eddy-current method (ISO 21986:2019)
[20] EN ISO 11357-1:2023	Plastics – Differential scanning calorimetry (DSC)
[21] EN ISO 1183-1:2019, EN ISO 1183-2:2019, EN ISO 1183-3:1999	Plastics – Methods for determining the density of non-cellular plastics (ISO 1183-1:2019, ISO 1183-2:2019, ISO 1183-3:1999)
[22] EN ISO 307:2019	Plastics – Polyamides – Determination of viscosity number (ISO 307:2019)
[23] EN ISO 1133-1:2022 and EN ISO 1133-2:2011	Plastics – Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics (ISO 1133-1:2022, ISO 1133-2:2011)
[29] EN ISO 11357-5:2014	Plastics - Differential scanning calorimetry (DSC) - Part 5: Determination of characteristic reaction-curve temperatures and times, enthalpy of reaction and degree of conversion (ISO 11357-5:2013)
[30] ISO 3597-2:2003-10	Textile-glass-reinforced plastics - Determination of mechanical properties on rods made of roving-reinforced resin – Part 2: Determination of flexural strength
[31] EN ISO 14130:1997	Fibre reinforced plastic composites - Determination of apparent interlaminar shear strength by short beam-method (ISO 14130:1997)

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ANNEX A: TEST PROGRAMME AND GENERAL ASSESSMENT

A.1 Test programme

The tests shall be performed according to Table A.1.1 with all sizes of the anchor element. Exception: If EAD 330076-01-0604 [1] or EAD 330499-02-0601 [2] specify tests with less than all sizes.

Test series for assessment of resistance to failure of the anchor in base material masonry under tension loading according to EAD 330076-01-0604 [1] may be performed with maximum length of cantilever arm (according to the intended use) additionally.

For tests with internal thread the minimum rod depth shall be used.

All tests shall be carried out without any ETICS.

Anchors shall be installed according to manufacturer's installation instruction.

Table A.1.1: Test programme

Test series	Purpose of test	Base material	Number of tests	Details, assess-ment
Resistance to failure of the anchor in base material masonry under tension loading according to EAD 330076-01-0604 [1]				
Resistance to failure of the anchor in base material masonry under shear loading according to EAD 330076-01-0604 [1]				
Resistance to failure of the anchor in base material masonry under pressure loading (only for hollow or perforated bricks where the minimum anchorage depth is in contact with less than 5 shells (partitions of the brick)				
P1	Resistance of a single anchor to failure under pressure loads $c_{test} \geq c_{cr}$, $s_{test} \geq s_{cr}$	All	5	2.2.2
P2	Resistance of a single anchor to failure under pressure loads $c_{test} = c_{min}$, $s_{test} \geq s_{cr}$	All	5	2.2.2
Resistance to failure of the anchor in base material concrete under tension and shear loading according to EAD 330499-02-0601 [2]				
Resistance of the plastic part transferring load				
TK1	Resistance to failure under tension load	Steel or concrete (see 2.2.4 – 2.2.6)	5	2.2.3
TK2a	Resistance for tension loading for dry condition		5	2.2.3
TK2b	Resistance for tension loading for wet condition		5	2.2.3
TK3a	Resistance for tension loading at maximum long-term temperature		5	2.2.3
TK3b	Resistance for tension loading at maximum short-term temperature		5	2.2.3
TK3c	Resistance for tension loading at minimum temperature		5	2.2.3
TK4a	Resistance to failure under sustained tension load at ambient temperature		5	2.2.3
TK4b	Resistance to failure under sustained tension load at long-term temperature		5	2.2.3
TK5	Resistance to failure under pressure load		5	2.2.4
TK6	Resistance to failure under shear load		5	2.2.5

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Test series	**Purpose of test**	**Base material**	**Number of tests**	**Details, assess-ment**
Resistance to buckling of the cantilever arm (at maximum cantilever arm)				
B1	The resistance to buckling	Concrete	5	2.2.6
B2	Resistance to combined shear and pressure load	Concrete	5	2.2.7
Resistance to shear load of the cantilever arm (at maximum cantilever arm) and max. T_{inst}				
V1	Resistance to shear load not influenced by edge and spacing effects	All	5	2.2.8
V2	Resistance to shear load at minimum edge distance	All	5	2.2.8
V3a	Resistance to sustained shear load at normal ambient temperature	Concrete /AAC	5	2.2.8
V3b	Resistance to sustained shear load at maximum long-term temperature	Concrete /AAC	5	2.2.8
V4	Maximum torque moment	All	5	2.2.9

A.2 Determination of the 5%-fractile of the ultimate loads

The 5%-fractile of the ultimate loads shall be calculated according to statistical procedures for a confidence level of 90 %. A logarithmical normal distribution and an unknown standard deviation of the population shall be assumed and the following steps shall be carried out:

1) Determination the logarithmic values of the ultimate loads

$$\varphi_i = ln\left(F_{u,i}\right) \quad \text{(A.2.1)}$$

2) Perform the statistical analysis determining the fractile value based on logarithmic data

$$\varphi_m = \sum_{i=1}^{n}\left(\frac{\varphi_i}{n}\right) \quad \text{(A.2.2)}$$

$$s(\varphi) = \sqrt{\frac{\sum_{i=1}^{n}(\varphi_m - \varphi_i)^2}{(n-1)}} \quad \text{(A.2.3)}$$

$$\varphi_{5\%} = \varphi_m - k_s \cdot s(\varphi) \quad \text{(A.2.4)}$$

3) Determine the standard fractile value from the logarithmic fractile value

$$F_{5\%} = e^{\varphi 5\%} \quad \text{(A.2.5)}$$

with:
- φ_i = logarithmic values of the ultimate load of a test
- $F_{u,i}$ = ultimate loads of a test
- n = number of tests of a test series
- φ_m = mean value of logarithmic values of a test series
- $s(\varphi)$ = standard deviation of logarithmic values of a test series
- $\varphi_{5\%}$ = 5%-fractile of logarithmic values of a test series
- k_s = statistical factor according to [6]
  - e.g.: n = 5 tests: k_s = 3,40
  - n = 10 tests: k_s = 2,57
- $F_{5\%}$ = 5%-fractile of ultimate loads in a test series

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A.3 Reduction factor

For test series TK2 and TK3 according to Table A.1.1 the factor α shall be calculated as follows:

$$\alpha = \min\left((F_{um,t} / F_{um,r})\ ;\ (F_{5\%,t} / F_{5\%,r})\right) \qquad \text{(A.3.1)}$$

with: $F_{um,t}$ = mean failure load in test series TK2 or TK3

$F_{um,r}$ = mean failure load in the reference test series TK1 according to Table A.1.1

$F_{5\%,t}$ = 5% fractile of failure loads test series TK2 or TK3

$F_{5\%,r}$ = 5% fractile of failure loads in the reference test series TK1 according to Table A.1.1

Equation (A.3.1) is based on test series with a comparable number of test results in both series. If the number of tests in the two series is very different, then evaluation of 5%-fractile values may be omitted when the coefficient of variation of the f test series TK2 or TK3 is smaller than or equal to the coefficient of variation of the reference test series or if the coefficient of variation in the test series TK2 or TK3 is $v \leq 15$ %.

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