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European Assessment Document for

Screw anchors for use in masonry

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) No 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

The screw anchors for use in masonry (in the following referred to as screw anchor) are made of carbon steel or stainless steel and contain less than 1 % organic material in volume or mass whichever is more onerous. They are screwed into a pre-drilled cylindrical hole perpendicular to the surface of the masonry (maximum deviation 5°). In masonry of low compressive strength, the screw anchor can be set without pre-drilling (e.g., autoclaved aerated concrete of strength class 2). The special thread of the screw anchor cuts an internal thread into the masonry unit while setting. The fastening is characterised by mechanical interlock in the masonry thread.

The installation can be done by a non-calibrated torque wrench, a calibrated torque spanner, a cordless screwdriver or an electrical or pneumatic impact screwdriver.

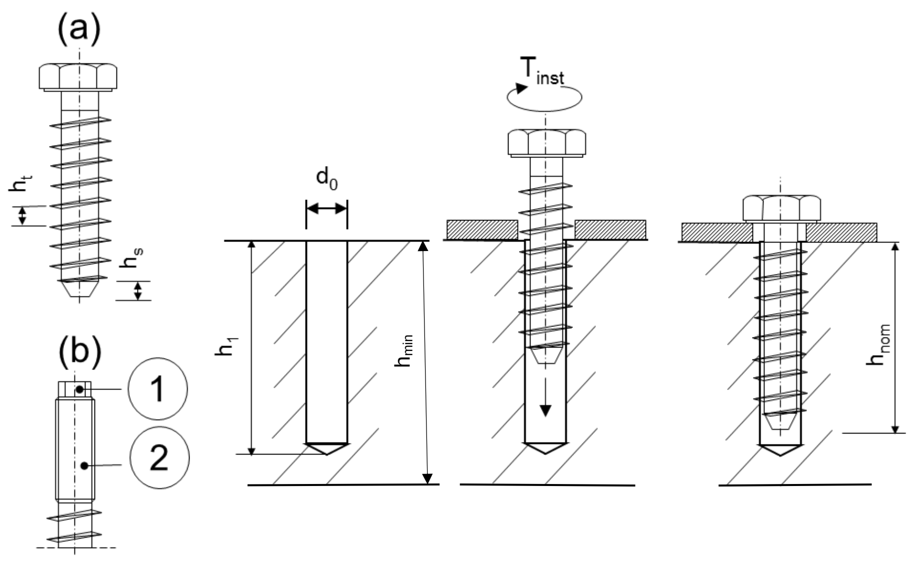
Note: The screw anchors may be sensitive to the applied torque or power while setting. Therefore, it is assumed that the manufacturer specifies a maximum installation torque or power limit for electric impact screw drivers.

As soon as no information on “power limit for electric impact screw drivers” is given in MPII, no power tool shall be used in assessment process and “T_{inst}” is applied by calibrated torque wrench while the level of “T_{inst}” is either obtained from MPII or default value set in the EAD shall be used.

The screw anchor may be loosened and retightened to facilitate attachment and realignment or allow levelling of the attached component (adjustment). Multiple setting of screw anchors is not covered in this EAD.

This EAD applies to screw anchors with the following minimum dimensions:

- minimum nominal core diameter of the main load bearing section: 4 mm
- minimum embedment depth $h_{nom} – h_s$: 50 mm
- in case of anchoring structural components which are statically indeterminate (such as light-weight suspended ceilings) and in case of components subject to internal exposure conditions: minimum embedment depth $h_{nom} – h_s$: 30 mm
- minimum thickness of the masonry members h_{min} = 80 mm.



(a) In-place installation

(b) Pre-positioned installation

1 Bit

2 connection thread for fixture

Figure 1.1.1: Screw anchor: Geometry and drill hole parameter

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

The product is not fully covered by the following harmonised technical specification: EAD 330232-01-0601 [1]. EAD 330232-01-0601 [1] covers mechanical fasteners in concrete in accordance with EN 206 [18] [1], but this EAD covers screw anchors in masonry in accordance with EN 771-1 to 4 [2]. The assessment methods in EAD 330232-01-0601 are not fully applicable for screw anchors subject of this EAD.

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.

1.2 Information on the intended use of the construction product

1.2.1 Intended use

The screw anchor is intended to be used in masonry units of clay, calcium silicate, normal weight concrete and lightweight aggregate concrete (solid and hollow or perforated format blocks) or autoclaved aerated concrete in accordance with EN 771-1 to 4 [2]. The screw anchor may also be used in joints of masonry.

Masonry units made of clay may have cracks resulting from burning the brick. The screw anchor is only intended to be used in masonry units made of clay without cracks, because the influence of cracks is not assessed in accordance with this EAD. Exception: if the screw anchor has also an ETA in accordance with EAD 330232-01-0601 [1], option 1-6, the screw anchor can also be used in bricks with cracks equal or smaller than 0,3 mm.

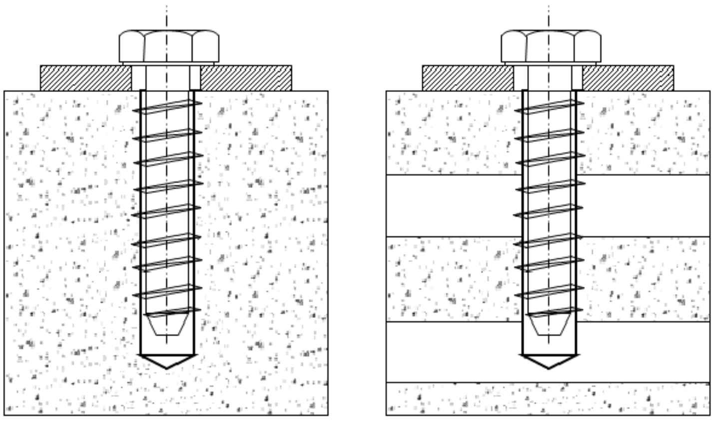


Figure 1.2.1.1: Screw anchor intended to be used in solid and hollow masonry

1 All undated references to standards in this EAD are to be understood as references to the dated versions listed in chapter 4.

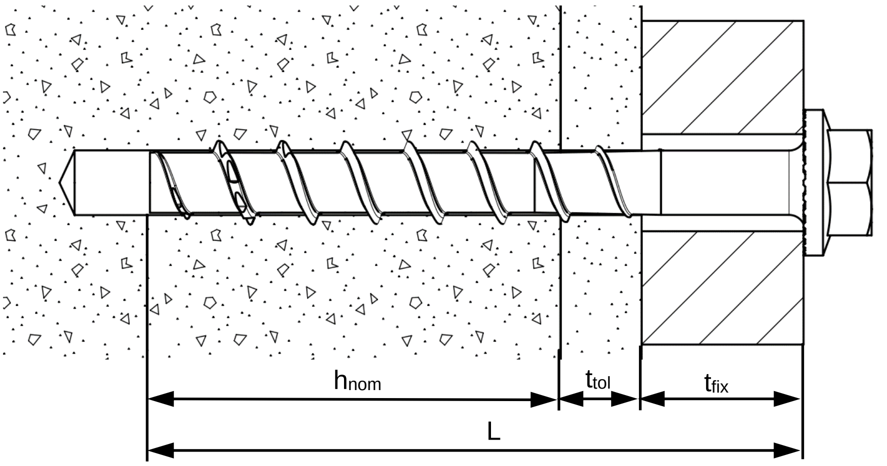


Figure 1.2.1.2: Screw anchor, installed conditions

The screw anchor is intended to be used in masonry structures which are in line with the structural rules for masonry, such as EN 1996-1-1 [5], clauses 3 and 8 taking into account the relevant national determined parameters.

The standards for masonry are not very restrictive with regard to details of units (e.g., type, dimensions and location of holes, number and thickness of webs). Screw anchor resistance and load displacement behaviour, however, decisively depend on these influencing factors.

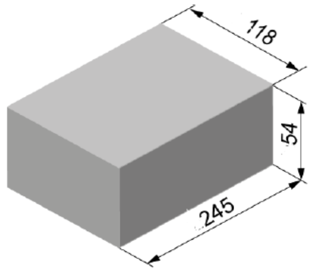
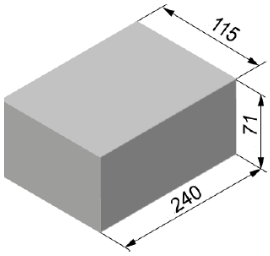
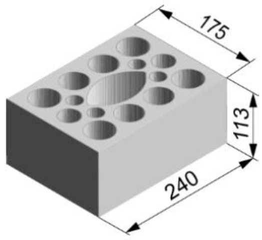
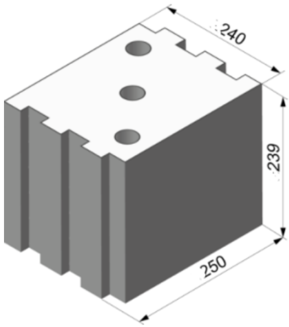
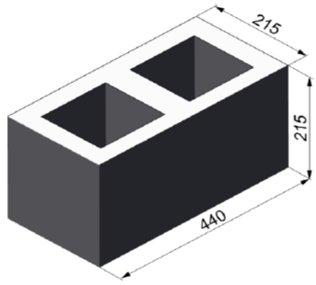
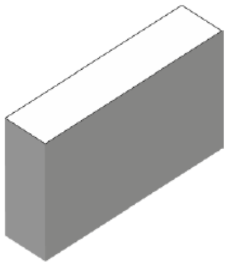
The product is intended for base materials and the installation conditions as defined as follows:

- 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 in accordance with EN 771-1,2,3 [2]: mean gross dry density in accordance with EN 772-13 [6] and mean compressive strength of the masonry unit in accordance with EN 772-1 [4],
- for masonry units in accordance with EN 771-4 [2]: mean dry density and mean compressive strength,
- for joints not to be filled with mortar: joint width,
- for joints filled with mortar in accordance with EN 998-2 [15]: mortar class, joint width
- consideration of plaster or similar materials,
- setting position (wall side or reveal, distance to joints with or without joint influence).

In the ETA the assessed performance shall be given in relation to the relevant base material and the installation conditions, which are used in the tests. Default brick types and sizes are given in Table 1.2.1.1.

The characteristic resistance for solid bricks and autoclaved aerated concrete is also valid for larger brick sizes and larger compressive strength of the masonry unit.

Table 1.2.1.1: Default brick types and sizes

Standard, solid material, dimensions	Figure	Standard, hollow and perforated material, dimensions	Figure
EN 771-1 [2] Solid clay brick Length l_{unit} = 245 mm Width b_{unit} = 118 mm Height h_{unit} = 54 mm Mean compressive strength = 15 N/mm^2			
EN 771-2 [2] Solid calcium silicate brick, Length l_{unit} = 240 mm Width b_{unit} = 115 mm Height h_{unit} = 71 mm Mean compressive strength = 15 N/mm^2		EN 771-2 [2] Perforated calcium silicate brick, Length l_{unit} = 240 mm Width b_{unit} = 175 mm Height h_{unit} = 113 mm Mean compressive strength = 15 N/mm^2	
EN 771-3 [2] Solid lightweight concrete block, Length l_{unit} = 250 mm Width b_{unit} = 240 mm Height h_{unit} = 239 mm Mean compressive strength = 5 N/mm^2		EN 771-3 [2] Hollow lightweight concrete block, Length l_{unit} = 440 mm Width b_{unit} = 215 mm Height h_{unit} = 215 mm Mean compressive strength = 5 N/mm^2	
EN 771-4 [2] Solid autoclaved aerated concrete block Length l_{unit} = 599 mm Width b_{unit} = 240 mm Height h_{unit} = 199 mm Mean compressive strength = 4 N/mm^2			

The characteristic resistance for solid bricks and autoclaved aerated concrete is also valid for larger brick sizes and larger compressive strength of the masonry unit.

The screw anchor is intended to be installed in dry or wet masonry.

The covered temperature range of the masonry during the working life is within the range -40 °C to +80 °C.

The screw anchor is intended to be used only subject to static or quasi-static actions in tension, shear or combined tension and shear or bending. The screw anchors are intended to be used also in areas with no and very low seismicity as defined in EN 1998-1 [10], clause 3.2.1. The screw anchor is intended to be used only where the masonry members, in which the screw anchors are embedded, are subject to static or quasi-static actions.

The screw anchor is intended to be used with requirements related to resistance to fire (only for dry masonry conditions, joints are completely filled with mortar and no larger cracks than 0,3 mm in masonry during fire exposure).

In this EAD the assessment is made to determine performances of essential characteristic of the screw anchors which can be used for design in accordance with TR 054 [11].

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 screw anchor for the intended use of 50 years when installed in the works (provided that the screw anchor is subject to appropriate installation (see 1.1.1)). 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

Screw anchor	=	screw anchor for achieving anchorage between the base material (masonry) and the fixture
Screw anchor group	=	several screw anchors (working together)
MPII	=	manufacturer's product installation instructions
Impact screwdriver	=	electric tool with sudden rotational force for setting and loosening screw anchors
AAC	=	autoclaved aerated concrete.

Screw anchors

The notations and symbols frequently used in this EAD are given below. Further particular notation and symbols are given in the text.

b_{unit}	=	width of the member of the base material [mm]
c_{cr}	=	edge distance for ensuring the transmission of the characteristic resistance of a single screw anchor [mm] (standard values see also clause 2.2.7)
c_{min}	=	minimum edge distance to the free edge of the wall [mm]
$c_{,test}$	=	edge distance to the free edge in tests [mm]
$c_{min,fi}$	=	minimum edge distance to the free edge of the wall for fire resistance [mm]
$c_{,test,fi}$	=	edge distance to the free edge for fire resistance in tests [mm]
$c_{j\parallel}$	=	distance to vertical joints without influence on resistance of the screw anchor, see also Figure 1.3.1 [mm]
$c_{j\perp}$	=	distance to horizontal joints without influence on resistance of the screw anchor, see also Figure 1.3.1 [mm]

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.

$c_{j,test}$ = distance to joints in tests [mm]

$c_{j,fi}$ = joint distance in tests for fire resistance [mm]

d = screw anchor bolt/thread diameter [mm]

d_0 = drill hole diameter [mm]

d_{cut} = cutting diameter of drill bit [mm]

$d_{cut,m}$ = medium cutting diameter of drill bit [mm]

$d_{cut,min}$ = minimum cutting diameter of drill bit [mm]

$d_{cut,max}$ = maximum cutting diameter of drill bit [mm]

d_f = diameter of clearance hole in the fixture [mm]

d_r = diameter of the upper part of the screw anchor (see Figure A.4.1) [mm]

d_{nom} = outside diameter of screw anchor [mm]

h = thickness of masonry member (wall) [mm]

h_{min} = minimum thickness of masonry member [mm]

h_s = non-load bearing tip of a screw anchor in accordance with Figure 1.1.1 [mm]

h_t = pitch of the thread of a screw anchor in accordance with Figure 1.1.1 [mm]

h_1 = depth of drilled hole to deepest point [mm]

h_{nom} = overall screw anchor embedment depth in the masonry [mm]

h_{unit} = height of the masonry unit [mm]

l_{unit} = length of the masonry unit [mm]

s = spacing of the screw anchors [mm]

s_{cr} = spacing for ensuring the transmission of the characteristic resistance of a single screw anchor [mm] (standard values see also clause 2.2.7)

s_{crII} = s_{cr} parallel to the horizontal joint, see also Figure 1.3.1 [mm] (standard values see also clause 2.2.7)

$s_{cr\perp}$ = s_{cr} perpendicular to the horizontal joint, see also Figure 1.3.1 [mm] (standard values see also clause 2.2.7)

s_{min} = minimum spacing [mm]

s_{test} = spacing in tests [mm]

s_{minII} = minimum spacing parallel to the horizontal joint, see also Figure 1.3.1 [mm]

$s_{min\perp}$ = minimum spacing perpendicular to the horizontal joint, see also Figure 1.3.1 [mm]

$s_{min,fi}$ = minimum spacing for fire resistance [mm]

$s_{test,fi}$ = spacing for fire resistance in tests [mm]

T = torque moment [Nm]

max. T_{inst} = maximum setting torque moment specified by the manufacturer for installation [Nm]

$T_{imp,max}$ = maximum torque of impact screwdriver or cordless screwdriver [Nm]

T_u = maximum torque moment during failure [Nm]

$T_{u5\%}$ = 5 %-fractile of the ultimate torque in a test series [Nm]

t_{fix} = thickness of fixture [mm]

t = thickness of outer web of the brick [mm]

w_j = maximum width of joints (for $c < c_j$) [mm]

Base materials (masonry) and parts of screw anchor

ρ_g	=	mean gross dry density of masonry unit [kg/dm³]
f_{mean}	=	mean compressive strength of masonry (intended use) in accordance with EN 772-1 [4] [N/mm²]
$f_{mean,test}$	=	mean compressive strength of masonry unit at the time of testing in accordance with EN 772-1 [4] [N/mm²]
f_{yk}	=	nominal characteristic steel yield strength [N/mm²]
$f_{y,test}$	=	steel tensile yield strength in the test [N/mm²]
f_{uk}	=	nominal characteristic steel ultimate strength [N/mm²]
$f_{u,test}$	=	steel ultimate tensile strength in the test [N/mm²]

Loads / Forces

F	=	force in general [kN]
N	=	normal force (+N = tension force) [kN]
V	=	shear force [kN]
M	=	moment [Nm]

Tests / Assessment

F_u	=	ultimate load in a test [kN]
F_{um}	=	mean ultimate load in a test series [kN]
$F_{5\%}$	=	5 %-fractile of the ultimate load in a test series [kN]
n	=	number of tests of a test series [-]
v	=	coefficient of variation [-]
$\delta(\delta_N, \delta_V)$	=	displacement (movement) of the screw anchor at the masonry surface relative to the masonry surface in direction of the load (tension, shear) outside the failure area. The displacement includes the steel and masonry deformations and a possible screw anchor slip [mm]
δ_0	=	displacement of the screw anchor under short-term loading [mm]
δ_∞	=	displacement of the screw anchor under long-term loading [mm]
N_{um}	=	mean failure tension load in test series [kN]
$N_{5\%}$	=	$F_{5\%}$ in accordance with B.1, evaluated from test series [kN]
N_p	=	applied tension load during tests [kN]
$N_{p,red}$	=	reduced tension load during tests [kN]
$N_{Rk,s}$	=	characteristic resistance to steel failure of a single screw anchor under tension load [kN]
$N_{Rk,p}$	=	characteristic resistance to pull out failure of a single screw anchor under tension load [kN]
$N_{Rk,b}$	=	characteristic resistance to brick break out failure of a single screw anchor under tension load [kN]
$N_{Rk,p,c}$	=	characteristic resistance of pull out failure of the screw anchor with edge effects [kN]
$N_{Rk,b,c}$	=	characteristic resistance of brick breakout failure of the screw anchor with edge effects [kN]
$N_{Rk,s,fi}$	=	characteristic fire resistance to steel failure under tension load [kN]
$N_{Rk,p,fi}$	=	characteristic fire resistance to pull-out failure under tension load without edge effects [kN]
$N_{Rk,b,fi}$	=	characteristic fire resistance to brick breakout failure under tension load without edge effects [kN]
N_{Rk}^{g}	=	characteristic resistance of a screw anchor group under tension load [kN]
$N_{Rk,fi}^{g}$	=	characteristic fire resistance of a screw anchor group under tension load [kN]

V_{um}	=	mean failure shear load in test series [kN]
$V_{5\%}$	=	$F_{5\%}$ in accordance with B.1, evaluated from test series [kN]
$V_{Rk,s}$	=	characteristic screw anchor resistance to steel failure under shear load [kN]
$V_{Rk,s,fi}$	=	characteristic fire resistance to steel failure under shear load [kN]
$V_{Rk,b,II}$	=	characteristic screw anchor resistance to brick breakout failure under shear load parallel to the vertical joint without edge influence [kN]
$V_{Rk,b,\perp}$	=	characteristic screw anchor resistance to brick breakout failure under shear load perpendicular to vertical joint without edge influence [kN]
$V_{Rk,b,II}^{g}$	=	characteristic resistance to brick breakout failure of a screw anchor group under shear load parallel to the vertical joint without edge influence [kN]
$V_{Rk,b,\perp}^{g}$	=	characteristic resistance to brick breakout failure of a screw anchor group under shear load perpendicular to the vertical joint without edge influence [kN]
$V_{Rk,c,II}$	=	characteristic screw anchor resistance to brick edge failure under shear load perpendicular to the edge with edge influence [kN]
$V_{Rk,c,\perp}$	=	characteristic screw anchor resistance to brick edge failure under shear load perpendicular to the edge with edge influence [kN]
$V_{Rk,c,II}^{g}$	=	characteristic resistance to brick edge failure of a screw anchor group under shear load parallel to the edge with edge influence [kN]
$V_{Rk,c,\perp}^{g}$	=	characteristic resistance to brick edge failure of a screw anchor group under shear load perpendicular to the edge with edge influence [kN]
$M^0_{Rk,s}$	=	characteristic resistance for steel failure under shear load with lever arm [Nm]
$M^0_{Rk,s,fi}$	=	characteristic fire resistance for steel failure under shear load with lever arm [Nm]
α	=	reduction factor [-]
α_p	=	reduction factor due to applied tension load during tests [-]
$\alpha_{g,N}$	=	group factor for screw anchor groups under tension load [-]
$\alpha_{g,VII}$	=	group factor for screw anchor groups under shear load parallel to the edge [-]
$\alpha_{g,V\perp}$	=	group factor for screw anchor groups under shear load perpendicular to the edge [-]
$\alpha_{j,N}$	=	reduction factor for resistance under tension loading for -screw anchors influenced by joints [-]
$\alpha_{j,VII}$	=	reduction factor for resistance under shear loading parallel to the vertical joint for screw anchors influenced by joints [-]
$\alpha_{j,V\perp}$	=	reduction factor for resistance under shear loading perpendicular to the vertical joint for screw anchors influenced by joints [-]
X	=	limit value in a trilinear function for combined tension and shear loads [-]

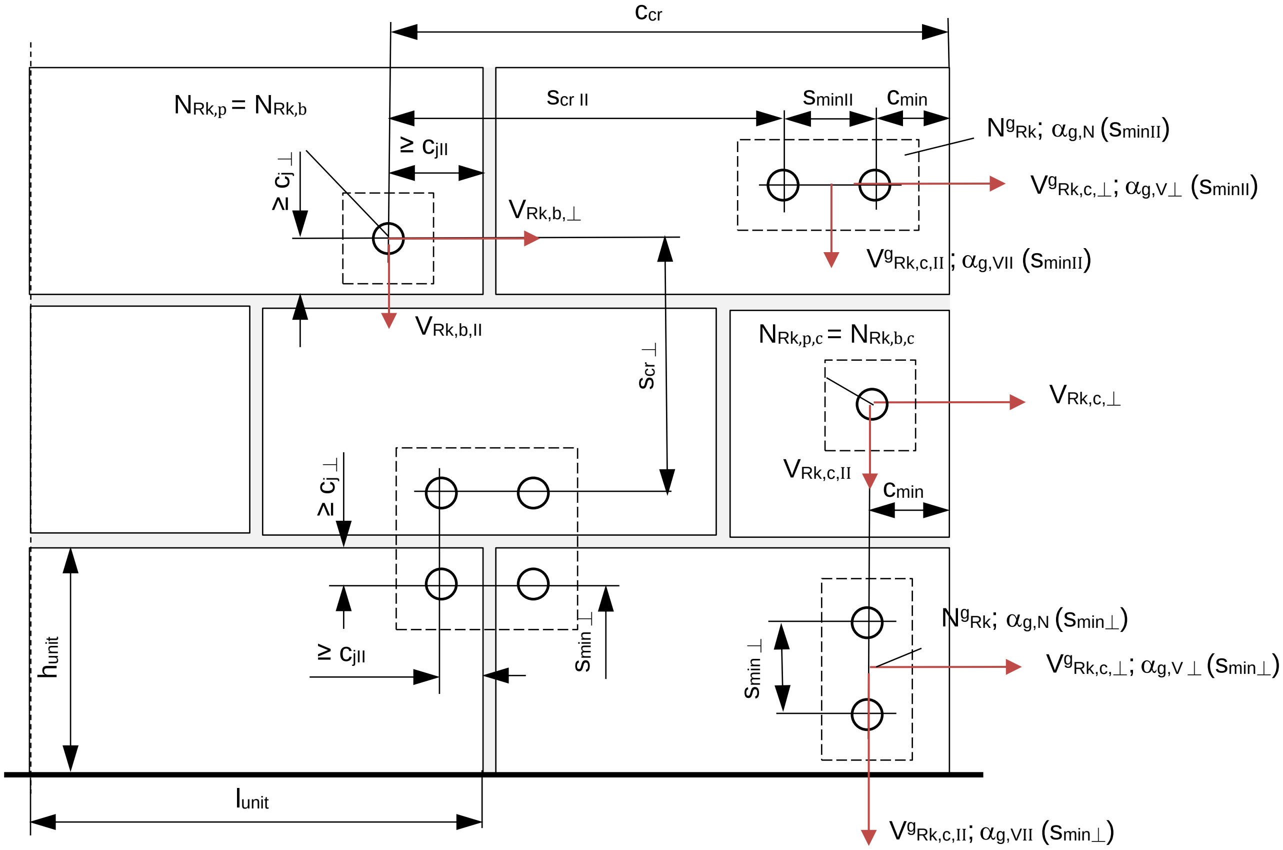


Figure 1.3.1: **Edge distances, joint distances, spacing and resistances for screw anchors (brick types and sizes are given in Table 1.2.1.1)**

Table 1.3.1: **Relation between test series (see Table A.1.1) and test position (in Figure 1.3.1)**

Resistance	Test series	Distances
$N_{Rk,p} = N_{Rk,b}$	A1	$c_{test} \geq c_{cr}$, $s_{test} \geq s_{cr}$, $c_{jII,test} = c_{jII}$, $c_{j\perp,test} = c_{j\perp}$
$V_{Rk,b,II}$	A2II	$c_{test} \geq c_{cr}$, $s_{test} \geq s_{cr}$, $c_{jII,test} = c_{jII}$, $c_{j\perp,test} = c_{j\perp}$
$V_{Rk,b,\perp}$	A2⊥	$c_{test} \geq c_{cr}$, $s_{test} \geq s_{cr}$, $c_{jII,test} = c_{jII}$, $c_{j\perp,test} = c_{j\perp}$
$N_{Rk,p,c} = N_{Rk,b,c}$	A3	$c_{test} \geq c_{min}$, $s_{test} \geq s_{cr}$
$V_{Rk,c,II}$	A4II	$c_{test} \geq c_{min}$, $s_{test} \geq s_{cr}$
$V_{Rk,c,\perp}$	A4⊥	$c_{test} \geq c_{min}$, $s_{test} \geq s_{cr}$
N^g_{Rk} (s_{minII}, $s_{min\perp}$), $\alpha_{g,N}$ (s_{minII}, $s_{min\perp}$)	A5	$s_{II,test} = s_{minII}$, $s_{\perp,test} = s_{min\perp}$, $c_{test} = c_{min}$
N^g_{Rk} (s_{minII}), $\alpha_{g,N}$ (s_{minII})	A5sII	$s_{II,test} = s_{minII}$, $c_{test} = c_{min}$
N^g_{Rk} ($s_{min\perp}$), $\alpha_{g,N}$ ($s_{min\perp}$)	A5⊥	$s_{\perp,test} = s_{min\perp}$, $c_{test} = c_{min}$
$V^g_{Rk,II}$ (s_{minII}, $s_{min\perp}$), $\alpha_{g,VII}$ (s_{minII}, $s_{min\perp}$)	A6II	$s_{II,test} = s_{minII}$, $s_{\perp,test} = s_{min\perp}$, $c_{test} = c_{min}$
$V^g_{Rk,II}$ ($s_{min\perp}$), $\alpha_{g,VII}$ ($s_{min\perp}$)	A6IIs⊥	$s_{\perp,test} = s_{min\perp}$, $c_{test} = c_{min}$
$V^g_{Rk,II}$ ($s_{minII}\alpha_{g,VII}$ (s_{minII})	A6IIsII	$s_{II,test} = s_{minII}$, $c_{test} = c_{min}$
$V^g_{Rk,\perp}$ (s_{minII}, $s_{min\perp}$), $\alpha_{g,V\perp}$ (s_{minII}, $s_{min\perp}$)	A6⊥	$s_{II,test} = s_{minII}$, $s_{\perp,test} = s_{min\perp}$, $c_{test} = c_{min}$
$V^g_{Rk,\perp}$ ($s_{min\perp}$), $\alpha_{g,V\perp}$ ($s_{min\perp}$)	A6⊥s⊥I	$s_{\perp,test} = s_{min\perp}$, $c_{test} = c_{min}$
$V^g_{Rk,\perp}$ (s_{minII}), $\alpha_{g,V\perp}$ (s_{minII})	A6⊥sII	$s_{II,test} = s_{minII}$, $c_{test} = c_{min}$

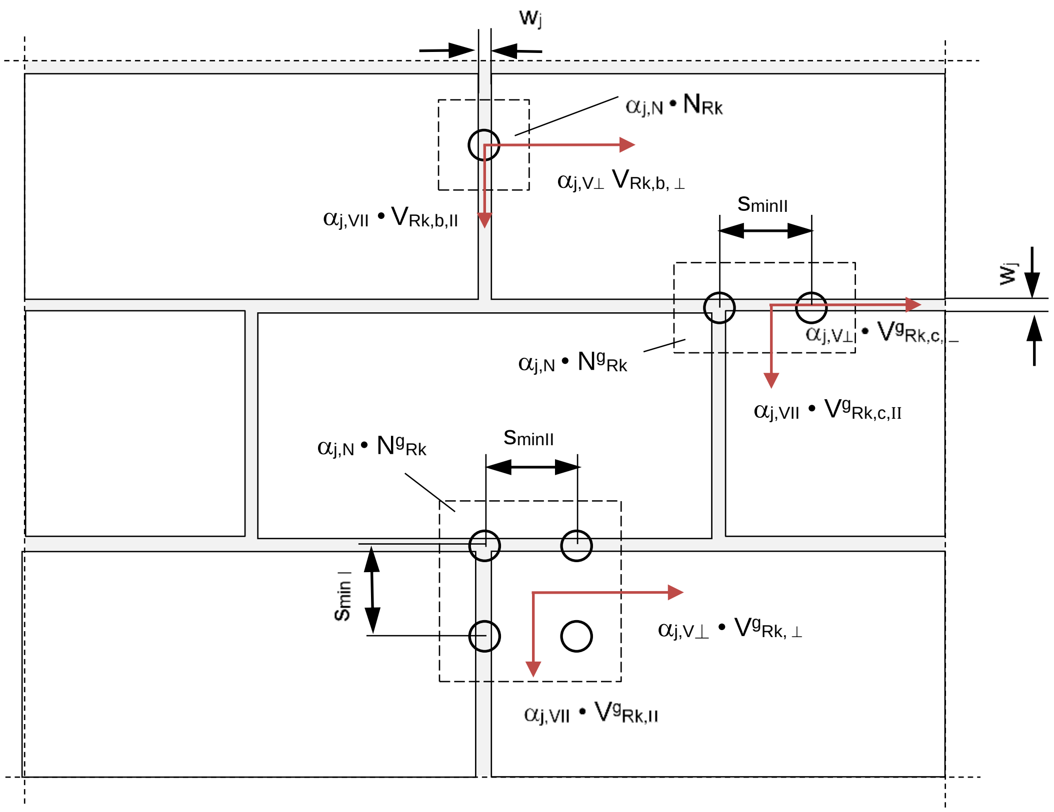


Figure 1.3.2: **Reduction factors for resistances of screw anchors in or near joints (brick types and sizes are given in Table 1.2.1.1)**

Table 1.3.2: **Relation between test series (see Table A.1.1) and test position (in Figure 1.3.2)**

Resistance	Test series	Distances
$\alpha_{j,N} \cdot N_{Rk}$	A1j	$c_{test} \geq c_{cr}$, $s_{test} \geq s_{cr}$, $c_{jII,test} < c_{jII}$, $c_{j\perp,test} < c_{j\perp}$
$\alpha_{j,V,II} \cdot V_{Rk,b,II}$	A2jII	$c_{test} \geq c_{cr}$, $s_{test} \geq s_{cr}$, $c_{jII,test} < c_{jII}$, $c_{j\perp,test} < c_{j\perp}$
$\alpha_{j,V,\perp} \cdot V_{Rk,b,}$	A2j⊥	$c_{test} \geq c_{cr}$, $s_{test} \geq s_{cr}$, $c_{jII,test} < c_{jII}$, $c_{j\perp,test} < c_{j\perp}$

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 screw anchor for use in masonry 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 1: Mechanical resistance and stability			
1	Characteristic resistance to steel failure of a single screw anchor under tension loading	2.2.1	Level $N_{Rk,s}$ [kN]
2	Characteristic resistance to steel failure of a single screw anchor under shear loading	2.2.2	Level $V_{Rk,s}$ [kN], $M^0_{Rk,s}$ [Nm]
3	Characteristic resistance to pull-out failure or brick breakout failure of a single screw anchor under tension loading	2.2.3	Level $N_{Rk,p}$, $N_{Rk,b}$, $N_{Rk,p,c}$, $N_{Rk,b,c}$ [kN] $\alpha_{j,N}$ [-]
4	Characteristic resistance to local brick failure and brick edge failure of a single screw anchor under shear loading	2.2.4	Level $V_{Rk,b,II}$, $V_{Rk,b,\perp}$, $V_{Rk,c,II}$, $V_{Rk,c,\perp}$ [kN] $\alpha_{j,VII}$, $\alpha_{j,V\perp}$ [-]
5	Characteristic resistance to brick breakout failure of a screw anchor group under tension loading	2.2.5	Level N^g_{Rk} [kN], $\alpha_{g,N}$ [-]
6	Characteristic resistance to local brick failure and brick edge failure of a screw anchors group under shear loading	2.2.6	Level $V^g_{Rk,b,II}$, $V^g_{Rk,b,\perp}$, $V^g_{Rk,c,II}$, $V^g_{Rk,c,\perp}$ [kN] $\alpha_{g,VII}$, $\alpha_{g,VII\perp}$ [-]
7	Edge distances, joint distances, spacing, member thickness	2.2.7	Level c_{cr}, s_{crII}, $s_{cr\perp}$, c_{min}, c_{jII}, $c_{j\perp}$, s_{minII}, $s_{min\perp}$, h_{min} [mm]
8	Resistance to combined tension and shear loading (hollow and perforated bricks)	2.2.8	Level Limit value X [-] for interaction
9	Displacements	2.2.9	Level δ_{N0}, $\delta_{N\infty}$, δ_{V0}, $\delta_{V\infty}$ [mm]
Basic Works Requirement 2: Safety in case of fire			
10	Reaction to fire	2.2.10	Class
11	Resistance to fire	2.2.11	Level $N_{Rk,s,fi}$ [kN], $N_{Rk,p,fi}$ [kN], $N_{Rk,b,fi}$ [kN], $N^g_{Rk,fi}$ [kN], $V_{Rk,s,fi}$ [kN], $M^0_{Rk,s,fi}$ [Nm], $c_{min,fi}$, $s_{min,fi}$, $c_{j,fi}$ [mm]
Aspects of durability			
12	Durability	EAD 330232-01-0601 [1], 2.2.11	Description

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.

Any relevant conditions about the test set-ups, based on the manufacturer's installation instructions (e.g., drilling technology, hole cleaning, installation tools, torque), shall be reported in the ETA.

2.2.1 Characteristic resistance to steel failure of a single screw anchor under tension loading

Purpose of the assessment

Determination of characteristic resistance to steel failure of a single screw anchor under tension loading.

Assessment method

Hydrogen embrittlement is tested and assessed in accordance with EAD 330232-01-0601 [1], 2.2.1.3. In EAD 330232-01-0601, Equation (2.2) the value for $N_{u,m}$ is taken from the reference tests in uncracked concrete with strength class C50/60.

For screws in masonry $N_{u,m}$ may be taken from reference tests in masonry in accordance with Table A.1.1, test series A1 (maximum $N_{u,m}$ of all test series A1). Because of the higher variation coefficient of failure loads in masonry the sustained load may be taken as follows: $N_{HE} = \min \{0{,}5\ N_{st,m}; 0{,}6\ N_{u,m}\}$. If during the constant load portion masonry failure occurs the test shall be repeated with base material with higher compressive strength or with screws with larger embedment depths.

Steel capacity $N_{Rk,s}$ is assessed in accordance with EAD 330232-01-0601 [1], 2.2.1.1.

Expression of results: $N_{Rk,s}$ [kN].

2.2.2 Characteristic resistance to steel failure of a single screw anchor under shear loading

Purpose of the assessment

Determination of characteristic resistance to steel failure of a single screw anchor under shear loading.

Assessment method

$V_{Rk,s}$ is assessed in accordance with EAD 330232-01-0601 [1], 2.2.7.1

$M^0_{Rk,S}$ is assessed in accordance with EAD 330232-01-0601 [1], 2.2.7.1

In case of steel failure in the tests A2 in accordance with Table A.1.1, $V_{Rk,s}$ (characteristic resistance of steel failure of the screw anchor) is calculated in accordance with following Equation:

$$V_{Rk,s} = 0{,}5 \cdot A_s \cdot f_{uk} \qquad (2.2.2.1)$$

with:
- A_s = decisive cross section of the screw anchor
- f_{uk} = nominal characteristic steel ultimate strength
- $f_{u,test}$ = steel ultimate strength at the time of testing ≥ f_{uk}.

Expression of results: $V_{Rk,s}$ [kN], $M^0_{Rk,s}$ [Nm].

2.2.3 Characteristic resistance to pull-out failure or brick breakout failure of a single screw anchor under tension loading

Purpose of the assessment

Determination of characteristic resistance to pull-out failure or brick breakout failure of a single screw anchor under tension loading.

Assessment method

1. Performance of tests

Tests are performed in accordance with Table A.1.1, test series A1 and A3 and in accordance with Table A.1.2, test series F1 to F7. Test details are given in Annex A:

- Install the screw anchor in accordance with A.3.
- Use test equipment in accordance with A.4, Example of test rig see Figure A.4.2
- Test procedure see A.5.1 and A.5.2 (for all tests), A.5.4 (for tests F3), A.5.5 (for tests F2), A.5.7 (for tests F4 and F5), A.5.8 (for tests F6 and F7)
- Prepare test report in accordance with A.6.

2. Assessment of functioning minimum interlock (test series F1 in accordance with Table A.1.2)

- Determine α in accordance with Equation (B.3.1)
- Determine reduction factor $\alpha_{2,1} = \alpha$ / 0,95
  If the calculated factor is greater than 1,0, then $\alpha_{2,1}$ = 1,0.

3. Assessment of functioning under repeated loading (test series F2 in accordance with Table A.1.2)

The increase of displacements during cycling shall stabilise in a manner indicating that failure is unlikely to occur after some additional cycles. This condition may be assumed as fulfilled if the displacements after cycling at max N of the test are smaller than the mean value of the displacements at overcoming loss of adhesion in the reference tests.

If the condition is not met, the test series shall be repeated with a reduced tension load max.$N_{p,red}$ until the condition is fulfilled.

- In case of reduced tension load: determine α_p = max.$N_{p,red}$ / max.N_p ≤ 1,0
- Determine α in accordance with Equation (B.3.1) for failure loads measured in the pull-out tests subsequent to the repeated loading
- Determine reduction factor $\alpha_{2,2} = \alpha$ / 1,0
  If the calculated factor is greater than 1,0, then $\alpha_{2,2}$ = 1,0.

4. Assessment of functioning in wet masonry (test series F3 in accordance with Table A.1.2)

- Determine α in accordance with Equation (B.3.1)
- Determine reduction factor $\alpha_{2,3} = \alpha$ / 0,8.
  If the calculated factor is greater than 1,0, then $\alpha_{2,3}$ = 1,0.

5. Assessment of maximum torque moment (test series F4 and F5 in accordance with Table A.1.2)

The tests are performed to check if failure occurs during setting (turn-through of the screw anchor), which would then reduce the performance of the screw anchor.

The tests may be omitted if the MPII specify setting with an impact screwdriver and/or a cordless screwdriver only.

The ultimate torque (T_u) and the 5%-fractile of the ultimate torque ($T_{u5\%}$) of the test series F4 and F5 shall be determined. The ratio of the maximum torque moment T_u during failure to the maximum torque moment max. T_{inst} given by the manufacturer shall be determined for every test of the test series. The 5 %-fractile of the ratio for all tests shall be at least 2,1. If the ratio is smaller than 2,1, then max. T_{inst} shall be reduced.

If no installation torque is specified by the manufacturer, max. T_{inst} shall be determined in all masonry units and joints in accordance with the specific intended use of the screw anchor, where max. T_{inst} is the maximum torque required to completely set the screw anchors in tests F5 in accordance with Table A.1.2.

6. Assessment of installation with impact screwdriver and cordless screwdriver (test series F6 and F7 in accordance with Table A.1.2)

The tests are performed to check if failure of the screw anchor occurs while setting with impact screwdrivers or cordless screwdrivers. In all 15 tests no failure shall occur. If failure occurs, the screw anchor may only be installed by a torque wrench with a maximum torque moment.

The tests may be omitted if the MPII do not allow setting with an impact screwdriver or a cordless screwdriver.

In cases when MPII allows for the use of impact installation tools but does not provide their exhaustive specification, the tests covering impact installation tools shall be omitted (relevant characteristics are not assessed) and for other tests defined "T_{inst}" applied by calibrated torque wrench shall be used."

7. Determination of characteristic resistance

The characteristic resistances of single screw anchors without spacing effects under tension loading shall be calculated as follows. Characteristic edge distances c_{cr} and minimum edge distances c_{min} and distance to joints c_j see 2.2.7.

$$N_{Rk,p} = N_{Rk,b} = N_{5\%,A1} \cdot \min(\alpha_1 ; \alpha_2; \alpha_p) \cdot \alpha_{V,N} \quad \text{for } c_{cr} = 1{,}5\ h_{nom} \text{ and } c_j = c_{j,test} \qquad (2.2.3.1)$$

$$N_{Rk,p,c} = N_{Rk,b,c} = N_{5\%,A3} \cdot \min(\alpha_1 ; \alpha_2; \alpha_p) \cdot \alpha_{V,N} \quad \text{for } c_{min} = c_{test} \text{ and } c_j = c_{j,test} \qquad (2.2.3.2)$$

with:

- $N_{Rk,p}$ = characteristic resistance of pull out failure of the screw anchor without edge effects
- $N_{Rk,b}$ = characteristic resistance of brick break out failure without edge effects
- $N_{Rk,p,c}$ = characteristic resistance of pull out failure of the screw anchor with edge effects
- $N_{Rk,b,c}$ = characteristic resistance of brick breakout failure with edge effects
- $N_{5\%,A1}$ = $F_{5\%}$ in accordance with B.1
  evaluated from the results of test series A1 in accordance with Table A.1.1
- $N_{5\%,A3}$ = $F_{5\%}$ in accordance with B.1
  evaluated from the results of test series A3 in accordance with Table A.1.1
- α_1 = minimum value α_1 in accordance with B.4,
  reduction factor from the load/displacement behaviour of all tests
- α_2 = min ($\alpha_{2,1}$; $\alpha_{2,2}$; $\alpha_{2,3}$)
  minimum reduction factor from the ultimate loads in the functioning tests F1 to F3 in accordance with Table A.1.2
  ($\alpha_{2,3}$ is only necessary for resistance of screw anchors intended to be installed in wet masonry)
- α_p = reduction factor from the applied loads in the functioning tests F2 in accordance with Table A.1.2
- $\alpha_{V,N}$ = minimum value α_V in accordance with Equations (B.2.1) or (B.2.2) and in accordance with 2.2.1, minimum reduction factor from the coefficient of variation of the ultimate loads in the functioning and basic tension tests.

The value of the characteristic resistance $N_{Rk,p}$, $N_{Rk,b}$, $N_{Rk,p,c}$, $N_{Rk,b,c}$ shall be rounded down to one decimal place.

8. Assessment of influence of joints in case of intended use with distance to joints < c_j

The joint factor $\alpha_{j,N}$ shall be calculated as follows:

$$\alpha_{j,N} = N_{um,A1j} / N_{um,A1} \leq 1{,}0 \qquad (2.2.3.3)$$

with:

- $\alpha_{j,N}$ = factor for influence of joints for screw anchor in joints or closer to the joints than joint distance c_j (see 2.2.7)
- $N_{um,A1}$ = mean value of failure loads evaluated from the results of test series A1 in accordance with Table A.1.1
- $N_{um,A1j}$ = mean value of failure loads evaluated from the results of test series A1j in accordance with Table A.1.1

Expression of results: $N_{Rk,p}$, $N_{Rk,b}$, $N_{Rk,p,c}$, $N_{Rk,b,c}$ [kN], $\alpha_{j,N}$ [-].

2.2.4 Characteristic resistance to local brick failure and brick edge failure of a single screw anchor under shear loading

Purpose of the assessment

Determination of characteristic resistance to local brick failure ($V_{Rk,b}$ – without influence of an edge) and brick edge failure ($V_{Rk,c}$ – without influence of an edge) of a single screw anchor under shear loading.

Assessment method

1. Performance of tests

Tests are performed in accordance with Table A.1.1, test series A2 and A4 and in accordance with Table A.1.2, test series F4 to F7.

Test details for test series A2 and A4 are given in Annex A.

- Install the screw anchor in accordance with A.3.
- Use test equipment in accordance with A.4, Example of test rig see Figure A.4.3
- Test procedure see A.5.1 and A.5.3
- Prepare test report in accordance with A.6.

Test details for test series F4-F7 are given in clause 2.2.3.

2. Assessment of maximum torque moment (test series F4 and F5 in accordance with Table A.1.2)

Assessment in accordance with clause 2.2.3/5

3. Assessment of installation with impact screwdriver and cordless screwdriver (test series F6 and F7 in accordance with Table A.1.2)

Assessment in accordance with clause 2.2.3/6

4. Determination of characteristic resistance

The characteristic resistances of single screw anchors without spacing effects under shear loading shall be calculated as follows. Characteristic edge distances c_{cr} and minimum edge distances c_{min} and distance to joints c_j (see 2.2.7 and Table A.1.1).

$$V_{Rk,b,II} = V_{5\%,A2II} \cdot \alpha_1 \cdot \alpha_{V,V} \quad \text{for } c_{cr} = 1{,}5\ h_{nom} \text{ and } c_j = c_{j,test} \qquad (2.2.4.1)$$

$$V_{Rk,b,\perp} = V_{5\%,A2\perp} \cdot \alpha_1 \cdot \alpha_{V,V} \quad \text{for } c_{cr} = 1{,}5\ h_{nom} \text{ and } c_j = c_{j,test} \qquad (2.2.4.2)$$

$$V_{Rk,c,II} = V_{5\%,A4,II} \cdot \alpha_1 \cdot \alpha_{V,V} \quad \text{for } c_{min} = c_{test} \qquad (2.2.4.3)$$

$$V_{Rk,c,\perp} = V_{5\%,A4,\perp} \cdot \alpha_1 \cdot \alpha_{V,V} \quad \text{for } c_{min} = c_{test} \qquad (2.2.4.4)$$

with:

$V_{Rk,b,II}$ = characteristic resistance of local brick failure without edge influence

$V_{Rk,b,\perp}$ = characteristic resistance of local brick failure without edge influence

$V_{Rk,c,II}$ = characteristic resistance of brick break out failure with edge influence under shear loading parallel to the edge

$V_{Rk,c,\perp}$ = characteristic resistance of brick break out failure with edge influence under shear loading perpendicular to the edge

$V_{5\%,A2II}$ = $F_{5\%}$ in accordance with B.1
evaluated from the results of test series A2II in accordance with Table A.1.1

$V_{5\%,A2\perp}$ = $F_{5\%}$ in accordance with B.1
evaluated from the results of test series A2⊥ in accordance with Table A.1.1

$V_{5\%,A4II}$ = $F_{5\%}$ in accordance with B.1
evaluated from the results of test series A4II in accordance with Table A.1.1 with shear loading parallel to the edge

$V_{5\%,A4\perp}$ = $F_{5\%}$ in accordance with B.1
evaluated from the results of test series A4⊥ in accordance with Table A.1.1 with shear loading perpendicular to the edge

α_1 = minimum value α_1 in accordance with B.4,
reduction factor from the load/displacement behaviour of all tests

$\alpha_{V,V}$ = minimum value α_V in accordance with Equation (B.2.2) minimum reduction factor from the coefficient of variation of the ultimate loads in the basic shear tests.

The value of the characteristic resistances $V_{Rk,b}$, $V_{Rk,c}$ shall be rounded down to one decimal place.

5. Assessment of influence of joints in case of intended use with distance to joints < c_j

The joint factor $\alpha_{j,VII}$ (shear loads parallel to the vertical joint) shall be calculated as follows:

$$\alpha_{j,VII} = V_{um,A2jII} / V_{um,A2II} \leq 1{,}0 \quad (2.2.4.5)$$

with:
- $\alpha_{j,VII}$ = factor for influence of joints for screw anchors in joints or closer to the joints than joint distance c_j (see 2.2.7)
- $V_{um,A2II}$ = mean value of failure loads evaluated from the results of test series A2II in accordance with Table A.1.1
- $V_{um,A2jII}$ = mean value of failure loads evaluated from the results of test series A2jII in accordance with Table A.1.1.

The joint factor $\alpha_{j,V\perp}$ (shear loads perpendicular to the vertical joint) shall be calculated as follows:

$$\alpha_{j,V\perp} = V_{um,A2j\perp} / V_{um,A2\perp} \leq 1{,}0 \quad (2.2.4.6)$$

with:
- $\alpha_{j,V\perp}$ = factor for influence of joints for screw anchors in joints or closer to the joints than joint distance c_j (see 2.2.7)
- $V_{um,A2\perp}$ = mean value of failure loads evaluated from the results of test series A2⊥ in accordance with Table A.1.1
- $V_{um,A2j\perp}$ = mean value of failure loads evaluated from the results of test series A2j⊥ in accordance with Table A.1.1.

Expression of results: $V_{Rk,b,II}$, $V_{Rk,b,\perp}$, $V_{Rk,c,II}$, $V_{Rk,c,\perp}$ [kN], $\alpha_{j,VII}$, $\alpha_{j,V\perp}$ [-].

2.2.5 Characteristic resistance to brick breakout failure of a screw anchor group under tension loading

Purpose of the assessment

Determination of characteristic resistance to brick breakout failure of a screw anchor group under tension loading.

Assessment method

In case of ($s_{min,II} \geq s_{cr} = 3\ h_{nom}$) and ($s_{min,\perp} \geq s_{cr} = 3\ h_{nom}$) and ($c_{min} \geq c_{cr} = 1{,}5\ h_{nom}$) for solid masonry or ($s_{min,II} \geq s_{cr} = l_{unit}$) and ($s_{min,\perp} \geq s_{cr} = h_{unit}$) and ($c_{min} \geq c_{cr} = 1{,}5\ h_{nom}$) for hollow or perforated masonry (see also 2.2.7) no tests are necessary. Under these conditions following group factors and characteristic resistances are given:

$$N_{Rk}^{g}\ (s_{cr}, c_{cr}) = \alpha_{g,N} \cdot N_{Rk,b} \quad (2.2.5.1)$$

with
- $\alpha_{g,N} = 2{,}0$ for double screw anchor groups
- $\alpha_{g,N} = 4{,}0$ for quadruple screw anchor groups
- $N_{Rk,b}$ in accordance with Equation (2.2.3.1).

In case of ($s_{min,II} < s_{cr} = 3\ h_{nom}$) or ($s_{min,\perp} < s_{cr} = 3\ h_{nom}$) or ($c_{min} < c_{cr} = 1{,}5\ h_{nom}$) for solid masonry or ($s_{min,II} < s_{cr} = l_{unit}$) or ($s_{min,\perp} < s_{cr} = h_{unit}$) or ($c_{min} < c_{cr} = 1{,}5\ h_{nom}$) for hollow or perforated masonry (see also 2.2.7), the following steps shall be taken.

1. Performance of tests

Tests are performed in accordance with Table A.1.1, test series A5. Test details are given in Annex A.

- Install the screw anchors in accordance with A.3.
- Use test equipment in accordance with A.4, Example of test rig see Figure A.4.1
- Test procedure see A.5.1 and A.5.2
- Prepare test report in accordance with A.6.

2. Determination of characteristic resistance of a screw anchor group

In accordance with the tested configuration the characteristic resistances of a screw anchor group under tension loading shall be calculated as follows. Minimum edge distances c_{min} and minimum spacing s_{min} see 2.2.7 and Figure 1.3.1.

Quadruple screw anchor group, $c_{min} = c_{test}$ and $s_{minII} = s_{II,test}$ and $s_{min\perp} = s_{\perp,test}$:

$$N_{Rk}^{g}\ (s_{minII}, s_{min\perp}) = N_{5\%,A5} \cdot \min(\alpha_1; \alpha_2; \alpha_p) \cdot \alpha_{V,N} \qquad (2.2.5.2)$$

Double screw anchor group, $c_{min} = c_{test}$ and $s_{minII} = s_{II,test}$:

$$N_{Rk}^{g}\ (s_{minII}) = N_{5\%,A5sII} \cdot \min(\alpha_1; \alpha_2; \alpha_p) \cdot \alpha_{V,N} \qquad (2.2.5.3)$$

Double screw anchor group, $c_{min} = c_{test}$ and $s_{min\perp} = s_{\perp,test}$:

$$N_{Rk}^{g}\ (s_{min\perp}) = N_{5\%,A5s\perp} \cdot \min(\alpha_1; \alpha_2; \alpha_p) \cdot \alpha_{V,N} \qquad (2.2.5.4)$$

with: N_{Rk}^{g} = characteristic resistance of the screw anchor group under tension loading

$N_{5\%,A5}$, $N_{5\%,A5sII}$, $N_{5\%,A5s\perp}$
= $F_{5\%}$ in accordance with B.1, evaluated from the results of test series A5, A5s_{II}, A5$s_{\perp}$ in accordance with Table A.1.1

α_1, α_2, α_p, $\alpha_{V,N}$ see 2.2.3.

If the characteristic resistance of a double screw anchor group exceeds twice $N_{Rk,b,c}$ (in accordance with Equation (2.2.3.2), then N_{Rk}^{g} = 2 $N_{Rk,b,c}$. If the characteristic resistance of a quadruple screw anchor group exceeds four times $N_{Rk,b,c}$ (in accordance with Equation (2.2.3.2), then N_{Rk}^{g} = 4 $N_{Rk,b,c}$.

The value of the characteristic resistance N_{Rk}^{g} shall be rounded down one decimal place.

3. Determination of group factors

The characteristic resistance of the tested screw anchor group may be transferred to screw anchor groups of screw anchors with smaller sizes and smaller characteristic resistance of the single screw anchors with the same edge distances and spacings in the same base material by using group factors.

Depending on the tested configuration the group factor shall be calculated as follows:

Quadruple screw anchor group, $c_{min} = c_{test}$, $s_{minII} = s_{II,test}$, $s_{min\perp} = s_{\perp,test}$

$$\alpha_{g,N}\ (s_{minII}, s_{min\perp}) = \min((N_{um,A5} / N_{um,A3})\ ;\ (N_{5\%,A5} / N_{5\%,A3})) \qquad (2.2.5.5)$$

Double screw anchor group, $c_{min} = c_{test}$, $s_{minII} = s_{II,test}$

$$\alpha_{g,N}\ (s_{minII}) = \min((N_{um,A5sII} / N_{um,A3})\ ;\ (N_{5\%,A5sII} / N_{5\%,A3})) \qquad (2.2.5.6)$$

Double screw anchor group, $c_{min} = c_{test}$, $s_{min\perp} = s_{\perp,test}$

$$\alpha_{g,N}\ (s_{min\perp}) = \min((N_{um,A5s\perp} / N_{um,A3})\ ;\ (N_{5\%,A5s\perp} / N_{5\%,A3})) \qquad (2.2.5.7)$$

with: $N_{um,A5}$, $N_{um,A5sII}$, $N_{um,A5s\perp}$
= mean failure load in test series A5, A5s_{II}, A5$s_{\perp}$ in accordance with Table A.1.1

$N_{5\%,A5}$, $N_{5\%,A5sII}$, $N_{5\%,A5s\perp}$
= $F_{5\%}$ in accordance with B.1, evaluated from the results of test series A5, A5s_{II}, A5$s_{\perp}$ in accordance with Table A.1.1

$N_{um,A3}$ = mean failure load in the reference test series A3 in accordance with Table A.1.1

$N_{5\%,A3}$ = $F_{5\%}$ in accordance with B.1, evaluated from reference test series A3 in accordance with Table A.1.1

$\alpha_{g,N}$ = group factor for quadruple screw anchor groups

$\alpha_{g,N}$ (s_{minII}) = group factor for double screw anchor groups parallel to the horizontal joint

$\alpha_{g,N}$ ($s_{min\perp}$) = group factor for double screw anchor groups perpendicular to the horizontal joint.

The group factor shall be rounded to steps of 0,05.

If the group factor of a double screw anchor group exceeds 2,0, then α_g = 2,0.

If the group factor of a quadruple screw anchor group exceeds 4,0, then $\alpha_g = 4,0$.

4. Determination of characteristic resistance of a screw anchor group by using group factors

The characteristic resistances of a double or quadruple screw anchor group under tension loading shall be calculated as follows:

$$N_{Rk}^{g} = \alpha_{g,N} \cdot N_{Rk,b,c} \qquad (2.2.5.8)$$

with: N_{Rk}^{g} = characteristic resistance of the screw anchor group under tension loading

$N_{Rk,b,c}$ = in accordance with Equation (2.2.3.2)

$\alpha_{g,N}$ = in accordance with Equations (2.2.5.5) to (2.2.5.7).

The value of the characteristic resistance N_{Rk}^{g} shall be rounded down to one decimal place.

Expression of results: N_{Rk}^{g} [kN], $\alpha_{g,N}$ [-] depending on the tested configuration e.g.,:

Quadruple screw anchor group: N_{Rk}^{g} (s_{cr}, c_{cr}), N_{Rk}^{g} (s_{minII}, $s_{min\perp}$) [kN], $\alpha_{g,N}$ (s_{minII}, $s_{min\perp}$)[-]

Double screw anchor group: N_{Rk}^{g} (s_{cr}, c_{cr}), N_{Rk}^{g} (s_{minII}), N_{Rk}^{g} ($s_{min\perp}$) [kN], $\alpha_{g,N}$ (s_{minII}), $\alpha_{g,N}$ ($s_{min\perp}$) [-].

For a schematic step-by-step procedure for assessing these characteristics see Figure 2.2.5.1.

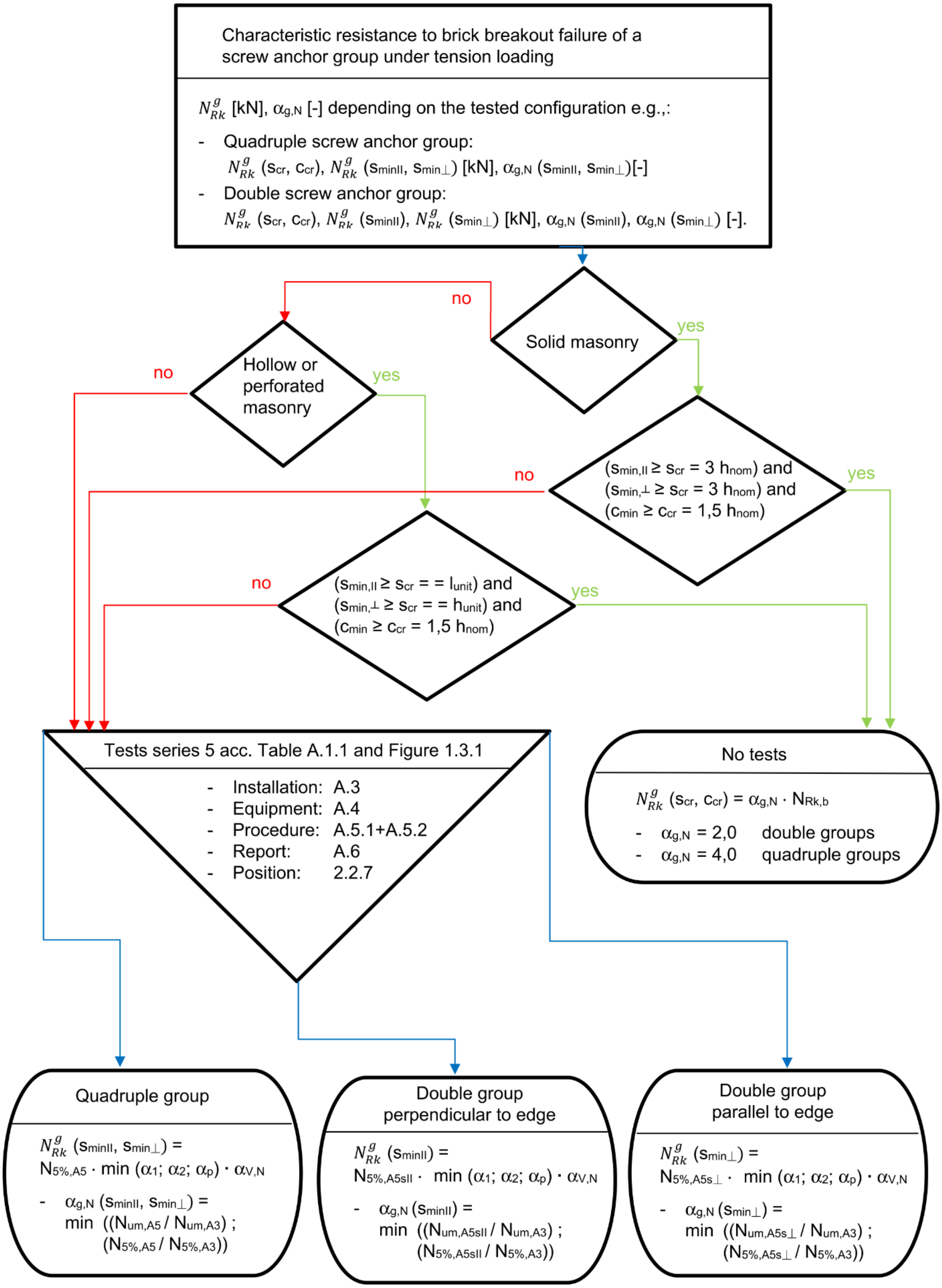


Figure 2.2.5.1: Schematic step-by-step procedure for assessing the characteristic resistance to brick breakout failure of a screw anchor group under tension loading

2.2.6 Characteristic resistance to local brick failure and brick edge failure of a screw anchor group under shear loading

Purpose of the assessment

Determination of characteristic resistance to brick breakout failure of a screw anchor group under shear loading.

Assessment method

In case of ($s_{minII} \geq s_{cr} = 3\ h_{nom}$) and ($s_{min\perp} \geq s_{cr} = 3\ h_{nom}$) and ($c_{min} \geq c_{cr} = 1{,}5\ h_{nom}$) for solid masonry or ($s_{minII} \geq s_{cr} = l_{unit}$) and ($s_{min\perp} \geq s_{cr} = h_{unit}$) and ($c_{min} \geq c_{cr} = 1{,}5\ h_{nom}$) for hollow or perforated masonry (see also 2.2.7) no tests are necessary. Under these conditions following group factors and characteristic resistances are given:

$$V^{g}_{Rk,b,II}\ (s_{cr}, c_{cr}) = \alpha_{g,VII} \cdot V_{Rk,b,II} \quad (2.2.6.1)$$

$$V^{g}_{Rk,b,\perp}\ (s_{cr}, c_{cr}) = \alpha_{g,V\perp} \cdot V_{Rk,b,\perp} \quad (2.2.6.2)$$

with: $V_{Rk,b,II}$ in accordance with Equation (2.2.4.1)

$V_{Rk,b,\perp}$ in accordance with Equation (2.2.4.2)

$\alpha_{g,V,II} = \alpha_{g,V,\perp} = 2{,}0$ for double screw anchor groups

$\alpha_{g,V,II} = \alpha_{g,V,\perp} = 4{,}0$ for quadruple screw anchor groups.

In case of ($s_{minII} < s_{cr} = 3\ h_{nom}$) or ($s_{min\perp} < s_{cr} = 3\ h_{nom}$) or ($c_{min} < c_{cr} = 1{,}5\ h_{nom}$) for solid masonry or ($s_{minII} < s_{cr} = l_{unit}$) or ($s_{min\perp} < s_{cr} = h_{unit}$) or ($c_{min} < c_{cr} = 1{,}5\ h_{nom}$) for hollow or perforated masonry (see also 2.2.7).

1. Performance of tests

Tests are performed in accordance with Table A.1.1, test series A6. Test details are given in Annex A.

- Install the screw anchors in accordance with A.3.
- Use test equipment in accordance with A.4, Example of test rig see Figure A.4.3
- Test procedure see A.5.1 and A.5.3
- Prepare test report in accordance with A.6.

2. Determination of characteristic resistance of a screw anchor group

In accordance with the tested configuration the characteristic resistances of a screw anchor group under shear loading shall be calculated as follows. Minimum edge distances c_{min} and minimum spacing s_{min} see 2.2.7 and Figure 1.3.1.

Shear load parallel to the edge:

Quadruple screw anchor group, $c_{min} = c_{test}$ and $s_{minII} = s_{II,test}$ and $s_{min\perp} = s_{\perp,test}$:

$$V^{g}_{Rk,c,II}(s_{minII}, s_{min\perp}) = V_{5\%,A6II} \cdot \alpha_1 \cdot \alpha_{V,V} \quad (2.2.6.3)$$

Double screw anchor group, $c_{min} = c_{test}$ and $s_{minII} = s_{II,test}$:

$$V^{g}_{Rk,c,II}\ (s_{minII}) = V_{5\%,A6IIsII} \cdot \alpha_1 \cdot \alpha_{V,N} \quad (2.2.6.4)$$

Double screw anchor group, $c_{min} = c_{test}$ and $s_{min\perp} = s_{\perp,test}$:

$$V^{g}_{Rk,c,II}\ (s_{min\perp}) = V_{5\%,A6IIs\perp} \cdot \alpha_1 \cdot \alpha_{V,N} \quad (2.2.6.5)$$

Shear load perpendicular to the edge:

Quadruple screw anchor group, $c_{min} = c_{test}$ and $s_{minII} = s_{II,test}$ and $s_{min\perp} = s_{\perp,test}$:

$$V^{g}_{Rk,c,\perp}(s_{minII}, s_{min\perp}) = V_{5\%,A6\perp} \cdot \alpha_1 \cdot \alpha_{V,V} \quad (2.2.6.6)$$

Double screw anchor group, $c_{min} = c_{test}$ and $s_{minII} = s_{II,test}$:

$$V^{g}_{Rk,c,\perp}\ (s_{minII}) = V_{5\%,A6\perp sII} \cdot \alpha_1 \cdot \alpha_{V,N} \quad (2.2.6.7)$$

Double screw anchor group, $c_{min} = c_{test}$ and $s_{min\perp} = s_{\perp,test}$:

$$V^{g}_{Rk,c,\perp}\ (s_{min\perp}) = V_{5\%,\ A6\perp s\perp} \cdot \alpha_1 \cdot \alpha_{V,N} \quad (2.2.6.8)$$

with: $V^{g}_{Rk,c,II}$ = characteristic resistance of the screw anchor group under shear loading parallel to the edge

$V^{g}_{Rk,c,\perp}$ = characteristic resistance of the screw anchor group under shear loading perpendicular to the edge

$V_{5\%,A6II}$, $V_{5\%,A6IIsII}$, $V_{5\%,A6IIs\perp}$

= $F_{5\%}$ in accordance with B.1, evaluated from the results of test series A6II, $A6IIs_{II}$, $A6IIs_{\perp}$ in accordance with Table A.1.1

$V_{5\%,A6\perp}$, $V_{5\%,A6\perp sII}$, $V_{5\%,A6\perp s\perp}$

= $F_{5\%}$ in accordance with B.1, evaluated from the results of test series A6⊥ $A6\perp s_{II}$, $A6\perp s_{\perp}$ in accordance with Table A.1.1

α_1, $\alpha_{V,V}$ see 2.2.4.

If the characteristic resistance of a double screw anchor group exceeds twice $V_{Rk,c,II}$ (in accordance with Equation (2.2.4.3), then $V^{g}_{Rk,c,II}$ = 2 $V_{Rk,c,II}$. If the characteristic resistance of a quadruple screw anchor group exceeds four times $V_{Rk,c,II}$ (in accordance with Equation (2.2.4.3), then $V^{g}_{Rk,c,II}$ = 4 $V_{Rk,c,II}$..

If the characteristic resistance of a double screw anchor group exceeds twice $V_{Rk,c,\perp}$ (in accordance with Equation (2.2.4.4), then $V^{g}_{Rk,c,\perp}$ = 2 $V_{Rk,c,\perp}$. If the characteristic resistance of a quadruple screw anchor group exceeds four times $V_{Rk,c,\perp}$ (in accordance with Equation (2.2.4.4), then $V^{g}_{Rk,c,\perp}$ = 4 $V_{Rk,c,\perp}$.

The value of the characteristic resistances $V^{g}_{Rk,c,II}$ and $V^{g}_{Rk,c,\perp}$ shall be rounded down to one decimal place.

3. <u>Determination of group factors</u>

The characteristic resistance of the tested screw anchor group may be transferred to screw anchor groups of screw anchors with smaller sizes and smaller characteristic resistance of the single screw anchor with the same edge distances and spacings in the same base material by using group factors.

Depending on the tested configuration the group factor shall be calculated as follows.

Shear load parallel to the edge:

Quadruple screw anchor group, $c_{min} = c_{test}$, $s_{minII} = s_{II,test}$, $s_{min\perp} = s_{\perp,test}$

$$\alpha_{g,VII} (s_{minII}, s_{min\perp}) = \min ((V_{um,A6II} / V_{um,A4II}) ; (V_{5\%,A6II} / V_{5\%,A4II})) \quad (2.2.6.9)$$

Double screw anchor group, $c_{min} = c_{test}$, $s_{minII} = s_{II,test}$

$$\alpha_{g,VII} (s_{minII}) = \min ((V_{um,A6IIsII} / V_{um,A4II}) ; (V_{5\%,A6IIsII} / V_{5\%,A4II})) \quad (2.2.6.10)$$

Double screw anchor group, $c_{min} = c_{test}$, $s_{min\perp} = s_{\perp,test}$

$$\alpha_{g,VII} (s_{min\perp}) = \min ((V_{um,A6IIs\perp} / V_{um,A4II}) ; (V_{5\%,A6IIs\perp} / V_{5\%,A4II})) \quad (2.2.6.11)$$

Shear load perpendicular to the edge:

Quadruple screw anchor group, $c_{min} = c_{test}$, $s_{min,II} = s_{II,test}$, $s_{min\perp} = s_{\perp,test}$

$$\alpha_{g,V\perp} (s_{minII}, s_{min\perp}) = \min ((V_{um,A6\perp} / V_{um,A4\perp}) ; (V_{5\%,A6\perp} / V_{5\%,A4\perp})) \quad (2.2.6.12)$$

Double screw anchor group, $c_{min} = c_{test}$, $s_{minII} = s_{II,test}$

$$\alpha_{g,V\perp} (s_{minII}) = \min ((V_{um,A6\perp sII} / V_{um,A4\perp}) ; (V_{5\%,A6\perp sII} / V_{5\%,A4\perp})) \quad (2.2.6.13)$$

Double screw anchor group, $c_{min} = c_{test}$, $s_{min\perp} = s_{\perp,test}$

$$\alpha_{g,V\perp} (s_{min\perp}) = \min ((V_{um,A6\perp s\perp} / V_{um,A4\perp}) ; (V_{5\%,A6\perp s\perp} / V_{5\%,A4\perp})) \quad (2.2.6.14)$$

with: $V_{um,A6II}$, $V_{um,A6IIsII}$, $V_{um,A6IIs\perp}$

= mean failure load in test series A6II, $A6IIs_{II}$, $A6IIs_{\perp}$ in accordance with Table A.1.1

$V_{5\%,A6II}$, $V_{5\%,A6IIsII}$, $V_{5\%,A6IIs\perp}$

= $F_{5\%}$ in accordance with B.1, evaluated from test series A6II, $A6IIs_{II}$, $A6IIs_{\perp}$ in accordance with Table A.1.1

$V_{um,A6\perp}$, $V_{um,A6\perp sII}$, $V_{um,A6\perp s\perp}$

= mean failure load in test series A6⊥, $A6\perp s_{II}$, $A6\perp s_{\perp}$ in accordance with Table A.1.1

$V_{5\%,A6\perp}$, $V_{5\%,A6\perp sII}$, $V_{5\%,A6\perp s\perp}$

= $F_{5\%}$ in accordance with B.1, evaluated from test series A6⊥, A6⊥s_{II}, A6⊥$s_{\perp}$ in accordance with Table A.1.1

$V_{um,A4II}$ = mean failure load in the reference test series A4II in accordance with Table A.1.1

$V_{5\%,A4II}$ = $F_{5\%}$ in accordance with B.1, evaluated from reference test series A4II in accordance with Table A.1.1

$V_{um,A4\perp}$ = mean failure load in the reference test series A4⊥ in accordance with Table A.1.1

$V_{5\%,A4\perp}$ = $F_{5\%}$ in accordance with B.1, evaluated from reference test series A,⊥ in accordance with Table A.1.1

$\alpha_{g,VII}$ = group factor for quadruple screw anchor groups, shear loading parallel to the edge

$\alpha_{g,V\perp}$ = group factor for quadruple screw anchor groups, shear loading perpendicular to the edge

$\alpha_{g,VII}$ (s_{minII}) = group factor for double screw anchor groups parallel to the horizontal joint, shear loading parallel to the edge

$\alpha_{g,V\perp}$ (s_{minII}) = group factor for double screw anchor groups parallel to the horizontal joint, shear loading perpendicular to the edge

$\alpha_{g,VII}$ ($s_{min\perp}$) = group factor for double screw anchor groups perpendicular to the horizontal joint, shear loading parallel to the edge

$\alpha_{g,V\perp}$ ($s_{min\perp}$) = group factor for double screw anchor groups perpendicular to the horizontal joint, shear loading perpendicular to the edge.

The group factor shall be rounded to steps of 0,05.

If the group factor of a double screw anchor group exceeds 2,0, then α_g = 2,0.

If the group factor of a quadruple screw anchor group exceeds 4,0, then α_g = 4,0.

4. <u>Determination of characteristic resistance of a screw anchor group by using group factors</u>

The characteristic resistances of a double or quadruple screw anchor group under shear loading shall be calculated as follows:

$$V_{Rk,c,II}^{g} = \alpha_{g,V} \cdot V_{Rk,c,II} \quad (2.2.6.15)$$

$$V_{Rk,c,\perp}^{g} = \alpha_{g,V} \cdot V_{Rk,c,\perp} \quad (2.2.6.16)$$

with: $V_{Rk,c,II}^{g}$ = characteristic resistance of the screw anchor group under shear loading parallel to the edge

$V_{Rk,c,\perp}^{g}$ = characteristic resistance of the screw anchor group under shear loading perpendicular to the edge

$V_{Rk,c,II}$ = in accordance with Equation (2.2.4.3)

$V_{Rk,c,\perp}$ = in accordance with Equation (2.2.4.4)

$\alpha_{g,V}$ = in accordance with Equation (2.2.6.9) to (2.2.6.11) depending on the tested configuration

$\alpha_{g,V}$ = in accordance with Equation (2.2.6.12) to (2.2.6.13) depending on the tested configuration.

The value of the characteristic resistances $V_{Rk,c,II}^{g}$ and $V_{Rk,c,\perp}^{g}$ shall be rounded down to one decimal place.

<u>Expression of results:</u> $V_{Rk,b,II}^{g}$, $V_{Rk,b,\perp}^{g}$, $V_{Rk,c,II}^{g}$ $V_{Rk,c,\perp}^{g}$ [kN] $\alpha_{g,VII}$, $\alpha_{g,V\perp}$ [-] depending on the tested configuration e.g.,:

Quadruple screw anchor group:

$V_{Rk,b,II}^{g}$ (s_{cr}, c_{cr}), $V_{Rk,b,\perp}^{g}$, (s_{cr}, c_{cr}), $V_{Rk,c,II}^{g}$ (s_{minII}, $s_{min\perp}$), $V_{Rk,c,\perp}^{g}$(s_{minII}, $s_{min\perp}$) [kN],

$\alpha_{g,VII}$ (s_{minII}, $s_{min\perp}$), $\alpha_{g,V\perp}$ (s_{minII}, $s_{min\perp}$)[-]

Double screw anchor group:

$V_{Rk,b,II}^{g}$ (s_{cr}, c_{cr}), $V_{Rk,b,\perp}^{g}$, (s_{cr}, c_{cr}), $V_{Rk,c,II}^{g}$ (s_{minII}), $V_{Rk,c,II}^{g}$ ($s_{min\perp}$), $V_{Rk,c,\perp}^{g}$ (s_{minII}), $V_{Rk,c,\perp}^{g}$ ($s_{min\perp}$), [kN]

$\alpha_{g,VII}$ (s_{minII}), $\alpha_{g,VII}$ ($s_{min\perp}$), $\alpha_{g,V\perp}$ (s_{minII}), $\alpha_{g,V\perp}$ ($s_{min\perp}$) [-].

2.2.7 Edge distances, joint distance, spacing, member thickness

Purpose of the assessment

Determination of edge distances, spacing and member thickness and distance to joints for which the characteristic resistances in accordance with 2.2.3 to 2.2.6 are given.

Assessment method

Characteristic edge distances (standard values) for single screw anchors are: $c_{cr} = 1{,}5\ h_{nom}$

Characteristic spacing (standard values) for single screw anchors are:

- For tests in solid units in walls: $s_{cr} = 3{,}0\ h_{nom}$
- For tests in solid units in single bricks with $l_{unit} < 3{,}0\ h_{nom}$ or $h_{unit} < 3{,}0\ h_{nom}$:
  $s_{cr,II} = l_{unit}$ (s_{cr} II horizontal joint),
  $s_{cr,\perp} = h_{unit}$ (s_{cr} ⊥ horizontal joint)
- For tests in hollow or perforated units: $s_{cr,II} = l_{unit}$ (s_{cr} II horizontal joint),
  $s_{cr,\perp} = h_{unit}$ (s_{cr} ⊥ horizontal joint).

The minimum edge distance c_{min} and minimum spacing $s_{min,II}$ and $s_{min,\perp}$ are based on the manufacturer's instructions. These values are assessed by test series A3 to A6 in accordance with Table A.1.1 in connection with the relevant characteristic resistances in accordance with 2.2.3, 2.2.4, 2.2.5 and 2.2.6.

The spacing s_{min} shall be greater than the following values:

- Anchorages in solid masonry and AAC: $s_{min} \geq \max(50\text{ mm}; 3\ d_0)$
- Anchorages in hollow or perforated masonry: $s_{min} \geq \max(75\text{ mm}; 5\ d_0)$.

In absence of manufacturer's instructions $c_{min} = c_{cr}$ and $s_{min} = s_{cr}$.

Member thickness h_{min} is specified by the manufacturer. In absence of manufacturer's specification $h_{min} = 80$ mm.

Edge distances c_{min} and c_{cr} for $V_{Rk,c,\perp}$ are also valid for joints which are not to be filled with mortar.

The distances to joints without influence of joints $c_{j,II}$, $c_{j,\perp}$ are based on the manufacturer's instructions and result from tested distances to joints in test series A1, A2, A5 and A6 in accordance with Table A.1.1 in connection with the relevant characteristic resistances in accordance with 2.2.3, 2.2.4, 2.2.5 and 2.2.6. In absence of manufacturer's specification $c_{j,II} = c_{j,\perp} = c_{cr}$.

Expression of results: c_{cr}, s_{cr}, c_{min}, $s_{min,II}$, $s_{min,\perp}$, h_{min}, $c_{j,II}$, $c_{j,\perp}$ [mm].

2.2.8 Resistance to combined tension and shear loading (hollow and perforated bricks)

Purpose of the assessment

Determination of resistance to combined tension and shear loading (hollow and perforated bricks).

Assessment method

In hollow and perforated bricks resistance to combined tension and shear load shall be tested.

Tests in accordance with test series A7 in accordance with Table A.1.1 are performed and the value X is assessed as follows:

$$N_{um,A7} = F_{um,A7} \cdot \sin \beta \qquad (2.2.8.1)$$

$$V_{um,A7} = F_{um,A7} \cdot \cos \beta \qquad (2.2.8.2)$$

$$\frac{N_{um,A7}}{N_{um,A1}} + \frac{V_{um,A7}}{V_{um,A2}} = X_H \qquad (2.2.8.3)$$

For $X_H \geq 1{,}0$: $X = 1{,}0$

For $X_H < 1{,}0$: $X = X_H$

with:

$F_{um,A7}$ = mean value of failure load of tests A7 in accordance with Table A.1.1

$N_{um,A7}$ = mean value of tension load from the failure load of tests A7 in accordance with Table A.1.1

$V_{um,A7}$ = mean value of shear load from the failure load of tests A7 in accordance with Table A.1.1

β = angle in tests A7 in accordance with Table A.1.1

$N_{um,A1}$ = mean value of failure loads in the reference tests A1 in accordance with Table A.1.1

$V_{um,A2}$ = mean value of failure loads in the reference tests A2 in accordance with Table A.1.1

X = limit value in a trilinear function for combined tension and shear loads.

Expression of results: Limit value X [-] for interaction.

2.2.9 Displacements

Purpose of the assessment

Determination of displacements of the screw anchor under tension and shear loading.

Assessment method

As a minimum, the displacements under short-term and long-term tension and shear loadings shall be given in the European Technical Assessment for a tension or shear load F which corresponds to the value in accordance with following Equation:

$$F = \frac{F_{Rk}}{\gamma_F \cdot \gamma_M} \qquad (2.2.9.1)$$

with:

F_{Rk} = characteristic resistance N_{Rk} or V_{Rk} in accordance with 2.2.3 or 2.2.4

γ_F = 1,4

γ_M = 2,0 for use in masonry made of autoclaved aerated concrete bricks

= 2,5 for use in all other kinds of bricks
in accordance with

The displacements under short-term tension loading (δ_{N0}) are evaluated from the tests with single screw anchors without edge or spacing effects in accordance with Table A.1.1, test series A1. The displacements under short-term tension loading are calculated as 95 %-fractile of the measured displacements at the load F for a confidence level of 90 %.

The long-term tension loading displacements $\delta_{N\infty}$ may be assumed to be equal to 2,0 times the value δ_{NO}.

The displacements under short-term shear loading (δ_{VO}) are evaluated from the corresponding shear tests with single screw anchors without edge or spacing effects in accordance with Table A1.1.1, test series A2II and A2⊥. The displacements under short-term shear loading are calculated as 95 %-fractile of the measured displacements at the load F for a confidence level of 90 %. The maximum value resulting from tests series A2II and A2⊥ is decisive for determination of δ_{V0}. The maximum value regardless direction shall be presented in the ETA.

The long-term shear loading displacements $\delta_{V\infty}$ may be assumed to be equal to 1,5 times the value δ_{VO}.

Under shear loading, the displacements might increase due to a gap between fixture and screw anchor. Therefore, in the ETA shall be stated clearly if this gap has been taken into account in the assessment.

Expression of results: δ_{N0}, $\delta_{N\infty}$, δ_{V0}, $\delta_{V\infty}$ [mm].

2.2.10 Reaction to fire

The screw anchor as defined in clause 1.1 is considered to satisfy the requirements of class A1 of the reaction-to-fire performance in accordance with the Commission Decision 96/603/EC, as amended by Commission Decisions 2000/605/EC and 2003/424/EC, without the need for testing on the basis of its fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

Therefore, when the conditions referred to above are fulfilled, the performance of the product is class A1.

2.2.11 Resistance to fire

Purpose of the assessment

Determination of resistance to fire of the screw anchor under tension and shear loading.

Assessment method

Fire resistance of the screw anchor shall be assessed in accordance with EAD 330232-01-0601 [1], with the following amendment: The screw anchor shall not be installed in concrete but it shall be installed at the unfavourable setting position in the brick which gives the lowest characteristic resistance.

Test duration in at least one test shall be greater than the resulting duration of fire resistance.

Tests in sand-lime bricks and clay bricks can be evaluated together if at least 3 tests are available in each stone, assuming that the loads and failure times are approximately the same.

All values of the characteristic resistances shall be rounded down to one decimal place.

Steel failure under tension loading:

Fire resistance to steel failure under tension loading shall be tested and assessed in accordance with EAD 330232-01-0601 [1], 2.2.17.

Tests may be omitted if resistance to steel failure is calculated in accordance with EN 1992-4 [17], Annex D.4.2.1.

$N_{Rk,s,fi}$ is determined in accordance with [1], Equation (2.34).

Pull-out failure:

If in tests pull-out failure occurs, $N_{Rk,p,fi}$ is assessed in accordance with EAD 330232-01-0601 [1], 2.2.17 with following amendment:

- σ_s shall be replaced by N_p
- $\sigma_{Rk,s}$ shall be replaced by $N_{Rk,p}$
- $\sigma_{Rk,s,fi}$ shall be replaced by $N_{Rk,p,fi}$.

If no pull-out failure occurs: $N_{Rk,p,fi} = N_{Rk,s,fi}$ or $N_{Rk,p,fi} = N_{Rk,b,fi}$ (depending on the failure mode in tests).

If no tests are performed, $N_{Rk,p,fi}$ is calculated in accordance with following Equations:

$$N_{Rk,p,fi(90)} = 0{,}7 \cdot 0{,}25 \cdot N_{Rk,p} \quad \text{for } c_{min,fi} = c_{j,fi} = 2\ h_{nom} \qquad (2.2.11.1)$$

$$N_{Rk,p,fi(120)} = 0{,}7 \cdot 0{,}2 \cdot N_{Rk,p} \quad \text{for } c_{min,fi} = c_{j,fi} = 2\ h_{nom} \qquad (2.2.11.2)$$

with: $N_{Rk,p}$ = characteristic resistance of pull-out failure in accordance with 2.2.3

Note: The factor 0,7 considers cracks in masonry during fire exposure up to 0,3 mm.

Brick breakout failure

If in tests brick breakout failure occurs, $N_{Rk,b,fi}$ is assessed in accordance with EAD 330232-01-0601 [1], 2.2.17 with following amendment:

- σ_s shall be replaced by N_p
- $\sigma_{Rk,s}$ shall be replaced by $N_{Rk,b}$
- $\sigma_{Rk,s,fi}$ shall be replaced by $N_{Rk,b,fi}$

If no brick breakout failure occurs: $N_{Rk,b,fi} = N_{Rk,s,fi}$ or $N_{Rk,b,fi} = N_{Rk,p,fi}$ (depending on the failure mode in tests). If no tests are performed, $N_{Rk,b,fi}$ is calculated in accordance with following Equations:

$$N_{Rk,b,fi(90)} = 0{,}7 \cdot N_{Rk,b} \cdot h_{ef}/200 \quad \text{for } c_{min,fi} = c_{j,fi} = 2\ h_{nom} \qquad (2.2.11.3)$$

$$N_{Rk,b,fi(120)} = 0{,}7 \cdot 0{,}8 \cdot N_{Rk,b} \cdot h_{ef}/200 \quad \text{for } c_{min,fi} = c_{j,fi} = 2\ h_{nom} \qquad (2.2.11.4)$$

with: $N_{Rk,b}$ = characteristic resistance of brick breakout failure in accordance with 2.2.3.

If no tests are performed, $N^g_{Rk,fi}$ is calculated in accordance with following Equations:

$$N^g_{Rk,fi(90)} = 0{,}7 \cdot N^g_{Rk} \cdot h_{ef}/200 \quad \text{for } s_{min,fi} = s_{min} \cdot 4/3,\ c_{min,fi} = c_{j,fi} = 2\ h_{nom} \qquad (2.2.11.5)$$

$$N^g_{Rk,fi(120)} = 0{,}7 \cdot 0{,}8 \cdot N^g_{Rk} \cdot h_{ef}/200 \quad \text{for } s_{min,fi} = s_{min} \cdot 4/3,\ c_{min,fi} = c_{j,fi} = 2\ h_{nom} \qquad (2.2.11.6)$$

with: N^g_{Rk} = characteristic resistance of brick breakout failure in accordance with 2.2.5

Note: The factor 0,7 considers cracks in masonry during fire exposure up to 0,3 mm.

Steel failure under shear loading

Fire resistance to steel failure under shear loading shall be tested and assessed in accordance with EAD 330232-01-0601 [1], 2.2.19.

$V_{Rk,s,fi}$ is determined in accordance with [1], Equation (2.35).

$M^0_{Rk,s,fi}$ is determined in accordance with [1], Equation (2.36).

The ultimate strength of screw anchors at fire exposure under tension load may be used for shear load as a conservative assumption. In this case the tests in this section may be omitted.

Edge distance and spacing

If in the test no splitting occurs, following minimum edge distances and spacing and joint distances may be assumed for the tested screw anchors and the tested bricks (defined by compression strength and geometry):

$s_{min,fi} = s_{min,test,fi}$, $c_{min,fi} = c_{min,test,fi}$, $c_{j,fi} = c_{j,test,fi}$

If characteristic resistances are calculated, the edge distances, spacing and joint distances are given in Equations (2.2.11.1) to (2.2.11.6).

In all other cases (also when transferring results to other screw anchor or bricks):

$s_{min,fi} = 4\ h_{nom}$, $c_{min,fi} = c_{j,fi} = 2\ h_{nom}$.

Expression of results: $N_{Rk,s,fi}$, $N_{Rk,p,fi}$, $N_{Rk,b,fi}$, $N^g_{Rk,b,fi}$, $V_{Rk,s,fi}$ [kN], $M^0_{Rk,s,fi}$ [Nm], $c_{min,fi}$, $s_{min,fi}$, $c_{j,fi}$ [mm].

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System 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 97/177/EC.

The system is 1.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the screw anchor for use in masonry 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) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Dimensions (outer diameter, inner diameter, thread length, etc.)	Calliper and/or gauge	Laid down in control plan	3	Every manufacturing batch or 100.000 elements or when raw material batch has been changed (The lower control interval is decisive)
2	Tensile Load or tensile strength	EN ISO 6892-1 [7], EN ISO 898-1 [8], EN ISO 3506-1 [3]		3	
3	Yield strength			3	
4	Zinc plating (where relevant)	x-ray measurement in accordance with EN ISO 3497 [9], magnetic method in accordance with EN ISO 2178 [12], Phase-sensitive eddy-current method in accordance with EN ISO 21968 [13]		3	
5	Fracture elongation A_5 (where relevant)	EN ISO 6892-1 [7] EN ISO 898-1 [8]		3	

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 screw anchor for use in masonry 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	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 screw anchor.	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	In accordance with Control plan	In accordance with 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	In accordance with Control plan	In accordance with Control plan	**1**/year

4 REFERENCE DOCUMENTS

[1] EAD 330232-01-0601	Mechanical fasteners for use in concrete
[2]	Specification for masonry units
EN 771-1:2011+A1:2015	Part 1: Clay masonry units
EN 771-2:2011+A1:2015	Part 2: Calcium silicate masonry units
EN 771-3:2011+A1:2015	Part 3: Aggregate concrete masonry units (Dense and lightweight aggregates)
EN 771-4:2011+A1:2015	Part 4: Autoclaved aerated concrete masonry units
[3] 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
[4] EN 772-1:2011+A1:2015	Methods of test for masonry units - Part 1: Determination of compressive strength
[5] EN 1996-1-1:2022	Design of masonry structures. Part 1-1: General rules for reinforced and unreinforced masonry structure
[6] EN 772-13:2000	Methods of test for masonry units - Part 13: Determination of net and gross dry density of masonry units
[7] EN ISO 6892-1:2019	Metallic materials - Tensile testing - Part 1: Method of test at room temperature
[8] EN ISO 898-1:2013/AC2013	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
[9] EN ISO 3497:2000	Metallic coatings - Measurement of coating thickness - X-ray spectrometric methods
[10] EN 1998-1:2004/A1:2013	Eurocode 8: Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings
[11] EOTA TR 054:2022-04	Design methods for anchorages with metal injection anchors and screws for use in masonry
[12] EN ISO 2178:2016	Non-magnetic coatings on magnetic substrates - Measurement of coating thickness - Magnetic method
[13] EN ISO 21968:2019	Non-magnetic metallic coatings on metallic and non-metallic basis materials - Measurement of coating thickness - Phase-sensitive eddy-current method
[14] ISO 5468:2017	Rotary and rotary impact masonry drill bits with hard metal tips - Dimensions
[15] EN 998-2:2016	Specification for mortar for masonry – Part 2: Masonry mortar
[16] EAD 330011-00-0601	Adjustable concrete screws
[17] EN 1992-4:2018	Design of concrete structures — Part 4: Design of fastenings for use in concrete
[18] EN 206:2013+A2:2021	Concrete: Specification, performance, production and conformity

ANNEX A: TEST PROGRAMME AND TEST DETAILS

A.1 Test programme

The test programme for the assessment consists of

- Basic tension tests and basic shear tests to assess basic values of characteristic resistance (see Table A.1.1) and
- Any other tests (functioning tests) to assess the characteristic resistance regarding various effects for the relevant application range in accordance with the intended use (see Table A.1.2).

If nothing else stated, all tests are performed in all bricks in accordance with the specific intended use of the screw anchor. If the intended use includes setting positions in joints or near joints of masonry, tests are also performed in the joints or near joints of masonry. If the intended use includes joints not filled with mortar, tests are also performed in the joints or near joints not filled with mortar of masonry.

Table A.1.1: Basic tests for screw anchors for use in masonry for each screw anchor size

	Purpose of test	Load direction	Distances (3) (5) (12)	Remarks, Tests with Example	Number of tests	Test details Assessment
A1	Resistance for tension loading not influenced by edge, spacing and joint effects $N_{Rk,p} = N_{Rk,b}$ test position in accordance with Figure 1.3.1	N	$c_{test} \geq c_{cr}$ $s_{test} \geq s_{cr}$ $c_{jII,test} = c_{jII}$ $c_{j\perp,test} = c_{j\perp}$	single screw anchors	5	A.5.2 2.2.3
A1j	Resistance for tension loading influenced by joint effects (5) $\alpha_{j,N} \cdot N_{Rk}$ test position in accordance with Figure 1.3.2	N	$c_{test} \geq c_{cr}$ $s_{test} \geq s_{cr}$ $c_{jII,test} < c_{jII}$ $c_{j\perp,test} < c_{j\perp}$	single screw anchors in joints or near joints e.g., Figure A.5.2.2	5	A.5.2 2.2.3
A2II	Resistance for shear loading parallel to the vertical joint not influenced by edge, spacing and joint effects (4) $V_{Rk,b,II}$ test position in accordance with Figure 1.3.1	V_{II}	$c_{test} = c_{cr}$ $s_{test} \geq s_{cr}$ $c_{jII,test} = c_{jII}$ $c_{j\perp,test} = c_{j\perp}$	single screw anchors	5	A.5.3 2.2.4
A2jII	Resistance for shear loading parallel to the vertical joint influenced by joint effects (4) (5) $\alpha_{j,V,II} \cdot V_{Rk,b,II}$ test position in accordance with Figure 1.3.2	V_{II}	$c_{test} = c_{cr}$ $s_{test} \geq s_{cr}$ $c_{jII,test} < c_{jII}$ $c_{j\perp,test} < c_{j\perp}$	single screw anchors in joints or near joints	5	A.5.3 2.2.4

	Purpose of test	Load direction	Distances (3) (5) (12)	Remarks, Tests with Example	Number of tests	Test details Assessment
A2⊥	Resistance for shear loading perpendicular to the vertical joint not influenced by edge, spacing and joint effects $V_{Rk,b,\perp}$ test position in accordance with Figure 1.3.1	$V_{\perp}$	$c_{test} = c_{cr}$ $s_{test} \geq s_{cr}$ $c_{jII,test} = c_{jII}$ $c_{j\perp,test} = c_{j\perp}$	single screw anchors	5	A.5.3 2.2.4
A2j⊥	Resistance for shear loading perpendicular to the vertical joint influenced by joint effects (1) (5) $\alpha_{j,V,\perp} \cdot V_{Rk,b,\perp}$ test position in accordance with Figure 1.3.2	$V_{\perp}$	$c_{test} = c_{cr}$ $s_{test} \geq s_{cr}$ $c_{jII,test} < c_{jII}$ $c_{,\perp,test} < c_{j\perp}$	single screw anchors in joints or near joints	5	A.5.3 2.2.4
A3	Resistance for tension loading at minimum edge distance (1) $N_{Rk,p,c} = N_{Rk,b,c}$ test position in accordance with Figure 1.3.1	N	$c_{test} = c_{min}$ $s_{test} \geq s_{cr}$	single screw anchors at the edge of test member e.g., Figure A.5.2.1	5	A.5.2 2.2.3
A4II	Resistance for shear loading parallel to the edge at minimum edge distance (1) (4) $V_{Rk,c,II}$ test position in accordance with Figure 1.3.1	V_{II}	$c_{test} = c_{min}$ $s_{test} \geq s_{cr}$	single screw anchors at the edge of test member e.g., Figure A.5.3.2	5	A.5.3 2.2.4
A4⊥	Resistance for shear loading perpendicular to the edge at minimum edge distance (1) $V_{Rk,c,\perp}$ test position in accordance with Figure 1.3.1	$V_{\perp}$	$c_{test} = c_{min}$ $s_{test} \geq s_{cr}$	single screw anchors at the edge of test member e.g., Figure A.5.3.3	5	A.5.3 2.2.4
A5	Resistance for tension loading at minimum spacing not influenced by joint effects (2) (9) N^{g}_{Rk} (s_{minII}, $s_{min\perp}$), $\alpha_{g,N}$ (s_{minII}, $s_{min\perp}$) test position in accordance with Figure 1.3.1	N	$s_{II,test} = s_{minII}$ $s_{\perp,test} = s_{min\perp}$ $c_{test} = c_{min}$	quadruple screw anchor group at the edge of test member e.g., Figure A.5.2.6	5	A.5.2 2.2.5
A5s_{II}	Resistance for tension loading at minimum spacing not influenced by joint effects (2) (6) N^{g}_{Rk} (s_{minII}), $\alpha_{g,N}$ (s_{minII}) test position in accordance with Figure 1.3.1	N	$s_{II,test} = s_{minII}$ $c_{test} = c_{min}$	double screw anchor group at the edge of test member e.g., Figure A.5.2.7	5	A.5.2 2.2.5

	Purpose of test	Load direction	Distances (3) (5) (12)	Remarks, Tests with Example	Number of tests	Test details Assessment
A5s⊥	Resistance for tension loading at minimum spacing not influenced by joint effects (2) N^g_{Rk} ($s_{min\perp}$), $\alpha_{g,N}$ ($s_{min\perp}$) test position in accordance with Figure 1.3.1	N	$s_{\perp,test} = s_{min\perp}$ $c_{test} = c_{min}$	double screw anchor group at the edge of test member	5	A.5.2 2.2.5
A6II	Resistance for shear loading parallel to the edge at minimum spacing not influenced by joint effects (2) (4) (10) $V^g_{Rk,II}$ (s_{minII}, $s_{min\perp}$), $\alpha_{g,VII}$ (s_{minII}, $s_{min\perp}$) test position in accordance with Figure 1.3.1	V_{II}	$s_{II,test} = s_{minII}$ $s_{\perp,test} = s_{min\perp}$ $c_{test} = c_{min}$	quadruple screw anchor group at the edge of test member	5	A.5.3 2.2.6
A6II s⊥	Resistance for shear loading parallel to the edge at minimum spacing not influenced by joint effects (2) (7) $V^g_{Rk,II}$ ($s_{min\perp}$) ; $\alpha_{g,VII}$ ($s_{min\perp}$) test position in accordance with Figure 1.3.1	V_{II}	$s_{\perp,test} = s_{min\perp}$ $c_{test} = c_{min}$	double screw anchor group at the edge of test member	5	A.5.3 2.2.6
A6II sII	Resistance for shear loading parallel to the edge at minimum spacing not influenced by joint effects (2) (8) $V^g_{Rk,II}$ (s_{minII}) ; $\alpha_{g,VII}$ (s_{minII}) test position in accordance with Figure 1.3.1	V_{II}	$s_{II,test} = s_{minII}$ $c_{test} = c_{min}$	double screw anchor group at the edge of test member	5	A.5.3 2.2.6
A6⊥	Resistance for shear loading perpendicular to the edge at minimum spacing not influenced by joint effects (2) (11) $V^g_{Rk,\perp}$ (s_{minII}, $s_{min\perp}$), $\alpha_{g,V\perp}$ (s_{minII}, $s_{min\perp}$) test position in accordance with Figure 1.3.1	$V_{\perp}$	$s_{II,test} = s_{minII}$ $s_{\perp,test} = s_{min\perp}$ $c_{test} = c_{min}$	quadruple screw anchor group at the edge of test member	5	A.5.3 2.2.6
A6⊥ s⊥	Resistance for shear loading perpendicular to the edge at minimum spacing not influenced by joint effects (2) $V^g_{Rk,\perp}$ ($s_{min\perp}$) ; $\alpha_{g,V\perp}$ ($s_{min\perp}$) test position in accordance with Figure 1.3.1	$V_{\perp}$	$s_{\perp,test} = s_{min\perp}$ $c_{test} = c_{min}$	double screw anchor group at the edge of test member	5	A.5.3 2.2.6

	Purpose of test	Load direction	Distances (3) (5) (12)	Remarks, Tests with Example	Number of tests	Test details Assessment
A6⊥ s_{II}	Resistance for shear loading perpendicular to the edge at minimum spacing not influenced by joint effects (2) $V^g_{Rk,\perp}$ (s_{minII}) ; $\alpha_{g,V\perp}$ (s_{minII}) test position in accordance with Figure 1.3.1	$V_\perp$	$s_{II,test} = s_{minII}$ $c_{test} = c_{min}$	double screw anchor group at the edge of test member	5	A.5.3 2.2.6
A7	Interaction (hollow and perforated masonry)	F with angle β	$c_{test} = c_{cr}$ $s_{test} \geq s_{cr}$	single screw anchors	5	A.5.6 2.2.8

Footnotes to Table A.1.1:

(1) Tests may be omitted, if minimum edge distances c_{min} is not smaller than the standard value c_{cr}

(2) Tests may be omitted, if minimum spacing s_{min} is not smaller than the standard values s_{cr}.

(3) Characteristic edge distances, characteristic spacing, minimum edge distances, minimum spacing, distance to joints see 2.2.7.

(4) Tests may be omitted if $V_{Rk,II} = V_{Rk,\perp}$

(5) Distance to joints $c_{j,test}$ at unfavourable setting position (in joints with maximum joint width wj or near joints / without mortar if intended to be used)

(6) Tests may be omitted, if $N^g_{Rk}(s_{minII}) = N^g_{Rk}(s_{min\perp})$, $\alpha_{g,N}(s_{minII}) = \alpha_{g,N}(s_{min\perp})$.

(7) Tests may be omitted, if $V^g_{Rk,II}(s_{min\perp}) = V^g_{Rk,\perp}(s_{min\perp})$, $\alpha_{g,VII}(s_{min\perp}) = \alpha_{g,V\perp}(s_{min\perp})$

(8) Tests may be omitted, if $V^g_{Rk,II}(s_{minII}) = V^g_{Rk,\perp}(s_{minII})$, $\alpha_{g,VII}(s_{minII}) = \alpha_{g,V\perp}(s_{minII})$

(9) Tests may be omitted, if resistance is calculated from double screw anchor groups with
$N^g_{Rk}(s_{minII}, s_{min\perp}) = N^g_{Rk}(s_{minII}) \cdot N^g_{Rk}(s_{min\perp})$ and $\alpha_{g,N}(s_{minII}, s_{min\perp}) = \alpha_{g,N}(s_{minII}) \cdot \alpha_{g,N}(s_{min\perp})$

(10) Tests may be omitted, if resistance is calculated from double screw anchor groups with
$V^g_{Rk,II}(s_{minII}, s_{min\perp}) = V^g_{Rk,II}(s_{min\perp}) \cdot V^g_{Rk,II}(s_{minII})$ and $\alpha_{g,VII}(s_{minII}, s_{min\perp}) = \alpha_{g,VII}(s_{min\perp}) \cdot \alpha_{g,VII}(s_{minII})$

(11) Tests may be omitted, if resistance is calculated from double screw anchor groups with
$V^g_{Rk,\perp}(s_{minII}, s_{min\perp}) = V^g_{Rk,\perp}(s_{min\perp}) \cdot V^g_{Rk,\perp}(s_{minII})$ and $\alpha_{g,V\perp}(s_{minII}, s_{min\perp}) = \alpha_{g,V\perp}(s_{min\perp}) \cdot \alpha_{g,V\perp}(s_{minII})$.

(12) Distances see also Figure 1.3.1 and 1.3.2

Table A.1.2: Functioning tests for screw anchors to be used in masonry

	Purpose of test	Screw anchor size	Masonry, bricks (5)	Minimum number of tests for each size	Criteria req. α	Test details Assessment
F1	Functioning minimum interlock, $d_{cut,max}$ and min d (4)	all	all	5	≥ 0,95	A.5.2 2.2.3
F2	Functioning under repeated loads $d_{cut,m}$	medium	all	5	≥ 1,0	A.5.2 A.5.5 2.2.3
F3	Functioning in wet masonry, (without cleaning) $d_{cut,m}$ (3)	Min, medium, large	Solid clay, calcium silicate, AAC	5	≥ 0,8	A.5.2 A.5.4 2.2.3
F4	maximum torque moment, $d_{cut,max}$ (1)	all	all	10	-	A.5.7 2.2.3
F5	maximum torque moment $d_{cut,min}$ in high strength material, maximum interlock alternatively in C50/60 (1)	all	all	10	-	A.5.7 2.2.3
F6	Impact screwdriver or cordless screwdriver, $d_{cut,max}$ (2)	all	all	15	-	A.5.8 2.2.3
F7	Impact screwdriver or cordless screwdriver, $d_{cut,min}$ in high strength material, alternatively in C50/60 (2)	all	all	15	-	A.5.8 2.2.3
F8	Hydrogen induces embrittlement	all	In accordance with 2.2.1	5	≥ 0,9	In accordance with 2.2.1

Footnotes to Table A.1.2:

(1) The tests may be omitted if the MPII specify setting with an impact screwdriver or a cordless screwdriver only.

(2) The tests may be omitted if the MPII specify setting without an impact screwdriver and without a cordless screwdriver.

(3) Only for intended use: installation in wet masonry

(4) If an economic production of screw anchor with min d for tests is not possible, screw anchor with nominal diameter d may be used and the diameter of the drill bit for the cylindrical hole d_0 is determined as for concrete screws in accordance with EAD 330232-01-0601 [1], 2.2.4.1.

(5) For solid masonry: test of smallest size and smallest compressive strength of the unit.

A.2 Test members

The tests shall be performed in single units or in a wall. For small masonry bricks, where splitting of brick could occur, tests in a wall shall be chosenand for large masonry bricks and blocks with $c_{min} \geq 1,5\ h_{nom}$ test in single bricks shall be chosen. Default test members for masonry units are given in Table 1.2.1.1. If the intended use according to the MPII differs from the default test members, the type of brick according to the intended use shall be chosen in addition, unless default brick is explicitly excluded by MPII.

If tests are done in a wall, the thickness of the joints shall be about 10 mm and the joints shall be completely filled with mortar of strength class M2.5 with a strength ≤ 5 N/mm². If tests are performed with a mortar strength greater than M2.5 then the minimum mortar strength shall be given in the European Technical Assessment. The units for test members of AAC may be glued together.

If tests are performed in joints, the thickness of the joint and the mortar strength, in which the screw anchor is tested, shall be given in the ETA.

The walls may be lightly pre-stressed (about 0,2 N/mm² compressive pre-stressing) in the vertical direction to improve handling and transportation of the wall. The pre-stressing force should be applied in the quarter points of the wall in order to achieve a uniform distribution of stress in the wall.

If the tests are carried out in single units, the single units may also be lightly pre-stressed (about 0,2 N/mm² compressive pre-stressing).

All tests shall be carried out in the base material (brick or joint) for which the screw anchor is intended to be used. All tests are carried out with test members with h_{min} in accordance with 2.2.7, except tests in AAC. Test series A1 and A2 in AAC are only performed with h_{min}, if no tests A3 to A6 are performed.

The tests shall be carried out at the most unfavourable setting position in the brick, which gives the lowest resistance of the screw anchor. If also screw anchors in joints are intended to be used, setting positions in joints have to be considered (see also Figure 1.3.1).

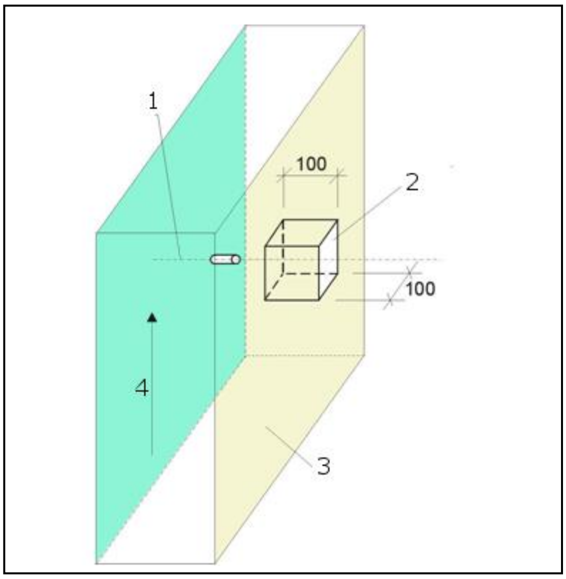
<u>Samples AAC:</u>

At the time of testing the autoclaved aerated concrete (AAC) test specimens shall meet the following conditions:

Low strength AAC:	mean dry density:	$\rho_m \geq 350$ kg/m³
	mean compressive strength:	f_{mean} = 1,8 to 2,8 N/mm²
High strength AAC:	mean dry density:	$\rho_m \geq 650$ kg/m³
	mean compressive strength:	f_{mean} = 6,5 to 8,0 N/mm².

Samples (cubes/cylinders) are taken from the test specimen for determination of the material characteristics (see Figure A.2.1). Cube: 100 x 100 x 100 mm; Cylinder: diameter 100 mm, height 100 mm.

The sample for determination of the material characteristic shall be taken from the same height as the position of the screw anchor relating to the direction of rise of the aerated concrete specimen, because the strength differs depending on the height of the direction of rise.



1 Position of screw anchor

2 Sample (cube)

3 Test specimen

4 Direction of rise

Dimensions in mm

Figure A.2.1: Taking of samples for autoclaved aerated concrete (AAC)

Material characteristics AAC:

For determination of the material characteristics the following conditions apply:

Test specimens shall be taken from each batch (cycle of production) on delivery from the manufacturing plant and from each pallet on delivery from the retailer. Test specimens shall always be taken from series production. The direction of rise shall be discernible on the test specimen.

At the beginning of testing the test specimens shall be at least 4 weeks old. The moisture content of the concrete during the time of testing shall be ≤ 30 M% measured on the sample (cube/cylinder) or AAC block. The test specimens shall be stored in the test laboratory or under comparable conditions such that air can gain access on all sides. The clear distance between test specimens and from the floor shall be at least 50 mm.

Determination of the material characteristics (compressive strength, dry density) and moisture content is always carried out on the sample (cube/cylinder) or an AAC block. The characteristics shall be determined on at least 5 samples (cube/cylinder) or blocks. The compressive strength shall be determined as the mean value. Testing of the compressive strength is performed in the direction of screw anchor setting (see Figure A.2.1).

A.3 Screw anchor installation

The screw anchors shall be installed in accordance with the installation instruction supplied by the manufacturer, unless explicitly required differently for a specific test. Torque shall be applied to the screw anchor by a torque wrench having traceable calibration. The measuring error shall not exceed 5 % of the applied torque throughout the whole measurement range.

The holes for screw anchors shall be perpendicular (± 5° deviation) to the surface of the member.

In the tests, the drilling tools and the type of drilling specified by the manufacturer shall be used. A drilling machine with a reasonable mass shall be used.

If the ETA is to cover more than one drilling technique, then tests where drilling has an influence shall be carried out for all drilling techniques.

If hard metal hammer-drill bits are required, these bits shall meet the requirements of the standards (e.g., ISO 5468 [14]) with regard to dimensional accuracy, symmetry, symmetry of insert tip, height of tip and tolerance on concentricity.

The diameter of the cutting edges as a function of the nominal drill bit diameter is given in Figure A.3.1. Table A.1.2 specify the required cutting diameter of drill bits ($d_{cut,min}$, $d_{cut,max}$, $d_{cut,m}$) for the functioning test series. For basic tests in accordance with Table A.1.1 the cutting diameter is $d_{cut,m}$.

The diameter of the drill bit shall be checked every 10 drilling operations to ensure continued compliance.

Table A.3.1: Tolerances of cutting diameter of hard metal hammer drill bits

d_{nom}	$d_{cut,min}$		$d_{cut,m}$		$d_{cut.max}$	
	from	to	from	to	from	to
5	5,05	5,15	5,20	5,30	5,35	5,40
6	6,05	6,15	6,20	6,30	6,35	6,40
7	7,05	7,20	7,25	7,35	7,40	7,45
8	8,05	8,20	8,25	8,35	8,40	8,45
10	10,05	10,20	10,25	10,35	10,40	10,45
11	11,10	11,20	11,25	11,35	11,45	11,50
12	12,10	12,20	12,25	12,35	12,45	12,50
13	13,10	13,20	13,25	13,35	13,45	13,50
14	14,10	14,20	14,25	14,35	14,45	14,50
15	15,10	15,20	15,25	15,35	15,45	15,50
16	16,10	16,20	16,25	16,35	16,45	16,50
18	18,10	18,20	18,25	18,35	18,45	18,50
19	19,10	19,20	19,30	19,40	19,50	19,55
20	20,10	20,20	20,30	20,40	20,50	20,55
22	22,10	22,20	22,30	22,40	22,50	22,55
24	24,10	24,20	24,30	24,40	24,50	24,55
25	25,10	25,20	25,30	25,40	25,50	25,55
28	28,10	28,20	28,30	28,40	28,50	28,55
30	30,10	30,20	30,30	30,40	30,50	30,55
32	32,15	32,25	32,35	32,50	32,60	32,70
34	34,15	34,25	34,35	34,50	34,60	34,70
35	35,15	35,25	35,35	35,50	35,60	35,70
37	37,15	37,25	37,35	37,50	37,60	37,70
40	40,15	40,25	40,40	40,60	40,70	40,80
44	44,15	44,25	44,40	44,60	44,70	44,80
48	48,15	48,25	48,40	48,60	48,70	48,80
52	52,15	52,25	52,40	52,60	52,80	52,95

For adjustable screw anchors following setting processes are defined for tension test series.

Setting process SP1 describes the representative setting process with n_a adjustments as requested by the manufacturer. For adjustable screw anchors the screw anchor is set in accordance with EAD 330011-00-0601 [16], 2.2.1, Setting process SP1 for all test series in accordance with this EAD, Table A.1.1 and Table A.1.2 with exception of test series F1 in accordance with Table A.1.2.

To check the sensitivity to a deviation from this procedure, setting process SP2 is accounted for in the assessment with two additional adjustments (n_a + 2). For adjustable screw anchors the screw anchor is set in accordance with EAD 330011-00-0601 [16], 2.2.1, Setting process SP2 for test series F1 in accordance with this EAD, Table A.1.2.

A.4 Test equipment

Tests shall be carried out using measuring equipment having traceable calibration. The load application equipment shall be designed to avoid any sudden increase in load especially at the beginning of the test. The measuring error of the load shall not exceed 2 % throughout the whole measuring range.

Displacements shall be recorded continuously (e.g., by means of displacement electrical transducers) with a measuring error not greater than 0,02 mm.

In tests an unrestricted formation of the rupture cone of the base material shall be obtained. For this reason, the clear distance between the support reaction and a screw anchor shall be at least 2 h_{nom} (tension test) or 2 c_1 (shear tests with edge influence). In shear tests without edge influence where steel failure is expected, the clear distance may be less than 2 c_1.

During tension tests the load shall be applied concentrically to the screw anchor. To achieve this, hinges shall be incorporated between the loading device and the screw anchor or between the loading device and fixture (tests with double screw anchor groups).

In shear tests the load shall be applied parallel to the surface of the base material. The height of the fixture shall be approximately equal to the outside diameter of the screw anchor. To reduce friction, smooth sheets (e.g., PTFE) with a maximum thickness of 2 mm shall be placed between the fixture and the test member.

For shear tests the hole clearance is defined as the difference between the diameter of the clearance hole in the fixture d_f and the relevant diameter of the screw anchor d_r (d_r is shown in Figure A.4.1). The relevant diameter of the screw anchor d_r may be the diameter of the shaft d_s (see Figure A.4.1 a), c) and e)), the diameter of the threaded head (see Figure A.4.1 d)) or the diameter of the thicker portion right below the head, if this thicker portion bears against the fixture for at least 0,5 t_{fix} (see Figure b)).

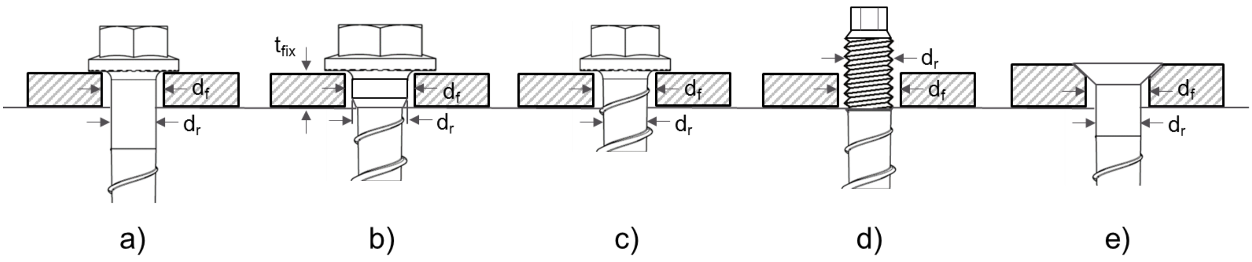


Figure A.4.1: Clearance hole for screw anchors

During shear tests the load shall be applied such that pull-out failure of the screw anchor or pry out failure is also covered. To achieve this, hinges shall be incorporated between the loading device and the fixture.

In torque tests the torque moment during installation until failure is measured. For this a calibrated torque moment transducer with a measuring error < 3 % throughout the whole measuring range shall be used.

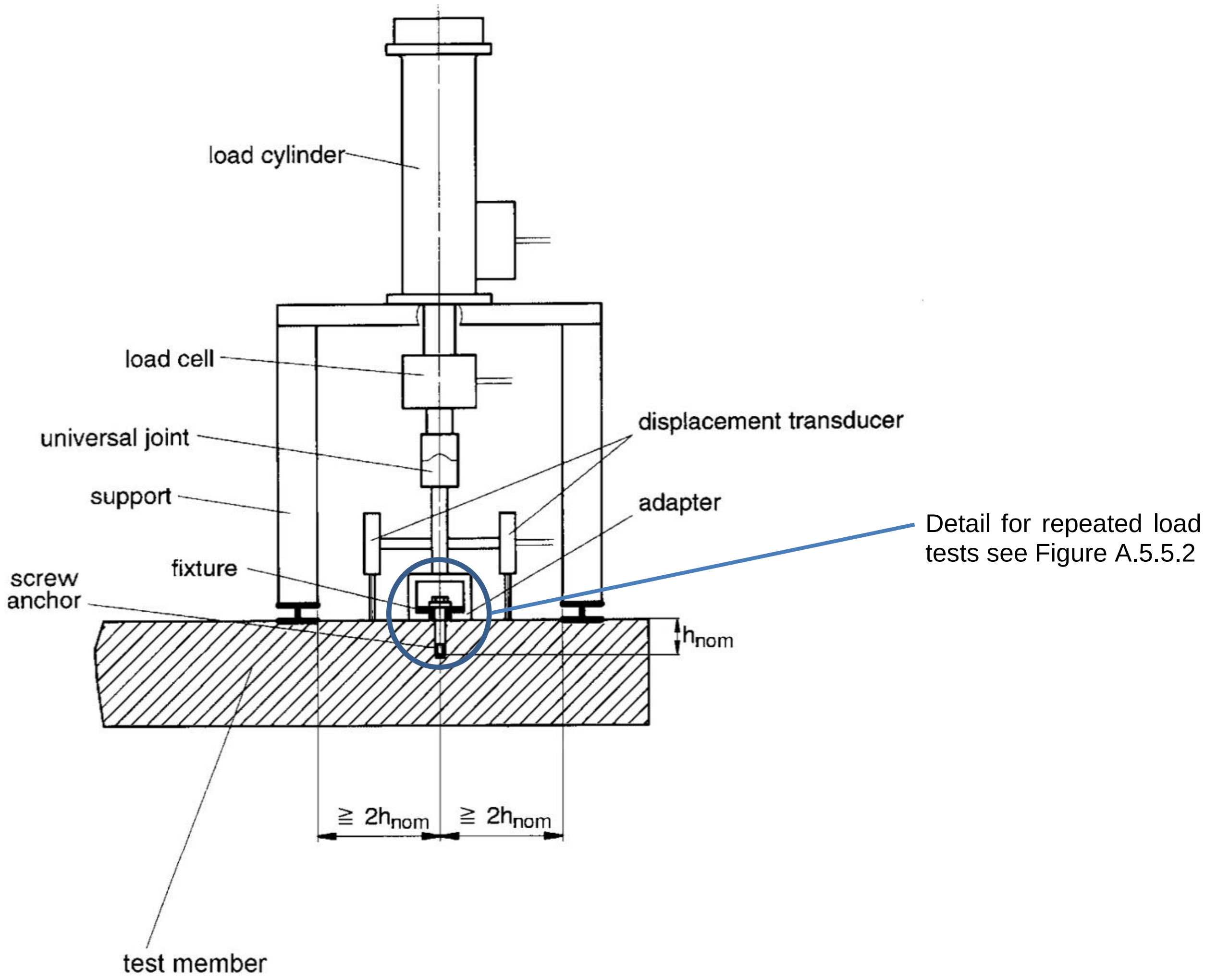
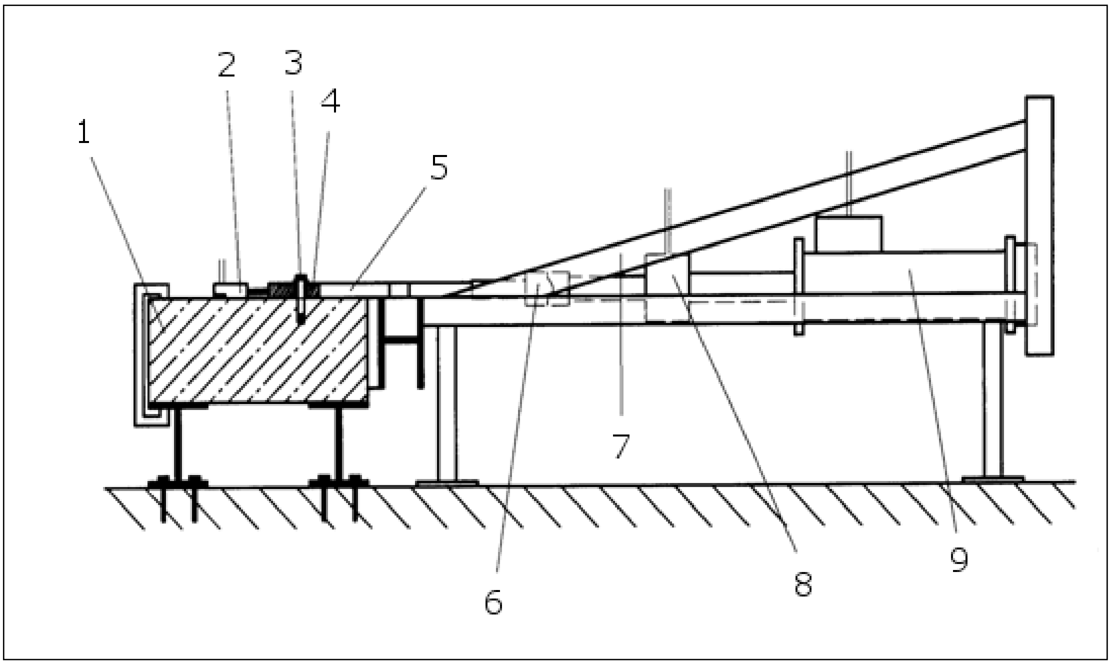
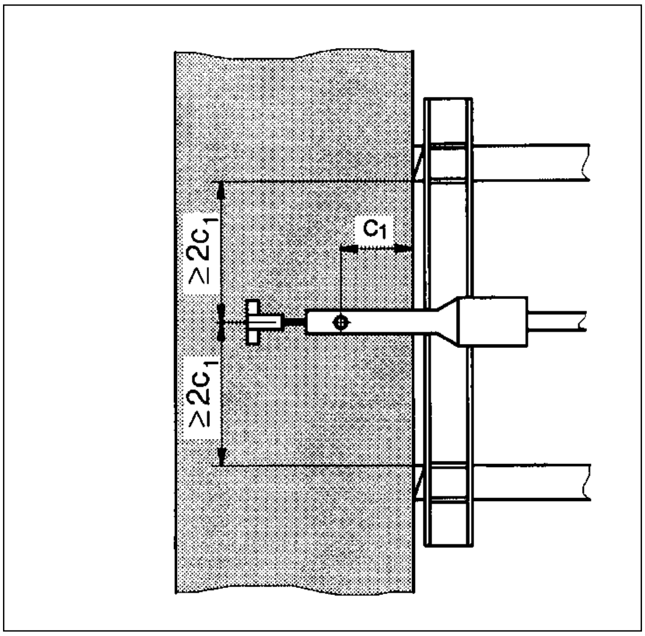


Figure A.4.2: Example of a tension test rig





1 Test member

2 Displacement transducer

3 Screw anchor

4 Fixture

5 Loading plate

6 Universal joint

7 Support

8 Load cell

Figure A.4.3: Example of a shear test rig (tests perpendicular to the edge of masonry)

A.5 Test procedure

A.5.1 General

The tests shall be carried out in the base material for which the screw anchor is intended to be used at normal ambient temperature (+21 °C ± 3 °C). The tests shall be carried out at the most unfavourable setting position in the brick, which give the lowest characteristic resistance of the screw anchor.

For all tests the load shall be increased in such a way that the peak load occurs after 1 to 3 minutes from commencement. Load and displacement shall be recorded either continuously or at least in about 100 intervals (up to peak load). The tests shall be carried out with displacement control. In case of displacement control, the test shall be continued after the maximum load up to at least 75 % of the maximum load to be measured (to allow the drop of the displacement curve).

A.5.2 Tension test

After installation, the screw anchor is connected to the test rig and loaded to failure. The displacements of the screw anchor relative to the surface of the test member shall be measured by use of either one displacement transducer on the socket of the test rig or at least two displacement transducers on either side (unconfined test: at a distance of ≥ 2,0 h_{nom} from the screw anchor); the mean value shall be recorded in the latter case.

The screw anchors of a screw anchor group shall be connected by a rigid fixture. The tension load shall be applied centrally to the fixture. The connection between the fixture and the load jack shall be hinged to permit differential screw anchor displacement to occur.

When testing screw anchors at the free edge of a test member, the test rig shall be placed such that an unrestricted failure towards the edge is possible (Distance between supporting bars shall be greater than height of masonry unit, supporting bars shall not expose masonry to any extreme contact pressure, height of masonry unit shall be greater than diameter of the cone). It can be necessary to support the test rig outside the test member.

Figure A.5.2.1: Example of test setup for tension tests near the edge (test series A3)

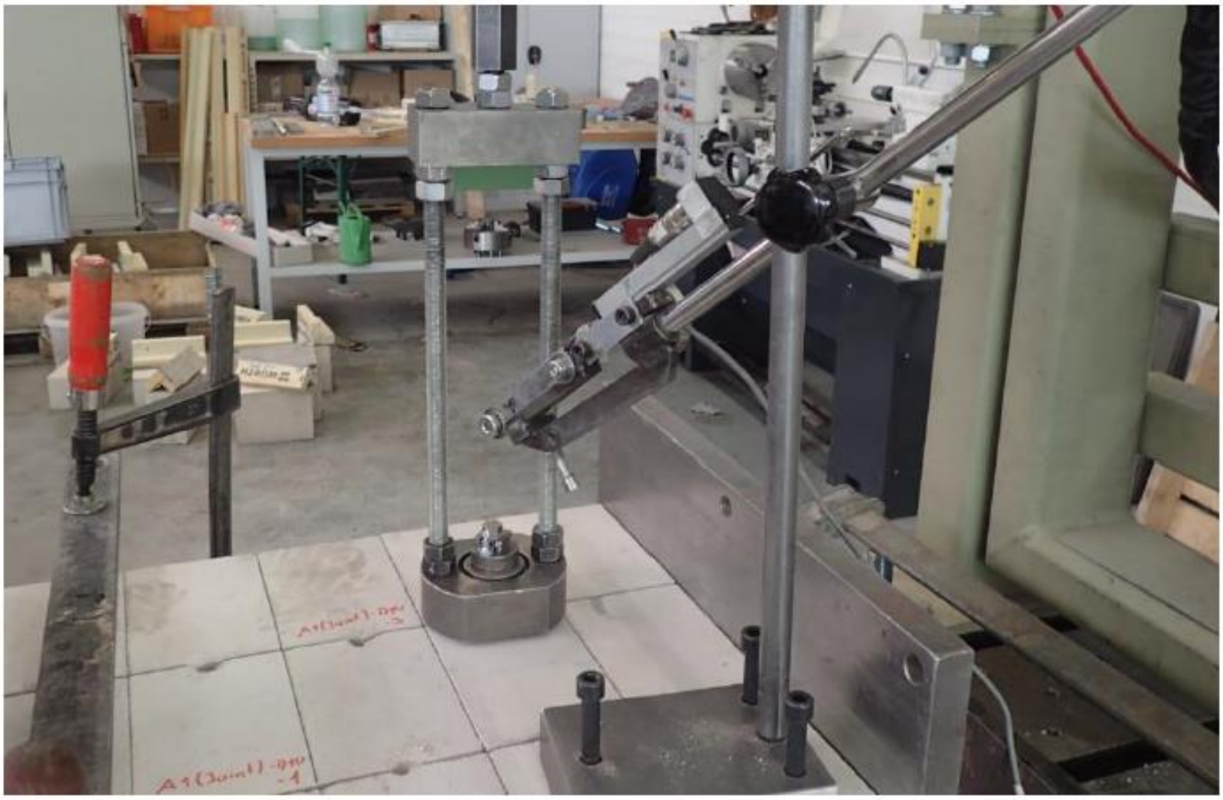


Figure A.5.2.2: Example of test setup for tension tests in joints (test series A1j)

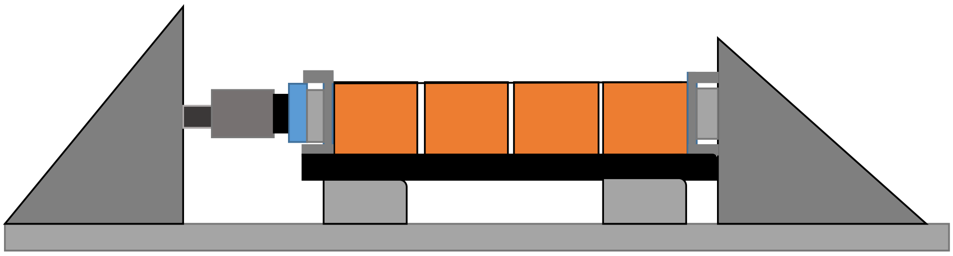


Figure A.5.2.3: Schematic drawing of test setup (side view)

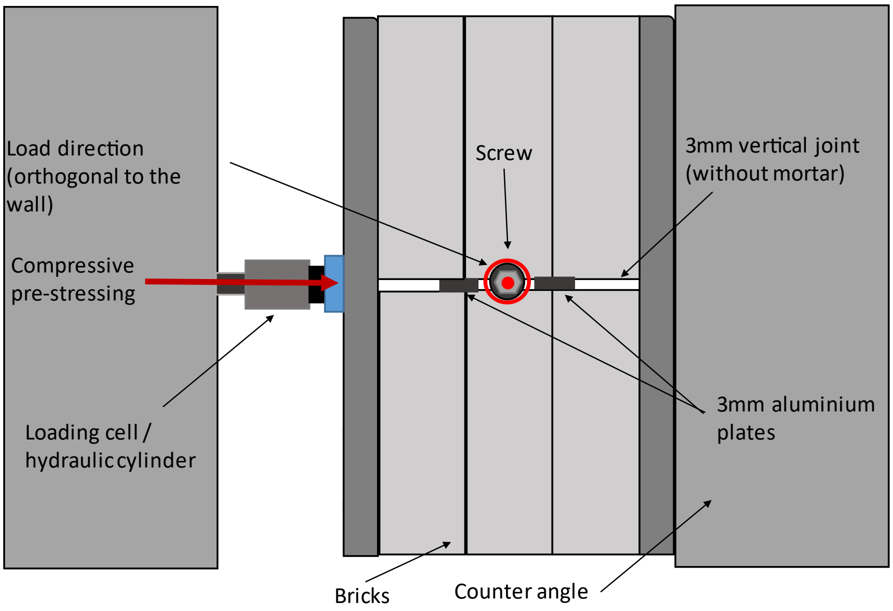


Figure A.5.2.4: Schematic drawing of test setup for tension tests in vertical joints (test series A1j)

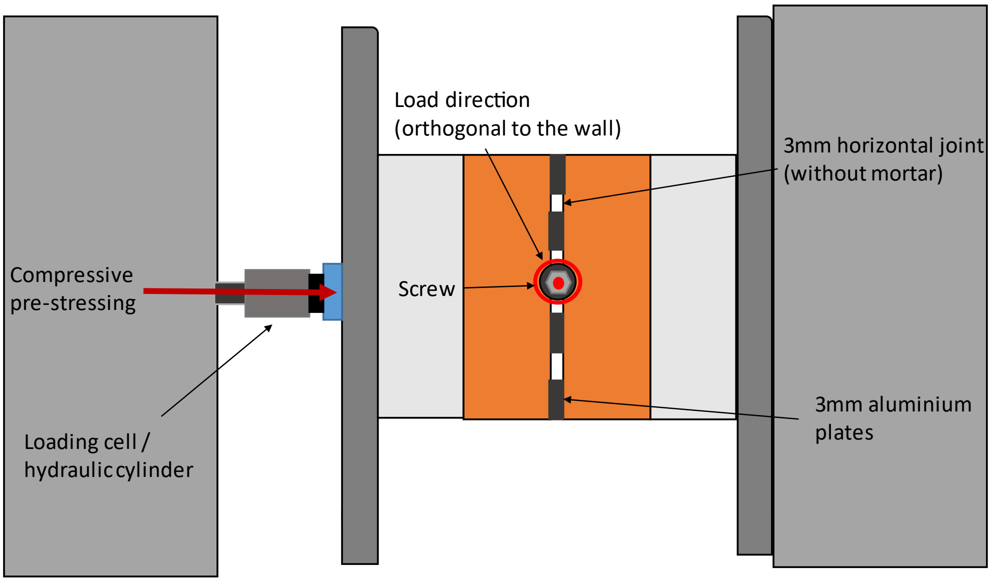


Figure A.5.2.5: Schematic drawing of test setup for tension tests in horizontal joints (test series A1j)

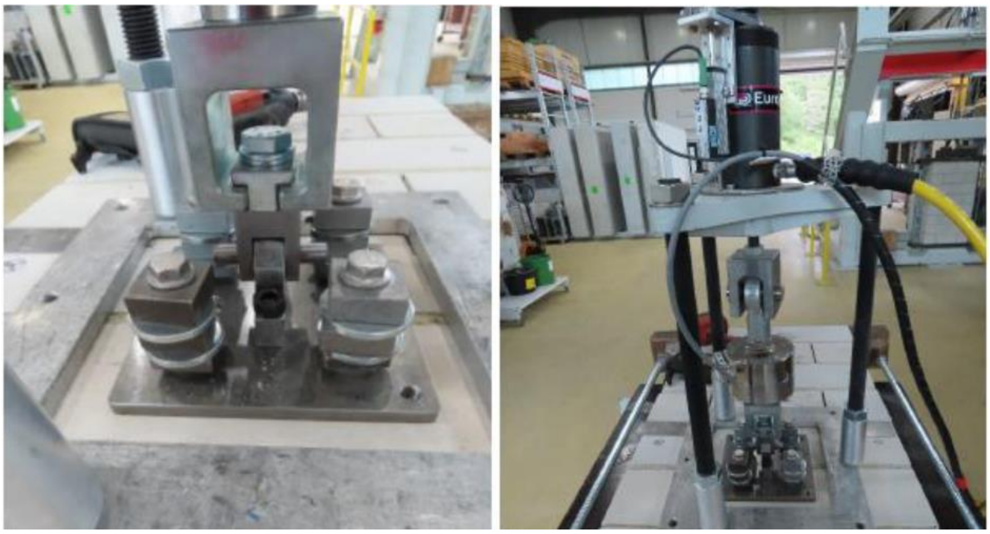


Figure A.5.2.6: Example of test setup for tension tests of a quadruple screw anchor group (test series A5)

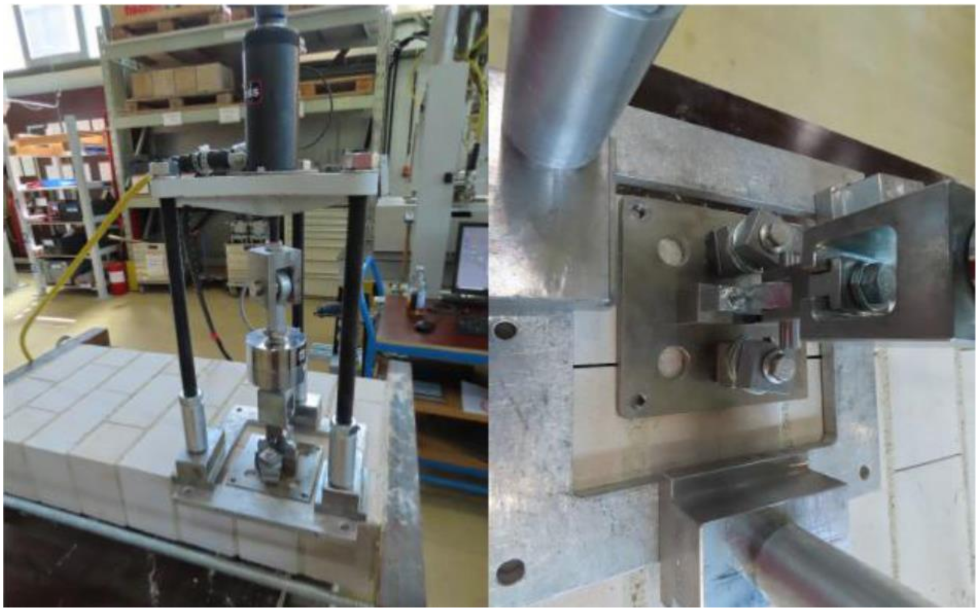


Figure A.5.2.7: Example of test setup for tension tests of a double screw anchor group (test series A5sII)

A.5.3 Shear test

After installation, the screw anchor is connected to the test rig without gap between the screw anchor and the loading plate. The tension rod shall be attached to the fixture with a hinge. Then it is loaded to failure.

The displacements of the screw anchor relative to the base material shall be measured in the direction of the load application, for example by use of a displacement transducer fixed behind the screw anchor (seen from the direction of load application) on the base material.

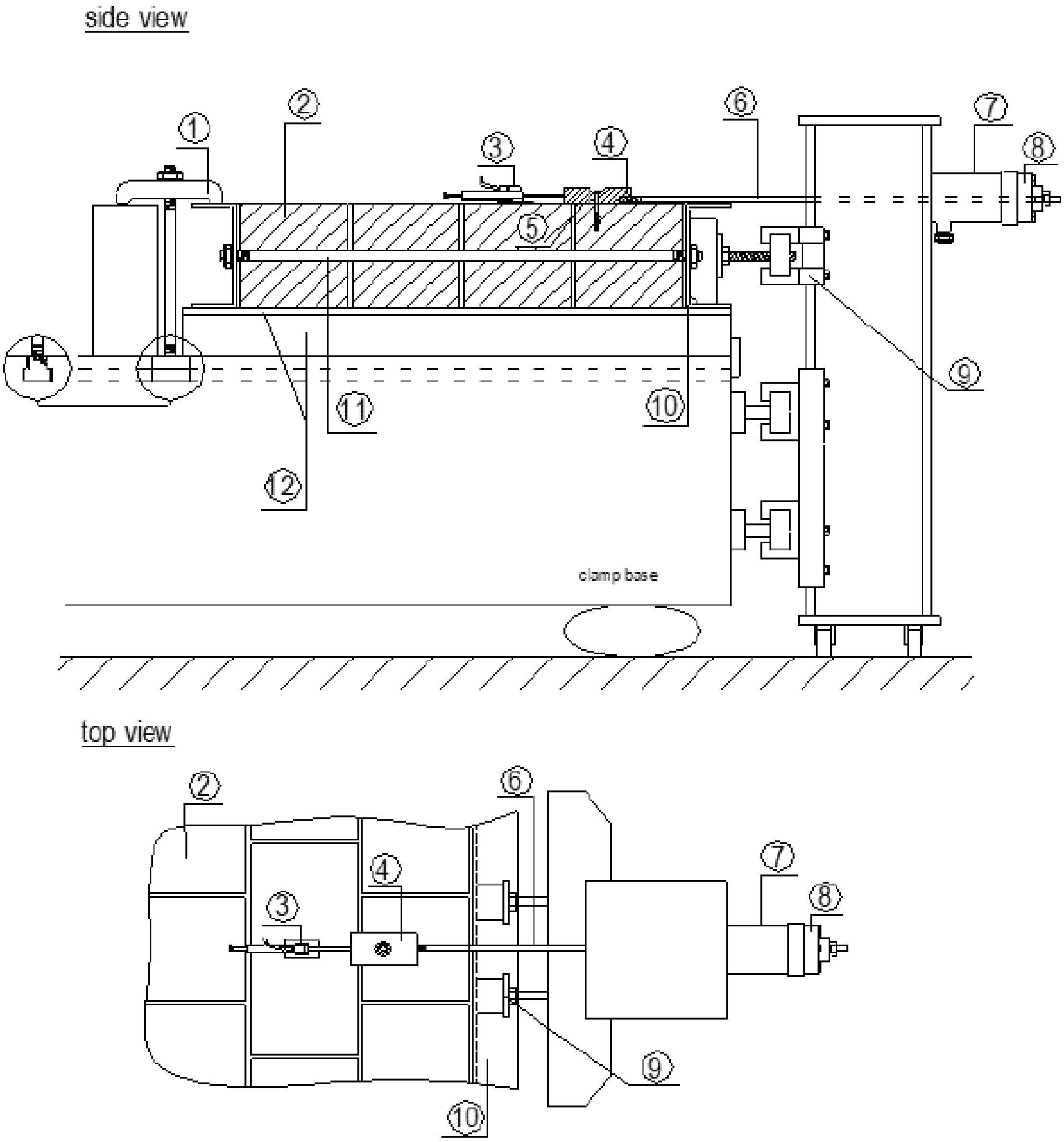
When testing screw anchors at an edge, the test rig shall be arranged such that an unrestricted brick edge failure may occur.

For groups of screw anchors:

The test is performed for the most unfavourable condition, i.e., resulting in the largest annular gapin accordance with. For more details see EAD 330232-01-0601 [1], clause 2.2.7.2.

After installation, the 4 screw anchors shall be connected by a rigid fixture with the dimension given in Figure A.5.3.6. Below the fixture, a sheet of PTFE (e.g., Teflon) with a maximum thickness of 2 mm shall be placed. The test arrangement shall simulate a hinged connection so that the 4 screw anchors are loaded equally. The shear force shall be applied to the front or back side of the fixture.

The load on the screw anchor group and the mean shear displacement of the fixture relative to the masonry outside the rupture cone shall be measured (see A.5.1).



1 restraint
2 brickwork
3 displacement transducer
4 loading fixture
5 teflon
6 tension rod
7 Hydraulic-cylinder
8 load cell
9 support
10 channel section
11 thread rod
12 supporting formwork

Figure A.5.3.1: Schematic drawing of the test setup for shear tests not influenced by edge and spacing effects (test series A2)

Figure A.5.3.2: Example of test setup for shear tests with shear loading parallel to the edge (test series A4II)

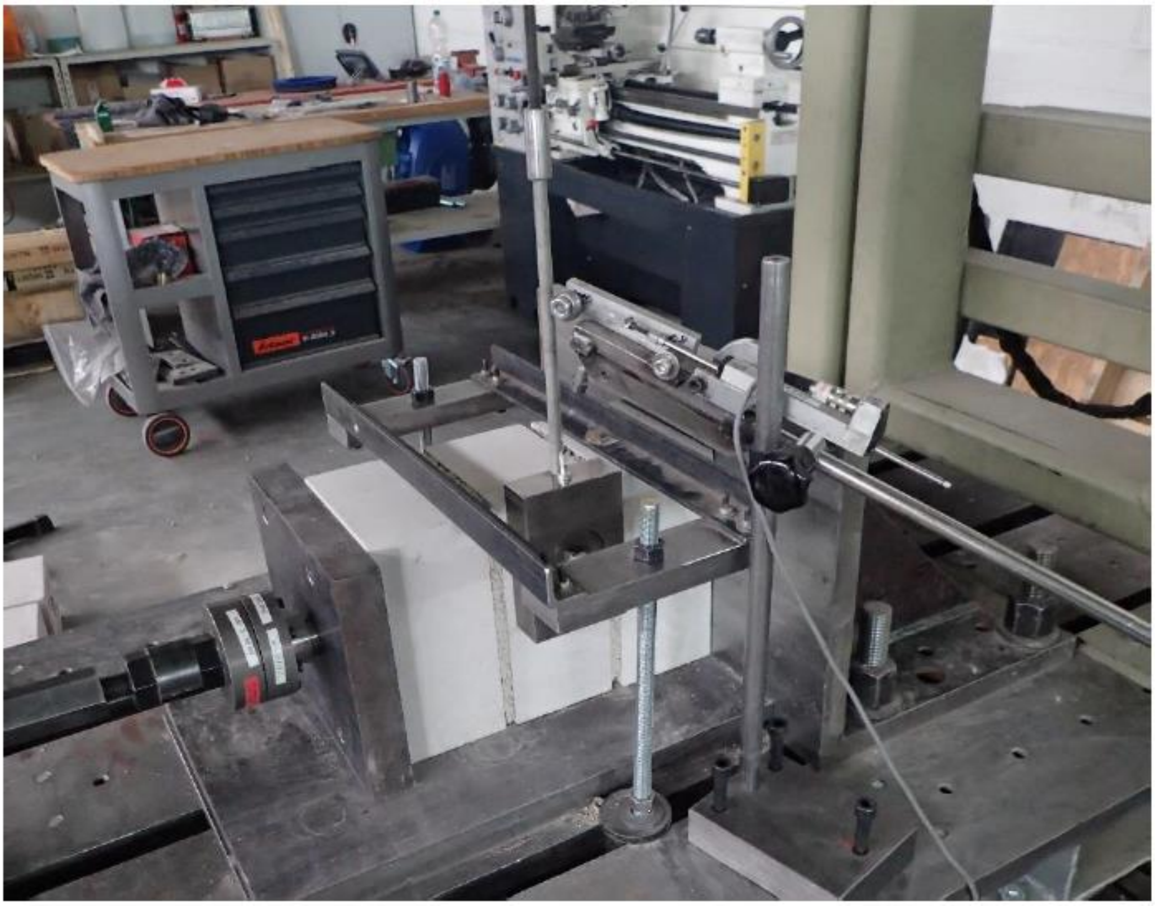


Figure A.5.3.3: Example of the test setup for shear tests with shear loading perpendicular to the edge (test series A4⊥)

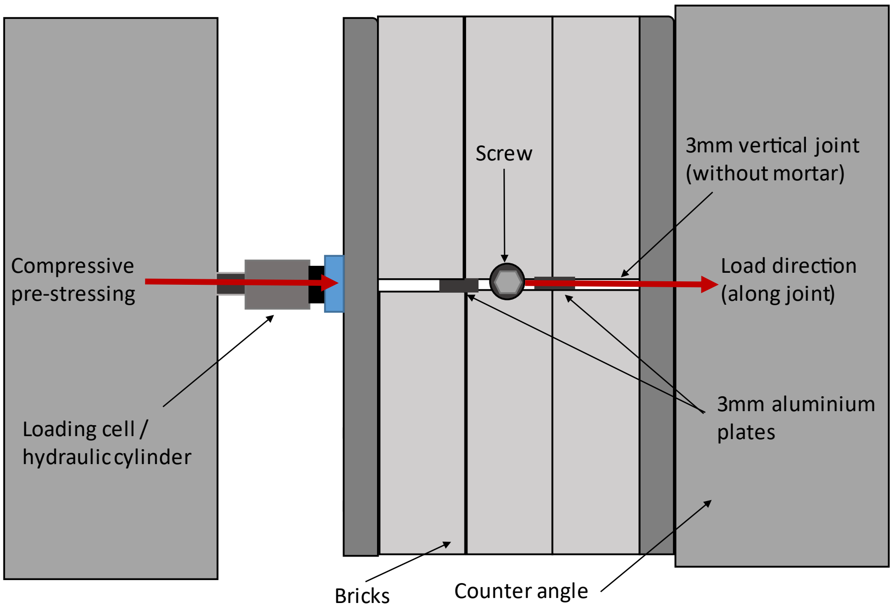


Figure A.5.3.4: Schematic drawing of test setup for shear tests in vertical joints (test series A2j)

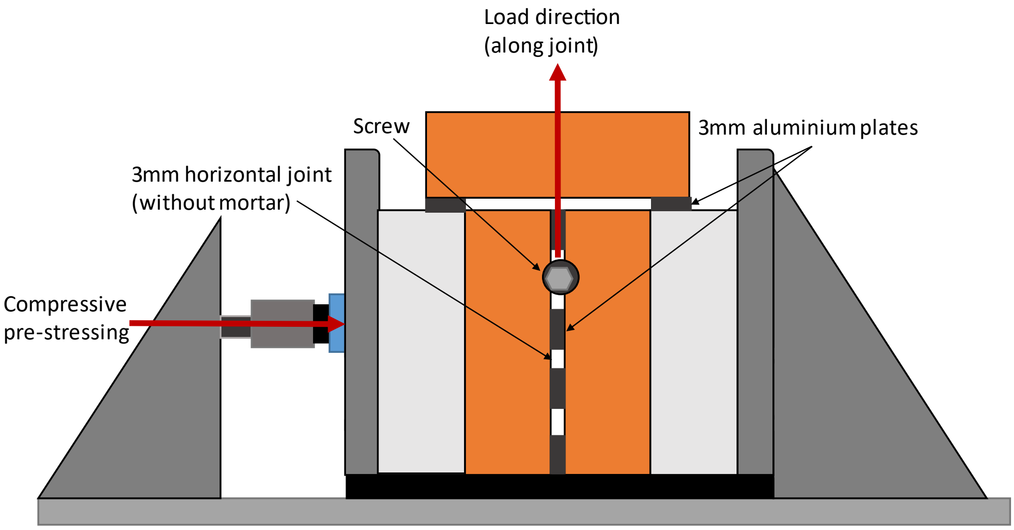
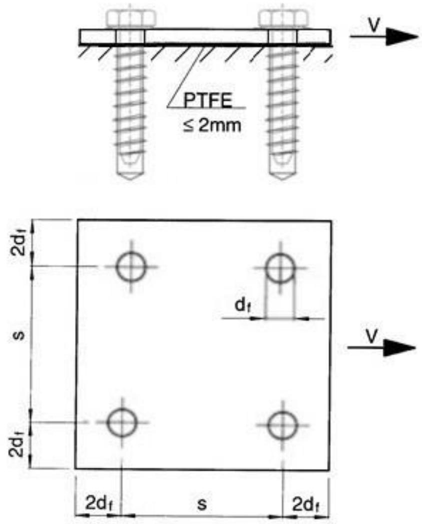


Figure A.5.3.5: Schematic drawing of test setup for shear tests in horizontal joints (test series A2j)



d_f	diameter of clearance hole in the fixture
s	spacing of fasteners
V	shear load
PTFE	Polytetraflourethylen

Figure A.5.3.6: Schematic drawing of test setup for shear tests with quadruple screw groups (test series A6)

A.5.4 Functioning in wet masonry (test series F3)

These tests may be omitted for dry installation conditions only.

Tension tests are carried out in wet solid bricks.

The masonry in the area of anchorage shall be water saturated when the hole is drilled and the embedded part is installed.

If bricks are put under water for one day (at least for 24 hrs) water saturated masonry will be achieved.

A.5.5 Tests under repeated loading (test series F2)

If the screw anchor has an ETA based on EAD 330232-00-0606 [1] and the assessment of repeated loads show no reduction of resistance, the screw anchor can be installed in accordance with the MPII.

Otherwise, the screw anchor shall be set on bevelled washers (inclination angle 5° ± 1°) and shall be installed in accordance with the MPII. The corner of the hexagon nut shall rest on the bevelled washer. The position is shown in Figure A.5.5.1. When the installation torque $T = T_{inst}$ is applied, the screw anchor head might just reach the bevelled washer (see Figure A.5.5.1 b) or might be fully pressed against the washer (see Figure A.5.5.1 c). Any position of the screw anchor head between the extreme positions shown in Figure A.5.5.1 is acceptable.

If the manufacturer applies for different head forms, the screw anchor with the most unfavourable head form shall be tested. The greatest torque moment in the shaft and the greatest notch effect shall be considered. If the most unfavourable head form is not obvious all head forms shall be tested.

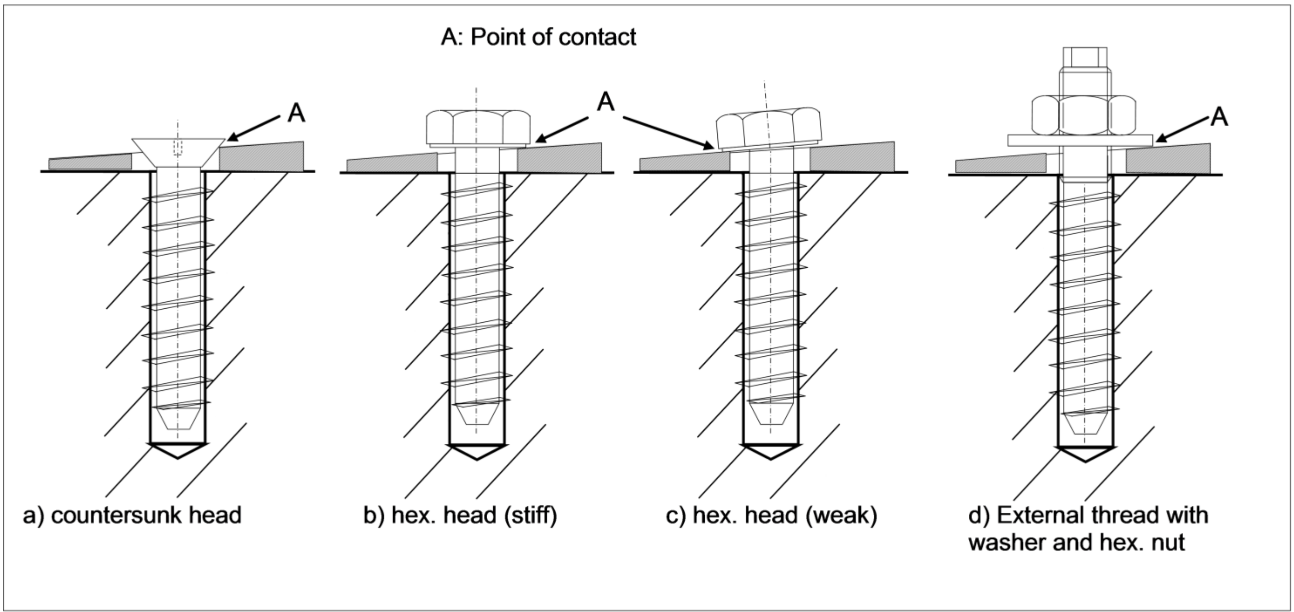
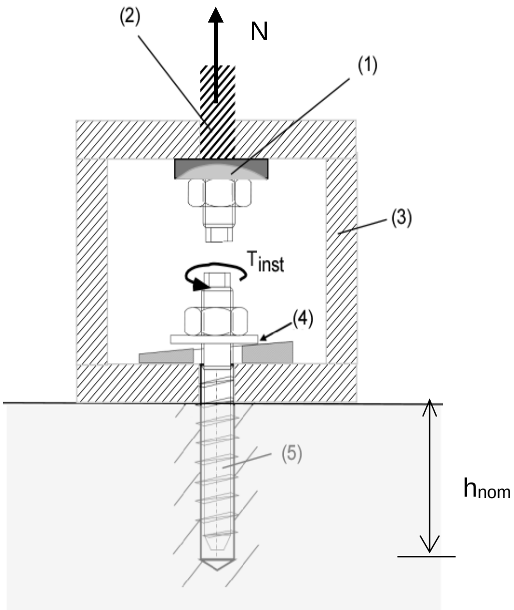


Figure A.5.5.1: Position of the fastener head on bevelled washers in tests with repeated loads



(1) Washer for centric tension load

(2) Threaded rod

(3) Adapter for load application (shall not be weak point of the assembly)

(4) Point of contact

(5) Screw anchor

Figure A.5.5.2: Detailed load application via adapter in tests with repeated loads

The screw anchor is subjected to 1 x 10^5 load cycles with a maximum frequency of approximately 6 Hz. During each cycle the load shall be varied as a sine curve between max N and min N in accordance with Equation (A.5.5.1) and (A.5.5.2). The displacements shall be measured during the first loading up to max N and either continuously or at least after 1, 10, 100, 1 000, 10 000 and 100 000 load cycles.

$$\text{max.N} = 0{,}4 \cdot N_{um} \quad \text{(A.5.5.1)}$$

$$\text{min.N} = 0{,}2 \cdot N_{um} \quad \text{(A.5.5.2)}$$

with: N_{um} = mean ultimate load in the test series A1 in accordance with Table A.1.1

After completion of the load cycles the screw anchor shall be unloaded, the displacement measured and a tension test performed.

A.5.6 Tests with combined tension and shear loading

The direction of load shall correspond to an angle of β = 30°, 45° or 60° relative to the surface of the masonry.

The angle β depends on the results of test series A1 and A2:

β = 30° if the shear resistance (test series A2) > tension resistance (test series A1)

β = 45° if the tension resistance (test series A1) ≈ shear resistance (test series A2)

β = 60° if the tension resistance (test series A1) > shear resistance (test series A2)

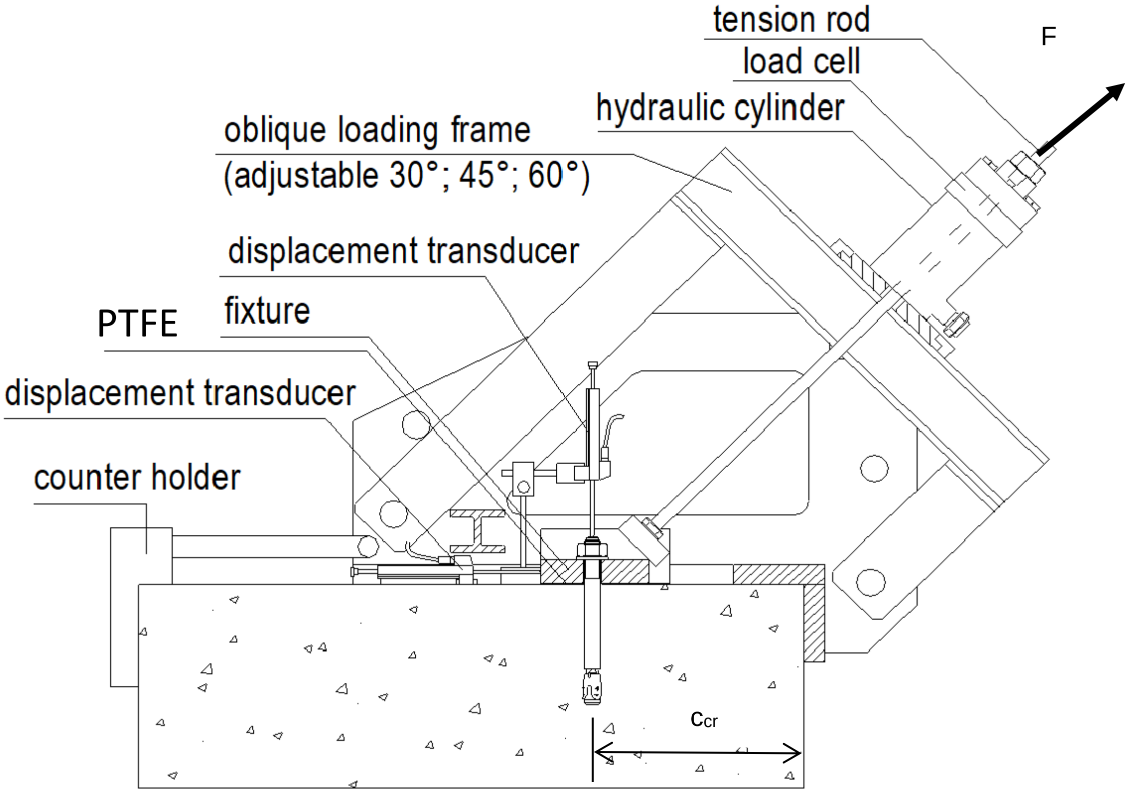


Figure A.5.6.1: Example of a test rig for tests for combined tension and shear loads (with PTFE = Polytetraflourethylen)

A.5.7 Maximum torque moment (test series F4 and F5)

The torque moment shall be measured with a calibrated torque moment transducer. The torque moment shall be increased until failure of the screw anchor.

The tests shall be carried out at the most unfavourable setting position, which give the lowest failure torque moments. If the unfavourable setting position is not clear, more than one position shall be tested. Setting position may be at the point of lowest stiffness in the brick (concerning geometry and material), e.g., at the thinnest shells of hollow lightweight concrete block, considering the influence over the whole load transfer zone.

A.5.8 Test with impact screwdriver or cordless screwdrivers (test series F6 and F7)

The tests shall be performed with the most adverse head form of the product. If the most adverse head form is not obvious all head forms shall be tested.

Impact screwdriver or cordless screwdriver with maximum power output specified in the MPII are used for setting the screw anchor.

If the manufacturer of the fastener does not recommend a specific impact screwdriver or cordless screwdriver, only setting with a calibrated torque wrench is possible.

The screw anchor shall be set up to the designated depth; afterwards the impact screwdriver or cordless screwdriver shall be set on the head of the fastener with maximum power output specified in the MPII. The screwdriver shall be switched off automatically after 5 seconds.

A.6 Test report

As a minimum requirement, the report shall include at least the following information:

General

- Description and type of screw anchor
- Screw anchor dimensions,
- Screw anchor material properties (e.g., coating, tensile strength, yield strength, elastic limit, fracture elongation)
- Name and address of manufacturer
- Name and address of test laboratory
- Date of tests
- Name of person responsible for the tests
- Type of test (e.g., tension, shear, short-term or repeated load test)
- Number of tests
- Testing equipment: load cells, load cylinder, displacement transducer, software, hardware, data recording
- Test rigs, illustrated by sketches or photographs
- Particulars concerning support of the test rig on the test member

Test members

- Base material (see also 1.2.1)
- Mean gross density in accordance with EN 772-13 [6]
- Dimensions of control specimens, and/or cores (if applicable) measured value of compressive strength at the time of testing (individual results and mean value and normalised value in accordance with EN 772-1 [4])
- Dimensions of test member, for perforated units also the hole configuration
- Direction of concrete pouring (for AAC only)

Screw anchor installation

- Information on the positioning of the screw anchor

- Distances of screw anchors from edges of test member
- Distance of screw anchors to joints
- Tools employed for screw anchor installation, e.g., impact drilling tool, drilling hammer, other equipment, e.g., torque wrench
- Type of drill bit, manufacturer's mark and measured drill bit dimensions, particularly the effective diameter, d_{cut}, of the hard metal insert
- Information on the direction of drilling
- Check cylindrical bore hole (no pendulum movement of the drill over the drill length during drilling)
- Information on cleaning of the hole
- Depth of drill hole
- Depth of anchorage h_{nom}
- Information on the direction of installation
- Installation time and testing time or other parameters for control of installation
- Type of attachment
- Description of adjustment processes applied in the respective tests

Measured values

- Parameters of load application (e.g., rate of increase of load or size of load increase steps)
- Displacements measured as a function of the applied load
- Any special observations concerning application of the load
- Failure load F_u
- Failure mode
- Load-displacement curve up to 75% in the post peak region
- Radius (maximum radius, minimum radius) and height of a cone produced in the test (where applicable)
- Particulars of repeated load tests (test series F2):
  - minimum load min.N and maximum load max.N
  - frequency of cycles
  - number of cycles
  - displacements as function of the number of cycles
- Particulars of torque test: maximum torque moment at failure T_u (test series F4 and F5)

ANNEX B: GENERAL ASPECTS OF ASSESSMENT

B.1 Determination of the 5%-fractile of the ultimate loads

The 5%-fractile of the ultimate loads is to be calculated in accordance with 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

$$\varphi_i = ln\left(F_{u,i}\right) \qquad \text{(B.1.1)}$$

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

$$\varphi_m = \sum_{i=1}^{n}\left(\frac{\varphi_i}{n}\right) \qquad \text{(B.1.2)}$$

$$s(\varphi) = \sqrt{\frac{\sum_{i=1}^{n}(\varphi_m - \varphi_i)^2}{(n-1)}} \qquad \text{(B.1.3)}$$

$$\varphi_{5\%} = \varphi_m - k_s \cdot s(\varphi) \qquad \text{(B.1.4)}$$

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

$$F_{5\%} = e^{\varphi 5\%} \qquad \text{(B.1.5)}$$

with:
φ_i = logarithmic values of the ultimate load of a test
$F_{u,i}$ = ultimate loads of a test,
if needed: converted to nominal values in accordance with B.5
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
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
if needed: converted to nominal values in accordance with B.5

If in the tests under shear loading displacements higher than 20 mm occur, then the load at a displacement of 20 mm shall be evaluated.

B.2 Coefficient of variation of ultimate load

If the coefficient of variation of the ultimate load in the functioning test is greater than 30 %, then the following α_V-value has to be taken into account:

$$\alpha_V = \frac{1}{1+0{,}03\cdot(v[\%]-30)} \leq 1{,}0 \qquad \text{(B.2.1)}$$

If the coefficient of variation of the ultimate load in the basic test is greater than 20 %, then the following α_V-value has to be taken into account:

$$\alpha_V = \frac{1}{1+0{,}03\cdot(v[\%]-20)} \leq 1{,}0 \qquad \text{(B.2.2)}$$

B.3 Reduction factor

In the functioning test series F1 to F3 in accordance with Table A.1.2 the factor α shall be calculated as follows:

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

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

$F_{um,r}$ = mean failure load in the reference test series A1 in accordance with Table A.1.1

$F_{5\%,t}$ = 5% fractile of failure loads of a test series in accordance with B.1

$F_{5\%,r}$ = 5% fractile of failure loads in the reference test series A1 in accordance with Table A.1.1, in accordance with B.1

Equation (B.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 functioning test series is smaller than or equal to the coefficient of variation of the reference test series or if the coefficient of variation in the functioning test series is $v \leq 15$ %.

B.4 Criteria for uncontrolled slip under tension loading

Uncontrolled slip occurs if the screw anchor moves in the drilled hole. This can be caused by failure of the masonry in the region of the undercut (region of the thread of the screw anchor).

Screw anchors used in solid masonry units

For the assessment of the load-displacement curves with respect to uncontrolled slip the following evaluation shall be done:

$N_{u,sl}$ shall be evaluated for every test from the measured load displacement curve. In general, uncontrolled slip is characterised by a significant change of stiffness, see Figure B.4.1.a). If the change in stiffness at a defined load is not so obvious e.g., the stiffness is smoothly decreasing, then the uncontrolled slip shall be evaluated as follows:

1) Compute the tangent to the load-displacement curve at a load 0,3 N_u (N_u = peak load in test). In general the tangent stiffness can be taken as the secant stiffness between the points 0/0 and 0,3 $N_u/\delta_{0,3}$ ($\delta_{0,3}$ = displacement at N = 0,3 N_u).
2) Divide the tangent stiffness by a factor of 1,5.
3) Draw a line through the point 0/0 with the stiffness as calculated in 2).
4) The point of intersection between this line and the measured load-displacement curve gives the load $N_{u,sl}$ where the adhesion fails, see Figure B.4.1.b).

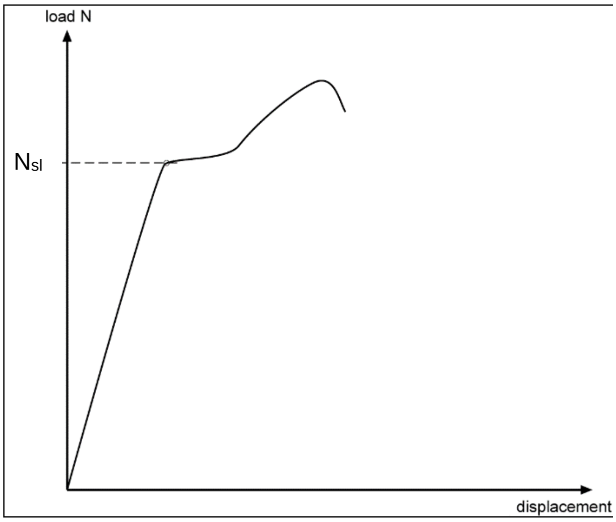
If there is a peak in the load-displacement curve to the left side of this line which is higher than the load at intersection then N_{sl} is taken as the peak load, see Figure B.4.1.c).

If there is a very stiff load-displacement curve at the beginning ($\delta_{0,3} \leq 0{,}05$ mm) then the drawing of the line for the calculation can be shifted to the point (0,3 $N_u/\delta_{0,3}$), see Figure B.4.1.d).

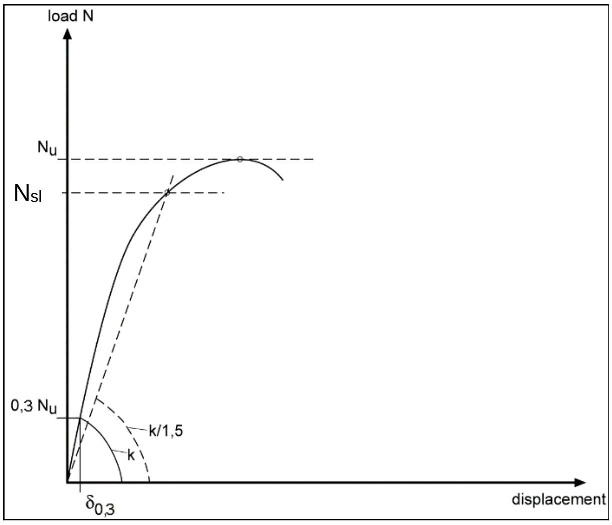
For all tests, the factor α_1 shall be calculated in accordance with following Equation:

$$\alpha_1 = \frac{N_{sl}}{0{,}5 \cdot N_u} \leq 1{,}0 \qquad (B.4.1)$$

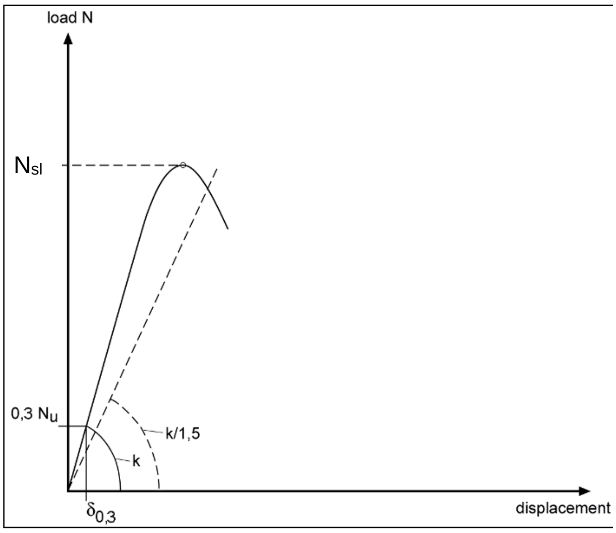
with: N_{sl} = load at uncontrolled slip as defined above
N_u = maximum load of single test.



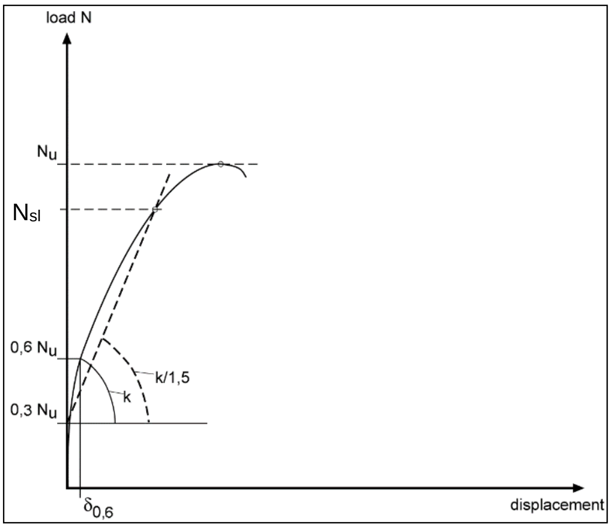
a) Load at uncontrolled slip by a significant change of stiffness



b) Evaluation of uncontrolled slip



c) Evaluation of uncontrolled slip



d) Evaluation of uncontrolled slip

Figure B.4.1: Example of load-displacement curve (solid masonry)

Screw anchors used in hollow or perforated masonry units and solid masonry with open structure (porous) material

Uncontrolled slip is characterised by a significant change of stiffness in accordance with Figure B.4.2. The corresponding load when uncontrolled slip starts is called N_1.

For all tests, the factor α_1 shall be calculated in accordance with following Equation:

$$\alpha_1 = \frac{N_1}{0{,}5 \cdot N_u} \leq 1{,}0 \qquad \text{(B.4.2)}$$

with: N_1 = load at which uncontrolled slip of the screw anchor occurs (see Figure B.4.2)
N_u = maximum load of single test

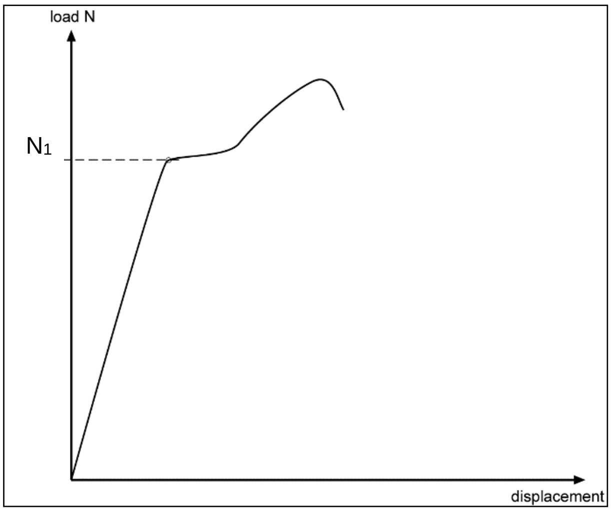


Figure B.4.2: Example of load-displacement curve (hollow or perforated masonry)

B.5 Conversion of ultimate loads

Conversion of ultimate loads to take into account the autoclaved aerated concrete unit strength:

The test results can be converted as far as compressive strength and dry density are concerned.

Compressive strength: For AAC blocks the characteristic compressive strength (used for conversion of ultimate loads) shall be determined from the declared characteristic value of compressive strength in accordance with EN 771-4 [2] using the factor of 0,9.

$$f_{ck} = 0{,}9 \, f_{c,decl} \tag{B.5.1}$$

Dry density: As reference values of dry density the following minimum values of dry density shall be used for low and high strength AAC for conversion of the test results:

low strength AAC: $\rho_{min} = 350 \text{ kg/m}^3$
high strength AAC: $\rho_{min} = 650 \text{ kg/m}^3$

The test results obtained for low and high strength AAC shall be converted using the following Equation:

$$F_{Ru}(f_{ck}) = F_{Ru}^{t} \cdot \frac{\rho_{min}^{3/4} \cdot f_{ck}}{\rho_{test}^{3/4} \cdot f_{c,test}} \tag{B.5.2}$$

with: $F_{Ru}(f_{ck})$ = failure load at unit compressive strength f_{ck} (used for conversion)

ρ_{test} = dry density of the AAC blocks at the time of testing $\geq \rho_{min}$

ρ_{min} = dry density of the AAC blocks given in the ETA

$f_{c,test}$ = compressive strength of the AAC blocks at the time of testing $\geq f_{ck}$

For the strength between low and high strength AAC the characteristic failure loads shall be determined by linear interpolation of the converted test results.

Conversion of ultimate loads to take into account the masonry unit strength:

In case of unit failure and pull-out failure, the failure loads may be converted to the declared mean compressive strength of the masonry unit in accordance with following Equation:

$$F_{Ru}(f_{mean}) = F_{Ru}^{t} \cdot \left(\frac{f_{mean}}{f_{mean,test}}\right)^{\alpha} \tag{B.5.3}$$

with: $F_{Ru}(f_{mean})$ = failure load at unit compressive strength f_{mean}

f_{mean} = mean value of compressive strength in accordance with Declaration of Performance of the masonry unit in accordance with EN 771-1 to 5 [3] used for tests,
with min. $f_{mean} = f_{mean,test} / 1{,}5$

$f_{mean,test}$ = mean compressive strength of the masonry unit at the time of testing,
with $f_{mean,test} > f_{mean}$

α = 0,5 for masonry units of clay or concrete and solid unit of calcium silicate

α = 0,75 for masonry units of perforated calcium silicate (in this connection the range in the unit strength in the tests is limited to + 100 % of the unit strength for the characteristic resistance).