EUROPEAN ASSESSMENT DOCUMENT

EAD 332277-00-0601

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FASTENER FOR PUSH-PULL PROPS FOR PRECAST WALL/COLUMN ELEMENTS

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

This EAD covers fasteners consisting of a plastic device in different sizes with internal hexagonal nut. The plastic anchoring body is circular shaped and the nut is placed behind the body as load introduction element. The materials have the following specifications:

- plastic anchoring body of Polyamide with circular shape with: tensile strength: $f_{u,k}$ ≥ 100 N/mm²,
- self-locking hexagon nut strength class 8 and 10 according to EN ISO 898-2 [5] [1] , minimum length of thread M12: 10 mm and M16: 14 mm.

This EAD covers only fasteners with a variation coefficient of test results ≤ 30% (see A.4.3) and with a steady increase of the load/displacement curves (see A.4.4)

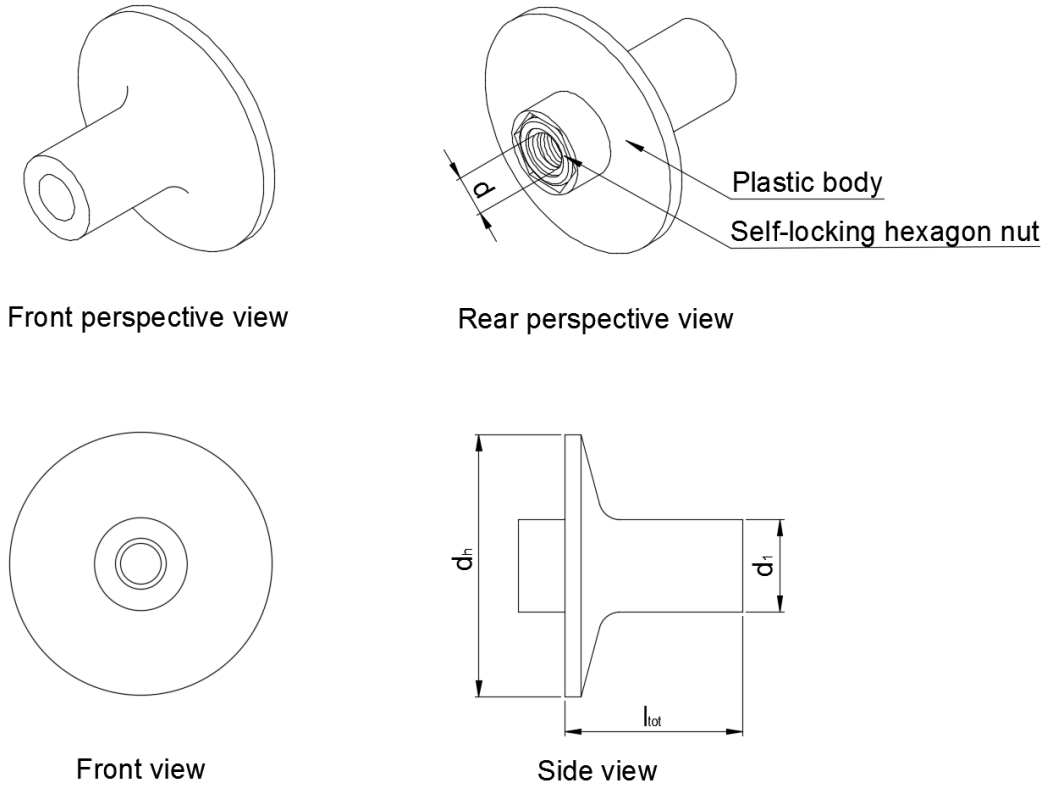


Figure 1.1: Example for anchor body with typical dimensions

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

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 may be considered for the determination of the performance and detailed in the ETA.

[1] All undated references to standards or to EADs in this document are to be understood as references to the dated versions listed in clause 4.

1.2 Information on the intended use of the construction product

1.2.1 Intended use

The fasteners are intended to be used for temporary bracing precast wall/column elements during their erection (see Figure 2).

The fastener is embedded in a precast/column wall element made of concrete. During concreting, the fastener may be fixed to the formwork by means of a plastic-to-be-nailed or magnetic fixing. After the concrete has hardened and a minimum concrete strength has been achieved, a push-pull prop may be connected to the fastener by a corresponding screw. Thus, the stability of the precast wall/column element against horizontal loads (e.g. wind) during the construction (temporary) is given.

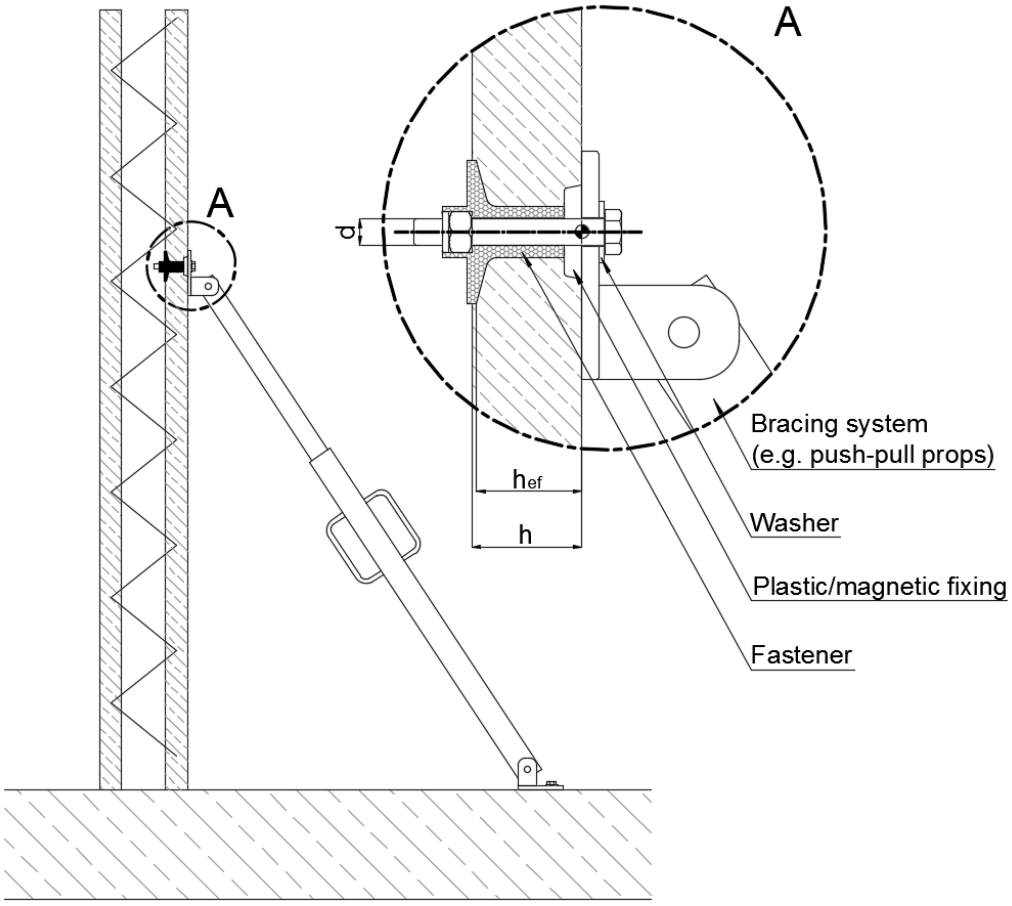


Figure 1.2: Intended use of the fastener

The fastener is intended to be used under the following conditions:

- as fasteners in reinforced normal concrete of a minimum strength class of C20/25 and a maximum strength class of C50/60 according to EN 206 [3] and minimum reinforcement min. A_s according to 2.2.1, Equation (2.5)
- used in wall precast element with minimum thickness of h_{min} = 50 mm,
- minimum edge distance $c_{min} = d_h/2 + 1{,}5\ h_{ef}$ [mm],
- minimum spacing $s_{min} = 2\ c_{min}$,
- used in cracked and in non-cracked concrete,
- fastening subject to static and quasi-static loading,
- the fastener is fixed with the formwork in such a way, that it does not move during the laying of the reinforcement and the application and compaction of the concrete. During pouring of concrete, attention is paid, that the concrete is well compacted under the head of the bolt.
- screw of strength class 8.8 according to the EN ISO 898-1 [2] has to be used to secure the bracing system to the fastening,

- service temperature: minimum -20 °C, maximum +40 °C,
- fasteners are used in structures subject to internal, dry conditions or in structures subject to external atmospheric exposure or exposure in permanently damp internal conditions,

The fastener for push-pull props is intended to be exposed to UV-radiation for not more than 1 year.

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 fastener for push-pull props for the intended use of 2 years when installed in the works (provided that the product is subject to appropriate installation (see 1.1)) These provisions are based upon the current state of the art and the available knowledge and experience and on the fact that the product is supposed to be used just during erection state.

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

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

1.3 Specific terms used in this EAD

1.3.1 Abbreviations

Fastener	=	A manufactured, assembled component for achieving fastening between base material and bracing system through a screw
Push-pull prop	=	Temporarily bracing system used for structural safety/stability of concrete precast wall/column elements during their erection
Fixture	=	Final pin-joint of the push pull prop to be fixed to the fastener

1.3.2 Notation

c_{min}	=	minimum edge distance
d	=	nominal thread diameter
d_1	=	external diameter of fastening shank
d_h	=	diameter of the plastic anchoring body
F	=	force in general
$f_{ck,cube}$	=	nominal characteristic concrete compressive strength (based on cubes)
h_{ef}	=	effective embedment depth
h_{min}	=	minimum thickness of concrete member
l_{tot}	=	total length of the fasten
s_{min}	=	minimum spacing
T_{inst}	=	maximum recommended installation torque specified by the manufacturer

1.3.3 Indices

cr	=	cracked concrete
test	=	tested result
u	=	ultimate – situation when failure occurs
ucr	=	uncracked concrete
5%	=	5% fractil of a test series

[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.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1 shows how the performance of the fastener for push-pull props for precast wall/column elements is assessed in relation to the essential characteristics.

Table 2.1 Essential characteristic 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			
Load bearing capacity under static and quasi-static actions			
1	Load bearing capacity under static and quasi-static actions in uncracked and cracked concrete	2.2.1	Level F_{Rkcr} , F_{Rkucr} [kN]
2	Minimum edge distance, spacing and member thickness	2.2.2	Level c_{min}, s_{min}, h_{min} [mm]
3	Resistance to damage during installation - Maximum torque moment	2.2.3	Level max. T_{inst} [Nm]

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

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

2.2.1 Load bearing capacity under static and quasi-static actions for installation in uncracked and cracked concrete

Characteristic resistance to plastic failure

Tests according to Table A.1, Line 1.1 and Line 1.2 are performed. Determination of reduction factor for outdoor exposure:

$$\alpha_{pl,red} = N_{Rk,pl(t=12)} / N_{Rk,pl(t=0)} \leq 1 \quad [-] \quad (2.1)$$

with: $N_{Rk,pl(t=0)}$ = characteristic resistance to plastic failure for maximum fastener size tested in delivery condition (not embedded in concrete),

5%-fractile of the failure loads (according to Equation (A.2)) in tests according to Table A.1, Line 1.1

$N_{Rk,pl(t=12)}$ = characteristic resistance to plastic failure for maximum fastener size subjected for a period of at least 12 months to outdoor exposure (not embedded in concrete, including all seasonal atmospheric events)

5%-fractile of the failure loads (according to Equation (A.2)) in tests according to Table A.1, Line 1.2

The characteristic resistance $N_{Rk,pl}$ to plastic failure for each fastener size is determined as follows:

$N_{Rk,pl} = N_{Rk,pl(t=0)} \cdot \alpha_{pl,red} \cdot \alpha_{cv}$ [N] (2.2)

with: $N_{Rk,pl(t=0)}$ = characteristic resistance to plastic failure for each fasteners tested in delivery condition (not embedded in concrete),

5%-fractile of the failure loads (according to Equation (A.2)) in tests according to Table A.1, Line 1.1

α_{cv} = reduction factor according to Equation (A.3)

$\alpha_{pl,red}$ = reduction factor according to Equation (2.1)

The load/displacement behaviour is assessed according to A.4.4.

Characteristic resistance to pull-out failure

The characteristic resistance $N_{Rk,p}$ to pull-out failure in uncracked concrete is determined as follows:

$N_{Rk,p} = 6 \cdot A_h \cdot f_{ck,cube} \cdot \psi_{ucr,N}$ [N] (2.3)

with: $\psi_{ucr,N}$ = 1,4 for fasteners in uncracked concrete

$f_{ck,cube}$ = characteristic concrete compressive strength measured on cubes with a side length of 150 mm [N/mm²]

A_h = load bearing area of plastic body [mm²]

$A_h = \frac{\pi}{4}\left(d_h^2 - d_1^2\right)$ (2.4)

d_h = head diameter of plastic body [mm]

d_1 = shank diameter of plastic body [mm]

Characteristic resistance to splitting failure

Minimum reinforcement is present to avoid splitting of the member.

The required cross-section of reinforcement is determined as follows:

$\min A_s = 0{,}5 \cdot \frac{\sum N_{Ed}}{f_{yk} / \gamma_{Ms,re}}$ [mm²] (2.5)

with: N_{ed} = design value of tension load acting on reinforcement

f_{yk} = nominal characteristic steel yield strength

$\gamma_{Ms,re}$ = recommended partial factor steel material reinforcement according to EN 1992-4 [1]

Characteristic resistance to concrete failure

Tests according to Table A.1, Line 2 to Line 5 are performed.

The characteristic resistance $F_{Rk,c}$ to concrete failure is determined as follows:

$F_{Rk,c} = \min(\alpha_{cv,90} \cdot F_{Rk,c,90°}; \alpha_{cv,60} \cdot F_{Rk,c,60°}; \alpha_{cv,30} \cdot F_{Rk,c,30°}; \alpha_{cv,0} \cdot F_{Rk,c,0°})$ (2.6)

with: $F_{Rk,c,90°}$; $F_{Rk,c,60°}$; $F_{Rk,c,30°}$; $F_{Rk,c,0°}$

= characteristic resistance to concrete failure for fasteners under loads applied with the different inclination angles 0°, 30°, 60° and 90°,

5%-fractile (according to Equation (A.2)) of the failure loads in tests according to Table A.1, Line 2 to 5, converted to the nominal concrete strength (according to Equation (A.1))

α_{cv} = reduction factor according to Equation (A.3) for fasteners under loads applied with the different inclination angles 0°, 30°, 60° and 90°

The load/displacement behaviour is assessed according to A.4.4.

Characteristic resistance to all failure modes in any load direction

For determination of the characteristic resistance in any load direction the characteristic resistance is controlled by the failure mode resulting to the minimum design strength $F_{Rd,min}$.

$$F_{Rd,min} = \min (N_{Rk,pl} / \gamma_{MPl}; N_{Rk,p} / \gamma_{Mp}; F_{Rk,c} / \gamma_{Mc}) \quad (2.7)$$

with: $N_{Rk,pl}$; $N_{Rk,p}$; $F_{Rk,c}$ according to Equations (2.2), (2.3), (2.6)

γ_{MPl} in absence of National regulations recommended value $\gamma_{MPl} = 2,0$

γ_{Mp}, γ_{Mc} in absence of National regulations recommended value given in EN 1992-4 [1] Table 4.1: $\gamma_{Mp} =, \gamma_{Mc} = 1,5$

The characteristic resistance of the fastener in uncracked concrete shall be determined as follows:

$$F_{Rk,ucr} = F_{Rd,min} \cdot \gamma_M \quad (2.8)$$

with: $F_{Rd,min}$ according to Equation (2.7)

γ_M depends on decisive failure mode (see Equation 2.7)

The characteristic resistance of the fastener in cracked concrete shall be determined as follows:

$$F_{Rk,cr} = F_{Rk,ucr} / 1,4 \quad (2.9)$$

with: $F_{Rk,ucr}$ according to Equation (2.8)

2.2.2 Minimum edge distance and spacing

The minimum values for edge distance c_{min}, spacing s_{min} and minimum member thickness h_{min} are given by the manufacturer and verified by the tests according to Table A.1, Line 2 - 5.

In absence of these data the default test conditions are as follows (according to the minimum values of the intended use):

- $h_{min} = 50$ mm
- $c_{min} = d_h/2 + 1,5\ h_{ef}$ [mm]
- $s_{min} = 2\ c_{min}$

2.2.3 Resistance to damage during installation - Maximum torque moment

Maximum values for torque moment are required to avoid fastening failure or concrete cone failure of the member during fixture installation and are calculated as:

$$\max.T_{inst} = \frac{F_{Rk,cr} \cdot k \cdot d}{1,3} \quad [Nm] \quad (2.10)$$

with:

max. T_{inst}	=	maximum installation torque without damage	[Nm]
$F_{Rk,cr}$	=	according to Equation (2.9)	[N]
d	=	nominal diameter of the threaded bolt	[mm]
k	=	friction factor = 0,1	[-]

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 1997/463/EC.

The system is 2+.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the fastener for push-pull props for precast wall/column elements in the procedure of assessment and verification of constancy of performance are laid down in Table 3.1.

Table 3.1 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	Plastic anchoring body: Material and material properties	Specific test report 2.2 according to EN 10204 [4]	Laid down in control plan	1 per delivery	
	Plastic body: Material and material properties	Inspection certificate 3.1 according to EN 10204 [4]			
	Hexagonal nut: Material and material properties	Specific test report 2.2 according to EN 10204 [4]			
2	Dimensions (diameter, thickness height of plastic body including possible tolerances as specified by the manufacturer)	Measuring by calliper		1 per 5.000 produced anchors minimum: 3 per batch (whichever criterion is the more rigorous)	
3	Check of the fastening with regard to defects, deformations and integrity of identification marking	Visual			
4	Check of hexagon nut with clamping part (identification, assembly), check of cap (tight fit), check of thread (screwing in the test pin without jamming)	Visual			
5	Centric tensile test: minimum breaking load	Tensile test			

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 the fastener for push-pull props are laid down in Table 3.2.

Table 3.2 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	Ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the fastener for push-pull props. In particular it shall be checked if all tasks given in Table 3.1 were performed [1)].	As defined in the control plan	As defined in the control plan	As defined in the control plan	1, when starting the production
Continuous surveillance, assessment and evaluation of factory production control					
2	Verifying that the system of factory production control and the specified automated manufacturing process are maintained taking account of the control plan. In particular it shall be checked if all tasks given in Table 3.1 were performed. [1)]	As defined in the control plan	As defined in the control plan	As defined in the control plan	1/year

[1)] If the product criteria in Table 3.1 are observed, it is not necessary to monitor specific stages of production.

4 REFERENCE DOCUMENTS

[1]	EN 1992-4:2018	Eurocode 2: Design of concrete structures – Part 4: Design of fastenings for use in concrete
[2]	EN ISO 898-1:2013	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread
[3]	EN 206:2013	Concrete - Part 1: Specification, performance, production and conformity
[4]	EN 10204:2004	Metallic products - Types of inspection documents
[5]	EN ISO 898-2:2012	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes - Coarse thread and fine pitch thread

ANNEX A DETAILS OF TESTS AND GENERAL ASSESSMENT OF TEST RESULTS

A.1 Test program

Table A.1 Required tests

No	Test		Concrete strength	Number of tests For each size
1	1.1	centric tension[1)] single fastener pure plastic test	-	≥ 5
	1.2	centric tension[2)] single fastener pure plastic test	-	≥ 5[3)]
2	load application 90° - centric tests unconfined, single fastener		C20/25	≥ 5
3	load application 60° unconfined, single fastener		C20/25	≥ 5
4	load application 30° unconfined, single fastener		C20/25	≥ 5
5	load application 0° - shear tests unconfined, single fastener		C20/25	≥ 5

1) Tensile tests in delivery condition
2) Tensile tests carried out on fasteners subjected for a period of at least 12 months to outdoor exposure (not embedded in concrete, including all seasonal atmospheric events)
3) Tests carried out with maximum fastener size

For the individual tests the ultimate loads and the failure modes and the load/displacement curves are reported (see Annex A.4).

A.2 Test details for tests of the fastener not embedded in concrete

The plastic tests have to be performed with the end product consisting of fastening screwed to a bolt with washer. The fastener is held at the plastic circular body and the load is introduced through a bolt with washer. The bearing is done on both sides with a plate with a hole according to Figure A.1.

Tests are carried out on fasteners on delivery condition and on fasteners subjected to outdoor exposure for at least 12 months.

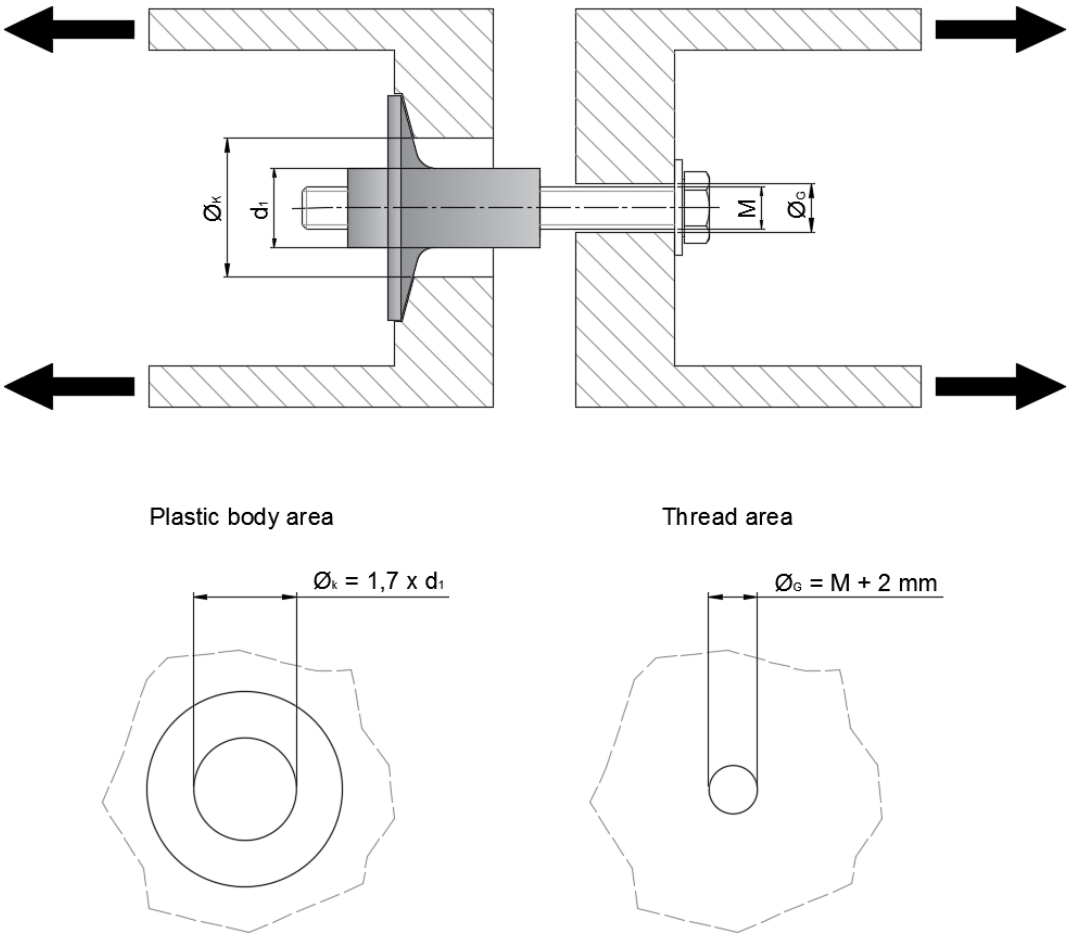


Figure A.1: Test rig for tension tests (sectional view) with bearing plates at both ends

Left side: Plate for the anchoring body (top view)

Right side: Plate for screw (top view)

A.3 Test details for tests of the fastener in concrete

The tests are carried out in concrete of at least the strength class C20/25 according to EN 206-1 [3]. The maximum aggregate size is 16 mm.

The concrete specimens may be produced in accordance with [3].

Following mean compressive strengths at the time of testing fastenings shall be obtained:

C20/25 f_c = 20-30 MPa (cylinder: diameter 150 mm, height 300 mm)

f_{cube} = 25-35 MPa (cube:150 x 150 x 150 mm)

It is recommended to measure the concrete compressive strength either on cylinders with a diameter of 150 mm and height of 300 mm, or on cubes of 150 mm.

The following conversion factors for concrete compressive strength from cube to cylinder may be used:

C20/25 $f_c = \frac{1}{1{,}25} f_{cube}$

For every concreting operation, specimens (cylinder, cube) shall be prepared having the dimensions conventionally employed in the member country. The specimens shall be made, cured and conditioned in the same way as the test members.

Generally, the concrete control specimens shall be tested on the same day as the fasteners to which they relate. If a test series takes a number of days, the specimens shall be tested at a time giving the best representation of the concrete strength at the time of the fastener tests, e.g. at the beginning and at the end of the tests. In this case the concrete strength at the time of testing can be determined by interpolation.

The concrete strength at a certain age shall be measured on at least 3 specimens. The mean value of the measurements governs.

Reinforcement has to be placed as shown in Figure A.2.

Tests are performed with minimum edge distance, minimum spacing and minimum member thickness.

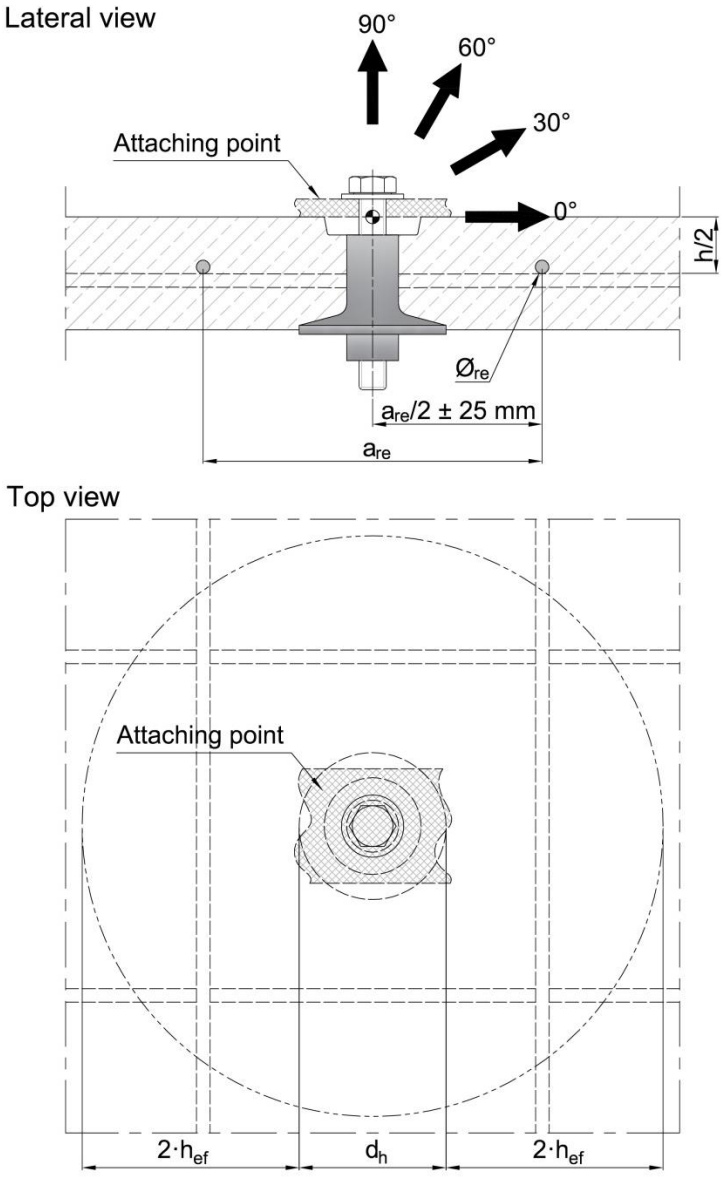
The tests are carried out on specimens under laboratory conditions.

The fastener is fixed with the formwork such, that it does not move during the laying of the reinforcement and the application and compaction of the concrete.

During the concrete placing attention is paid, that the concrete is well compacted under the head of the bolt.

The test rig shall allow the formation of an unrestricted rupture cone. For this reason the clear distance between the support reaction and a fastener shall be at least $2 \cdot h_{ef}$ (see Figure A.2).

Examples of attaching points for load application are shown in Figure A.3.



$Ø_{re}$: diameter of reinforcement

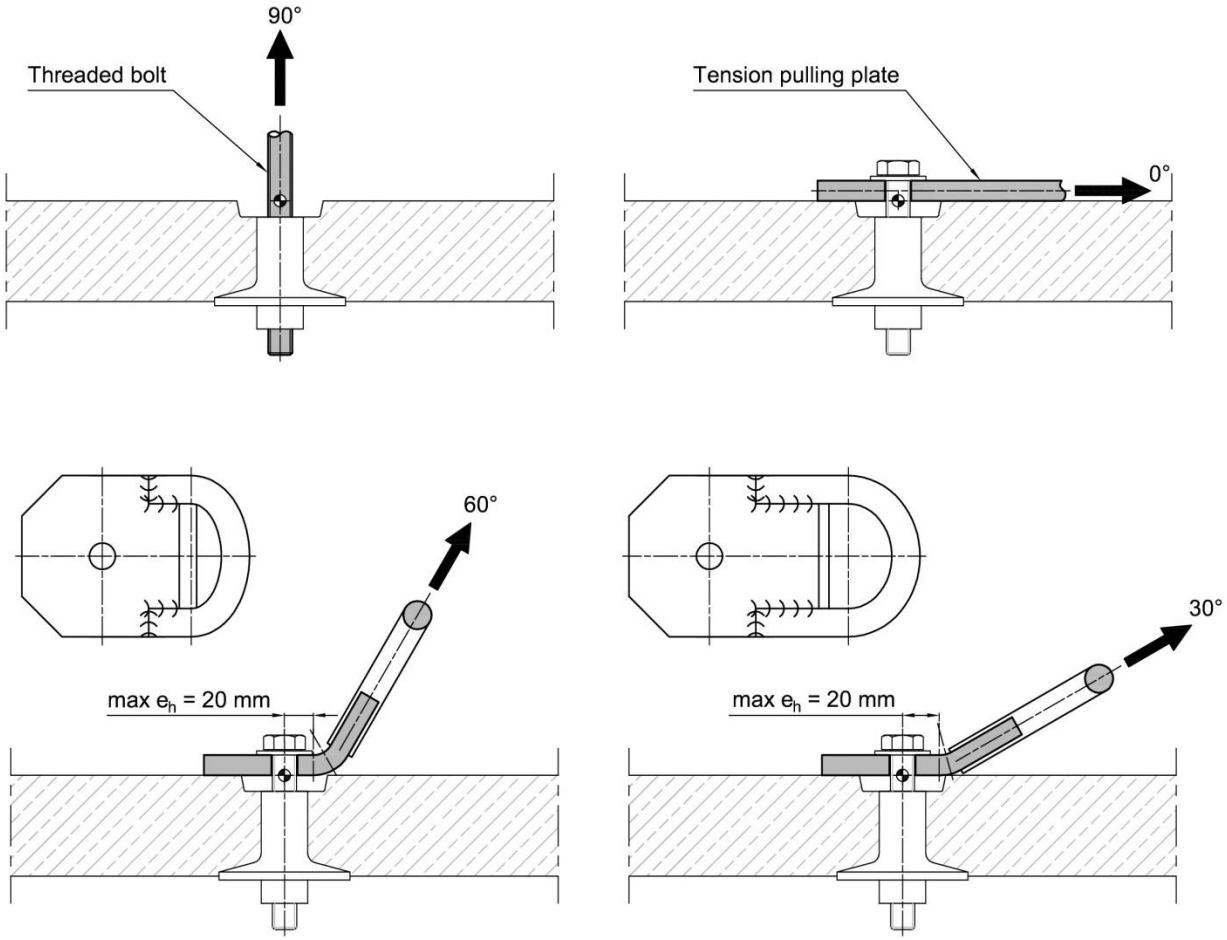
a_{re} : distance of reinforcement

h: thickness of concrete member

d_h : diameter of plastic anchoring body

h_{ef} : effective embedment depth

Figure A.2: Setup for tests in concrete



e_h : distance between fastener axis and curvature of the test fixture

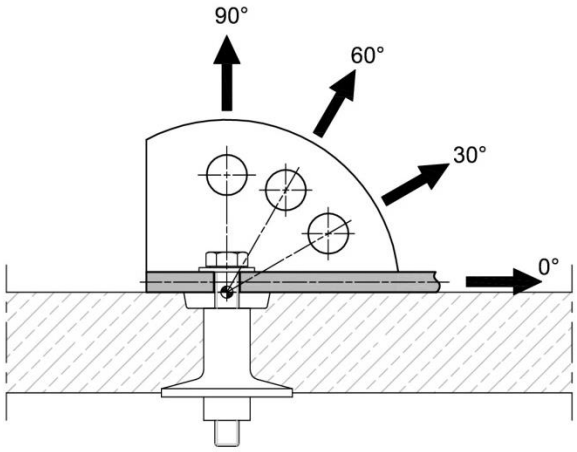


Figure A.3: Examples of attaching points

A.4 General assessment of test results

A.4.1 Conversion of failure loads

The conversion of failure loads in case of concrete failure is done according to Equation (A.1):

$$F_{u,c} = F_{u,test} \cdot \left(\frac{f_c}{f_{c,test}} \right)^{0,5} \qquad \text{with } 0,8 \le \frac{f_c}{f_{c,test}} \le 1,25 \tag{A.1}$$

with: $F_{u,test}$ = failure (ultimate) load of a test series

f_c = nominal characteristic concrete compressive strength

$f_{c,test}$ = compressive strength of concrete at the time of testing

A.4.2 5%-fractiles

The 5 %-fractile of the ultimate loads measured in a test series is to be calculated according to statistical procedures for a confidence level of 90 %. If a precise verification does not take place, a normal distribution and an unknown standard deviation of the population may be assumed.

$$F_{u,5\%} = F_{u,m}(1 - k_s \cdot cv_F) \quad \text{(A.2)}$$

with: $F_{u,m}$ = mean failure(ultimate) load of a test series

k_s = statistical factor

e.g.: n = 5 tests: k_s = 3,40

n = 10 tests: k_s = 2,57

cv_F = coefficient of variation [%] related to loads

Note: The confidence level of 90% is defined for characteristic resistance of fasteners in EN 1992-4 and is therefore used for the assessment in this EAD.

A.4.3 Coefficient of variation

If the coefficient of variation of the failure load in any basic test series exceeds 15% and is not larger than 30%, the following reduction shall be taken into account:

$$\alpha_{cv} = \frac{1}{1 + 0{,}03(cv_F - 15)} \leq 1{,}0 \quad \text{(A.3)}$$

If the maximum limit for the coefficient of variation of the failure load of 30% is exceeded the number of tests shall be increased to meet this limit. This EAD does not cover fasteners for which this limit cannot be achieved.

A.4.4 Load/displacement behaviour

The load/displacement curves shall show a steady increase. A reduction in load and/or a horizontal part in the curve caused by uncontrolled slip are not acceptable (see Figure A.4).

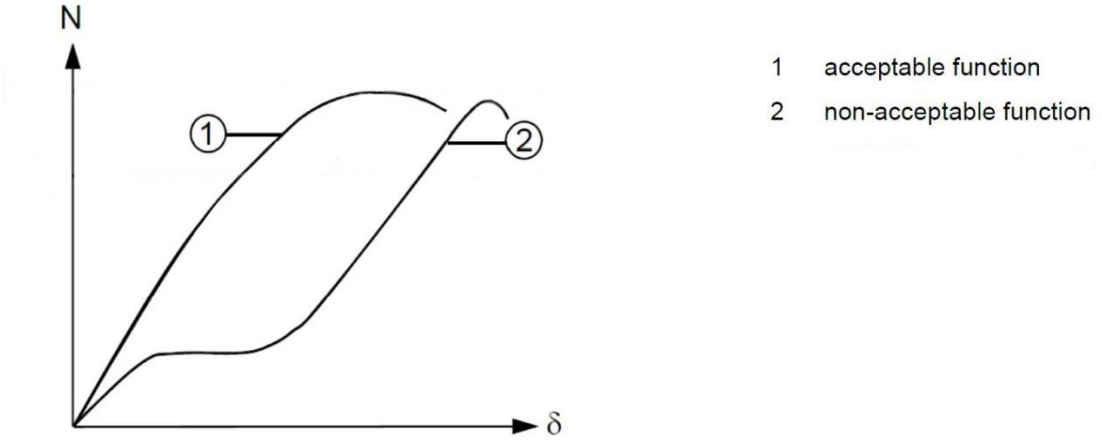


Figure A.4: Requirements for load/displacement curve