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EAD **200077-00-0103**

August 2018

European Assessment Document for

Kits for construction of a micropile –

Kits with thread bars

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

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

The “Kits for construction of a micropile – Kits with thread bars” are intended to construct micropiles. In the text the product is designated as “Kit for micropile”. An example of a micropile is shown in Figure 1.1.1.

The components of the product Kit for micropile are put together to assemble anchorages and splices, and to apply corrosion protection systems to be incorporated in the construction works. According to the intended use, see Clause 1.2.1, there are five types of the Kit for micropile:

- Kit for micropile for temporary use
- Kit for micropile for semi-permanent use
- Kit for micropile galvanised for semi-permanent use
- Kit for micropile protected by cover of mortar for permanent use
- Kit for micropile protected according to EN 1537[1], table C.2, 1., c), for permanent use.

Components of Kit for micropile for temporary use and for semi-permanent use, and of Kit for micropile protected by cover of mortar for permanent use:

Mandatory components:

- Continuously threaded steel bar, see Clause 1.1.1. The continuous thread is provided by ribs, hot rolled over the entire length of the bar – thread bar. The load bearing capacity of the Kit for micropile is determined by the thread bar.
- Components for anchorages for load transfer to the structure, see Clause 1.1.2.
- Components for splices to connect the thread bars, see Clause 1.1.3.
- Spacers, see Figure 1.1.1 and Clause 1.1.9, for maintaining a distance between thread bar and drillhole wall. These are not needed for performing the tests.
- Injection system for filling the residual void of the drillhole, see Figure 1.1.1 and Clause 1.1.9. Injection system is not needed for performing the tests.
- Pile neck sheathing, see Figure 1.1.1 and Clause 1.1.8, serves for protection and for load transfer to the micropile.

Optional component:

- Heat shrinking sleeve, see Clause 1.1.6. The heat shrinkable sleeve is shrunk on to protect the splice. Application of the heat shrinking sleeve is optional as it is related to the condition on site.

Product to install the Kit for micropile:

- Mortar, see Figure 1.1.1 and Clause 1.1.7, for filling the residual void of the drillhole. Mortar is provided at the construction site and not subject of EAD.

Components of Kit for micropile galvanised for semi-permanent use:

Mandatory components:

- Continuously threaded steel bar, see Clause 1.1.1. The continuous thread is provided by ribs, hot rolled over the entire length of the bar. The thread bar is hot-dip galvanised. The load bearing capacity of the Kit for micropile is determined by the thread bar.
- Components for anchorages for load transfer to the structure, see Clause 1.1.2.
- Components for splices to connect the thread bars, see Clause 1.1.3. The components for splices are hot-dip galvanised.

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

- Spacers, see Figure 1.1.1 and Clause 1.1.9, for maintaining a distance between thread bar and drillhole wall. These are not needed for performing the tests.
- Injection system for filling the residual void of the drillhole, see Figure 1.1.1 and Clause 1.1.9. Injection system is not needed for performing the tests.
- Pile neck sheathing, see Figure 1.1.1 and Clause 1.1.8, serves for protection and for load transfer to the micropile.

Optional component:

- Heat shrinking sleeve, see Clause 1.1.6. The heat shrinkable sleeve is shrunk on to prevent unscrewing or to protect the splice. Application of the heat shrinking sleeve is optional as it is related to the condition on site.

Product to install the Kit for micropile:

- Mortar, see Figure 1.1.1 and Clause 1.1.7, for filling the residual void of the drillhole. Mortar is provided at the construction site and not subject of EAD.

Components of Kit for micropile protected according to EN 1537, table C.2, 1., c) for permanent use:

Mandatory components:

- Continuously threaded steel bar, see Clause 1.1.1. The continuous thread is provided by ribs, hot rolled over the entire length of the bar. The load bearing capacity of the Kit for micropile is determined by the thread bar.
- Corrugated plastic sheathing, see Clause 1.1.5, slipped over the thread bar.
- Inside the corrugated plastic sheathing a plastic cord is wound helically around the thread bar, see Figure 1.1.1 and Clause 1.1.5. Alternatively, plastic inner-spacers can be installed.
- Cement grout, see Figure 1.1.1 and Clause 1.1.5, is injected inside the corrugated plastic sheathing.
- Components for anchorages for load transfer to the structure, see Clause 1.1.2.
- Components for splices to connect the thread bars, see Clause 1.1.3.
- Heat shrinking sleeve, see Clause 1.1.6. The heat shrinkable sleeve is shrunk on to prevent unscrewing and to protect the splice.
- Spacers, see Figure 1.1.1 and Clause 1.1.9, for maintaining a distance between corrugated plastic sheathing and drillhole wall. These are not needed for performing the tests.
- Injection system for filling the residual void of the drillhole, see Figure 1.1.1 and Clause 1.1.9. Injection system is not needed for performing the tests.
- Pile neck sheathing, see Figure 1.1.1 and Clause 1.1.8, serves for protection and for load transfer to the micropile.

Product to install the Kit for micropile:

- Mortar, see Figure 1.1.1 and Clause 1.1.7, for filling the residual void of the drillhole. Mortar is provided at the construction site and not subject of EAD.

Regarding mortar and grout, see Figure 1.1.1, distinction is made between:

- Grout, i.e., cement grout inside a corrugated plastic sheathing, see Clause 1.1.5, and
- Mortar filling the residual void of the drillhole, see Clause 1.1.7. Mortar is not subject of EAD.

Installation – Relevant for all five types of the Kit for micropile

On site, the Kit for micropile is installed by:

- The kit components are delivered to the construction site.
- Thread bars, possibly provided with grouted corrugated plastic sheathings, are jointed with couplers to the intended length of the micropile.
- Corrosion protection is applied to the assembled thread bars.
- The assembled thread bars are equipped with spacers and injection system.

- The thread bars, finally assembled, are inserted into a predrilled hole – drillhole.
- With the injection system the drillhole is filled with mortar, which acts both as corrosion protection and as load transfer to the micropile. The mortar is provided at the construction site.
- The pile neck sheathing is placed.
- At the protruding end of the micropile, the anchorage is installed.

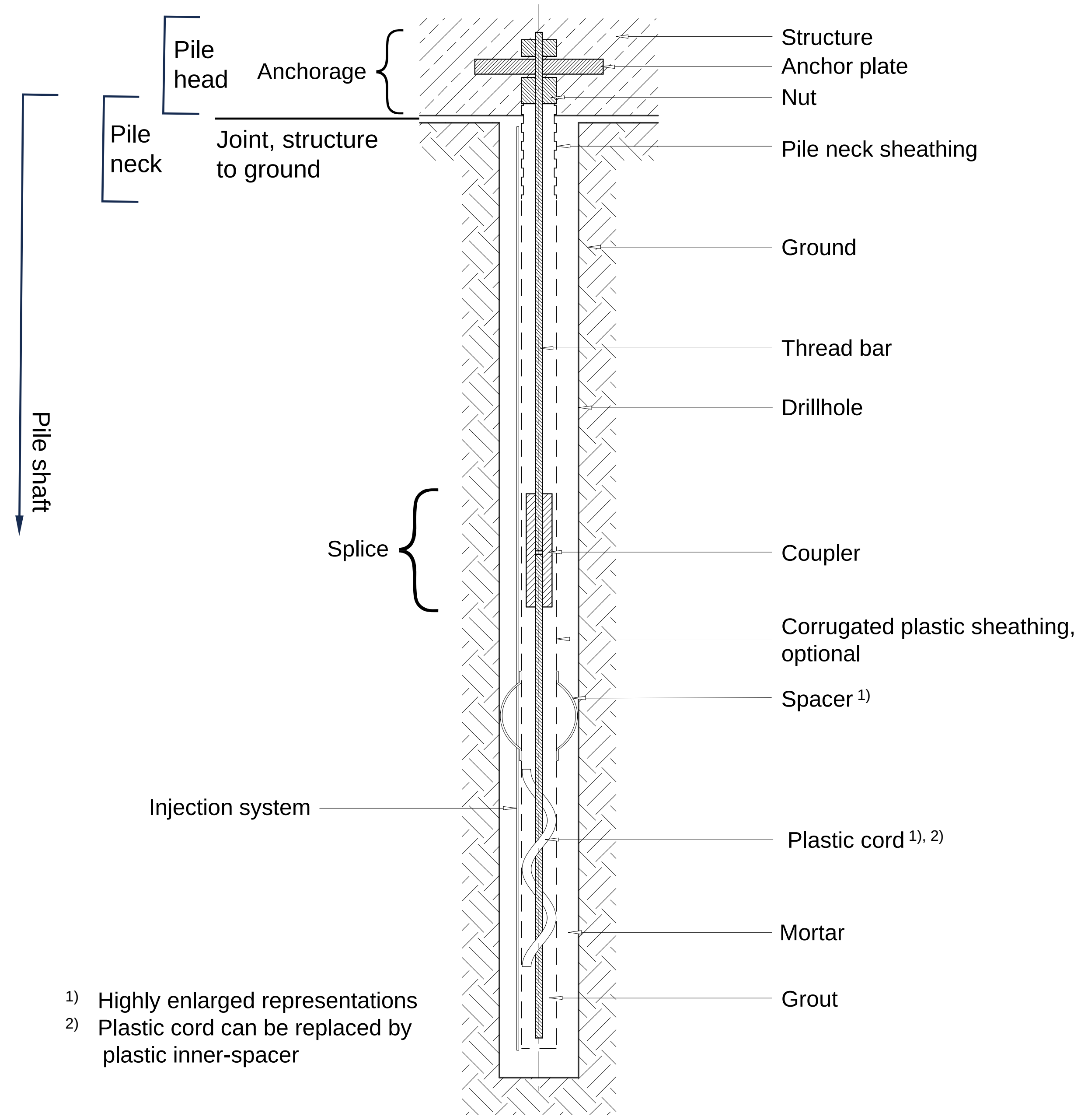

Figure 1.1.1 Micropile with thread bar – Schematic

Limited slip at anchorage and splice is 0.10 mm to 0.20 mm at maximum, dependent on the length of anchorage or splice respectively, see Figure 1.1.5, whereby length of anchorage or splice is the dimension of anchorage and splice including all nuts that is measured along the length of the thread bar, see examples of Figure 1.1.2, Figure 1.1.3, and Figure 1.1.4.

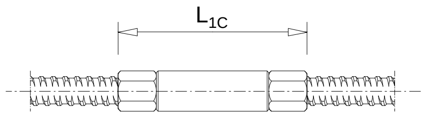

Figure 1.1.2 Length of splice – Example with torqued splice

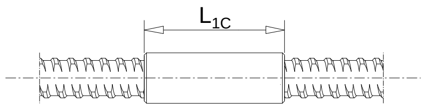

Figure 1.1.3 Length of splice – Example splice with adhesive

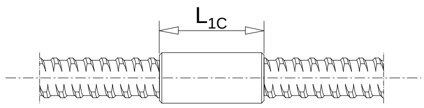

Figure 1.1.4 Length of splice – Example with contact coupler

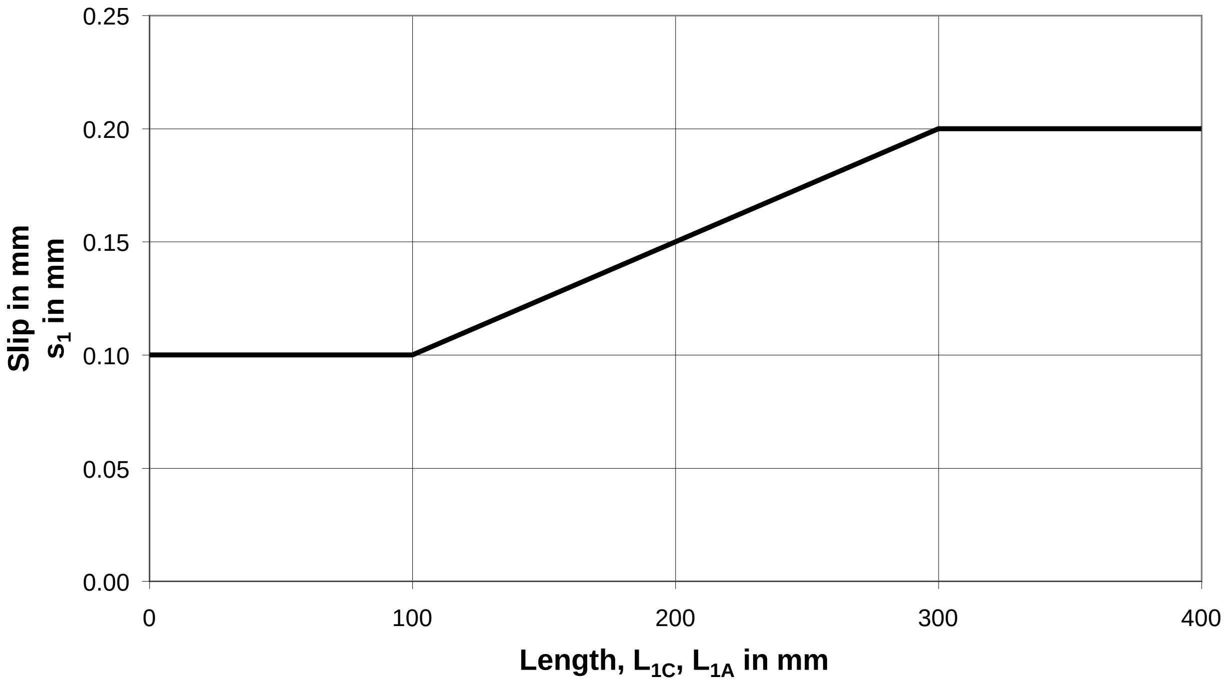

Figure 1.1.5 Maximum slip s_1 versus length of splice or length of end anchorage

Where

L_{1C}.............mm².................... Length of splice

L_{1A}.............mm².................... Length of end anchorage, see Figure 2.2.2.3.1

NOTE See Clause 2.2.2 for application of s_1.

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

The product is not covered by EAD 200036-00-0103. Thread bars and hollow bars are different technologies with different features of the bars and different installation technologies. This results in incompatible assessment procedures and different corrosion protection systems.

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

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.

1.1.1 Thread bar

1.1.1.1 General

The thread bar is a hot rolled and continuously threaded steel bar and is specifically hot rolled for the Kit for micropile. The thread is provided by hot rolled ribs. Reference diameter and reference mechanical characteristics of the thread bar are introduced, see Clause 1.1.1.2. Reference diameters shall be within 15 mm to 80 mm. Within these limits, any series of reference diameters are covered by the EAD. An example of typical series of reference diameters is given in Table 1.1.1.1.1, together with reference mechanical characteristics. These reference values are employed in product assessment.

Table 1.1.1.1.1 Thread bar – Diameters and mechanical characteristics

Example of reference diameters of thread bar	Reference yield strength	Reference tensile strength
$\varnothing_{ref}$	$R_{e,\,ref}$	$R_{m,\,ref}$
mm	MPa	MPa
18 – 22 – 25 – 28 – 30 – 35 – 43 – 50 – 57.5 – 63.5 – 75	≤ 670	≤ 800

1.1.1.2 Thread bar – Reference values

Reference values are either:

- Nominal diameters, nominal yield strength, and nominal tensile strength of the thread bars taken from the MPII.
- If these nominal values are not provided, test specimens available shall be measured and tested according to Annex A to determine the reference values.

Determined are:

- $\varnothing_{ref}$ according to Equation (1.1.1.2.1)
- S_{ref} according to Equation (1.1.1.2.2)
- $R_{e,\,ref}$ according to Equation (1.1.1.2.3)
- $R_{m,\,ref}$ according to Equation (1.1.1.2.4).

$\varnothing_{ref} = \varnothing_{nom}$ from MPII or
$\varnothing_{ref}$ according to Annex A (1.1.1.2.1)

$$S_{ref} = \frac{\varnothing_{ref}^2 \cdot \pi}{4} \quad (1.1.1.2.2)$$

$R_{e,\,ref} = R_{e,\,nom}$ from MPII or
$R_{e,\,ref}$ according to Annex A (1.1.1.2.3)

$R_{m,\,ref} = R_{m,\,nom}$ from MPII or
$R_{m,\,ref}$ according to Annex A (1.1.1.2.4)

Where

S_{ref} .... mm² .... Reference cross-sectional area of thread bar

$\varnothing_{nom}$ .... mm .... Nominal diameter of thread bar

$\varnothing_{ref}$ .... mm .... Reference diameter of thread bar

$R_{e, nom}$ .... MPa .... Nominal yield strength of thread bar

$R_{e, ref}$ .... MPa .... Reference yield strength of thread bar

$R_{m, nom}$ .... MPa .... Nominal tensile strength of thread bar

$R_{m, ref}$ .... MPa .... Reference tensile strength of thread bar.

1.1.2 Components for anchorage

The anchorage at the pile head transfers the load from the structure to the micropile. Anchorage components are made of steel. There are two anchorage assemblies, i.e., anchorage with anchor plate and anchorage with torqued anchor piece. Components for the two anchorage assemblies include:

- Kit for micropile without bursting reinforcement:
  - Anchorage with anchor plate, see Figure 1.1.1 and Figure 2.2.2.4.1, comprises:
    - Anchor plate
    - Two Nuts.
  - Anchorage with torqued anchor piece, see Figure 2.2.2.3.2 and Figure 2.2.2.3.3, comprises:
    - Anchor piece
    - One nut
    - Additional bonded length if specified in the MPII.
- Kit for micropile with bursting reinforcement:
  - Anchorage with anchor plate, see Figure 1.1.1 and Figure 2.2.2.4.1, comprises:
    - Anchor plate
    - Two Nuts
    - Bursting reinforcement if specified in the MPII.
  - Anchorage with torqued anchor piece, see Figure 2.2.2.3.2 and Figure 2.2.2.3.3, comprises:
    - Anchor piece
    - One nut
    - Additional bonded length if specified in the MPII
    - Bursting reinforcement if specified in the MPII.

Details on bursting reinforcement and whether the Kit for micropile is without bursting reinforcement or the Kit for micropile is with bursting reinforcement are given in the MPII.

1.1.3 Components for splice

The splice joints two thread bars with a coupler. Coupler is made of steel. There are splices in three coupler assemblies, i.e., torqued splice, splice with adhesive, and end-bearing splice. Components for the three coupler assemblies are:

- Coupler, locked with two nuts for a torqued splice
- Coupler with adhesive for splice with adhesive
- An unlocked contact coupler to transfer compression forces only – contact coupler for an end-bearing splice.

Included are couplers with means to prevent unscrewing, e.g., set screws, heat shrinking sleeve, or adhesive.

1.1.4 Corrosion protection system

Five corrosion protection systems are considered for the Kit for micropile, in relation with the categories of intended use, see Clause 1.2.1:

- Temporary corrosion protection
- Semi-permanent corrosion protection
- Semi-permanent corrosion protection with hot-dip galvanisation
- Permanent corrosion protection with mortar
- Permanent corrosion protection according to EN 1537, table C.2, 1., c).

These five corrosion protection systems employ three principles of corrosion protection:

- Concept of thickness sacrificed to corrosion, without and with hot-dip galvanising

  Thickness sacrificed to corrosion depends on the corrosiveness of the environment and the working life. Steel components of the Kit for micropile can be hot-dip galvanised.

  In the joint between ground and structure, a sheathing – pile neck sheathing – protects the thread bar.

- Cover of mortar

  The thread bar in the centre of the micropile shall be covered by a layer of mortar that passivates the steel surface, provided crack widths are small and there is an absence of spalling of cover of mortar in service. For corrosive environment, thickness of mortar is increased. Cover of mortar for temporary micropiles should not be less than 20 mm on the thread bar.

  The splice can be protected with a heat shrinking sleeve.

  In the joint between ground and structure, a sheathing – pile neck sheathing – protects the thread bar.

- Corrosion protection according to EN 1537, table C.2, 1., c), with a cover of grout, encapsulated in a corrugated plastic sheathing

  The thread bar shall be pre-grouted according to EN 446 with a defined cover of grout according to EN 447 in a corrugated plastic sheathing in accordance with EN 1537, clause 6.5.1.4.

  The splice is protected with a heat shrinking sleeve.

  NOTE Micropiles with corrosion protection according to EN 1537, table C.2, 1., c), are intended for use in high corrosive environments.

Corrosion protection of the anchorage at the pile head is provided by concrete of the structure.

1.1.5 Corrugated plastic sheathing – Grout

The corrugated plastic sheathing is employed for permanent corrosion protection according to EN 1537, table C.2, 1., c), for the Kit for micropile protected according to EN 1537, table C.2, 1., c), for permanent use. It provides a resistant encapsulation of thread bar and grout for corrosion protection and by the corrugation for load transfer from the grout to the mortar. The corrugated plastic sheathing shall be in accordance with EN 1537, clause 6.5.1.4.

NOTE See Clause 1.1 and Figure 1.1.1 for the distinction between grout and mortar.

For Kit for micropile protected according to EN 1537, table C.2, 1., c), for permanent use the encapsulation of the thread bar with the grouted corrugated plastic sheathing is prepared in a workshop or equivalent controlled conditions in accordance with EN 1537, table C.2, 1., c). The thread bar is provided with a wound-on plastic cord or plastic inner-spacers to maintain the distance between thread bar and corrugated plastic sheathing. The corrugated plastic sheathing is slipped on the thread bar. At one end of the corrugated plastic sheathing a plastic cap with an inlet and at the other end a vent cap are connected to the corrugated plastic sheathing. The void between thread bar and corrugated plastic sheathing is grouted with the inclined thread bar from bottom to top as specified by EN 446 and EN 1537. Cover of grout on thread bar shall be $\geq$ 5 mm and crack width in grout shall be limited. Grout serves as corrosion protection and for load transfer from thread bar to corrugated plastic sheathing.

1.1.6 Heat shrinking sleeve

Heat shrinking sleeve provides for corrosion protection of the splice and comprises:

- A polymeric backing that shrinks once exposed to elevated temperatures. The polymer backing is shaped as sleeve, similar to a flexible hose.
- The inner surface of the polymer backing is provided with an adhesive.

The EAD is only applicable to kits with heat shrinking sleeves, where at least one size of the heat shrinking sleeves can be shrunk on a 100 mm diameter cylinder.

Heat shrinking sleeve is also used to prevent unscrewing of a splice.

1.1.7 Mortar

Mortar, EN 14199, clause 3.14, provides for corrosion protection and for load transfer from thread bar to drillhole wall or corrugated plastic sheathing to drillhole wall. Mortar is provided on the construction site and is not subject of assessment within EAD. Mortar shall be in accordance with the specifications of EN 14199, clause 6.5. However, concrete according to EN 14199, clause 6.5, is not used instead of mortar.

Chemical agents that are aggressive to the mortar are considered by the use of cements designated for this aggressiveness.

NOTE 1 Aggressive chemical agents to which mortar cannot resist are possible.

NOTE 2 The aggressiveness of the chemical agents can be determined according to EN 206.

1.1.8 Pile neck sheathing

Pile neck sheathing comprises either

- Steel tube for protection and for load transfer to the micropile
- Plastic tube for protection
- Corrugated plastic sheath for protection.

The pile neck sheathing is placed at the joint ground to structure after filling the drillhole. The installed pile neck sheathing is completely filled with mortar.

1.1.9 Further components

For the outer cover of mortar, spacers provide the necessary distance between thread bar and drillhole wall or between corrugated plastic sheathing and drillhole wall.

The injection system comprises hoses and valves to fill the residual void of the drillhole.

1.2 Information on the intended uses of the construction product

1.2.1 Intended uses

The micropile constructed with the Kit for micropile is intended to be used for pile foundation of buildings and civil engineering works according to the principles for the execution of geotechnical works. Their structural functions are:

- To transfer loads to the underlying layers of the ground.
- To limit deformations.

The micropile is intended for:

- Tensile, compression, and alternating loads
- Only axial loading of the micropile
- Pile foundation as a redundant system.

Micropiles may be:

- Temporary
- Semi-permanent or

– Permanent.

The Kit for micropile is intended for the uses of Table 1.2.1.1.

Table 1.2.1.1 Types of Kit for micropile and their intended use

№	Category of intended use
1	Kit for micropile for temporary use
2	Kit for micropile for semi-permanent use
3	Kit for micropile galvanised for semi-permanent use
4	Kit for micropile protected by cover of mortar for permanent use
5	Kit for micropile protected according to EN 1537, table C.2, 1., c), for permanent use

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 Kit for micropile for the intended use of 2 years for temporary micropile, up to 50 years for semi-permanent micropile subject to sacrificial corrosion, and up to 100 years for permanent micropile when installed in the works, provided that the Kit for micropile is subject to appropriate installation, see the Clause 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 defined by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[2].

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

1.3 Specific terms used in this EAD

1.3.1 Temporary micropiles

Temporary micropiles are micropiles that are in use for up to two years.

1.3.2 Semi-permanent micropiles

Semi-permanent micropiles are micropiles subject to sacrificial corrosion that are, dependent on the ground conditions, in use for up to 50 years.

1.3.3 Permanent micropiles

Permanent micropiles are micropiles that are in use for up to 100 years, provided they are corrosion protected by a cover of mortar or by corrosion protection according to EN 1537, table C.2, 1., c).

1.3.4 Splice

Assembly of a coupler (sleeve) and two thread bars to accomplish the jointing of the two thread bars.

Splice is either a torqued splice, see Figure 1.3.6.1, a splice with adhesive, see Clause 1.3.6, or an end bearing splice, see Figure 1.3.5.1.

[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 the working life referred to above.

1.3.5 End bearing splice

Assembly of a contact coupler and two thread bars, see Figure 1.3.5.1, to accomplish a joint of the two thread bars to transfer compression loads. The compression loads are transferred directly from thread bar to thread bar via contact of the thread bars end faces.

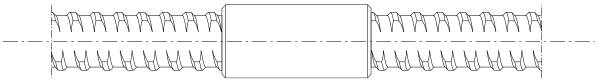

Figure 1.3.5.1 End bearing splice – Contact coupler and two thread bars – Schematic example

1.3.6 Torqued splice, splice with adhesive

Torqued splice is an assembly of a coupler and two thread bars, locked with nuts, see Figure 1.3.6.1, to accomplish a joint of the thread bars to transfer tension, compression, and alternating loads with limited slip. Splice with adhesive, see Figure 1.3.6.2, employs the same coupler without nuts and remains unlocked. Instead, an adhesive is applied inside the coupler.

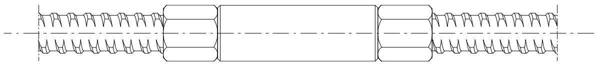

Figure 1.3.6.1 Torqued splice – Coupler, two nuts, and two thread bars – Schematic example

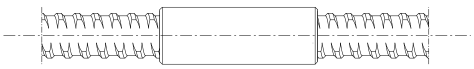

Figure 1.3.6.2 Splice with adhesive – Schematic example

1.3.7 Anchorage with anchor plate

Anchorage with anchor plate is an assembly of an anchor plate and a thread bar, locked with two nuts, see Figure 1.1.1 and Figure 1.3.7.1, to transfer tension, compression, and alternating loads with limited slip.

Anchorage with anchor plate can be installed with an additional bonded length.

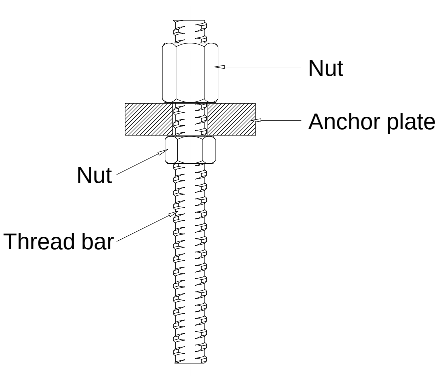

Figure 1.3.7.1 Anchorage with anchor plate – Schematic example

1.3.8 Anchorage with torqued anchor piece

Assembly of a torqued anchor piece and a thread bar, locked with one nut, see Figure 1.3.8.1, to transfer tension, compression, and alternating loads with limited slip.

Torqued anchorage is installed with an additional bonded length.

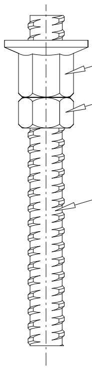

Figure 1.3.8.1 Torqued anchor piece – Schematic example

1.3.9 Contact coupler

Steel sleeve (coupler) with internal thread and without nuts, see Figure 1.3.5.1. It is used in end bearing splices to hold the ends of the thread bars in concentric contact. Compression loads are transferred directly from one thread bar end face to the other thread bar end face.

1.3.10 Coupler

Steel sleeve (coupler) with internal thread, see Figure 1.3.6.1. It is used to transfer tensile, compression, or alternating loads with reduced slip in torqued splices, locked with nuts or in splices with adhesive without nuts.

1.3.11 Anchor piece

Steel part (anchor piece) with internal thread, see Figure 1.3.11.1. It is used for torqued anchorage, generally with an additional bonded length to transfer tensile, compression, or alternating loads with limited slip. In torqued anchorage the anchor piece is locked with one nut.

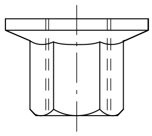

Figure 1.3.11.1 Anchor piece – Schematic example

1.3.12 Additional bonded length

The torqued anchor piece is installed with an additional bonded length extending along the thread bar adjacent to the torqued anchor piece, see Figure 2.2.2.3.2. Thereby, the load of the thread bar reduces along the additional bonded length and the torqued anchor piece only transfers a remaining part of that load.

Anchorage with anchor plate can be installed with an additional bonded length.

1.3.13 MPII

MPII are the Manufacturer's Product Installation Instructions.

1.3.14 Symbols

1.3.14.1 Description of the construction product

L_{1C} .... mm^2 .... Length of splice

L_{1A} .... mm^2 .... Length of end anchorage

1.3.14.2 Reference values

$\varnothing_{nom}$ .... mm...................... Nominal diameter of thread bar

$\varnothing_{ref}$ .... mm .... Reference diameter of thread bar
$R_{e, nom}$ .... MPa .... Nominal yield strength of thread bar
$R_{e, ref}$ .... MPa .... Reference yield strength of thread bar
$R_{m, nom}$ .... MPa .... Nominal tensile strength of thread bar
$R_{m, ref}$ .... MPa .... Reference tensile strength of thread bar
S_{ref} .... mm^2 .... Reference cross-sectional area of thread bar.

1.3.14.3 Resistance to static load

$F_{u, s}$ .... kN .... Maximum force in tensile test
$R_{e, ref}$ .... MPa .... Reference yield strength of thread bar
$R_{m, ref}$ .... MPa .... Reference tensile strength of thread bar
S_{ref} .... mm^2 .... Reference cross-sectional area of thread bar
r_t .... — .... Ratio for maximum force.

1.3.14.4 Slip

L_g .... mm .... Gauge length for displacement measurement
$R_{e, ref}$ .... MPa .... Reference yield strength of thread bar
S_{ref} .... mm^2 .... Reference cross-sectional area of thread bar
ΔL_s .... mm .... Slip of splice according to ISO 15835-2
$s_{O, 1}$ .... mm .... Slip of Option 1
$s_{O, 2}$ .... mm .... Slip of Option 2
s_1 .... mm .... Value according to Figure 1.1.5
$r_{O, 1}$, $r_{O, 2}$ .... — .... Ratios for Option 1 and Option 2
a, b .... mm .... Side lengths of specimen
h .... mm .... Height of specimen
c .... mm .... Concrete cover of reinforcement.
L_{1A} .... mm .... Length of end anchorage

1.3.14.5 Resistance to fatigue

σ_{max} .... MPa .... Upper stress level in fatigue test
$2 \cdot \sigma_a$ .... MPa .... Stress range in fatigue test, i.e., two times the stress amplitude
F_r .... kN .... Force range in fatigue test, see EN ISO 15630-1, clause 8.1
F_{up} .... kN .... Upper force in fatigue test
$R_{e, ref}$ .... MPa .... Reference yield strength of the thread bar
S_{ref} .... mm^2 .... Reference cross-sectional area of thread bar.

1.3.14.6 Load transfer to the structure

$F_{u, br}$ .... kN .... Maximum force in load transfer test for specimen with bursting reinforcement
$F_{u, 0}$ .... kN .... Maximum force in load transfer test for specimen without bursting reinforcement
$f_{cm, e}$ .... MPa .... Concrete compressive strength at time of end of load transfer test
$f_{cm, 0}$ .... MPa .... Reference concrete compressive strength for load transfer test
R_m .... MPa .... Actual tensile strength of thread bar
$R_{m, ref}$ .... MPa .... Reference tensile strength of thread bar

S_{ref} ....mm² .... Reference cross-sectional area of thread bar

$r_{LT, br}$ ....—....................... Ratio for specimen with bursting reinforcement

$r_{LT, 0}$ ....—....................... Ratio for specimen without bursting reinforcement.

1.3.14.7 Load transfer to the micropile

$F_{mean, d}$ .... N .... Mean value of all F_{mean} of reference diameter d

F_1 .... N .... Force in pull-out test at a slip of 1 mm

τ_{dk} ....MPa .... Characteristic bond strength for reference diameter d

l .... mm .... Length of bonded section in pull-out test

$f_{cm, 0}$ ....MPa .... Reference compressive strength of concrete

$f_{cm, e}$ ....MPa .... Actual mean compressive strength of concrete at end of test

$F_{0.01}$ .... N .... Force in pull-out test at a slip of 0.01 mm

$F_{0.1}$ .... N .... Force in pull-out test at a slip of 0.1 mm

d................ mm .... Reference diameter of thread bar

$R_{e, ref}$ ....MPa .... Reference yield strength of thread bar

S_{ref} ....mm² .... Reference cross-sectional area of thread bar.

$a_{1/4}$ .... mm .... Rib height at quarter-point

a_m .... mm .... Rib height at mid-point

$a_{3/4}$ .... mm .... Rib height at three-quarters-point

β ....° .... Rib inclination

b................ mm .... Width of rib

c................ mm .... Rib spacing

Σe_i .... mm .... Part of the circumference without ribs

f_R ....—....................... Relative rib area.

1.3.14.8 Corrosion protection of permanent micropile

A_0 ....N/mm .... Peel strength to steel surface at ambient temperature prior to burial in soil

A_6 ....N/mm .... Peel strength to steel surface at ambient temperature after 6 months buried in soil

A_{70} ....N/mm .... Peel strength to steel surface at 23 °C after 70 days ageing as arithmetic mean of three results

A_{100} ....N/mm .... Peel strength to steel surface at 23 °C after 100 days ageing as arithmetic mean of three results

A_T ....N/mm .... Peel strength to steel surface at 23 °C without artificial ageing

E_0 ....% .... Elongation at break at ambient temperature prior to burial in soil and at ambient temperature without artificial ageing

E_6 ....% .... Elongation at break at ambient temperature after 6 months buried in soil

E_{70} ....% .... Elongation at break at ambient temperature after 70 days ageing

E_{100} ....% .... Elongation at break at ambient temperature after 100 days ageing

P_{70} ....N/mm .... Peel strength layer to layer at 23 °C after 70 days ageing as arithmetic mean of three results

P_{100} ....N/mm .... Peel strength layer to layer at 23 °C after 100 days ageing as arithmetic mean of three results

P_T ....N/mm .... Peel strength layer to layer at 23 °C without artificial ageing

S_0 ....N/mm.................... Tensile strength at ambient temperature prior to burial in soil and at ambient temperature without artificial ageing

S_6 ....N/mm.................... Tensile strength at ambient temperature after 6 months buried in soil

S_{70}............N/mm.................... Tensile strength at ambient temperature after 70 days ageing

S_{100} ....N/mm.................... Tensile strength at ambient temperature after 100 days ageing

T_{max} .... °C....................... Maximum continuous operating temperature.

Cl^- ....ppm..................... Cl^- in adhesive

ρ_{Cl} ....µg/l...................... Concentration of Cl^- in aqueous extract

NO_3^- ....ppm..................... NO_3^- in adhesive

ρ_{NO3}............µg/l...................... Concentration of NO_3^- in aqueous extract

NO_2^-..........ppm..................... NO_2^- in adhesive

ρ_{NO3}............µg/l...................... Concentration of NO_2^- in aqueous extract

SO_4^{2-} ....ppm..................... SO_4^{2-} in adhesive

ρ_{SO4}............µg/l...................... Concentration of SO_4^{2-} in aqueous extract

S^{2-} ....ppm..................... S^{2-} in adhesive

ρ_S ....µg/l...................... Concentration of S^{2-} in aqueous extract

m_{40} .... g........................ Mass portion for extraction

1.3.14.9 Crack width in mortar

$\varnothing_{ref}$ .... mm...................... Reference diameter of thread bar

$R_{e, ref}$..........MPa..................... Reference yield strength of thread bar

S_{ref}.............mm²..................... Reference cross-sectional area of thread bar

$X_{95\ \%}$ .... mm...................... 95 % fractile

m_x, k_n, V_x....... .... Values calculated according to EN 1990, clauses 3.2.1 and 3.2.2, and Annex D, clause D.7.2.

1.3.14.10 Mass per metre

S_{ref}.............mm²..................... Reference cross-sectional area of thread bar

m_n ....kg/m..................... Reference mass per metre of thread bar

m...............kg/m..................... Actual mass per metre of thread bar

ρ...............kg/m³.................... Density, 7 850 kg/m³, for hot rolled thread bar.

1.3.14.11 Strength characteristics of thread bar

R_m/R_e ....—....................... Ratio tensile strength to yield strength

A_{gt} ....%....................... Elongation at maximum force in tensile test

E ....MPa..................... Modulus of elasticity

$(R_m/R_e)_k$........—....................... Characteristic value of the ratio tensile strength to yield strength

R_e..............MPa..................... Yield strength in tensile test

$R_{e, k}$ ....MPa..................... Characteristic value of yield strength

$R_{e, ref}$..........MPa..................... Reference yield strength of thread bar

R_m ....MPa..................... Tensile strength in tensile test

$R_{m, k}$...........MPa..................... Characteristic value of tensile strength

$R_{m, ref}$ ....MPa..................... Reference tensile strength of thread bar

S_{ref}.............mm²..................... Reference cross-sectional area of thread bar

r_{Rm}, r_{Re} .... — .... Ratios.

1.3.14.12 Modulus of elasticity

E .... MPa .... Modulus of elasticity

$R_{m, ref}$ .... MPa .... Reference tensile strength of thread bar

ε_{50} .... % .... Extension at 0.50 · $R_{m, ref}$ in force-extension diagram

ε_{20} .... % .... Extension at 0.20 · $R_{m, ref}$ in force-extension diagram

S_{ref} .... mm² .... Reference cross-sectional area of thread bar.

1.3.14.13 Elongation at maximum force

$A_{gt, k}$ .... % .... Characteristic value of elongation at maximum force.

1.3.14.14 Crack width of grout

S_{ref} .... mm² .... Reference cross-sectional area of thread bar

$R_{e, ref}$ .... MPa .... Reference yield strength of thread bar

$R_{m, ref}$ .... MPa .... Reference tensile strength of thread bar.

1.3.14.15 Determination of reference values

d_{act} .... mm .... Actual diameter of specimen

m_{act} .... kg/m .... Actual mass per metre of specimen

ρ .... kg/m³ .... Density, 7 850 kg/m³, for hot rolled thread bar

$\varnothing_{ref}$ .... mm .... Reference diameter of the group

S_{ref} .... mm² .... Reference cross-sectional area of the group

$R_{e, act}$ .... MPa .... Actual yield strength of specimen

$R_{e, mean}$ .... MPa .... Arithmetic mean of actual yield strengths of all specimens of the group

$R_{e, ref}$ .... MPa .... Reference yield strength of the group

$R_{m, act}$ .... MPa .... Actual tensile strength of specimen

$R_{m, mean}$ .... MPa .... Arithmetic mean of actual tensile strengths of all specimens of the group

$R_{m, ref}$ .... MPa .... Reference tensile strength of the group

S_{ref} .... mm² .... Reference cross-sectional area of specimen.

1.3.14.16 Load transfer test

ε .... mm/m .... Strain

ε_t .... mm/m .... Strain, measured perpendicular to loading direction – transversal strain

ε_v .... mm/m .... Strain, measured parallel to loading direction – longitudinal strain

ε_5, ε_7, ε_9, ε_{n-8}, ε_{n-6}, ε_{n-4}, ε_{n-2}, ε_n .... mm/m .... Strain, measured at specific readings.

w_5, w_7, w_9, w_{n-8}, w_{n-6}, w_{n-4}, w_{n-2}, w_n .... mm...................... Crack width, measured at specific readings.

e_x, e_y .... mm...................... Edge distance in x- and y-direction respectively

x, y .... mm...................... Minimum specified centre spacing in x- and y-direction

a, b .... mm...................... Side lengths of specimen

A_c ....mm^2..................... Gross cross-sectional concrete area of specimen

c................ mm...................... Concrete cover of reinforcement

F .... kN .... Force in load transfer test

$f_{cm,0}$ ....MPa..................... Reference concrete compressive strength for load transfer test

$f_{cm,e}$ ....MPa..................... Concrete compressive strength at time of end of load transfer test

$F_{u,br}$............ kN .... Maximum force in load transfer test for specimen with bursting reinforcement

$F_{u,0}$............. kN .... Maximum force in load transfer test for specimen without bursting reinforcement

h................ mm...................... Height of specimen

m................—...................... Number of load cycles

n.................—...................... Number of readings for measurements

$R_{m,ref}$ ....MPa..................... Reference tensile strength of thread bar

S_{ref}.............mm^2..................... Reference cross-sectional area of thread bar

w .... mm...................... Crack width

w_{max}........... mm...................... Maximum crack width.

1.3.14.17 Extraction

m_{40} .... g........................ Mass portion for extraction

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 Kit for micropile is assessed in relation to the essential characteristics. In Table E.1, the essential characteristics relevant for the categories of intended use of Table 1.2.1.1 are listed.

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

№	Essential characteristic	Assessment method	Type of expression of product performance
Basic requirement for construction works 1: Mechanical resistance and stability			
1	Resistance to static load	2.2.1	Level
2	Slip	2.2.2	Level
3	Resistance to fatigue	2.2.3	Level
4	Load transfer to the structure	2.2.4	Level and description
5	Load transfer to the micropile	2.2.5	Level and description
6	Corrosion protection of temporary micropile	2.2.6	Level and description
7	Corrosion protection of semi-permanent micropile	2.2.7	Description
8	Corrosion protection of permanent micropile	2.2.8	Level and description
9	Crack width in mortar	2.2.9	Level
10	Mass per metre	2.2.10	Level
11	Strength characteristics of thread bar	2.2.11	Level
12	Modulus of elasticity	2.2.12	Level
13	Elongation at maximum force	2.2.13	Level
14	Crack width of grout	2.2.14	Level
15	Hot-dip galvanising	2.2.15	Level

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.

If for any components covered by harmonised standards or European Technical Assessments the manufacturer of the component has included the performance regarding the relevant characteristic in the Declaration of Performance, retesting of that component for issuing the ETA under the current EAD is not required.

The assessment of the Kit for micropile shall be carried out by means of the assessment of anchorages, splices, corrosion protection systems, and thread bars that are representative for the performance of the Kit for micropile.

2.2.1 Resistance to static load

2.2.1.1 Torqued splice and splice with adhesive

Purpose of the assessment

To assess resistance to static load of torqued splice and splice with adhesive.

Assessment method

Resistance to static load including measurement of displacements of the torqued splice and the splice with adhesive shall be tested in tensile test following ISO 15835-1, clause 4, and ISO 15835-2, clauses 5.2 and 5.3, and clause 5.4 for displacement measurement. The following parameters apply in relation to ISO 15835-2, clauses 5.3 and 5.4:

- Testing of torqued splice and of splice with adhesive according to Figure 2.2.2.2.1.
- Test equipment shall be according to EN ISO 15630-1, clause 5.2.
- Tensile test shall be performed at room temperature.
- EN ISO 6892-1, clauses 10.1 and 10.2 apply.
- Force-displacement-plots shall be recorded throughout the test.
- The specimens, see Figure 2.2.2.2.1, shall be loaded in three load cycles according to Figure 2.2.2.2.2, between $0.02 \cdot R_{e,\,ref}$ and $0.65 \cdot R_{e,\,ref}$. Stresses shall be calculated with the reference cross-sectional area of the thread bar, S_{ref}.
- Testing rate for load cycles shall be according to EN ISO 6892-1, clauses 10.3.3.1, 10.3.3.2.4, and 10.3.3.2.5 whereby the crosshead separation rate applies.
- After the third load cycle the extensometer may be removed and loading shall be continued until failure of the specimens.
- Testing rate shall be according to EN ISO 6892-1, clause 10.3.3.3, whereby the crosshead separation rate applies.
- Maximum force, $F_{u,\,s}$, and location and mode of failure shall be determined.

NOTE Determination of A_{gt} according to ISO 15835-2 is not required.

With maximum force of the test, $F_{u,\,s}$, a ratio shall be calculated:

- Ratio according to Equation (2.2.1.1.1) for failure in free length of thread bar
- Ratio according to Equation (2.2.1.1.2) for failure of coupler, pull-out of thread bar, or other failure within the splice.

$$r_t = \frac{1\,000 \cdot F_{u,\,s}}{R_{m,\,ref} \cdot S_{ref}} \tag{2.2.1.1.1}$$

$$r_t = \frac{1\,000 \cdot F_{u,\,s}}{1.30 \cdot R_{e,\,ref} \cdot S_{ref}} \tag{2.2.1.1.2}$$

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$F_{u,\,s}$ .... kN .... Maximum force in tensile test

$R_{e,\,ref}$ .... MPa .... Reference yield strength of thread bar, see Clause 1.1.1.2

$R_{m,\,ref}$ .... MPa .... Reference tensile strength of thread bar, see Clause 1.1.1.2

S_{ref} .... mm² .... Reference cross-sectional area of thread bar, see Clause 1.1.1.2

r_t .... — .... Ratio for maximum force.

Expression of results

Reference tensile strength times reference cross-sectional area, $\frac{R_{m,\,ref} \cdot S_{ref}}{1\,000}$ in kN, of thread bar and minimum value of ratio r_t shall be given in the ETA.

2.2.1.2 Anchorage with torqued anchor piece

Purpose of the assessment

To assess resistance to static load of anchorage with torqued anchor piece.

Assessment method

Resistance to static load including measurement of displacement of anchorage with torqued anchor piece, shall be tested in tension according to Clause 2.2.1.1. The following items shall be considered:

- Testing of torqued anchor piece according to Figure 2.2.2.3.3.
- Ratio r_t according to Equation (2.2.1.1.1) or Equation (2.2.1.1.2) for failures according to Clause 2.2.1.1 shall be calculated.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$R_{m,\,ref}$ .... MPa .... Reference tensile strength of thread bar, see Clause 1.1.1.2

S_{ref} .... mm² .... Reference cross-sectional area of thread bar, see Clause 1.1.1.2

r_t .... — .... Ratio for maximum force.

Expression of results

Reference tensile strength times reference cross-sectional area, $\frac{R_{m,\,ref} \cdot S_{ref}}{1\,000}$ in kN, of thread bar and minimum value of ratio r_t shall be given in the ETA.

2.2.1.3 Anchorage with anchor plate

Purpose of the assessment

To assess resistance to static load of anchorage with anchor plate.

Assessment method

Resistance to static load including measurement of displacement of anchorage with anchor plate, shall be tested in tension according to Clause 2.2.1.1. The following items shall be considered:

- Testing of anchorages with anchor plate according to Figure 2.2.2.4.1.

- Ratio r_t according to Equation (2.2.1.1.1) or Equation (2.2.1.1.2) for failures according to Clause 2.2.1.1 shall be calculated.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$R_{m, ref}$ .... MPa .... Reference tensile strength of thread bar, see Clause 1.1.1.2

S_{ref} .... mm^2 .... Reference cross-sectional area of thread bar, see Clause 1.1.1.2

r_t .... — .... Ratio for maximum force.

Expression of results

Reference tensile strength times reference cross-sectional area, $\frac{R_{m, ref} \cdot S_{ref}}{1\,000}$ in kN, of thread bar and minimum value of ratio r_t shall be given in the ETA.

2.2.2 Slip

2.2.2.1 End-bearing splice

Purpose of the assessment

To assess slip of end-bearing splice.

Assessment method

Slip of end bearing splice shall be tested according to Clause 2.2.1.1, but in a compression test with the following deviations:

- For compression test, the end faces of the specimens in contact with compression testing machine shall be machined to flat and parallel load transfer planes, perpendicular to the thread bar axis.
- Length of specimens shall be length of contact coupler plus ≥ 50 mm protruding thread bar on both ends of the contact coupler.
- Testing shall be performed with a compression testing machine according to EN 12390-4. Hardened load transfer steel platens shall be inserted between testing machine and specimens.
- Force-displacement-plots shall be recorded throughout the test.
- The specimens shall be loaded in three load cycles according to Figure 2.2.2.2.2, between $0.02 \cdot R_{e, ref}$ and $0.65 \cdot R_{e, ref}$. Stresses shall be calculated with the reference cross-sectional area of the thread bar, S_{ref}.
- Compressive loading by the testing machine shall be continued after the third load cycle up to ≥ 5 ‰ strain in compression.
- Testing rate throughout the compression test shall be according to EN ISO 6892-1, clauses 10.3.3.1, 10.3.3.2.4, and 10.3.3.2.5 whereby the crosshead separation rate applies.
- Where buckling of the specimens occurs, the respective tests shall be considered as invalid.

Slip of Option 1 and Option 2 according to ISO 15835-1, clause 5.4.1, and ISO 15835-2, clauses 5.4.4 and 5.4.5, shall be determined with the force-displacement plots at $0.65 \cdot R_{e, ref}$ of the third load cycle and at $0.02 \cdot R_{e, ref}$ after the third load cycle, see Figure 2.2.2.2.2.

With slip according to Option 1, see Equation (2.2.2.1.1), Option 2, see Equation (2.2.2.1.2), and with s_1 according to Figure 1.1.5, ratios according to Equation (2.2.2.1.3) and Equation (2.2.2.1.4) shall be calculated. As length in Figure 1.1.5, the length of the coupler of the end bearing splice shall be taken, see Figure 1.1.4.

$$s_{O,1} = \Delta L_s \qquad (2.2.2.1.1)$$

For Option 1, ΔL_s according to ISO 15835-2, clause 5.4.4, shall be taken

$$s_{O,2} = \Delta L_s \qquad (2.2.2.1.2)$$

For Option 2, ΔL_s according to ISO 15835-2, clause 5.4.5, shall be taken

$$r_{O,1} = \frac{s_{O,1}}{s_1} \qquad (2.2.2.1.3)$$

$$r_{O,2} = \frac{s_{O,2}}{s_1} \qquad (2.2.2.1.4)$$

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$R_{e,ref}$...........MPa..................... Reference yield strength of thread bar, see Clause 1.1.1.2
S_{ref}.............mm²..................... Reference cross-sectional area of thread bar, see Clause 1.1.1.2
ΔL_s .... mm...................... Slip of splice according to ISO 15835-2
$s_{O,1}$ .... mm...................... Slip of Option 1
$s_{O,2}$ .... mm...................... Slip of Option 2
s_1................ mm...................... Value according to Figure 1.1.5
$r_{O,1}$, $r_{O,2}$ ....—....................... Ratios for Option 1 and Option 2.

Expression of results

- Maximum ratio $r_{O.1}$ and
- Maximum ratio $r_{O.2}$

shall be given in the ETA.

2.2.2.2 Torqued splice and splice with adhesive

Purpose of the assessment

To assess slip of torqued splice and splice with adhesive.

Assessment method

Measurement of displacement of the torqued splice and splice with adhesive shall be tested according to Clause 2.2.1.1 in tensile test. Resistance to static load and measurement of displacement of the splice can be tested in one combined test.

Slip of Option 1 and Option 2 according to ISO 15835-1, clause 5.4.1, and ISO 15835-2, clauses 5.4.4 and 5.4.5, shall be determined with the force-displacement plots, see Clause 2.2.1.1, at 0.65 · $R_{e,ref}$ of the third load cycle and at 0.02 · $R_{e,ref}$ after the third load cycle, see Figure 2.2.2.2.2. Stresses shall be calculated with the reference cross-sectional area of the thread bar, S_{ref}.

Slip of Option 1 and Option 2 according to ISO 15835-1, clause 5.4.1, and ISO 15835-2, clauses 5.4.4 and 5.4.5, shall be determined with the force-displacement-plots, see Clause 2.2.1.1, at 0.65 · $R_{e,ref}$ of the third load cycle and at 0.02 · $R_{e,ref}$ after the third load cycle, see Figure 2.2.2.2.2, see also Clause 2.2.2.1. Stresses shall be calculated with the reference cross-sectional area of the thread bar, S_{ref}.

With slip according to Option 1 and Option 2 and with s_1 according to Figure 1.1.5, ratios according to Equation (2.2.2.2.1) and Equation (2.2.2.2.2) shall be calculated. As length in Figure 1.1.5, length of coupler plus length of both nuts for torqued splice, see Figure 1.1.2, and length of coupler for splice with adhesive, see Figure 1.1.3, shall be taken.

$$r_{O,1} = \frac{s_{O,1}}{s_1} \qquad (2.2.2.2.1)$$

$$r_{O,2} = \frac{s_{O,2}}{s_1} \qquad (2.2.2.2.2)$$

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$R_{e, ref}$ .... MPa .... Reference yield strength of thread bar, see Clause 1.1.1.2

S_{ref} .... mm² .... Reference cross-sectional area of thread bar, see Clause 1.1.1.2

$s_{O, 1}$ .... mm .... Slip of Option 1

$s_{O, 2}$ .... mm .... Slip of Option 2

s_1 .... mm .... Value according to Figure 1.1.5

$r_{O, 1}$, $r_{O, 2}$ ....—....................... Ratios for Option 1 and Option 2.

Expression of results

– Maximum value of ratio $r_{O, 1}$ and

– Maximum value of ratio $r_{O, 2}$

shall be given in the ETA.

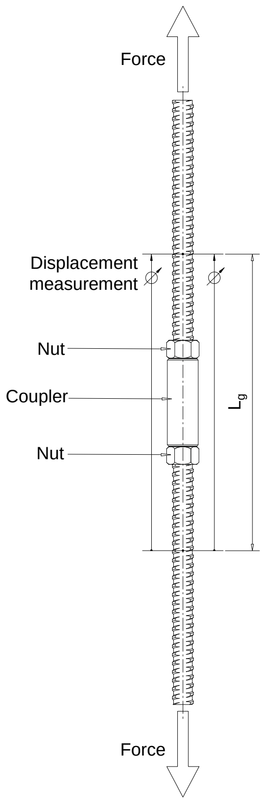

Figure 2.2.2.2.1 Torqued splice – Measurement of displacement – Schematic

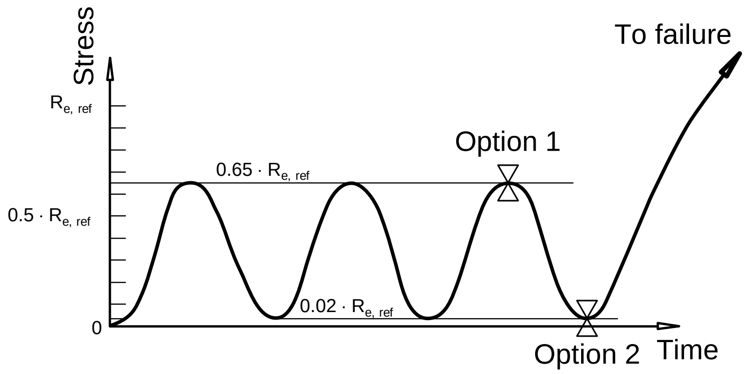

Figure 2.2.2.2.2 Slip measurement, 3 load cycles, Option 1, and Option 2

Where

L_g .... mm .... Gauge length for displacement measurement

$R_{e, ref}$ .... MPa .... Reference yield strength of thread bar, see Clause 1.1.1.2

2.2.2.3 Anchorage with torqued anchor piece

Purpose of the assessment

To assess slip of anchorage with torqued anchor piece.

Assessment method

Measurement of displacement of the torqued anchor piece shall be tested according to Clause 2.2.1.2 in tensile test. Resistance to static load and measurement of displacement of torqued anchor piece can be tested in one combined test.

Slip of Option 1 and Option 2 including calculation of ratios $r_{O,1}$ and $r_{O,2}$ shall be determined according to Clause 2.2.2.2. As length in Figure 1.1.5, the length of anchor piece plus length of nut shall be taken, see Figure 2.2.2.3.1.

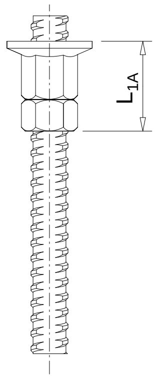

Figure 2.2.2.3.1 Length of end anchorage – Example with torqued anchor piece

For torqued anchor piece, installed with an additional bonded length, the load of the thread bar reduces along the additional bonded length and the torqued anchor piece only transfers a remaining part of that load, see also Clause 1.3.12. To consider the effect of bond, calculations shall be performed employing a mechanical model in a finite element programme, FEM programme.

Modelling

The mechanical model, see Figure 2.2.2.3.4, comprises:

- Beams representing the thread bar
- Beams representing the concrete with an additional bonded length as given in the MPII
- Springs representing bond in the additional bonded length
- Spring representing the torqued anchor piece.

Support

The support shall be at the last node of the concrete beams, see Figure 2.2.2.3.4.

Loading

The load shall be a single force on the last node of the thread bar beams, see Figure 2.2.2.3.4.

Model parameters

The parameters of the mechanical model are obtained from:

- Clause 1.1.1.2 and Clause 2.2.12 with regard to thread bar
- Clause 2.2.4.1 and Clause B.1 with regard to concrete
- Results of pull-out tests, Clause 2.2.5.4, with regard to bond
- Static load tests according to Figure 2.2.2.3.3 with regard to torqued anchor piece
- Additional bonded length is taken from the MPII.
- Stresses in thread bar shall be calculated with the reference cross-sectional area of the thread bar, S_{ref}.

Analysis

The mechanical model shall be entered into a FEM programme, capable of modelling bars and springs. Within the FEM programme, the mechanical model shall be solved when loaded to $0.65 \cdot R_{e,ref}$ and $0.02 \cdot R_{e,ref}$.

Result

Force in spring and displacement of spring representing the torqued anchor piece, see Figure 2.2.2.3.4, shall be calculated. The calculated displacement and force shall be used to determine slip of Option 1 and Option 2 and calculate ratios $r_{O,1}$ and $r_{O,2}$ with Equation (2.2.2.2.1) and Equation (2.2.2.2.2).

Load transfer test, see Figure 2.2.2.3.2 and Clause 2.2.4.1, shall be employed to validate the mechanical model. Validation is performed by comparison of displacement measured in load transfer test and displacement calculated with the mechanical model.

Record measurements and observations of testing, and description, parameters, and result of the mechanical model in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$r_{O,1}$, $r_{O,2}$ ....—...................... Ratios for Option 1 and Option 2

$R_{e,ref}$...........MPa..................... Reference yield strength of thread bar, see Clause 1.1.1.2

S_{ref}..............mm²..................... Reference cross-sectional area of thread bar, see Clause 1.1.1.2.

L_{1A}.............. mm...................... Length of end anchorage

Expression of results

For anchorage with torqued anchor piece without additional bonded length:

– Maximum value of ratio $r_{O,1}$ from tensile test,
– Maximum value of ratio $r_{O,2}$ from tensile test,

shall be given in the ETA.

For anchorage with torqued anchor piece with additional bonded length:

– Maximum value of ratio $r_{O,1}$ from mechanical model,
– Maximum value of ratio $r_{O,2}$ from mechanical model,

shall be given in the ETA.

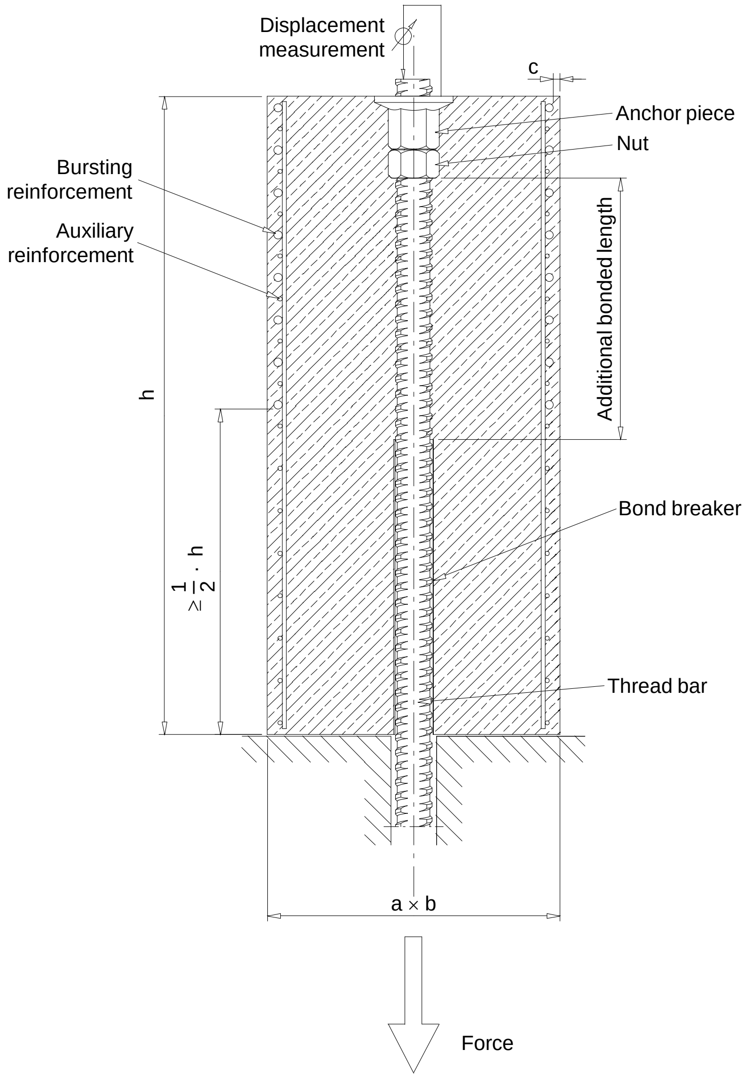

Figure 2.2.2.3.2 Anchorage with torqued anchor piece – Load transfer test – Schematic example

Where

a, b .... mm...................... Side lengths of specimen

h................. mm...................... Height of specimen

c................. mm...................... Concrete cover of reinforcement.

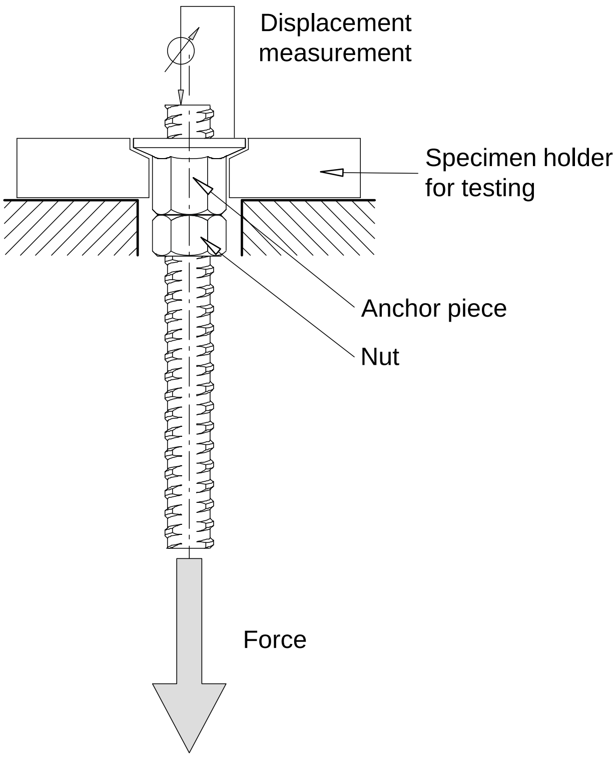

Figure 2.2.2.3.3 Anchorage with torqued anchor piece – Measurement of displacement – Schematic

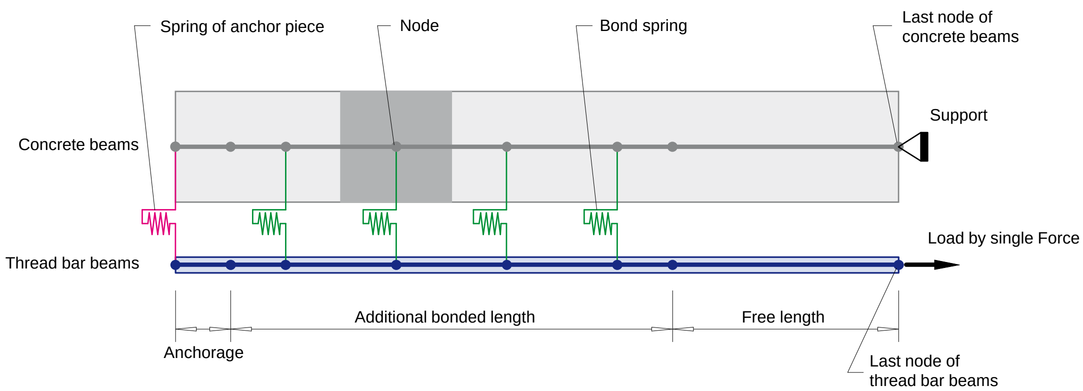

Figure 2.2.2.3.4 Anchorage with torqued anchor piece – Model for slip calculation

2.2.2.4 Anchorage with anchor plate

Purpose of the assessment

To assess slip of anchorage with anchor plate.

Assessment method

Resistance to static load including measurement of displacement of anchorage with anchor plate, shall be tested according to Clause 2.2.1.3 in tensile test. Resistance to static load and measurement of displacement of anchorage with anchor plate can be tested in one combined test.

Slip of Option 1 and Option 2 including calculation of ratios $r_{O,1}$ and $r_{O,2}$ shall be determined according to Clause 2.2.2.2. As length in Figure 1.1.5, the thickness of anchor plate plus length of nuts shall be taken.

An additional bonded length can be applied to further reduce slip. The respective assessment for an anchorage with additional bonded length shall be by calculations according to Clause 2.2.2.3.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$r_{O,1}$, $r_{O,2}$ ....—...................... Ratios for Option 1 and Option 2.

Expression of results

- Maximum value of ratio $r_{O,1}$ and
- Maximum value of ratio $r_{O,2}$

shall be given in the ETA.

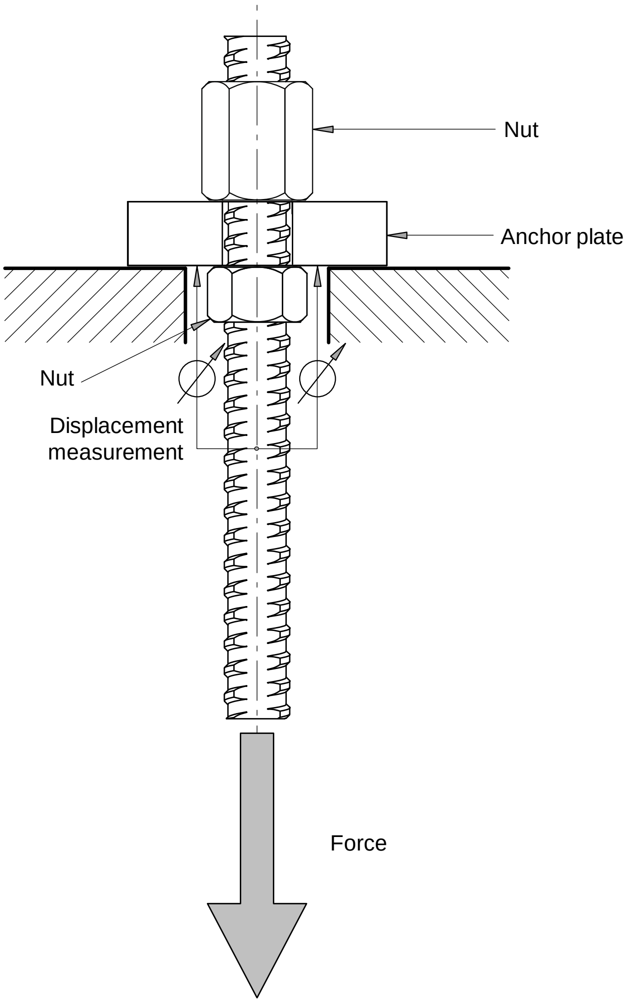

Figure 2.2.2.4.1 Anchorage with anchor plate – Displacement measurement – Schematic

2.2.3 Resistance to fatigue

The assessment of resistance to fatigue shall be carried out by means of assessment of resistance to fatigue of anchorage, splice, and thread bar that are representative of this essential characteristic for the Kit for micropile.

2.2.3.1 Resistance to fatigue of anchorage and splice

Purpose of the assessment

To assess resistance to fatigue of torqued anchorage and splice.

Assessment method

Resistance to fatigue of anchorage and splice shall be tested in tension following ISO 15835-1, clause 4 and ISO 15835-2, clauses 5.2 and 5.5.1. Anchorage and splice shall be subjected to a fatigue test according to ISO 15835-2, clause 5.5.1. The following parameters apply in relation to ISO 15835-2, clause 5.5.1:

- Upper stress level $\sigma_{max} = 0.65 \cdot R_{e,\,ref}$
- Stress range $2 \cdot \sigma_a$
- Continue the fatigue test until failure of the specimens. The fatigue test shall be terminated once $2 \cdot 10^6$ load cycles have been attained.

Stresses shall be calculated with the reference cross-sectional area of the thread bar, S_{ref}. The stress range is taken from the MPII. If the stress range is not available in the MPII, a series of pre-tests shall be carried out to determine the stress range. The pre-tests shall be performed according to ISO 15835-2 as given above with the largest thread bar. Once two consecutive pre-tests with the same stress range attain $2 \cdot 10^6$ load cycles, that stress range shall be taken.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

σ_{max} .... MPa .... Upper stress level in fatigue test

$R_{e,\,ref}$ .... MPa .... Reference yield strength of the thread bar, see Clause 1.1.1.2

S_{ref} .... mm² .... Reference cross-sectional area of thread bar, see Clause 1.1.1.2

$2 \cdot \sigma_a$ .... MPa .... Stress range in fatigue test, i.e., two times the stress amplitude.

Expression of results

- Stress range, $2 \cdot \sigma_a$, and reference cross-sectional area, S_{ref}, and
- Number of load cycles attained

shall be given in the ETA.

2.2.3.2 Resistance to fatigue of thread bar

Purpose of the assessment

To assess resistance to fatigue of thread bar.

Assessment method

Specimens of thread bar shall be tested according to EN 10080, clause 7.2.5. The thread bar shall be subjected to a fatigue test according to EN ISO 15630-1, clause 8. The following parameters apply on relation to EN ISO 15630-1, clause 8:

- Upper force, F_{up}, according to Equation (2.2.3.2.1).
- Stress range $2 \cdot \sigma_a$, i.e., a force range, F_r, according to Equation (2.2.3.2.2).
- The fatigue test shall be continued until failure of the thread bar. The fatigue test shall be terminated once $2 \cdot 10^6$ load cycles have been attained.

Stresses shall be calculated with the reference cross-sectional area of the thread bar, S_{ref}. The stress range is taken from the MPII. If the stress range is not available in the MPII, a series of pre-tests shall be carried out to determine the stress range. The pre-tests shall be performed according to EN ISO 15630-1, clause 8, as given above with the largest thread bar. Once two consecutive pre-tests with the same stress range attain $2 \cdot 10^6$ load cycles, that stress range shall be taken.

$$F_{up} = 0.7 \cdot \frac{R_{e,\,ref} \cdot S_{ref}}{1\,000} \qquad (2.2.3.2.1)$$

$$F_r = \frac{2 \cdot \sigma_a \cdot S_{ref}}{1\,000} \qquad (2.2.3.2.2)$$

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.3.

Where

F_{up} .... kN .... Upper force in fatigue test

$2 \cdot \sigma_a$ ....MPa..................... Stress range in fatigue test, i.e., two times the stress amplitude

F_r .... kN .... Force range in fatigue test, see EN ISO 15630-1, clause 8.1

$R_{e,\,ref}$ ....MPa..................... Reference yield strength of the thread bar, see Clause 1.1.1.2

S_{ref} ....mm^2..................... Reference cross-sectional area if thread bar, see Clause 1.1.1.2.

Expression of results

– Stress range, $2 \cdot \sigma_a$, and reference cross-sectional area, S_{ref}, and

– Number of load cycles attained

shall be given in the ETA.

2.2.4 Load transfer to the structure

2.2.4.1 Anchorage with torqued anchor piece

Purpose of the assessment

To assess load transfer to the structure of anchorage with torqued anchor piece.

Assessment method

The torqued anchor piece without or with bursting reinforcement and without or with additional bonded length shall be subjected to a load transfer test according to Annex B. See Figure 2.2.2.3.2, and Clause B.1 and Figure B.4.1 for concrete part and reinforcement of the specimens. Due to the additional bonded length the test shall be performed in tension, see Figure 2.2.2.3.2. The bursting reinforcement and additional bonded length are taken from Table B.1.1.

The maximum force[3], $F_{u,\,br}$, measured in the load transfer test on a specimen with bursting reinforcement shall be at least as by Equation (2.2.4.1.1).

$$F_{u,\,br} \geq 1.1 \cdot \frac{R_{m,\,ref} \cdot S_{ref}}{1\,000} \cdot \frac{f_{cm,\,e}}{f_{cm,\,0}} \qquad (2.2.4.1.1)$$

The maximum force[3], $F_{u,\,0}$, measured in the load transfer test on a specimen without bursting reinforcement shall be at least as by Equation (2.2.4.1.2).

$$F_{u,\,0} \geq 1.3 \cdot \frac{R_{m,\,ref} \cdot S_{ref}}{1\,000} \cdot \frac{f_{cm,\,e}}{f_{cm,\,0}} \qquad (2.2.4.1.2)$$

With maximum force, $F_{u,\,br}$, measured in load transfer tests on a specimen with bursting reinforcement, the ratio, $r_{LT,\,br}$, shall be calculated by Equation (2.2.4.1.3).

$$r_{LT,\,br} = \frac{1\,000 \cdot F_{u,\,br}}{R_{m,\,ref} \cdot S_{ref} \cdot \frac{f_{cm,\,e}}{f_{cm,\,0}}} \qquad (2.2.4.1.3)$$

With maximum force, $F_{u,\,0}$, measured in load transfer tests on a specimen without bursting reinforcement, the ratio, $r_{LT,\,0}$, shall be calculated by Equation (2.2.4.1.4).

$$r_{LT,\,0} = \frac{1\,000 \cdot F_{u,\,0}}{R_{m,\,ref} \cdot S_{ref} \cdot \frac{f_{cm,\,e}}{f_{cm,\,0}}} \qquad (2.2.4.1.4)$$

Concrete strength[4] at end of load transfer test shall be $f_{cm,\,e} \leq 0.8 \cdot f_{cm,\,0} + 3$, different to concrete strength according to Clause B.2. In case a thread bar with a strength of at least $R_m \cdot S_{ref} \geq 1.1 \cdot R_{m,\,ref} \cdot S_{ref}$ or

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[3] The required performance originates from EAD 160004-00-0301.

$R_m \cdot S_{ref} \geq 1.3 \cdot R_{m, ref} \cdot S_{ref}$ is available, the test can be performed with concrete strength of $f_{cm, e} \leq f_{cm, 0} + 3$.

Slip between thread bar and concrete should be measured. The measurement helps for validation of the model for slip calculation in Clause 2.2.2.3.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

- $F_{u, br}$ .... kN .... Maximum force in load transfer test for specimen with bursting reinforcement, see Annex B
- $F_{u, 0}$ .... kN .... Maximum force in load transfer test for specimen without bursting reinforcement, see Annex B
- $R_{m, ref}$ ....MPa..................... Reference tensile strength of thread bar, see Clause 1.1.1.2
- R_m ....MPa..................... Actual tensile strength of thread bar
- S_{ref}.............mm^2..................... Reference cross-sectional area of thread bar, see Clause 1.1.1.2
- $f_{cm, e}$ ....MPa..................... Concrete compressive strength at time of end of load transfer test
- $f_{cm, 0}$ ....MPa..................... Reference concrete compressive strength, see Table B.1.1
- $r_{LT, br}$ ....—....................... Ratio for specimen with bursting reinforcement
- $r_{LT, 0}$ ....—....................... Ratio for specimen without bursting reinforcement.

Expression of results

- Where the MPII explicitly excludes installation options different from the MPII, it shall be stated that the performance applies only to the options specified in the MPII.
- Description of bursting reinforcement and additional bonded length or the conclusion no bursting reinforcement and no additional bonded length and
- Minimum value of ratio $r_{LT, br}$ or minimum value of ratio $r_{LT, 0}$ and reference tensile strength times reference cross-sectional area, $\frac{R_{m, ref} \cdot S_{ref}}{1\,000}$ in kN,

shall be given in the ETA.

2.2.4.2 Anchorage with anchor plate

Purpose of the assessment

To load transfer to the structure of anchorage with anchor plate.

Assessment method

The anchorage with anchor plate shall be subjected to a load transfer test according to Annex B. The test shall be performed in compression.

The maximum force[5], $F_{u, br}$, measured in the load transfer test on a specimen with bursting reinforcement shall be at least as by Equation (2.2.4.1.1).

$$F_{u, br} \geq 1.1 \cdot \frac{R_{m, ref} \cdot S_{ref}}{1\,000} \cdot \frac{f_{cm, e}}{f_{cm, 0}} \qquad (2.2.4.1.1)$$

The maximum force[6], $F_{u, 0}$, measured in the load transfer test on a specimen without bursting reinforcement shall be at least as by Equation (2.2.4.1.2).

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[4] The criterion regarding compressive strength of concrete originates from EAD 160004-00-0301.

[5] The required performance originates from EAD 160004-00-0301.

[6] The required performance originates from EAD 160004-00-0301.

$$F_{u,0} \geq 1.3 \cdot \frac{R_{m,ref} \cdot S_{ref}}{1\,000} \cdot \frac{f_{cm,e}}{f_{cm,0}} \tag{2.2.4.1.2}$$

With maximum force, $F_{u,br}$, measured in load transfer tests on a specimen with bursting reinforcement, the ratio, $r_{LT,br}$, shall be calculated by Equation (2.2.4.1.3).

$$r_{LT,br} = \frac{1\,000 \cdot F_{u,br}}{R_{m,ref} \cdot S_{ref} \cdot \frac{f_{cm,e}}{f_{cm,0}}} \tag{2.2.4.1.3}$$

With maximum force, $F_{u,0}$, measured in load transfer tests on a specimen without bursting reinforcement, the ratio, $r_{LT,0}$, shall be calculated by Equation (2.2.4.1.4).

$$r_{LT,0} = \frac{1\,000 \cdot F_{u,0}}{R_{m,ref} \cdot S_{ref} \cdot \frac{f_{cm,e}}{f_{cm,0}}} \tag{2.2.4.1.4}$$

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$F_{u,br}$ .... kN .... Maximum force in load transfer test for specimen with bursting reinforcement, see Annex F

$F_{u,0}$ .... kN .... Maximum force in load transfer test for specimen without bursting reinforcement, see Annex F

$R_{m,ref}$ .... MPa .... Reference tensile strength of thread bar, see Clause 1.1.1.2

S_{ref} .... mm² .... Reference cross-sectional area of thread bar, see Clause 1.1.1.2

$f_{cm,e}$ .... MPa .... Concrete compressive strength at time of end of load transfer test

$f_{cm,0}$ .... MPa .... Reference concrete compressive strength, see Table B.1.1

$r_{LT,br}$ .... — .... Ratio for specimen with bursting reinforcement

$r_{LT,0}$ .... — .... Ratio for specimen without bursting reinforcement.

Expression of results

– Where the MPII explicitly excludes installation options different from the MPII, it shall be stated that the performance applies only to the options specified in the MPII.

– Description of bursting reinforcement or the conclusion no bursting reinforcement and

– Minimum value of ratio $r_{LT,br}$ or minimum value of ratio $r_{LT,0}$ and reference tensile strength times reference cross-sectional area, $\frac{R_{m,ref} \cdot S_{ref}}{1\,000}$ in kN,

shall be given in the ETA.

2.2.5 Load transfer to the micropile

2.2.5.1 General

The assessment of load transfer to the micropile shall be carried out by means of assessment of:

– Compression for the pile head, see Clause 2.2.5.2,

– Compression for the pile length with a cover of mortar, see Clause 2.2.5.2,

– Surface geometry of thread bar, see Clause 2.2.5.3, and

– Bond behaviour, see Clause 2.2.5.4,

that are representative of this essential characteristic for the Kit for micropile.

2.2.5.2 Compression test

Purpose of the assessment

To assess load transfer to the micropile in compression test.

NOTE Concerned is the micropile without corrugated plastic sheathing.

Assessment method

Compression test for the pile head and for the pile length with a cover of mortar are combined to one test, see Figure 2.2.5.2.1 for the specimens.

For compression tests the end faces of the specimens shall be machined to flat and parallel load transfer planes, perpendicular to the thread bar axis. Testing shall be performed with a compression testing machine according to EN 12390-4. Hardened load transfer steel platens shall be inserted between testing machine and specimens.

When commencing the compression test, mortar shall be at least 7 days old and compressive strength of mortar shall be ≥ 40 MPa.

Compressive loading by the testing machine shall be in subsequent steps at

(0 / 0.2 / 0.4 / 0.55 / 0.65 / 0.8 / 0.9 and 1.0) · $R_{e, ref}$. Stresses shall be calculated with the reference cross-sectional area of the thread bar, S_{ref}.

The test shall be performed force controlled. Loading speed shall be set such that approximately 5 minutes elapse from step to step and at each step holding time of approximately 5 minutes is observed. After attaining 1.0 · $R_{e, ref}$ and the 5 minutes holding time is elapsed, the specimens shall be unloaded. During holding time and after relieving the force:

- Cover of mortar shall be inspected for cracks and spalling
- Crack width shall be measured.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$R_{e, ref}$.......... MPa .... Reference yield strength of thread bar, see Clause 1.1.1.2

S_{ref}............. mm² .... Reference cross-sectional area of thread bar, see Clause 1.1.1.2.

Expression of results

- Maximum number of cracks as observed during holding time,
- Maximum crack width in mm, if any crack, measured during holding time, and
- Description of spalling of mortar or the conclusion no spalling is present

shall be given in the ETA.

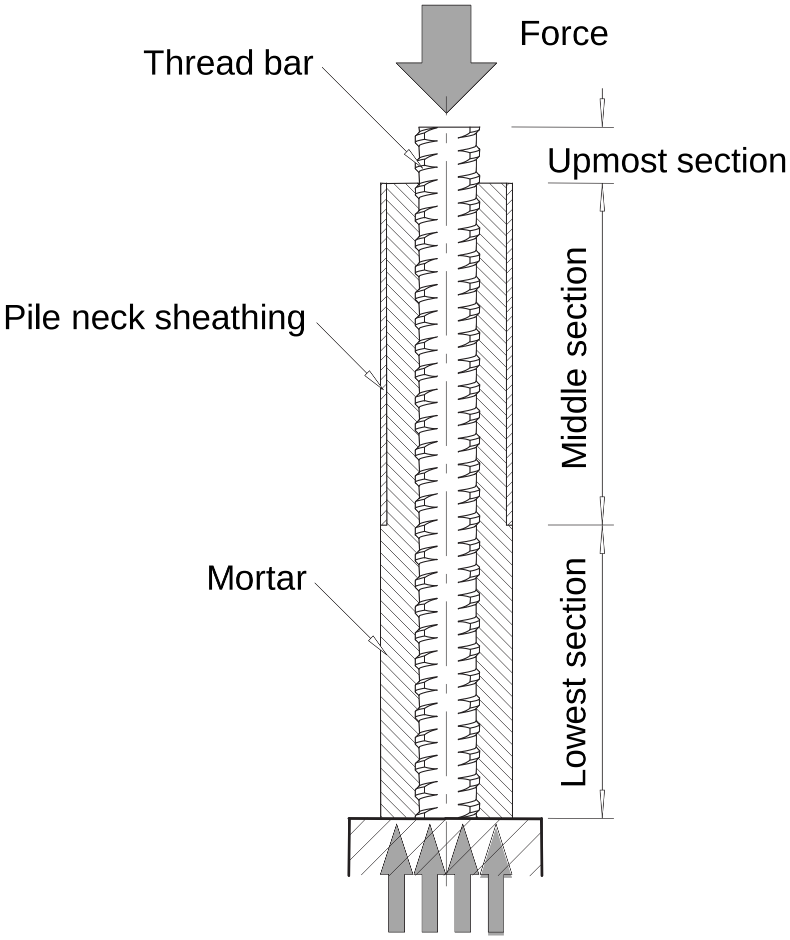

Figure 2.2.5.2.1 Compression test – Schematic

Length of lowest section shall be ≥ 6 · $\varnothing_{ref}$.

2.2.5.3 Surface geometry of thread bar

Purpose of the assessment

To assess surface geometry of thread bar.

Assessment method

Properties subject to testing shall be taken from EN 10080, clause 7.4.2. Measurement of surface geometry dimensions as well as determination of relative rib area shall be carried out in accordance with EN ISO 15630-1, clauses 10 and clause 11:

- According to EN ISO 15630-1, clause 10, whereby the clauses for rib measurement apply:
  - Test piece and test equipment according to EN ISO 15630-1, clause 10.1 and clause 10.2.
  - Rib height according to EN ISO 15630-1, clause 10.3.1.2, at quarter-point, $a_{1/4}$, mid-point, a_m, and three-quarters-point, $a_{3/4}$.
  - Rib spacing, c, according to EN ISO 15630-1, clause 10.3.3.
  - Rib inclination angle, β, according to EN ISO 15630-1, clause 10.3.6.
  - Width of rib, b, according to EN ISO 15630-1, clause 10.3.8.
- According to EN ISO 15630-1, clause 11, for relative rib area applies:
  - Measure part of the circumference without ribs, Σe, according to EN ISO 15630-1, clause 10.3.5.
  - Calculation of relative rib area, f_R, according to EN ISO 15630-1, clause 11.3.1.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$a_{1/4}$ .... mm...................... Rib height at quarter-point

a_m .... mm...................... Rib height at mid-point

$a_{3/4}$ .... mm...................... Rib height at three-quarters-point

β.................... ° .... Rib inclination

b................. mm...................... Width of rib

c................. mm...................... Rib spacing

Σe_i .... mm...................... Part of the circumference without ribs

f_R ....—....................... Relative rib area.

Expression of results

- Description of surface geometry in representations like outline drawings,
- Dimensions of surface geometry, a_m, b, c, Σe_i, and β, and
- Relative rib area f_R

shall be given in the ETA.

2.2.5.4 Bond strength

Purpose of the assessment

To assess bond strength of thread bar.

Assessment method

Specimens with thread bar shall be subjected to pull-out test following EN 10080, Annex D, to determine the bond behaviour. External dimensions of the concrete part of the specimens may be larger than 10 · d to achieve pull out as failure mode.

The characteristics as defined in EN 10080, Annex D, shall be determined.

The bond strength shall be evaluated from the results of the pull-out tests by Equation (2.2.5.4.1) and Equation (2.2.5.4.2).

$$F_{mean} = \frac{F_{0.01} + F_{0.1} + F_1}{3} \tag{2.2.5.4.1}$$

$$\tau_{dk} = \frac{F_{mean,\,d}}{d \cdot \pi \cdot l} \cdot \frac{\sqrt[3]{f_{cm,\,0}^2}}{\sqrt[3]{f_{cm,\,e}^2}} \cdot 0.7 \tag{2.2.5.4.2}$$

NOTE The coefficient 0.7 is applied in the absence of a more in-depth statistical evaluation.

Characteristic bond strength for reference diameters not tested may be interpolated.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.3.

Where

$F_{mean,\,d}$ .... N .... Mean value of all F_{mean} of reference diameter d

$F_{0.01}$ .... N .... Force in pull-out test at a slip of 0.01 mm

$F_{0.1}$ .... N .... Force in pull-out test at a slip of 0.1 mm

F_1 .... N .... Force in pull-out test at a slip of 1 mm

τ_{dk}...............MPa..................... Characteristic bond strength for reference diameter d d................ mm...................... Reference diameter of thread bar, see Clause 1.1.1.2

l.................. mm...................... Length of bonded section in pull-out test

$f_{cm,0}$............MPa..................... Reference compressive strength of concrete

$f_{cm,e}$............MPa..................... Actual mean compressive strength of concrete at end of test.

Expression of results

Characteristic bond strength, τ_{dk}, shall be given in the ETA.

2.2.6 Corrosion protection of temporary micropile

2.2.6.1 Corrosion protection

Purpose of the assessment

To assess corrosion protection of the Kit for micropile to construct a temporary micropile.

Assessment method

The Kit for micropile to construct a temporary micropile is assessed for the following established criteria and corrosion protection details of the Kit for micropile:

NOTE 1 For corrosion protection criteria take EN 14199, clauses 7.6.1, 7.6.2, first item of list, into account.

NOTE 2 Assessment of crack width according to Clause 2.2.9 is not relevant for corrosion protection of temporary micropile.

- Pile shaft

  ≥ 20 mm cover of mortar provides sufficient corrosion protection for 2 years in non-aggressive and moderate aggressive ground conditions. Basis of cover of mortar to drillhole diameter are the thread bar dimensions according to Clause 2.2.6.2.

- Splice

  ≥ 15 mm cover of mortar provides sufficient corrosion protection for 2 years in non-aggressive and moderate aggressive ground conditions. Basis of cover of mortar to drillhole diameter are the coupler dimensions according to Clause 2.2.6.3.

- Pile neck

  Pile neck of the micropile at the joint structure to ground with form-fit and force-fit connection of concrete structure to body of mortar shall be protected with a cover of mortar. ≥ 20 mm cover of mortar provides sufficient corrosion protection for 2 years in non-aggressive and moderate aggressive ground conditions, and non-aggressive outer environmental conditions. Basis of cover of mortar to drillhole diameter are the thread bar dimensions according to Clause 2.2.6.2.

  Pile neck of the micropile without form-fit and force-fit connection of concrete structure to body of mortar shall be protected with pile neck sheathing, which provides sufficient corrosion protection for 2 years in non-aggressive and moderate aggressive ground conditions, and non-aggressive and moderate aggressive outer environmental conditions.

- Pile head

  The pile head is protected by the concrete of the structure, which provides sufficient corrosion protection for 2 years in non-aggressive and aggressive outer environmental conditions.

Expression of results

The results of the assessment regarding the corrosion protection aspects

- Pile shaft
- Splice
- Pile neck
- Pile head

shall be described in the ETA.

It shall be described whether or not 2 years working life are attained and

- Reference diameter in mm, core diameter in mm, and height of ribs in mm of thread bar, and
- Main dimensions of nuts and coupler in mm

shall be given in the ETA.

2.2.6.2 Thread bar

Dimensions relevant for mortar cover are:

- Reference diameter of thread bar
- Core diameter of thread bar, i.e., diameter of thread bar between ribs
- Height of ribs.

The core diameter shall be measured with an instrument of a resolution of at least 0.1 mm. The core diameter shall be measured between the ribs, approximately in rib middle, see Figure 2.2.6.2.1.

For measurement of height of ribs see Clause 2.2.5.3. The relevant height shall be height in approximately rib middle, see Figure 2.2.6.2.1.

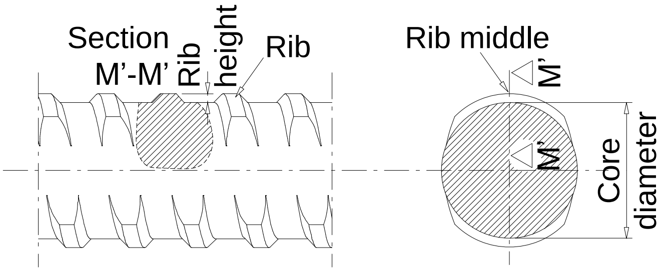

Figure 2.2.6.2.1 Dimensions – Schematic

Mean of core diameters of all specimens and mean of height of ribs of all specimens shall be calculated.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

2.2.6.3 Nuts and couplers

Shape and external dimensions of nut and coupler are relevant for mortar cover.

External dimensions of nut and coupler shall be measured with a calliper of a resolution of at least 0.1 mm. Relevant external dimensions shall be measured and indicated on outline drawings.

Mean of external dimensions shall be calculated for all specimens.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

2.2.7 Corrosion protection of semi-permanent micropile

Purpose of the assessment

To assess corrosion protection of the Kit for micropile to construct a semi-permanent micropile.

Assessment method

The Kit for micropile to construct a semi-permanent micropile is assessed for the following established criteria and corrosion protection details of the Kit for micropile:

NOTE 1 For corrosion protection criteria take EN 14199, clauses 7.6.1, 7.6.2, second item of list, into account.

NOTE 2 Assessment of crack width according to Clause 2.2.9 is not relevant for corrosion protection of semi-permanent micropile.

- Pile shaft and splice

For semi-permanent micropiles the concept of thickness sacrificed to corrosion, without and with hot-dip galvanising, is applied. This concept assumes no encapsulation by mortar, but relies on the cross section of the steel being over-dimensioned to allow for loss of material due to corrosion in the course of the required working life.

Corrosion load for metallic materials in the ground, without and with hot-dip galvanising, in accordance with EN 12501-1 and EN 12501-2. Relevant criteria are ventilation, ground structure, water content, neutral salts, pH-values, and specific ground resistance. Loss of material from long-term exposure of steel and hot-dip galvanised steel in grounds subject to the corrosion loads defined above provides sufficient corrosion protection for up to 50 years in non-aggressive, moderate aggressive, and aggressive ground conditions.

Guide values specified in EN 1993-5, Table 4-1, are observed.

– Pile neck

Pile neck of the micropile shall be protected with pile neck sheathing, which provides sufficient corrosion protection for up to 50 years in non-aggressive, moderate aggressive, and aggressive ground conditions., and non-aggressive, moderate aggressive, and aggressive outer environmental conditions.

– Pile head

The pile head is protected by the concrete of the structure, which provides sufficient corrosion protection for up to 50 years in non-aggressive, moderate aggressive, and aggressive outer environmental conditions.

Expression of results

The results of the assessment regarding the corrosion protection aspects

– Pile shaft and splice

– Pile neck

– Pile head

shall be described in the ETA. It shall be described in the ETA whether or not 50 years working life are attained.

2.2.8 Corrosion protection of permanent micropile

2.2.8.1 General

Corrosion protection of the Kit for micropile to construct a permanent micropile shall be by either:

– Cover of mortar or

– Corrosion protection according to EN 1537, table C.2, 1., c).

2.2.8.2 Corrosion protection by cover of mortar

Purpose of the assessment

To assess corrosion protection by cover of mortar of the Kit for micropile to construct a permanent micropile.

Assessment method

The Kit for micropile to construct a permanent micropile is assessed for the following established criteria and corrosion protection details of the Kit for micropile:

NOTE 1 For corrosion protection criteria take EN 14199, clauses 7.6.1, 7.6.2, first item of list, 7.6.8 into account.

NOTE 2 Crack width is assessed according to Clause 2.2.9.

– Pile shaft

Cover of mortar according to Table 2.2.8.2.2 provides sufficient corrosion protection for 100 years in non-aggressive and moderate aggressive ground conditions. Basis of cover of mortar to drillhole diameter are the thread bar dimensions according to Clause 2.2.8.4.

Table 2.2.8.2.2 Minimum cover of mortar

Cover of mortar	
Compression loading 1)	Tensile loading
mm	mm
25 2)	35 2)

1) Cover to be increased for load transfer to the micropile, see Clause 2.2.5.
2) For non-aggressive ground conditions. For moderate aggressive ground conditions cover shall be increased by 5 mm.

– Splice

Cover of mortar according to Table 2.2.8.2.2 provides sufficient corrosion protection for 100 years in non-aggressive and moderate aggressive ground conditions. Basis of cover of mortar to drillhole diameter are the coupler dimensions according to Clause 2.2.8.5.

– Pile neck

Pile neck of the micropile shall be protected with pile neck sheathing, which provides sufficient corrosion protection for 100 years in non-aggressive and moderate aggressive ground conditions, and non-aggressive and moderate aggressive outer environmental conditions

– Pile head

The pile head is protected by the concrete of the structure, which provides sufficient corrosion protection for 100 years in non-aggressive and aggressive outer environmental conditions.

Expression of results

The results of the assessment regarding the corrosion protection aspects

– Pile shaft
– Splice
– Pile neck
– Pile head

shall be described in the ETA.

It shall be described whether or not 100 years working life are attained and

– Reference diameter in mm, core diameter in mm, and height of ribs in mm of thread bar, and
– Main dimensions of nuts and coupler in mm

shall be given in the ETA.

2.2.8.3 Corrosion protection according to EN 1537, table C.2, 1., c)

Purpose of the assessment

To assess corrosion protection according to EN 1537, table C.2, 1., c), of the Kit for micropile to construct a permanent micropile.

Assessment method

The Kit for micropile to construct a permanent micropile is assessed for the following established criteria and corrosion protection details of the Kit for micropile:

NOTE 1 For corrosion protection criteria take EN 1537, clauses 6.1.4, 6.2.1.2, 6.2.3.4, 6.3.3.1, 6.4.2.1, 6.4.2.3, 6.4.2.4, 6.4.3.1 to 6.4.3.5, 6.5.1.1 to 6.5.1.4, 6.5.1.7 to 6.5.1.9, 6.5.1.12, 6.6.2.3, 6.6.2.4, 6.6.2.6, 6.7.3, 6.7.5, 6.7.6, 6.7.8 to 6.7.10, 6.7.12, 6.7.13 and table C.2 into account.

– Pile shaft and pile neck

A corrugated plastic sheathing with wall thickness according to EN 1537, clause 6.5.1.4, and an inner diameter for a cover of ≥ 5 mm of grout on the thread bar is slipped over the thread bar. The thread bar with corrugated plastic sheathing is pre-grouted, see Clause 2.2.8.6 for grout. By the layer of grout, the steel surface is passivated, provided crack widths are limited. The sheathed and grouted thread bar provides sufficient corrosion protection for 100 years in non-aggressive, moderate aggressive, and aggressive ground conditions.

NOTE 2 Crack width is assessed according to Clause 2.2.14.

– Splice

The splice is provided with a heat shrinking sleeve, see Clause 2.2.8.7. The heat shrinking sleeve overlaps the adjacent sheathed and grouted thread bars. The coupler assembly with heat shrinking sleeve provides sufficient corrosion protection for 100 years in non-aggressive, moderate aggressive and aggressive ground conditions.

– Pile head

The pile head is protected by the concrete of the structure, which provides sufficient corrosion protection for 100 years in non-aggressive and aggressive outer environmental conditions.

Expression of results

The results of the assessment regarding the corrosion protection aspects

– Pile shaft
– Splice
– Pile neck
– Pile head

shall be described in the ETA. It shall be described in the ETA whether or not 100 years working life is attained.

2.2.8.4 Thread bar

Dimensions relevant for mortar cover are:

– Reference diameter of thread bar
– Core diameter of thread bar, i.e., diameter of thread bar between ribs
– Height of ribs.

The core diameter shall be measured with an instrument of a resolution of at least 0.1 mm. The core diameter shall be measured between the ribs, approximately in rib middle, see Figure 2.2.6.2.1.

For measurement of height of ribs see Clause 2.2.5.3. The relevant height shall be height in approximately rib middle, see Figure 2.2.6.2.1.

Mean of core diameters of all specimens and mean of height of ribs of all specimens shall be calculated.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

2.2.8.5 Nuts and couplers

Shape and external dimensions of nuts and couplers are relevant for mortar cover.

External dimensions of nut and coupler shall be measured with a calliper of a resolution of at least 0.1 mm. Relevant external dimensions shall be measured and indicated on outline drawings.

Mean of external dimensions shall be calculated for all specimens.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

2.2.8.6 Grout

Purpose of the assessment

To assess corrosion protection by cover of grout of permanent micropile.

Assessment method

The assessment shall be performed by testing the grout according to EN 445 for the following items:

- Content of aggressive components, i.e., chloride (Cl^-), sulphate (SO_3^{2-}), and sulphide-ions (S^{2-}) content of cement grout shall be determined according to EN 196-2.
  - Cl^- according to EN 196-2, clause 4.5.16
  - SO_3^{2-} according to EN 196-2, clause 4.4.2
  - S^{2-} according to EN 196-2, clause 4.4.5.
- Sieve test of cement grout shall be performed according to EN 445, clause 4.2.
- Fluidity of cement grout shall be determined according to the cone method of EN 445, clause 4.3.1.
- Fluidity of cement grout shall be determined according to the grout spread method of EN 445, clause 4.3.2.
- Bleeding of cement grout shall be determined by the wick-induced method according to EN 445, clause 4.5.
- Bleeding of cement grout shall be determined by the inclined tube test method according to EN 445, clause 4.4.
- Volume change of cement grout shall be determined according to EN 445, clause 4.5.
- Compressive strength of cement grout shall be determined according to EN 445, clause 4.6.
- Setting time of cement grout shall be determined as initial setting time and as final setting time according to EN 196-3, clause 6.
- Fluid density of cement grout shall be determined according to EN 445, clause 4.7.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in EN 447.

Expression of results

Content of aggressive components in %, residue on sieve, fluidity in s, spread diameter in mm, wick-induced bleeding in %, bleeding in inclined tube in %, volume change in %, compressive strength in MPa, initial setting time in h, final setting time in h, and fluid density in kg/m^3 of grout shall be given in the ETA.

2.2.8.7 Heat shrinking sleeve

Purpose of the assessment

To assess corrosion protection by heat shrinking sleeve, see Clause 1.1.6. Heat shrinking sleeve provides the corrosion protection of the splice.

Assessment method and Expression of results

Unless otherwise specified by the manufacturer, the maximum operating temperature is T_{max} = 30 °C. Then the tests at T_{max} given below are omitted and only tests at 23 °C shall be performed. Heat shrinking sleeve shall be tested according to EN 12068 for the following items:

- Thickness of heat shrinking sleeve shall be determined after shrinking onto a circular steel bar or steel tube according to EN ISO 3126. The following parameters apply in relation to EN ISO 3126:
  - Measuring device shall be contact instrument according to EN ISO 3126, clause 4.2.1.8 and clause 5.2.1, as measurement of coating thickness with magnetic method in accordance with EN ISO 2178.
  - Thickness shall be determined according to EN ISO 3126, clause 5.1, where the measurements according to EN ISO 3126, clause 5.2.3, are taken in about the middle of the shrunk-on heat shrinking sleeve.
  - Mean wall thickness shall be calculated according to EN ISO 3126, clause 5.2.3.

  The tests shall be performed in the numbers given in Table D.4.

  Minimum wall thickness in mm shall be given in the ETA.

- Mass of adhesive of heat shrinking sleeve shall be determined by weighing specimens of 50 mm × 100 mm of the heat shrinking sleeve before and after removing the adhesive. The adhesive shall be removed from the backing by mechanical working. The backing shall be thoroughly cleaned of adhesive residues with a solvent. Mass of adhesive shall be defined by mass per unit area of heat shrinking sleeve before shrinking.

  The tests shall be performed in the numbers given in Table D.4.

  Minimum mass of adhesive per unit area in g/m^2 shall be given in the ETA.

- Tensile strength of heat shrinking sleeve shall be determined according to EN 12068, Annex A. For sizes of heat shrinking sleeve where the specimens according to EN 12068, clause A.3.1.2, cannot be taken, the tensile tests shall be performed with small specimens in shape of EN 60811-501, figure 2.

  The tests shall be performed in the numbers given in Table D.4.

  Mean tensile strength in N/mm shall be given in the ETA.

- Elongation at break of heat shrinking sleeve shall be determined according to EN 12068, Annex A. For sizes of heat shrinking sleeve where the specimens according to EN 12068, clause A.3.1.2, cannot be taken, the tensile tests shall be performed with small specimens in shape of EN 60811-501, figure 2. Elongation at break and tensile strength can be tested in one combined test.

  The tests shall be performed in the numbers given in Table D.4.

  Mean elongation at break in % shall be given in the ETA.

- Peel strength layer to layer of heat shrinking sleeve shall be determined at 23 °C and at T_{max} according to EN 12068, Annex B. The specimens shall be prepared according to EN 12068, clause B.3.2.

  NOTE Instructions for tapes do not apply.

  The tests shall be performed in the numbers given in Table D.4.

  - Mean peel strength layer to layer in N/mm at 23 °C,
  - Mean peel strength layer to layer in N/mm at T_{max}, and
  - T_{max} in °C

  shall be given in the ETA.

- Peel strength to steel surface of heat shrinking sleeve shall be determined at 23 °C and at T_{max} according to EN 12068, Annex C. The specimens shall be prepared according to EN 12068, clause C.3.

  NOTE Instructions for tapes do not apply.

  The tests shall be performed in the numbers given in Table D.4.

  - Mean peel strength to steel surface in N/mm at 23 °C,
  - Mean peel strength to steel surface in N/mm at T_{max}, and
  - T_{max} in °C

  shall be given in the ETA.

- Thermal ageing of heat shrinking sleeve shall be determined at 23 °C or at T_{max} according to EN 12068, Annex E, by means of tensile strength, elongation at break, peel strength layer to layer, and peel strength to steel surface. For thermal ageing by means of tensile strength and elongation at break the following applies in relation to EN 12068:

  - Apparatus for ageing shall be according to EN 12068, clause E.1.2.
  - Pieces of heat shrinking sleeve to take specimens for tensile strength and elongation at break shall be prepared according to EN 12068, clause E.1.3. Tensile strength and elongation at break can be tested in one combined test.
  - Ageing shall be carried out according to EN 12068, clause E.1.4.
  - After ageing the specimens for tensile strength and elongation at break shall be taken according to EN 12068, clause A.3.1.2. For sizes of heat shrinking sleeve where the specimens according to

EN 12068, clause A.3.1.2, cannot be taken, the tensile tests shall be performed with small specimens in shape of EN 60811-501, figure 2.

- Conditioning, testing in tensile test, and expression of results shall be according to EN 12068, clause A.4.1 and EN 12068, clause A.5.
- From the test results, the ratios S_{100}/S_0, E_{100}/E_0, S_{100}/S_{70}, and E_{100}/E_{70}, shall be calculated according to EN 12068, clause E.1.5.

For thermal ageing by means of peel strength layer to layer the following applies in relation to EN 12068:

- Apparatus for ageing shall be according to EN 12068, clause E.1.2.
- Specimens for peel strength layer to layer shall be prepared according to EN 12068, clause E.2.3 and EN 12068, clause B.3.2.
- Ageing shall be carried out according to EN 12068, clause E.2.4.
- After ageing, conditioning, testing, and expression of results shall be according to EN 12068, clause B.4 and EN 12068, clause B.5.

  NOTE Instructions for tapes do not apply.

- From the test results, the ratios P_{100}/P_T and P_{100}/P_{70} shall be calculated according to EN 12068, clause E.2.5.

For thermal ageing by means of peel strength to steel surface the following applies in relation to EN 12068:

- Apparatus for ageing shall be according to EN 12068, clause E.1.2.
- Specimens for peel strength to steel surface shall be prepared according to EN 12068, clause E.3.3 and EN 12068, clause C.3.

  NOTE Instructions for tapes do not apply.

- Ageing shall be carried out according to EN 12068, clause E.3.4.
- After ageing, conditioning, testing, and expression of results shall be according to EN 12068, clause E.3.4, EN 12068, clause C.4, and EN 12068, clause C.5.
- From the test results, the ratios A_{100}/A_T and A_{100}/A_{70} shall be calculated according to EN 12068, clause E.3.5.

The tests shall be performed in the numbers given in Table D.4.

- The minimum value of ratios S_{100}/S_0, E_{100}/E_0, P_{100}/P_T, A_{100}/A_T, S_{100}/S_{70}, E_{100}/E_{70}, P_{100}/P_{70}, and A_{100}/A_{70}, and
- T_{max} in °C

shall be given in the ETA. The ratios are dimensionless values.

- Indentation resistance pressure of heat shrinking sleeve shall be determined at 23 °C and at T_{max} according to EN 12068, Annex G.

  The tests shall be performed in the numbers given in Table D.4.

  - Minimum residual wall thickness in mm determined at 23 °C,
  - Minimum residual wall thickness in mm determined at T_{max},
  - Rating of the mechanical resistance according to EN 12068, Table 1, and
  - T_{max} in °C

  shall be given in the ETA.

- Impact resistance of heat shrinking sleeve shall be determined at 23 °C according to EN 12068, Annex H.

  The tests shall be performed in the numbers given in Table D.4.

  Rating of the mechanical resistance according to EN 12068, Table 1 shall be given in the ETA.

- Saponification value of adhesive shall be determined according to EN 12068, Annex L.

The tests shall be performed in the numbers given in Table D.4.

The mean saponification value in mg KHO/g shall be given in the ETA.

- Microbiological resistance of heat shrinking sleeve shall be determined according to EN 12068, Annex M, by means of tensile strength, elongation at break, and peel strength to steel surface. The specimens according to EN 12068, Annex M, shall be buried according to EN 12225. The following parameters apply in relation to EN 12225:
  - Test soil shall be according to EN 12225, clause 5.1, with biological activity according to EN 12225, clause 8.1.
  - The specimens according to EN 12068, Annex M, shall be buried according to EN 12225, clause 8.2.1 and EN 12225, clause 8.2.2. Test duration shall be 6 months.
  - After recovery of the specimens, testing shall be according to EN 12068, Annex M, for tensile strength, elongation at break, and peel strength to steel surface.

  For testing microbiological resistance by means of tensile strength and elongation at break the following applies in relation to EN 12068:

  - The specimens shall be prepared according to EN 12068, clause A.3.1.2. For sizes of heat shrinking sleeve where the specimens according to EN 12068, clause A.3.1.2, cannot be taken, the tensile tests shall be performed with small specimens in shape of EN 60811-501, figure 2. One set of specimens for testing prior to burial and a second set of specimens for testing after burial shall be prepared. Tensile strength and elongation at break can be tested in one combined test.
  - Prior to burial of the specimens, conditioning, testing in tensile test, and expression of results of one set of specimens shall be according to EN 12068, clause A.4.1 and EN 12068, clause A.5.
  - The second set of specimens shall be buried for 6 months.
  - After burial of the specimens, conditioning, testing in tensile test, and expression of results shall be according to EN 12068, clause M.5, EN 12068, clause A.4.1, and EN 12068, clause A.5.
  - From the test results, the ratios S_6/S_0 and E_6/E_0 shall be calculated EN 12068, clause M.6.

  For testing microbiological resistance by means of peel strength to steel surface the following applies in relation to EN 12068:

  - Specimens for peel strength to steel surface shall be prepared according to EN 12068, clause M.4 and EN 12068, clause C.3. One set of specimens for testing prior to burial and a second set of specimens for testing after burial of 6 months shall be prepared.

    NOTE Instructions for tapes do not apply.

  - Prior to burial of the specimens, conditioning, testing, and expression of results shall be according to EN 12068, clause M.5, EN 12068, clause C.4, and EN 12068, clause C.5.
  - The second set of specimens shall be buried for 6 months.
  - After burial of the specimens, conditioning, testing, and expression of results shall be according to EN 12068, clause M.5, EN 12068, clause C.4, and EN 12068, clause C.5.
  - From the test results, the ratios A_6/A_0 shall be calculated according to EN 12068, clause M.6.

  The tests shall be performed in the numbers given in Table D.4.

  The minimum value of ratios S_6/S_0, E_6/E_0, and A_6/A_0 shall be given in the ETA. The ratios are dimensionless values.

- Water absorption of the specimens shall be determined according to EN ISO 62. The following parameters apply in relation to EN ISO 62:
  - Apparatuses according to EN ISO 62, clause 4.
  - Specimens of 50 mm × 100 mm shall be punched out from the heat shrinking sleeve.
  - EN ISO 62, clause 6.3, method 1 shall be applied.

  The tests shall be performed in the numbers given in Table D.4.

  Mean water absorption in % shall be given in the ETA.

- Softening point of adhesive of heat shrinking sleeve shall be determined according to EN 1238. The following parameters apply in relation to EN 1238:
  - The adhesive for testing shall be removed from the backing of the heat shrinking sleeve by mechanical working and placed on the ring of the testing apparatus.
  - The rings in EN 1238, clause 5.2, are considered to deliver equivalent results. For reference the tapered ring according to EN 1238, figure 1, shall be used.
  - For softening point of adhesive below 80 °C procedure EN 1238, clause 8.2, and for softening point of adhesive above 80 °C procedure EN 1238, clause 8.3, shall be applied.

  The tests shall be performed in the numbers given in Table D.4.

  Mean softening point in °C shall be given in the ETA.

- Oxygen stability of adhesive of heat shrinking sleeve shall be determined according to EN ISO 11357-6. The following parameters apply in relation to EN ISO 11357-6:
  - The adhesive for testing shall be removed from the backing of the heat shrinking sleeve by mechanical working.
  - For an adhesive that can be cut, specimen with thickness of (650 ± 100) μm shall be cut.
  - For an adhesive that cannot be cut, specimen with a mass of (15 ± 2) mg shall be placed directly on the crucible. The top of the specimen need not to be flat.
  - Testing temperature shall be 100 °C.
  - Heating of specimen shall be under nitrogen flow.
  - Testing shall be under oxygen flow.

  The tests shall be performed in the numbers given in Table D.4.

  Oxidation induction time in min shall be given in the ETA.

- Resistance to salt spray of adhesive shall be determined according to EN ISO 9227 with NSS test procedure at (35 ± 2) °C and for 168 hours. Specimens shall be a smooth structural steel plate. The plate shall be covered with a layer of adhesive, corresponding to the mass per unit area of adhesive of the heat shrinking sleeve.

  Once salt spray is completed, the specimens shall be inspected for signs of corrosion.

  The tests shall be performed in the numbers given in Table D.4.

  Description of signs of corrosion or the conclusion no corrosion present shall be given in the ETA.

- Aggressive components[7] in adhesive of heat shrinking sleeve shall be determined by ion chromatography method.

  The adhesive shall be subjected to the extraction method according to Annex C.

  Cl^- shall be determined[7] according to EN ISO 10304-4 and Equation (2.2.8.7.1).

$$Cl^- = \frac{0.16 \cdot \rho_{Cl}}{m_{40}} \qquad (2.2.8.7.1)$$

  - $Cl^- \leq 50$ ppm

  NO_3^-, NO_2^-, and SO_4^{2-} shall be determined[7] according to EN ISO 10304-1 and Equation (2.2.8.7.2), Equation (2.2.8.7.3), and Equation (2.2.8.7.4).

$$NO_3^- = \frac{0.16 \cdot \rho_{NO3}}{m_{40}} \qquad (2.2.8.7.2)$$

[7] The required performance regarding aggressive components originates from EAD 160027-00-0301.

$$NO_2^- = \frac{0.16 \cdot \rho_{NO2}}{m_{40}} \qquad (2.2.8.7.3)$$

$$SO_4^{2-} = \frac{0.16 \cdot \rho_{SO4}}{m_{40}} \qquad (2.2.8.7.4)$$

- $NO_3^- \leq 50$ ppm
- $NO_2^- \leq 10$ ppm
- $SO_4^{2-} \leq 100$ ppm

S^{2-} shall be determined[8] by a common ion chromatography method and Equation (2.2.8.7.5).

$$S^{2-} = \frac{0.16 \cdot \rho_S}{m_{40}} \qquad (2.2.8.7.5)$$

- $S^{2-} \leq 50$ ppm

The tests shall be performed in the numbers given in Table D.4.

Content of Cl^-, NO_3^-, NO_2^-, SO_4^{2-}, and S^{2-} in ppm shall be given in the ETA.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.4.

Where

A_0 ....N/mm.................... Peel strength to steel surface at ambient temperature prior to burial in soil

A_6 ....N/mm.................... Peel strength to steel surface at ambient temperature after 6 months buried in soil

A_{70} ....N/mm.................... Peel strength to steel surface at 23 °C after 70 days ageing as arithmetic mean of three results

A_{100} ....N/mm.................... Peel strength to steel surface at 23 °C after 100 days ageing as arithmetic mean of three results

A_T ....N/mm.................... Peel strength to steel surface at 23 °C without artificial ageing

E_0 ....%....................... Elongation at break at ambient temperature prior to burial in soil and at ambient temperature without artificial ageing

E_6 ....%....................... Elongation at break at ambient temperature after 6 months buried in soil

E_{70} ....%....................... Elongation at break at ambient temperature after 70 days ageing

E_{100} ....%....................... Elongation at break at ambient temperature after 100 days ageing

P_{70} ....N/mm.................... Peel strength layer to layer at 23 °C after 70 days ageing as arithmetic mean of three results

P_{100} ....N/mm.................... Peel strength layer to layer at 23 °C after 100 days ageing as arithmetic mean of three results

P_T ....N/mm.................... Peel strength layer to layer at 23 °C without artificial ageing

S_0 ....N/mm.................... Tensile strength at ambient temperature prior to burial in soil and at ambient temperature without artificial ageing

S_6 ....N/mm.................... Tensile strength at ambient temperature after 6 months buried in soil

S_{70} ....N/mm.................... Tensile strength at ambient temperature after 70 days ageing

S_{100} ....N/mm.................... Tensile strength at ambient temperature after 100 days ageing

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[8] The required performance regarding aggressive components originates from EAD 160027-00-0301.

T_{max} .... °C...................... Maximum continuous operating temperature.

Cl^- .... ppm .... Cl^- in adhesive

ρ_{Cl} ....µg/l..................... Concentration of Cl^- in aqueous extract

NO_3^-........... ppm .... NO_3^- in adhesive

ρ_{NO3}............µg/l..................... Concentration of NO_3^- in aqueous extract

NO_2^-.......... ppm .... NO_2^- in adhesive

ρ_{NO3}............µg/l..................... Concentration of NO_2^- in aqueous extract

SO_4^{2-} .... ppm .... SO_4^{2-} in adhesive

ρ_{SO4}............µg/l..................... Concentration of SO_4^{2-} in aqueous extract

S^{2-} .... ppm .... S^{2-} in adhesive

ρ_S ....µg/l..................... Concentration of S^{2-} in aqueous extract

m_{40} .... g....................... Mass portion for extraction, see Annex C

2.2.9 Crack width in mortar

Purpose of the assessment

To assess crack width in mortar for permanent micropiles.

Assessment method

Crack width in mortar shall be tested in tension. Specimens for testing crack width in mortar comprises a one-piece thread bar with cover of mortar.

Table 2.2.9.1 Parameter of specimens for testing crack width in mortar

Parameter	Parameter specified in MPII [1)]	Parameter not specified in the MPII
1	2	3
Mortar composition	Mortar composition as specified in the MPII.	– CEM I or CEM II cement according to EN 197-1 – Tap water – Water to cement ratio 0.4
Mortar cover	Cover of mortar according to the MPII.	Cover of mortar according to Equation (2.2.9.1).

1) If the MPII allows for deviating parameters besides the specified parameters of column 2 of Table 2.2.9.1, the tests shall be performed with the parameters of column 3 of Table 2.2.9.1. Additional tests can be performed with the parameters of column 2 of Table 2.2.9.1.

$$\text{Cover of mortar} \geq \max \begin{cases} 0.50 \cdot \varnothing_{ref} \\ 35\text{ mm} \end{cases} \qquad (2.2.9.1)$$

The bar is placed vertically and attached to a frame. The formwork is placed concentrically to the bar and attached to the frame to hold it in position while moulding the specimen. In the mortar body, two injection channels shall be arranged parallel to the thread bar, opposite each other and close to the surface of the thread bar. The injection channels shall be formed by circular plastic cords or similar that shall be pulled at an early age after setting of the mortar.

Loading of the specimens shall be performed in a test rig. The ends of the thread bars are attached to the restraining and loading devices of the test rig with grips or with nuts screwed onto the thread bars. When commencing the test, mortar shall be at least 7 days old and compressive strength of mortar shall be ≥ 25 MPa.

Loading by the test rig shall be performed in subsequent steps at:

(0 / 0.19 / 0.38 / 0.57 / 0.65 / 0.76 and 0.95) · $R_{e, ref}$. Stresses shall be calculated with the reference cross-sectional area of the thread bar, S_{ref}.

The test shall be performed force controlled. Loading speed shall be set such that approximately 1 minute elapse from step to step. Holding time of approximately 1 minute shall be observed at each step or extended until crack width measurement is completed. After holding time of last load step is elapsed, the specimens shall be unloaded.

The specimens shall be prepared for resin injection and loaded to 0.65 · $R_{e, ref}$. The two-component resin shall have a low viscosity and shall be able to penetrate cracks of width ≤ 0.05 mm. This shall be verified during testing.

Resin shall be injected in the voids to conserve the crack pattern inside mortar while the force shall be maintained until the resin is hardened.

Subsequently the specimens shall be unloaded and removed from the test rig. To enable inspection of the conserved crack pattern, the specimens shall be cut longitudinally with 3 cuts and opened. Crack widths of conserved cracks shall be measured close to the surface of the thread bar.

Crack width of mortar shall be determined as 95 % fractile according to EN 1990, Annex D. k_n shall be taken from EN 1990, Table D.1 for unknown V_x. Calculation of 95 % fractile shall be by Equation (2.2.9.2).

$$X_{95\,\%} = m_x \cdot (1 + k_n \cdot V_x) \tag{2.2.9.2}$$

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.2.

Where

$\varnothing_{ref}$ .... mm...................... Reference diameter of thread bar, see Clause 1.1.1.2

$R_{e, ref}$...........MPa..................... Reference yield strength of thread bar, see Clause 1.1.1.2

S_{ref}.............mm^2..................... Reference cross-sectional area of thread bar, see Clause 1.1.1.2

$X_{95\,\%}$........... mm...................... 95 % fractile

m_x, k_n, V_x....... .... Values calculated according to EN 1990, clauses 3.2.1 and 3.2.2, and Annex D, clause D.7.2.

Expression of results

95 % fractile of crack widths in mm shall be given in the ETA.

2.2.10 Mass per metre

Purpose of the assessment

To assess reference mass per metre and deviation of reference mass per metre.

Assessment method

Reference mass shall be calculated by Equation (2.2.10.1).

$$m_{ref} = \frac{S_{ref} \cdot \rho}{10^6} \tag{2.2.10.1}$$

Actual mass per metre of thread bar shall be determined according to EN ISO 15630-1, clause 12. The actual mass per metre, m, shall be calculated as the quotient of the specimens mass in kg, divided by the specimens length in m.

Deviation of reference mass in % shall be determined by Equation (2.2.10.2).

$$\left(\frac{m}{m_{ref}} - 1\right) \cdot 100 \qquad (2.2.10.2)$$

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.3.

Where

S_{ref}.............mm²..................... Reference cross-sectional area of thread bar, see Clause 1.1.1.2

m_{ref} ....kg/m..................... Reference mass per metre of thread bar

m................kg/m..................... Actual mass per metre of thread bar

ρ................kg/m³.................... Density, 7 850 kg/m³, for hot rolled thread bar.

Expression of results

Range of deviation of reference mass in % and reference mass per metre, m_{ref}, shall be given in the ETA.

2.2.11 Strength characteristics of thread bar

Purpose of the assessment

To assess strength characteristics of thread bar.

Assessment method

Strength characteristics shall be determined in tension. The stress values shall be calculated based on the reference cross-sectional area, S_{ref}. Relevant characteristics in tensile test, see also EN 10080, clause 7.2.3, are:

- Tensile strength, R_m
- Yield strength, R_e
- Ratio tensile strength to yield strength, R_m/R_e
- Elongation at maximum force, A_{gt}
- Modulus of elasticity, E, shall be determined with the force-extension diagram of the tensile test, see Clause 2.2.12.

The tensile test on specimens of thread bar shall be carried out in accordance with EN ISO 15630-1, clause 5. The following parameters and procedures apply in relation to EN ISO 15630-1:

- Specimens shall be according to EN ISO 15630-1, clause 4, without artificial ageing and according to EN ISO 15630-1, clause 5.1, see also Figure 2.2.11.1.

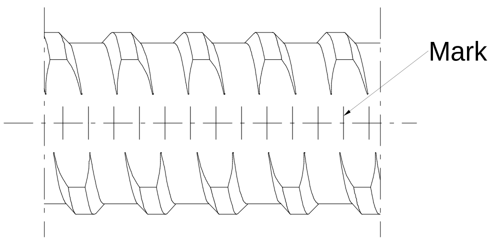


Figure 2.2.11.1 Thread bar with applied marks for elongation measurement – Schematic

- Test equipment shall be according to EN ISO 15630-1, clause 5.2.
- Tensile test shall be performed at room temperature.
- EN ISO 6892-1, clauses 10.1 and 10.2 apply.
- Force-extension diagram shall be recorded.
- Testing rate shall be according to EN ISO 6892-1, clauses 10.3.3.1, 10.3.3.2.1, 10.3.3.2.4, 10.3.3.2.5, and 10.3.3.3, whereby the crosshead separation rate applies.

– Determination of R_e shall be according to EN ISO 6892-1, clauses 11 and 13, or EN ISO 15630-1, clause 5.3. These procedures are considered as equivalent. Reference procedure for proof strength is EN ISO 15630-1, clause 5.3, second method.
– Determination of R_m shall be with the maximum force in tensile test, considering EN ISO 15630-1, clause 5.3.
– Determination of A_{gt} shall be according to EN ISO 15630-1, clause 5.3, and EN ISO 6892-1, clause 3.4. Reference procedure is the manual method.
– From yield strength, R_e, and tensile strength, R_m, the ratio tensile strength to yield strength, R_m/R_e, shall be calculated according to Equation (2.2.11.1).

$$R_m/R_e = \frac{R_m}{R_e} \tag{2.2.11.1}$$

Characteristic values shall be calculated according to EN 10080, clause 8.5.2:

– Tensile strength, R_m, with 5 % fractile as characteristic value, $R_{m,\,k}$
– Yield strength, R_e, with 5 % fractile as characteristic value, $R_{e,\,k}$
– Ratio tensile strength to yield strength with 10 % fractile as characteristic value, $(R_m/R_e)_k$

With characteristic values and reference values of tensile strength and yield strength, ratios according to Equation (2.2.11.2) and Equation (2.2.11.3) shall be calculated.

$$r_{Rm} = \frac{R_{m,\,k}}{R_{m,\,ref}} \tag{2.2.11.2}$$

$$r_{Re} = \frac{R_{e,\,k}}{R_{e,\,ref}} \tag{2.2.11.3}$$

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.3.

Where

R_m/R_e .... — .... Ratio tensile strength to yield strength
A_{gt} .... % .... Elongation at maximum force in tensile test
E .... MPa .... Modulus of elasticity
$(R_m/R_e)_k$ .... — .... Characteristic value of the ratio tensile strength to yield strength
R_e .... MPa .... Yield strength in tensile test
$R_{e,\,k}$ .... MPa .... Characteristic value of yield strength
$R_{e,\,ref}$ .... MPa .... Reference yield strength of thread bar, see Clause 1.1.1.2
R_m .... MPa .... Tensile strength in tensile test
$R_{m,\,k}$ .... MPa .... Characteristic value of tensile strength
$R_{m,\,ref}$ .... MPa .... Reference tensile strength of thread bar, see Clause 1.1.1.2
S_{ref} .... mm^2 .... Reference cross-sectional area of thread bar, see Clause 1.1.1.2
r_{Rm}, r_{Re} .... — .... Ratios.

Expression of results

– Minimum ratio r_{Re} and reference yield strength, $R_{e,\,ref}$,
– Minimum ratio r_{Rm} and reference tensile strength, $R_{m,\,ref}$, and
– Characteristic ratio tensile strength to yield strength, $(R_m/R_e)_k$

shall be given in the ETA.

2.2.12 Modulus of elasticity

Purpose of the assessment

To assess modulus of elasticity of thread bar.

Assessment method

Modulus of elasticity shall be determined with the force-extension diagram according to Clause 2.2.11. The modulus of elasticity shall be calculated as secant modulus in the force-extension diagram between $0.20 \cdot R_{m,\,ref} \cdot S_{ref}$ and $0.50 \cdot R_{m,\,ref} \cdot S_{ref}$ by Equation (2.2.12.1).

Modulus of elasticity and strength characteristics can be tested in one combined test.

$$E = \frac{0.50 \cdot R_{m,\,ref} - 0.20 \cdot R_{m,\,ref}}{\varepsilon_{50} - \varepsilon_{20}} \cdot 100 \qquad (2.2.12.1)$$

The mean value shall be calculated for modulus of elasticity.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.3.

Where

E ....MPa..................... Modulus of elasticity

$R_{m,\,ref}$ ....MPa..................... Reference tensile strength of thread bar, see Clause 1.1.1.2

ε_{50} ....%....................... Extension at $0.50 \cdot R_{m,\,ref}$ in force-extension diagram

ε_{20} ....%....................... Extension at $0.20 \cdot R_{m,\,ref}$ in force-extension diagram

S_{ref}.............mm²..................... Reference cross-sectional area of thread bar, see Clause 1.1.1.2.

Expression of results

Arithmetic mean of modulus of elasticity, E, and reference cross-sectional area, S_{ref}, shall be given in the ETA.

2.2.13 Elongation at maximum force

Purpose of the assessment

To assess elongation at maximum force of thread bar.

Assessment method

Elongation at maximum force shall be determined according to Clause 2.2.11. Elongation at maximum force and strength characteristics can be tested in one combined test.

Characteristic values of elongation at maximum force shall be calculated according to EN 10080, clause 8.5.2:

– Elongation at maximum force with 10 % fractile as characteristic value, $A_{gt,\,k}$.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in Table D.3.

Where

$A_{gt,\,k}$..............%....................... Characteristic value of elongation at maximum force.

Expression of results

Characteristic elongation at maximum force, $A_{gt,\,k}$, shall be given in the ETA.

2.2.14 Crack width of grout

Purpose of the assessment

To assess crack width of grout.

Assessment method

Crack width of grout shall be tested following EN 1537, Annex A, test A and test B.

The forces referred to in EN 1537, Annex A, are:

- As maximum load the force $\geq \min \begin{cases} 0.95 \cdot R_{e,\,ref} \cdot S_{ref} \\ 0.80 \cdot R_{m,\,ref} \cdot S_{ref} \end{cases}$ shall be applied.
- As lock-off load the force $\geq 0.65 \cdot R_{e,\,ref} \cdot S_{ref}$ shall be applied.

NOTE For the term lock-off load see EN 1537, clause 3.1.17.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers given in EN 1537, clause 6.7.13.

Where

S_{ref}............. mm^2..................... Reference cross-sectional area of thread bar, see Clause 1.1.1.2

$R_{e,\,ref}$........... MPa..................... Reference yield strength of thread bar, see Clause 1.1.1.2

$R_{m,\,ref}$.......... MPa..................... Reference tensile strength of thread bar, see Clause 1.1.1.2.

Expression of results

Maximum of crack width in mm determined in test A and test B shall be given in the ETA.

2.2.15 Hot-dip galvanising

Purpose of the assessment

To assess coating thickness of hot-dip galvanised components.

Assessment method

Thread bar and components for splice and anchorage shall be hot-dip galvanised according to EN ISO 1461. The extent of testing and coating properties are given in EN ISO 1461. Testing shall be in accordance with EN ISO 2178.

Record measurements and observations in accordance with Annex F.

The tests shall be performed in the numbers:

- 3 reference diameters hot-dip galvanised thread bars with 1 specimen each reference diameter and
- 3 hot-dip galvanised components – nut or coupler – of different reference diameters.

Expression of results

Mean coating thickness in mm of hot-dip galvanisation shall be given in the ETA.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System of assessment and verification of constancy of performance to be applied

For the product covered by this EAD, the applicable European legal act is Commission Decision 98/214/EC as amended by Commission Decision 2001/596/EC.

The system is 2+.

3.2 Tasks of the manufacturer

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

The manufacturer (regarding the components he buys from the market with Declaration of Performance) shall take into account the Declaration of Performance issued by the manufacturer of that component. No retesting is necessary.

Table 3.2.1 Control plan for the manufacturer – Cornerstones

№	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples [1]	Minimum frequency of control
Factory production control (FPC), including testing of samples taken at the factory in accordance with a prescribed test plan					
1	Static load test of anchorage Anchorage with torqued anchor piece Anchorage with anchor plate	 2.2.1.2 2.2.1.3	[2]	0.2 % [3], [4] ≥ 2 [4] 0.2 % [3], [4] ≥ 2 [4]	per year
2	Static load test of anchorage including measurement of slip Anchorage with torqued anchor piece Anchorage with anchor plate	 2.2.1.2, 2.2.2.3 2.2.1.3, 2.2.2.4	[2]	3 [4] 3 [4]	per year
3	Static load test of torqued splice and splice with adhesive	2.2.1.1	[2]	0.2 % [3], [4] ≥ 2 [4]	per year
4	Static load test of torqued splice and splice with adhesive including measurement of slip	2.2.1.1, 2.2.2.2	[2]	3 [4]	per year
5	Resistance to fatigue of anchorage Anchorage with torqued anchor piece Anchorage with anchor plate	2.2.3.1	[2]	1 [4] 1 [4]	per year
6	Resistance to fatigue of torqued splice [5]	2.2.3.1	[2]	1 [4]	per year
7	Thread bar Cross-sectional area, mass per metre, tolerance on mass per metre Surface geometry [6] Strength characteristics [6] $\varnothing_{ref}$ < 57.5 mm $\varnothing_{ref} \geq$ 57.5 mm Elongation at maximum force [6] $\varnothing_{ref}$ < 57.5 mm $\varnothing_{ref} \geq$ 57.5 mm Resistance to fatigue [10]	 2.2.10 2.2.5.3 2.2.11 2.2.13 2.2.3.2 Visual inspection [11]	 [2] [2] [2] [2] [2] [2]	 ≥ 3 ≥ 3 ≥ 3 ≥ 1 ≥ 3 ≥ 1 ≥ 5 [9] all	 [7] [7] [7] [8] [7] [8] per year per year

№	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples [1]	Minimum frequency of control
8	Nuts, couplers, contact coupler, anchor piece, and anchor plates				
	Dimensions	[2]	[2]	0.4 % [12), 13)] ≥ 2 [13]	per year
	Hardness	[2]	[2]	0.1 % [12] ≥ 2 [13]	per year
	Material of simple anchor plates	[14]	[2]	all	per year
	Material of components other than simples anchor plates	[15]	[2]	all	per year
	[10]	Visual inspection [11]	[11]	all	per year
9	Corrugated plastic sheathing				
	Dimensions	[2]	[2]	0.1 % [16), 17)] ≥ 2 [17]	per year
	Material	[15]	[2]	all	per year
	[10]	Visual inspection [11]	[2]	all	per year
10	Grout	EN 445	EN 447	EN 446	EN 446
11	Dimensions of heat shrinking sleeve	2.2.8.7	[2]	0.5 % [18] ≥ 1 [18]	per year
12	Material of heat shrinking sleeve	[19]	[2]	100 %	per year
13	Thickness of heat shrinking sleeve after shrinking	2.2.8.7	[2]	0.5 % [18] ≥ 1 [18]	per year
14	Bond to steel surface of heat shrinking sleeve	[20), 21)]	[2]	0.5 % [18] ≥ 1 [18]	per year
15	Mass per unit area of adhesive of heat shrinking sleeve	2.2.8.7	[2]	1 [22]	per year
16	Tensile strength of heat shrinking sleeve	2.2.8.7	[2]	1 [22]	per year
17	Elongation at break of heat shrinking sleeve	2.2.8.7	[2]	1 [20]	per year
18	Peel strength to steel surface of heat shrinking sleeve	2.2.8.7	[2]	1 [22]	per year
19	Chemical composition of adhesive of heat shrinking sleeve	[2]	[2]	1 [22]	per year
20	Peel strength layer to layer of heat shrinking sleeve	2.2.8.7	[2]	2 [23]	Once every 5 years
21	Thermal aging resistance of heat shrinking sleeve	2.2.8.7	[2]	2 [23]	Once every 5 years
22	Indentation resistance of heat shrinking sleeve	2.2.8.7	[2]	2 [23]	Once every 5 years
23	Impact resistance of heat shrinking sleeve	2.2.8.7	[2]	2 [23]	Once every 5 years
24	Saponification value of heat shrinking sleeve	2.2.8.7	[2]	2 [23]	Once every 5 years

[1] For two specified numbers of samples, the higher number applies.
[2] According to the control plan.
[3] Percentage of produced anchorages or splices per reference diameter. After 5 years of successful testing the frequency may be reduced to 0.1 %.
[4] For at least 1 reference diameter. In case of a production of less than 20 anchorages or couplers of 1 reference diameter per year, testing is not required. All reference diameters shall be tested within 5 years.
[5] Not for end-bearing splice with contact coupler.
[6] Assessment of long-term quality level according to EN 10080, clause 8.5.
[7] Per reference diameter and rolling batch, at least however, as specified in EN 10080, clause 8.1.
[8] Per reference diameter and rolling batch, at least however, as specified in EN 10080, clause 8.1, with 1 specimen instead of 3 specimens.
[9] Of one reference diameter. Reference diameters < 57.5 mm are all tested within 5 years. Reference diameters ≥ 57.5 mm are represented by one of these reference diameters, rotating for every 5 years. However, in case of failure, all of these reference diameters are tested.
[10] Main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, smoothness, corrosion, porosities, blisters according to the component's specification.
[11] Successful visual inspection does not need to be documented.
[12] Percentage of produced component per reference diameter and batch.
[13] Per reference diameter. In case of a production of less than 20 components of 1 reference diameter per year, testing that reference diameter is not required. However, components of all reference diameters shall be testes within 5 years.
[14] Control by means of a test report type "2.2" according to EN 10204 for simple anchor plates.
[15] Control by means of an inspection certificate type "3.1" according to EN 10204.
[16] Percentage and minimum number per reference diameter.
[17] Per reference diameter. In case of a production of less than 20 components of 1 reference diameter per year, testing that reference diameter is not required. However, components of all reference diameters shall be testes within 5 years.
[18] Percentage and minimum number for 1 size per year. All diameters are tested within 5 years.
[19] Control by means of a test report type "2.2" according to EN 10204.
[20] Detailed visual inspection of work samples.
[21] Visual inspection of applied heat shrinking sleeve regarding all-over adherence to steel surface, free of entrapped air and bond defects.
[22] 1 size, all sizes are tested within 5 years. Sampling for peel strength appropriate to the test procedure.
[23] Samples from 2 sizes. Sampling for peel strength appropriate to the test procedure.

Key to terms in Table 3.2.1:

Material	Defined according to technical specification deposited by the supplier.
Dimensions	Measuring of all the dimensions and angles according to the specification given in the test plan.

Regarding traceability of components applies:

- Full traceability of each anchorage component, splice component, and thread bar to its raw material.
- Full traceability of the heat shrinking sleeve to its raw material.

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 Kit for micropile are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body – Cornerstones

№	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 Kit for micropile.	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer.	According to Control plan	According to Control plan	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control					
1	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1.	According to Control plan	According to Control plan	1/year [1)] 2/year for thread bar

[1)] Frequency of inspections by the notified body is once a year. Inspection of thread bar manufacturing is twice a year.

4 REFERENCE DOCUMENTS

EAD 160004-00-0301	Post-tensioning kits for prestressing of structures
EAD 160027-00-0301	Special filling products for post-tensioning kits
EAD 200036-00-0103	Kit for micropiles – Kit with hollow bars for self-drilling micropiles – Hollow bars of seamless steel tubes
EN 196-2:2013	Method of testing cement – Part 2: Chemical analysis of cement
EN 196-3:2016	Methods of testing cement – Part 3: Determination of setting times and soundness
EN 197-1:2011	Cement - Part 1: Composition, specifications and conformity criteria for common cements
EN 206:2013 + A2:2021	Concrete – Specification, performance, production and conformity
EN 445:2007	Grout for prestressing tendons – Test methods
EN 446:2007	Grout for prestressing tendons – Grouting procedures
EN 447:2007	Grout for prestressing tendons – Basic requirements
EN 1238:2011	Adhesive – Determination of the softening point of thermoplastic adhesive (ring and ball)
EN 1537:2013	Execution of special geotechnical works – Ground anchors
EN 1990:2023	Eurocode – Basis of structural and geotechnical design
EN 1993-5:2007/AC:2009	Eurocode 3 – Design of steel structures – Part 5: Piling
EN 10080:2005	Steel for the reinforcement of concrete – Weldable reinforcing steel – General
EN 10204:2004	Metallic products – Types of inspection documents
EN 12068:1998	Cathodic protection – External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection – Tapes and shrinkable materials
EN 12225:2020	Geotextiles and geotextile-related products – Method for determining the microbiological resistance by a soil burial test
EN 12390-4:2019	Testing hardened concrete – Part 4: Compressive strength – Specification for testing machines
EN 12501-1:2003	Protection of metallic materials against corrosion – Corrosion likelihood in soil – Part 1: General
EN 12501-2:2003	Protection of metallic materials against corrosion – Corrosion likelihood in soil – Part 2: Low alloyed and non alloyed ferrous materials
EN 14199:2015	Execution of special geotechnical works – Micropiles
EN 60811-501:2012/A1:2018	Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds
EN ISO 62:2008	Plastic – Determination of water absorption
EN ISO 1461:2022	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
EN ISO 2178:2016	Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method
EN ISO 3126:2005	Plastic piping systems – Plastic components – Determination of dimensions

EN ISO 6892-1:2019	Metallic materials – Tensile testing – Part 1: Method of test at room temperature
EN ISO 9227:2022	Corrosion tests in artificial atmospheres – Salt spray tests
EN ISO 10304-1:2009/ AC:2012	Water quality – Determination of dissolved anions by liquid chromatography of ions – Part 1: Determination of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate
EN ISO 10304-4:2022	Water quality – Determination of dissolved anions by liquid chromatography of ions – Part 4: Determination of chlorate, chloride and chlorite in water with low contamination
EN ISO 11357-6:2018	Plastics – Differential scanning calorimetry (DSC) – Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)
EN ISO 15630-1:2019	Steel for the reinforcement and prestressing of concrete – Test methods – Part 1: Reinforcing bars, wire rod and wire
EN ISO/IEC 17025:2017	General requirements for the competence of testing and calibration laboratories
ISO 15835-1:2018	Steels for the reinforcement of concrete – Reinforcement couplers for mechanical splices of bars – Part 1: Requirements
ISO 15835-2:2018	Steels for the reinforcement of concrete – Reinforcement couplers for mechanical splices of bars – Part 2: Test methods

ANNEX A DETERMINATION OF REFERENCE VALUES

A.1 General

Reference values are determined only if the respective information on nominal values is missing in the MPII.

A.2 Reference diameter

Actual mass per metre of the specimens shall be determined according to EN ISO 15630-1, clause 12. The actual mass per metre, m_{act}, shall be calculated as the quotient of the specimens mass in kg, divided by the specimens length in m. From actual mass per metre, the actual diameter shall be calculated with Equation (A.2.1).

$$d_{act} = 2\,000 \cdot \sqrt{\frac{m_{act}}{\pi \cdot \rho}} \quad \text{(A.2.1)}$$

The actual diameters of all specimens shall be divided into groups of diameters. Grouping is according to the criteria below:

- The arithmetic mean of actual diameters of all specimens of the group shall be calculated.
- The arithmetic mean is rounded according to Equation (A.2.2).

$$\begin{array}{l} \leq 30.0 \text{ mm, rounded to the nearest } 0.1 \text{ mm} \\ \left.\begin{array}{r} > 30.0 \text{ mm} \\ \text{to} \\ 70.0 \text{ mm} \end{array}\right\}\text{, rounded to the nearest } 0.2 \text{ mm} \\ > 70.0 \text{ mm, rounded to the nearest } 0.5 \text{ mm} \end{array} \quad \text{(A.2.2)}$$

- The actual diameters of all specimens of the group do not deviate by more than $\pm$ 2.5 % of the rounded arithmetic mean.
- The rounded arithmetic mean of the group is the reference diameter, $\varnothing_{ref}$, of that group.
- The reference diameters of all groups establish a series of reference diameters.

Reference cross-sectional area of the group, S_{ref}, shall be calculated with the reference diameter, $\varnothing_{ref}$, by Equation (1.1.1.2.2).

Where

d_{act} .... mm .... Actual diameter of specimen

m_{act} ....kg/m..................... Actual mass per metre of specimen

ρ ....kg/m^3 .... Density, 7 850 kg/m^3, for hot rolled thread bar

$\varnothing_{ref}$ .... mm...................... Reference diameter of the group

S_{ref} ....mm^2 .... Reference cross-sectional area of the group.

A.3 Reference yield strength and reference tensile strength

Yield strength and tensile strength shall be determined in tension, see also EN 10080, clause 7.2.3. Stress values shall be calculated based on the reference cross-sectional area, S_{ref} according to Clause A.2. Tensile test on the specimens shall be carried out in accordance with EN ISO 15630-1, clause 5. The following parameters and procedures apply in relation to EN ISO 15630-1:

- Specimens shall be according to EN ISO 15630-1, clause 4, without artificial ageing and according to EN ISO 15630-1, clause 5.1.
- Test equipment shall be according to EN ISO 15630-1, clause 5.2.
- Tensile test shall be performed at room temperature.

- EN ISO 6892-1, clauses 10.1 and 10.2 apply.
- Force-extension diagram shall be recorded.
- Testing rate shall be according to EN ISO 6892-1, clauses 10.3.3.1, 10.3.3.2.1, 10.3.3.2.4, 10.3.3.2.5, and 10.3.3.3, whereby the crosshead separation rate applies.
- Determination of $R_{e, act}$ shall be according to EN ISO 6892-1, clauses 11 and 13, or EN ISO 15630-1, clause 5.3. These procedures are considered as equivalent. Reference procedure for proof strength is EN ISO 15630-1, clause 5.3, second method.
- Determination of $R_{m, act}$ shall be with the maximum force in tensile test, considering EN ISO 15630-1, clause 5.3.

The actual yield strengths, $R_{e, act}$, of the specimens shall be divided into groups of yield strength. Grouping is according to the criteria below:

- The arithmetic mean, $R_{e, mean}$, of actual yield strengths of all specimens of the group shall be calculated.
- The actual yield strengths of all specimens of the group do not deviate by more than ± 50 MPa of the arithmetic mean.

The reference yield strength of the group shall be calculated with Equation (A.3.1).

$$R_{e, ref} = 0.85 \cdot R_{e, mean}, \text{ rounded to the nearest 10 MPa} \quad (A.3.1)$$

The arithmetic mean, $R_{m, mean}$, of actual tensile strengths of all specimens of the group shall be calculated and the reference tensile strength shall be calculated with Equation (A.3.2).

$$R_{m, ref} = 0.85 \cdot R_{m, mean}, \text{ rounded to the nearest 10 MPa} \quad (A.3.2)$$

Where

$R_{e, act}$ .... MPa .... Actual yield strength of specimen

$R_{e, mean}$ .... MPa .... Arithmetic mean of actual yield strengths of all specimens of the group

$R_{e, ref}$ .... MPa .... Reference yield strength of the group

$R_{m, act}$ .... MPa .... Actual tensile strength of specimen

$R_{m, mean}$ .... MPa .... Arithmetic mean of actual tensile strengths of all specimens of the group

$R_{m, ref}$ .... MPa .... Reference tensile strength of the group

S_{ref} .... mm² .... Reference cross-sectional area of specimen, see Clause A.2.

ANNEX B LOAD TRANSFER TEST

B.1 Specimen

The specimen is schematically shown in Figure B.4.1.

Table B.1.1 Parameter of specimens for load transfer test

Parameter	Parameter specified in MPII	Parameter not specified in the MPII
Anchorage components	The components of the Kit for micropile shall be used, see Clause 1.1.	
Void	Shape and dimensions as specified in the MPII.	Plastic tube with outer diameter ≥ reference diameter of thread bar
Bursting reinforcement	The component of the Kit for micropile shall be used, see Clause 1.1.2.	The Kit for micropile is without bursting reinforcement, see Clause 1.1.2.
Additional bonded length for anchorage with torqued anchor piece	Additional bonded length as specified in the MPII.	No additional bonded length.
Auxiliary reinforcement	As specified in Clause B.1.	
Combined bursting and auxiliary reinforcement	As specified in the MPII.	The Kit for micropile is without bursting reinforcement, see Clause 1.1.2.
Reference concrete compressive strength, $f_{cm,0}$	$f_{cm,0}$ according to the MPII.	Concrete compressive strength C20/25 shall be applied.
Centre distances in x- and y-direction	Dimensions a and b shall be according to the MPII.	A square specimen with a = b shall be used. Pre-tests shall be carried out in accordance with Annex B. Once maximum force given by Equation (B.2.1) or Equation (B.2.2) and stabilisation criteria given by Clause B.3 are met, the side length of the tested specimen shall be taken as dimension a.

The specimens shall be concrete prisms. Their concrete cross section, $A_c = a \cdot b$, corresponding to the minimum centre distances, their shape and dimensions of the void, and their reference concrete strength shall be taken from Table B.1.1. The specimens shall contain those anchorage components and bursting reinforcement that will be embedded in the structural concrete. Components and reinforcement shall be arranged as given in Table B.1.1.

The height h of specimens shall be:

- At least twice the longer of the two side lengths a or b. See Figure B.4.2, showing a specimen of that proportions.

  And

- The height of the lower part of the specimens, i.e., with auxiliary reinforcement reinforced shall be at least $0.5 \cdot h$. See Figure B.4.1, showing a specimen with bursting reinforcement and auxiliary reinforcement.

Reinforcement shall be placed as bursting reinforcement and auxiliary reinforcement:

- For kit with bursting reinforcement, amount and configuration of the bursting reinforcement shall be as given in the MPII. The part of the specimens with the anchorage components shall contain the bursting reinforcement.
- Auxiliary reinforcement comprises longitudinal reinforcement and transverse stirrups reinforcement:
  - Longitudinal reinforcement shall be bars with a total cross-sectional area of $\leq 0.003 \cdot A_c$
  - Transverse reinforcement shall be stirrups, uniformly distributed along the height of specimens, with ≤ 50 kg steel/(m^3 concrete).
  - The 50 kg/m^3 stirrups, uniformly distributed along the height of specimens, shall be placed over the entire height of the specimens.
  - If specified in the MPII, auxiliary reinforcement shall be combined with bursting reinforcement. For combined reinforcement, only the reinforcement beyond 50 kg/m^3 shall be considered as bursting reinforcement. If not specified as combined reinforcement, bursting reinforcement and auxiliary reinforcement shall be placed as two independent reinforcements.
- For kit without bursting reinforcement, only the auxiliary reinforcement shall be placed in the specimens.

The concrete cover to the reinforcement shall be at least 10 mm, see Figure B.4.1.

The concrete of the test specimens shall be according to Table B.1.1. The composition of the concrete used for the load transfer specimens shall be given in the test report. The specimens should be concreted normally in a horizontal position. After casting the specimens shall be de-moulded after one day and then moist-cured by covering until testing. The test cylinders or cubes cast for determination of compressive strength of concrete shall be cured in the same way.

For extended applications, minimum centre spacing of anchorage in x- and y-directions, x and y, and minimum edge spacing shall be derived from the tested dimensions a and b. Without specific testing Equation (B.1.1), Equation (B.1.2), Equation (B.1.3), Equation (B.1.4), and Equation (B.1.5) shall be applied, see Figure B.4.1.

Derived centre spacings shall conform to Equation (B.1.1) and Equation (B.1.2).

$$x \geq 0.85 \cdot a \tag{B.1.1}$$

$$y \geq 0.85 \cdot b \tag{B.1.2}$$

With derived centre spacings Equation (B.1.3) shall be met. I.e., reduction of centre distance in one direction requires to increase centre distance in the other direction.

$$A_c = x \cdot y \geq a \cdot b \tag{B.1.3}$$

Edge distances shall be calculated with centre spacings in x- and y-direction by Equation (B.1.4) and Equation (B.1.5).

$$e_x = \frac{x}{2} - 10\text{ mm} + c \tag{B.1.4}$$

$$e_y = \frac{y}{2} - 10\text{ mm} + c \tag{B.1.5}$$

Where

$\left.\begin{matrix} a \\ b \end{matrix}\right\}$ .... mm...................... Side lengths of specimen

$\left.\begin{matrix} x \\ y \end{matrix}\right\}$ .... mm...................... Minimum specified centre spacing in x- and y-direction

A_c ....mm^2..................... Gross cross-sectional concrete area of specimen

$\left.\begin{matrix} e_x \\ e_y \end{matrix}\right\}$ .... mm..................... Edge distance in x- and y-direction respectively

c................ mm..................... Concrete cover of reinforcement

$f_{cm,\,0}$ ....MPa..................... Reference concrete compressive strength for load transfer test, see Table B.1.1

h................ mm..................... Height of specimen.

B.2 Test procedure

The specimens shall be mounted in a calibrated test rig or testing machine. The load shall be applied to the specimens as shown in Figure B.4.1 using the anchorage components.

The load shall be increased in steps, see Figure B.2.1, $0.12 \cdot R_{m,\,ref} \cdot S_{ref}$, $0.2 \cdot R_{m,\,ref} \cdot S_{ref}$, $0.4 \cdot R_{m,\,ref} \cdot S_{ref}$, $0.6 \cdot R_{m,\,ref} \cdot S_{ref}$, and $0.8 \cdot R_{m,\,ref} \cdot S_{ref}$. After attaining the load $0.8 \cdot R_{m,\,ref} \cdot S_{ref}$, at least ten, i.e., $m \geq 10$, load cycles shall be performed with a force range of $0.8 \cdot R_{m,\,ref} \cdot S_{ref}$ and $0.12 \cdot R_{m,\,ref} \cdot S_{ref}$ being the upper and the lower load respectively.

The load cycle shall be performed force controlled and comprises:

– Steadily increase force from lower load to upper load. Time to increase force from lower load to upper load shall be at least 1 minute but not longer than 10 minutes.
– Holding upper load constant as long as required to inspect the specimens and perform measurements.
– Steadily decrease force from upper load to lower load. Time to decrease force from upper load shall be at least 1 minute but not longer than 10 minutes.
– Holding lower load constant as long as required to inspect the specimens and perform measurements.

The necessary number of load cycles depends upon stabilisation of strain readings and crack widths. See Clause B.3 for stabilisation criteria. Following cyclic loading, the specimens shall be loaded continuously to failure. The test may be terminated without failure at a force exceeding:

– For specimen with bursting reinforcement as by Equation (B.2.1).

$$F_{u,\,br} \geq 1.1 \cdot \frac{R_{m,\,ref} \cdot S_{ref}}{1\,000} \cdot \frac{f_{cm,\,e}}{f_{cm,\,0}} \qquad \text{(B.2.1)}$$

– For specimen without bursting reinforcement as by Equation (B.2.2).

$$F_{u,\,0} \geq 1.3 \cdot \frac{R_{m,\,ref} \cdot S_{ref}}{1\,000} \cdot \frac{f_{cm,\,e}}{f_{cm,\,0}} \qquad \text{(B.2.2)}$$

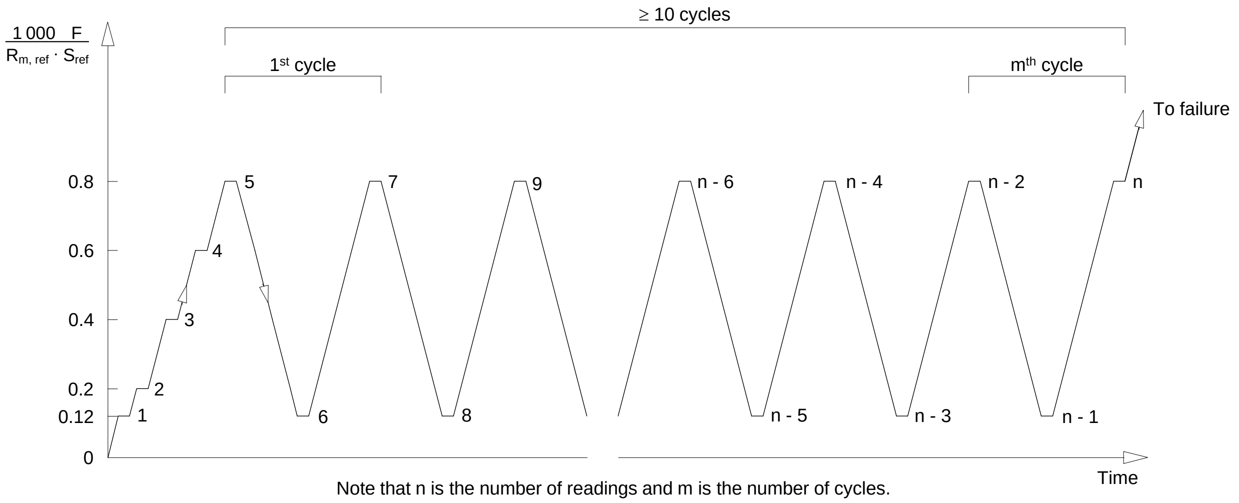


Figure B.2.1 Loading sequence in load transfer test

During cyclic loading, measurement shall be taken as numbered in Figure B.2.1, i.e., 1, 2, … to n. At the upper and the lower loads of several cycles, the measurements shall permit to decide whether stabilisation of strains and crack widths is being attained, see Clause B.3.

Equivalent to Figure B.2.1, the load levels 1 to 4 may be taken at different load levels than indicated in Figure B.2.1. Measurement shall be performed at least at 3 load levels.

At the final test to failure, the mean compressive strength of concrete[9] of specimens shall be as by Equation (B.2.3).

$$f_{cm,\,e} \leq f_{cm,\,0} + 3\text{ MPa} \qquad \text{(B.2.3)}$$

Where

F .... N .... Force in load transfer test

$F_{u,\,br}$ .... kN .... Maximum force in load transfer test for specimen with bursting reinforcement

$F_{u,\,0}$ .... kN .... Maximum force in load transfer test for specimen without bursting reinforcement

$R_{m,\,ref}$ .... MPa .... Reference tensile strength of thread bar, Clause 1.1.1.2

$f_{cm,\,e}$ .... MPa .... Concrete compressive strength at time of end of load transfer test

$f_{cm,\,0}$ .... MPa .... Reference concrete compressive strength for load transfer test

S_{ref} .... mm² .... Reference cross-sectional area of thread bar, Clause 1.1.1.2

m ....— .... Number of load cycles

n ....— .... Number of readings for measurements.

B.3 Stabilisation criteria

Crack widths[10] w shall be:

– Upon first attainment of upper load, $w_{max} \leq 0.15$ mm
– Upon last attainment of lower load, $w_{max} \leq 0.15$ mm
– Upon last attainment of upper load, $w_{max} \leq 0.25$ mm.

Crack widths shall be considered to have stabilised, either if their width under upper load conforms to Equation (B.3.1) or crack width does not exceed 0.10 mm throughout the test.

$$w_n - w_{n-8} \leq \frac{1}{3} \cdot (w_{n-8} - w_5),\ m \geq 10 \qquad \text{(B.3.1)}$$

Longitudinal and transverse strains[9] can be considered to have stabilised if the increase of strain under the upper load conforms to Equation (B.3.2).

$$\varepsilon_n - \varepsilon_{n-8} \leq \frac{1}{3} \cdot (\varepsilon_{n-8} - \varepsilon_5),\ m \geq 10 \qquad \text{(B.3.2)}$$

See Figure B.4.3 and Figure B.4.4 for details on how to assess stabilisation criteria.

Stabilisation criteria shall be assessed for all cracks and for all strain measurement gauges placed on the specimens.

Where

w .... mm...................... Crack width

w_{max} .... mm...................... Maximum crack width

---

9 The criterion regarding compressive strength of concrete originates from EAD 160004-00-0301.

10 The criteria regarding crack width and stabilisation of crack width and strain originate from EAD 160004-00-0301.

w_5, w_{n-8}, w_n .... mm...................... Crack width, measured at specific load cycles.

ε_5, ε_{n-8}, ε_n .... mm/m.................... Strain, measured at specific load cycles.

m.................—....................... Number of load cycles

n..................—....................... Number of readings for measurements.

B.4 Measurements and observations

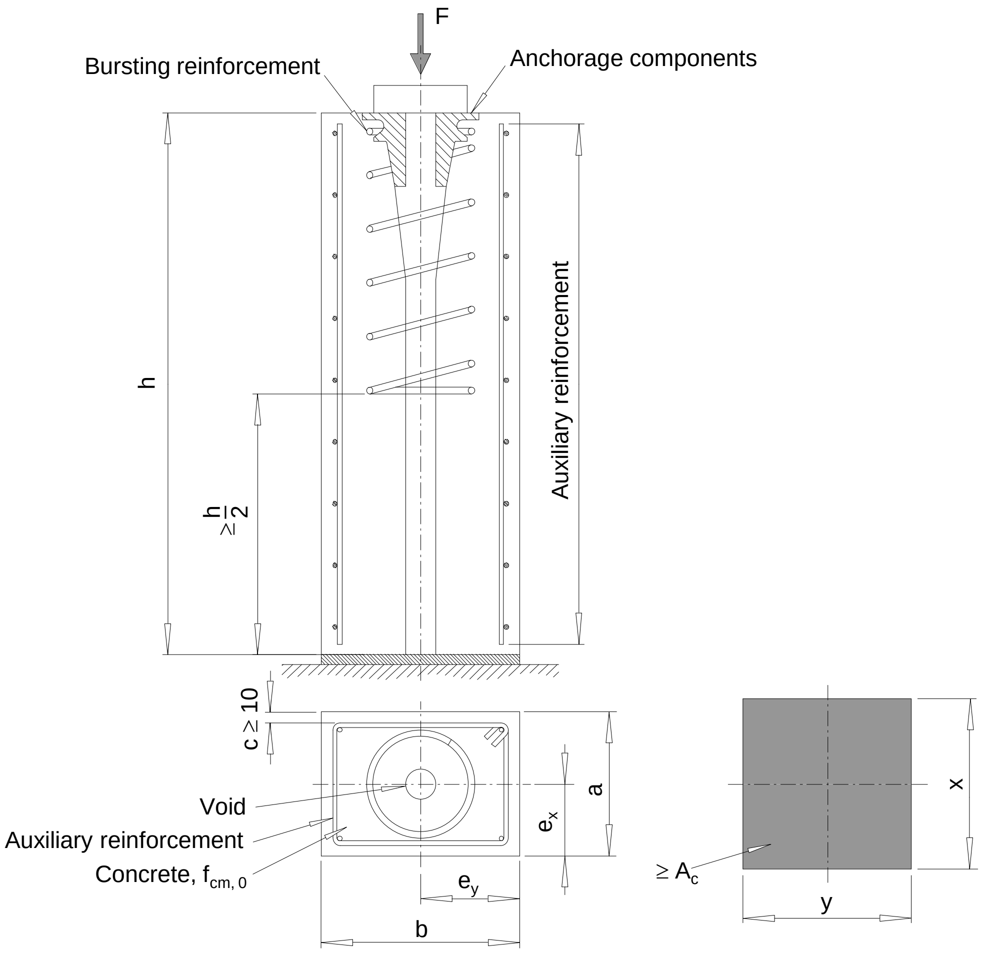
The following measurements and observations shall be made and recorded:

- Determination of actual material characteristics of tested components.
- Checking of the components for materials, machining, geometry, hardness, et cetera.
- Longitudinal and transverse concrete strains on at least two side faces of the specimens in the region of maximum bursting effect under the upper and lower load, dependent on number of load cycles. Longitudinal and transverse concrete strains and crack width and propagation shall also be recorded at readings 1, 2, and 3 indicated in Figure B.2.1.
- Formation, width, and propagation of cracks on the side faces of the specimens, as mentioned above.
- Visual inspection and/or measurement of deformation of anchorage components in contact with concrete. Any unusual or excessive deformation, such as large permanent deformations, shall be reported in the test report, and such actual deformation may be measured.
- Location and mode of failure.
- Measured maximum force $F_{u,\,br}$ or $F_{u,\,0}$.
- Concrete compressive strength at time of end of load transfer test, $f_{cm,\,e}$.
- Examination of components and specimens after testing, photographic documentation, comments.

Where

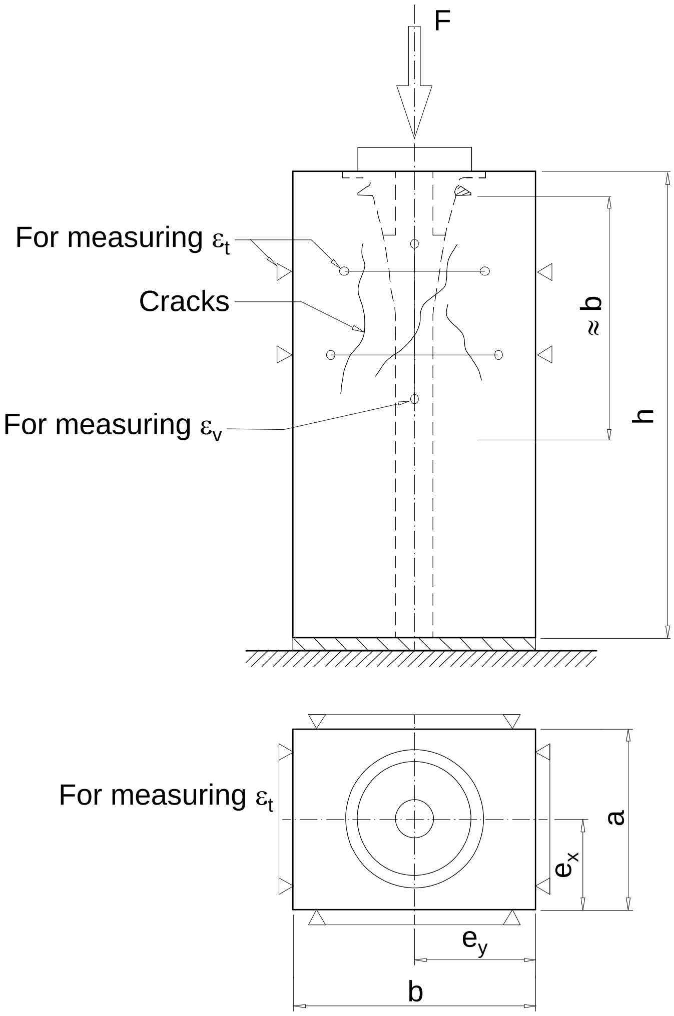
$F_{u,\,br}$............. kN .... Maximum force in load transfer test for specimen with bursting reinforcement

$F_{u,\,0}$.............. kN .... Maximum force in load transfer test for specimen without bursting reinforcement.



Dimensions in mm

Figure B.4.1 Specimen for load transfer test – Schematic



For b ≥ a

Gauges for strain measurements shall be placed in the middle of the section, indicated as ≈ b.

Gauge length for strain measurement ≈ 0.6 up to 0.8 · b

Figure B.4.2 Load transfer test – Measurements on at least 2 side faces – Schematic

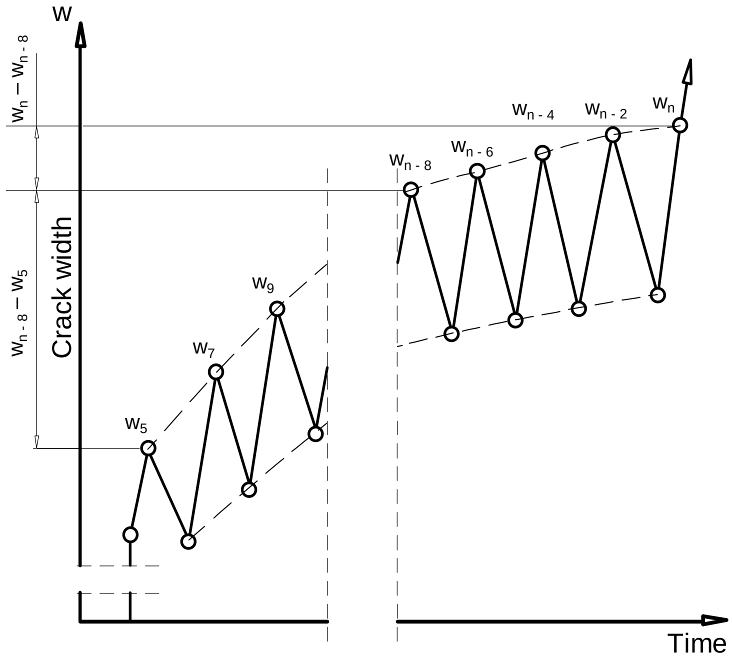


Figure B.4.3 Assessment of crack width stabilisation

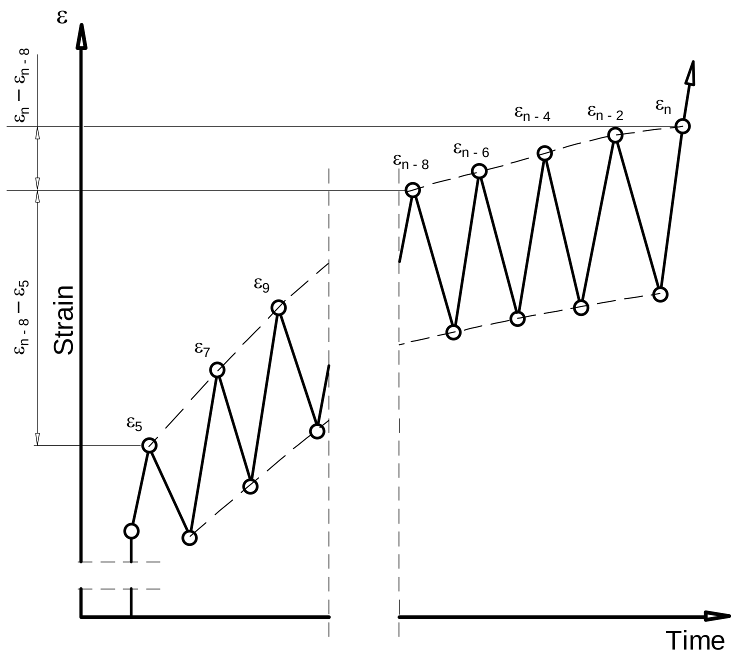


Figure B.4.4 Assessment of strain stabilisation

Where

ε_5, ε_7, ε_9, ε_{n-8}, ε_{n-6}, ε_{n-4}, ε_{n-2}, ε_n .... mm/m.................... Strain, measured at specific readings, see Clause B.3.

w_5, w_7, w_9, w_{n-8}, w_{n-6}, w_{n-4}, w_{n-2}, w_n .... mm...................... Crack width, measured at specific readings.

a, b .... mm...................... Side lengths of specimen

ε .... mm/m.................... Strain

ε_t .... mm/m.................... Strain, measured perpendicular to loading direction – transversal strain

ε_v .... mm/m.................... Strain, measured parallel to loading direction – longitudinal strain

c .... mm...................... Concrete cover of reinforcement

e_x, e_y .... mm...................... Edge distance in x- and y-direction respectively

F .... kN .... Force in load transfer test

$f_{cm,0}$ .... MPa..................... Reference concrete compressive strength for load transfer test, see Table B.1.1

$f_{cm,e}$ .... MPa..................... Concrete compressive strength at time of end of load transfer test

h .... mm...................... Height of specimen

m .... —....................... Number of load cycles

n .... —....................... Number of readings for measurements

w .... mm...................... Crack width.

x, y .... mm...................... Minimum specified centre spacing in x- and y-direction

A_c ....mm^2..................... Gross cross-sectional concrete area of specimen

ANNEX C EXTRACTION

C.1 Equipment

The following equipment is used for the extraction:

- Glass extraction apparatus comprising a 500 ml boiling flask, reflux condenser with aspirator, thistle tube, and heating tube, see Figure C.1.1. The boiling energy is supplied along the heating tube.
- Beakers
- Filter with filter paper
- Laboratory equipment for stirring and pre-heating
- Fume cupboard.

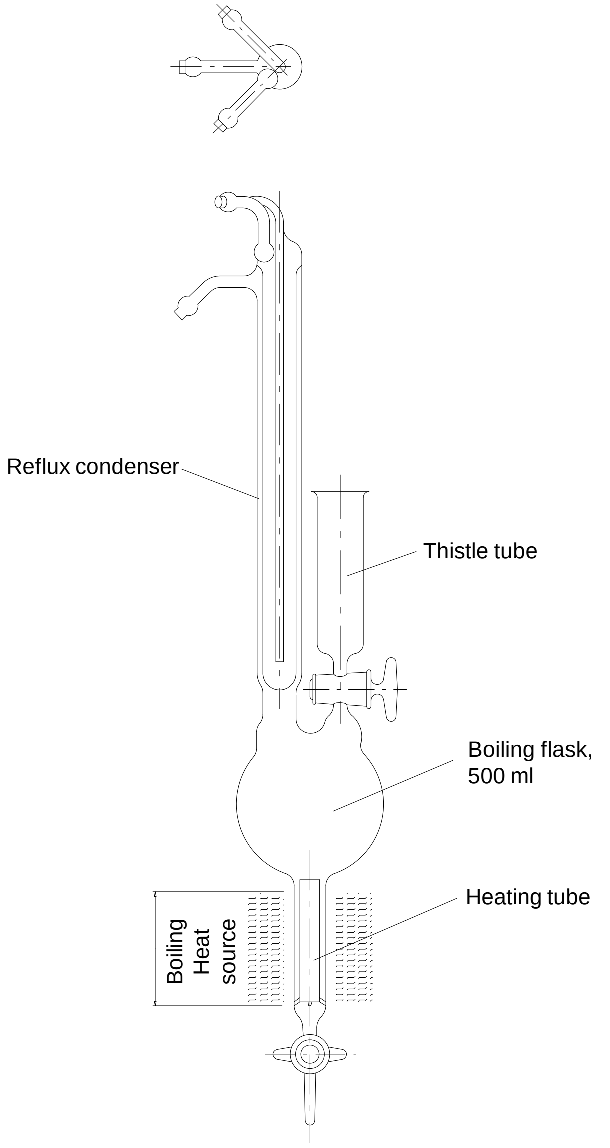


Figure C.1.1 Glass extraction apparatus

C.2 Agents

The following agents shall be used for the extraction:

- Toluene

- Anhydrous ethyl alcohol or anhydrous ethyl alcohol denatured by addition of not more than 5 % methyl alcohol
- Acetone
- Distilled water.

C.3 Extraction procedure

Perform the extraction under a fume cupboard.

Weigh m_{40} = 40 g of test material to the nearest 0.1 g into a 250 ml beaker and heat to (60 ± 5) °C. Heat 80 ml of toluene to the same temperature and add it slowly to the test sample, stir continuously until completely dissolved. Transfer the solution to the extraction apparatus and rinse the beaker twice with 15 ml of toluene, brought to approximately 60 °C. Without allowing the mixture to cool in the extractor, add 25 ml of alcohol and 15 ml of acetone, pre-heated to about 40 °C.

NOTE 1 Perform two successive one-hour extractions for products with a kinematic viscosity greater than 110 mm^2/s at 50 °C.

Boil the mixture vigorously for two minutes. Turn off the heat source. Once the boiling has stopped, add 125 ml of distilled water. Boil again for one hour.

Allow to cool and rest to obtain the separation of two phases. Remove the lower layer and filter, if necessary, on filter paper to obtain the aqueous extract.

NOTE 2 A certain amount of alcohol and acetone remains dissolved in the hydrocarbon phase.

The volume of the aqueous extract obtained is counted as 160 ml.

Where

m_{40} .... g........................ Mass portion for extraction

ANNEX D NUMBER OF TESTS

Relevant tests for anchorages and splices are listed in Table D.1.

Table D.2, Table D.3, and Table D.4 rely on the concept of series. This concept presumes a series of sizes of thread bars and other components, where within each series there are similarities among others in terms of:

- Material
- Grade of material, strength of concrete
- Geometry
- The same method of anchoring the thread bar.

Untested sizes shall be assessed based on affinity of the components. Criteria among others for affinity are:

- Dimensions follow sizes in a steady progression.
- Properties of lager sizes are also applicable to smaller sizes.
- Properties are interpolated between sizes.

Table D.1 Relevant tests on splices and anchorages

Component	Test or measurement			
	Static	Slip	Fatigue	Load transfer
Splice				
End-bearing splice	— 1)	yes, in compression	—	— 2)
Torqued splice	yes, in tension	yes	yes	— 2)
Splice with adhesive	yes, in tension	yes	yes	— 2)
Anchorage				
Anchorage with anchor plate	yes, in tension	yes	yes	yes
Anchorage with torqued anchor piece	yes, in tension	yes	yes	yes

Key

—........ Not relevant

1) No specific testing is required as for end-bearing splice.

2) Load transfer not relevant for splices.

Table D.2 Number of tests for splices and anchorages

Test method	Number of tests		
	Reference diameter		
	Small	Medium	Largest
Resistance to static load at anchorages and splices including measurement of slip	2	1	2
Resistance to fatigue at anchorages and splices	1	1	2

Test method	Number of tests		
	Reference diameter		
	Small	Medium	Largest
Load transfer to the structure, anchorage, for concrete grade C20/25	1 [1)]	1 [1)]	2 [1)]
Load transfer to the structure for one concrete grade according to the MPII	1	1	2
Load transfer to the micropile	1	1	1
Crack width in mortar	2	2	2
Dimensions	3	3	3
[1)] These tests shall be omitted if the MPII explicitly excludes concrete grades other than those specified in the MPII.			

Sizes out of a series of reference diameters of kits shall be interpreted as follows:

– "Small" The largest in the lower third of sizes in one series
– "Medium" In middle third of sizes in one series
– "Largest" The largest size in one series.

Table D.3 Number of tests for the thread bar

Characteristics	Number of tests		
	Reference diameter		
	Small	Medium	Largest
Mass per metre, cross-sectional area, surface geometry, core diameter 3 heats [1)] per reference diameter, 3 tests each	9	9	9
Strength characteristics 3 heats [1)] per reference diameter, 10 tests each	30	30	30
Modulus of elasticity 3 tests per reference diameter	3	3	3
Resistance to fatigue [2)]	5	5	5
Bond characteristics in pull-out test	5	5	5

[1)] Heat of steel is metal produced by a single cycle of a melting process.
[2)] Number of tests for static and quasi static actions. For actions with fatigue loading two further heats with 5 tests each shall be tested. These tests may be spread across the finite and high cycle fatigue range as specified in the MPII. If not specified in the MPII, the stress range shall be maintained.

Table D.4 Number of tests for the heat shrinking sleeve

Characteristics	Number of tests	
	Size of heat shrinking sleeve	
	Smallest	Largest
Thickness after shrinking	1 each size [1)]	
Mass per unit area of adhesive	2 each size [1)]	

Characteristics	Number of tests	
	Size of heat shrinking sleeve	
	Smallest	Largest
Tensile strength	5	5
Elongation at break	5	5
Peel strength layer to layer	3 – ambient 3 – T_{max} Small 2) size instead of smallest	3 – ambient 3 – T_{max} Large 2) size instead of largest
Peel strength to steel surface	3 – ambient 3 – T_{max} Small 2) size instead of smallest	3 – ambient 3 – T_{max} Large 2) size instead of largest
Thermal ageing resistance Tensile strength, Elongation at break	5 – initial 5 – 70 days 5 – 100 days	5 – initial 5 – 70 days 5 – 100 days
Peel strength layer to layer	3 – initial 3 – 720 days 3 – 100 days Small 2) size instead of smallest	3 – initial 3 – 70 days 3 – 100 days Large 2) size instead of largest
Peel strength to steel surface	3 – initial 3 – 70 days 3 – 100 days Small 2) size instead of smallest	3 – initial 3 – 70 days 3 – 100 days Large 2) size instead of largest
Indentation resistance	3 – ambient or 3 – T_{max} Small 2) size instead of smallest	3– ambient or 3 – T_{max} Large 2) size instead of largest
Impact resistance	1 Small 2) size instead of smallest	1 Large 2) size instead of largest
Saponification value	4	
Microbiological resistance Tensile strength, Elongation at break	5 – initial 5 – 6 months	5 – initial 5 – 6 months
Peel strength to steel surface	3 – initial 3 – 6 months Small 2) size instead of smallest	3 – initial 3 – 6 months Large 2) size instead of largest
Water absorption	2	2
Softening point of adhesive	2	
Oxygen stability of adhesive	1	

Characteristics	Number of tests Size of heat shrinking sleeve	
	Smallest	Largest
Resistance to salt spray of adhesive	2	
Content of aggressive components of adhesive	1	

1) Number of sizes of heat shrinking sleeve

2) Small and large refer to smallest and largest sizes suitable for a tube with external diameter of 100 mm.

ANNEX E ESSENTIAL CHARACTERISTICS FOR THE INTENDED USES

The essential characteristics relevant for the intended uses are listed in Table E.1. Intended uses are according to Table 1.2.1.1:

- Column 1 in Table E.1 Micropile for temporary use
- Column 2 in Table E.1 Micropile for semi-permanent use
- Column 3 in Table E.1 Micropile galvanised for semi-permanent use
- Column 4 in Table E.1 Micropile protected by cover of mortar for permanent use
- Column 5 in Table E.1 Micropile protected according to EN 1537, table C.2, 1., c), for permanent use.

Table E.1 Essential characteristics for the intended uses

№ 1)	Essential characteristic 1)	Product and intended use				
		1	2	3	4	5
	Basic requirement for construction works 1: Mechanical resistance and stability					
1	Resistance to static load	+	+	+	+	+
2	Slip	+	+	+	+	+
3	Resistance to fatigue	+	+	+	+	+
4	Load transfer to the structure	+	+	+	+	+
5	Load transfer to the micropile	+	+	+	+	+
6	Corrosion protection of temporary micropile	+	—	—	—	—
7	Corrosion protection of semi-permanent micropile	—	+	+	—	—
8	Corrosion protection of permanent micropile	—	—	—	+	+
9	Crack width in mortar	—	—	—	+	—
10	Mass per metre	+	+	+	+	+
11	Strength characteristics of thread bar	+	+	+	+	+
12	Modulus of elasticity	+	+	+	+	+
13	Elongation at maximum force	+	+	+	+	+
14	Crack width of grout	—	—	—	—	+
15	Hot-dip galvanising	—	—	+	—	—

Key

+ ....Essential characteristic relevant for the intended use
— ....Essential characteristic not relevant for the intended use
1) ....Line numbers and essential characteristics correspond to Table 2.1.1.

ANNEX F CONTENTS OF TEST REPORT

Testing of the Kit for micropile shall be documented with test reports that should be prepared in accordance with the general principles of EN ISO/IEC 17025 and include at least the following specific information:

- Detailed description of all components of the Kit for micropile
- Certificates of all relevant materials to confirm conformity with respective specifications. Actual characteristics of components (mechanical, chemical, metallurgical, geometrical, etc. as relevant) at time of testing and source of manufacture. These include in particular thread bar, anchorage and coupler components, and corrosion protection components (internal grout, cement grout, corrugated plastic sheathing, etc.) and further components used in testing
- Certificates of equipment and test machine calibration
- Description and drawing of specimens with actual dimensions
- Description and drawing of test set-up and measuring equipment including calibration certificate
- Reference to relevant clause of the EAD
- Actual ambient temperature, where relevant
- Record of all measurements and observations
- Photographs of specimens prior, during, and after testing
- Any other information specified in the test procedures
- Statement of any unexpected or unusual behaviour / observation of components during testing.