



## EUROPEAN ASSESSMENT DOCUMENT

EAD 200036-00-0103

August 2016

### **KIT FOR MICROPILES – KIT WITH HOLLOW BARS FOR SELF-DRILLING MICROPILES – HOLLOW BARS OF SEAMLESS STEEL TUBES**

The reference title and language for this EAD is English. The applicable rules of copyright refer to the document elaborated in and published by EOTA.

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

## Contents

<b>1 SCOPE OF THE EAD .....</b>	<b>5</b>
<b>1.1 Description of the construction product.....</b>	<b>5</b>
1.1.1 General description of the kit .....	5
1.1.2 Kit components.....	6
1.1.3 Further product related aspects .....	9
<b>1.2 Information on the intended uses of the construction product.....</b>	<b>9</b>
1.2.1 Intended uses.....	9
1.2.2 Working life/Durability .....	10
<b>1.3 Specific terms used in this EAD .....</b>	<b>10</b>
1.3.1 Sacrificial corrosion allowance.....	10
1.3.2 Surface coating .....	10
1.3.3 Encapsulation by cement mortar .....	10
1.3.4 Symbols .....	11
<b>2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA.....</b>	<b>12</b>
<b>2.1 Essential characteristics of the product .....</b>	<b>12</b>
<b>2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product.....</b>	<b>14</b>
Essential characteristics of the kit .....	14
2.2.1 Resistance to static load.....	14
2.2.2 Resistance to fatigue .....	14
2.2.3 Load transfer to the structure.....	15
2.2.4 Load transfer to the micropile .....	15
2.2.5 Corrosion protection for temporary micropiles .....	15
2.2.6 Corrosion protection, sacrificial corrosion allowance for permanent micropiles.....	15
2.2.7 Corrosion protection, sacrificial corrosion allowance with surface coating by hot-dip galvanisation for permanent micropiles.....	16
2.2.8 Impact energy and torque.....	16
Essential characteristics of the hollow bar of seamless steel tube.....	16
2.2.9 Shape.....	16
2.2.10 Dimensions.....	17
2.2.11 Surface geometry .....	17
2.2.12 Mass per metre .....	17
2.2.13 Cross-sectional area.....	17

2.2.14	Strength characteristics .....	17
2.2.15	Moment of inertia .....	18
2.2.16	Resistance to fatigue .....	18
2.2.17	Bond strength .....	19
2.2.18	Hot-dip galvanising .....	20
	Essential characteristics of anchorage components, couplers, and pile neck protection tube .....	20
2.2.19	Shape .....	20
2.2.20	Dimensions .....	20
2.2.21	Hardness .....	20
2.2.22	Material .....	20
2.2.23	Hot-dip galvanising .....	21
<b>3</b>	<b>ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE.....</b>	<b>21</b>
3.1	System of assessment and verification of constancy of performance to be applied .....	21
3.2	Tasks of the manufacturer .....	21
3.3	Tasks of the notified body.....	26
<b>4</b>	<b>REFERENCE DOCUMENTS.....</b>	<b>28</b>
<b>ANNEX 1</b>	<b>NUMBER OF TESTS .....</b>	<b>29</b>
Anx 1.1	General .....	29
Anx 1.2	Number of tests for the Kit.....	30
Anx 1.3	Hollow bar .....	31
Anx 1.4	Anchorage components, couplers and pile neck protection tube .....	31
<b>ANNEX 2</b>	<b>VERIFICATION OF STRESS RANGE IN FATIGUE TEST BY CALCULATION .....</b>	<b>32</b>
<b>ANNEX 3</b>	<b>ESSENTIAL CHARACTERISTICS FOR THE INTENDED USES .....</b>	<b>33</b>

## 1 SCOPE OF THE EAD

### 1.1 Description of the construction product

#### 1.1.1 General description of the kit

The product, "Kit for micropiles – Kit with hollow bars for self-drilling micropiles – Hollow bars of seamless steel tubes", is comprised of the following components, see Figure 1.

- Hollow bars in steel,
- Drill bit,
- Couplers to connect the hollow bars,
- Anchorage components to connect hollow bars and structure,
- Pile neck protection tube,
- Corrosion protection system and
- Ancillary components.

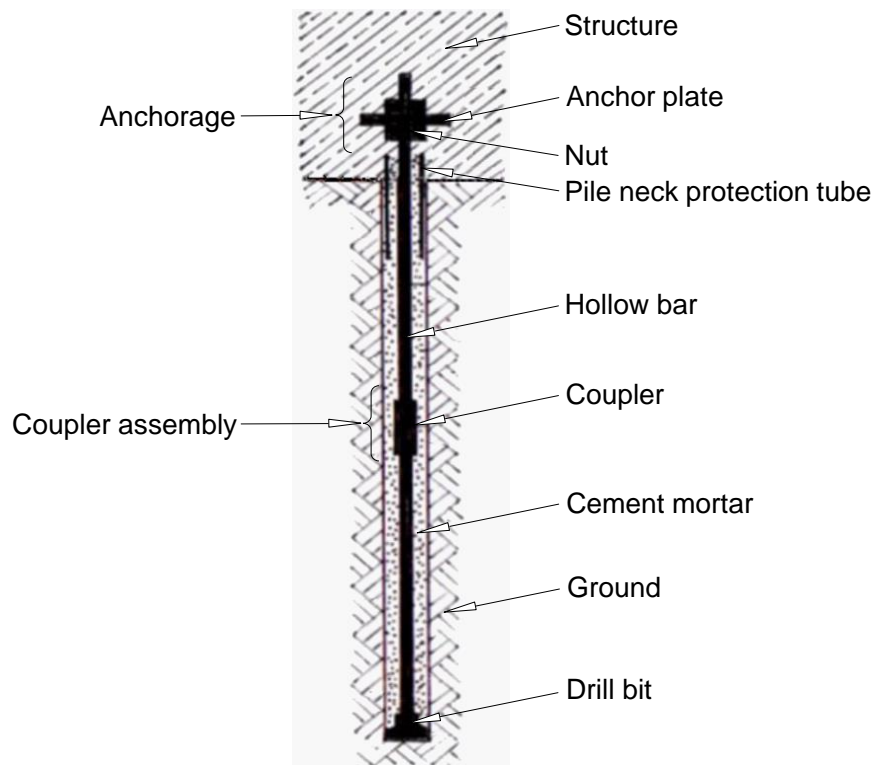
The micropile is inserted into the ground with a sacrificial drill bit by rotary drilling or by rotary percussive drilling, observing torque or pairs of values for impact energy and torque respectively. The drill bit is selected to be appropriate for the geotechnical conditions on site. The annular void between hollow bar and borehole wall is filled with cement mortar through hollow bar and drill bit. The borehole filling forms a body of cement mortar that transfers the load to the borehole wall.

Anchorage components and couplers are made of steel. Corrosion protection systems are cement mortar and sacrificial corrosion without and with hot-dip galvanising. Hot-dip galvanising is applied according to EN ISO 1461<sup>1</sup>.

The load-bearing capacity of anchorage and coupler assembly is not impaired by components of anchorage and coupler assembly. Reference thereby is the nominal maximum force of the hollow bar. Under compression forces buckling of the micropile is taken into consideration.

---

<sup>1</sup> Standards and other documents referred to in the EAD are listed in Clause 4



**Figure 1** Micropile – Schematic

## 1.1.2 Kit components

### 1.1.2.1 Hollow bar

The hollow bar

- is made of a hot-rolled seamless steel tube.
- On the hot-rolled seamless steel tube a thread is cold-rolled over the entire length of the hollow bar.
- The hollow bar is delivered in standard lengths of 1 to 6 m, however, also larger lengths are possible.
- Guide values of strength of the hollow bar are given in Table 1.

Individual hollow bars are connected with couplers to obtain the required length of the micropile.

**Table 1:** Mechanical properties of the hollow bar – Data for a brief overview

Characteristic yield strength	Characteristic tensile strength	Characteristic elongation at ultimate force
$R_{p0.2}$	$R_m$	$A_{gt}$
MPa	MPa	%
$\geq 450$	$\geq 600$	$\geq 5.0$

NOTE 1MPa = 1 N/mm<sup>2</sup>

#### 1.1.2.2 Drill bit

The micropile system uses a sacrificial drill bit that is of no functional value for the inserted pile. The drill bit is selected to suit the given ground conditions on site. The diameter of the drill is appropriate for the intended cover of cement mortar.

The drill bit is not subject of EAD and ETA. Therefore, no essential characteristic is assessed for the drill bit.

#### 1.1.2.3 Anchorage components

Anchorage components are made of steel.

An anchorage is comprised of

- Anchor plate and
- Two nuts.

To reduce slip, the nuts are locked.

The load-bearing capacity of the micropile is not impaired by the anchorage components. Reference thereby is the nominal maximum force of the hollow bar.

#### 1.1.2.4 Coupler

The coupler is made of a seamless steel tube with a machined internal thread and a centre stop. If improved tightness of the connection between two hollow bars is deemed necessary, a sealing ring is inserted.

Two hollow bars are jointed with one coupler in a coupler assembly.

To reduce slip, the hollow bars are locked.

The load-bearing capacity of the micropile is not impaired by the coupler. Reference thereby is the nominal maximum force of the hollow bar.

#### 1.1.2.5 Pile neck protection tube

The pile neck protection tube is a steel tube or a plastic tube.

To select an appropriate pile neck protection tube, the following parameter are considered

- Direction of load
  - Tension load, compression load, alternating load
- Intended working life
  - Temporary micropile, permanent micropile
- Form and force-fit connection concrete foundation to body of cement mortar

To achieve a form and force-fit connection concrete foundation to body of cement mortar the pile head is trimmed. I.e. Impurities, laitance, and loose cement mortar are removed from the pile and the cement mortar of the pile is wetted prior to placing the structural concrete.

Temporary micropile with a form and force-fit connection between concrete foundation and body of cement mortar in general do not require a pile neck protection tube.

#### 1.1.2.6 Corrosion protection

##### 1.1.2.6.1 General

Micropiles are suitable for two types of corrosion protection.

- Corrosion protection for temporary micropiles
- Corrosion protection for permanent micropiles

Corrosion protection includes the following measures to achieve the required working life of the micropile.

- Effective cover consisting of suitable cement mortar
- Increase of steel cross section proportional to loss of material due to corrosion – sacrificial corrosion allowance. Guide values for the corrosion rate are specified in Table 4-1 of EN 1993-5.
- Hot-dip galvanising according to EN ISO 1461
- Specific means such as use of special cements and coatings
- Combinations of the above measures

##### 1.1.2.6.2 Temporary micropiles

Corrosion protection of temporary micropiles is provided by a defined body of cement mortar.

The pile neck is protected by a corrugated plastic tube, except for micropile with a form and force-fit connection concrete foundation to body of cement mortar, see Clause 1.1.2.5.

##### 1.1.2.6.3 Permanent micropiles

The following techniques are applied to ensure the intended working life of the micropile.

- Sacrificial corrosion allowance (increase of steel cross section proportional to loss of material due to corrosion) dependent on the ground conditions, disregarding the system-inherent encapsulation by a body of cement mortar;
- Sacrificial corrosion allowance (increase of steel cross section proportional to loss of material due to corrosion) for bars with hot-dip galvanised coatings, dependent on the ground conditions, disregarding the system-inherent encapsulation by a body of cement mortar;
- The pile neck is in any case protected by a corrugated plastic tube or a steel tube.

##### 1.1.2.7 Cement mortar

Cement mortar is provided on the construction site and is not subject of assessment within EAD and ETA. Suitable specifications of cement mortar are included in EN 14199. However, concrete according to EN 14199 is not suitable instead of cement mortar.



Chemical agents that are aggressive to the cement mortar of the system-inherent mortar body are considered by use of suitable cements.

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

NOTE 2 The aggressiveness of the chemical agents may be determined according to EN 206, Clause 4.1.

In case of presence of aggressive agents that can increase the micropile's corrosion rate, the working life shall be reduced accordingly.

The body of cement mortar is specified in the ETA, in particular regarding thickness and minimum compressive strength, however dependent on the conditions of use.

Cement mortar is not subject of EAD and ETA. Therefore no essential characteristic is assessed for cement mortar.

#### 1.1.2.8 Ancillary components

Spacers are ancillary components for the micropile and are made of cast iron or steel. To result in a defined cover of cement mortar, spacers provide the necessary distance between hollow bar and borehole wall.

Spacers are components of the kit, however no essential characteristic is assessed for the spacers.

#### 1.1.3 Further product related aspects

The product is not covered by a harmonised European standard.

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.

### 1.2 Information on the intended uses of the construction product

#### 1.2.1 Intended uses

Micropiles are intended to transfer loads from buildings and civil engineering structures to the surrounding soil or rock. The micropiles are inserted by drilling and forming a body of cement mortar, see Clause 1.1.1. Pile foundations are designed so as to form a redundant structural system. Pile foundations with only one micropile are not executed. Micropiles are thereby designed to be subjected to axial loads in tension or compression or to axial alternating loads only.

Micropiles are

- permanent or
- temporary.

## 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 micropiles – Kit with hollow bars for self-drilling micropiles – Hollow bars of seamless steel tubes for the intended use of 2 years or up to 50 years when installed in the works, provided that the Kit for micropiles – Kit with hollow bars for self-drilling micropiles – Hollow bars of seamless steel tubes is subject to appropriate installation, see Clauses 1.1.2.6 and 1.1.3. 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<sup>2</sup>.

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 Sacrificial corrosion allowance

This method assumes no surface treatment or cement mortar encapsulation. It relies on the cross section of the hollow bar and other components being over-dimensioned to allow for corrosion. The predicted thickness loss due to corrosion is based on historical data taken from steel structures placed in similar environments with varying levels of soil aggressiveness. This method is not recommended for load-bearing elements with a small cross-sectional area or of high strength steels. Sacrificial corrosion allowance is generally used where the percentage loss of cross section does not exceed half of its initial cross section. It is normally used where degree of redundancy exists for the load-bearing elements.

### 1.3.2 Surface coating

Steel coatings such as galvanising protect the steel against corrosion. The protection period is dependent on the thickness and quality of the coating. Metallic coatings are robust and self-healing and the consequences of surface damage are less severe. Zinc coating imparts a protective surface to the steel, which remains after the loss of galvanising thickness. This surface reduces the subsequent rate of corrosion of the parent metal and thus the magnitude of the secondary sacrificial thickness.

### 1.3.3 Encapsulation by cement mortar

Corrosion protection provided by alkalinity of hydrated cement mortar has long been accepted, providing that a high level of alkalinity is maintained. Therefore, cement mortar is considered acceptable as an impermeable protective encapsulation providing that the crack width within the body of cement mortar is limited.

It is assumed that the cement mortar cover of hollow bar and couplers is sufficient thick. The cement mortar may be placed during or after drilling and is injected via the hollow bar or separate

---

<sup>2</sup> The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

tremie pipe. The use of pressure grouting techniques may enhance the thickness and quality of the cement mortar and improve its properties as a corrosion barrier.

For temporary micropiles with a working life of less than 2 years crack width is not relevant.

### 1.3.4 Symbols

$\frac{F_m}{F_{p0.2}}$ .....	— .....	Ratio tensile strength to yield strength
$\rho$ .....	kg/m <sup>3</sup> .....	Density, 7 850 kg/m <sup>3</sup> for hollow bar
$\tau_{dk}$ .....	MPa .....	Characteristic bond strength for diameter d
$\gamma_{dm}$ .....	— .....	Partial safety factor of bond strength
$2 \cdot \sigma_A$ .....	MPa .....	Stress range, i.e. two times the stress amplitude.
$A_d$ .....	N .....	Design load
$A_{gt}$ .....	% .....	Total elongation at maximum force in tensile test
d .....	mm .....	Nominal diameter of hollow bar
E .....	MPa .....	Mean modulus of elasticity defined from the compression test
f .....	mm .....	Mean elastic deflection in bending test
F .....	N .....	Force in bending 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
$F_1$ .....	N .....	Force in pull-out test at a slip of 1 mm
$f_{cm,0}$ .....	MPa .....	Nominal concrete compressive strength in load transfer test Nominal compressive strength of cement mortar for pull out test
$f_{cm,e}$ .....	MPa .....	Concrete compressive strength at time of end of load transfer test Actual mean compressive strength of cement mortar at end of pull-out test
$F_m$ .....	N .....	Maximum force of hollow bar in tensile test
$F_{m,nom}$ .....	N .....	Nominal maximum force of hollow bar
$F_{max}$ .....	N .....	Upper load in fatigue test
$F_{mean}$ .....	N .....	Result of a single test
$F_{mean,d}$ .....	N .....	Mean value of all $F_{mean}$ of nominal diameter d
$F_{p0.2}$ .....	N .....	Yield force of hollow bar in tensile test
$F_{p0.2,nom}$ .....	N .....	Nominal yield force of hollow bar
$F_{Tu}$ .....	N .....	Maximum force of anchorage or coupling assembly in static tensile test
$F_u$ .....	N .....	Maximum force in load transfer test
I .....	mm <sup>4</sup> .....	Moment of inertia
l .....	mm .....	Length of bonded section in pull out test Support distance in three-point bending test
$l_t$ .....	mm .....	Transfer length of design load $A_d$
m .....	kg/m .....	Mass per metre of hollow bar
$m_n$ .....	kg/m .....	Nominal mass per metre of hollow bar

$R_m$  .....MPa .....Tensile strength

$R_{p0.2}$  .....MPa .....Yield strength

$S$  .....mm<sup>2</sup> .....Cross-sectional area of hollow bar

$S_n$  .....mm<sup>2</sup> .....Nominal cross-sectional area of hollow bar

## 2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

### 2.1 Essential characteristics of the product

Table 2, Table 3, and Table 4 show how the performance of the Kit for micropiles – Kit with hollow bars for self-drilling micropiles – Hollow bars of seamless steel tubes is assessed in relation to the essential characteristics.

**Table 2** Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics – Kit for micropiles – Kit with hollow bars for self-drilling micropiles – Hollow bars of seamless steel tubes

No	Essential characteristic	Method of verification and assessment	Type of expression of product performance (level, class, or description)
Basic requirement for construction works 1: Mechanical resistance and stability			
1	Resistance to static load	2.2.1	Description
2	Resistance to fatigue	2.2.2	Description
3	Load transfer to the structure	2.2.3	Description
4	Load transfer to the micropile	2.2.4	Description
5	Corrosion protection for temporary micropiles	2.2.5	Description
6	Corrosion protection, sacrificial corrosion allowance for permanent micropiles	2.2.6	Description
7	Corrosion protection, sacrificial corrosion allowance with surface coating by hot-dip galvanisation for permanent micropiles	2.2.7	Description
8	Impact energy and torque	2.2.8	Description

**Table 3** Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics – Hollow bar of seamless steel tube

<b>No</b>	<b>Essential characteristic</b>	<b>Method of verification and assessment</b>	<b>Type of expression of product performance (level, class, or description)</b>
Basic requirement for construction works 1: Mechanical resistance and stability			
1	<b>Shape</b>	<b>2.2.9</b>	<b>Description</b>
2	<b>Dimensions</b>	<b>2.2.10</b>	<b>Description</b>
3	<b>Surface geometry</b>	<b>2.2.11</b>	<b>Description</b>
4	<b>Mass per metre</b>	<b>2.2.12</b>	<b>Level</b>
5	<b>Cross-sectional area</b>	<b>2.2.13</b>	<b>Level</b>
6	<b>Strength characteristics</b>	<b>2.2.14</b>	<b>Level</b>
7	<b>Moment of inertia</b>	<b>2.2.15</b>	<b>Level</b>
8	<b>Resistance to fatigue</b>	<b>2.2.16</b>	<b>Description</b>
9	<b>Bond strength</b>	<b>2.2.17</b>	<b>Level</b>
10	<b>Hot-dip galvanising</b>	<b>2.2.18</b>	<b>Description</b>

**Table 4** Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics – Anchorage components, couplers, and pile neck protection tube

<b>No</b>	<b>Essential characteristic</b>	<b>Method of verification and assessment</b>	<b>Type of expression of product performance (level, class, or description)</b>
Basic requirement for construction works 1: Mechanical resistance and stability			
1	<b>Shape</b>	<b>2.2.19</b>	<b>Description</b>
2	<b>Dimensions</b>	<b>2.2.20</b>	<b>Description</b>
3	<b>Hardness</b>	<b>2.2.21</b>	<b>Level</b>
4	<b>Material</b>	<b>2.2.22</b>	<b>Description</b>
5	<b>Hot-dip galvanising</b>	<b>2.2.23</b>	<b>Description</b>

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

### Essential characteristics of the kit

#### 2.2.1 Resistance to static load

Resistance to static load of anchorages and coupler assemblies shall be tested following ETAG 013, Annex B.1.1, with a holding time of at least one hour. The displacements shall be measured in steps until 95 % of the hollow bar's nominal yield force,  $F_{p0.2, nom}$ , has been reached.

The number of tests is specified in Anx 1.2, Table 14.

The following is based on ETAG 013, Clause 6.1.1-I, but has been adapted to the particularities of micropiles. Reference for load-bearing capacity of the micropile are nominal yield force,  $F_{p0.2, nom}$ , and nominal maximum force,  $F_{m, nom}$ , of the hollow bar, see the Clauses 1.1.2.3 and 1.1.2.4.

- Failure can be by fracture of hollow bar, nut, or coupler, or by pull-out of hollow bar from nut or coupler. I.e. there is no requirement set on the failure mode.
- At measured maximum force in static load test,  $F_{Tu}$ , anchorage and coupler assembly attain at least 100 % of the hollow bar's nominal maximum force,  $F_{m, nom}$ .
- With the load held at 95 % of the hollow bar's nominal yield force,  $F_{p0.2, nom}$ , the relative movements between the hollow bar and nut and coupler shall stabilise within the first 30 minutes.

Where

$F_{Tu}$  ..... N..... Maximum force of anchorage or coupling assembly in static tensile test

$F_{m, nom}$  ..... N..... Nominal maximum force of hollow bar

$F_{p0.2, nom}$  ..... N..... Nominal yield force of hollow bar

#### 2.2.2 Resistance to fatigue

Resistance to fatigue of anchorages and coupler assemblies shall be tested following ETAG 013, Annex B.2.

The following test conditions shall be taken into account

Upper load.....  $F_{max} = 0.7 \cdot F_{p0.2, nom}$

Stress range.....  $2 \cdot \sigma_A$

Continue the fatigue test until failure of the specimen. The fatigue test may be terminated when  $2 \cdot 10^6$  load cycles have been attained.

Where

$F_{max}$ ..... N..... Upper load in fatigue test

$F_{p0.2, nom}$  ..... N..... Nominal yield force of hollow bar

$2 \cdot \sigma_A$  .....MPa ..... Stress range, i.e. two times the stress amplitude. The stress shall be calculated based on the nominal cross-sectional area of the hollow bar

The number of tests is specified in Anx 1.2, Table 14.

### 2.2.3 Load transfer to the structure

Load transfer to the structure shall be tested according to ETAG 013, Annex B.3.

The number of tests is specified in Anx 1.2, Table 14.

The following is based on ETAG 013, Clause 6.1.3-I, and has been adapted to the particularities of micropiles. Reference for load-bearing capacity of the micropile is the nominal maximum force,  $F_{m, nom}$ , of the hollow bar, see Clause 1.1.2.3.

For a specimen without bursting reinforcement, the measured maximum force,  $F_u$ , in the load transfer test attains at least

$$F_u \geq 1.3 \cdot F_{m, nom} \cdot \frac{f_{cm, e}}{f_{cm, 0}}$$

Where

$F_u$ ..... N..... Maximum force in load transfer test

$F_{m, nom}$  ..... N..... Nominal ultimate force of hollow bar

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

$f_{cm, 0}$ .....MPa ..... Nominal concrete compressive strength in load transfer test

### 2.2.4 Load transfer to the micropile

Verification of load transfer to the micropile is done by calculation based on the results of the pull-out test specified in Clause 2.2.17. Reference for load-bearing capacity of the micropile is the nominal yield force,  $F_{p0.2, nom}$ , of the hollow bar, see the Clause 1.1.2.3.

It is assumed, that the transfer of compression loads into the micropile is via the hollow bar. The bond characteristics of the hollow bar determine the load transfer and further allow for the upper bound of the bursting forces, covered by the steel tube.

Length and wall thickness of the pile neck protection tube are for the nominal yield force of the hollow bar.

Where

$F_{p0.2, nom}$ ..... Nominal yield force of hollow bar

### 2.2.5 Corrosion protection for temporary micropiles

Corrosion protection of temporary micropiles is provided by a defined body of cement mortar.

The pile neck of micropiles without form and force-fit connection concrete foundation to body of cement mortar shall always be protected using a corrugated plastic tube or steel tube, see Clause 1.1.2.5.

The requirements regarding the characteristics of an effective cover of cement mortar are defined in the paragraph above and in Clause 1.3.3. Thereby, for temporary micropiles with a working life of up to 2 years crack width is not relevant.

### 2.2.6 Corrosion protection, sacrificial corrosion allowance for permanent micropiles

Assessment of the corrosion load of metallic materials in the ground shall be in accordance with EN 12501-1 and EN 12501-2. Relevant criteria as ventilation, ground structure, water content, neutral salts, pH-values, and specific ground resistance shall be defined for 3 corrosion loads, i.e. low, medium and high.

A model for the time-dependent corrosion behaviour, sacrificial corrosion allowance according to Clause 1.3.1, of micropiles shall be prepared based on literature values resulting from long-term exposure of steel in grounds subject to the corrosion loads defined above.

With reference to Clause 1.3.1 this method of sacrificial thickness assumes no cement mortar encapsulation, 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.

According to the requirements specified above, the following data are defined.

- Criteria to assess the corrosion load in the ground according to EN 12501-1 and EN 12501-2
- Guide values for the sacrificial corrosion allowance, corrosion rate, of the hollow bars dependent on the working life based on literature values.

### **2.2.7 Corrosion protection, sacrificial corrosion allowance with surface coating by hot-dip galvanisation for permanent micropiles**

The hollow bar is hot-dip galvanised according to the requirements of EN ISO 1461. The extent of testing and coating properties are defined in EN ISO 1461. Testing shall be in accordance with EN ISO 2178.

The micropile's other components, if made of steel and subject to corrosion same as the hollow bars, are galvanised as well.

The time-dependent corrosion behaviour of the zinc coating, i.e. zinc loss, shall be determined according to Clause 2.2.6 based on literature values for corrosion.

With reference to Clause 1.3.2, the coating imparts a protective surface to the steel and increases the working life. The protection period is dependent on the thickness and quality of the coating.

According to the requirements specified above, the following data shall be defined.

- Criteria to assess the corrosion load in the ground according to EN 12501-1 and EN 12501-2
- Guide values for zinc coating loss for a specified zinc coating thickness and dependent on the working life, based on literature values
- Data on the smallest mean thickness of a zinc coating. Guide values of EN ISO 1461 are observed.

### **2.2.8 Impact energy and torque**

Torque or torque combined with percussions causes stresses to the hollow bar. The equivalent stress as a result of torque or of torque and impact energy respectively does not exceed 90 % of the nominal yield strength of the hollow bar.

Pairs of limit values for impact energy and torque are specified in the ETA.

## **Essential characteristics of the hollow bar of seamless steel tube**

### **2.2.9 Shape**

Description of the shape of the hollow bar.

Exemplary drawings and figures of the shape shall be given in the ETA.



### 2.2.10 Dimensions

The relevant dimensions, external and inner diameter, of the hollow bar shall be determined.

The number of tests is specified in Anx 1.3, Table 15.

The dimensions shall be in accordance with the specifications of the hollow bar.

### 2.2.11 Surface geometry

Sizes subject to testing and properties are specified in EN 10080, Clause 7.4.2. Measurement of specified sizes and properties as well as definition of relative rib area shall be carried out in accordance with EN ISO 15630-1, Clauses 10, 11 and 12.

The number of tests is specified in Anx 1.3, Table 15.

Surface geometry shall be in accordance with the specifications of the hollow bar.

### 2.2.12 Mass per metre

Mass per metre is determined according to EN ISO 15630-1, Clauses 10, 11 and 12.

The number of tests is specified in Anx 1.3, Table 15.

Mass per metre and respective tolerances shall be in accordance with the specifications of the hollow bar.

### 2.2.13 Cross-sectional area

Cross-sectional area is calculated from mass per metre by

$$S = \frac{m \cdot 10^6}{\rho}$$

Nominal cross-sectional area is calculated by

$$S_n = \frac{m_n \cdot 10^6}{\rho}$$

Where

S.....mm<sup>2</sup> ..... Cross-sectional area of hollow bar

S<sub>n</sub> .....mm<sup>2</sup> ..... Nominal cross-sectional area of hollow bar

m ..... kg/m ..... Mass per metre of hollow bar

m<sub>n</sub> ..... kg/m ..... Nominal mass per metre of hollow bar

ρ .....kg/m<sup>3</sup> ..... Density, 7 850 kg/m<sup>3</sup> for hollow bar

### 2.2.14 Strength characteristics

The tensile test shall be carried out in accordance with EN ISO 15630-1, clause 5.

The hollow bar's maximum force, F<sub>m</sub>, yield force, F<sub>p0.2</sub>, ratio tensile strength to yield strength  $\frac{F_m}{F_{p0.2}}$  and total elongation at maximum force, A<sub>gt</sub>, shall be determined according to EN 10080, Clause 7.2.3. If stress values are defined, these shall be calculated based on the hollow bar's nominal cross-sectional area. Tensile test diagrams shall be recorded for at least 3 specimens of a heat's test series.

As product specification, the lower limit of the statistical tolerance interval applies in regard to

- Maximum force,  $F_m$ , and yield force,  $F_{p0.2}$ , with a 5 % fractile as characteristic value,
- Ratio tensile strength to yield strength,  $\frac{F_m}{F_{p0.2}}$ , and elongation at maximum force,  $A_{gt}$ , with a 10 % fractile as characteristic value

The number of tests is specified in Anx 1.3, Table 15.

Where

$F_m$ ..... N.....	Maximum force of hollow bar in tensile test
$F_{p0.2}$ ..... N.....	Yield force of hollow bar in tensile test
$\frac{F_m}{F_{p0.2}}$ ..... —.....	Ratio tensile strength to yield strength
$A_{gt}$ ..... %.....	Total elongation at maximum force in tensile test

### 2.2.15 Moment of inertia

To determine the moment of inertia of hollow bars, a bending test and a compression test to define the modulus of elasticity shall be performed. The compression test serves to determine the modulus of elasticity.

The bending test on the hollow bar shall be a three-point bending test with two series of measurements under step loading. The moment of inertia shall be calculated based on the linear-elastic deflection behaviour.

$$I = \frac{F \cdot l^3}{48 \cdot E \cdot f}$$

The modulus of elasticity is determined by performing a compression test with three series of measurements on a hollow bar section with a cylindrically machined inside and outside surface and measuring the deformations under incremental unloading using applied strain gauges.

Each diameter shall be tested.

Where

$I$ .....mm <sup>4</sup> .....	Moment of inertia
$F$ ..... N.....	Force in bending test
$l$ ..... mm.....	Support distance in three-point bending test
$E$ .....MPa.....	Mean modulus of elasticity defined from the compression test
$f$ ..... mm.....	Mean elastic deflection in bending test

### 2.2.16 Resistance to fatigue

The hollow bar shall be tested as given in EN 10080, Clause 7.2.5. The fatigue test shall be carried out according to EN ISO 15630-1, Clause 8, using the following parameters.

Upper load.....  $F_{max} = 0.7 \cdot F_{p0.2, nom}$

Stress range.....  $2 \cdot \sigma_a$

The fatigue test is continued until failure of the thread bar. The fatigue test may be terminated when  $2 \cdot 10^6$  load cycles have been attained.

The stress value shall be calculated with the nominal cross-sectional area of the hollow bar.

The number of tests is specified in Anx 1.3, Table 15.

Where

- $F_{max}$ ..... N..... Upper load in fatigue test  
 $F_{p0.2, nom}$ ..... N..... Nominal yield load of hollow bar  
 $2 \cdot \sigma_a$ .....MPa ..... Stress range, i.e. two times the stress amplitude. The stress value shall be calculated based on the nominal cross-sectional area of the hollow bar

### 2.2.17 Bond strength

The hollow bar shall be subjected to a pull-out test following EN 10080, Annex D, to determine the bond behaviour. The concrete body is formed by the cement mortar used for the micropile's body of cement mortar. The cement mortar shall meet the specifications of EN 14199.

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

The bond strength shall be determined, based on the pull out tests, using the following equations

$$F_{mean} = \frac{(F_{0.01} + F_{0.1} + F_1)}{3}$$

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

The coefficient 0.7 shall be applied in the absence of a more in-depth statistical evaluation.

The bond strength of diameters not tested shall be calculated by interpolation.

The transfer length of a design load shall be calculated using the following equation.

$$l_t = \gamma_{dm} \cdot \frac{A_d}{\tau_{dk} \cdot \pi \cdot d}$$

Where

In the absence of standards and regulations applicable at the place of use, the recommended value for  $\gamma_{dm}$  is 1.65. The reference for the recommended value is EN 1992-1-1.

The number of tests is specified in Anx 1.3, Table 15.

Where

- $\tau_{dk}$  .....MPa ..... Characteristic bond strength for diameter d  
 $\gamma_{dm}$  ..... – ..... Partial safety factor of bond strength  
 $A_d$  ..... N..... Design load  
d ..... mm..... Nominal diameter of hollow bar  
 $F_{0.01}$  ..... 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  
 $f_{cm, 0}$  .....MPa ..... Nominal compressive strength of cement mortar

$f_{cm, e}$ .....MPa .....	Actual mean compressive strength of cement mortar at end of pull-out test
$F_{mean}$ ..... N.....	Result of a single test
$F_{mean, d}$ ..... N.....	Mean value of all $F_{mean}$ of nominal diameter $d$
$l$ ..... mm.....	Length of bonded section in pull out test
$l_t$ ..... mm.....	Transfer length of design load $A_d$

### 2.2.18 Hot-dip galvanising

The hollow bar is hot-dip galvanised according to the requirements of EN ISO 1461, see Clause 1.1.1. The extent of testing and coating properties are defined in EN ISO 1461. Testing shall be in accordance with EN ISO 2178.

Determined is the mean coating thickness of the hot-dip galvanisation.

## Essential characteristics of anchorage components, couplers, and pile neck protection tube

### 2.2.19 Shape

The shape of the anchorage components, couplers and pile neck protection tube is determined by visual inspection by reference to workshop drawings.

The shape of the anchorage components, couplers and pile neck protection tube is given in representations like outline drawings.

### 2.2.20 Dimensions

The relevant dimensions of the anchorage components, couplers and pile neck protection tube shall be determined.

The number of tests is specified in Anx 1.4, Table 16.

Dimensions shall be in accordance with the component's specification.

### 2.2.21 Hardness

For the material of the anchorage components, couplers and pile neck protection tube, hardness according to Vickers shall be determined as given in EN ISO 6507-1 and converted into material strength.

The number of tests is specified in Anx 1.4, Table 16.

Hardness values shall be in accordance with the component's specification.

### 2.2.22 Material

Material characteristics of the anchorage components, couplers and pile neck protection tube shall be determined according to the respective reference standard of the component's material.

The number of tests is specified in Anx 1.4, Table 16.

Material shall be in accordance with to the respective reference standard of the component's material.

### 2.2.23 Hot-dip galvanising

The components are hot-dip galvanised according to the requirements of EN ISO 1461, see Clause 1.1.1. The extent of testing and coating properties are defined in EN ISO 1461. Testing shall be in accordance with EN ISO 2178.

Determined is the mean coating thickness of the hot-dip galvanisation.

## 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 the EAD the applicable European legal act is: Decision 1998/214/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 5 to Table 10.

**Table 5** Kit – Control plan for the manufacturer – Cornerstones

No	Subject of control	Test or control method	Criteria, if any	Minimum number of samples <sup>1)</sup>	Minimum frequency of control
<b>Factory production control (FPC) including testing of samples taken at the manufacturing plant in accordance with the prescribed test plan</b>					
1	Static load-bearing capacity of anchorage	2.2.1	2.2.1	0.2 % <sup>2), 3)</sup> ≥ 2 <sup>3)</sup>	Per year
2	Static load-bearing capacity of coupler assembly	2.2.1	2.2.1	0.2 % <sup>2), 3)</sup> ≥ 2 <sup>3)</sup>	Per year
3	Resistance to fatigue of anchorage	2.2.2	2.2.2	1 <sup>3)</sup>	Per year
4	Resistance to fatigue of coupler assembly	2.2.2	2.2.2	1 <sup>3)</sup>	Per year

<sup>1)</sup> For two specified numbers of samples, the higher number applies.

<sup>2)</sup> Percentage of produced anchorages/couplers per diameter. If the test results were always satisfactory, the minimum frequency may be reduced to 0.1 % after 20 batches of nuts and couplers, at the latest however after 5 years.

<sup>3)</sup> Per component and diameter. In case of a production of less than 20 anchorages or couplers of a diameter per year, testing is not required. However, the components of all diameters shall be tested within 5 years.

**Table 6** Hollow steel bar – Control plan for the manufacturer – Cornerstones

No	Subject of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Factory production control (FPC) including testing of samples taken at the manufacturing plant in accordance with the prescribed test plan</b>					
1	Dimensions	2.2.10	2.2.10	3 <sup>1)</sup>	Per year
2	Surface geometry	2.2.11	2.2.11	3 <sup>1)</sup>	Per year
3	Mass per metre	2.2.12	2.2.12	3 <sup>1)</sup>	Per year
4	Cross-sectional area	2.2.13	2.2.13	3 <sup>1)</sup>	Per year
5	Strength properties	2.2.14	2.2.14	3 <sup>1)</sup>	Per year
6	Visual inspection <sup>4)</sup>	5)	5)	all	Per year

1) Per diameter and rolling batch, at least however as specified in EN 10080, Clause 8.1.

2) Test report type "2.2" according to EN 10204

3) According to the specification of the component's material

4) Successful visual inspection does not need to be documented.

5) Visual inspection means e.g. main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, corrosion, coating, according to the components' specifications.

**Table 7** Nuts and couplers – Control plan for the manufacturer – Cornerstones

No	Subject of control	Test or control method	Criteria, if any	Minimum number of samples <sup>1)</sup>	Minimum frequency of control
<b>Factory production control (FPC) including testing of samples taken at the manufacturing plant in accordance with the prescribed test plan</b>					
1	Dimensions	2)	2)	0.5 % <sup>3), 4)</sup> , ≥ 3 <sup>5)</sup>	Per year
2	Hardness	2)	2)	0.5 % <sup>3)</sup> , ≥ 3 <sup>5)</sup>	Per year
3	Static load-bearing capacity	2)	2)	0.1 % <sup>3), 6)</sup> , ≥ 2 <sup>5)</sup>	Per year
4	Material	“2.2” <sup>7)</sup>	2)	all	Per year
5	Visual inspection <sup>8)</sup>	9)	9)	all	Per year

1) For two specified numbers of samples, the higher number applies.

2) As defined by the component's specification

3) Percentage of produced components per diameter.

4) For small-scale production ( $\leq 500$  pieces), the frequency shall be increased to 5 % of the produced components per diameter and heat.

5) Per component and diameter. In case of a production of less than 20 anchorages or couplers of a diameter per year, testing is not required. However, the components of all diameters shall be tested within 5 years.

6) The static load-bearing capacity of nuts and couplers is tested in tensile tests with high-strength steel bolts having the same thread as the hollow bars. The couplers are loaded up to failure, the nuts up to a specified test load. These tests may be replaced by an inspection certificate "3.1" of the material according to EN 10204.

7) Test report type “2.2” according to EN 10204

8) Successful visual inspection does not need to be documented.

9) Visual inspection means e.g. main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, corrosion, coating, according to the components' specifications

**Table 8** Hot-dip galvanisation – All components – Control plan for the manufacturer – Cornerstones

No	Subject of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Factory production control (FPC) including testing of samples taken at the manufacturing plant in accordance with the prescribed test plan</b>					
1	Coating thickness	“2.2” <sup>1)</sup>	2)	3)	100 %
2	Visual inspection <sup>4)</sup>	5)	5)	all	Per year

1) Test report type “2.2” according to EN 10204

2) As defined by the component’s specification

3) The number of tests for one sample is defined in EN ISO 1461.

4) Successful visual inspection does not need to be documented.

5) Visual inspection means e.g. relevant dimensions of zinc coating, gauge testing, correct marking or labelling, surface with regard to zinc flux and zinc ash residues.

**Table 9** Anchor plate and pile neck protection tube in steel – Control plan for the manufacturer – Cornerstones

No	Subject of control	Test or control method	Criteria, if any	Minimum number of samples <sup>1)</sup>	Minimum frequency of control
<b>Factory production control (FPC) including testing of samples taken at the manufacturing plant in accordance with the prescribed test plan</b>					
1	Dimensions	2)	2)	0.5 % <sup>3), 4)</sup> , ≥ 3 <sup>5)</sup>	Per year
2	Material	“2.2” <sup>6)</sup>	2)	all	Per year
3	Visual inspection <sup>7)</sup>	8)	8)	all	Per year

1) For two specified numbers of samples, the higher number applies.

2) As defined by the component’s specification

3) Percentage of produced components per diameter.

4) For small-scale production ( $\leq 500$  pieces), the frequency shall be increased to 5 % of the produced components per diameter and heat.

5) Per component and diameter. In case of a production of less than 20 anchorages of a diameter per year, testing is not required. However, the components of all diameters shall be tested within 5 years.

6) Test report type “2.2” according to EN 10204

7) Successful visual inspection does not need to be documented.

8) Visual inspection means e.g. main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, corrosion, coating, according to the components’ specifications



**Table 10** Pile neck protection tube in plastic – Control plan for the manufacturer  
– Cornerstones

No	Subject of control	Test or control method	Criteria, if any	Minimum number of samples <sup>1)</sup>	Minimum frequency of control
<b>Factory production control (FPC) including testing of samples taken at the manufacturing plant in accordance with the prescribed test plan</b>					
1	Dimensions	2)	2)	0.1 % <sup>3), 4)</sup> , ≥ 2 <sup>5)</sup>	Per year
2	Material	“2.2” <sup>6)</sup>	2)	all	Per year
3	Visual inspection <sup>7)</sup>	8)	8)	all	Per year

1) For two specified numbers of samples, the higher number applies.

2) As defined by the component's specification

3) Percentage of produced components per diameter.

4) For small-scale production ( $\leq 500$  pieces), the frequency shall be increased to 5 % of the produced components per diameter and heat.

5) Per component and diameter. In case of a production of less than 20 anchorages of a diameter per year, testing is not required. However, the components of all diameters shall be tested within 5 years.

6) Test report type “2.2” according to EN 10204

7) Successful visual inspection does not need to be documented.

8) Visual inspection means e.g. main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, corrosion, coating, according to the components' specifications

### 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 micropiles – Kit with hollow bars for self-drilling micropiles – Hollow bars of seamless steel tubes are laid down in Table 11 to Table 13.

**Table 11** Kit – Control plan for the notified body – Cornerstones

№	Subject of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Initial inspection of the manufacturing plant and of factory production control</b>					
1	<p>The notified product certification body shall verify the ability of the manufacturer for a continuous and orderly manufacturing of the product according to the European Technical Assessment. In particular the following items shall be appropriately considered</p> <ul style="list-style-type: none"> <li>– personnel and equipment</li> <li>– the suitability of the factory production control established by the manufacturer</li> <li>– full implementation of the prescribed test plan</li> </ul>				—
<b>Continuous surveillance, assessment, and evaluation of factory production control</b>					
2	<p>The notified product certification body shall verify</p> <ul style="list-style-type: none"> <li>– the manufacturing process</li> <li>– the system of factory production control</li> <li>– the implementation of the prescribed test plan</li> </ul> <p>are maintained.</p>				Once per year

**Table 12** Hollow bar – Control plan for the notified body – Cornerstones

No	Subject of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Initial inspection of the manufacturing plant and of factory production control</b>					
1	The notified product certification body shall verify the ability of the manufacturer for a continuous and orderly manufacturing of the product according to the European Technical Assessment. In particular the following items shall be appropriately considered <ul style="list-style-type: none"> <li>– personnel and equipment</li> <li>– the suitability of the factory production control established by the manufacturer</li> <li>– full implementation of the prescribed test plan</li> </ul>				—
<b>Continuous surveillance, assessment, and evaluation of factory production control</b>					
2	The notified product certification body shall verify <ul style="list-style-type: none"> <li>– the manufacturing process</li> <li>– the system of factory production control</li> <li>– the implementation of the prescribed test plan</li> </ul> are maintained, in particular see EN 10080, Clause 8.3.1.				Once per year

**Table 13** Anchorage components and couplers – Control plan for the notified body – Cornerstones

No	Subject of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Initial inspection of the manufacturing plant and of factory production control</b>					
1	The notified product certification body shall verify the ability of the manufacturer for a continuous and orderly manufacturing of the product according to the European Technical Assessment. In particular the following items shall be appropriately considered <ul style="list-style-type: none"> <li>– personnel and equipment</li> <li>– the suitability of the factory production control established by the manufacturer</li> <li>– full implementation of the prescribed test plan</li> </ul>				—
<b>Continuous surveillance, assessment, and evaluation of factory production control</b>					
2	The notified product certification body shall verify <ul style="list-style-type: none"> <li>– the manufacturing process</li> <li>– the system of factory production control</li> <li>– the implementation of the prescribed test plan</li> </ul> are maintained.				Once per year <sup>1)</sup>

<sup>1)</sup> Inspection of the manufacturer of the micropile

#### 4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment, is of relevance.

ETAG 013, 06.2002	Guideline for European Technical Approval of Post-Tensioning Kits for Prestressing of Structures
EN 206	Concrete – Specification, performance, production and conformity
EN 1992-1-1	Eurocode 2 – Design of concrete structures – Part 1-1: General rules and rules for buildings
EN 1993-5	Eurocode 3 – Design of steel structures – Part 5: Piling
EN 1993-1-9	Eurocode 3 – Design of steel structures – Part 1-9: Fatigue
EN 10080	Steel for the reinforcement of concrete – Weldable reinforcing steel – General
EN 10204	Metallic products – Types of inspection documents
EN 12501-1	Protection of metallic materials against corrosion – Corrosion likelihood in soil – Part 1: General
EN 12501-2	Protection of metallic materials against corrosion – Corrosion likelihood in soil – Part 2: Low alloyed and non alloyed ferrous materials
EN 14199	Execution of special geotechnical works – Micropiles
EN ISO 1461	Hot-dip galvanised coatings on fabricated iron and steel articles – Specifications and test methods
EN ISO 2178	Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method
EN ISO 6507-1	Metallic materials – Vickers hardness test – Part 1: Test method
EN ISO 15630-1	Steel for the reinforcement and prestressing of concrete – Test methods – Part 1: Reinforcing bars, wire rod and wire
1998/214/EC	Commission Decision 98/214/EC of 9 March 1998 on the procedure for attesting the conformity of construction products pursuant to Article 20(2) of Council Directive 89/106/EEC as regards structural metallic products and ancillaries, OJ L 80 of 18.03.1998, p. 46, amended by Commission Decision 2001/596/EC of 8 January 2001, OJ L 209 of 02.08.2001, p. 33
305/2011	Regulation (EU) № 305/2011 of the European Parliament and of the Council of 09 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 088 of 04 April.2011, p. 5 amended by Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, OJ L 157 of 27 May 2014, p. 76 and Commission Delegated Regulation (EU) № 574/2014 of 21 February 2014, OJ L 159 of 28 May 2014, p. 41

## ANNEX 1 NUMBER OF TESTS

### Anx 1.1 General

Table 14 to Table 16 rely on the concept of series. This concept presumes one or more series of hollow bars, where within each series there are similarities in terms of

- Material
- Grade of material, strength of concrete
- Geometry
- The same method of anchoring the steel bars
- The same applies for the other components of the kit

Moreover, typical to hollow bars are

- The variation of cross-sectional area within one nominal diameter
- Different threads of hollow bars, nuts, and couplers for different nominal diameters
- The assessment of different essential characteristics of the kits can result for each characteristic in a different series of hollow bars

As the parameters stated above and the combinations of that parameters are specific to the various kits under assessment, it is not advisable to give more precise figures. However, the general principle of the tables below shall be maintained. I.e.

- Identification of series

One, two, or even more series of hollow bars together with their components are identified within the various kits. The parameters above serve as criteria to define the series.

- Identification of nominal diameters subject to testing for each series

From the parameters given above, it is possible that not the nominal diameter alone determines testing and e.g. two hollow bars with one nominal diameter but different cross-sectional areas are tested. Hence, in Table 14 to Table 16 the term size is used instead of referring to nominal diameter or cross-sectional area. However, in general three nominal diameters or three cross-sectional areas are selected from each series. For these three nominal diameters or cross-sectional areas Table 14 to Table 16 give the number of tests.

These nominal diameters or cross-sectional areas identified for testing, have for each essential characteristic to be the most critical.

Very small series may deem it advisable to test less diameters or cross-sectional areas than indicated above. However, even in that case, the total number of tests shall remain unchanged for each series.

- Assessment of untested nominal diameters

Untested nominal diameters or untested cross-sectional areas are assessed by calculations and affinity verifications. It is an essential element of the concept of series that such calculations and verifications are possible. The results of these calculations and verifications of course have to be on the safe side.

Hence, the tests have been performed on the nominal diameters or cross-sectional areas that are the most critical within each series and the untested nominal diameters or cross-sectional areas are verified to remain on the safe side.

Alternatively, intermediate sizes may of course be verified by testing as well.

– Unnecessary repetition of tests

Although it is thought to be self-evident, the need to point on the fact that it is unnecessary to repeat a test for pure formal reasons is a never ending issue. If the essential characteristic already has been appropriately assessed, it is unnecessary to repeat a test only because “of a figure found in a table”.

On the other hand it might be important or even essential to perform a test for that a figure cannot be found in any table. The latter of course as a result of a comprehensible decision on solid ground only.

## Anx 1.2 Number of tests for the Kit

**Table 14:** Number of tests for the kit relating to basic requirement for construction works 1

Test method	Number of tests			Total number of tests
	Small <sup>1)</sup>	Medium <sup>1)</sup>	Largest <sup>1)</sup>	
Resistance to static load of anchorages and coupler assemblies including measurement of displacements	2	1	2	5
Resistance to fatigue of anchorages and coupler assemblies	1	1	2	4
Load transfer to the structure of mechanical anchorages for an intended concrete grade	1 <sup>2)</sup>	1 <sup>2)</sup>	2 <sup>2)</sup>	4

- <sup>1)</sup> Small is in general not the smallest size within one series  
 Medium is a size in the medium range of one series  
 Largest is the largest size of one series

- <sup>2)</sup> In case the thread of the hollow bar does not have an influence on load transfer to the structure, the respective series can be spread across size with different threads.

### Anx 1.3 Hollow bar

**Table 15:** Number of tests for the hollow bar, relating to basic requirement for construction works 1

Test method	Number of tests			Total number of tests
	Small <sup>1)</sup>	Medium <sup>1)</sup>	Largest <sup>1)</sup>	
Cross-sectional area, mass per metre, surface geometry, dimensions	9	9	9	27
Strength properties	30	30	30	90
Resistance to fatigue <sup>2)</sup>	5	5	5	15
Bond strength, pull-out test, transfer length	3	3	3	9

<sup>1)</sup> Small is in general not the smallest size within one series  
Medium is a size in the medium range of one series  
Largest is the largest size of one series

<sup>2)</sup> The number of tests per size shall be increased to include three different heats with 5 specimens each, i.e. 90 tests instead of 30, unless the stress range  $2 \cdot \sigma_A$  can be verified by calculation according to Annex 2

### Anx 1.4 Anchorage components, couplers and pile neck protection tube

**Table 16:** Characteristics to be tested and number of tests for the anchorage components, couplers and pile neck protection tube relating to basic requirement for construction works 1

Test method	Number of tests			Total number of tests
	Small <sup>1)</sup>	Medium <sup>1)</sup>	Largest <sup>1)</sup>	
Material	4 × 1	4 × 1	4 × 1	12
Dimensions	4 × 3	4 × 3	4 × 3	36
Hardness	4 × 3	4 × 3	4 × 3	36

<sup>1)</sup> Small is in general not the smallest size within one series  
Medium is a size in the medium range of one series  
Largest is the largest size of one series

## **ANNEX 2 VERIFICATION OF STRESS RANGE IN FATIGUE TEST BY CALCULATION**

The verification of the stress range by calculation requires the following specifications to be met.

- The hollow bars feature a continuous cold-rolled thread over the entire length of the bar.
- The threads are rope threads, either continuously round or trapezoidal with defined rounded groove, according to the relevant standard or specification.
- The materials are steels within the scope of EN 1993-1-9, for quenching and tempering and as specified in the ETA.
- The fatigue limit for 2 million ( $2 \cdot 10^6$ ) stress cycles for calculation is taken from EN 1993-1-9, applicable to the materials used and taking into account the relevant detail category for threads.

The calculation has to take into account the stress concentration by the thread as well as size and surface effects of the hollow bar.

The loading conditions are as specified in Clause 2.2.16.



### ANNEX 3 ESSENTIAL CHARACTERISTICS FOR THE INTENDED USES

The essential characteristics relevant for the intended uses are listed in Table 17. Intended uses are

- Column **①** in Table 17 Micropile for temporary use
- Column **②** in Table 17 Micropile for permanent use
- Column **③** in Table 17 Micropile galvanised for permanent use

**Table 17** Essential characteristics for the intended uses

№	Essential characteristic	Product and intended use		
		1	2	3
<b>1 Kit for micropiles – Kit with hollow bars for self-drilling micropiles – Hollow bars of seamless steel tubes</b>				
Basic requirement for construction works 1: Mechanical resistance and stability				
1.1	Resistance to static load	+	+	+
1.2	Resistance to fatigue	+	+	+
1.3	Load transfer to the structure	+	+	+
1.4	Load transfer to the micropile	+	+	+
1.5	Corrosion protection of temporary micropile	+	—	—
1.6	Corrosion protection, sacrificial corrosion allowance for permanent micropiles	—	+	—
1.7	Corrosion protection, sacrificial corrosion allowance with surface coating by hot-dip galvanisation for permanent micropiles	—	—	+
1.8	Impact energy and torque	+	+	+
<b>2 Hollow bar of seamless steel tube</b>				
Basic requirement for construction works 1: Mechanical resistance and stability				
2.1	Shape	+	+	+
2.2	Dimensions	+	+	+
2.3	Surface geometry	+	+	+
2.4	Mass per metre	+	+	+

№	Essential characteristic	Product and intended use		
		1	2	3
2.5	Cross-sectional area	+	+	+
2.6	Strength properties	+	+	+
2.7	Moment of inertia	+	+	+
2.8	Resistance to fatigue	+	+	+
2.9	Bond strength	+	+	+
2.10	Hot-dip galvanising	—	—	+
<b>3 Anchorage components, couplers, and pile neck protection tube</b>				
Basic requirement for construction works 1: Mechanical resistance and stability				
3.1	Shape	+	+	+
3.2	Dimensions	+	+	+
3.3	Hardness	+	+	+
3.4	Material	+	+	+
3.5	Hot-dip galvanising	—	—	+

## Key

- + ..... Essential characteristic relevant for the declaration of performance
- ..... Essential characteristic not relevant for the declaration of performance