

KIT FOR HOLLOW-BAR DRILLED AND GROUTED MICROPILES AND SOIL NAILING - MEANING AND MISUSE OF THE CE-MARK

Björn Ischebeck, Friedr. Ischebeck GmbH, Ennepetal, GERMANY

Alice Y. Kayser, Friedr. Ischebeck GmbH, Ennepetal, GERMANY

ABSTRACT

The construction product market is one of the largest markets in Europe. To ensure a reasonable safety level in regards to health, durability, energy economy and protection of the environment it requires harmonized legislation.

In 1989, the construction Product Directive is launched which was binding only to the member states. The harmonization of all requirements for every application seemed impossible.

European technical standards for Execution of special geotechnical works: Micropiles (EN 14199:2015) and Execution of special geotechnical works: Soil nailing (EN 14490:2010) define the requirements for the execution and the product itself.

2011/2013 the Construction Product Regulation is introduced binding directly each citizen. This Regulation harmonized the assessment of essential product characteristics.

A construction product means any product or kit, which is produced and introduced into the market for incorporation in a permanent manner in construction works or parts thereof.

If a construction product is covered by a Harmonized Standard or conforms to a European Technical Assessment (ETA) the manufacturer shall draw up a Declaration of Performance.

The ETA is based on a European Assessment Document (EAD), which consists of the harmonized technical specification. This technical data sheet shows the definition of the essential characteristics and the method of verification.

The characteristics are related to the system as well as to the single components (such as steel load bearing element and coupling nut) and include:

- Load bearing capacity
- Resistance against fatigue
- Resistance against alternating loads (tension and compression)
- Transfer of the impact energy produced by roto-percussion
- Protection against corrosion

The declaration of performance must express the performance of the construction product in relation to the essential characteristics. The declaration of performance shall bear a CE Marking.

The declaration of performance gives transparency about the characteristics of the offered product. There is a national approval or the engineer has to decide if the product fulfills the requirements and is fit for purpose.

This paper shall give an overview about the actual legislation in Europe in regards to Micropiles and Soil Nails and technical requirements resulting thereof.

KEYWORDS

Construction Product Regulation EU 305/2011, CE Mark, European Assessment Document (EAD), European Technical Assessment (ETA), Declaration of Performance (DoP), EN 14199 Micropile, EN 14490 Soil Nailing

1. BACKGROUND OF CONSTRUCTION PRODUCT REGULATION

Construction products¹, which belong to one of the largest markets in Europe, are assigned to be included into final constructions or involved to support the construction process. Building sites (design and execution phase) always need special attention and therefore rules for Member States on health and safety, protection of animals, properties and environment, but also durability and energy economical aspects are important goals.

Construction product Council Directive 89/106/EEC² was the first step in 1989 to harmonize all product classifications and applications within European Union to achieve above mentioned goals. Any product that has been introduced into the market under the Directive needed to follow national laws like national product standards, national technical approvals / specifications and provisions that had been prepared by each Member State based on their own needs. Due to the quantities of documents and individual focuses it is confusing, therefore technical documentation needs to be simplified and unified for the EU.

Since 1st July 2013 the harmonization has been completed with the construction product Regulation (CPR) No. EU/305/2011 and for new products entering the market no further national laws are allowed anymore to fulfil requirements according to this regulation. The CPR directly repeals the former Directive (valid from 21st Dec. 1988 to 30th June 2013) and is a binding legislative act to be applied instantly for all European countries. Content of the CPR covers everything concerning any construction product or kit³ and it shall simplify the assessment of product performance.

One goal described in the CPR is the elimination of technical barriers for products within the EU. To achieve this goal, products have to be according to harmonized technical specifications. These technical specifications shall assess the performance of products. Essential characteristics of products' performances have to be verified by tests, calculation methods and other instruments that are explained in harmonized standards and/or European Assessment Documents (EAD⁴). If a product is not covered or not completely covered in a harmonized standard, an EAD is needed for this product. The EAD describes the type of product it applies to.

The EAD is basis for a European Technical Assessment (ETA). The EOTA defines ETA as "...a document providing information about the performance of a construction product, to be declared in relation to its essential characteristics."⁵ As soon as an ETA is published it has to be adopted in the market.

European Technical Approvals, also abbreviated as ETA, were issued until 30th June 2013. These type of ETAs have a valid period by end of 2018. No ETAs will be published anymore after 1st July 2013.

EAD and ETAssessment are basis of a product to receive a CE marking (CE mark). The CE mark shall show and express, that this marked product has been checked for essential characteristics according to harmonized standards.

¹ Construction products will be simplified to products

² EEC = European Economic Community

³ Definition 305/2011: "'kit' means a construction product placed on the market by a single manufacturer as a set of at least two separate components that need to be put together to be incorporated in the construction works"

⁴ The European Organization for Technical Assessment (EOTA) is responsible for developing and publishing EADs.

⁵ www.eota.eu

Details on above mentioned documents and procedures mainly needed for the CE mark will be described in this paper. Due to changes of directives into regulations as explained above and confusion in regards to meaning of expressions like ETA (ETA Assessment or ETA Approval) clarifying is needed. This paper finishes with a summary and outlook.

2. OVERVIEW EUROCODES AND EU STANDARDS IN REGARDS TO HOLLOW BARS

European standards and Eurocodes are an outcome of lowering trade barriers with uniform level of safety within the EU. There are 10 Eurocodes for the construction industry distinguished between the following:

- Eurocode 0 (EN 1990) : Basis of structural design
- Eurocode 1 (EN 1991) : Actions on structures
- Eurocode 2 (EN 1992) : Design of concrete structures
- Eurocode 3 (EN 1993) : Design of steel structures
- Eurocode 4 (EN 1994) : Design of composite steel and concrete structures
- Eurocode 5 (EN 1995) : Design of timber structures
- Eurocode 6 (EN 1996) : Design of masonry structures
- Eurocode 7 (EN 1997) : Geotechnical design
- Eurocode 8 (EN 1998) : Design of structures of earthquake resistance
- Eurocode 9 (EN 1999) : Design of aluminum structures

Micropiles or Soil Nails belong to the geotechnical field and thus EC 7 shall be used for micropile designs. In regards to standards, product regulations are differentiated between the descriptions of characteristics and application fields with the product. Because of that, application standards for micropiles are regulated in EN 14199 and EN 14490, which include references to product material requirements like for example EN 10210⁶.

The main component to create a micropile is the hollow bar, in addition to the main are accessories like drill bit, coupling nut, washer plate and spherical collar nut that belong to the whole kit for installing micropiles.

Looking at the product kit hollow bar precisely, it is not only EC 7, which is relevant to be fulfilled. The kit also needs to comply with further requirements according to EC 0, EC 2 and EC 3 (s. Figure 1). The EC 0 defines among other topics different design working life periods dependent on construction types, e.g. 100 years for bridges. The EC 2 requires various grout cover thicknesses in different constellations to meet crack width limitations and corrosion protection. The EC 3 governs steel structures, which includes slip between steel components.

Eurocodes regulate everything concerning structural design. Products however used for construction are covered either by harmonized standards (hEN)⁷ or EADs. European standards in general are developed to support harmonization of Europe.

⁶ EN 10210 “Hot finished structural steel hollow sections” is a harmonized standard for products made of fine-grain steel and can be found on the European commissions’ website.

⁷ hEN can be labeled as such, if i) the European commission and the EFTA instruct CEN, CENELEC or ETSI by a standardization request to develop the standard and ii) the European commission published the standard in an EU Official Journal (OJ). EFTA = European Trade Association; CEN = Comité Européen de Normalisation = European Committee for Standardization; CENELEC = Européen de Normalisation Électrotechnique = European Committee for Electrotechnical Standardization; ETSI = European Telecommunications Standards Institute

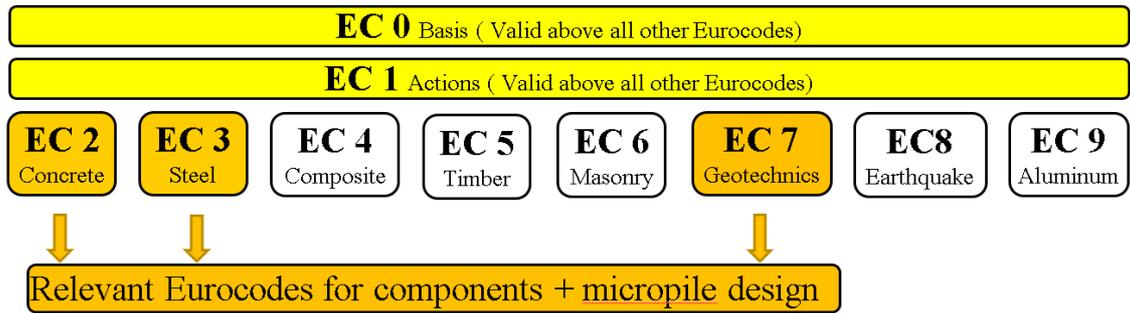


Figure 1: Overview Eurocodes – relevance for geotechnical design

3. BACKGROUND AND MEANING OF CE MARK

CE⁸ mark means colloquially “Conformity with Europe”. This mark, attached to a product, shall simplify and in the end represent all test procedures that had been done with the product which received the mark for these reasons. Furthermore it shall be easy for users to recognize and therefore trust in its safe use, but what is behind the CE mark? The mark shall express that the manufacturer takes responsibility for the conformity in regards to the main characteristics published in the DoP.

Where can one find the specification? How does the process of receiving the CE mark look like?

If a product is covered by a harmonized European standard (hEN) or European Assessment Document (EAD), specifications and test methods to evaluate the characteristics are described in that hEN respectively EAD. As soon as hEN or EAD exist for a certain product, all products of this kind from a manufacturer need to carry the mark when entering the European market without barriers. A product shall automatically simply specified as checked for its main characteristics according to the related hEN or EAD solely by carrying the mark. If there is no hEN or EAD for a product, the product needs to be specified in a European Technical Assessment (ETA). The ETA can be applied with special application forms (manufacturer’s technical files / technical documents) from the manufacturer to the Technical Assessment Body (TAB). The TAB checks after incoming application for a certain product, if a hEN or EAD exist for that product. If so, the application will be declined. If not, an EAD has to be developed in order to work as basis for the ETA. (s. Figure 2)

3.1 European Assessment Document (EAD)

The EAD is a harmonized technical specification and includes all information to characterize a product. A general description and the intended use is first part of an EAD, followed by essential characteristics that are relevant for the intended use of the product. The EAD is completed with methods and criteria for assessing the performance of the product, but also principles for the applicable factory production control.⁹ All together the EAD gives all necessary descriptions and tools to verify the characteristics of a product.

⁸ CE = Communautés Européennes = European Communities

⁹ www.eota.eu: “What is an EAD?”

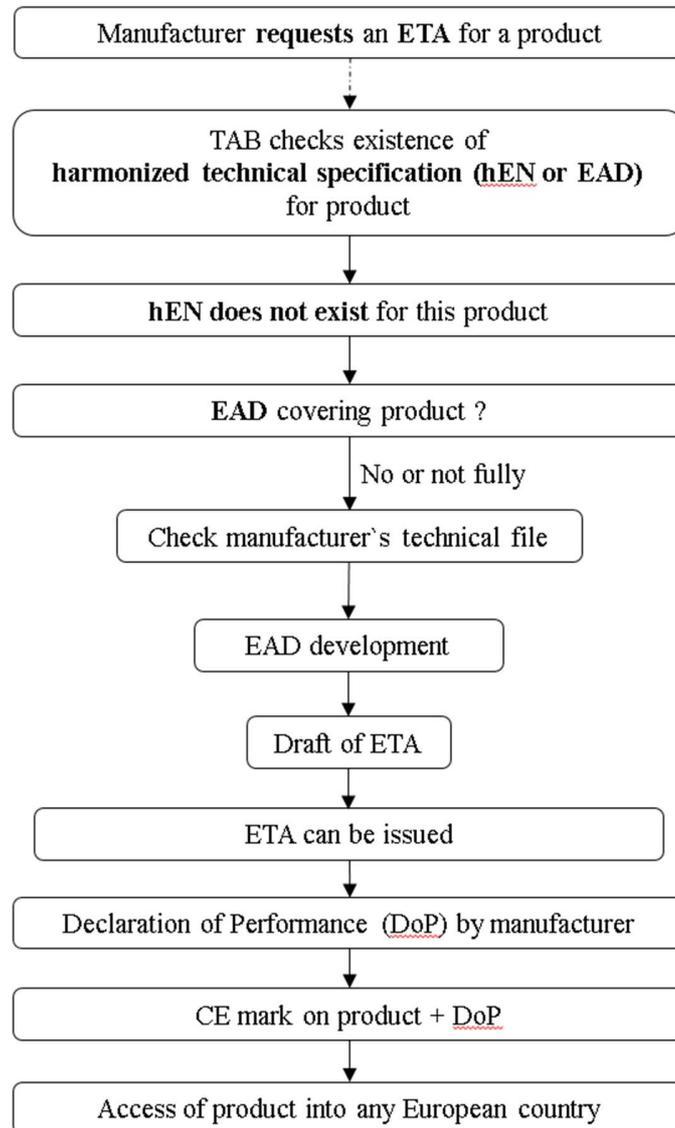


Figure 2: ETA development, if product is not or not fully covered by an EAD
(Own research based on www.eota.eu „How an EAD is developed?“ and Regulation No. 305)

Based on technical documents the organization of TABs is able to proceed with the application for an ETA and inform the Commission of the work program (Regulation No. 305/2011 – Annex II).

3.2 European Technical Assessment (ETA)

“The ... ETA is a document providing information about the performance of a construction product, to be declared in relation to its essential characteristics.”¹⁰ With an existing ETA a manufacturer can CE mark a product. An ETA consist of “...general information on the manufacturer and product type, name and

¹⁰ Source: www.eota.eu - “What is an ETA?”

manufacturing plant. Performances of the product to be declared and references to the methods used for its assessment. Technical details necessary for the implementation of the AVCP¹¹ system.”¹²

3.3 Declaration of Performance (DoP)

A product, that is characterized by a hEN or ETA and therefore carrying a CE mark, needs to be accompanied by a DoP. The DoP shall be drawn up by the manufacturer and provide information on the product performance based on the hEN or ETA.

Based on above explained processes and documents for a product, which had been applied for a CE mark, this product type from a manufacturer must carry a CE mark when entering the European market. The CE mark therefore enables the product a complete free entrance to the end user within Europe without any further tests but only accompanied with the DoP.

4. CRITERIA EXAMPLE OF HOLLOW BAR KIT IN AN EAD

The essential characterization of a product in an EAD is beside other contents described in section 3.1 mandatory for an ETA application. Therefore this section gives a closer look into some examples of essential characteristics of the hollow bar kit.

4.1 Load bearing capacity

A hollow bar kit, which is made of steel, shall secure constructions and transfer loads into the ground after correct and successful installation. Therefore the load bearing capacity is a key essential characteristic during the life cycle of the hollow bar kit. Load bearing capacity depends on material composition and amount of material. Steel types and their characteristics varies tremendously with incremental changes of the steel composition. Depending on the requirements for specific applications steel brings suitable individual characteristics along.

Considering the hollow bar precisely, the steel type and dimension (wall thickness respectively effective area of cross section) are both important to be capable of transferring the loads from a construction into soil in general. Tolerances of wall thicknesses are further an issue of quality control, as more or less material amount influences the load carrying capacity.

In addition to material composition, the system, especially the coupling nut, has to be able to carry the loads into ground. The hollow bar has to be the weakest point, if it comes to any failure at all, but not the coupling nut. The coupling nut is connecting each hollow bar to each other as a rigid joint and in case of overloading the system, the hollow bar (steel) shall deform and elongate visibly as much as necessary for one can react and do something against e.g. a moving tie-back wall, etc. before any accident or collapse arise.

4.2 Resistance against fatigue

Fatigue occurs with time and diverse environmental influences can accelerate the material aging process. Steel quality and the joints are important characteristics in respect of resistance against fatigue. Following characteristics have significant effects on steel quality. Notched impact strength evaluates the material resistance against fracture due to sudden impacts. The higher the resulting test value the more energy can be taken by the material, which means the resistance against higher impacts is better (absorption of energy). Carbon content of steel composition has a huge influence on the steel character brittleness, which shall be

¹¹ AVCP = Assessment and Verification of Constancy of Performance

¹² Source: www.eota.eu - “What Is an ETA?”

low to resist impact energies. Ductility, ability of plastic deformation, is another important variable considering overloading effects.

There are many characteristics that a system has to bring along in able to withstand alternating loads, which are not going into negative, without resulting in a fatigue fracture or loosening of any joints.

4.3 Resistance against alternating loads (tension and compression)

Alternating loads changing from positive to negative more specifically changing from compression to tension require above (section 4.2) mentioned characteristics, but special attention on joints in specific. These have stricter requirements and therefore i.e. a steel ring as central stop in a coupling nut is supportive as tight steel to steel connection to transfer loads, but also reduce work on site (no additional counter nuts necessary).

4.4 Transfer of the impact energy produced by roto-percussion

Depending on the soil type the installation process is accompanied by roto-percussive impact energy. Such impact energies have an effect on the whole hollow bar system, which is used as drilling tool, and therefore the steel material needs to fit these conditions (while and after installation). Notched impact strength is another characteristic to point out in this context, as ductile material last longer, either while drilling process or afterwards during working life.

4.5 Protection against corrosion

Corrosion is a tremendously important issue. There are different understandings and ways to realize the corrosion protection. The most favorable way in realizing corrosion protection will definitely be a cost efficient, easy, but also reliable way. Reinforced concrete is used in the whole world for centuries and it is a common understanding that concrete is perfect material to protect steel. Requirements on steel quality, thread shapes and other characteristics are described in standards. Yield strength of steel has to be limited to concrete strain in order to function as a composite material. Uniform elongation is necessary to have an even development of cracks in regards to corrosion protection and predictable development. Slip within coupling has to be limited as well to prevent unnecessary development of cracks in the area of joints.

In total cracks are needed in reinforced concrete, but in general need to be kept as small as possible. Cracks smaller than 0.1 mm (grout cover thickness in an economical and required manner and in combination with limited yield strength and suitable thread shape) are seen as self-healing therefore it is a goal to achieve.

5. TRANSPARENCY CONCERNING NATIONAL TECHNICAL APPROVAL AND DOP

Due to an overwhelming offer and variety of products for clients, contractors and design engineers, they are challenged with identifying and assessing the main characteristics of a chosen system or technique, thus this audience needs to be informed and trained properly. The suitability of a product for a certain job site solution needs to be checked. It is recommended that above mentioned audience should have knowledge and awareness about the product differences and suitabilities they choose.

National technical approvals for products, if differ from harmonized technical specifications, will be replaced by DoP and CE marking bit by bit as soon as the latter exists for a product. The change will take a certain period of time (s. background of construction product regulation in section 1). The DoP is therefore one document for an applicant to use and extract the necessary information. Independently from the CE mark on the product, the corresponding application with the product will be described and approved separately. Some applications need more and others less criteria, therefore beside product criteria described in the DoP the appropriate application standards, like EN 14199 and EN 14490, are also necessary to have a complete information package.

Applications differ from construction site to construction site and there are various solutions as well. Guidelines and manuals are generally always supportive, but under certain circumstances engineers still have a specific scope for decision-making. This condition leads to importance of experience and information level of applicants.

6. SUMMARY AND OUTLOOK

CE mark and DoP together are important for the European Union to keep barriers away respectively customs clearances low and therefore speed up goods traffic. This information package also represents the result from a long way of development, where many parties of countries are involved to ensure the correctness of product definition and prevent misuse. Nevertheless misuse or misinterpretation is easily created, if a product carries a CE mark and the user does not know the background or meaning of this mark. A CE marked product always have to be accompanied by the DoP to be complete. The DoP however is not a grading document pointing out the suitability for a certain application. It is an accompanying document in combination with the CE mark to give transparency about essential characteristics, but only to show that it conforms the minimum requirements according to the harmonized technical specifications.

Regulation No. 305 gives another push in the construction product market and shall guide all parties with clearer handling of products. Such big changes need time and clarification to have real understanding of transparency and benefit.

7. REFERENCES

European Standards (EN)

EN 10210:	Hot finished structural steel hollow sections
EN 14199:	Execution of special geotechnical works - Micropiles
EN 14490:	Execution of special geotechnical works - Soil nailing
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EN 1991:	Eurocode 1: Actions on structures
EN 1992:	Eurocode 2: Design of concrete structures
EN 1993:	Eurocode 3: Design of steel structures
EN 1994:	Eurocode 4: Design of composite steel and concrete structures
EN 1995:	Eurocode 5: Design of timber structures
EN 1996:	Eurocode 6: Design of masonry structures
EN 1997:	Eurocode 7: Geotechnical design
EN 1998:	Eurocode 8: Design of structures of earthquake resistance
EN 1999:	Eurocode 9: Design of aluminum structures

Regulation and Council directive

Regulation No 305/2011

Directive 89/106/EEC

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