



EUROPEAN ASSESSMENT DOCUMENT

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PILE JOINTS AND ROCK SHOES FOR CONCRETE PILES

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

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1 SCOPE OF THE EAD

1.1 Description of the construction product

1.1.1 General

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

This document supersedes EAD 200014-00-0103. In comparison to the above mentioned version the following has changed:

- addition of mechanical resistance to high cycle fatigue

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

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1.1.2 Pile joint

The pile joint for precast concrete piles is made of steel sheet, steel bar and steel reinforcement bar, see Figure 1 and details in Annex 1. Different types and grades of metal are used for the various components of the pile joint as clarified in Annex 1. The welding between the reinforcement bar and locking components comply with EN ISO 17660-1.

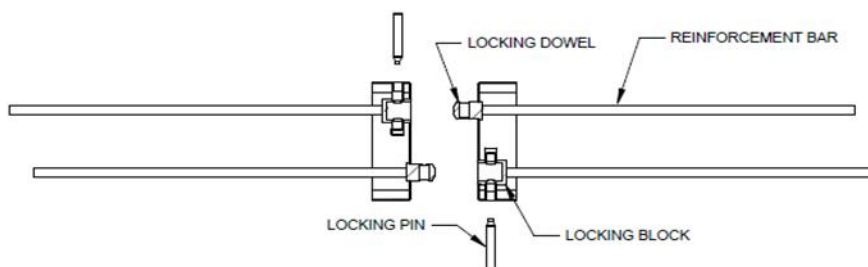


Figure 1. Pile joint for precast concrete piles, principal drawing.

1.1.3 Rock shoe

The rock shoe for precast concrete piles is made of steel sheet, steel bar and steel reinforcement bar, see Figure 2 and details in Annex 2. Different types and grades of metal are used for the various components of the rock shoe as clarified in Annex 2. The welding between the reinforcement bar and steel sheet comply with EN ISO 17660-1.

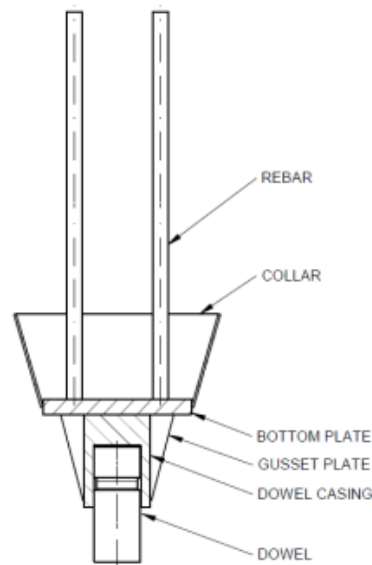


Figure 2. Rock shoe for precast concrete piles, principal drawing.

1.2 Information on the intended use(s) of the construction product

1.2.1 General

Pile joints and rock shoes are intended to be used with concrete piles made of concrete manufactured according to EN 206. They are intended to be used in undisturbed natural soils (sand, silt, clay, schist) and compacted non-aggressive fills of mineral soil materials. Corrosion rate 1,2 mm per 100 years as recommended in standard EN 1993-5 Table 4-1 should then be taken into account. Alternatively, empirical measurement data and statistical deterioration design model may be used when the conditions certainly can be classified as normal.

1.2.2 Pile joint

A pile joint is a connecting device for precast concrete pile segments. It is used to connect additional segments of precast reinforced concrete piles, during pile driving to depths greater than the length of a single segment.

The pile joint is incorporated into the precast concrete as the pile is cast, and the steel reinforcement bars bond it to the pile. By using a mould spacer device during casting, the correct position of the joint in the pile can be assured every time. During pile driving, when two concrete pile segments are jointed together and the locking dowels enter the locking blocks, the two halves of the joint in the extended concrete pile are locked securely with 4 or 8 locking pins. The locking pins are hammered in by hand or by machine. The lock mechanism for the pin (locking ring) ensures that the joint remains intact during pile driving. Immediately before offering a second pile segment for joining, the protective plugs in the locking blocks shall be removed on site and the connection surfaces shall be cleaned before joining of the pile segments.

Pile joints are to be used under static, quasi static actions or predominantly dynamic actions (fatigue actions). Seismic actions and actions caused by hurricanes are excluded.

1.2.3 Rock shoe

A rock shoe is a protective device for the leading end of the first precast concrete pile segment being driven. It is used at the leading end of the first precast reinforced concrete pile segment, when it is piled into rocky ground or down to solid rock. The rock shoe prevents damage to the pile during pile driving in

rocky ground and it anchors, if required, the pile to the bedrock and even to slanting rock strata. The rock pin is tempered and made of special steel and hardened to hardness 520 - 640 HV.

The rock shoe is incorporated into the leading end of the reinforced concrete pile and the steel reinforcement bars bond it to the pile. By using a casting guide device during casting, the correct position of the rock shoe in the pile can be assured every time. If the dowel is removed for casting, it should be refitted before moving to the site.

Rock shoes are to be used under static or quasi static actions. Predominantly dynamic actions (fatigue actions), seismic actions and actions caused by hurricanes are excluded.

1.2.4 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 pile joints and rock shoes for concrete piles for the intended use of 100 years when installed in the works provided that the pile joints and rock shoes for concrete piles are subject to appropriate installation (see 1.1). These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works¹.

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

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 1 shows how the performance of pile joints and rock shoes for concrete piles is assessed in relation to the essential characteristics.

Table 1 Essential characteristics of the product and assessment methods and criteria for the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance <i>(level, class, description)</i>
Basic Works Requirement 1: Mechanical resistance and stability			
1	Resistance of pile joint	2.2.1.1	Class
2	Resistance of rock shoe	2.2.1.2	Class
3	Robustness and rigidity of pile joint	2.2.1.3	Class
4	Dimensional tolerances	2.2.1.4	Level
5	Mechanical resistance to high-cycle fatigue	2.2.1.5	Level
Basic Works Requirement 2: Safety in case of fire			
5	Reaction to fire	2.2.2	Class

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

2.2.1 Mechanical resistance and stability

2.2.1.1 Resistance of pile joint

The standard EN 12794 "Precast concrete products - Foundation piles" explains the link between calculation and testing. The calculation shall be done according to EN 12794, Annex B.

The ultimate resistance (in compression, tension and bending) of the pile joint shall be calculated according to EN 1992/1993/1997 taking into account the design strengths of materials. The static calculations shall be verified by an impact load test followed by a bending test described in Annex A of EN 12794. The interaction between bending moment and normal force shall be taken into account.

Test procedure and results have to be expressed in a test report according to EN 12794 annex A.

2.2.1.2 Resistance of rock shoe

The standard EN 12794 "Precast concrete products - Foundation piles" explains the link between calculation and testing. The calculation shall be done according to EN 12794, Annex B.

The ultimate resistance (in compression, tension and bending) of the pile joint shall be calculated taking into account the design strengths of materials. The static calculations shall be verified by an impact load test followed by a modified bending test described in Annex A of EN 12794.

Test procedure and results have to be expressed in a test report according to EN 12794 annex A.

2.2.1.3 Robustness and rigidity of pile joint

Robustness and rigidity of pile joints shall be verified by impact loading testing followed by subsequent bending testing in conformity with the procedures and methods given in according to Annex A of the standard EN 12794.

Pile joints shall be classified in classes indicating the required resistances, performance and type of verification methods. The classification is shown in EN 12794, Table 4.

2.2.1.4

2.2.1.4 Dimensional tolerances

The dimensions and shape (length, width and straightness) shall be measured on each sample before testing according to Ch. 2.2.1.1 to 2.2.1.3. The dimensional tolerances of all relevant dimensions according to Annex 1 and 2 shall be given by the manufacturer.

For pile joints, EN 12794 clause 4.3.1.3 shall be applied. For pile shoes, EN 12794 clause 4.3.1.4 shall be applied.

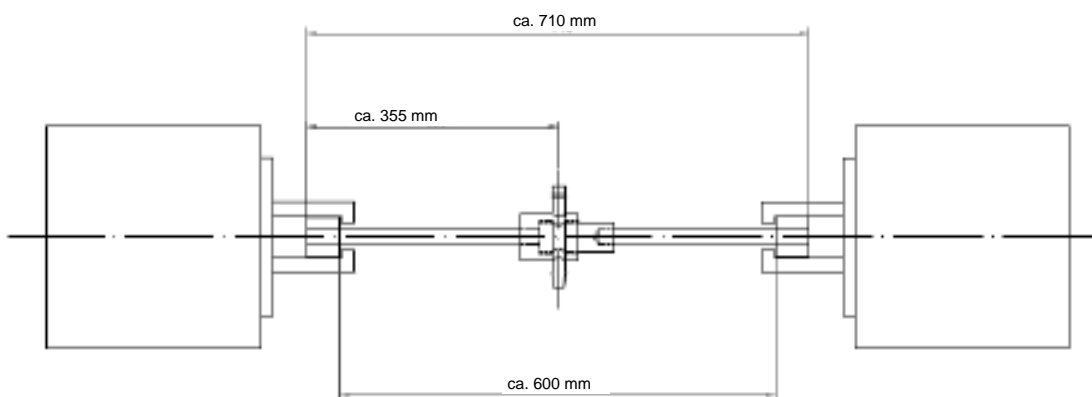
ETA shall contain the main dimensions and tolerances.

2.2.1.5 Mechanical Resistance to high-cycle fatigue

For the dimensioning of the pile joints regarding to mechanical resistance to high-cycle fatigue a S-N-curve is needed.

The test shall be carried out according to EN ISO 15630-1, Cl. 8 with the following modifications:

- The test specimen shall include all load bearing components of the connection (e.g. reinforcement bar, locking block, lock ring, guidance pipe, locking pin)
- The following free lengths are the minimum required lengths:
For $\varnothing K < 25$ mm: free length = 250 mm of reinforcement bar + length of pile joint²
For $\varnothing K \geq 25$ mm: free length = 200 mm of reinforcement bar + 2 x $\varnothing K$ + length of pile joint
- The pile joint should be positioned in the middle of the test piece.
- The tests shall be carried out with an upper force (F_{up}) of 0,6 $R_{eH, nom}$.
- As a maximum frequency 150 Hz is recommended.
- Test rig:



²

The length of the pile joint is the distance between the last visible changes in the reinforcing bar profile from one bar to the opposite bar plus one nominal diameter at both ends.

For the most unfavourable diameter (normally the largest diameter of reinforcing bar and/or the diameter with the largest notch stress cause of threads) 24 tests shall be carried out in order to get a complete S-N curve.

All tests shall be carried out until the fracture of the specimen or 10 million load cycles are reached.

The S-N curve shall be determined with respect to the following restrictions:

- The 5%-characteristic value has to be calculated with a characteristic fractile factor k_n (confidence level of 75%) according to EN 1990, Annex D.
- The stress ranges have to be distributed evenly in the finite fatigue life range.
- In the infinite fatigue life range the stress exponent k_2 according to EN 1992 has to be applied to consider long term effects.

Another possibility is to test only the finite fatigue life range as given in up to two million load cycles and to estimate the following stress exponents to get a complete S-N curve.

- a) If the determined stress exponent k_1 is less than the exponent according to EN 1992, then the stress exponent k_1 determined in the tests shall be applied in the range from 2 million to 10 million load cycles, followed by the stress exponent $k_2 = 2k_1 - 1$ according to [Haibach, E.].
- b) If the determined stress exponent k_1 is greater than the exponent according to EN 1992, then the stress exponent k_1 according to EN 1992 shall be applied in the range from 2 million to 10 million load cycles, followed by the stress exponent k_2 according to EN 1992.

The S-N-Curve can be given in the ETA with the parameters: stress range $\Delta\sigma_{Rsk}$ (5% characteristic value) at N^* cycles and the stress exponents k_1 , k_2 .

2.2.2 Reaction to fire

Pile joints and rock shoes for concrete piles made of steel are considered to satisfy the requirements for performance Class A1 of the characteristic reaction to fire, in accordance with the provisions of EC Decision 96/603/EC³ (as amended) without the need for testing on the basis of its listing in that Decision.

3

Official Journal of the European Communities/Union L 267, 19.10.1996, p. 23–26 (see www.eur-lex.europa.eu)

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is: Decision [2000/606//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 2.

Table 2 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]*					
1	Incoming raw materials	Inspection document 3.1 acc. to EN 10204 (to be furnished by the supplier)	See control plan		Every delivery
2	Dimensions	Check of Dimensions and Tolerances	See control plan		In the beginning of each shift and when product type is changed
3	Welding of reinforcing steel	EN ISO 17660-1	See control plan		EN ISO 17660-1
4	Threaded connections of reinforcing steel	ISO 15835-1	See control plan		ISO 15835-1

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 pile joints and rock shoes for concrete are laid down in Table 3.

Table 3 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control <i>(for systems 1+, 1 and 2+ only)</i>					
1	Ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the pile joints and rock shoes for concrete piles	-	see control plan	-	Before certification
Continuous surveillance, assessment and evaluation of factory production control <i>(for systems 1+, 1 and 2+ only)</i>					
3	Verification that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan	-	see control plan	-	once a year

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.

EN 206	Concrete. Specification, performance, production and conformity
EN 1993-5	Design of steel structures. Part 5: Piling
EN 1992-1-1	Eurocode 2: Design of concrete structures. Part 1-1: General rules and rules for buildings
EN 10025-2	Hot rolled products of structural steels. Part 2: Technical delivery conditions for non-alloy structural steels
EN 10204	Metallic products. Types of inspection documents
EN 10267	Ferritic-pearlitic steels for precipitation hardening from hot-working temperatures
EN 10083-3	Steels for quenching and tempering. Part 3: Technical delivery conditions for alloy steels
EN 12794+A1/AC	Precast concrete products. Foundation piles
ISO 15835-1	Steels for the reinforcement of concrete – Reinforcement couplers for mechanical splices of bars – Part 1: Requirements
EN ISO 17660-1	Welding. Welding of reinforcing steel. Part 1: Load-bearing welded joints
Haibach, E.	Betriebsfestigkeit: Verfahren und Daten zur Bauteilberechnung, Düsseldorf: VDI-Verlag 2002

ANNEX 1: EXAMPLE OF PILE JOINT

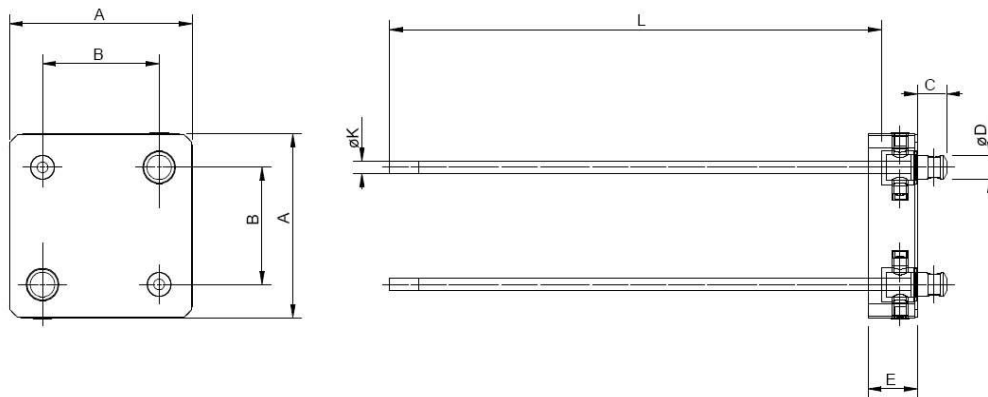


Figure 1-1. Principal Dimensions of locking block of pile joints for precast concrete piles

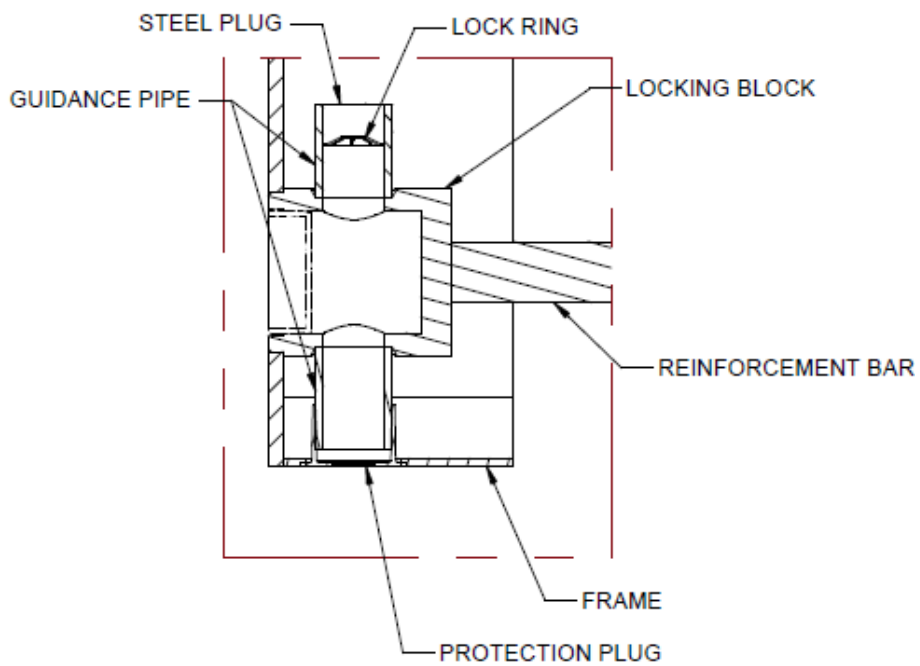


Figure 1-2. Detail of locking block of pile joints for precast concrete piles

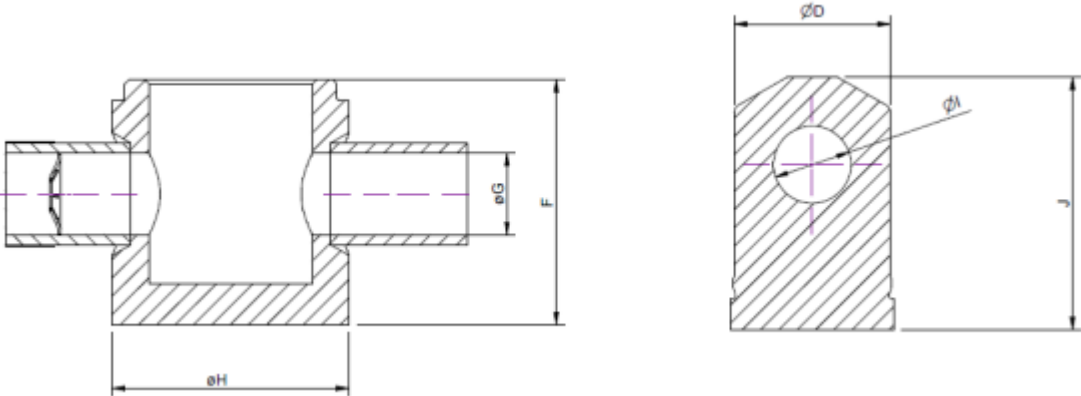


Figure 1-3. Principal Dimensions of the locking block of pile joints for precast concrete piles

ANNEX 2 DETAILS OF ROCK SHOE

Figure 2-1. Principal dimensions of rock shoes for precast concrete piles

