



EUROPEAN ASSESSMENT DOCUMENT

EAD 160012-01-0301

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HEADED REINFORCING STEEL BARS

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) 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

Headed reinforcing steel bars are steel bars for the reinforcement in concrete, which are equipped with a device for mechanical anchorage of the bar in the concrete. The anchorage device – the head - is made of steel and is attached to one or both ends of the rebar (reinforcing bar). Heads can also be integrally formed from the bar.

The product is defined by the specification of the rebar (diameter, nominal yield strength, strength and elongation), the geometry of the anchorage device (head) and their ability to transfer loads from the reinforcement to the concrete. Headed reinforcing steel bars are made of weldable rebar. The rebar shall comply with EN 10080¹ and their mechanical properties shall be in line with Annex C of EN 1992-1-1.

This EAD does not cover heads or head to connections, which consist of or include other materials than steel.

This EAD does not cover transverse steel bars or other devices, welded on-site to the rebar to provide end anchorage.

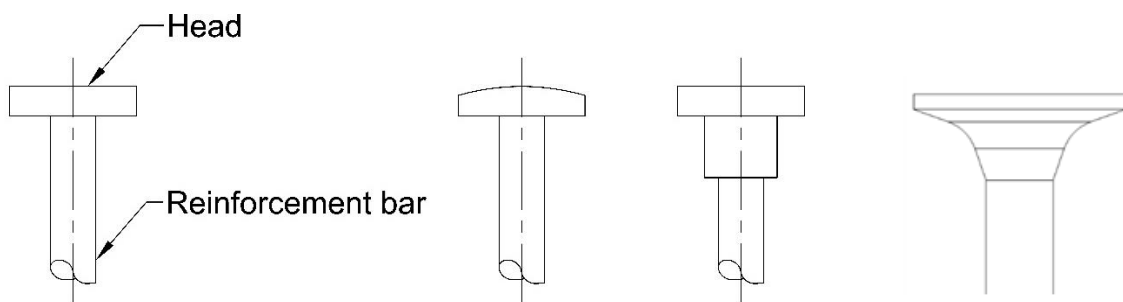


Figure 1.1.1 –Examples of shapes of headed reinforcing steel bars, showing different head geometries

The product is not fully covered by EAD 160012-00-0301. Compared to the previous version of the EAD, the following changes are introduced: extended intended use for high-cycle fatigue loading and assessment method related to the extended intended use.

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 All undated references to standards or to EADs in this EAD are to be understood as references to the dated versions listed in chapter 4.

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

1.2.1 Intended use(s)

Headed reinforcing steel bars are used to anchor in reinforced concrete structures. The head provides mechanical end anchorage or an alternative to developing reinforcement through the combination of bond and bends/hooks.

This EAD applies to the use in concrete structures with:

- Static and quasi-static loading
- High-cycle fatigue loading
- Seismic loading

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 headed reinforcing steel bars for the intended use of 100 years when installed in the works. 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 works².

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 General terms and definitions

For the purpose of this EAD, the terms and definitions given in ISO 15698-1 apply.

1.3.2 Rebar

Rebar to which the head(s) is/are attached to or forged from.

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

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of headed reinforcing steel bars is assessed in relation to the essential characteristics.

Table 2.1.1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability			
1	Robustness of head-to-bar connection	2.2.1	Level, description
2	Characteristic resistance under static and quasi-static loading	2.2.2	Level, description
3	Characteristic resistance under seismic loading	2.2.3	Level, description
4	Characteristic resistance under fatigue loading	2.2.4	Level, description
Basic Works Requirement 2: Safety in case of fire			
5	Reaction to fire	2.2.5	Class

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

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

Headed reinforcing steel bars are rebar products and follow the rebar diameters. Products with variation in rebar diameter and head dimension only may form a series. The requirements for a series of headed bar products are given in clause 6.2 of ISO 15698-1. The extent of testing may be reduced for a series of headed bar products in accordance with clause 7.2.1 of ISO 15698-1.

2.2.1 Robustness of head-to-bar connection

Purpose of the assessment

The test is performed to evaluate the robustness of the connection of the head to the rebar with regard to variations in the load situation. The EAD covers different production processes for connection of head-to-bar connection and assessment and test methods, appropriate for the given production process, are introduced:

- i) Bend test;

ii) Wedge tensile test.

For welded or forged connections, which are influenced by heat-affected zone, the bend test shall be applied. The object of the bend test is to expose the head-to-bar intersection to high tensile strain to check the risk of local brittleness (forged heads) and local weld fusion line defects (welded heads). The wedge tensile test with prescribed angle of wedge placed underneath the head of headed reinforcing steel bar and prescribed tensile force in line with the category of the headed reinforcing steel bar also serves to reveal any possible flaws. The category of headed reinforcing steel bar follows from the characteristic resistance under static and quasi-static loading according to clause 2.2.2.

For the diameters of rebar larger or equal to 32 mm the bend test applied for forged or welded products shall be replaced by wedge tensile test due to the possibility of serious safety issues for the personnel involved in performing the bend test.

For connections other than welded or forged the bend test is not applicable. Therefore, the wedge tensile test is to be used for these products.

Assessment method

The wedge tensile test or bend test, as appropriate for the production process robustness test of head to connection, shall be performed according to clause 7.3 of ISO 15698-1 and clause 6 of ISO 15698-2.

Welded and forged connections of head to a bar up to rebar diameter of 32 mm shall be tested by bend test according to clause 6.3 of ISO 15698-2. All other connections (threaded, etc.) shall be tested by wedge tensile test according to clause 6.2 of ISO 15698-2. The wedge angle shall be according to clause 7.3.2 of ISO 15698-1. Forged or welded connection with rebar diameter equal or higher than 32 mm shall be tested by wedge test as well.

At least three samples of all rebar diameters have to be tested. The assessment of the test results is described in clause 7.3 of ISO 15698-1 and clause 6 of ISO 15698-2.

Expression of results

The following description shall be expressed in ETA:

- a) For bars with forged or welded heads up to rebar diameter of 32 mm tested by bend test according to clause 6.3 of ISO 15698-2:
No cracks visible in the head, the bar, or the head-to-bar connection to a person with normal or corrected vision.

or

- b) For bars with other types of heads and bars with forged or welded heads of rebar diameter equal or higher than 32 mm tested by wedge tensile test according to clause 6.2 of ISO 15698-2:
The capability of head for anchoring corresponds to category B1 or B2 or B3, as relevant, according to clause 7.3.2 of ISO 15698-1.

2.2.2 Characteristic resistance under static and quasi-static loading

Purpose of the assessment

This test is performed in order to assess the suitability of the head for transfer of static loads from the rebar into the concrete. For assessment of performance one of the two options is to be followed:

- a) Test in air provided that the conditions given in 7.2.1 of ISO 15698-1 are fulfilled;
- b) Test in concrete for all other cases by one of the two following variants:
 - i) Taking into account the bond force F_b and the corresponding anchoring length l_b of the given portion of the bar, test set-up according to Figure 1b) of ISO 15698-2 with correction shown in Figure A.1 in Annex A;

- ii) Without any bond force, test set-up according to Figure 1a) of ISO 15698-2 with correction shown in Figure A.1 in Annex A.

The normal-density concrete shall be of minimum class C30/37 and shall fulfil the provisions stated in clause 5.5.2 of ISO 15698-2.

For test in concrete the specimen shall be pre-loaded to the value of $0,9.R_{EH}$ and released. This pre-loading cycle shall be repeated 10 times. R_{EH} is the nominal yield strength of rebar.

Assessment method

The test is performed according to clause 7.2 of ISO 15698-1 and clause 5 of ISO 15698-2. The assessment of the test results is described in clause 7.2.2 of ISO 15698-1 and clause 5.7.3 of ISO 15698-2.

The characteristic resistance under static and quasi-static loading is the tensile force obtained in test when the force cannot be increased any more.

Based on the type of performed test (in air or in concrete) and the characteristic resistance under static and quasi-static loading, the headed bars are to be categorized into categories B1, B2 or B3 according to clause 7.2.2 of ISO 15698-1. All test results shall fulfil the requirements for given category.

Expression of results

The test method (in air or in concrete with taking into account the bond force or in concrete without taking into account the bond force) shall be given in ETA. The force F_b (for category B1) and the resistance under static and quasi-static loading for each tested specimen shall be given in ETA.

The following description shall be expressed in ETA: The capability of head for anchoring corresponds to category B1 or B2 or B3, as relevant, according to clause 7.2.2 of ISO 15698-1. For category B1 For the intended use of headed reinforcing steel bar the minimum concrete characteristic compressive cylinder strength shall be given in ETA.

2.2.3 Characteristic resistance under seismic loading

Purpose of the assessment

The test is performed in order to assess the suitability of the head and its connection to the rebar for transfer of low-cycle elastic-plastic loads from the rebar into the concrete. The test loading is intended to model loads occurring during a seismic event.

Assessment method

The test is performed according to clause 7.2.4 of ISO 15698-1 and clause 5.9 of ISO 15698-2. The load transfer test for Category S (Seismic) shall be conducted with products cast into a concrete specimen. The concrete test specimen is made in accordance with clause 5.5 of ISO 15698-2 and Annex A.

The assessment of the test results is described in clause 7.2.4 of ISO 15698-1 and clause 5.9.3 of ISO 15698-2 and in Annex A.

Expression of results

The following description shall be expressed in ETA: Sustained loading program according to clause 7.2.4 of ISO 15698-1 without failure (category S).

2.2.4 Characteristic resistance under fatigue loading

Purpose of the assessment

The test is performed in order to assess the suitability of the head and its connection to the rebar for transfer of high-cycle elastic loads from the rebar into the concrete.

Assessment method

The test is performed according to clause 7.2.3 of ISO 15698-1 and clause 5.8 of ISO 15698-2. The load transfer test for Category F (fatigue) shall be carried out with specimen according to clause 5.5 of ISO 15698-2 and Annex A. The test conditions and assessment of the test results are described in clause 7.2.3 of ISO 15698-1 and clause 5.8.4 of ISO 15698-2 with modifications given in Annex B.

Expression of results

a) For category F1 the following descriptions shall be expressed in ETA:

- One or more number of specimens failed in the affected zone. The fatigue performance of headed bar is lower than that of the rebar;
- The number of cycles of rebar at stress range/s determined for headed bar shall be given in ETA;
- The maximum number of cycles and stress range/s of headed bar tested in one series shall be given in ETA.

b) For category F2 the following descriptions shall be expressed in ETA:

- All specimens failed in the rebar outside the affected zone. The fatigue performance of headed bar is at least equal to that of the rebar;
- The upper stress level/s, the stress range/s of rebar/s and corresponding number/s of cycle/s at stress range/s for headed bar/s shall be given in ETA;
- The minimum number/s of cycles at the stress range/s of headed bar/s tested in one series shall be given in ETA.

2.2.5 Reaction to fire

Headed reinforcing steel bars are considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire in accordance with the EC Decision 96/603/EC (as amended by EC Decision 2000/605/EC without the need for testing on the basis of its fulfilling the conditions set out in that Decision and its intended use being covered by that Decision. Therefore, the performance of the product is class A1.

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: 97/597/EC

The system is: 1+

3.2 Tasks of the manufacturer

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

The Control Plan for the manufacturer (FPC) shall be agreed between the TAB and the manufacturer within ETA process considering the cornerstones specified in this Clause.

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
Incoming products					
1	Incoming products	Visual inspection of products and control of inspection certificate by the manufacturer	As defined in the control plan	1	Each delivery
Component – for separately fabricated heads, to be attached to the rebar					
2	Geometry of head	Control plan	As defined in the control plan	1	Each manufacturing batch
Product¹⁾					
3	Dimensions	Essential dimensions influencing the performance ²⁾	As defined in the control plan	1	Each manufacturing batch
4	Characteristic resistance under static and quasi-static loading and robustness of head-to-bar connection	Options ³⁾ : - Bend test - Wedge tensile test	As defined in the control plan	2	The least of: - Each manufacturing batch - 1000 products - Change of production parameters
¹⁾ Manufacturer of loose head, has to conduct assembling and testing the complete headed reinforcing steel bar products. The test shall be performed with rebar of the same grade as used in load transfer tests according to clause 2.2.1 and clause 2.2.2. ²⁾ For example: head geometry of heads formed from the rebar, perpendicularity of head relative to the rebar. ³⁾ Test method depending on the head-to-bar connection see clause 7.3.1 of ISO 15698-1.					

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	<p>Notified Body will ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the "Headed Reinforcing Steel Bars".</p> <p>In particular, the following items shall be given special attention</p> <ul style="list-style-type: none"> • Control of material for production; • Strength and robustness of head-to-bar connection; • Implementation of prescribed test plan. 	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	As defined in the control plan	As defined in the control plan	When starting the production or a new line
Continuing surveillance, assessment and evaluation of factory production control					
2	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2	As defined in the control plan	As defined in the control plan	1/year
Audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities					
3	Strength and robustness of head-to-bar connection.	2.2.2	As defined in the control plan	3 samples of one bar diameter and manufacturing process	1/year

4 REFERENCE DOCUMENTS

EAD 160012-00-0301:11-2017	Headed Reinforcement Steel Bars, 2018/C 090/04
EN 10080:2005	Steel for the reinforcement of concrete. Weldable reinforcing steel. General
EN 10204:2004	Metallic products – Types of inspection documents
EN 12390-2:2019	Testing hardened concrete. Part 2: Making and curing specimens for strength tests
EN 12390-4:2019	Testing hardened concrete. Part 4: Compressive strength. Specification for testing machines
EN 206:2013+A2:2021	Concrete. Specification, performance, production and conformity
EN ISO 15630-1:2019	Steel for the reinforcement and prestressing of concrete - Test methods - Part 1: Reinforcing bars, rods and wire (ISO 15630-1:2019)
EN ISO 15630-2:2019	Steel for the reinforcement and prestressing of concrete - Test methods - Part 2: Welded fabric and lattice girders (ISO 15630-2:2019)
ISO 15698-1:2012 (reviewed and confirmed in 2018)	Steel for the reinforcement of concrete – Headed bars – Part 1: Requirements
ISO 15698-2:2012 (reviewed and confirmed in 2018)	Steel for the reinforcement of concrete – Headed bars – Part 2: Test methods

ANNEX A: TEST SPECIMEN FOR TEST OF HEADED BAR EMBEDDED IN CONCRETE

The test specimen shall be made according to clause 5.5 of ISO 15698-2 with the following modification:

- 1) For heads of Category B1, the surface geometry of the rebar to be tested shall be described in terms of surface condition (rust, etc.) and relative rib area in accordance with EN 10080 and measured in accordance with EN ISO 15630-1. All the parameters required for calculation of the relative rib area (or relative indentation area) shall be measured and recorded.
- 2) The scheme in Figure 1 of ISO 15698-2 shall be corrected as shown in Figure A.1.
- 3) The concrete strength shall be verified by cylinders or cubes from the same batch and tested at the same age as the concrete test specimen. The concrete strength shall be determined according to EN 12390-4 and classified according to EN 206.
- 4) Tolerances of test specimen according to 5.5.2 of ISO 15698-2 are in line with tolerances defined according to EN 12390-2.

Note – The last scheme in Figure 2 of ISO 15698-2 shall be corrected as shown in Figure A.2.

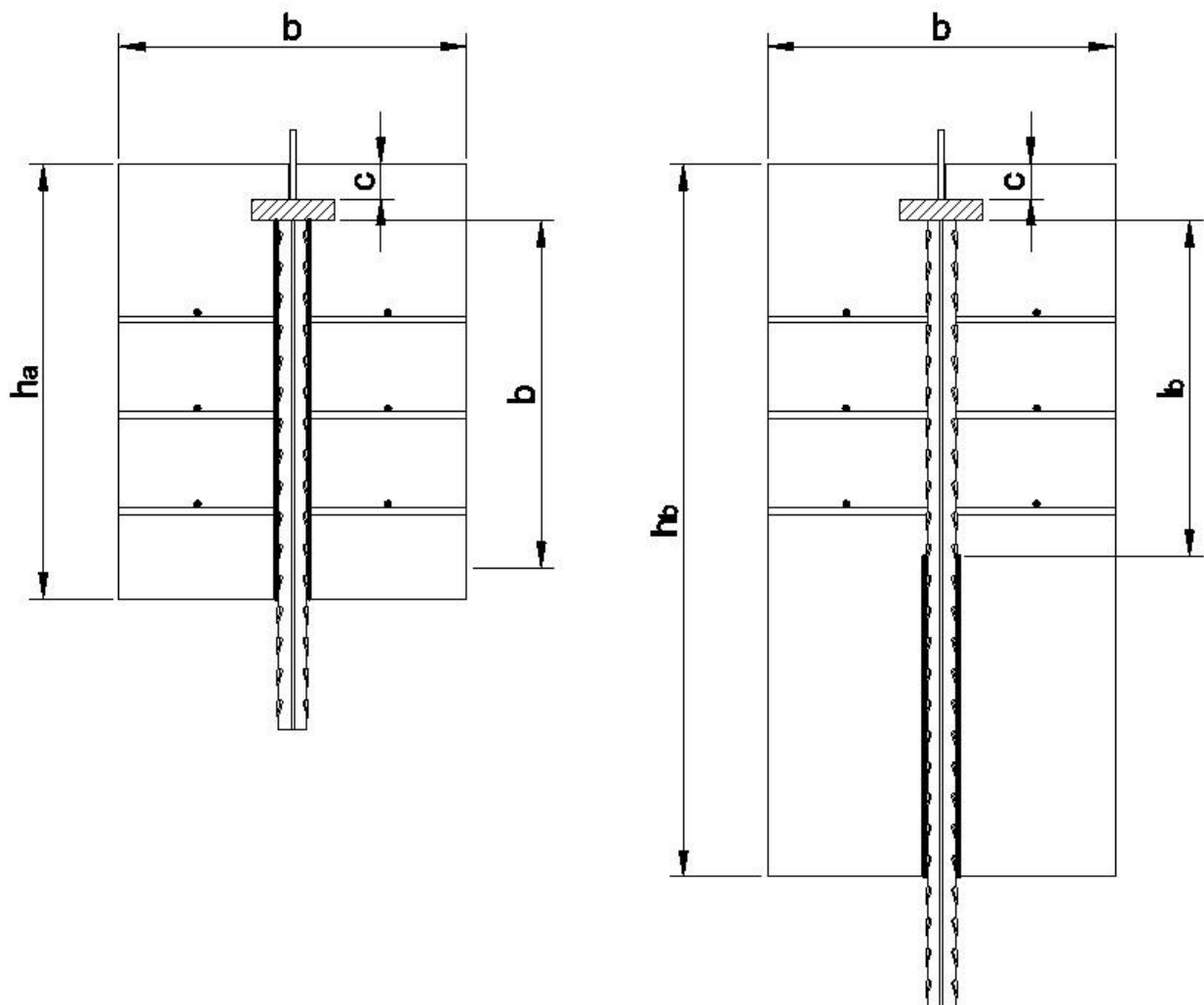


Figure A.1 – Corrected Figure 1 of ISO 15698-2

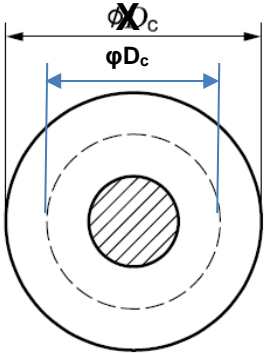


Figure A.2 – Corrected last scheme in Figure 2 of ISO 15698-2

ANNEX B: FATIGUE TESTING OF HEADED BAR EMBEDDED IN CONCRETE

The test shall be carried out according to clause 7.2.3 of ISO 15698-1 and clause 5.8 of ISO 15698-2 with following modifications:

- The concrete tests specimen for testing in concrete shall be executed in accordance with clause 5.5 of ISO 15698-2 and Annex A;
- The tests shall be performed at two (low and high) stress ranges both with an upper stress level $\sigma_{\max} = 0,6 \cdot R_{eH}$;
- The low stress range is $2\sigma_{a,\text{low}} = 0,324 \cdot R_{eH}$;
- and high stress range is $2\sigma_{a,\text{high}} = 0,5 \cdot R_{eH}$;
- The S-N curve of rebar shall be provided;
- The S-N curve of rebar may be plotted according to clause 6.8.4 of EN 1992-1-1;
- For both categories F1 and F2 the required number of load cycles $N_{2\sigma_{a,\text{low}}}$ and $N_{2\sigma_{a,\text{high}}}$ for rebar are to be determined from S-N curve $2\sigma_{a,\text{low}}$ and $2\sigma_{a,\text{high}}$ for both stress ranges;
- R_{eH} is the yield strength of rebar.