INTERNATIONAL STANDARD

ISO 15698-1

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Steel for the reinforcement of concrete — Headed bars —

Part 1: Requirements

Aciers pour l'armature du béton — Barres avec platine d'ancrage —

Partie 1: Exigences

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15698-1 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 16, *Steels for the reinforcement and prestressing of concrete*.

ISO 15698 consists of the following parts, under the general title *Steels for the reinforcement of concrete — Headed bars*:

— *Part 1: Requirements*

— *Part 2: Test methods*

Introduction

Reinforcing bars with end anchorages have been used for many years, in particular in civil engineering structures, such as marine structures (e.g. offshore platforms), bridges, structures for nuclear power plants, etc. The properties and the requirements for the anchorage products have normally been specified for each separate project. The properties have often been tested individually, due to the lack of standards for the products. Some countries have, however, developed national standards or recommendations for requirements and test methods for such products, e.g. USA.

As a result of the discussions carried out in ISO/TC 17/SC 16, it has been agreed to name these anchorage products “headed bars” as a general term for various types of heads at the bar end.

The advantage of headed bars, as compared to ordinary bond anchored bars, is that the bar can be loaded up to the ultimate capacity of the bar at its end in a very stiff fixing without slip at the end of the bar. In some cases, the head at the bar end is designed such that the end anchorage is combined with a bond anchorage to achieve the ultimate capacity of the bar. The bond length will then be substantially reduced as compared to the bond length without an end anchorage.

The goal of this part of ISO 15698 is to specify requirements to the product in a neutral way, i.e. not to refer to specific types and geometries of heads, and to specify test methods such that the variety of headed bars currently on the market are covered, as well as new types that might be developed in the future.

Steel for the reinforcement of concrete — Headed bars —

Part 1: Requirements

1 Scope

This part of ISO 15698 specifies requirements for headed steel bars to be used as reinforcement of concrete structures.

This part of ISO 15698 is a product standard and not an application standard. It is intended to cover a large variety of products and also to support the development of new products.

This part of ISO 15698 specifies requirements for headed reinforcing bars with heads made of steel. Heads or head-bar connections made using other materials, including metal-filled sleeves, are not covered by this part of ISO 15698.

End anchorages consisting of a steel bar or other steel component positioned orthogonally at the end(s) of a bar and welded on-site to the bar are outside the scope of this part of ISO 15698.

This part of ISO 15698 is intended to cover products which are manufactured in a continuous production that allows the products to be tested in accordance with a defined testing regime.

Requirements and testing for headed bars under impact loading are outside the scope of this part of ISO 15698.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 630-2, *Structural steels — Part 2: Technical delivery conditions for structural steels for general purposes*

ISO 4950-2, *High yield strength flat steel products — Part 2: Products supplied in the normalized or controlled rolled condition*

ISO 4950-3, *High yield strength flat steel products — Part 3: Products supplied in the heat-treated (quenched + tempered) condition*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 6935-1, *Steel for the reinforcement of concrete — Part 1: Plain bars*

ISO 6935-2, *Steel for the reinforcement of concrete — Part 2: Ribbed bars*

ISO 15698-2, *Steel for the reinforcement of concrete — Headed bars — Part 2: Test methods*

ISO 16020, *Steel for the reinforcement and prestressing of concrete — Vocabulary*

ISO 17660-1, *Welding of reinforcing steel — Part 1: Load-bearing welded joints*

ISO 22965-2, *Concrete — Part 2: Specification of constituent materials, production of concrete and compliance of concrete*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16020 and the following apply.

3.1
head
separate piece of steel of any shape firmly attached to the end of a bar or a protuberance of the bar itself at the end, used to anchor a steel reinforcing bar in concrete

3.2
headed bar
steel reinforcing bar that has steel head(s) on one or both ends with the purpose of anchoring the bar in concrete

3.2.1
welded headed bar
headed bar that has the head(s) welded onto the bar

3.2.2
forged headed bar
headed bar that has the head(s) integrally forged from the bar

3.2.3
threaded headed bar
headed bar that has the head(s) attached utilising tapered or straight threads internal to the head or by a separate internally threaded nut or sleeve fixing the head to the threaded bar end(s)

3.2.4
swaged or extruded headed bar
headed bar with the head(s) attached to the bar by swaging or extruding the head directly onto the bar or by using a sleeve

3.2.5
Shear-bolted sleeve-headed bar
headed bar with sleeve(s) attached to the bar by a series of shear bolts which indent into the surface of the reinforcing bar and push the bar against the opposite internal surface of the sleeve

3.3
loose head
head which is not permanently attached to the bar by the head manufacturer, but is attached on-site or in a reinforcement workshop

3.4
head bearing area
area of the head projected onto a plane orthogonal to the longitudinal axis of the bar minus the bar cross-sectional area and minus any area of the head that extends more than one bar diameter from its main face, representing the contact surface between head and concrete where the bar tensile force is transferred to the concrete by compression stress

3.5
head anchorage capacity
maximum force that can be transferred from the head of the bar to the surrounding concrete

3.6
headed bar series
headed bars of identical shape and with the ratio between the head bearing area and the bar cross-sectional area within specified maximum and minimum values, produced from identical materials, by the same production method, but with different nominal bar diameters

3.7
qualification test
test designed to verify the anchorage capacity (category) of a headed bar series

3.8
manufacturer
organization which manufactures headed bars for concrete reinforcement

3.9
batch of headed bars
quantity of headed reinforcing bars that is represented by the specimens which have been tested

3.10
affected zone
portion of the reinforcing bar where any properties of the bar, including the physical, metallurgical or material characteristics, have been altered by fabrication of the headed bar, such as the heat-affected zone for forged and welded headed bars, the location of threads for threaded headed bars, or the location of a sleeve

4 Symbols

For the purposes of this document, the symbols in Table 1 apply.

Table 1 — Symbols

Symbol	Unit	Designation
$D_{H,max}$	mm	Major dimension of head (see 5.2)
$D_{H,min}$	mm	Minor dimension of head (see 5.2)
α_A	-	Aspect ratio between the minor and the major head dimension (see 5.2)
d	mm	Nominal diameter of the reinforcing bar
$R_{eH,spec}$	MPa	Specified characteristic (or nominal) yield strength value of the reinforcing bar. For reinforcement steel without a distinct yield plateau, the characteristic $R_{p0,2,spec}$ may be used
$R_{p0,2,spec}$	MPa	Specified characteristic (or nominal) 0,2 % proof stress of the reinforcing bar
$R_{p0,2,act}$	MPa	Actual 0,2 % proof stress of the reinforcing bar
$R_{m,spec}$	MPa	Specified characteristic (or nominal) tensile strength value of the reinforcing bar
$R_{m,act}$	MPa	Actual tensile strength value of the reinforcing bar to be tested
$(R_m/R_{eH})_{spec}$	-	Specified characteristic tensile strength to yield strength ratio
A_{gt}	%	Percentage total elongation of the reinforcing bar at maximum force
A_5	%	Percentage total elongation after fracture by a gauge length of $5d$
A_{10}	%	Percentage total elongation after fracture by a gauge length of $10d$
$A_{B,nom}$	mm^2	Nominal cross-sectional area of the reinforcing bar
$A_{B,act}$	mm^2	Actual cross-sectional area of the reinforcing bar
F_b	N	The portion of the reinforcing bar's force intended to be anchored by bond (see 7.2.2, Category B1)
$2\sigma_a$	MPa	Stress range for high-cycle elastic fatigue loading test
σ_{max}	MPa	Maximum stress in axial load fatigue test
$\varepsilon_{y,act}$	%	Strain at actual yield strength of the reinforcing bar. For reinforcement steel without a distinct yield plateau the strain at actual 0,2 % proof stress may be used, taken as $\varepsilon_{p0,2,act} = R_{p0,2,act}/E + 2\times10^{-3}$
δ	mm	Anchor head movement
1 MPa = 1 N/mm^2		

5 Requirements

5.1 Materials

5.1.1 Steel for reinforcing bars

Steel reinforcing bars shall comply with ISO 6935-1 and ISO 6935-2 or any other product standard for steel reinforcing bars as specified by the purchaser.

For welded headed bars, the steel reinforcing bars, in accordance with ISO 6935-1 and ISO 6935-2, shall be of the weldable (W) type. Other types of weldable steel reinforcing bars shall be permitted if specified and agreed upon by the purchaser and manufacturer and only if the suitability of the head and bar materials for the welding process specified is demonstrated by a welding procedure qualification according to ISO 17660-1, unless otherwise agreed upon by the purchaser and manufacturer.

For forged bars, threaded headed bars and shear-bolted sleeve-headed bars, any type of reinforcing bars may be used.

For swaged or extruded headed bars, any ribbed type of reinforcing bars may be used.

5.1.2 Steel for heads

Heads shall be forged, machined or cut from casts of steel identified by a mill certificate. The chemical composition of heads for welded headed bars shall comply with a standard for weldable structural steel, such as quality C and D of ISO 630-2 or quality DD and E of ISO 4950. The impact test energy value shall be minimum 27 J at 0 °C. For headed bars where the danger of lamellar tearing of the head plate material exists, laminations and lamellar tearing in the steel plate shall be avoided by the choice of a suitable parent material. The steel plate shall be controlled by testing or inspection, for example in accordance with EN 10164. The resistance to lamellar tearing shall be specified in the test report, see ISO 15698-2.

NOTE Steels of class Z15, Z25 or Z35 according to EN 10164 are examples of steels resistant to lamellar tearing.

The welding shall be carried out according to ISO 17660-1, unless otherwise agreed upon by the purchaser and manufacturer.

5.2 Head shape and dimensions

The head may have any shape.

The size of the concrete contact area is described by the major dimension $D_{H,max}$, see Figure 1, and the aspect ratio which is the ratio between the minor and the major dimension: $\alpha_A = D_{H,min}/D_{H,max} \leq 1$.

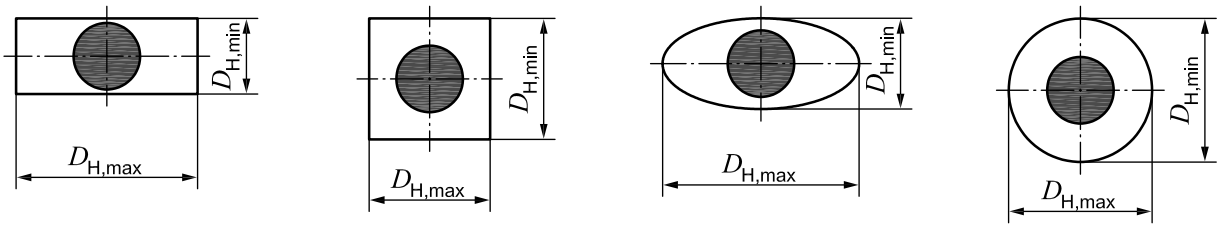


Figure 1 — Definition of head geometry

The head thickness may be constant or variable as indicated in Figure 2. The thickness variation along the head's main axis is determined by the thickness profile, i.e., the section given by the plane spanned by the head's main axis and the bar axis.

5.3 Head bearing area

If part of the head bearing area is not in the same plane as the bearing area of the head itself, this shall be stated in the test report.

In some cases, such as when the head is attached to the bar using a sleeve, some of the bearing area will be at the sleeve-to-bar intersection, at some distance from the head itself. This may be of importance in the structural design and should, thus, be stated in the test report.

The suitability of the head bearing area and head thickness shall be verified by qualification tests according to ISO 15698-2.

5.4 Anchorage capacity

The anchorage capacity is specified for three categories of loading:

— Category B: Anchorage capacity under static loading (Basic)

— Category F: Anchorage capacity under high-cycle elastic fatigue loading (Fatigue)

— Category S: Anchorage capacity under low-cycle elastic-plastic loading (Seismic)

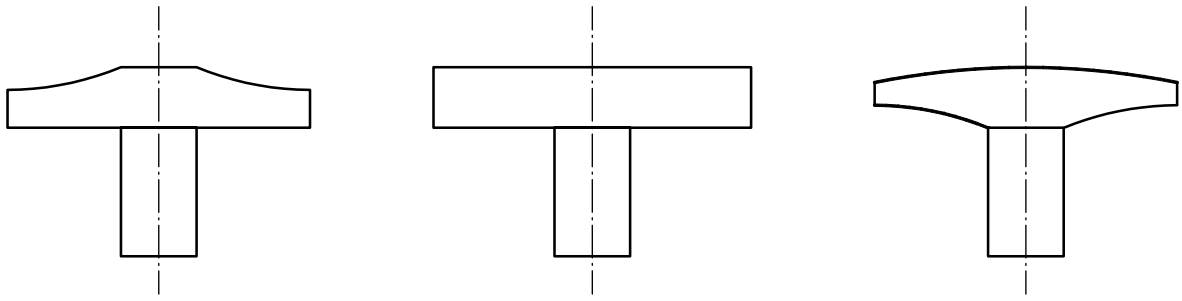
NOTE 1 Categories B and F are subdivided into subcategories (B1, B2 and B3, F1 and F2), see 7.2.2, 7.2.3 and Annex A.

The anchorage capacity shall be verified by testing according to ISO 15698-2 for the relevant category. Categories F and S shall be tested for bars intended for use in structural members exposed to fatigue and earthquake, respectively, or on the purchaser's request.

NOTE 2 The anchorage capacity of the head depends on the strength of the head-to-bar connection, on the compressive strength of the concrete and on the net head bearing area. For ribbed bars, the bond between steel and concrete may contribute to the anchorage capacity, but this is only taken into account in Category B1 (see 7.2.2). The strength of the head-to-bar connection may also be influenced by the production method of the reinforcing bars, such as hot–rolled or hot–rolled and quenched and self-tempered (QST).

NOTE 3 The concrete under the head is locally confined by the surrounding concrete. The qualification test set-up represents the confinement by the surrounding concrete and reinforcement in a simplified way. Concrete design aspects like embedment depth, concrete cover, spacing and confinement details are, thus, outside the scope of this standard.

NOTE 4 This standard does not cover safety elements introduced by, for example, the application of partial factors for capacity (e.g. γ_m-values) to be applied to the tested values. The safety elements are referred to provisions in national design standards.



a) b) c)

Figure 2 — Examples of head thickness variation

5.5 Tolerances

Geometric tolerances for the head shall be within the limits given in Table 2. Tolerances for the reinforcing bars and for material properties for the head are given in the product standards.