SLOVENSKI STANDARD
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Aluminium and aluminium alloys - Products for structural railway applications - Technical conditions for inspection and delivery - Part 4: Forgings

Aluminium und Aluminiumlegierungen - Erzeugnisse für tragende Anwendungen im Schienenfahrzeugbau - Technische Lieferbedingungen - Teil 4: Schmiedestücke

Aluminium et alliages d'aluminium - Produits pour applications ferroviaires structurales - Conditions techniques de contrôle et de livraison - Partie 4: Pieces forgées

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Aluminium et alliages d'aluminium - Produits pour applications ferroviaires structurales - Conditions techniques de contrôle et de livraison - Partie 4: Pièces forgées

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Foreword

This document (EN 13981-4:2006) has been prepared by Technical Committee CEN/TC 132 “Aluminium and aluminium alloys”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2007, and conflicting national standards shall be withdrawn at the latest by May 2007.

Within its program of work, Technical Committee CEN/TC 132 entrusted CEN/TC 132/WG 21 “Aluminium for railway applications” to prepare the following standard:

EN 13981-4, *Aluminium and aluminium alloys — Products for structural railway applications — Technical conditions for inspection and delivery — Part 4*: *Forgings.*

EN 13981 comprises the following parts under the general title *"Aluminium and aluminium alloys — Products for structural railway applications — Technical conditions for inspection and delivery":*

— *Part 1*: *Extruded products*

— *Part 2*: *Plates and sheets*

— *Part 3*: *Castings*

— *Part 4: Forgings*

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1 Scope

This European Standard specifies requirements for forgings (hand forgings, die forgings) which contribute to the structural properties of the railcar bodyshell and other major structural components.

The requirements on welded joints specified in this European Standard are not applicable to welded assemblies and sub-assemblies as they are specified for material qualification purposes only.

It specifies particular requirements regarding qualification, quality control, material properties and dimensional tolerances. Furthermore, guide-lines for application and use are given.

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.

EN 515, *Aluminium and aluminium alloys — Wrought products — Temper designations*

EN 571-1, *Non destructive testing — Penetrant testing — Part 1: General principles*

EN 573-3, *Aluminium and aluminium alloys — Chemical composition and form of wrought products — Part 3: Chemical composition*

EN 586-1, *Aluminium and aluminium alloys — Forgings — Part 1: Technical conditions for inspection and delivery*

EN 586-2, *Aluminium and aluminium alloys — Forgings — Part 2: Mechanical properties and additional property requirements*

EN 586-3, *Aluminium and aluminium alloys — Forgings — Part 3: Tolerances on dimensions and form*

EN 895, *Destructive tests on welds in metallic materials — Transverse tensile test*

EN 1011-4:2000, *Welding — Recommendations for welding of metallic materials — Part 4: Arc welding of aluminium and aluminium alloys*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 12258-1:1998, *Aluminium and aluminium alloys — Terms and definitions — Part 1: General terms*

EN ISO 10042, *Arc-welded joints in aluminium and its alloys — Quality levels for imperfections (ISO 10042:2005)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12258-1:1998 and the following apply.

3.1
forging lot
quantity of forgings of the same grade or alloy, form, temper, shape, thickness or cross-section, subsequently forged without die change

3.2
inspection lot
consignment, or part thereof, submitted for inspection, comprising products of the same grade or alloy, form, temper, shape, thickness or cross-section and processed in the same manner. Products included in one inspection lot shall be manufactured in the same production unit

3.3
heat treatment batch or lot
quantity of products of the same grade or alloy, form, thickness or cross-section and produced in the same way, heat-treated in one furnace load, or such products solution-treated and subsequently precipitation-treated in one furnace load. More than one solution-treatment lot can be included in the precipitation furnace load

3.4
structural property
property having a direct effect on the static and dynamic load carrying capability of a component or assembly

4 Ordering information

The ordering information shall be formulated as laid down in EN 586-1. Reference to this European Standard shall be made. In addition, it shall be indicated whether the forging is intended to be welded or not.

If the purchaser requires the ultrasonic inspection of the forging stock or the forgings, this shall be stated in the order.

5 Requirements

5.1 Production and manufacturing processes

Unless otherwise specified on the order, the production and manufacturing processes shall be left to the discretion of the manufacturer.

Unless it is explicitly stated on the order, no obligation shall be placed on the manufacturer to use the same processes for subsequent and similar orders.

5.2 Quality assurance

The manufacturer shall establish and maintain a quality management system which should be at least equivalent to EN ISO 9001.

The manufacturer shall establish and maintain inspection plans defining all inspections and tests to be performed on the forging to fulfil the requirements of this European Standard and any other agreed requirement, the frequency of the tests and the type of record to be established.

The inspection plan shall specify for each inspection or test whether it is to be performed per cast, per forging lot, per heat treatment batch, per inspection lot or per any other lot of importance.

The inspection plan shall comply as a minimum to the test procedures and test requirements stipulated in this European Standard (see Table 3). The inspection plan shall include additional schemes for appropriate process control. If required the inspection plan shall be submitted to the purchaser for approval before start of production.

The manufacturer shall be responsible for carrying out all inspections and tests required by this European Standard, prior to the shipment of the forging. If the purchaser wishes to inspect the forging at the manufacturer's works, he shall stipulate this at the time of placing the order.

The extent of inspections shall be in compliance with Table 3. Unless explicitly stated quality controls and inspections shall be performed on inspection lots.

5.3 Alloys, chemical composition and tempers

The alloys shall be selected from the following:

EN AW-5754, EN AW-5083, EN AW-6082, EN AW-6061, EN AW-6110A.

Any other alloy shall be qualified according to a mutually agreed procedure which shall consider the intended joining technique and the intended use.

The chemical compositions of these alloys shall be as specified in EN 573-3. The chemical composition of alloy EN AW-6110A is specified in Annex D. In addition, the lead (Pb) content of all 6xxx series alloys shall be limited to max. 0,01 %.

If the purchaser requires content limits for elements not specified in the above standard, these limits shall be stated on the order, after agreement between purchaser and supplier.

The tempers shall be selected from those specified in EN 586-2 or in Table A.1 unless otherwise agreed upon between supplier and purchaser. Tempers shall be as defined in EN 515.

Other tempers shall be qualified according to a mutually agreed procedure which shall consider the intended joining technique and the intended use.

5.4 Mechanical properties of forgings

5.4.1 Mechanical properties of forgings under static loading

Tensile strength, yield strength and elongation of forgings shall conform to the requirements in EN 586-2 unless otherwise agreed upon between supplier and purchaser and stated on the order.

The mechanical properties of alloys EN AW-6061 and EN AW-6110A shall comply with Annex A.

5.4.2 Mechanical properties of forgings under cyclic loading

The minimum values for the maximum stress specified in Table 1 shall be met for all alloys and wall thicknesses under the following conditions:

Percentage of non-failure: 97,5 %

Number of cycles: 10^7

The test pieces shall be tested according to 7.6.

Table 1 — Fatigue properties of forgings (not applicable for design purposes, see C.2)

Stress ratio $R = \sigma_{min}/\sigma_{max}$	–1	0,1	0,5
Maximum stress [a] [b] σ_{max}	65	110	180

a Meeting these values is a necessary condition for the use of design codes mentioned under C.2.

b If σ_{max} exceeds the yield strength as specified in 5.4.1, σ_{max} is equal to $R_{p0,2}$.

5.5 Mechanical properties of welded joints

5.5.1 General

The properties specified in 5.5 are only applicable to forgings which are intended to be welded.

Forgings shall be capable of providing the properties specified under 5.5.2 and 5.5.3 in the welded condition.

Values specified under 5.5.2 and 5.5.3 shall be used for qualification only and not for design purposes.

5.5.2 Mechanical properties of welded joints under static loading

The requirements on tensile strength and yield strength of welded joints between forgings have to be mutually agreed between supplier and purchaser at the time of placing the order. Test pieces shall be prepared according to 7.4. The test used for verification shall comply with 7.5.

5.5.3 Mechanical properties of welded joints under cyclic loading

The minimum values for the maximum stress specified in Table 2 shall be met for all alloys and wall thicknesses under the following conditions:

Percentage of non-failure: 97,5 %

Number of cycles: 10^7

Welded test pieces shall be prepared according to 7.4 and tested according to 7.6.

Table 2 — Fatigue properties of MIG welded butt joints (not applicable for design purposes, see C.2)

Stress ratio $R = \sigma_{min}/\sigma_{max}$	–1	0,1	0,5
Maximum stress [a] [b] σ_{max}	30	55	80

a Meeting these values is a necessary condition for the use of design codes mentioned under C.2.

b If σ_{max} exceeds the yield strength as specified in 5.5.2, σ_{max} is equal to $R_{p0,2}$.

5.6 Freedom from surface defects

Lubricants used during the forging process have to be removed to enable a visible surface inspection of the forgings.

The surface of the forging shall be free from defects prejudicial to its suitable and proper use.

The forging shall have a smooth and clean surface. However, small surface defects such as light scratches, indentations, discolouration and non-uniform surface appearance resulting from heat-treatment etc., which cannot always be totally avoided, are permitted on the product surface unless the customer specifies them as unacceptable in his order.

If a special surface treatment is agreed between supplier and purchaser, superficial defects shall not impair the decorative appearance of the surface after this treatment. Limiting samples may be agreed between supplier and purchaser.

Repair welding shall not be permitted.

5.7 Tolerances on dimensions and form

For the different forms of forgings, the tolerances on dimensions and form shall be as specified in EN 586-3. If other tolerances are required, this shall be indicated in the drawing.

6 Qualification procedures

6.1 First-off article approval procedure

Any forging of a given alloy and temper produced for the first time in the forging plant shall be qualified by tests to be performed on a representative forging lot. The test methods, the sampling and minimum test frequency and the acceptance criteria shall be as specified in Table 3.

All test results of the “first-off” approval procedure shall be recorded and included in a first-off test report. The test report shall be approved by the purchaser.

6.2 Additional qualification procedure

Qualification tests shall be performed by the manufacturer when setting up the production of an alloy which is not listed under 5.3.