



# SLOVENSKI STANDARD

## SIST EN 485-2:1998

01-april-1998

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Aluminium and aluminium alloys - Sheet, strip and plate - Part 2: Mechanical properties

Aluminium und Aluminiumlegierungen - Bänder, Bleche und Platten - Teil 2:  
Mechanische Eigenschaften

Aluminium et alliages d'aluminium - Tôles, bandes et tôles épaisses - Partie 2:  
Caractéristiques mécaniques

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EUROPEAN STANDARD

EN 485-2

NORME EUROPÉENNE

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Descriptors: iron-and steel products, rolled products, metal plates, steel strips, aluminium, aluminium alloys, mechanical properties, tension tests, bend tests, hardness tests, resistivity, corrosion resistance

English version

## Aluminium and aluminium alloys - Sheet, strip and plate - Part 2: Mechanical properties

Aluminium et alliages d'aluminium - Tôles, bandes et tôles épaisses - Partie 2: Caractéristiques mécaniques

Aluminium und Aluminiumlegierungen - Bänder, Bleche und Platten - Teil 2: Mechanische Eigenschaften

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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# CEN

European Committee for Standardization  
Comité Européen de Normalisation  
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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## Foreword

This European Standard has been drawn up by CEN/TC 132 "Aluminium and aluminium alloys", whose Secretariat is held by the Association Française de Normalisation (AFNOR).

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

Within its programme of work, Technical Committee CEN/TC 132 entrusted CEN/TC 132/WG 7 "Sheets, strips and plates" to prepare the following standard:

EN 485-2 Aluminium and aluminium alloys - Sheets, strips and plates - Part 2: Mechanical properties.

This standard is part of a set of four standards. The other standards deal with:

EN 485-1 Aluminium and aluminium alloys - Sheets, strips and plates - Part 1: conditions for inspection and delivery.

EN 485-3 Aluminium and aluminium alloys - Sheets, strips and plates - Part 3: Tolerances on shape and dimensions for hot-rolled products.

EN 485-4 Aluminium and aluminium alloys - Sheets, strips and plates - Part 4: Tolerances on shape and dimensions for cold-rolled products.

CEN/TC 132 met on 20 and 21 October 1992 in Paris and agreed on the text to be submitted to CEN members for formal vote.

The following countries were represented at that meeting : BELGIUM - DENMARK - FRANCE - GERMANY - ITALY - NORWAY - SPAIN - SWEDEN - SWITZERLAND - UNITED-KINGDOM.

The annex A is normative and contains "Rules for rounding".

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 april 1995, and conflicting national standards shall be withdrawn at the latest by april 1995.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

## 1 Scope

This Part of EN 485 specifies the mechanical properties of wrought aluminium and aluminium alloy sheet, strip and plate for general engineering applications.

It applies to flat rolled products.

It does not apply to semi-finished rolled products in coiled form to be subjected to further rolling (reroll stock) or to special products such as corrugated, embossed, painted, etc. sheets and strips or to special applications such as aerospace, can stock, finstock, etc. which are dealt with in separate EN standards.

The systems for designating these materials are described in EN 573-1 and EN 573-2. Their chemical composition limits are given in EN 573-3.

Mechanical property limits are specified for all Class A alloys, as defined in EN 573-4.

Temper designations are defined in EN 515.

## 2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 485-1	Aluminium and aluminium alloys - Sheet, strip and plate - Part 1 : Technical conditions for inspection and delivery
EN 515	Aluminium and aluminium alloys - Wrought products - Temper designations
EN 573-1	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 1 : Numerical designation system
EN 573-2	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 2 : Chemical symbol based designation system
EN 573-3	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 3 : Chemical composition
EN 573-4	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 4 : Forms of products
EN 2004-1	Aerospace series - Test methods for aluminium and aluminium alloy products - Part 1 : Determination of electrical conductivity of wrought aluminium alloys
EN 10002-1	Metallic materials - Tensile testing - Part 1 : Method of test (at ambient temperature)

ISO 6506	Metallic materials - Hardness test - Brinell test
ISO 6507-1	Metallic materials - Hardness test - Vickers test - Part 1 : HV 5 to HV 100
ISO 6507-2	Metallic materials - Hardness test - Vickers test - Part 2 : HV 0,2 to less than HV 5
ISO 7438	Metallic materials - Bend test
ISO 9591	Corrosion of aluminium alloys - Determination of resistance to stress-corrosion cracking
ASTM G34-86	Exfoliation corrosion susceptibility in 7xxx series copper-containing aluminium alloys (EXCO test)
ASTM G66-86	Visual assessment of exfoliation corrosion susceptibility of 5xxx series aluminium alloys (ASSET test)

### 3 Tensile test

The selection, preparation and number of specimens and test-pieces is specified in EN 485-1.

The test shall be carried out in accordance with EN 10002-1, particular attention being paid to the following :

- normally the test-pieces shall be taken with their length transverse (or long transverse) to the principal direction of rolling. If the width of the product is less than 300 mm, then test in the longitudinal direction is permitted. In both cases the mechanical property limits specified in tables 2 to 34 apply ;
- machined test-pieces of rectangular or circular cross-section (as applicable) shall be used ;
- for specified thicknesses up to and including 12,5 mm the test-piece shall have a rectangular (or square) cross-section. Its reduced section shall be 12,5 mm wide and its thickness equal to the full thickness of the product ;
- for specified thicknesses from 10,0 mm up to and including 12,5 mm a round test-piece may be used. However, in case of dispute, a rectangular test-piece shall be used ;
- for specified thicknesses exceeding 12,5 mm the test-piece shall have a circular cross-section with a recommended diameter of 10 mm for its reduced section ;
- recommended shapes for rectangular and round test-pieces are shown in figures 1 and 2 ;
- during a test to determine proof stress, the rate of stress application shall not exceed 12 MPa/s. After removal of the extensometer the rate of straining may be increased but it shall not exceed 50 % of the length of the reduced section per minute ;
- elongation for rectangular (or square) test-pieces shall be measured using an original gauge length of 50 mm ;



- elongation for round test-pieces shall be measured using an original gauge length equal to  $5 D$  where  $D$  is the diameter of the reduced section ;
- for determination of compliance, proof stress and tensile strength values shall be rounded to the nearest 1 MPa and elongation values to the nearest 1 % using the rounding rules set out in annex A.

#### 4 Bend test

Sheet, strip and plate shall be capable of being bent cold through an angle of  $90^\circ$  or  $180^\circ$ , as applicable, around a pin having a radius equal to  $k$  times the thickness  $t$  of the sheet, strip or plate (e.g.  $2,5 t$ ) without cracking. Recommended values of the minimum bend radii for different alloys, tempers and thicknesses are given in tables 2 to 34. Compliance with these values and/or conduct of the test is only required when so specified on the order.

The test shall be carried out in accordance with ISO 7438, particular attention being paid to the following :

- the bend test shall be carried out on a specimen taken adjacent to the tensile test specimen ;
- the test-piece shall be taken in the transverse direction, the bend axis being parallel to the rolling direction. For material less than 150 mm wide, the test-piece may be taken in the rolling direction ;
- the width of the test piece shall be at least 20 mm and preferably 40 mm to 50 mm. For material less than 20 mm wide, the width of the test-piece shall be the full width of the material ;
- the edges of the test-piece may be machined when practical. They may be rounded to a radius of approximately 2 mm.

#### 5 Hardness test

Hardness test may be a convenient means for checking the homogeneity of a lot; it may also be used for a quick semi-quantitative check of the thermal treatment to which the material has been submitted or, as a first approach, for material identification purpose. However its accuracy is generally less than what can be expected from a tensile test which it can in no way replace.

The values in tables 2 to 34 are typical Brinell hardness (HBS) values for a test carried out according to ISO 6506 with a 2,5 mm diameter steel ball. They are given for information only.

If the Brinell hardness test is not possible (because of thin gauge or soft temper) then Vickers hardness test, according to ISO 6507-1 or ISO 6507-2, can be used. In that case the values will be approximately 10 % above the stated Brinell values.

Table 1, given for convenience, shows for several HBS values the minimum gauge down to which the hardness measurement remains valid, according to the rules stated in ISO 6506, using a 2,5 mm diameter steel ball and a load of 612,9 N.

**Table 1 : Minimum material gauge and Brinell hardness values**

Brinell hardness HBS	30	40	50	60	70	80	90	100
minimum gauge mm	2,1	1,6	1,3	1,1	0,91	0,80	0,71	0,64
Brinell hardness HBS	110	120	130	140	150	160	170	180
minimum gauge mm	0,58	0,53	0,49	0,45	0,42	0,40	0,37	0,35

## 6 Electrical conductivity

Electrical conductivity measurements are required for lot acceptance-purposes, in the case of alloy EN AW-7075 in the T73-type and T76-type tempers, in order to assess the resistance to stress-corrosion cracking or the exfoliation-corrosion resistance of the material as applicable.

The specimen for electrical conductivity testing shall be taken adjacent to the tensile test specimen.

The measurement shall be carried out by the eddy-current method as specified in EN 2004-1. The reference blocks to be used shall be agreed between producer and purchaser. The results shall be rounded to the nearest 0,1 MS/m, using the rounding rules set out in annex A.

The acceptance criteria are specified in table 33.

## 7 Stress-corrosion resistance

7.1 Plate made of alloy EN AW-7075 in the T73 and T7351 tempers and over 25 mm in thickness, shall be capable of exhibiting no evidence of stress-corrosion cracking when subjected to ISO 9591 accelerated stress-corrosion cracking test.

For the purpose of this standard the following provisions apply :

- a minimum of three adjacent replicate test pieces shall be taken from each specimen and submitted to the test ;
- exposure shall be carried out by alternate immersion in a 3,5 % by mass sodium chloride solution in water ;
- test-pieces shall be stressed in the short transverse direction with a stress level of 75 % of the specified proof stress ;
- no stress-corrosion related rupture shall be observed after a minimum exposure time of 20 days.

The method of stressing (bending, uniaxial loading, C-ring, etc.), the shape and dimensions of the test-pieces and the frequency of the test are left to the discretion of the producer, who shall maintain records of all lots so tested and make them available for examination at the producer's facility for not less than five years.

**7.2** For lot acceptance-purposes, resistance to stress-corrosion cracking for each lot of material shall be established by testing the previously selected tensile test specimens to the criteria shown in table 33.

## **8 Exfoliation corrosion resistance (5xxx series alloys)**

**8.1** Products made of alloys EN AW-5086 and EN AW-5083 in the H116 temper shall be capable of exhibiting no evidence of exfoliation corrosion when subjected to ASTM G66-86 accelerated exfoliation corrosion susceptibility test.

The test shall be carried out on full thickness test-pieces for material less than 2,5 mm in thickness. For material 2,5 mm or more in thickness, 10 % of the thickness shall be removed by machining, from one as-rolled surface, and both the machined and as-rolled surfaces submitted to the test and evaluated.

**8.2** For lot-acceptance purposes, the acceptability of each lot of material mentioned in 8.1 shall be determined by the producer, by metallographic examination of one specimen per lot selected from midsection at one end of a random sheet, plate or coil, using the following procedure :

- a section perpendicular to the rolling surface and parallel to the rolling direction shall be polished (preferably electrolytic polish) and then microetched for 3 min, using a solution of 40 ml 85 % phosphoric acid in 60 ml distilled water, at  $35\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  ;
- the metallographic examination shall be carried out at 500 times magnification ;
- the revealed microstructure shall be predominantly free of a continuous grain boundary network of aluminium-magnesium precipitate ( $\text{Al}_3\text{Mg}_2$ ).

Acceptability shall be determined by comparison to producer-established reference photomicrographs of acceptable material. If the microstructure shows evidence of  $\text{Al}_3\text{Mg}_2$  precipitates in excess of the relevant reference, the lot is either rejected or subjected to the ASTM G66-86 test

Reference photomicrographs shall be established on acceptable material (according to ASTM G66-86), for each thickness range specified in table 27 (EN AW-5086) or 26 (EN AW-5083) as applicable. Production practices shall not be changed after establishment of these references.

Significant changes in production practices that alter the microstructures of the alloy shall require the establishment of new reference photomicrographs as described above.

The producer shall maintain at the producing facility all records relating to the establishment of reference photomicrographs and production practices.

## **9 Exfoliation corrosion resistance (7xxx series alloys)**

**9.1** Products made of alloy EN AW-7075 in the T76-type tempers shall be capable of exhibiting no evidence of exfoliation corrosion in excess of grade EB, as defined in ASTM G34-86, when subjected to the test in 9.3.

**9.2** For lot acceptance-purposes, resistance to exfoliation corrosion for each lot of material shall be established by testing the previously selected tensile test specimens to the criteria shown in table 33.

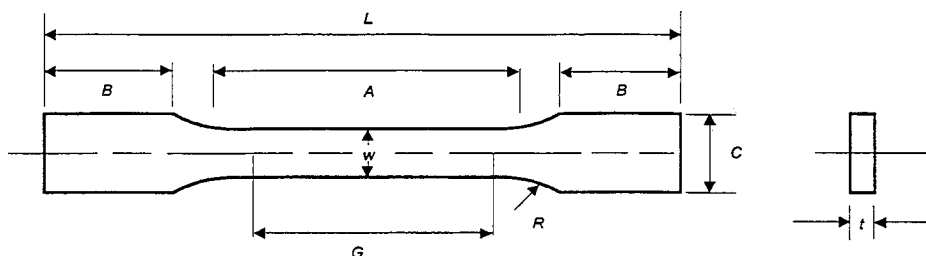
**9.3** When carried out, for monitoring purposes, the test shall be in accordance with ASTM G34-86 (EXCO test), and the following additional requirements shall apply :

- the specimens for test shall be selected at random from material considered acceptable in accordance with the lot acceptance criteria shown in table 33, for each thickness range listed in that table ;
- the test-pieces shall be a minimum of 50 mm x 100 mm with the 50 mm dimension parallel to the direction of final rolling. They shall include the full-section thickness of the material, except that for material 2,5 mm or more in thickness, 10% of the thickness shall be removed by machining the test surface. For machined test-pieces, the machined surface shall be evaluated by exposure to the test solution ;
- the frequency of the test is left to the discretion of the producer, who shall maintain records of all lots so tested and make them available for examination at the producer's facility for not less than five years.

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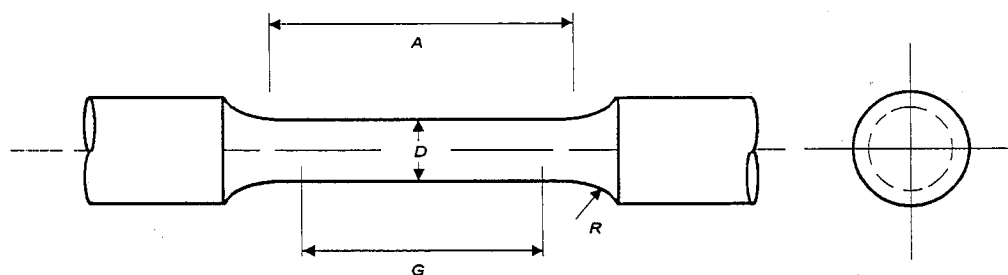
Dimensions in millimetres

Standard test-piece	
Nominal width	12,5
G - Gauge length	50,0 ± 0,5
W - Width	12,5 ± 0,10
t - Thickness	thickness of material
R - Radius of fillet, min.	12,5
L - Overall length, min.	200
A - Length of reduced section, min.	57
B - Length of grip section, min.	50
C - Width of grip section, approximate	20

Figure 1 : Standard rectangular tensile test-piece

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Dimensions in millimetres

	Standard test-piece	Small-size test-pieces proportional to standard		
	10	8	6	4
Nominal diameter	10	8	6	4
G - Gauge length	50,0 ± 0,5	40,0 ± 0,5	30,0 ± 0,5	20,0 ± 0,5
D - Diameter	10,0 ± 0,10	8,0 ± 0,10	6,0 ± 0,10	4,0 ± 0,05
R - Radius of fillet, min.	9	8	6	4
A - Length of reduced section, min.	60	48	36	24

Figure 2 : Standard 10 mm tensile test-piece with 50 mm gauge length and examples of small-size proportional test-pieces