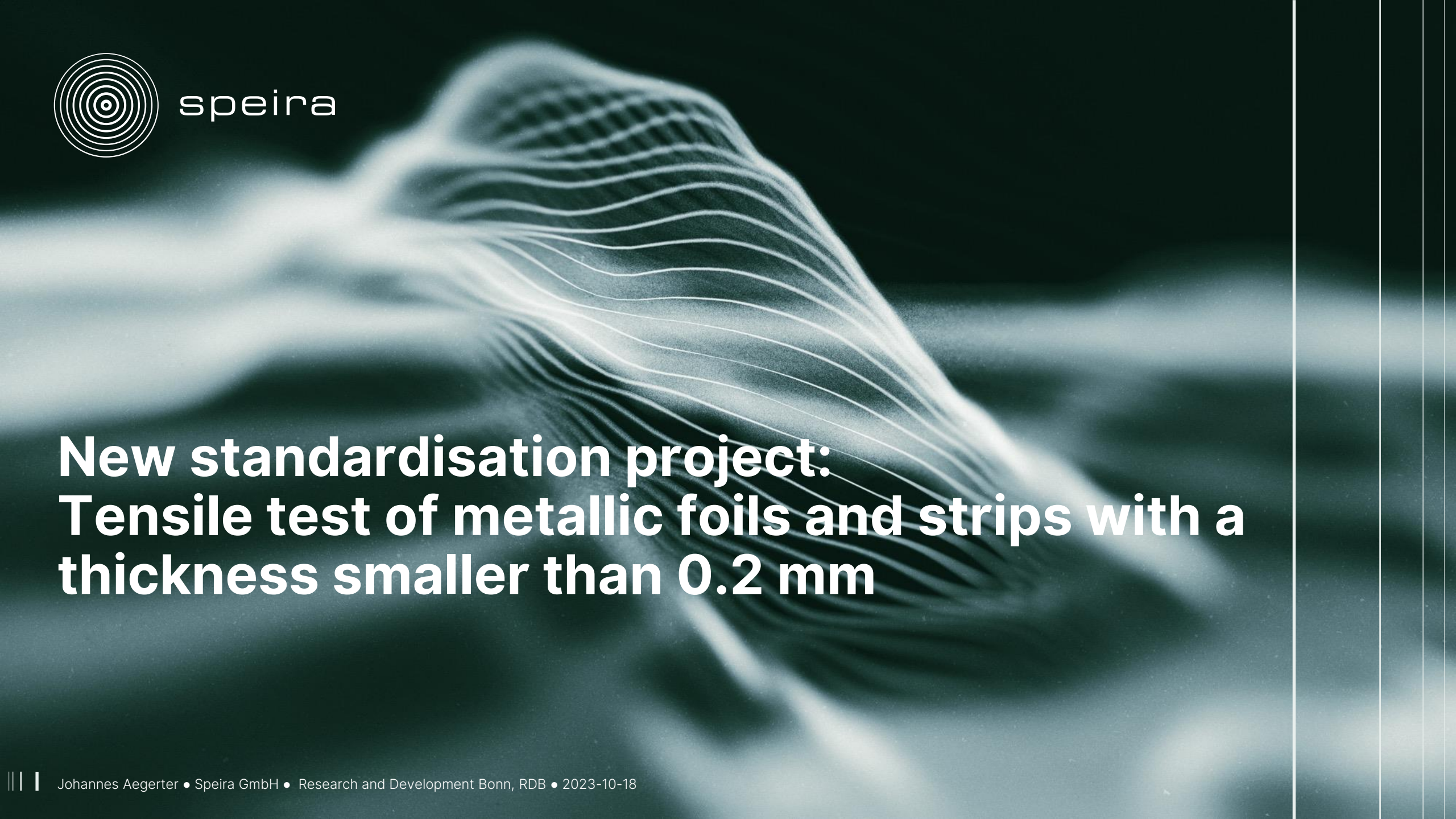


speira

New standardisation project: Tensile test of metallic foils and strips with a thickness smaller than 0.2 mm

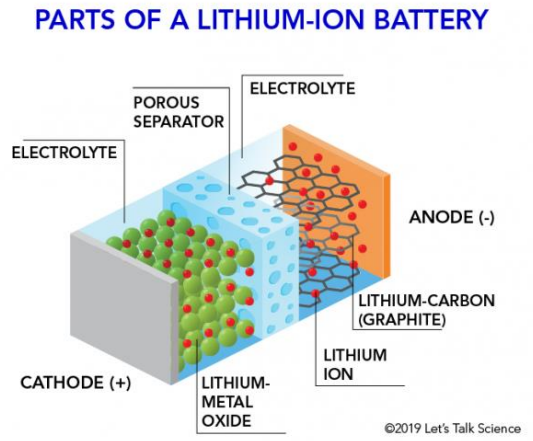
Johannes Aegerter • Speira GmbH • Research and Development Bonn, RDB • 2023-10-18

New standardisation project: Tensile test of metallic foils and strips with a thickness smaller than 0.2 mm

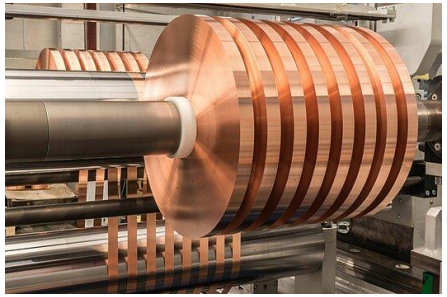
Source: https://www.braun.de

Source: https://www.wikinger-verpackung.de

Source: https://alfipa.de



In the last years: Strong impact on thin rolled products and standards by lithium-ion battery systems



Source: https://de.schlenk.com/

Source: https://alfipa.de

Source: https://www.mahle.com/

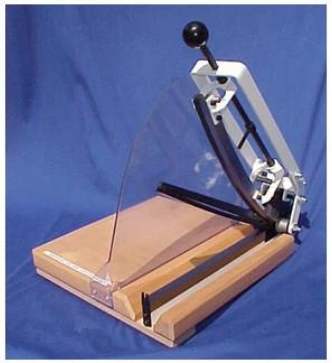
Source: https://alfipa.de

New standardisation project: Tensile test of metallic foils and strips with a thickness less than 0.2 mm

Probenformen für Zugproben

Zwick

- Proben für den Zugversuch an Metallfolien
  - Streifenproben
  - Sehr wichtig sind saubere, grad- und kerbfreie Probenkanten,
    - da es sonst an diesen Fehlstellen (mehr noch als bei dickeren Proben) zum vorzeitigen Probenbruch kommt.
    - Dieses würde zu zu niedrige Zugfestigkeiten und vor allem zu niedrige Bruchdehnungen führen



Folienstreifenschere zum Schneiden von Folienstreifenproben nach DIN 50 154 (Foto: Fa. MST Liebert)

Standard	Zu prüfender Werkstoff	Proben-form	Proben-dicke a_0	Proben-breite b_0	Mess-länge L_0	Versuchs-länge L_c	Herstellung durch/mittels
ASTM E 345	Metalle	A B	≤ 0,150 ≤ 0,150	12,5 12,5	50 125	60 125	Fräsen Folienstreifen-schere
DIN 50 154	Al und Al-Legierungen		≤ 0,179	15,0	100	100	Folienstreifen-schere

Johannes Aegerter, Hermann Bloching, 21.10.03 No.19

September 2019

DIN 50154

DIN

ICS 77.150.10

Supersedes
DIN 50154:1980-12

Tensile test on foils and strips of aluminum and aluminum wrought alloys with a nominal thickness less than 0,200 mm, English translation of DIN 50154:2019-09

Zugversuch an Folien und Bändern aus Aluminium und Aluminium-Knetlegierungen mit einer Nenndicke kleiner 0,200 mm,
Englische Übersetzung von DIN 50154:2019-09

Essai de traction des feuilles et bandes en aluminium et en alliages d'aluminium corroyés ayant une épaisseur inférieure à 0,200 mm,
Traduction anglaise de DIN 50154:2019-09

ASTM INTERNATIONAL

Designation: E345 – 16

Standard Test Methods of Tension Testing of Metallic Foil[1]

This standard is issued under the fixed designation E345; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

Standards for tensile testing on ISO and EN-level

INTERNATIONAL STANDARD **ISO 6892-1**

Third edition
2019-11

Metallic materials — Tensile testing —

Part 1:
Method of test at room temperature

Matériaux métalliques — Essai de traction —

Partie 1: Méthode d'essai à température ambiante

Table B.1 — Dimensions of test pieces

Dimensions in millimetres

Test piece type	Width b_o	Original gauge length L_o	Parallel length L_c		Free length between the grips for parallel sided test piece
			Minimum	Recommend-ed	
1	12,5 ± 1	50	57	75	87,5
2	20 ± 1	80	90	120	140
3	25 ± 1	50[a]	60[a]	—	Not defined

[a] The ratio L_o/b_o and L_c/b_o of a type 3 test piece in comparison to one of types 1 and 2 is very low. As a result, the properties, especially the elongation after fracture (absolute value and scatter range), measured with this test piece, will be different from the other test piece types.

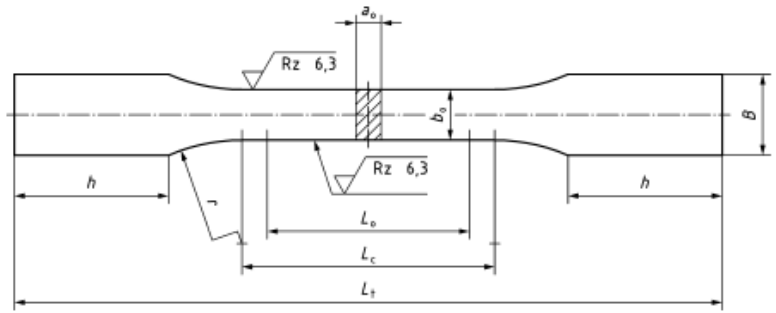
Annex B
(normative)

Types of test pieces to be used for thin products: sheets, strips, and flats between 0,1 mm and 3 mm thick

B.1 General

For products of less than 0,5 mm thickness, special precautions can be necessary.

Zugprobe H:

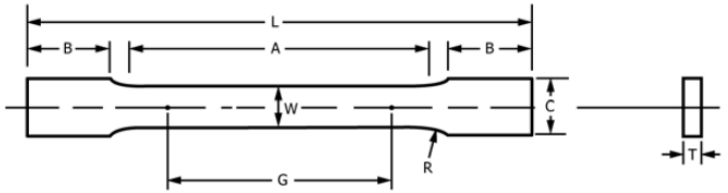


4.9 Zugprobe Form H

Zur Prüfung von Flacherzeugnissen mit einer Dicke zwischen 0,1 mm und 3 mm (Bleche, Bänder und flache Walzprodukte) werden üblicherweise anstelle von proportionalen Flachproben (Form E) nicht proportionale Flachproben verwendet.

Standards for tensile testing on ASTM-Level

E8/E8M – 22



Dimensions

	Standard Specimens		Subsize Specimen
	Plate-Type, 40 mm [1.500 in.] Wide	Sheet-Type, 12.5 mm [0.500 in.] Wide	6 mm [0.250 in.] Wide
	mm [in.]	mm [in.]	mm [in.]
G—Gauge length (Note 1 and Note 2)	200.0 ± 0.2 [8.00 ± 0.01]	50.0 ± 0.1 [2.000 ± 0.005]	25.0 ± 0.1 [1.000 ± 0.003]
W—Width (Note 3 and Note 4)	40.0 ± 2.0 [1.500 + 0.125, -0.250]	12.5 ± 0.2 [0.500 ± 0.010]	6.0 ± 0.1 [0.250 ± 0.005]
T—Thickness (Note 5)		thickness of material	
R—Radius of fillet, min (Note 6)	25 [1]	12.5 [0.500]	6 [0.250]
L—Overall length, min (Note 2, Note 7, and Note 8)	450 [18]	200 [8]	100 [4]
A—Length of reduced parallel section, min	225 [9]	57 [2.25]	32 [1.25]
B—Length of grip section, min (Note 9)	75 [3]	50 [2]	30 [1.25]
C—Width of grip section, approximate (Note 4 and Note 9)	50 [2]	20 [0.750]	10 [0.375]

6.3 *Sheet-Type Specimens:*

6.3.1 The standard sheet-type test specimen is shown in Fig. 1. This specimen is used for testing metallic materials in the form of sheet, plate, flat wire, strip, band, hoop, rectangles, and shapes ranging in nominal thickness from 0.13 mm to 19 mm [0.005 in. to 0.750 in.]. When product specifications so permit, other types of specimens may be used, as provided in 6.2, 6.4, and 6.5.

NOTE 7—Test Methods E345 may be used for tension testing of materials in thicknesses up to 0.15 mm [0.0059 in.].

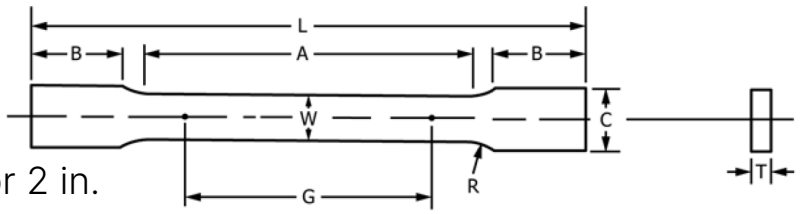
6.5 *Specimens for Sheet, Strip, Flat Wire, and Plate*—In testing sheet, strip, flat wire, and plate, use a specimen type appropriate for the nominal thickness of the material, as described in the following:

6.5.1 For material with a nominal thickness of 0.13 mm to 5 mm [0.005 in. to 0.1875 in.], use the sheet-type specimen described in 6.3.

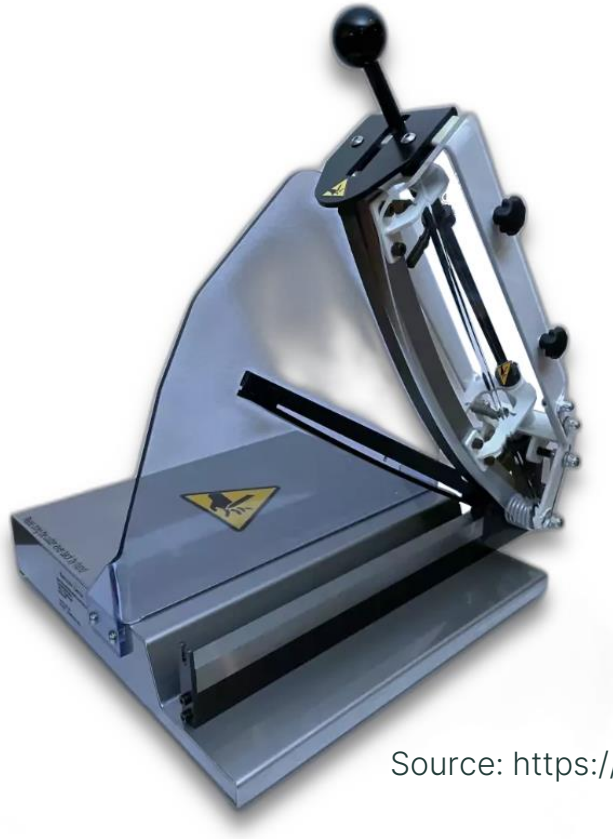
Test piece geometry

- ISO/NP 6892-6:
  - Parallel sided test pieces without a head
    - Width b_o = 15 mm
    - Original gauge length L_o = 50 mm resp. 100 mm (recommended)
  - Test piece preparation by using a double bladed cutter, e. g. Type “Cut7”
  - Test piece geometry identical to DIN 50154 and diverse EN-Standards for semi finished products out of aluminium (EN 546-1 und -2, EN 683-1 und -2)

- ASTM E345:
  - Type A: Dog bone type:
    - Width b_o = 12,5 or 0,5 in.
    - Original gauge length L_o = 50 mm or 2 in.



  - Type B: Parallel sided test pieces without a head:
    - Width b_o = 12,5 or 0,5 in.
    - Original gauge length L_o = 50 mm or 5 in.



Source: https://cut7.de/

Determination of the thickness

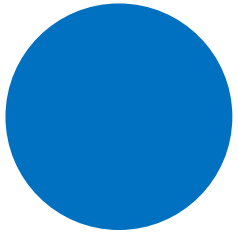
- Tactile thickness determination by use of suitable devices at least 5 positions along the length.
- Gravimetric thickness determination:
  - Use of the test piece itself

$$a_o = \frac{m \cdot 1000}{L_t \cdot b_o \cdot \rho}$$

  - Rectangular cut

$$a_o = \frac{m \cdot 1000}{L \cdot w \cdot \rho}$$

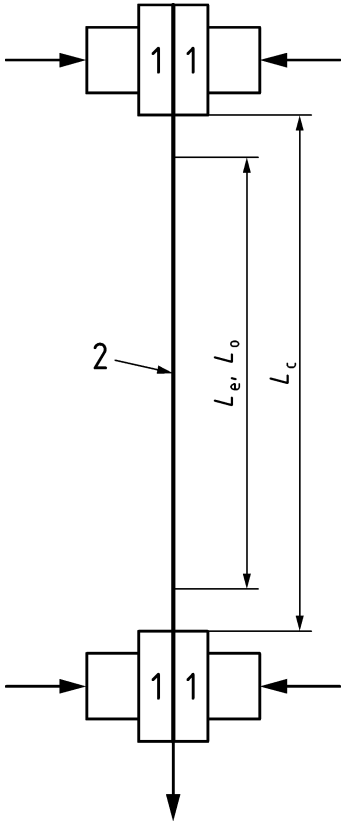
  - Punched blank



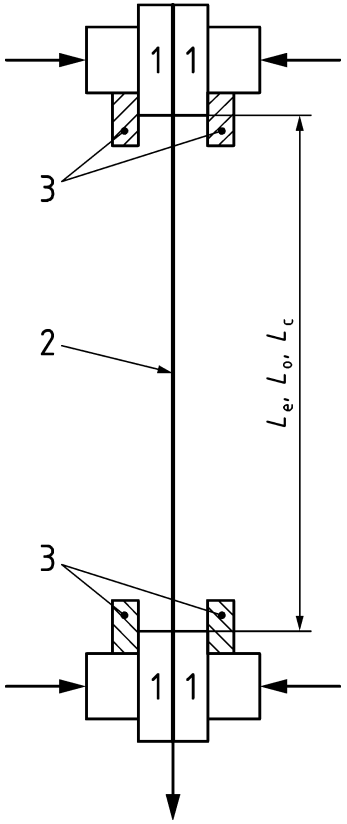
$$a_o = \frac{m \cdot 1000 \cdot 4}{\pi \cdot D^2 \cdot \rho}$$

- Attention: - Cuts shall be free of any lubricants, oil or grease
  - No rectangular or square cuts shall be punched

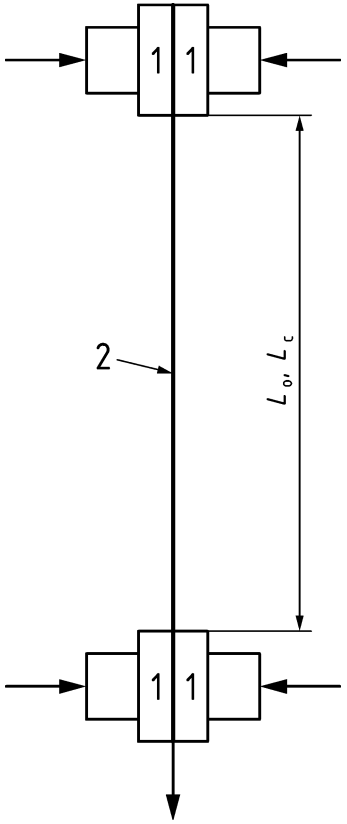
ISO/NP 6892-6: Strain measurement (equal to DIN 50154)



a) Direct strain measurement on the test piece using an extensometer



b) Measurement of the change in distance between gripping jaws L_c via an extensometer



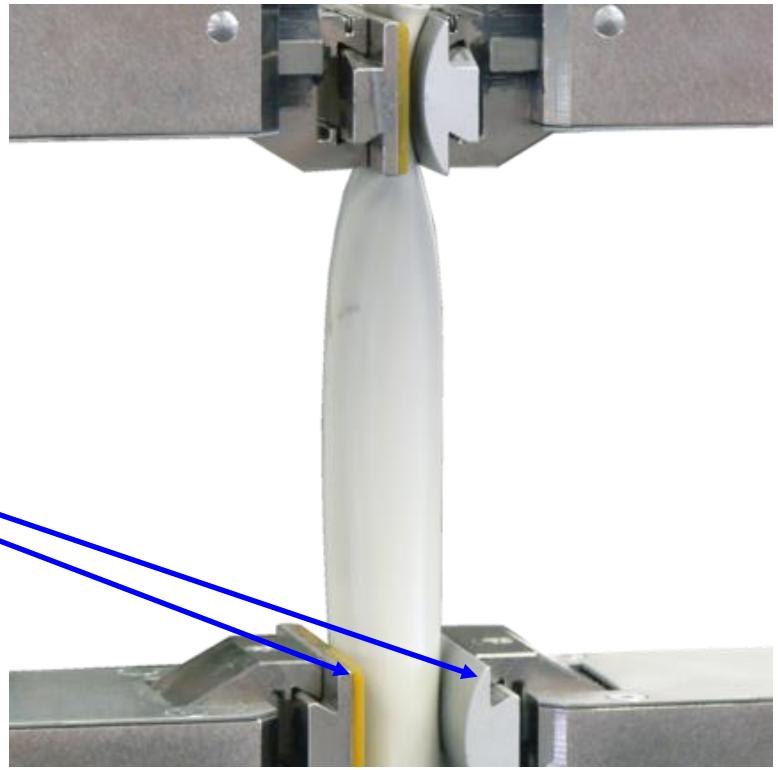
c) 7.6.3 Measurement of the change in distance between gripping jaws L_c via crosshead displacement

1	Gripping jaw
2	Test piece
3	Block
L_c	Parallel length, here: distance between gripping jaws
L_e	Extensometer gauge length
L_o	Original gauge length

Gripping jaws (ISO/NP 6892-6)

- On one hand a surface roughness as low as possible to avoid fracture in the gripping area
- On the other hand high enough to prevent slipping of the test piece.
  - Note: In some cases a coating of the gripping jaws with an elastomer (e. g. Vulkollan) may be helpful to fulfil these requirement.

- Edge radii of the gripping jaws:
  - At least 0,5 mm to avoid fracture in the area of the gripping jaws
  - If the strain is measured directly on the test piece by an extensometer:
    - Before specified value is only a minimum value.
    - This means convex gripping jaws or convex gripping jaw in combination with flat gripping jaws can be used
  - If the strain is measured according distance between gripping jaws L_c:
    - The maximum radii shall not exceed 1 mm.



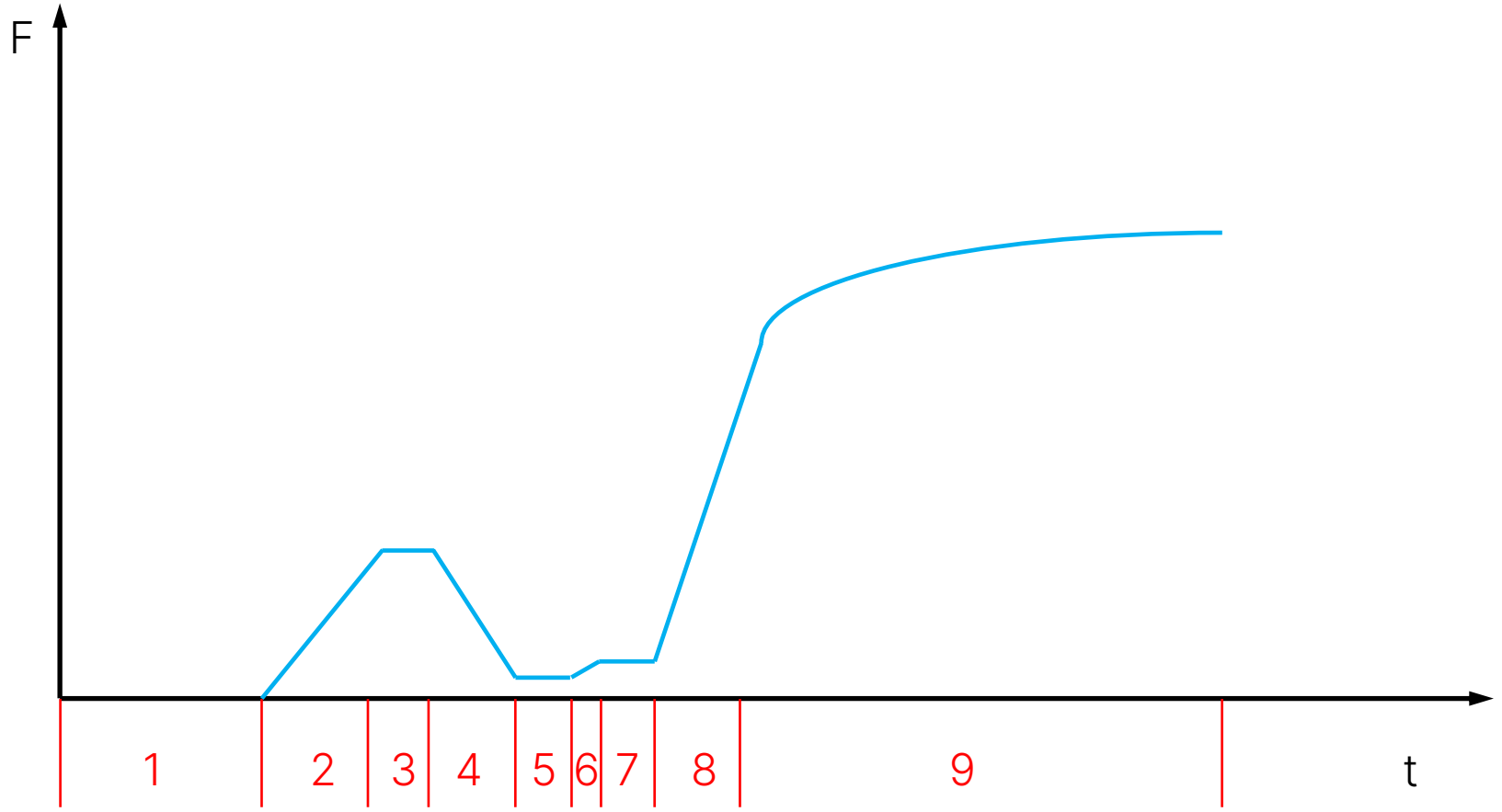
Gripping of the test piece (ISO/NP 6892-6)

- The test piece shall be gripped in the tensile testing machine so that its axis coincides with the line of action of the test force.

- Test piece which foldings:
  - The lower end of the test piece can be loaded with a small weight which mass is lower than 0,5 % of the corresponding presumed proof strength.

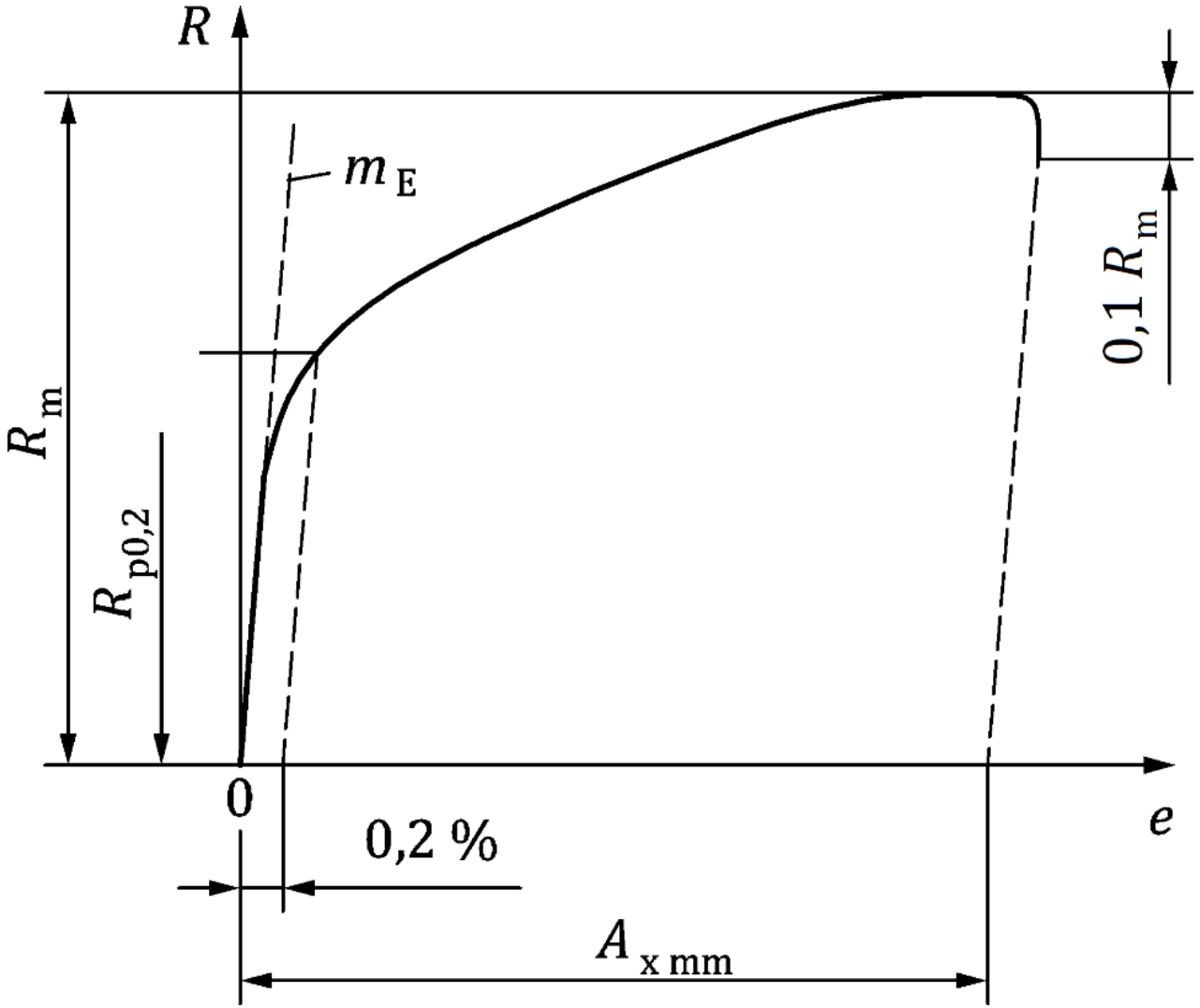
  - After gripping the test piece a maximum tension stress of 1/3 of the presumed proof strength is applied followed by de-loading up to approximately 5 % of the presumed proof strength. Then the real test will be started (attaching the extensometer, loading the test piece, etc.)

Optional pre-loading of the test piece in the elastic range



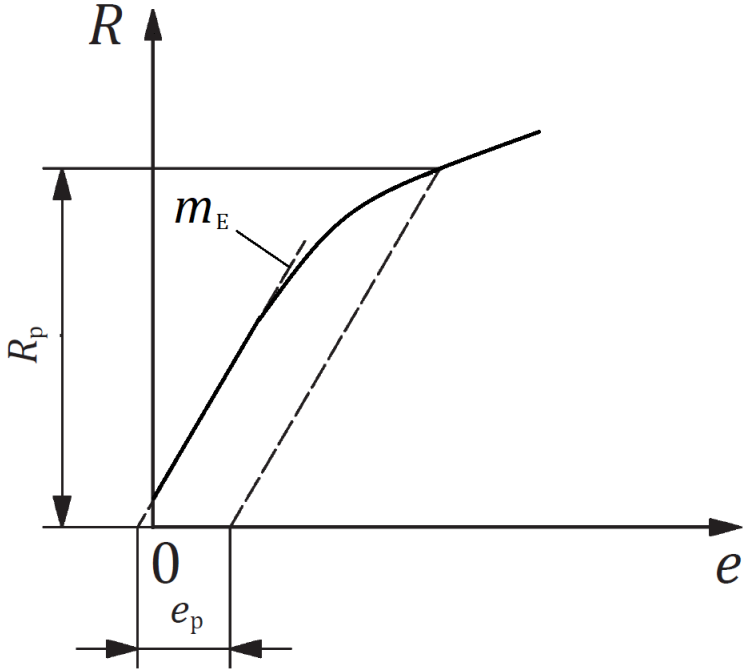
	Action
1	Gripping of the test piece
2 (new)	Applying pre-load 1
3 (new)	Holding of the pre-load 1
4 (new)	De-loading below pre-load 2
5 (new)	Stop of testing machine
6	Applying pre-load 1
7	Fixing of extensometer and setting it to zero
8	Elastic deformation of the test piece
9	Plastic deformation of the test piece

Determination of the properties (ISO/NP 6892-6)

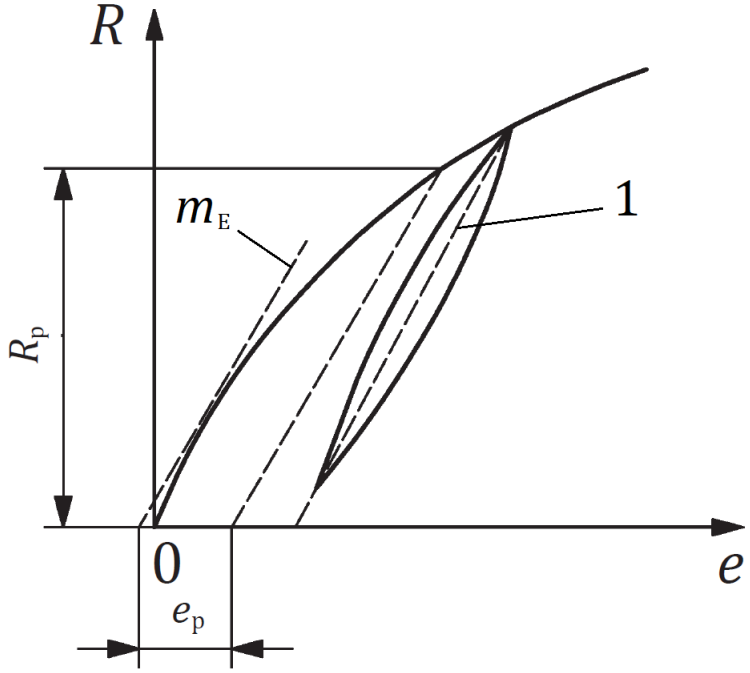


NOTE The slope of the elastic part of the stress/extension curve m_E does not necessarily have to correspond to the value of the modulus of elasticity because the elastic deformation of the test set-up and/or the shear deformation of the gripping jaws coating are also measured, especially in test set-ups as in 7.6.2 and 7.6.3. Here the slope m_E rather represents a quantity for determining the proof strength Rp0,2 and the percentage elongation at fracture $A_{50\,mm}$ or $A_{100\,mm}$. However, under optimum test conditions the value and test set-up according to 7.6.1 m_E can be quite close to the value of the modulus of elasticity.

Methods for the determination of the slope of the elastic line (ISO/NP 6892-6)

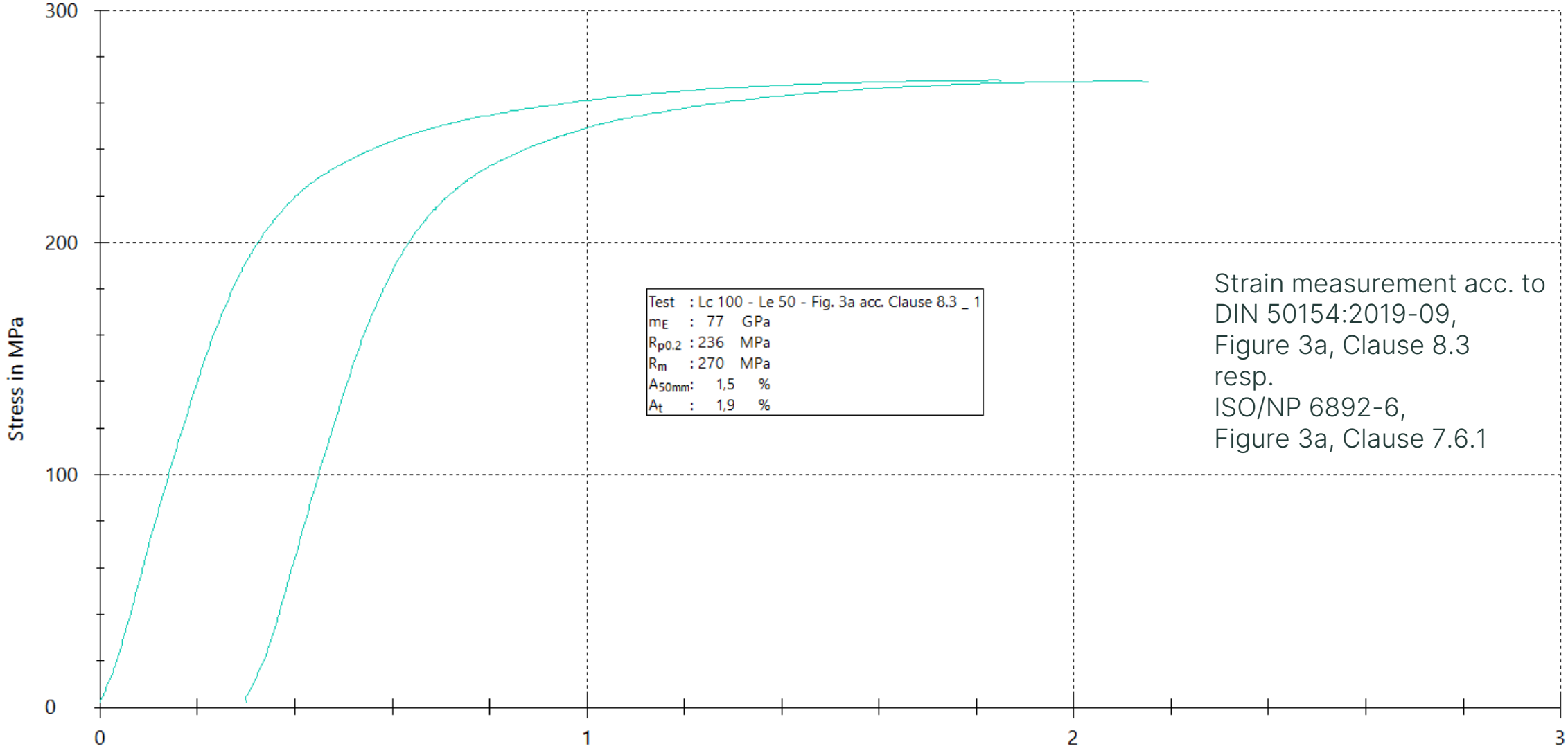


- Linear regression method:
  - Regression between two default stress values
- Automatic method for determination of the stress values for the linear regression:
  - Slide segment method



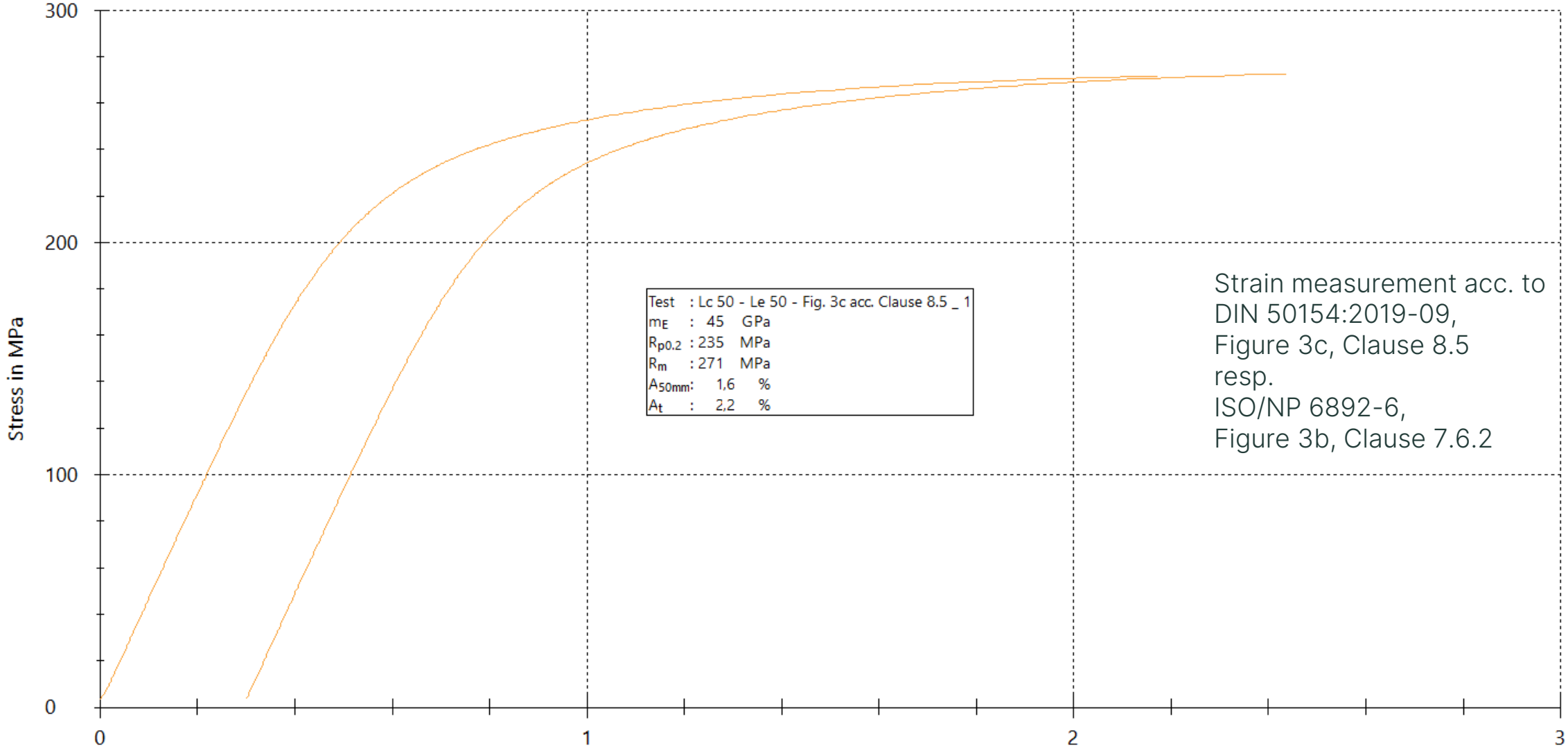
- Hysteresis method

Stress-strain curves depending on the used strain measurement system: Extensometer on the test piece



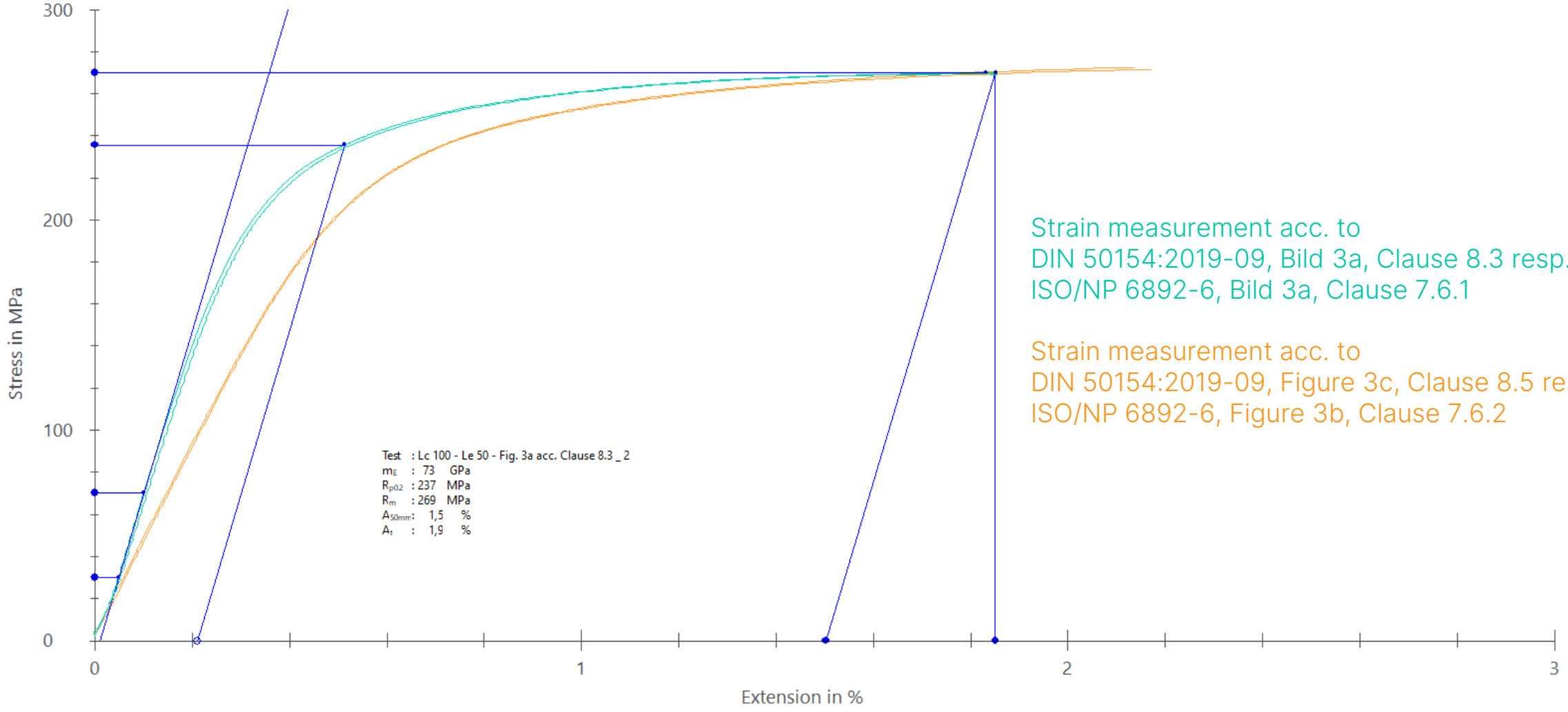
Strain measurement acc. to DIN 50154:2019-09, Figure 3a, Clause 8.3 resp. ISO/NP 6892-6, Figure 3a, Clause 7.6.1

Stress-strain curves depending on the used strain measurement system: Extensometer on the gripping jaws



Strain measurement acc. to DIN 50154:2019-09, Figure 3c, Clause 8.5 resp. ISO/NP 6892-6, Figure 3b, Clause 7.6.2

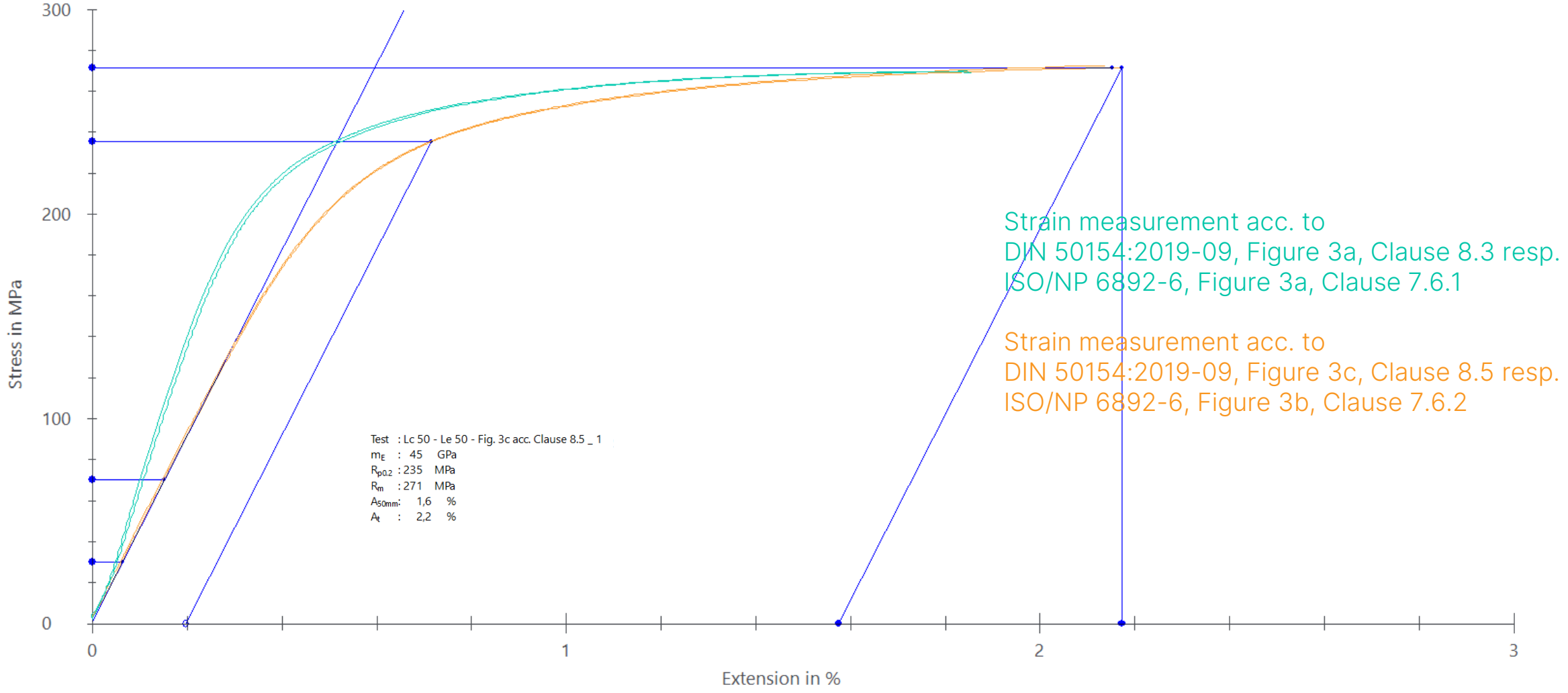
Kurvenformen in Abhängigkeit vom verwendeten Dehnungsmessverfahren



Strain measurement acc. to
DIN 50154:2019-09, Bild 3a, Clause 8.3 resp.
ISO/NP 6892-6, Bild 3a, Clause 7.6.1

Strain measurement acc. to
DIN 50154:2019-09, Figure 3c, Clause 8.5 resp.
ISO/NP 6892-6, Figure 3b, Clause 7.6.2

Kurvenformen in Abhängigkeit vom verwendeten Dehnungsmessverfahren

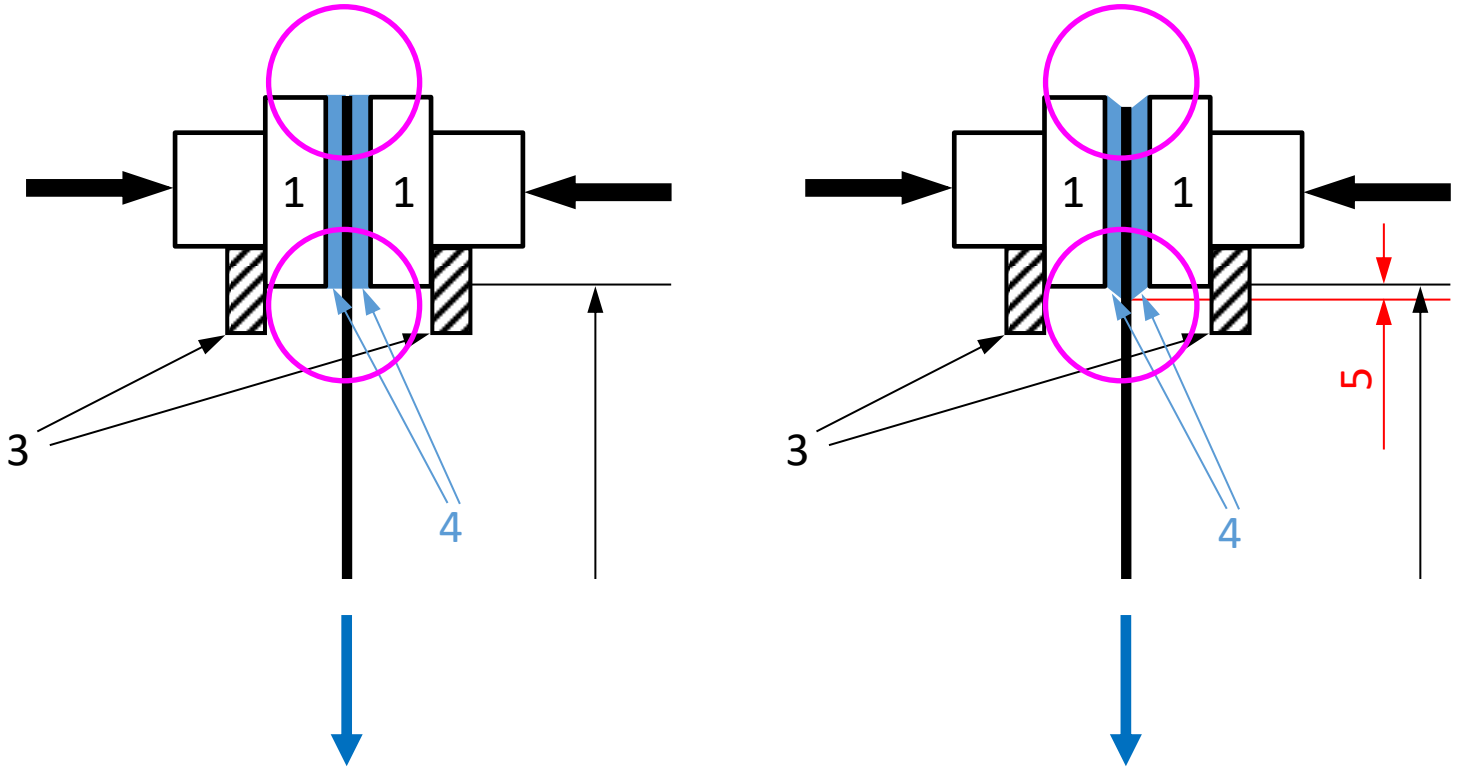


Strain measurement acc. to
DIN 50154:2019-09, Figure 3a, Clause 8.3 resp.
ISO/NP 6892-6, Figure 3a, Clause 7.6.1

Strain measurement acc. to
DIN 50154:2019-09, Figure 3c, Clause 8.5 resp.
ISO/NP 6892-6, Figure 3b, Clause 7.6.2

Compliance of the testing system

- Sum of the compliance of the single components:
  Load frame, load cell, gripping system,...
- Compliance in the area of the gripping system:



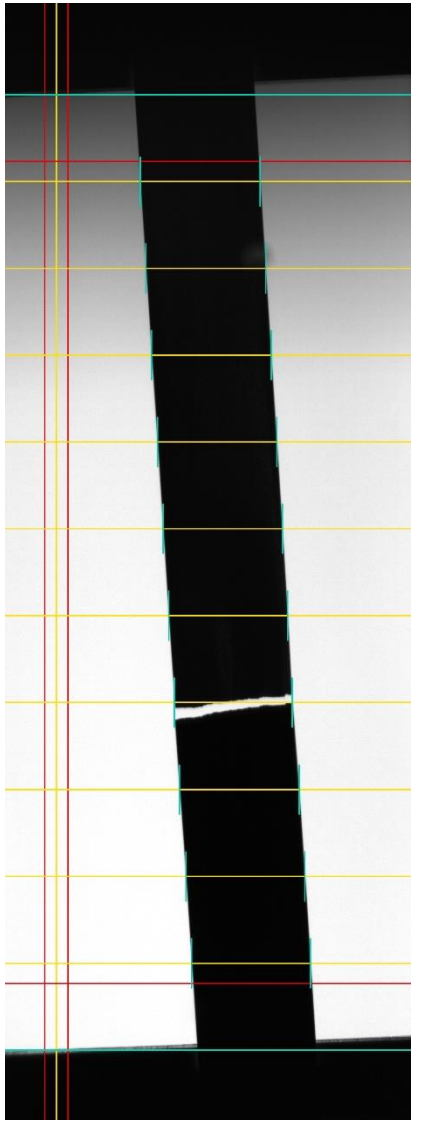
1 Grip
3 Block
4 Elastomer (e. g. Vulkollan)
5 Elastic compliance of elastomer

Shear deformation of elastomers on the gripping jaws leads to higher elastic strains and to lower slope of the elastic line m_E

Validity of the test

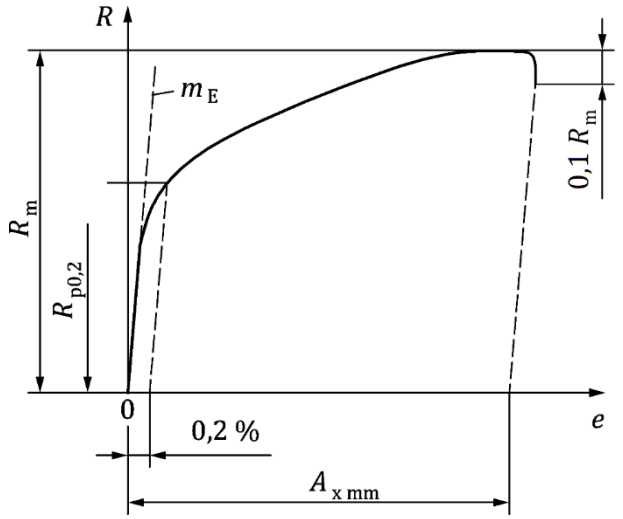
- Slipping of the test piece between the gripping jaws is not allowed.

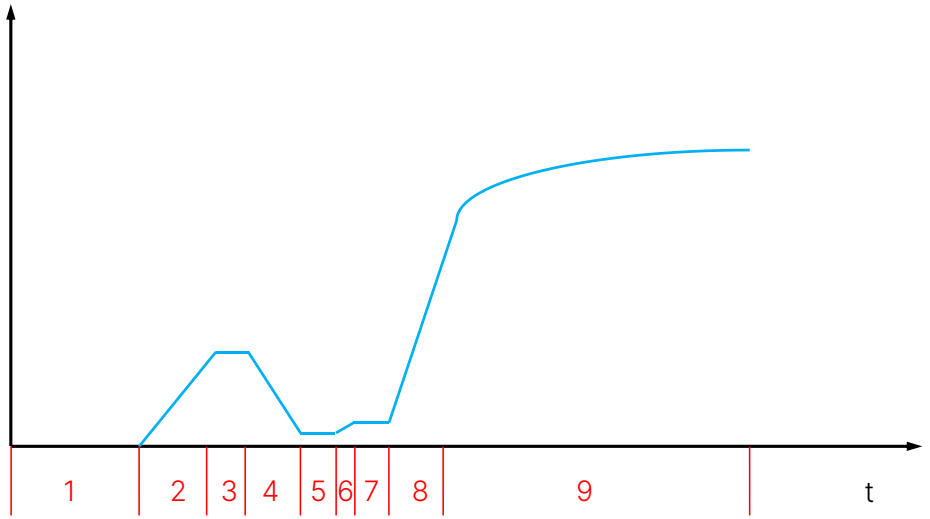
- The shortest distance of the position of the fracture must be more than 5 mm from a gripping jaw
  - Optical extensometer systems can give information about the position of fracture and the validity of the test.
  - Especially, if robotic testing systems are used, such an automatic fracture position determination is mandatory.

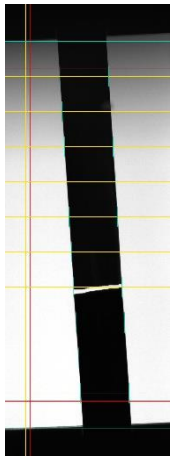


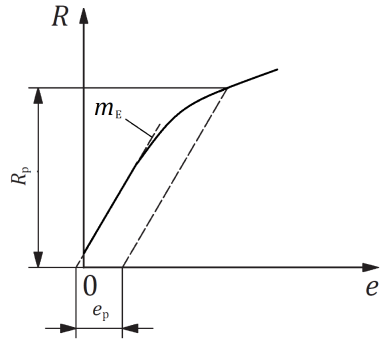
Use of computer controlled testing machines

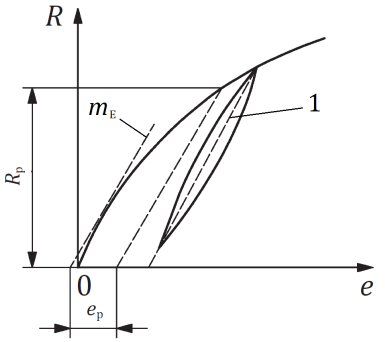
- Computer controlled testing machines are normative in ISO/NP 6892-6
  - Compliance of testing parameters
  - Evaluation of the test











New standardisation project: ISO/NP 6892-6

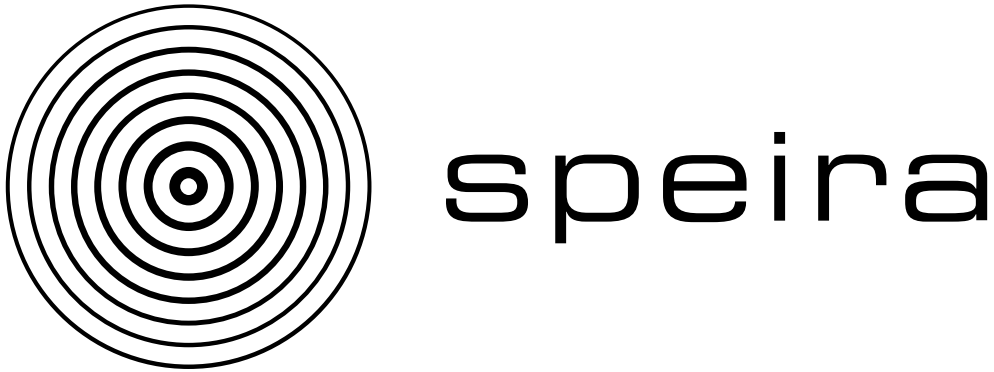
- Title:
  Metallic materials — Tensile testing —
  Tensile test on foils and strips of metals with a nominal thickness less than 0,200 mm by using computer controlled testing machines

- Project is registered in the work programme of ISO/TC 164/SC 1 (responsible committee)

- Concerns were expressed by the US side (Duplication of ASTM E 345)

  → Revision of ASTM E 345 and adoption of relevant issues of the registered ISO/NP 6892-6

  → Publication of the revised standard as ISO/ASTM standard (double Logo)


speira