



Linear Abrasion Testing

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The purpose of this test method is to determine the wear resistance by linear abrasion testing. For this, the surface of the specimen is submitted to a controlled scraping effect with friction media to be defined.

1.2 Applicability. Materials and parts with surfaces subjected to wear.

1.3 Remarks. A specified number of cycles with a specified friction media are applied to the specimen at a specified pressure force. Then the specimen is evaluated visually.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

DIN 61200	ISO 815	ISO 1518	ISO 13715
ISO 37	ISO 868	ISO 7619-1	

2.2 GM Standards/Specifications.

GMW3221	GMW14130	GMW15058	GMW15651
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2.3 Additional References.

- Article Number NW841023, Rüger Industriebedarf, Stahlstr. 26-28, 65428 Rüsselsheim, Germany, www.rueger-industriebedarf.com (Brush example)
- Carborundum-Dilumit Schleiftechnik GmbH, Düsseldorf, Germany, www.carborundum-dilumit.de (Sandpaper provider)
- EMPA Testmaterialien AG, Moevenstrasse 12, CH-9015 St.Gallen, Switzerland (Rubber membrane provider)
- Lanxess Company, Cologne, North Rhine-Westphalia, www.lanxess.com (Antiozonant (Cyclic Acetal) Vulkazon AFS provider)
- Prüf- und Forschungsinstitut Pirmasens e.V., (PFI), www.pfi-germany.de (Test apparatus and brush provider)
- Taber Industries, www.taberindustries.com (Test apparatus provider)
- Testfabrics, Incorporated, www.testfabrics.com (Number 10 Oceanic Duck Cloth provider)
- Van Clewe Textilveredlung, Dingden, Germany, www.van-clewe.de (Foam provider)

3 Resources

3.1 Facilities. A standard laboratory is needed to perform this procedure.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

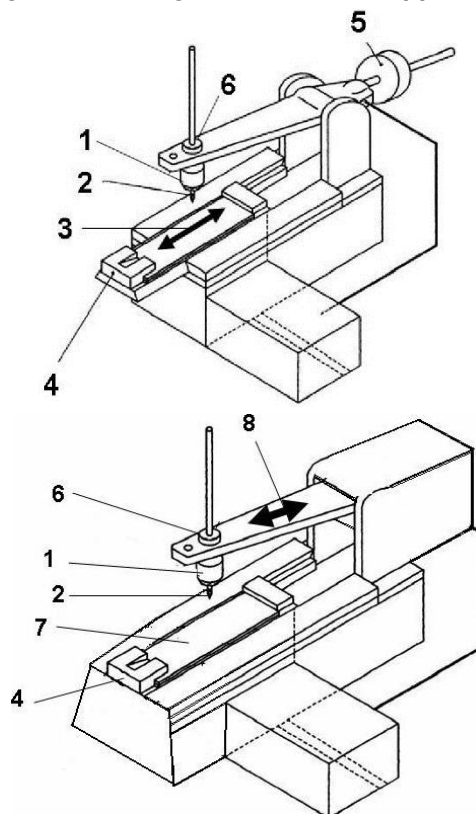
3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 The test device was designed based on the scratch test apparatus used in ISO 1518. The principle arrangements are shown in Figure 1. Both principles, a movement of the specimen or a movement of the test media may be used. Essential is the specimen carriage (Item 3) or the test apparatus arm (Item 8), capable of horizontal movement and a perpendicular located test media (Item 2) in a jig (Item 1). The arm holding the test scraper shall have retainers for load weight (Item 6) and if needed, balance weight (Item 5). The speed (cycles per minute) and the stroke length (stroke arm or carriage travel) of the movement shall be adjustable.

Test apparatus found to meet these requirements include the Clemen Keyl from Prüf- und Forschungsinstitut Pirmasens e.V., (PFI), www.pfi-germany.de; General Motors Europe (GME) and the Taber Linear Abrader including the bottom attaching universal T-slot table with specimen hold down clamp and weights. Kits are available from Taber Industries, at www.taberindustries.com.

Figure 1: Arrangements of Test Apparatus



- Note:**
- 1 = Jig for test media
 - 2 = Test media
 - 3 = Moving specimen carriage
 - 4 = Specimen clamps
 - 5 = Balance weights
 - 6 = Load weights
 - 7 = Fixed specimen
 - 8 = Moving apparatus arm with test media

3.2.2 Test Media (Friction Media). The test media is a replaceable device to be installed in the jig (Figure 1, Item 1). At the end of the test media turned towards the specimen, a friction media (e.g., scraper, brush, sandpaper) is installed. A more detailed description of relevant test media is given in the Appendices (see Appendix A, Table A1 for more detail).

3.3 Test Vehicle/Test Piece.

3.3.1 Specimens shall be cut from finished components. Shape and size shall be such that an even contact between the specimen and its carrier is obtained, and the required stroke length in one (1) direction is possible on the test surface. The specimens shall have a uniform thickness.

3.3.2 For initial sample approval and arbitration purposes at least three (3) specimens shall be tested; for routine quality control purpose at least one (1) specimen shall be tested. If test is required to be executed in more than one (1) direction, for each direction the minimum number of specimens applies.

3.4 Test Time.

Calendar time: < 1 day
Test time: 3 hours maximum
Coordination time: 4 hours maximum

3.5 Test Required Information.

- Friction media (test media)
- Stroke length
- Number of cycles
- Speed (cycles/minute)
- Pressure force

This data shall be specified on engineering drawing, in the material specification, etc., and shall be indicated in all test certificates, reports, etc. See appropriate Appendix for coding of this data (see Appendix A, Table A1 for more detail).

3.6 Personnel/Skills. Personnel trained in accordance with laboratory accreditation requirements.

4 Procedure

4.1 Preparation.

4.1.1 Textiles (Including Leather and Plastic Roll Goods (PRG)). From available material, specimens shall be taken in warp and filling, wale and course or longitudinal and transverse direction (longitudinal direction equals machine direction). If the machine direction cannot be determined, specimens shall be taken from the material in two (2) directions perpendicular to one another. For initial sample approval and arbitration purposes, test at least three (3) specimens taken from each direction and for routine quality control at least one (1) specimen shall be tested in each direction. The tests shall be performed after conditioning for a minimum of 24 h to GMW3221, Code A.

4.1.2 Elastomers. The curing time between vulcanization (application of coating) and testing the elastomer shall be 72 h minimum. The specimens shall remain at a temperature of $+23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for at least 8 h before testing, and shall be free from stain during this period.

4.1.3 For all others materials see relevant material specification or drawing for conditioning requirements.

4.1.4 Immersion in Test Liquid. This immersion is only applicable if specified in the respective material specification or engineering drawing. Specimens shall be dipped into the specified test liquid for a period of $10\text{ s} \pm 1\text{ s}$, at a temperature of $+23^{\circ}\text{C} \pm 5^{\circ}\text{C}$, and allowed to dry in air for a period of $1\text{ h} \pm 5\text{ minutes}$ at a temperature of $+23^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The test liquids shall be clearly defined, either by chemical composition or by reference to the respective material specification. The appropriate liquid shall be called up on the respective engineering drawing or material specification.

4.2 Conditions.

4.2.1 Environmental Conditions. Standard laboratory conditions, temperature of $+23^{\circ}\text{C} \pm 5^{\circ}\text{C}$, humidity not controlled.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.

4.3.1 The specimen shall be placed upon the carrier so as to be fully supported over the test area, clamped into position, such that the test may be performed centrally on the specimen.

4.3.2 The test media shall be installed at the arm of the test apparatus.

4.3.2.1 Test apparatus with a balance weight.

4.3.2.1.1 The arm having the specific media attached, shall be in full contact with the test surface (Figure 1, Item 5).

4.3.2.1.2 The arm with the test medium shall be loaded with the required pressure force by means of a suitable weight (Figure 1, Item 6).

4.3.2.2 Test apparatus without balancing equipment.

4.3.2.2.1 Determine the weight of the arm with test media and load additional suitable weights until the required pressure force can be applied (Figure 1, Item 6).

4.3.3 The specimen shall be exposed for the defined stroke length and cycles at the specified speed. One (1) cycle is defined as double stroke (1 cycle = 2x stroke length).

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. The abrasion of specimen is evaluated visually. The evaluation and rating depends on the selected friction media and tested material, see appropriate Appendix for details (see Appendix A, Table A1).

5.3 Test Documentation. The resistance to linear abrasion shall be indicated with reference to this test method according to the engineering drawings or material specifications.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary.

Cycle: One (1) back and forth movement (equals two (2) strokes).

Speed: Number of cycles completed in a given time (cycles/minute).

Stroke: One (1) back or forth movement.

7.2 Acronyms, Abbreviations, and Symbols.

CBS	Cyclohexyl Benzothiazole Sulphenamide
GME	General Motors Europe
GSSLT	Global Subsystem Leadership Team
IP	Instrument Panel
NOK	Not OK
NR	Natural Rubber
PFI	Prüf- und Forschungsinstitut Pirmasens e.V.
PHR	Parts per Hundred Rubber
PRG	Plastic Roll Goods
RC	Rockwell C Scale

TiO ₂	Titanium Dioxide
TMTD	Tetramethyl Thiuram Monosulphide
ZnO	Zinc Oxide

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Test to GMW14125

Example:

Linear Abrasion to

GMW14125-A1X2-Rating 6 minimum

Where:

Linear Abrasion = Designation

GMW14125 = Test Method

A1 = Test media, stroke length, number of cycles, speed (Appendix A for coding explanation)

X2 = Pressure force (Appendix A for coding explanation)

Rating 6 minimum = Minimum value required (see relevant Appendix for evaluation and rating explanation).

Note: Other minimum values may be specified in the engineering drawing or material specification if required.

9 Release and Revisions

This standard was originated in May 2005. It was first approved by the Textile Global Subsystem Leadership Team (GSSLT) in January 2009. It was first published in February 2009.

Issue	Publication Date	Description (Organization)
1	FEB 2009	Initial publication.
2	SEP 2014	Revised to current template. (Materials – Textiles GSSLT)
3	APR 2016	Addition of Appendix K, adding new details for a unique application of the basic test methodology. (Materials – Textiles GSSLT)

Appendix A: Coding

A1 Test Media, Stroke Length, Number of Cycles, Speed

See Table A1. If no identification is given, apply Coding A1.

A2 Pressure Force

See Table A2. If no identification of the pressure force is given, a pressure force of 5 N (Coding X1) shall be applied.

Table A1: Coding of Test Media, Stroke Length, Number of Strokes, Stroke Speed

Coding	Test Media	Additional Information	Stroke Length (mm)	Number of Cycles	Speed ^{Note 1,2} (cycles/minute)
A1	Test Scraper with width, X = 5 mm	See Appendix B	50 ± 1	10	6
A2	Test Scraper with width, X = 10 mm		50 ± 1	10	30
A3	Test Scraper with width, X = according to special data		50 ± 1	10	30
B	Test Brush, length installed longitudinal to specimen	See Appendix C	100 ± 2	20	15
C	Test Ball	See Appendix D	25 ± 1	10	60
D	Test Wedge with Sandpaper (short stroke length)	See Appendix E	13 ± 0.5	As many needed until holes appear in specimen	51
E	Test Wedge with Sandpaper (long stroke length)	See Appendix F	60 ± 1	Per material specification	48
F	Test Wedge with Hook and Loop Fastener	Code F is replaced by GMW15651. If this code is specified, use GMW15651 as procedure. Contact responsible GM Engineering for GMW15651 parameters.			
G	Test Wedge with Artificial Buttock Cover	See Appendix G	60 ± 1	2000	30
H	Test Wedge with Paper Clip (marring with linear abrasion tester)	See Appendix H	100 ± 2	0.5	15
I	Wool Test Felt	See Appendix J	10 ± 1	10 000	60
K	Universal Adapter with CS10 Weardisc	See Appendix K	75 ± 5	10	25
Z	According to special data				

Note 1: A cycle is defined as one (1) back and forth movement (equals two (2) strokes). Speed of 30 cycles/minute identifies, therefore, a speed where the 30 forward movements and 30 backward movements (in total 60 strokes) appear within 1 minute.

Note 2: Tolerance of test speed ± 5%. For test apparatus without digital preselection of test speed, the velocity is to be checked before the start of the test.

Table A2: Coding of Pressure Force

Coding	Pressure Force in Newtons (N)
X0	2 ± 0.05
X1	5 ± 0.1
X2	10 ± 0.2
X3	1 ± 0.01
X4	2.5 ± 0.05
X5	24 ± 0.5
X6	8 ± 0.5
X7	3.2 ± 0.05
X9	According to special data

Appendix B: Coding – A1, A2 and A3, Test Scraper

B1 Typical Application

Flocked Elastomer, Pile Carpets (e.g., Velour Carpet).

B2 Test Scraper Design

Test scraper material shall be made from tool steel (e.g., Material Number 1.2823). See Figure B1 for all test scrapers dimensions. The test cutting edge (Figure B1, Item 1) shall be hardened to Rockwell C Scale (RC) 60 RC to 62 RC and designed according to ISO 13715. For the **width X** see Table A1. In the area of the test cutting edge, the test scrapers are shaped circularly as seen from the sharp side (Figure B1). The radius of the test cutting edges are in each case X/2 (half of the width). Shapes and dimensions of the test scrapers shall be kept exactly within the area of the test cutting edges, according to ISO 13715. All other dimensions may be selected as required. The test cutting edges shall be controlled at least once per year, depending on frequency of usage and base material to be tested.

B3 Test Procedure Addition

The initial stroke of the specimen in relation to the test medium shall always be directed toward the blunt face of the scraper.

B4 Rating and Evaluation

B4.1 Textiles. The evaluation shall be performed visually using the ratings in Table B1 as well as the photo standard for Velour Carpet in Figure B2.

B4.2 Elastomers and Plastics. The evaluation shall be performed visually. The areas adjacent to the points where the strokes are reversed (approximately 5 mm before the end of each stroke) shall be ignored. After completion of the test, the coating shall have full coverage over the substrate.

Table B1: Rating – Coding A

Rating	Definition
10	No change
9	-
8	Light scratch marks visible, some marring allowed but no scuffing, no accumulation of fiber at the points of reversal
7	-
6	Scratch marks visible, slight scuffing, no accumulation of fiber at the points of reversal
5	Scratch marks visible, moderate scuffing, light accumulation of fiber at the points of reversal
4	Scratch marks visible, severe scuffing, clear accumulation of fiber at the points of reversal
3	-
2	Fibers abraded, clear accumulation of fiber at the points of reversal
1	-