

Plastics — Compression-moulded sheets of polyethylene (PE-UHMW, PE-HD) — Requirements and test methods

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National foreword

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**Plastics — Compression-moulded sheets
of polyethylene (PE-UHMW, PE-HD) —
Requirements and test methods**

*Plastiques — Plaques moulées par compression en polyéthylène
(PE-UHMW, PE-HD) — Exigences et méthodes d'essai*



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Contents

Page

Foreword.....	iv
1 Scope	1
2 Normative references	1
3 Material	1
4 Requirements	2
4.1 Appearance	2
4.2 Dimensional tolerances	2
4.3 Properties	3
5 Test methods.....	4
5.1 Test specimens	4
5.2 Delivery condition.....	5
5.3 Appearance	5
5.4 Dimensions.....	5
5.5 Density	5
5.6 Determination of abrasion properties	5
5.7 Tensile stress at yield, σ_y , and tensile strain at yield, ε_y	6
5.8 Modulus of elasticity in tension, E_t	6
5.9 Impact strength of notched specimens.....	6
5.10 Melt mass-flow rate (MFR)	6
6 Designation	6
7 Marking	7
Annex A (normative) Requirements for rectangularity	8
Annex B (normative) Determination of abrasion properties.....	9
Annex C (informative) Example of apparatus for the determination of abrasion properties	11

Foreword

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Plastics — Compression-moulded sheets of polyethylene (PE-UHMW, PE-HD) — Requirements and test methods

1 Scope

This International Standard specifies the requirements and test methods for solid flat compression-moulded sheets of polyethylene (PE-UHMW and PE-HD, see ISO 1043-1) without fillers or reinforcing materials. It applies only to thicknesses from 10 mm to 200 mm.

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 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion materials*

ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

ISO 1183 (all parts), *Plastics — Methods for determining the density of non-cellular plastics*

ISO 1872-1, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

ISO 11542-1, *Plastics — Ultra-high-molecular-weight polyethylene (PE-UHMW) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

ISO 11542-2, *Plastics — Ultra-high-molecular-weight polyethylene (PE-UHMW) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*

3 Material

Sheets shall consist of PE-UHMW moulding materials as defined in ISO 11542-1 or PE-HD selected from polyethylene (PE) moulding materials as defined in ISO 1872-1, without fillers or reinforcing materials. Materials and additives of unknown identity shall not be used.

NOTE Legal conditions may necessitate a specific choice of moulding material (see 4.3.2).

4 Requirements

4.1 Appearance

Sheets shall have smooth surfaces. Small grooves and any resultant irregularities in the thicknesses of sheets are acceptable as long as the requirements specified in 4.2.1 are fulfilled. Sheets shall be examined in accordance with 5.3.

Where agreed between interested parties, sheets with a smooth machined surface may be supplied.

Sheets shall be substantially free from bubbles, voids, cracks and other inhomogeneities which would make them unfit for the intended use. Specific requirements with respect to this internal integrity shall be agreed upon between the interested parties. Sheets shall be examined in accordance with 5.2.

4.2 Dimensional tolerances

4.2.1 Thickness

For any individual sheet, the thickness tolerance with reference to the nominal thickness shall be as specified in Table 1. Testing shall be in accordance with 5.4.1.

Table 1 —Tolerances on thickness of sheet

Values in millimetres

Nominal thickness h_n	Tolerances			
	PE-UHMW		PE-HD	
	Group 1.1	Group 1.2	High MW Group 2.1	Low MW Group 3.1
$10 \leq h_n \leq 20$	$\begin{matrix} +3 \\ 0 \end{matrix}$	$\begin{matrix} +3 \\ 0 \end{matrix}$	$\begin{matrix} +3 \\ 0 \end{matrix}$	$\begin{matrix} +3 \\ 0 \end{matrix}$
$20 < h_n \leq 40$	$\begin{matrix} +5 \\ 0 \end{matrix}$	$\begin{matrix} +5 \\ 0 \end{matrix}$	$\begin{matrix} +5 \\ 0 \end{matrix}$	$\begin{matrix} +5 \\ 0 \end{matrix}$
$40 < h_n \leq 60$	$\begin{matrix} +6 \\ 0 \end{matrix}$	$\begin{matrix} +6 \\ 0 \end{matrix}$	$\begin{matrix} +6 \\ 0 \end{matrix}$	$\begin{matrix} +6 \\ 0 \end{matrix}$
$60 < h_n \leq 80$	$\begin{matrix} +8 \\ 0 \end{matrix}$	$\begin{matrix} +8 \\ 0 \end{matrix}$	$\begin{matrix} +8 \\ 0 \end{matrix}$	$\begin{matrix} +8 \\ 0 \end{matrix}$
$80 < h_n \leq 100$	$\begin{matrix} +10 \\ 0 \end{matrix}$	$\begin{matrix} +10 \\ 0 \end{matrix}$	$\begin{matrix} +10 \\ 0 \end{matrix}$	$\begin{matrix} +10 \\ 0 \end{matrix}$
$100 < h_n \leq 120$	$\begin{matrix} +12 \\ 0 \end{matrix}$	$\begin{matrix} +12 \\ 0 \end{matrix}$	$\begin{matrix} +12 \\ 0 \end{matrix}$	$\begin{matrix} +12 \\ 0 \end{matrix}$
$120 < h_n \leq 150$	$\begin{matrix} +14 \\ 0 \end{matrix}$	$\begin{matrix} +14 \\ 0 \end{matrix}$	$\begin{matrix} +14 \\ 0 \end{matrix}$	$\begin{matrix} +14 \\ 0 \end{matrix}$
$150 < h_n \leq 200$	$\begin{matrix} +16 \\ 0 \end{matrix}$	$\begin{matrix} +16 \\ 0 \end{matrix}$	$\begin{matrix} +16 \\ 0 \end{matrix}$	$\begin{matrix} +16 \\ 0 \end{matrix}$

4.2.2 Length and width

The nominal length, l_n , and nominal width, b_n , of sheets shall be as agreed between the interested parties.

4.2.3 Rectangularity

For any individual sheet selected at random from any delivery, the rectangularity tolerance, expressed as the difference in length of the diagonals, $|d_1 - d_2|$ (see Figure 1), shall be in accordance with Table A.1.

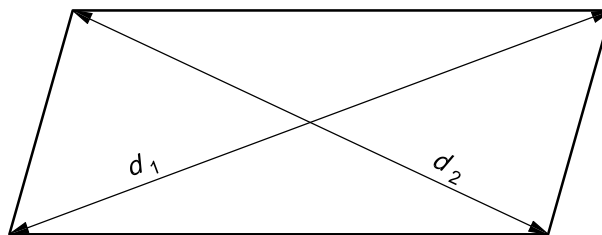


Figure 1 — Difference between lengths of diagonals, $|d_1 - d_2|$

Testing shall be in accordance with 5.4.3.

4.3 Properties

4.3.1 Physical properties

Requirements for physical properties are given in Table 2.

Table 2 — Physical properties

Properties	Unit	Requirements (average values)				Test method subclause
		PE-UHMW		PE-HD		
		Group 1.1	Group 1.2	Group 2.1	Group 3.1	
Density	g/cm ³	0,920 to 0,945	0,920 to 0,945	0,945 to 0,960	0,940 to 0,965	5.5
Abrasion	—	70 to < 90	90 to 110	360 to 440	900 to 1 000	5.6
Tensile stress at yield	MPa	≥ 17	≥ 17	≥ 19	≥ 19	5.7
Tensile strain at yield	%	≥ 8	≥ 8	≥ 8	≥ 8	5.7
Modulus of elasticity in tension	MPa	≥ 500	≥ 600	≥ 800	≥ 700	5.8
Impact strength of double-notched specimens	kJ/m ²	≥ 40	≥ 170	≥ 15	≥ 5	5.9.1
Charpy impact strength of notched specimens	kJ/m ²	no breaks	no breaks	no breaks	≥ 9	5.9.2
MFR: 190 °C/5 kg	g/10 min	not measurable	not measurable	≤ 0,1	0,3 to 0,7	5.10
MFR: 190 °C/21,6 kg	g/10 min	not measurable	not measurable	≤ 3	7 to 20	5.10

4.3.2 Physiological behaviour

Any relevant legislation for physiological behaviour shall be taken into consideration.

5 Test methods

5.1 Test specimens

5.1.1 Preparation of test specimens

Test specimens shall be obtained by machining them from the sheet.

For sheets of thickness ≥ 10 mm but ≤ 20 mm, the test specimens shall be taken as shown in Figure 2, and for sheets of thickness > 20 mm but ≤ 200 mm they shall be taken as shown in Figure 3.

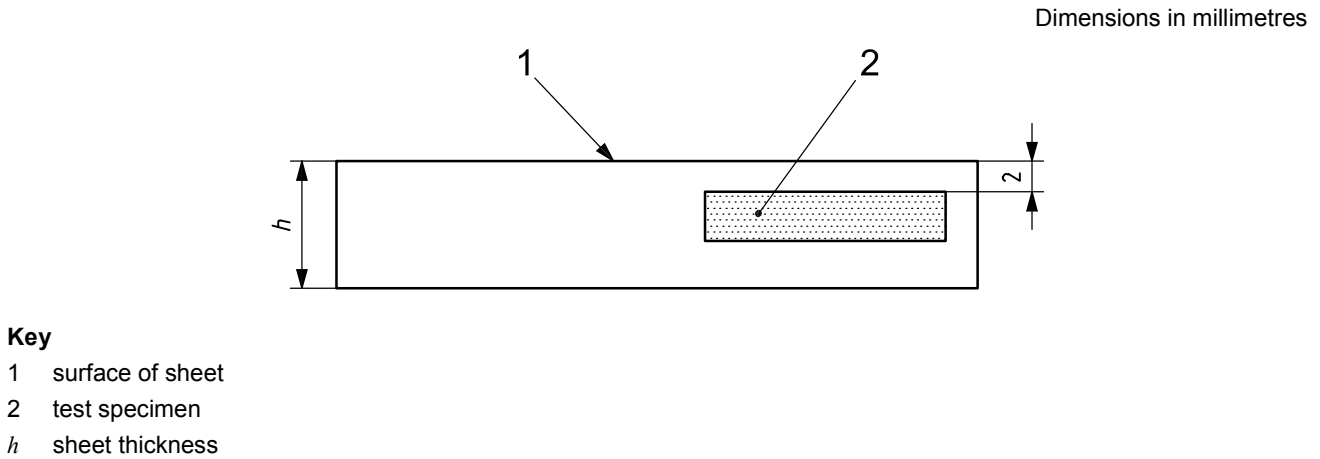


Figure 2 — Taking test specimens from sheets of thickness ≥ 10 mm but ≤ 20 mm

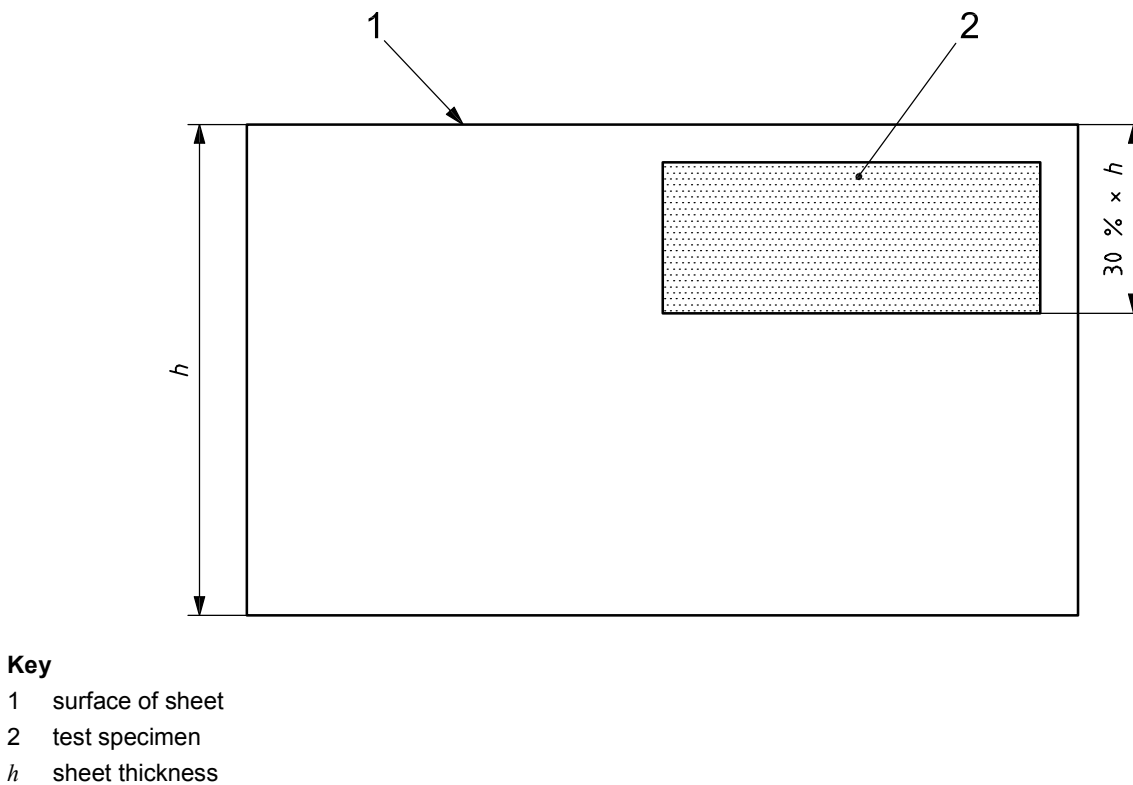


Figure 3 — Taking test specimens from sheets of thickness > 20 mm but ≤ 200 mm

The surfaces of the test specimens shall be free from damage and faults in order to avoid notch effects. Should any burrs occur on the test specimens during machining, these shall be eliminated without damaging the surfaces of the specimens. If required, the cut edges shall be finished with abrasive paper (grain size 220 or finer), the direction of abrasion being along the length of the test specimens.

5.1.2 Conditioning

All test specimens shall be conditioned for at least 16 h at $23\text{ °C} \pm 2\text{ °C}$ in accordance with ISO 291 or as specified in the appropriate material standard. Shorter conditioning times may be used by agreement between the interested parties when it can be shown that there is no significant difference in the results obtained.

5.1.3 Testing

Testing shall be carried out in standard atmosphere 23/50 as specified in ISO 291 or as specified in the appropriate material standard unless otherwise agreed between the interested parties or specified in the individual test standards.

5.2 Delivery condition

Sheets shall be visually examined when delivered to ensure freedom from mechanical damage or other obvious defects. Sheets can be inspected by ultrasonic or X-ray methods where required.

5.3 Appearance

Where possible, sheets shall be examined for visual defects by transmitted light using a suitable light source. Otherwise, sufficiently bright reflected light shall be used. Any defects thus identified shall be compared with the agreed specification (which may be either a written specification or in the form of reference samples) and classified accordingly.

5.4 Dimensions

5.4.1 Thickness, h

The thickness, h , shall be measured using suitable calibrated equipment accurate to $\leq 0,10$ mm.

5.4.2 Length, l , and width, b

The length, l , and width, b , shall be measured to the nearest 1 mm using suitable equipment. Measurements shall be made directly across the surface of the sheet and along the cut edge.

5.4.3 Rectangularity

The rectangularity, expressed as the difference between the lengths of the diagonals, $|d_1 - d_2|$, as shown in Figure 1, shall be measured to the nearest 1 mm using a graduated ruler or tape measure.

5.5 Density

The density shall be determined in accordance with the appropriate part of ISO 1183.

5.6 Determination of abrasion properties

Preparation of test specimens and abrasion testing shall be carried out in accordance with Annex B.

5.7 Tensile stress at yield, σ_y , and tensile strain at yield, ϵ_y

The tensile stress at yield, σ_y , and tensile strain at yield, ϵ_y , shall be determined using at least five type 1B test specimens in each direction in accordance with ISO 527-2, using a test speed of 50 mm/min \pm 5 mm/min.

5.8 Modulus of elasticity in tension, E_t

The modulus of elasticity in tension, E_t , shall be determined using at least five type 1B test specimens in each direction in accordance with ISO 527-2, using a test speed of 1 mm/min \pm 0,2 mm/min.

5.9 Impact strength of notched specimens

5.9.1 Impact strength of double-notched specimens

The impact strength of double-notched specimens shall be determined in accordance with ISO 11542-2.

5.9.2 Charpy impact strength of notched specimens, a_{CN}

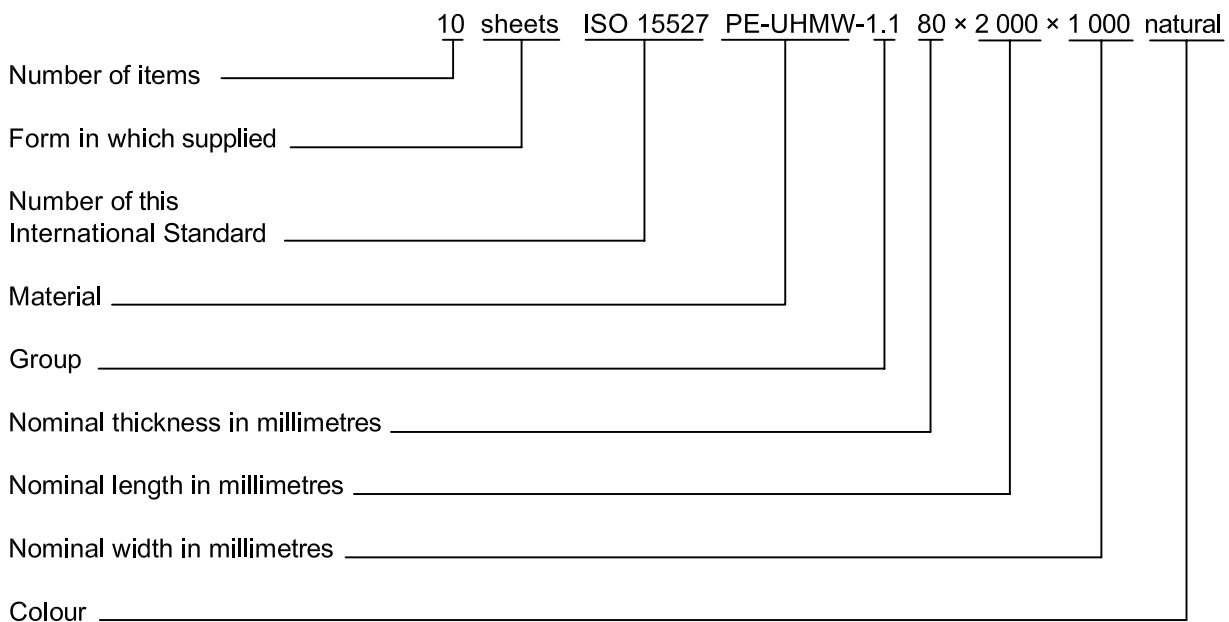
The Charpy impact strength of notched specimens, a_{CN} , shall be determined in accordance with ISO 11542-2, using at least 10 test specimens at 23 °C \pm 2 °C.

5.10 Melt mass-flow rate (MFR)

If appropriate for the material being evaluated, the melt mass-flow rate shall be determined in accordance with ISO 1133 using a temperature of 190 °C and load of 5 kg and using a temperature of 190 °C and load of 21,6 kg.

6 Designation

Example for PE-UHMW sheets:



Designation: 10/sheets/ISO 15527/PE-UHMW-1.1/80 x 2 000 x 1 000/natural

7 Marking

Sheets that conform to this International Standard may be marked with the following information:

- a) the manufacturer's name, trade mark or identification mark;
- b) the number of this International Standard, ISO 15527;
- c) the date of manufacture/batch number.

Annex A
(normative)

Requirements for rectangularity

Table A.1 — Maximum limits of deviation from rectangularity (see 4.2.3)

Values in millimetres

Nominal sheet dimensions (length × width)	Maximum limit of deviation from rectangularity $ d_1 - d_2 $
2 000 × 1 000	7
2 000 × 1 500	9
2 000 × 2 000	11
3 000 × 1 000	7
3 000 × 1 500	11
3 000 × 2 000	13
4 000 × 2 000	14
6 000 × 1 000	8
6 000 × 1 500	11

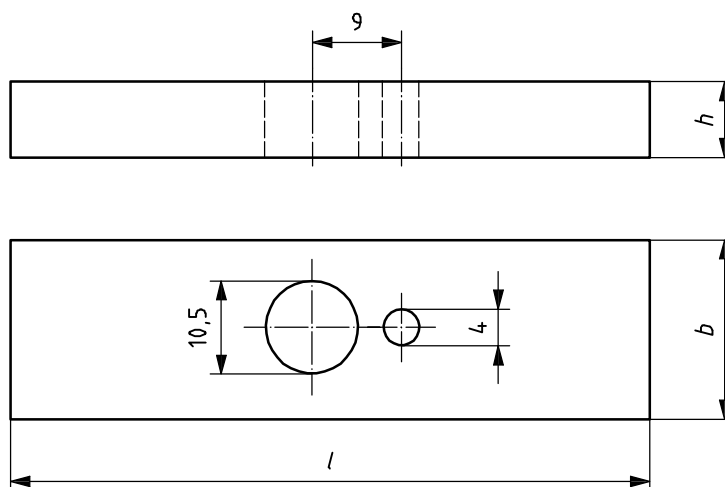
Annex B (normative)

Determination of abrasion properties

B.1 Sampling

Test specimens as shown in Figure B.1 shall be prepared by machining them from the sheet.

Dimensions in millimetres



Thickness, h	6,35 mm \pm 0,10 mm
Width, b	25,40 mm \pm 0,20 mm
Length, l	76,20 mm \pm 0,20 mm

Figure B.1 — Machined test specimen

B.2 Testing

Carry out abrasion testing on at least two test specimens. Weigh the specimens before testing. Then rotate the specimens for at least 3 h in a slurry of abrasive material in water, using an apparatus similar to that shown in Annex C. The rate of rotation shall be $1\,200\text{ min}^{-1} \pm 200\text{ min}^{-1}$ and the temperature of the slurry shall not exceed 23 °C.

Use silica sand (grain size 0,2 mm to 1,0 mm) or aluminium oxide (grain size 0,2 mm to 1,0 mm) as the abrasive material. It is recommended that an abrasive/water slurry with a mass ratio of 3:2 be used.

After testing, weigh the test specimens again. The loss in mass of the test specimens shall be at least 50 mg.

For comparable test results, it is necessary to measure a reference specimen during each test. For the abrasion testing of PE-UHMW, a reference specimen made from material with an elongational stress of $0,24\text{ MPa} \pm 0,01\text{ MPa}$ and/or a viscosity number of $2\,300\text{ ml/g} \pm 100\text{ ml/g}$ (see ISO 11542-1) shall be used.

B.3 Calculation

$$\text{Degree of abrasion} = \frac{\Delta m_s}{\Delta m_r} \times 100$$

where

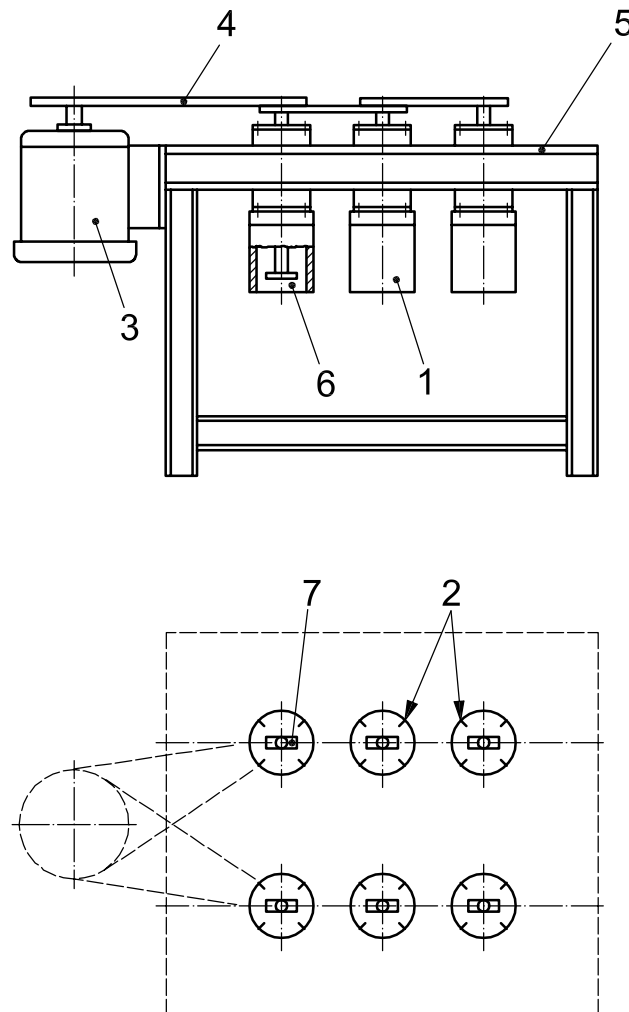
Δm_s is the change in mass of the test specimen;

Δm_r is the change in mass of the reference specimen.

Annex C (informative)

Example of apparatus for the determination of abrasion properties

The method used for the determination of the abrasion properties is given in Annex B.



Key

- 1 abrasion test cup (diameter 120 mm, rust-proof steel, with cooling jacket)
- 2 baffles
- 3 drive motor
- 4 belt drive
- 5 supporting structure
- 6 slurry of abrasive in water
- 7 specimen

Figure C.1 — Example of test apparatus

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