INTERNATIONAL STANDARD

ISO 19721

First edition
2022-11

Plastics — Abrasion test method for artificial turfs using combined UV exposure and mechanical wear

Plastiques — Méthode d'essai d'abrasion pour gazons artificiels combinant exposition UV et usure mécanique

Reference number
ISO 19721:2022(E)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 6, *Ageing, chemical and environmental resistance*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The radiant exposure, combined with simultaneous or sequential mechanical stud wear test, can assess the abrasion resistance of artificial turf used outdoors. The test method developed considers exposure that provides UV radiant exposure and stud wear. This accelerated test method is to be used as a screening or qualifying test for artificial turfs for public sports facilities. The test method may not necessarily correlate to results from exposure to actual use conditions.

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Plastics — Abrasion test method for artificial turfs using combined UV exposure and mechanical wear

1 Scope

This document specifies an abrasion test method for accelerated testing of artificial turfs for use in sports facilities.

Combined exposure to simulated solar UV radiation and mechanical wear in simultaneous or sequential modes is the method used. The details of radiation, temperature, and moisture exposure, as well as to mechanical abrasion using soccer shoe studs on rotating drum assembly, are given in this document.

NOTE It was determined that simultaneous exposure was more effective than sequential exposure.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 4892-3, *Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps*

EN 15306, *Surfaces for outdoor sports areas — Exposure of synthetic turf to simulated wear*

DIN 75220, *Ageing of automobile components in solar simulation units*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org

3.1
artificial turf
synthetic fibres made to mimic the natural grass

Note 1 to entry: It is a carpet-like mat consisting of *piles* (3.2), backing sheet, silica sand, rubber chips and shock absorption pad.

Note 2 to entry: See Annex A for the details on the construction of artificial turf.

3.2
pile
directional treads or fibres affixed to the backing layer sheet

3.3
abrasion
process of rubbing away *pile* (3.2) material under contact with stud under load

3.4
simultaneous exposure
exposure to UV radiation and *abrasion* (3.3) occurring at the same time

3.5
sequential exposure
exposure to UV radiation and *abrasion* (3.3) occurring one after the other

4 Principle

The specimen is exposed to both UV radiation and mechanical wear, either simultaneous or sequential. To create such a test, an apparatus consisting of an abrasion device, test specimen support and an artificial radiation source is used. The artificial turf specimen is placed on the specimen support and is made to come in contact with an abrasion device for cyclic frictional force application at the same time or in sequence with being subjected to predetermined exposure to radiation, heat and humidity conditions.

5 Apparatus

For the simultaneous exposure, the test device shall include a stud-cylinder abrasion device, test specimen support and radiation source; all assembled in an environmental test chamber or room with temperature and humidity control. A water spray nozzle can also be added.

For sequential exposure, a stud-cylinder abrasion device, and a test chamber meeting the irradiance, temperature, humidity and wetting, and other requirements for exposure devices in ISO 4892-1 are required.

A typical test apparatus is given in Annex C.

5.1 Laboratory radiation source, an UVA-340 fluorescent lamp, Xenon arc lamp or metal halide lamp shall be used. If other radiation source is used, the radiation source shall be reported.

5.1.1 Fluorescent UVA-340 lamp, in accordance with ISO 4892-3, type 1A(UVA-340).

5.1.2 Metal halide lamp in accordance with DIN 75220.

5.1.3 Xenon arc lamp, in accordance with ISO 4892-2, method A (Xenon arc with simulated direct solar radiation filters).

5.2 Abrasion device, in accordance with EN 15306.

5.3 Spraying system, in accordance with ISO 4892-1.

6 Test specimens

The test specimen shall be at least 800 mm × 400 mm. The uniform abraded surface shall be at least 500 mm × 300 mm. Other sizes may be used upon agreement between the parties involved.

The dimension is changeable only if the irradiance uniformity is satisfied. Different specimen dimensions may be used provided that the irradiance uniformity on the specimen is assured.

7 Test conditions

7.1 Radiation

Unless otherwise specified, the irradiance shall be controlled at the levels specified in Tables 1, 2 and 3. Other exposure levels may be used if agreed between the parties involved.

7.2 Relative humidity

Unless otherwise specified, the relative humidity or condensation cycle shall be controlled at the levels specified in Tables 1, 2 and 3. Other exposure levels may be used if agreed between the parties involved.

7.3 Spray cycle

The spray cycles given in Table 3 shall be used.

NOTE Spray cycle can be added to conditions given in Table 1 and Table 2, upon agreement by the parties involved.

7.4 Exposure conditions

The exposure conditions specified in Tables 1, 2 and 3, providing various exposure conditions and cycle conditions for UVA-340, metal halide and Xenon devices, respectively, shall be followed.

Examples of test results using the conditions given in Table 2 are shown in Annex B.

NOTE Each type of radiation source has its own spectral irradiation distribution, and so can lead to different test results irrespective of the test materials. Therefore, the test result comparison of different test materials is effective only when obtained under the same light source, same cycles, and same test period. The light source can be selected upon agreement between the parties involved.

Table 1 — Test conditions for UVA-340 and stud wear exposure

Step	Parameter		Test condition	
UV exposure [a]	Irradiance setpoint		0,80 W/m^2·nm at 340 nm	—
	Cycle		UV exposure (240 ± 4) min	Condensation (120 ± 2) min
	BPT		(60 ± 3) °C	(45 ± 3) °C
Stud wear	Linear speed (to and from)		(0,25 ± 0,05) m/s	
	Transverse movement (20 ± 1) mm		(0,015 ± 0,005) m/s	
	Temperature and relative humidity	Simultaneous exposure	Same as those in exposure step	
		Sequential exposure	(23 ± 2) °C, (50 ± 10) % R.H.	

[a] Detailed test conditions may be redesigned upon agreement between the parties involved. If the detailed test conditions are changed, they shall be stated in the test report.

Table 2 — Test conditions for metal halide and stud wear exposure

Step	Parameter		Test condition [a]
UV exposure [b]	Irradiance setpoint [c]		(1 000 ± 100) W/m^2 at (300 to 3 000) nm
	Chamber temperature		(32 ± 3) °C
	BPT		(48 ± 3) °C
	Relative humidity		(60 ± 10) %
Stud wear	Linear speed (to and from)		(0,25 ± 0,05) m/s
	Transverse movement (20 ± 1) mm		(0,015 ± 0,005) m/s
	Temperature and relative humidity	Simultaneous exposure	Same as those in exposure step
		Sequential exposure	(23 ± 2) °C, (50 ± 10) % R.H.

[a] Either open or closed system can be used to obtain the required test conditions and shall be reported.

[b] Detailed test conditions may be redesigned upon agreement between the parties involved. If the detailed test conditions are changed, they shall be stated in the test report.

[c] The tolerance of radiation is generally used among 10 % (±100), 5 % (±50), 2 % (±20) of the required irradiance, and can be chosen upon agreement between the parties involved.

Table 3 — Test conditions for Xenon and stud wear exposure

Step	Parameter		Test condition [a]	
UV exposure [b]	Irradiance setpoint	(300 to 400) nm	(60 ± 2) W/m^2	
		340 nm	(0,51 ± 0,02) W/m^2·nm	
	Spray		(102 ± 0,5) min, No spray	(18 ± 0,5) min, Water sprayed
	Chamber temperature		(38 ± 3) °C	—
	BPT		(63 ± 3) °C	—
	Relative humidity		(50 ± 10) %	—
Stud wear	Linear speed (to and from)		(0,25 ± 0,05) m/s	
	Transverse movement (20 ± 1) mm		(0,015 ± 0,005) m/s	
	Temperature and relative humidity	Simultaneous exposure	Same as those in exposure step	
		Sequential exposure	(23 ± 2) °C, (50 ± 10) % R.H.	

[a] Either open or closed system can be used to obtain the required test conditions, and shall be reported.

[b] Detailed test conditions may be redesigned upon agreement between the parties involved. If the detailed test conditions are changed, they shall be stated in the test report.

8 Procedure

8.1 Conditioning

The test specimen shall be stored for 24 h at (23 ± 2) °C, (50 ± 10) % R.H. before conducting the test.

8.2 Mounting and handling of the test specimen

The test specimen shall be constructed in accordance with the method provided by the manufacturer. The conditioned test specimen shall be mounted on the tray and the height of the cylinder shall be adjusted until all studs make contact with the test specimen.

NOTE Some common artificial turf constructions are given in Table A.1.

8.3 Combined exposure

8.3.1 General

The test specimens are subjected to both UV exposure and stud wear mechanical exposure. Two procedures are allowed: simultaneous exposure (8.3.2) and sequential exposure (8.3.3).

UV exposure and stud wear test shall be carried out following the procedure specified in Tables 1, 2, and 3, depending on the laboratory radiation source. Any changes to the specified conditions shall be stated in the test report.

Stud wear should be performed in accordance with EN 15306.

Stud-wear cycle should always begin at the end of the dry phase in the UV exposure cycle. This condition can be achieved by drying the turf for a period of at least 1 h under UV exposure.

8.3.2 Simultaneous exposure

UV exposure and stud wear mechanical exposure shall be performed within one device, in simultaneous manner as specified in Table 4.

NOTE UV radiant exposure is limited by the ratio of the stud wear device to the specimen's surface. Stud abrasion is performed with the same climatic parameters as the UV exposure.

Table 4 — UV-Stud cycles in a simultaneous manner

Step	UV exposure	Stud wear
1	Initial UV exposure (h)	—
2	UV exposure (h)	Stud wear (cycle)
3	Final UV exposure (h)	—

8.3.3 Sequential exposure

UV exposure and stud wear mechanical exposure shall be performed in the same or a separate device, in continual alternations as specified in Table 5.

Stud wear shall be performed at (23 ± 2) °C, (50 ± 10) % R.H.

Sequential UV and stud wear test parameters (the total number of cycles and the duration of exposure/abrasion period, etc.) are to be decided upon agreement between the parties involved because of the difference in the environmental conditions of each country and the frequency of use[1],[2].

Table 5 — Sequential UV and stud wear test

Step	UV exposure	Stud wear
1	Initial UV exposure (h)	—
2	—	Stud wear (cycle)

8.4 Radiant exposure measurement

Radiation exposure measurement shall be performed in accordance with ISO 4892-1.

9 Determination of the changes

9.1 Change of appearance

Report the visual change in fibrillation, flattening, breaking of fibres, abrasion, etc., using photographs.

9.2 Test of sports functional characteristics

Measure the sports performance and material properties as specified in the relevant product specification and record any changes following exposure to combined UV and stud wear.

10 Test report

The test report shall contain at least the following information:

a) a reference to this document, i.e. ISO 19721:2022;

b) type of test;

c) description of the test equipment;

d) artificial turf material, system description and manufacturer;

e) test specimen shape, dimension, and sampling method;

f) test conditions, amount of silica sand and filler, radiant exposure and spectral irradiance, temperature and relative humidity, water spray cycle conditions, test conditions agreed between the parties involved;

g) assessment items;

h) exposure steps (test time, radiation intensity, etc.);

i) test result (change of shape, dimension, exterior appearance, material property, etc.);

j) date and time of the test;

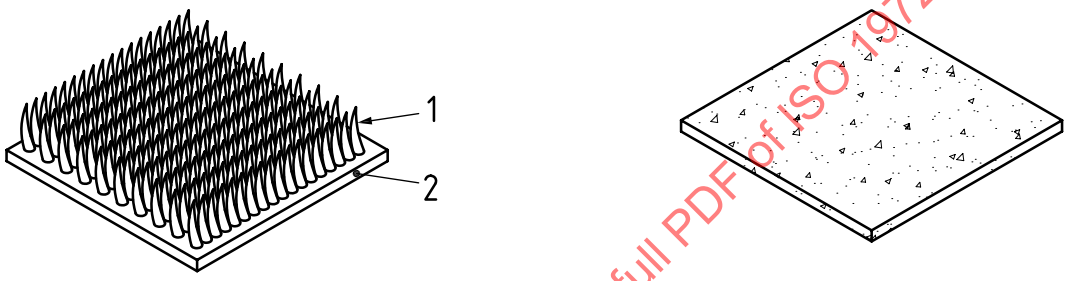
k) any other relevant information that may have an influence on the test result obtained.

Annex A
(informative)

Artificial turf

A.1 Artificial turf system

The construction of an artificial turf is illustrated in Figure A.1. A turf mat [see A.2 and Figure A.1 a)] consists of a backing layer sheet containing artificial turf piles, silica sand and rubber chips (see A.3) and with shock absorption pad [see A.4 and Figure A.1 b)] attached, the artificial turf system is complete.



a) Artificial turf mat **b) Shock absorption pad**

Key

1 turf pile

2 backing layer sheet

Figure A.1 — Schematic illustration of a typical artificial turf

A.2 Turf mat

The turf mat is made up by piles and form sheets. Various types of mats can be produced depending on pile height and whether to use infills and/or shock absorption pad.

A.3 Rubber (or elastomeric) infills

Elastomeric infills are used as filler materials between piles and there are rubber, natural material and flexible thermoplastic elastomeric types. They come in the form of crushed or granule shapes and shall not become sticky or lump together under the summer heat and shall not harden or be broken in the winter season.

A.4 Shock absorption pad

The shock absorption pad is used under the turf mat and is typically made from rubber roll sheet or rubber chip sheet or flexible form plastics. Other materials are available depending on the application. The shock absorption pad is generally used for products that do not employ rubber infills.

The artificial turf system can be formed with various compositions. Example classifications of artificial turf system are shown in Table A.1.

Table A.1 — Composition of an artificial turf system

Classification	Mat	Pad	Sand	Elastic chip [a]
Type 1	●	—	●	●
Type 2	●	●	●	—
Type 3	●	—	●	—
Type 4	●	●	—	—
Type 5	●	—	—	—

[a] Elastic chips can be made from various materials, including rubber materials.

Annex B
(informative)

Examples of test results

B.1 Specimen

The artificial turf system used for the test is illustrated in Figure A.1 a). Type 5 turf of Table A.1 was tested. The turf pile was made from polyethylene and factory specified pile height was 35 mm. Other specimen dimensions given in Clause 6 were utilized.

B.2 Simultaneous test (UV removed)

B.2.1 Test conditions

The test conditions of the simultaneous test were the following:

1) Radiation source: Metal halide (UV removed)
   - UV radiation was removed by placing a glass plate with a UV blocking film to the bottom of the metal halide light source.
2) Irradiation: Average: 732 W/m^2 (300 nm to 3 000 nm)
3) Temperature
   - Chamber Temperature: Average 31,1 °C
   - BPT: Average 46,1 °C
   - BST: Average 48,9 °C
4) Relative humidity: Average 37 % R.H.
5) Longitudinal speed of stud drum: 0,25 m/s
6) Transversal speed of stud drum: 0,015 m/s
7) Exposure cycle

The used test procedure is shown in Table B.1.

Table B.1 — Metal halide-stud cycles in a simultaneous manner

Step	UV exposure	Stud wear
1	40 h	—
2	5 h 20 min	2 000 cycle
3	4 h 40 min	—
Repeat	Twice	
Total	100 h	4 000 cycle

B.2.2 Test results

Simultaneous tests were carried out under the conditions described in B.2.1, and then the pile height, SEM of a surface were evaluated.

1) Pile height

The pile heights of five specimens, which were chosen in a random fashion, were measured after simultaneous test. Table B.2 shows the pile height before and after the test.

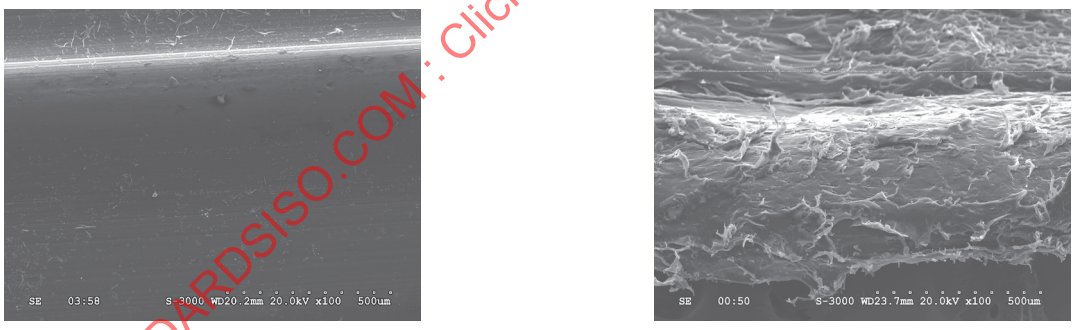
Table B.2 — Pile height before and after the test

Pile height [a] mm		
No.	**Initial**	**After test**
1	32	18
2	32	18
3	31	23
4	33	23
5	32	20
Average	32	20
Standard deviation	0,7	2,5

[a] The factory specified pile height is 35 mm.

2) SEM image of pile yarn

The surface of artificial turf pile was measured with SEM. Figure B.1 shows the image of the pile yarn before a) and after testing b).



a) Pile yarn before testing **b) Pile yarn after testing**

Figure B.1 — SEM image of the pile yarn before and after the test

B.3 Simultaneous test (with UV)

B.3.1 Test conditions

The test conditions of the simultaneous test were the following:

1) Radiation source : Metal halide (with UV) according to DIN 75220

2) Irradiation: Average 968 W/m^2 (300 nm to 3 000 nm)

3) Temperature

— Chamber Temperature: Average 32,1 °C

— BPT: Average 50,3 °C

— BST: Average 54,7 °C

4) Relative humidity: Average 33 % R.H.

5) Longitudinal speed of stud drum: 0,25 m/s

6) Transversal speed of stud drum: 0,015 m/s

7) Exposure cycle

The used test procedure is shown in Table B.3.

Table B.3 — Metal halide-stud cycles in a simultaneous manner

Step	UV exposure	Stud wear
1	40 h	—
2	5 h 20 min	2 000 cycle
3	4 h 40 min	—
Repeat	Twice	
Total	100 h	4 000 cycle

B.3.2 Test results

Simultaneous tests were carried out under the conditions described in B.3.1, and then the pile height, SEM were evaluated.

1) Pile height

The pile heights of five specimens, which were chosen in a random fashion, were measured after simultaneous test. Table B.4 shows the pile height before and after the test.

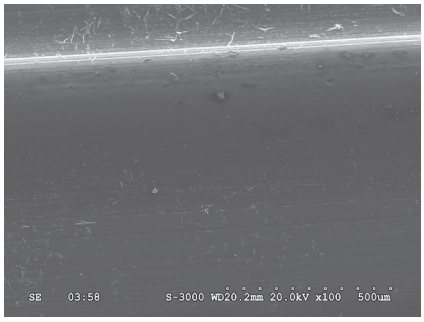
Table B.4 — Pile height before and after the test

Pile height [a] mm		
No.	**Initial**	**After test**
1	32	14
2	32	16
3	31	16
4	33	17
5	32	16
Average	32	16
Standard deviation	0,7	1,1

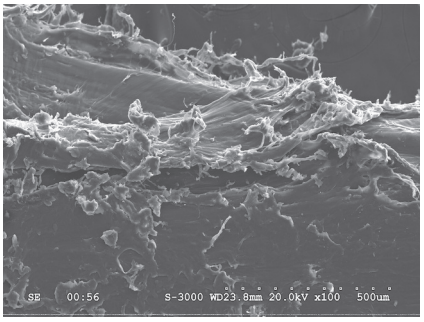
[a] The factory specified pile height is 35 mm.

2) SEM image of pile yarn

The surface of artificial turf pile was measured with SEM. Figure B.2 shows the image of the pile yarn before a) and after testing b).



a) Pile yarn before testing



b) Pile yarn after testing

Figure B.2 — SEM image of pile yarn before and after the test

B.4 Stud wear test

B.4.1 Test conditions

The test conditions of the stud test were the following:

1) Longitudinal speed of stud drum: 0,25 m/s

2) Transversal speed of stud drum: 0,015 m/s

3) Exposure cycle

The used test procedure is shown in Table B.5.

Table B.5 — Stud wear test

Step	UV exposure	Stud wear
1	—	2 000 cycle
Repeat	Twice	
Total	0 h	4 000 cycle

B.4.2 Test results

Stud wear test was carried out under the conditions described in B.4.1, and then the pile height, SEM were evaluated.

1) Pile height

The pile heights of five specimens, which were chosen in a random fashion, were measured after stud wear test. Table B.6 shows the pile height before and after the test.

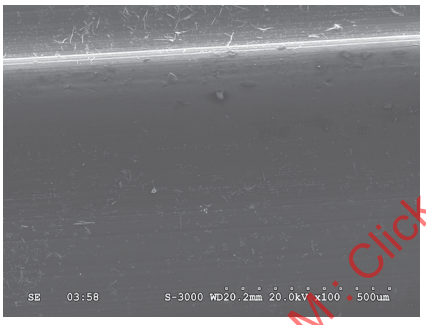
Table B.6 — Pile height before and after the test

Pile height [a] mm		
No.	**Initial**	**After test**
1	32	18
2	32	18
3	31	23
4	33	23
5	32	20
Average	32	20
Standard deviation	**0,7**	**2,5**

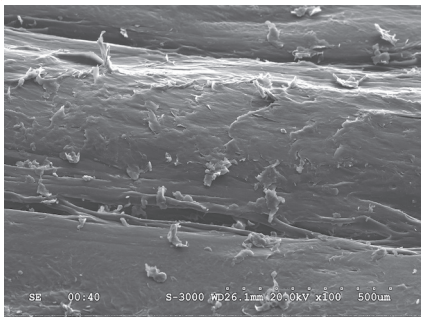
[a] The factory specified pile height is 35 mm.

2) SEM image of pile yarn

The surface of artificial turf pile was measured with SEM. Figure B.3 shows the image of the pile yarn before a) and after testing b).



a) Pile yarn before testing



b) Pile yarn after testing

Figure B.3 — SEM image of pile yarn before and after the test