INTERNATIONAL STANDARD

ISO 18947-2

First edition
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Imaging materials and prints — Abrasion resistance —

Part 2: Rub testing of photographic prints

Matériaux pour l'image et les impressions — Résistance à l'abrasion —

Partie 2: Essai de frottement des impressions photographiques

Reference number
ISO 18947-2:2021(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 42, *Photography*.

This first edition of ISO 18947-2:2021 cancels and replaces the first edition of ISO 18947:2013, which has been technically revised.

The main changes are as follows:

— visual evaluation was added;

— details of the test procedure have been refined;

— drawings of the test devices have been updated.

A list of all parts in the ISO 18947 series can be found on the ISO website.

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

This method belongs to a series of test methods for the evaluation of permanence and durability of image prints, which refers to the resistance of image prints to physical, mechanical, chemical and/or environmental stresses in conditions of use. The permanence of the image under environmental stresses is tested by each stress factor individually: light (ISO 18937[10]), heat (ISO 18936[9]), ozone (ISO 18941[11]), and humidity (ISO 18946[12]). These stress factors are given by the ambient conditions, over which the user often has limited control. The exposure to mechanical and physical stress may often be controlled by the user, unless intense handling is integral to intended use. Tests for rubbing of prints resulting in abrasion or smearing of the image are handled in the series ISO 18947, scratch resistance is addressed in ISO 18922[7] (for film) and in the series ISO 18951 (all parts) (for reflection prints, currently under development), respectively, and durability tests to simulate accidental exposure to water or food spill is described ISO 18935[8].

The process of rubbing a surface may result in different types of degradation, e.g. abrasion, scuffing, smudging, and others. They may be observed as loss of colour intensity, scratches, changes in gloss, coloration of former uncoloured areas, (coloured) material transfer to a receptor and others.

This document provides standardized requirements to evaluate and quantify the abrasion resistance of image prints in their various formats such as hard copy prints and photo books.

Abrasion and smudge can include both accidental and repeating stresses, resulting from handling of the image. The following are some examples of sources of abrasion:

— dirt particles rubbing on a printed surface;

— sheet-to-sheet abrasion (sliding motion of sheets relative to each other);

— prints sliding on tables or other flat surfaces;

— interaction with dirt or components inside of printers;

— magnets or other items used in the display of images.

This revised edition transforms ISO 18947 into a multipart standard to extend the applicability of this standard to analogue and digital photographic, graphic and office prints. In addition, this revised edition allows for the use of additional types of rub testers. The level of abrasion observed in a test depends on the combination of many factors, including factors of the print material under test as well as the test apparatus.

Different test devices show different levels of rub work, depending on load of the device, relative movement of the samples (direction and speed), test length on the device and the selection of the material and geometry of the abrading receptor.

Material factors that contribute to friction coefficients and therefore influence the susceptibility of printed images to abrasive conditions include surface roughness, surface elasticity, substrate porosity of samples and the chemical formulation, mobility as well as localization of the colorants on the surface or within a receiver layer.

For photographic prints produced with photo-grade papers, a correlation between abrasion results on linear, reciprocating abrasion testers was found in a Round Robin study of TC42/WG5, that included imaging technologies like silver halide, inkjet, electro-photographic and dye diffuse thermal transfer. Together with results from IPI[23][24][25] this Round Robin study serves as background for this document, which is dedicated to (quasi-)linear, reciprocating abrasion test of photographic prints on photo-grade papers, including resin coated (RC photo-grade), barrier coated (water impermeable) paper and coated (water permeable) paper as defined by ISO 18055-1[6], as well as photo-grade films. The term (quasi-)linear considers that the movement on the Sutherland type tester (see ISO 18947-1:2021[13], A.2) follows an arc segment of a circle with a large diameter, resulting in a mainly linear motion with a small orthogonal component.

Imaging materials and prints — Abrasion resistance —

Part 2:
Rub testing of photographic prints

1 Scope

This document specifies tests to determine the abrasion resistance of photographic images for typical use in indoor context that is characterized by mild abrasive conditions. Examples are flipping of pages in an album, careful manual handling of prints (stacking, shifting) or use of magnets for attachment to a board. Photographic images refer to individual prints or prints in albums, which can be produced by a wide range of printing technologies, including silver halide, electrophotography, inkjet, dye diffusion thermal transfer, commonly known as dye sublimation, and dye transfer processes. Photographic images require “photo-grade” media, including coated or surface treated print materials, which are prerequisite to obtain photographic quality with aforementioned printing technologies. Test procedures are limited to (quasi-) linear, reciprocal abrasion test devices.

For other printing technologies (e.g. offset lithography and other photomechanical printing processes) or non-photo-grade media or other levels of rubbing representative of other application profiles, different test methods and/or device options may be considered (see ISO 18947-1).

Heavy duty abrasive conditions, such as floor tiles, floor graphics, abrasive cleaning and vehicle graphics, are out of scope of this document.

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 2813, *Paints and varnishes — Determination of gloss value at 20°, 60° and 85°*

ISO 8254-1, *Paper and board — Measurement of specular gloss — Part 1: 75 degree gloss with a converging beam, TAPPI method*

3 Terms and definitions

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

ISO and IEC maintain terminological 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
abrasion
loss of material from a surface or deformation of a surface, with changes in gloss, colour, or density, due to frictional forces as a result of rubbing

Note 1 to entry: Surface deformations can result in changes in gloss and colour.

3.2
interval scale
<psychophysical> scale established by a psychophysical method, which, in addition to possessing the attributes of *rank order* (3.5), is distinguished by the fact that equal differences between numerical values correspond to equal differences between properties measured (in sensory analysis, perceived intensities)

Note 1 to entry: Larger values correspond to larger perceived intensities and the size of the difference between two values reflects the size of the difference in perceived intensity of the property being measured. However, a numerical value of zero may not indicate a total absence of the property and the ratio of two values cannot be assumed to reflect the ratio of the perceived intensities.

3.3
minimum density
D_{min}
optical density corresponding to the maximum transmittance (film) or reflectance (paper) that a photographic product can achieve

Note 1 to entry: The representation of the minimum density level of a photographic print depends on the printing technology and includes (a) non-printed area of the print material, i.e. a substrate with or without a specific image receiving or image forming layer, (b) coated or printed pre-white area (wherein a white layer is applied before the image is printed such that a coloured or transparent substrate is covered) or (c) a printed area of the material, where a transparent and/or white process colour (e.g. ink or toner) is printed image-wise.

Note 2 to entry: In this document, transparent substrates are evaluated in reflection mode by use of a white or black backing, as suitable.

[SOURCE: ISO 12641-2:2019, 3.6]

3.4
quasi-linear
<materials testing> curvilinear motion with a small component of total displacement orthogonal to its main direction of movement

Note 1 to entry: The Sutherland type abrasion tester provides an arc motion, where the length of the arc is much shorter than the radius of the circle, resulting in a mainly linear motion with a small orthogonal component.

3.5
rank order
<psychophysical> result of a method involving the arrangement by an observer of a series of stimuli in order of increasing or decreasing image quality or an attribute thereof, in accordance with the set of instructions provided

3.6
ratio scale
<psychophysical> scale established by a psychophysical method, which has the properties of an *interval scale* (3.2) but for which, in addition, the ratio between the values allocated to the two stimuli is equal to the ratio between the perceived intensities of these stimuli

Note 1 to entry: With this scale, a numerical value of zero designates total absence of the property.

Note 2 to entry: The ratio scale is the only case for which it is meaningful to say that one result is, for instance, ten times as great as another.

3.7
receptor
<materials testing> substrate used to rub the test specimen and onto which ink or other material that is removed from the specimen is transferred

Note 1 to entry: An example of a receptor is the back side of the printed media (printed or D_{min} area) being evaluated or a standard reference paper.

3.8
scuff
form of abrasion, leading to a change in gloss

3.9
smudge
result of rubbing leading to the displacement and re-deposition of materials into adjacent areas

Note 1 to entry: see *abrasion* (3.1).

4 General test background

4.1 Summary of practice

This method utilizes a (quasi-)linear, reciprocating rubbing device, or its equivalent, as e.g. described in A.1 or A.2. The test specimen is placed in contact with a receptor surface under a specified load and is rubbed with a back and forth motion at a specified frequency and for a specified number of cycles. A cycle consists of two strokes, namely a forth stroke and a back stroke.

NOTE 1 Devices described in ISO 18947-1:2021, A.3 to A.6 were not included in the corresponding inter laboratory test on photographic prints, and therefore it is not known, whether results from those abrasion tests would also provide some level of correlation for selected test parameters.

After treatment, the test specimen is removed from the test device and evaluated for its degree of degradation by measuring the change in gloss, optical density, colour and/or change in physical appearance in both imaged (or printed) and minimum density, D_{min}, areas.

The receptor is analysed for the amount of colorant or coating transferred from the specimen as evidenced by an increase in optical density or change in colour. Results are compared to equivalent, non-abraded specimen and receptor, respectively.

NOTE 2 It is not the purpose of this document to define limits of acceptability or failure.

4.2 Significance and use

Depending upon their intended use applications, abrasion resistance is a desirable and sometimes critical property of imaging materials. The result of abrasion can be degradation in both image quality and appearance, and/or functionality. The amount of abrasion damage to a printed image is dependent on many variables, including the nature of the abrading material, pressure, temperature, and humidity. This method can be used to evaluate the relative abrasion, smudge, and scuff resistance of printed photographic images and unprinted photographic materials under laboratory conditions for simulation of the application profile of photographic images for intended use under “mild” abrasive conditions in typical indoor context, including - but not limited to:

— handling of individual prints (rubbing during stacking, e.g. hand, shoebox, envelope, as well as sliding with fingers);

— photographic images in albums (insertion in corner pieces, page-to-page rubbing);

— photobooks (page-to-page rubbing).

This method provides a reasonably simple procedure that can be used to set specifications for printed photographic materials and determine whether a product meets a predetermined standard for abrasion, smudge, or scuff resistance in aforementioned use.

4.3 Applicability and usage of alternative test methods

For more severe rubbing conditions, alternative test conditions may be more representative of application profile envisaged (see ISO 18947-1).

5 Test device

5.1 Test device description

Test devices suitable for this test are (quasi-)linear, reciprocating abrasion testers as for example shown in A.1 or A.2. Equipment that applies a similar reciprocating abrasive force in a similar manner as described in the preceding standards may also be used[1)].

5.2 Test device preparation

The test device shall be set on a stable laboratory bench, in a room conditioned to the desired test temperature and relative humidity. Conditions of (23 ± 3) °C and (50 ± 10) % relative humidity shall be used for testing, unless specific product end-use requires different conditions.

6 Samples

6.1 Test target definition

Test targets consisting of uniform patches sized to fit the abrasion test device shall be used.

The target shall comprise a specified print substrate, with an associated colour as measured in the minimum density, D_{min}, patch as well as the colour(s) of the imaging material utilized by the printing system under test.

Required colours for test include:

— the 100 % patches of the primary colours, typically cyan, magenta, and yellow, which are addressed by sRGB values (255, 255, 0), (255, 0, 255) and (0, 255, 255), respectively.

— neutral patches (composite black) with sRGB values (0, 0, 0) and secondary colours, typically red, green and blue, addressed by sRGB values (0, 0, 255), (0, 255, 0) and (255, 0, 0), respectively.

Optionally, the following test patches may be tested in addition:

— the D_{min} patch as controlled by the sRGB values (255, 255, 255) – see also Note 1 to entry to term 3.3.

— 100 % patches of any system spots colours, e.g. orange and/or white ink.

— If the printing system makes use of multiple ink levels for a colorant (e.g. cyan and light cyan ink), then a second set of patches of D_{max} may also be included. Further, a third set of patches falling between 0,3 and 0,5 optical densities may also be included.

For monochrome imaging systems (e.g. silver halide, true monochrome inks) the requirements for the test target design collapse into one colour patch, with D_{min} patch and intermediate density patches as an optional test.

Each test patch shall be bordered by an adjacent minimum density, D_{min}, area, oriented with the abrasive action of the test instrument, such that the smudging of colorant or imaging media into adjacent minimum density area, D_{min}, can be assessed. Testing of the D_{min} area alone focusses on the abrasive effects of rubbing of the minimum area in the absence of colorant smearing. This may be of

1) Sutherland® Rub Tester (Danilee Co.), AB-301 Color Fastness Rubbing Tester (Tester Sangyo Co., Ltd.), FR-2 (Suga Test Instruments Co., Ltd.), and TRIBOGEAR TYPE 32 (Shinto Scientific Co., Ltd.) are examples of a suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

interest in view of the various constructions of the minimum density area as indicated by the Note 1 to term 3.3.

NOTE A test target consisting of a white line, checkerboard, or other high contrast pattern can better characterize smudge. In addition, a crockmeter can be useful in characterizing ink transfer from one surface to another, see e.g. ASTM F 1319[9].

The size of the patches shall be large enough to accommodate the size of the device mountings and weights.

See suitable example of a test target in Annex B.

6.2 Preparation of samples and selection of the receptor material

Samples for abrasion testing shall be printed with test targets defined in 6.1. Samples may also be prints treated at either side (varnished, laminated, bonded, backed, etc.) as in final application.

Samples shall be of a size appropriate for the test device to be used.

The drying time between printing or processing and abrasion testing may influence the results. Printed samples shall be dried or cured and conditioned to the level of intended use prior to rub testing. Shorter times may be tested in addition to investigate susceptibility of the printed images to abrasion by conditions of processing and early handling after printing.

Water-based inkjet-printed samples shall be left face-open under the standard environmental condition at least 14 days prior to rub testing. A shorter conditioning time may be agreed upon when the purpose of the test is to evaluate the abrasion resistance at a shorter time after printing. During drying, curing, and conditioning, dust deposition on the surface to be tested shall be avoided.

The receptor material shall be chosen in view of the intended use: backside of the print substrate (stacking), frontside of another print (pages in an album), a standard receptor material (general purpose). The evaluation of rub on printed receptor surfaces may be difficult. Therefore, standard (unprinted) receptor substrates (recommended for third party evaluation) or back sides of front side printed substrates (to simulate rubbing resistance for real production runs) are recommended.

Samples shall be tested in two directions perpendicular to each other. If there is a proof for non-directionality rub testing in one direction is sufficient.

NOTE Samples can show different properties depending on the test direction. This can be caused by e.g. fibre orientation, texture or others and can cause differences in rub tests. Coated photo-grade print materials tend to have limited directionality.

Both the test specimen and the receptor shall be a flat sample with no surface irregularities, such as scoring or creases.

If testing multiple samples, it is important that each has comparable, if not, identical colorant coverage and colorant density. If the purpose of the test is to compare the print technologies, select appropriate substrates and minimize substrate differences whenever possible.

Care shall be taken to avoid contaminating the sample with fingerprints during handling, as this can influence the test results.

Samples and receptors shall be conditioned at (23 ± 3) °C and (50 ± 10) % relative humidity for 24 h or longer. A shorter conditioning time may be agreed upon when the purpose of the test is to evaluate the abrasion resistance at a shorter time after printing.

If tests need to be performed under different climatic conditions, samples also shall be conditioned in this climate and the conditions shall be recorded.

7 Test procedure

The test shall be conducted under environmental conditions of (23 ± 3) °C and at a relative humidity of (50 ± 10) %. The test procedure for each of the test devices referenced in 4.1 and 5.1 is slightly different based on the specific design and capabilities of each of the test devices as described in A.1 and A.2. The following are the key parameters that need to be controlled and reported relative to the specific test device being used:

— the size of the sample specimen and the dimensions of the printed colour patches;

— the positioning of the reciprocal movement across the border of imaged and minimum density area, D_{min}, in order to assess smudge;

— the specific receptor material and the dimensions of the receptor;

— the weight or load applied to either the test specimen or receptor;

— the number of rubbing cycles or strokes (one cycle comprises of two strokes, i.e. one stroke in forth direction and one stroke in back direction);

— the rate of reciprocal cycling, expressed in cycles/minute; and

— the line speed of rubbing, expressed in mm/sec.

The minimum test duration shall be 10 cycles. The test may be continued in increments of 10 cycles up to 50 cycles and may be further continued in increments of 50 cycles up to 500 total cycles or until a specified amount of change is achieved or exceeded. In this case, the total number of cycles to reach the specified change shall be reported. If no detectable change is encountered after a total of 500 cycles, stop and report.

NOTE Other test specimens and receptor dimensions and applied loads can optionally be used in cases in which the intended conditions of use are such that the specified parameters and conditions produce results that do not adequately correlate to the abrasion, smudge, or scuff experienced under the intended conditions of use.

8 Evaluation

8.1 General

After completion of the test, samples are inspected for changes in scuff, gloss, smudge and colour and the receptors are evaluated for transfer of colour density. Both instrument-based measurements as well as visual evaluation apply. For evaluation of transparent materials, a white backing is applied to allow observation and/or measurement in reflection mode. For evaluation of prints on a transparent material that have a pre-white layer, a black backing material shall be used.

NOTE Other assessments may be useful in particular applications, e.g. gonio-photometric measurement and analysis can be applicable to fine art materials with surfaces for which visible scuffs do not result in significant changes in gloss or density.

8.2 Instruments measurements

Instrument-based measurements are applied if a correlation with visual examination has been proven.

Changes of gloss shall be examined using a gloss meter at either a 20°, 60°, 75°, or 85° angle as described in ISO 2813 and ISO 8254-1.

NOTE 1 Pertinent standards describe the choice of measurement angle as function of the level of gloss of the non-abraded image print.

Changes in colour are measured either with a densitometer (Status A or T filters) as described in ISO 5-3[1] and ISO 5-4[2] or with a spectro-colorimeter (CIE $L^*a^*b^*$) as described in ISO 13655 with either 0°/45° or 45°/0° geometry.

For gloss, consider directional dependence due to eventual presence of quasi-linear abrasive patterns and/or printed substrate texture.

Both the imaged and adjacent minimum density, D_{min}, areas of the specimen shall be measured. These areas are defined by adjacent squares with an edge-length of 20 mm or the width of the receptor, whatever is smaller, centrally located on a boundary line between printed and minimum density, D_{min}, areas fully covered by the motion path of the receptor. In each square area, five measurements are taken at positions that are arranged as the dot pattern that represents an "x-pattern" like the number "5" on dice (⚄), see schematics in Figure B.1. The equivalent measurements are performed on the non-rubbed area for comparison.

NOTE 2 Typical spot size for measurement of colour or micro gloss is in the range of 3 mm to 8 mm diameter.

Alternately, use an area or scanning array measurement system with totally averaged area equivalent to approximately five times the typical single spot size, for both rubbed and non-rubbed area.

Optionally, each corresponding receptor may be measured for densitometric or colorimetric gain, due to transfer of colorant from the specimen.

NOTE 3 The amount of colorant migration to the receptor does not necessarily represent the magnitude of damage on the image patch since some of the colorant loss can take the form of colorant debris that comes off the image patch during the abrasion test process but does not migrate to the receptor area.

8.3 Calculations

Calculations shall be performed to assess the difference between the tested (abraded) and untested specimen and receptor for each colour patch and adjacent minimum density, D_{min}, area on the specimen. Results shall be expressed in terms of an absolute change in gloss or as absolute or percentage change in optical density relative to the untested specimen.

Percentage change in optical density shall be calculated as per Formula 1, where d is the symbol for measured density, X is the colour patch being measured, e.g. C, M, Y, R, G, B, and N, which are the symbols for cyan, magenta, yellow, red, green, blue, and neutral test patches that are to be measured, and (Z) stands for either (R), (G), or (B), which are the symbols for the red, green, and blue Status A or Status T densities of the test patches of the untested sample (0) and the tested sample (t) that are measured by the densitometer:

$$\left[d\mathrm{X}(\mathrm{Z})_0 - d\mathrm{X}(\mathrm{Z})_t\right] / d\mathrm{X}(\mathrm{Z})_0 \times 100 \quad (1)$$

For example, the measured density of a cyan patch is represented by the expression dC(R). For a secondary colour, such as red, the measured density is represented by both the blue and green components, e.g. dR(B) and dR(G), and for the black or neutral patch, all three components are represented, e.g. dN(B), dN(G), and dN(R). For secondary and neutral colour patches, the percentage change in optical density shall be calculated and reported for each component.

Colorimetric changes shall be reported as ΔE^*_{ab}, as per Formula 2:

$$\Delta E^*_{ab} = \sqrt{\left(L^*_t - L^*_0\right)^2 + \left(a^*_t - a^*_0\right)^2 + \left(b^*_t - b^*_0\right)^2} \quad (2)$$

where L^*, a^*, and b^* are the colour coordinates of the colour area or the adjacent minimum density, D_{min}, area of the untested sample (0) and the tested sample (t), as defined by ISO 13655.

Abrasion is expressed as the change in optical density or colour of the imaged area of the specimen.

Scuff is expressed as the change in gloss of the imaged or minimum density areas.

Smudge is expressed as the absolute change in optical density or the change in colour of an adjacent unprinted area

Colorant transfer is the change in optical density or colour of the receptor.

8.4 Visual evaluation

Rubbed test prints are evaluated for changes in scuff, gloss, smudge and colour. Evaluation of colour changes also include lateral transfer of colorant in minimum density areas adjacent to printed areas (smudge). The evaluation focuses on the adjacent areas at the borderline between the test patch and minimum density area as defined in 8.2, but may also consider additional parts of the full patch. Also, receptors are evaluated for colorant transfer, which may appear larger than the visual colour differences of the rubbed prints.

For the evaluation of colorant transfer, typically the receptors are evaluated since the differences of the rubbed prints are smaller than the ones on the receptor. However, for the evaluation of scuff, gloss changes, smudge and any other image quality related change the prints need to be evaluated.

When colorant transfer to the receptor is evaluated the endpoints of a possible scaling are 'unrubbed receptor material' on the better side and eventually 'full tone printed areas' on the worse side of a scale. Additional grade samples in between – either prepared independently or out of the range of test results – may be selected to ease visual evaluation and should be agreed upon between the test provider and the customer.

If rubbed prints are evaluated, evaluation of colour changes also includes lateral transfer of colorant into minimum density areas adjacent to printed areas (smudge).

The viewing conditions shall be suitable for evaluation of colour and gloss, which represent two difference settings of the observer geometry. For colour evaluation, a diffuse and uniform illumination of the specimens with a white, broadband light source shall be used with an illuminance level exceeding 500 lx in the display zone. Suitable lamp types include tungsten halogen, xenon, metal halide, broadband LED and broadband fluorescent.

NOTE Narrowband light sources with emission lines smaller than the colour matching functions typically introduce stronger metameric effects than broadband light sources. This often results in larger variability of the visual evaluation.

Care shall be taken to avoid glare in the visual field of the observer.

For evaluation of physical defects and changes in the gloss, the surface of the specimens should be inspected with oblique directional lighting, while changing the incident and observation angle by means of tilting samples for contrast maximization. More than two observers shall be used to perform the visual evaluation.

The minimum aim of the visual evaluation is the establishment of a rank order by pairwise comparison. The test provider and the customer may agree on more elaborated aims of the visual evaluation, being either an interval scale or a ratio scale[14].

9 Test report

For each sample tested, the following parameters, conditions, and results shall be reported:

a) a reference to this document, i.e. ISO 18947-2:2021;

b) the nature of the samples including (if known) printing process, printing media type, colorant type, and product name of the printing system. For test prints the printer settings, printed test image density, and materials used to make the test specimen (in the case of analogue test specimens, the process used to make the print);

c) the test device used to perform the test, including model number, manufacturer, and any unique modifications that have been made;

d) the dimensions of the test specimen, the individual colour patches, and the receptor;

e) a precise description of the receptor material;

f) the weight or force applied to the receptor and test specimen;

g) the total number of cycles, the rate of cycling, the line speed (or angular speed), and the direction of the motion against the direction of the print product (perpendicular or parallel);

h) the visual rank order of the samples and the number of individuals delivering rankings;

and for instrumental evaluation in addition:

i) the specific instruments and pertinent geometries, illuminants and filters used to measure density, colour and gloss if applicable;

j) abrasion resistance in terms of the change in colour, optical density or gloss of each sample (or each patch), if applicable;

k) smudge resistance in terms of the change in colour or optical density of the unprinted area adjacent to each of the colour patches if optical measurements were performed;

l) colorant transfer in terms of the change in optical density or colour of the receptor if optical measurements were performed;

m) scuff in terms of the change in gloss if gloss measurements were performed.

The institution and/or organization responsible for the results reports the following in addition:

n) the location and date of the test;

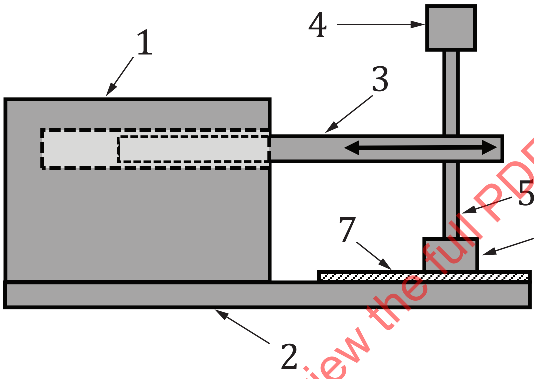
o) the person, institute, and/or organization responsible for the report.

Annex A
(informative)

Examples of test equipment, corresponding procedures and operating parameters

A.1 Linear reciprocal flat rub tester

A flat sample specimen is rubbed with a flat abrasion head. The force is uniformly applied among the abrader, and the abrader or the sample moves (quasi-)linearly with a specific constant speed back and force, as shown in Figure A.1.



Key

1	motor with a driver of a reciprocating linear motion	5	adjustable height rod
2	base	6	abrasive pad and holder
3	reciprocating arm	7	specimen
4	normal force weight		

NOTE The reciprocating arm (3) moves back and forth.

Figure A.1 — Conceptual diagram of the linear flat abrader

The examples of test devices are described in IEC 63211-3-5[14], ASTM D 5264[15], ASTM F 1571[16] and ASTM F 2497[17]. Control of the following test parameters is essential:

a) force (N/cm^2),

b) line speed (cm/s),

c) frequency (cycles/min), and

d) number of rubbing cycles.

An alternate realization of a linear flat abrader is a swinging arm device, which abrades in a curvilinear motion with a small component of total displacement orthogonal to its main direction of movement, see ISO 18947-1.

A.2 Linear reciprocal curved rub tester

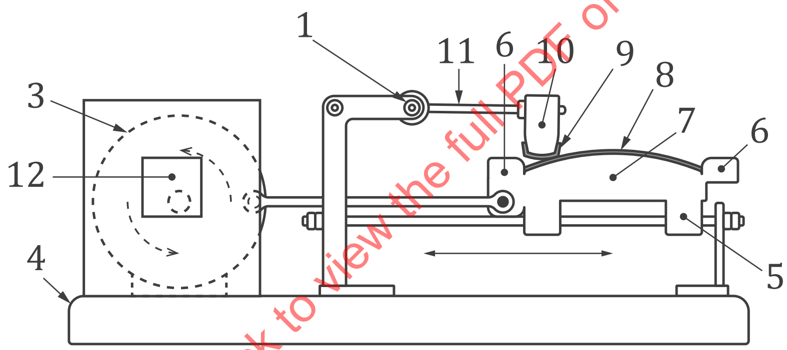
The rubbing tester which is described in ISO 105-X19[3] consists of a curved sample stage and rubbing finger in conjunction with a forcing arm. (See Figures A.2 and A.3).

NOTE The test device in ISO 105-X19 is equivalent to those defined in JIS L 0849[21] and JIS K5701-1[22].

The rubbing finger has a curved surface of 45 mm surface radius, and it is approximately 20 mm long and 20 mm wide, capable of affixing a receptor (e.g. a standard reference paper, the face or back side of an unprinted piece of the sample paper, or a cloth, such as un-dyed cotton cloth). The contact area between the sample and receptor is approximately 100 mm^2. One end of the forcing arm is on a fixed axis, and a force is exerted on the rubbing finger at the other end. The curved specimen stage has a 200 mm surface radius, is capable of reciprocating horizontally at a speed of 30 reciprocations per minute along a 120 mm track, and is capable of reciprocating the rubbing finger in a 100 mm track.

When this type of instrument is used, the following procedure and key parameters are typical:

The test specimen is mounted on the stage, and the abrasive receptor is attached to the tip of the rubbing finger. The rubbing meter is started for 50 cycles at a speed of 30 cycles/min along a 100 mm track on the specimen exerting a force of 2 N (approximately 200 g). The force and number of reciprocations can be varied and will depend on the type of materials and the intended application.



Key

1	fulcrum shaft
2	(empty)
3	motor with crank wheel
4	base
5	horizontal moving device
6	clamp for test specimen
7	convex specimen stage
8	test specimen
9	rubbing receptor
10	rubbing finger
11	arm
12	cycle counter

NOTE Each turn of the crank wheel introduces a horizontal forth and back movement of the specimen stage. As a result, the rubbing finger (with receptor) moves up and down as determined by the convex shape of the specimen stage (with specimen).

Figure A.2 — Typical figure of rubbing meter (Gakushin test method)