INTERNATIONAL STANDARD

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Paints and varnishes — Evaluation of defects on coated surfaces using optical imaging —

Part 3: Evaluation of delamination and corrosion around a scribe

Peintures et vernis — Évaluation par imagerie optique des défauts des surfaces revêtues —

Partie 3: Évaluation du décollement et de la corrosion autour d'une rayure

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 21227-3 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

ISO 21227 consists of the following parts, under the general title *Paints and varnishes — Evaluation of defects on coated surfaces using optical imaging*:

— *Part 1: General guidance*

— *Part 2: Evaluation procedure for multi-impact stone-chipping test*

— *Part 3: Evaluation of delamination and corrosion around a scribe*

Introduction

The conventional ISO test methods for evaluating surface defects and changes in appearance often utilize pictorial standards which depict particular types of surface deterioration and require human visual evaluation. The technology and procedures described in this part of ISO 21227 can yield more objective, accurate, quantitative and reproducible results when compared to the human visual evaluation techniques.

Paints and varnishes — Evaluation of defects on coated surfaces using optical imaging —

Part 3:
Evaluation of delamination and corrosion around a scribe

1 Scope

This part of ISO 21227 specifies a method for evaluating delamination and corrosion around a scribe by means of digital optical imaging. The damaged surface can be produced in accordance with ISO 9227, ISO 11997-1 or ISO 11997-2.

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 4628-8, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 8: Assessment of degree of delamination and corrosion around a scribe*

ISO 21227-1, *Paints and varnishes — Evaluation of defects on coated surfaces using optical imaging — Part 1: General guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21227-1 and the following apply.

3.1
delaminated area
area from which a paint or paint system has detached

3.2
corroded area
substrate area from which a paint or paint system has detached and which has subsequently been attacked by corrosion

4 Principle

A grey scale or colour image is produced from the digital optical image of a surface damaged by delamination or corrosion around a scribe. In the simplest case, this image is converted into a binary image (thresholding). The damaged area is measured and the mean and maximum width of delamination or corrosion is determined.

In addition, the shape of the zone affected by delamination or corrosion around a scribe can be identified using digital optical imaging.

5 Requirements

5.1 General

The assessment shall be carried out under the conditions specified in ISO 21227-1.

5.2 Illumination

The illumination shall be such that the damaged areas can be clearly distinguished from the undamaged areas. Because of the high contrast, corrosion can be easily recognized under diffused reflection illumination after stripping the coating. When detecting delamination without previously removing the coating, directional reflection illumination can be of advantage because of the low contrast.

5.3 Resolution

The minimum resolution shall be 6 pixels per millimetre.

NOTE Different resolutions, in particular in the case of damage involving a large number of fissures, can lead to different values for the damaged areas.

If a resolution deviating from the resolution specified above is used, this shall be stated in the test report.

6 Calibration

By adjusting the optical imaging system, it is possible to digitize a damaged area. By calibrating the scale in both X and Y directions (e.g. with graph paper graduated in millimetres), the previously generated binary image can be measured with sufficient accuracy to obtain the width of the delamination or corrosion.

When using a reference scale based on pictorial standards, calibration should be performed with these images. In this case, an interlaboratory test should be conducted to determine the correlation between visual assessment and digital optical imaging.

7 Procedure

Prepare the test panels for digital evaluation following the procedure given in ISO 4628-8.

Using the previously calibrated digital optical imaging system, take a picture of the test panel area containing the scribe and of the adjacent damaged area. After suitable threshold setting and detection, the digital image delivers a value for the damaged area including the area of the scribe. The scribe length on the assessed area shall also be determined. The start and end of the scribe and the corresponding damaged area are not assessed.

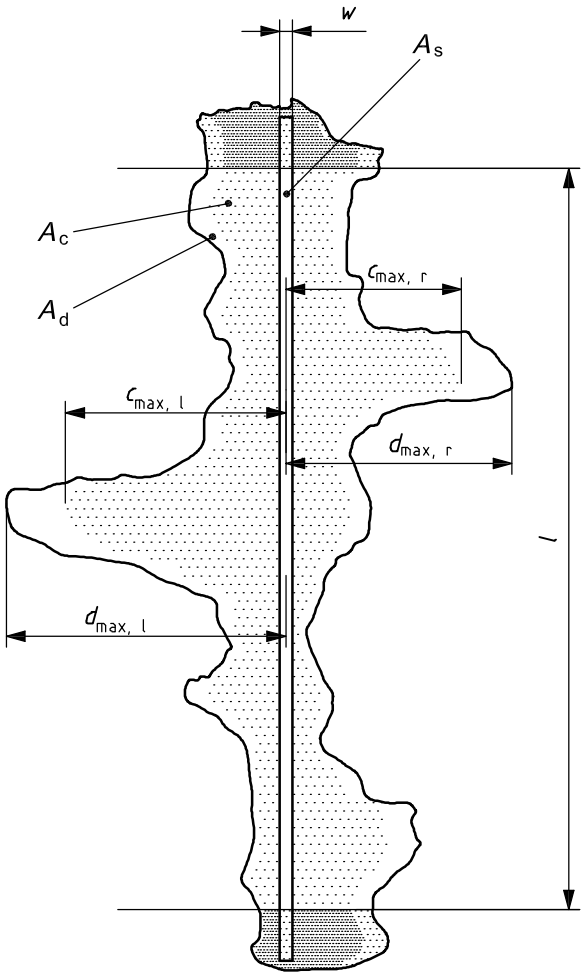
If the test panel contains several scribes or zones to be assessed (e.g. two intersecting scribes), they may be treated as sections of a single scribe, and the relevant areas and scribe lengths may be added to one another. The area of intersection is not assessed.

If the scribe width is not known, it shall be measured. If the scribe width cannot be measured, it shall be set to the same value (preferably zero) for all comparative samples, and this value shall be quoted in the test report.

8 Evaluation

8.1 General

Unlike visual assessment of delamination or corrosion area, digital optical imaging can directly determine the size of an area of any shape (see Figure 1); A_d, A_c, d_{max} and c_{max} are evaluated and d and c are then calculated. Consequently, subsequent assessments will be more precise and reproducible.



Key

A_s	area of the scribe in the area of evaluation
A_d	area of delamination including the evaluated area of corrosion and area of the scribe
A_c	area of corrosion including the evaluated area of the scribe
w	width of the scribe
l	evaluated length of the scribe
$d_{max,\ l}$	maximum width of delamination on the left side of the scribe
$d_{max,\ r}$	maximum width of delamination on the right side of the scribe
$c_{max,\ l}$	maximum width of corrosion on the left side of the scribe
$c_{max,\ r}$	maximum width of corrosion on the right side of the scribe

Figure 1 — Image with all parameters required for assessment

8.2 Mean width of delamination or corrosion

With the known scribe width w, calculate the scribe area A_s, using Equation (1):

$$A_s = w \times l \tag{1}$$

Calculate the mean delamination width d, in millimetres, using Equation (2):

$$d = \frac{A_d - A_s}{2} \times \frac{1}{l} \tag{2}$$

Calculate the mean corrosion width c, in millimetres, as given in Equation (3):

$$c = \frac{A_c - A_s}{2} \times \frac{1}{l} \tag{3}$$

where

A_s is the evaluated scribe area in the area of evaluation, in square millimetres;

A_d is the evaluated area of delamination and corrosion, including the scribe area, in square millimetres;

A_c is the evaluated area of corrosion, including the scribe area, in square millimetres;

l is the evaluated scribe length, in millimetres.

8.3 Rating in accordance with ISO 4628-8

To allow comparison with the visual evaluation, the value determined through image evaluation from the width of the delaminated or corroded area around the scribe shall correspond to the numerical rating scale from 0 to 5 as specified in ISO 4628-8. The relationship between the width, in millimetres, and the numerical rating is given by Equation (4):

$$d \text{ (or } c) = \mathrm{e}^{0{,}505\,\mathrm{NR} - 0{,}409}$$

or

$$\mathrm{NR} = 0{,}81 + 1{,}98 \times \ln d \text{ (or } c) \tag{4}$$

where

d is the mean delamination width, in millimetres;

c is the mean corrosion width, in millimetres;

NR is the numerical rating (grade).

For further details, see Annex A.

9 Precision

In an interlaboratory test, seven samples with different degrees of delamination damage were assessed by six laboratories both visually and using different digital optical imaging systems.

The relative standard deviation of the laboratories in determining the mean width of delamination from analysis of the damaged area was on average 9 % for all samples. The individual laboratories worked with different resolutions.

The mean deviation of the visual assessment compared to digital image processing was 15 %. However, it should be noted that the mean relative standard deviation of the individual laboratories for the visual assessment was 31 %.

Both procedures, visual assessment and digital optical imaging, ranked the samples in the same order for delamination width.

The mean relative standard deviation of the individual laboratories for determining the shape of the delamination area, expressed as the standard deviation of 100 equidistantly spaced measurements of the delamination width, was 11 %.

The precision of the method specified in this part of ISO 21227 can be considered to be much higher for determining both the width of delamination and the shape of the delamination area than the precision observed in the interlaboratory test, because some sources of error (different resolution, assessment at the scribe ends, etc.) are avoided in this method.

10 Test report

The test report shall contain at least the following information:

a) all information necessary for identification of the coating tested (manufacturer, trade name, batch number, etc.);

b) a reference to this part of ISO 21227 (ISO 21227-3:2007);

c) the test conditions and apparatus, including

   1) the type of illumination (light source, arrangement of lamps),

   2) the image acquisition procedure, including: original image, image acquisition system, resolution, image size, grey scale, colour scale, gamma correction,

   3) all processing procedures used for the image processing and image analysis, if available;

d) the result of the evaluation, as indicated in Clause 8;

e) any deviations from the procedure specified;

f) any unusual features (anomalies) observed during the test;

g) the date of testing;

h) the name of the person carrying out the test.

Annex A
(normative)

Ratings in accordance with ISO 4628-8 to be used to evaluate the delamination and corrosion around a scribe

The numerical ratings (grades) shall be as shown in Figure A.1 and specified in Table A.1.

Figure A.2 shows the relationship between delamination or corrosion width around a scribe and the numerical rating.

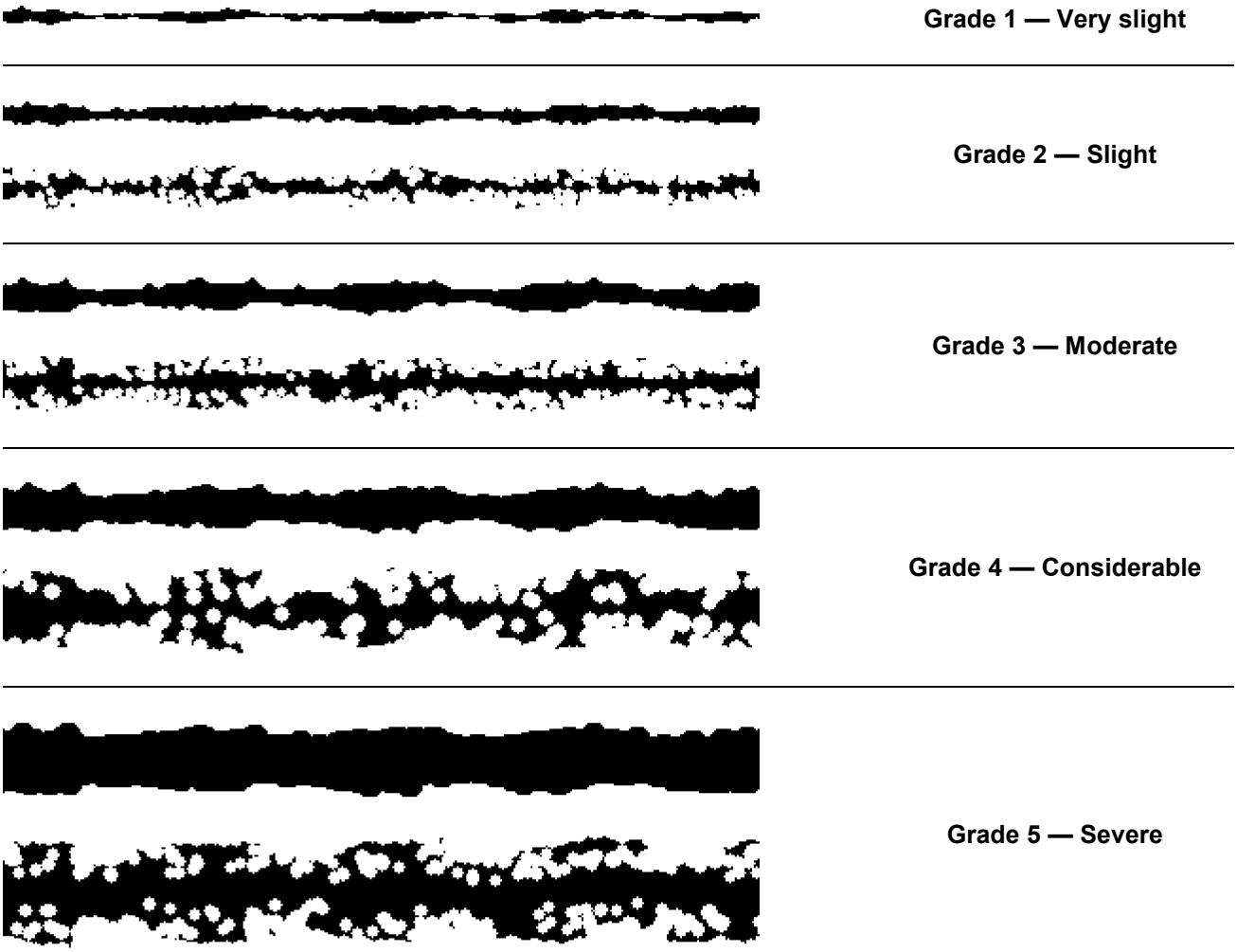


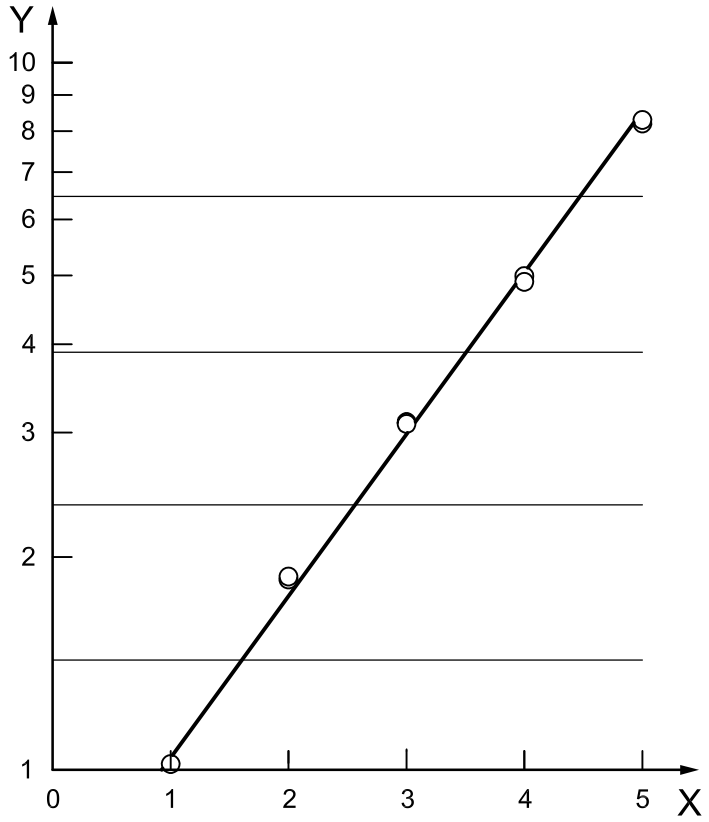
Figure A.1 — Binary images of the pictorial standards for assessment of degree of delamination and corrosion around a scribe in accordance with ISO 4628-8

Table A.1 — Delamination or corrosion width

Numerical rating (grade)	Rod[a] mm	Branched[b] mm	Lower limit mm	Upper limit mm
1	1,06	1,06	0,00	1,42
2	1,86	1,84	1, 42	2,35
3	3,07	3,11	2,35	3,89
4	4,90	4,98	3,89	6,45
5	8,30	8,21	6,45	

[a] The state in which delamination and corrosion advance comparatively uniformly (see upper pictures for grades 2 to 5 in Figure A.1).

[b] The state in which delamination and corrosion advance in an unbalanced way, like a branch (see lower pictures for grades 2 to 5 in Figure A.1).



Key

X numerical rating (grade), NR

Y delamination or corrosion width, in millimetres

Figure A.2 — Relationship between corrosion or delamination width around a scribe and numerical rating

Annex B
(informative)

Extended evaluation

B.1 Maximum width of delamination or corrosion

If the scribe is distinguishable, the maximum width of delamination $d_{\text{max, r}}$ and $d_{\text{max, l}}$ or the maximum width of the corrosion $c_{\text{max, r}}$ and $c_{\text{max, l}}$ can be determined on both left- and right-hand sides by measuring to the outmost edges of the damaged zone perpendicular to the scribe.

B.2 Shape of delamination

In an extended evaluation, there are several possible ways of describing the shape of delamination, for example:

— the length of the edge contour of the damaged zone is compared to the assessed length or area; however, the result depends greatly on the resolution employed;

— the standard deviation is obtained from, for example, 100 values for the width of delamination or corrosion; this value may not be taken as a measure of the degree of cleavage in the damaged area;

— the width of delamination or corrosion is represented by a histogram.

However, to date, it has not been possible to agree upon an extended evaluation procedure.

Bibliography

[1] ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

[2] ISO 11997-1, *Paints and varnishes — Determination of resistance to cyclic corrosion conditions — Part 1: Wet (salt fog)/dry/humidity*

[3] ISO 11997-2, *Paints and varnishes — Determination of resistance to cyclic corrosion conditions — Part 2: Wet (salt fog)/dry/humidity/UV light*

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