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

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

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

Partie 2: Mode opératoire d'évaluation pour l'essai d'impacts multiples de cailloux

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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 21227-2 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 appearance changes often utilize pictorial standards which depict particular types of surface deterioration and require human visual evaluation. The technology described in this part of ISO 21227 can yield more objective, accurate, quantitative and reproducible results when compared to the human visual evaluation techniques.

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

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

1 Scope

This part of ISO 21227 describes a procedure for evaluating multi-stone impact damage by means of optical imaging. A suitable method for simulating the damaging process is specified in ISO 20567-1.

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 20567-1, *Paints and varnishes — Determination of stone-chip resistance of coatings — Part 1: Multi-impact testing*

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

3 Principle

From a digital optical image of the degradation caused by stone chipping, a grey-scale or colour image is made. This image is transformed into a binary image (through thresholding) in which the damaged areas of the surface are shown as black patches while the undamaged areas of the surface are visible as white patches. The percentage of the damaged to the total test area is recorded and a rating determined.

4 Requirements

4.1 General

The conditions specified in ISO 21227-1 apply to this part of ISO 21227 as well.

4.2 Illumination

The illumination shall be such that the damaged areas can be clearly distinguished from the undamaged areas. Experience has shown that diffuse bright-field illumination is suitable for image acquisition of multi-impact degradation.

NOTE   If direct illumination is used, any kind of surface disturbance which is not caused by stone chipping can also be detected.

4.3   Region of interest and resolution

The size of the region of interest (ROI) of the image should preferably be 70 mm × 70 mm. When the test is performed using smaller ROIs, for example because these are easier to illuminate, it shall be ensured that the difference between the result of the evaluation of the reference area and that of the evaluation of the total area is not larger than half a rating as defined in ISO 20567-1.

NOTE 1   The ROI size of 70 mm × 70 mm was chosen to exclude regions of uneven distribution of damage at the edges of the area of 80 mm × 80 mm previously used.

NOTE 2   The result of the evaluation of a smaller ROI can be considerably different from evaluation of the total area.

The minimum resolution shall be 6 pixels per millimetre.

NOTE 3   Different resolutions can lead to different values for the damaged areas.

5   Calibration

5.1   General

The purpose of the calibration process is to fix the image acquisition parameters in such a way that image analysis will make it possible to assign the right rating to test panels that have not been examined before, by using ratings that have been determined for reference panels in accordance with ISO 20567-1. Furthermore, a visual comparison is made to verify the correspondence between the reference panel and the digitized image with regard to the detected degradation. This calibration procedure guarantees only the repeatability of the process; for the reproducibility, refer to Clause 8.

The reference panels shall be as similar as possible to the test panels as far as the structure and contrast of the individual layers are concerned; they shall therefore be prepared in the same laboratory, using the same equipment.

5.2   Calibration process

Carry out the calibration process as described below using a self-made set of reference panels to which the ratings defined in ISO 20567-1 (see Annex A) have been assigned and which cover the whole range of these ratings.

Take a picture of the impact area of each reference using the selected optical-imaging system. Visually compare each digitized image with the corresponding reference panel to determine whether the damaged and undamaged areas correspond to those on the reference panel. If so, analyse the image using the optical-imaging system. The result of this analysis shall represent the rating for each reference panel. If calibration is not possible although the settings of all the system components involved in the image acquisition process have been optimized, the selected optical-imaging system is not suitable for the evaluation to be made.

NOTE   The results of optical imaging and visual evaluation can differ since visual evaluation unconsciously considers not only the damaged area but also additional characteristics, e.g. the size and distribution of the defects.

6   Procedure

Prepare the test panels for optical imaging following the procedure specified in ISO 20567-1.

Create an image of the test panel using the calibrated optical-imaging system. Once suitable threshold values have been established, the digitized image provides, on analysis, a value for the damaged area. To ensure optimum results, the difference between the test panels and the reference panels shall not be too big.

7 Evaluation

7.1 General

The result of the image analysis is a data recording to which one or more ratings are assigned.

7.2 Evaluation

If the coating is delaminated or flaked, all such damage shall be included in the evaluation, irrespective of which layer it occurs in.

NOTE   This type of damage can also occur on soft substrates, such as plastics or aluminium.

7.3 Rating in accordance with ISO 20567-1

Determine the percentage of the total evaluated area represented by the damaged area, the damaged and undamaged areas together making up 100 %. The damaged areas shall be those visible in the image as discrete black- or grey-shaded patches, while the undamaged areas shall be those which appear white.

To allow comparison with the visual evaluation, the percentage damaged area determined through image evaluation shall be expressed as a rating on the rating scale from 0 to 5,0 as specified in ISO 20567-1. Results that fall between two whole numbers shall be expressed as half-point ratings such as 3,5.

7.4 Extended evaluation

For an extended evaluation, the contributions of the individual layers to the total damaged area can be determined. The layer that accounts for the largest share of the damaged area shall be regarded as the main separation level.

If possible, the extent of individual areas of damage and the percentage of the total area represented by each such area shall be determined. The data compiled in this way can be used as the basis for a number of further analyses.

An example of an extended evaluation is given in Annex B.

8 Precision

In 2003, ISO/TC 35/SC 9 carried out an international round-robin test in which nine laboratories from four countries participated. Two test panels were used, each containing two areas of stone-chip damage, created in accordance with ISO 20567-1. Different digital optical-imaging technologies were used for the evaluation of a region of interest of 70 mm $\times$ 70 mm, all using diffuse bright-field illumination.

The repeatability limit, r, was not determined.

The reproducibility limit, R, was determined for two different levels of damage. The results are given in Table 1.

Table 1 — Reproducibility limit

Damaged area %	Rating in accordance with ISO 20567-1	Reproducibility standard deviation, s_R %	Reproducibility limit, R %
3,2	1,5	0,6	1,6
6,3	2	1,1	3,0