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**Paints and varnishes — Determination  
of stone-chip resistance of coatings —**

**Part 1:  
Multi-impact testing**

*Peintures et vernis — Détermination de la résistance des revêtements  
aux impacts de cailloux —*

*Partie 1: Essais de chocs multiples*



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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.

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 20567-1 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

ISO 20567 consists of the following parts, under the general title *Paints and varnishes — Determination of stone-chip resistance of coatings*:

- *Part 1: Multi-impact testing*
- *Part 2: Single-impact test with a guided impact body*

## Introduction

In the automobile industry, multi-layer paint coatings are applied to car bodies for protection. Grit, road-metal and other materials can damage these coatings in such a way that individual layers come off or the whole coating delaminates from the substrate.

Stone chipping can be simulated by means of single- and/or multi-impact tests. Part 1 of this International Standard describes multi-impact testing, Part 2 describes a single-impact test.

This part of ISO 20567 is based on the German Standard DIN 55996-1:2001, *Beschichtungsstoffe — Prüfung der Steinschlagfestigkeit von Beschichtungen — Teil 1: Multischlagprüfung (Paints and varnishes — Stone chip resistance test for coatings — Part 1: Multi impact test)*.

NOTE A recommended procedure for calibration of the apparatus is given in Annex A. Note that this annex is informative because the method described in it is not the only one suitable for checking whether a uniform impact pattern is produced.

# Paints and varnishes — Determination of stone-chip resistance of coatings —

## Part 1: Multi-impact test

### 1 Scope

This part of ISO 20567 specifies three methods for the evaluation of the resistance of automobile finishes and other coatings to chilled-iron grit projected onto the surface under test to simulate the impact of small stones.

### 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 1513, *Paints and varnishes — Examination and preparation of samples for testing*

ISO 1514, *Paints and varnishes — Standard panels for testing*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

ISO 11124-2, *Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives — Part 2: Chilled-iron grit*

ISO 11125-2, *Preparation of steel substrates before application of paints and related products — Test methods for metallic blast-cleaning abrasives — Part 2: Determination of particle size distribution*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

ISO 21227-2, *Paints and varnishes — Evaluation of defects on coated surfaces using optical imaging — Part 2: Evaluation procedure for multi-impact stone-chipping test*

IEC 60454-2, *Specification for pressure-sensitive adhesive tapes for electrical purposes — Part 2: Methods of test*

### 3 Principle

The stone-chip resistance of the coating under test is checked by projecting a large number of small sharp-edged bodies onto it in a short period of time. The material used in the test is chilled-iron grit which is projected onto the coating at a defined angle using compressed air. The extent of the damage caused will depend not only on the angle, but also on the pressure level, the mass of the projectiles, the duration of the bombardment and the design of the test apparatus.

Loose fragments of coating material are removed using adhesive tape.

The extent of the damage is determined by comparison with pictorial reference standards.

### 4 Apparatus

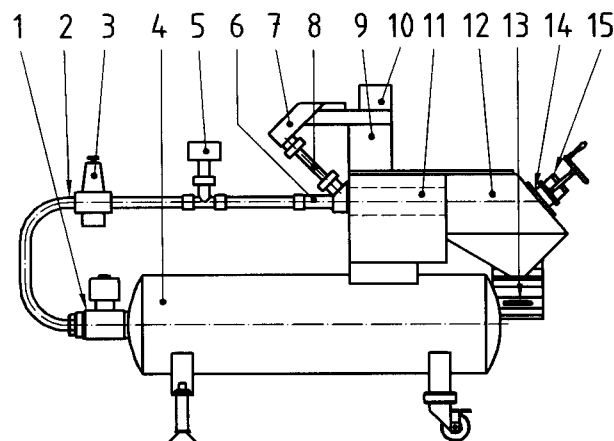
Ordinary laboratory apparatus, plus the following:

#### 4.1 Multi-impact tester

Figures 1 and 2 show the test apparatus and its dimensions.

The vibrating conveyor carries the grit from the funnel into the air blast in front of the grit-accelerating nozzle. It shall be designed so that the grit feed speed can be varied. The apparatus shall be capable of projecting 500 g of grit during a period of 10 s. The pressure chamber shall be large enough to allow the specified working pressure of 200 kPa to be held at a constant level for at least 10 s while the solenoid valve is open.

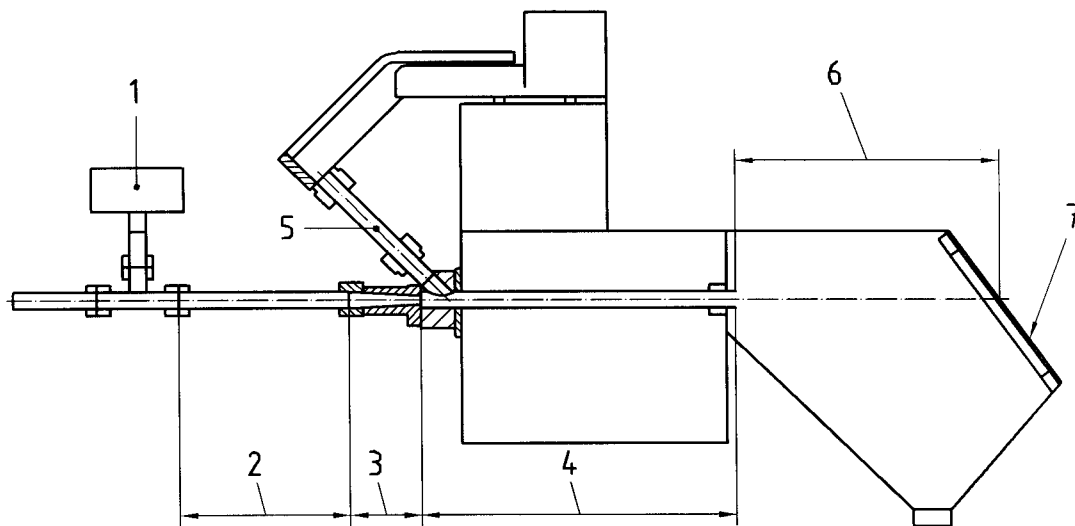
Used grit can be taken from the grit-catching chamber after the test and used again to a limited extent (see 5.1).



#### Key

- |  |  |
|--|--|
| 1 solenoid valve                         | 9 vibrating conveyor   |
| 2 compressed-air line                    | 10 grit feed funnel  |
| 3 pressure reducer (to working pressure) | 11 grit-accelerating pipe (accessible from back for replacement) |
| 4 pressure chamber (capacity 90 l)       | 12 protective housing  |
| 5 manometer (indicates working pressure) | 13 grit-catching chamber   |
| 6 air-accelerating nozzle                | 14 test panel  |
| 7 grit feed chute                        | 15 test panel holder   |
| 8 grit feed pipe                         |  |

Figure 1 — Multi-impact tester — General view

**Key**

- |  |  |
|--|--|
| <p>1 pressure gauge</p> <ul style="list-style-type: none"> <li>— measurement range: up to 400 kPa (= 4 bar)</li> <li>— diameter of scale: 100 mm</li> <li>— accuracy: class 1,0</li> </ul> <p>2 connecting pipe</p> <ul style="list-style-type: none"> <li>— length: <math>(190 \pm 1)</math> mm</li> <li>— inside diameter: <math>(19 \pm 0,2)</math> mm</li> </ul> <p>3 air-accelerating nozzle</p> <ul style="list-style-type: none"> <li>— length: <math>(80 \pm 1)</math> mm</li> <li>— inside diameter at entry: <math>(19 \pm 0,2)</math> mm</li> <li>— inside diameter at exit: <math>(7 \pm 0,2)</math> mm</li> </ul> <p>4 flange and grit-accelerating pipe</p> <ul style="list-style-type: none"> <li>— overall length: <math>(352 \pm 2)</math> mm</li> <li>— inside diameter: <math>(30 \pm 0,2)</math> mm</li> </ul> | <p>5 grit feed pipe</p> <ul style="list-style-type: none"> <li>— length: <math>(205 \pm 3)</math> mm</li> <li>— inside diameter: <math>(19 \pm 1)</math> mm</li> <li>— connected to grit-accelerating pipe at angle of <math>(45 \pm 1)^\circ</math> and distance of <math>(35 \pm 1)</math> mm from tip of air-accelerating nozzle</li> </ul> <p>6 jet of grit</p> <ul style="list-style-type: none"> <li>— distance from grit-accelerating pipe to centre of test panel: <math>(290 \pm 1)</math> mm</li> <li>— angle between axis of jet and test panel: <math>(54 \pm 1)^\circ</math></li> </ul> <p>7 aperture</p> <ul style="list-style-type: none"> <li>— 80 mm <math>\times</math> 80 mm window defining test area on test panel</li> </ul> |
|--|--|

**Figure 2 — Multi-impact tester — Detailed drawing and dimensions****5 Materials****5.1 Grit <sup>1)</sup>**

The grit shall be chilled-iron grit conforming to the requirements of ISO 11124-2, except that the particle size, determined in accordance with ISO 11125-2, shall be 4 mm to 5 mm.

The grit shall be replaced after a maximum of 100 test runs (i.e. after it has been projected 100 times) or at the end of the series of tests during which the grit passes the point at which it has been used for a total of 100 test runs.

1) For information about grit suppliers, please contact the Normenausschuss Beschichtungsstoffe und Beschichtungen (NAB), at DIN, Burggrafenstraße 6, 10787 Berlin, Germany.

## 5.2 Adhesive tape

Unless otherwise agreed, adhesive tape with an adhesive strength between 6 N/25 mm width and 10 N/25 mm width (determined in accordance with IEC 60454-2) shall be used. The tape shall be at least 50 mm wide.

## 6 Sampling

Take a representative sample of the coating material to be tested, as described in ISO 15528.

Examine and prepare each sample for testing, as described in ISO 1513.

## 7 Test panels

### 7.1 Substrate

Unless otherwise agreed, use 200 mm × 100 mm steel test panels that are between 0,7 mm and 1,0 mm thick.

### 7.2 Preparation and coating

Unless otherwise agreed, prepare each test panel in accordance with ISO 1514 before coating and drying or stoving. Use the application method specified by the paint manufacturer.

### 7.3 Thickness of coating

Determine the thickness, in micrometres, of the dry coating by one of the procedures specified in ISO 2808.

## 8 Procedure

### 8.1 Conditioning of the test panels

Condition the test panels for at least 16 h at  $(23 \pm 2) ^\circ\text{C}$  and  $(50 \pm 5) \%$  relative humidity before carrying out the test, unless otherwise agreed (see ISO 3270).

### 8.2 Test conditions

Carry out the test at  $(23 \pm 2) ^\circ\text{C}$  and  $(50 \pm 5) \%$  relative humidity (see ISO 3270).

NOTE Exceptionally, other test conditions may be agreed between the interested parties.

### 8.3 Projection of grit

Load the tester with  $500^{+20}_0$  g of grit. Carry out the test using one of the sets of conditions given in Table 1. The method used shall be agreed between the interested parties.

Weigh the grit after each test run (i.e. after each projection) and, if required, add grit to keep the total mass at  $500^{+20}_0$  g.

When the two test runs have been completed, place a strip of adhesive tape approximately 120 mm to 150 mm long over the test area of the test panel and press it firmly onto the surface. Bend one end of the tape upwards and pull the strip off with a jerk (at an angle of  $90^\circ$  to the test panel) to remove chips of paint that have not been completely separated from the panel.

Check the length of time taken to project the grit with a stopwatch each time a new series of tests is started and, if required, during an ongoing series of tests.

After a maximum of 100 test runs (see 5.1), replace the used grit with 500 g of fresh grit. Do not replace the grit during an ongoing series of tests.

**Table 1 — Test methods**

Method	Pressure kPa <sup>a</sup>	Mass of grit g	Time taken to project grit s
A	100 ± 5	2 × 500 <sup>+20</sup> <sub>0</sub>	2 × (10 ± 2)
B	200 ± 10	2 × 500 <sup>+20</sup> <sub>0</sub>	2 × (10 ± 2)
C	200 ± 10	1 × 500 <sup>+20</sup> <sub>0</sub>	10 ± 2
	200 ± 10	1 × 500 <sup>+20</sup> <sub>0</sub>	10 ± 2
<sup>a</sup> 100 kPa = 1 bar. followed by, for example, corrosion or weathering exposure, then			

## 9 Evaluation

Evaluate the damage on the exposed test area by comparison with the reference standards shown in Figure 3. The comparison can be done visually or by means of optical imaging in accordance with ISO 21227-2. The reference standards represent ratings from 0,5 to 5,0 in steps of 0,5. Estimate and record intermediate ratings as necessary.

In addition to the degree of chipping, specify, if possible, the main separation level or the layers of the paint system between which loss of adhesion occurred.

## 10 Precision

### 10.1 Repeatability limit, *r*

The repeatability limit *r* is the value below which the absolute difference between two test results can be expected to lie, with a 95 % probability, when this method is used under repeatability conditions, i.e. when the test results are obtained on identical material by one operator in one laboratory within a short interval of time using the same apparatus.

For this method, *r* is 0,5 on the rating scale.

### 10.2 Reproducibility limit, *R*

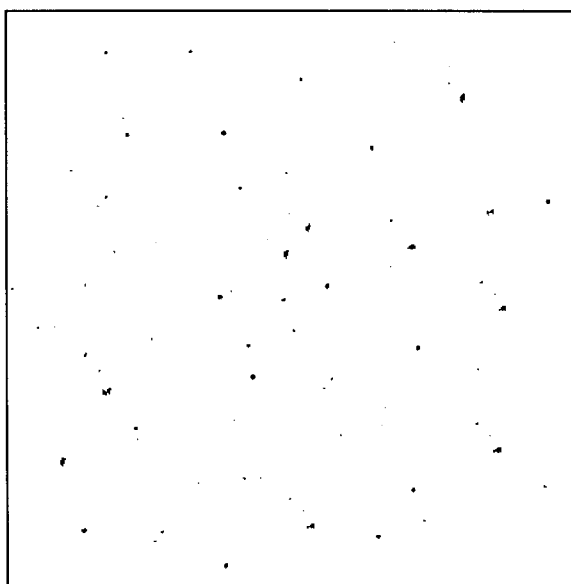
The reproducibility limit *R* is the value below which the absolute difference between two test results, each the mean of duplicates, can be expected to lie, with a 95 % probability, when this test method is used under reproducibility conditions, i.e. when the test results are obtained on identical material by operators in different laboratories using different apparatus.

For this method, *R* is 1,0 on the rating scale.

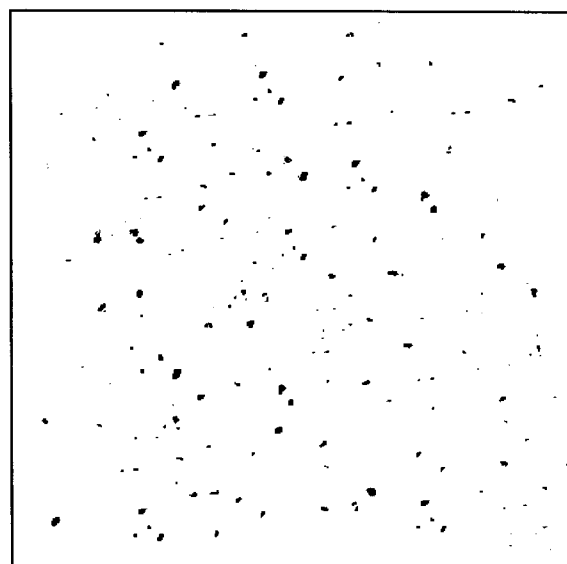
## 11 Test report

The test report shall contain at least the following information:

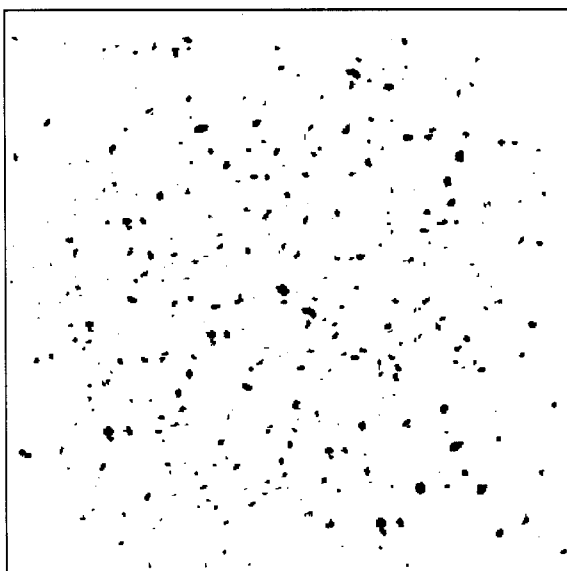
- a) all details necessary for complete identification of the product tested (manufacturer, trade name, batch number etc.);
- b) a reference to this part of ISO 20567 (ISO 20567-1:2005);
- c) details of the test panels, including:
  - 1) details of the substrate (including material and thickness) and its surface preparation,
  - 2) the method used to apply the product to the substrate, including the drying time and drying conditions for each layer,
  - 3) if applicable, the conditions under which the panels were aged,
  - 4) details of how the test panels were conditioned before the test and, if applicable, details of any tests carried out previously with the same test panels,
  - 5) the dry-film thickness of the coating, in micrometres, and the method in ISO 2808 used to measure it, plus a note as to whether the tested coating consisted of a single layer or several layers;
- d) the test method used (A, B or C), as well as (for method C only) details of the corrosion or weathering exposure conditions;
- e) the ambient temperature and humidity during the test;
- f) details of the chilled-iron grit, including manufacturer, trade name and mean particle size;
- g) the designation of the adhesive tape used and its adhesive strength, in N/25 mm width;
- h) the results of the test, as described in Clause 9;
- i) any deviations from the procedure specified;
- j) any unusual features (anomalies) observed during the test;
- k) the date of testing;
- l) the name of the person who carried out the test.



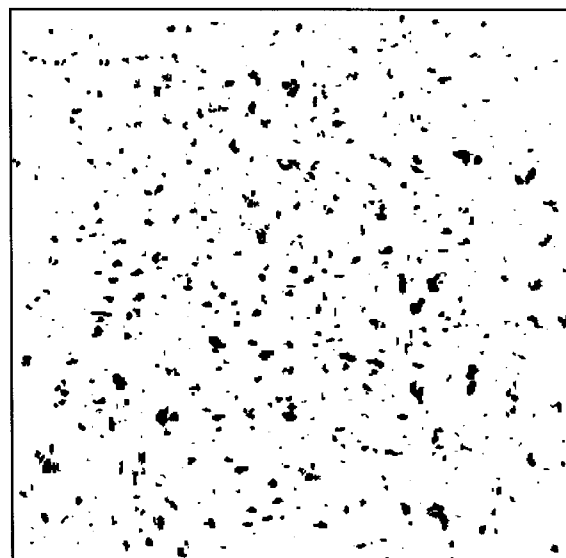
Rating 0,5    Affected area 0,2 %



Rating 1,0    Affected area 1,0 %

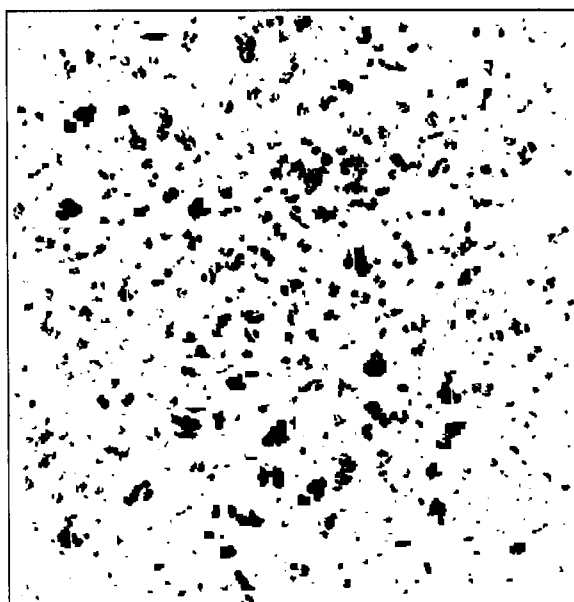


Rating 1,5    Affected area 2,5 %



Rating 2,0    Affected area 5,5 %

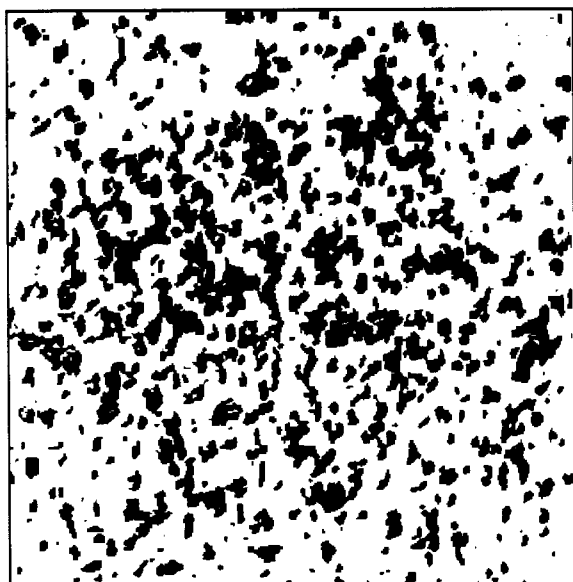
**Figure 3 — Pictorial standards for stone chip resistance rating**



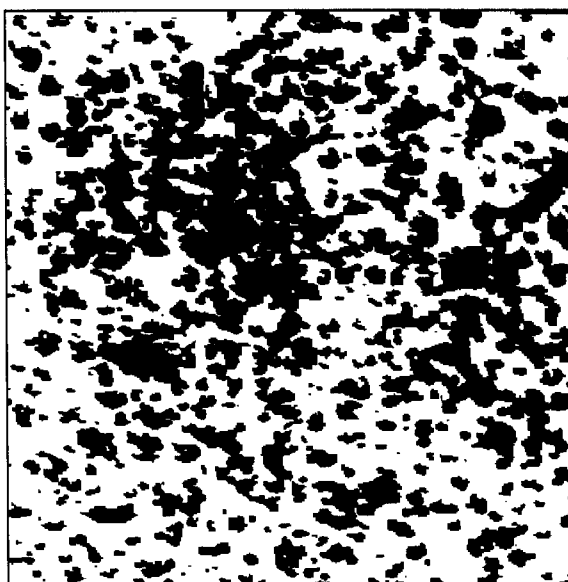
Rating 2,5    Affected area 10,7 %



Rating 3,0    Affected area 19,2 %

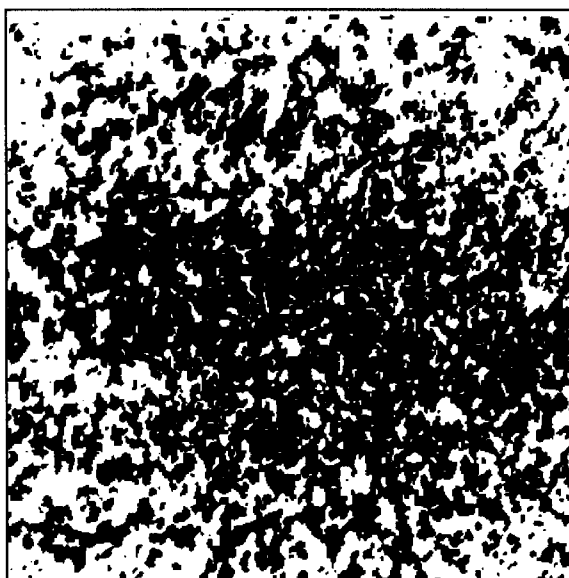


Rating 3,5    Affected area 29,0 %

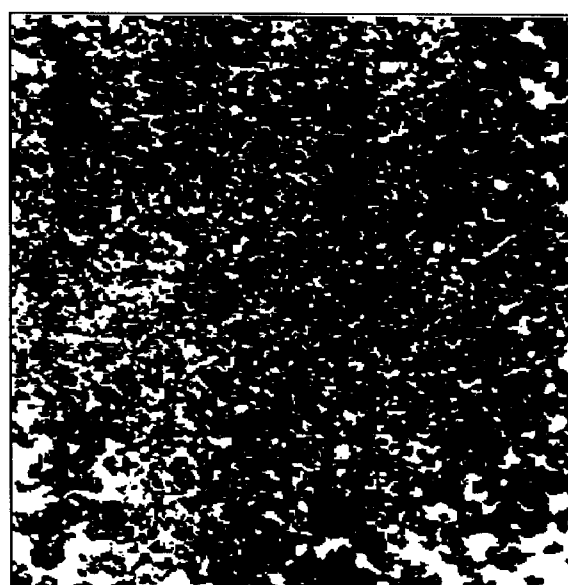


Rating 4,0    Affected area 43,8 %

Figure 3 — Pictorial standards for stone chip resistance rating (*continued*)



Rating 4,5    Affected area 58,3 %



Rating 5,0    Affected area 81,3 %

Figure 3 — Pictorial standards for stone chip resistance rating (*concluded*)

## **Annex A** (informative)

### **Recommended procedure for calibration of test apparatus**

#### **A.1 Materials**

**A.1.1** Grit, as specified in 5.1.

#### **A.2 Apparatus**

**A.2.2** Calibrated scales, capable of weighing 500 g to an accuracy of 0,1 g.

**A.2.3** Calibrated stopwatch.

**A.2.4** Carbon paper.

**A.2.5** White paper, for example photocopying paper.

**A.2.6** Plastic film, for example PE film with a thickness of approximately 150 µm to 200 µm, or transparent envelope.

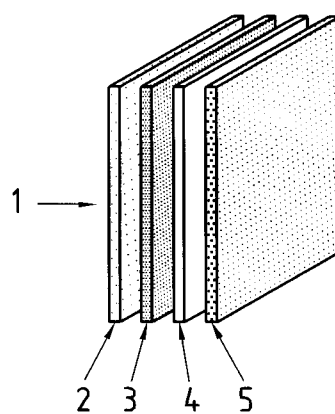
**A.2.7** Steel panel, as specified in 7.1, or aluminium panel with a minimum thickness of 1,25 mm

#### **A.3 Procedure**

To calibrate the test apparatus, mount a calibration panel constructed as shown in Figure A.1 in the apparatus. Then project  $(500 \pm 5)$  g of fresh grit onto the test area within  $(10 \pm 2)$  s, using an air pressure of 200 kPa (= 2 bar).

Visually evaluate the marks produced on the sheet of white paper by the impact of the grit on the carbon paper. The ratio of black areas to white areas shall be the same each time the test apparatus is calibrated. Use the calibration impact pattern sheet supplied with the apparatus as a reference standard.

Continue to replace used grit with 500 g of fresh grit after every 100 test runs regardless of the intervals at which the test apparatus is calibrated (see 8.3).



**Key**

- 1 test area
- 2 plastic film (or transparent envelope)
- 3 carbon paper
- 4 white paper
- 5 steel or aluminium panel

**Figure A.1 — Calibration panel**

