



SURFACE VEHICLE RECOMMENDED PRACTICE

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Optical Imaging Evaluation of Impact Damage Resistance Testing on Exterior Finishes

RATIONALE

SAE J2261 provides technical background information of potential relevance to the development of additional SDPs. As such, it is not dynamic in nature, but retains relevance. Updates are not likely to be required in the near term.

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1. SCOPE

This SAE Recommended Practice covers a procedure for evaluating plastic and multiple-layer coatings exposed to gravelometer testing (as defined in SAE J400) with an optical imaging and analysis system. The intent of the procedure is to detect, count and characterize instances of damage in the coated surface that fracture the top coat layer or penetrate through multiple layers of the coating system. It may be possible to extend this methodology of coating damage evaluation to specimens that have undergone test procedures or exposures that produce similar, discrete damage sites in the coating system. If so applied, evaluation results must be interpreted with respect to the limitations and intent implied by the original evaluation procedure and its associated rating system, if applicable.

1.1 Applicability

This method may be applied to the evaluation of surface damage on plastic and coated surfaces caused by means other than gravelometer testing; provided that the specimen substrate is not significantly deformed to a degree that would prevent all surface damage sites from remaining in a single focal plane capable of being adequately resolved by the image capturing device.

1.2 Application

This SAE Recommended Practice covers a procedure for evaluating plastic and multiple-layer coatings exposed to gravelometer testing (as defined in SAE J400) with an optical imaging and analysis system. The intent of the procedure is to detect, count and characterize instances of damage in the coated surface that fracture the top coat layer or penetrate through multiple layers of the coating system. It may be possible to extend this methodology of coating damage evaluation to specimens that have undergone test procedures or exposures that produce similar, discrete damage sites in the coating system. If so applied, evaluation results must be interpreted with respect to the limitations and intent implied by the original evaluation procedure and its associated rating system, if applicable.

2. REFERENCES

2.1 Related Publications

The following publications are listed for information purposes only and are not a required part of this SAE Technical Report.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J400 Test for Chip Resistance of Surface Coatings

2.1.2 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 21227-2¹ Paints and varnishes – Evaluation of defects on coated surfaces using optical imaging – Part 2: Evaluation of multi-impact stone chipping test

3. SUMMARY OF METHOD

Tested specimens are digitally captured under predetermined (software controlled) Illumination geometries. The images are then processed to highlight the damage sites. Subsequent processing may be applied to separate out the damage sites layer-by-layer on specimens having multi-layer coatings. The damage sites are then automatically measured and analyzed geometrically (by a software program) to derive statistical characteristics. The ratio of the damaged area to the total evaluated area on the sample specimen is measured and recorded as a percentage. If desired and within the capability of the analysis program, other quantitative variables may be determined. This data is then saved to disk.

The procedure above may also be applied to reference specimens, ultimately allowing a rating of the test specimens by comparing their statistical data with those of the numerically ranked reference specimens. The reference samples shall be as similar as possible to the samples to be tested, as far as material formulation, structure, finish and contrast of the individual layers (in coating systems) are concerned; therefore they shall be made using real resources and systems subject to strict quality control.

During the evaluation procedure, optimal specimen illumination and image processing conditions are established and their software settings shall be savable to disk. This allows them to be recalled, ensuring stable and reproducible evaluation conditions specimen-to-specimen, especially critical if the evaluation procedure is interrupted or conducted over multiple sessions.

¹ To be published.

4. EQUIPMENT

4.1 Optical Imaging System

4.1.1 Hardware

The hardware shall include an image capturing device, fixed-geometry illumination source or sources, and a means for performing the capture of specimen surface images in the absence of ambient light. Illumination source and imaging control shall be provided by computer software to allow accurate reproducibility of the image capture conditions.

4.1.1.1 Image Capture Device

This component shall include a charge coupled device (CCD, or CCD chip) providing an imaging resolution of 10 pixels/mm and the capability to record 8 bit/pixel grayscale (256 shade) images. The viewing lens shall be fixed-focal length type with a fixed aperture to ensure identical image capture magnification and prevent variations in the detection resolution. A vibration damping mounting shall be included to ensure optimal image clarity.

4.1.1.2 Illumination Sources

Typical geometries shall include provisions for selecting the desired source and the ability to adjust its illumination intensity. Geometries shown to be suitable for this purpose are direct illumination (to allow capturing of specular reflection characteristics) and diffuse illumination (to allow capturing of chromatic reflection).

Direct illumination is capable of illuminating the specimen surface at a 0 degree incident angle. In plastic specimens, this allows optimal detection of surface irregularities. In coated specimens it allows detection of specimen topcoat (clearcoat) damage without influence from reflections originating in pigmented sub layers. (Direct illumination reflects from the surface of the clear topcoat layer and provides image information only from that layer.)

Diffuse illumination provides a means for highlighting (optimizing contrast) between pigmented coating layers to facilitate their differentiation in the specimen image damage sites (a capability critical for detecting and analyzing such defects extending through multiple coating layers). For advanced analysis on a layer-by-layer basis, the application of direct and diffuse illumination sources may be combined to allow comprehensive characterization of specimen surface damage.

Since the influence of variable ambient lighting would render the specimen illumination unreliable and irreproducible, the image capture shall be performed in a dark box or similar light-proof enclosure housing the illumination sources and image capture device.

4.1.1.3 Illumination Source Calibration

Prior to conducting an evaluation, the spectral characteristics of the illumination sources shall be verified to a traceable source. An appropriate spectral measuring device shall be mounted to acquire its readings in the same plane and at the same distance from the illumination source(s) as that of the test specimen surface during an image capture procedure. As well, the illumination intensity across the region viewed by the capture device shall exhibit a verifiable uniformity no greater than $\pm 5\%$. Imaging system manufacturers typically include a methodology for verifying these functional characteristics of the illumination sources.

4.1.1.4 Specimen Indexing Capability

If the region of interest (ROI) to be evaluated on the sample surface exceeds the viewing region of the image capture device, a means shall be provided for reliably indexing (incrementally moving) the specimen so that sequential image captures may be performed; such that the entire ROI is captured in segments (multiple images). This may be achieved with movable fixturing to which the test specimen is fastened and its positional adjustment within the capture region performed either manually by the operator or automatically via software program control driving servo indexing motors. The fixturing shall be anchored to the system so that its incremental movements are precise, consistently repeatable and preventive of image overlap. To accommodate such an indexing device, the image processing software shall include a routine for stitching partial, segmented specimen images into a single image.