Designation: F 1364 – 03

Standard Practice for Use of a Calibration Device to Demonstrate the Inspection Capability of an Interferometric Laser Imaging Nondestructive Tire Inspection System[1]

This standard is issued under the fixed designation F 1364; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard practice describes the construction and use of a calibration device for demonstrating the anomaly detection capability of interferometric laser imaging nondestructive tire inspection system. A common practice within the industry is to refer to these systems as shearographic/holographic (S/H) systems.

1.2 This standard practice applies to S/H systems that are used for evaluating the structural integrity of pneumatic tires, (for example, presence or absence of anomalies within the tire).

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

F 538 Terminology Relating to the Characteristics and Performance of Tires

2.2 *ASTM Adjuncts:*

Straining Block Drawings[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *analysis*, *n*—an act of inspecting the S/H image and associating this image with a known calibration reference. **F 538**

3.1.2 *shearogram/hologram*, *n*—the common term for an interferometric image provided by S/H systems. **F 538**

3.1.3 *shearographic or holographic (S/H) systems*, *n*—a shearographic or holographic system using interferometric laser imaging to nondestructively inspect tires. **F 538**

3.1.4 *straining block*, *n*—a test block containing a number of anomalies, that is capable of simulating an anomaly in a tire. **F 538**

3.1.5 *straining block anomoly*, *n*—a change in the strain pattern of the deformable surface of a straining block as a result of applied stress brought about through a change in atmospheric pressure on the deformable surface.

3.1.5.1 *Discussion*—A distinction is made between an anomaly in the straining block and an anomaly in the a tire. **F 538**

3.1.6 *straining block holding fixture*, *n*— a device for holding one or more straining blocks in the S/H system during the inspection process (see Fig. 1). **F 538**

4. Summary of Practice

4.1 The straining block is designed to create an image of a known anomaly against which the performance of the S/H system may be evaluated. The block is constructed by securing a flexible membrane over a rigid block that contains a series of holes of various sizes and shapes. The membrane should be made of a material that retains its physical properties over time with minimal aging effects. The interior holes in the block are either vented to atmospheric pressure or sealed at a nominal pressure, allowing a differential pressure to exist on the membrane when the block is subjected to a vacuum. It is the deflection of the surface under this differential pressure that is measured by the S/H system. The thickness of material must be selected to give deflections that are representative of those associated with anomalies found in a tire.

4.2 The size of the holes in a straining block can be used to determine the sensitivity of the S/H system. Generally, larger holes are more readily detectable. However, it is possible for a poorly calibrated S/H system to detect some small holes and miss very large ones. Therefore, a calibration block should contain holes of varying diameter and depth, consistent with the range of anomaly sizes that are expected in use of the S/H system. Typically, the calibration holes in the straining blocks vary between diameters of 1 mm (0.04 in.) and 100 mm (4 in.). A drawing of one version of the straining blocks is shown in Fig. 2.

4.3 These straining blocks shall be placed in a series of locations within the S/H system to confirm the detectability of anomalies over the entire field of view within the S/H system.

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[1] This practice is under the jurisdiction of ASTM Committee F09 on tires and is the direct responsibility of Subcommittee F09.10 on Equipment, Facilities, and Calibration.

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[2] Available from ASTM Headquarters. Order PCN 12–613640–20.

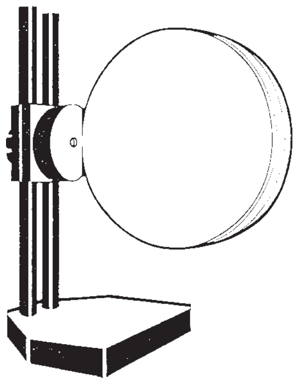

FIG. 1 Straining Block Holding Fixture

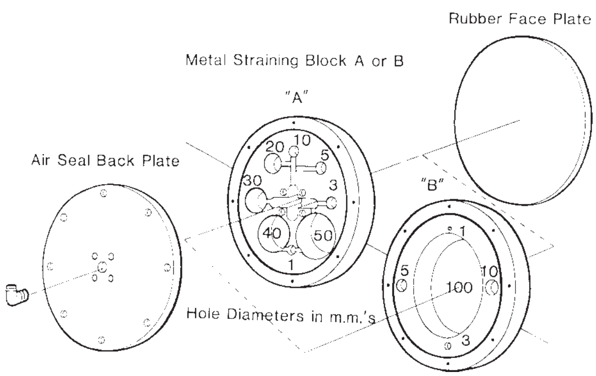

FIG. 2 Straining Block

Alternately, a straining block can be designed to be rectangular in shape with proportions covering the system's field of view with anomalies located at each corner, allowing assessment of the entire field of view in a single inspection. An example of a typical straining block holding fixture is shown in Fig. 1. Straining blocks may also be integrated into the design of the S/H machine.

4.4 By studying the presence and clarity of the fringe patterns obtained from each straining block an assessment of machine calibration may be made. Adjustments such as optical alignment, laser power, vacuum level, beam ratio modifications, multiple exposure, viewer maintenance and other alterations shall be made to optimize the ability to detect the various hole sizes in the straining blocks.

5. Significance and Use

5.1 All S/H systems change with time and use. Therefore, a calibration procedure for evaluating the operation of an S/H system is desirable. This calibration procedure provides a method of obtaining an optimized interferometric image pattern associated with a given size anomaly.

5.2 The use of straining blocks as calibration devices provides a means for ensuring the continued optimal performance of the S/H system. Straining blocks can also be used to compare performance of S/H systems in different facilities.

5.3 At not greater than a three (3) month interval the S/H system shall be calibrated following the procedures described in this practice. When necessary, adjustments, repairs, or modifications shall be made to the S/H system until it is able to observe, in the same image, all anomalies of size within the range of interest contained in the straining blocks.

6. Preparation of the Straining Blocks

6.1 One configuration of straining blocks is shown in Fig. 2. Alternative configurations and layouts are acceptable, provided they meet the requirements detailed in this standard. A detailed description of how to manufacture the blocks can be obtained, upon request, from ASTM.[2] Most suppliers of S/H systems will proved a calibration standard with void sizes varying throughout the range of interest.

6.2 Fig. 1 shows a fixture that can be used for holding one or the other straining blocks. Straining blocks may also be integrated into the design of the S/H machine.

7. Procedure

7.1 One or more straining blocks shall be mounted at various locations within the field of coverage of the S/H system. This is to simulate the surface locations of a tire being inspected.

7.2 The S/H system is then operated through an inspection cycle and the resultant shearograms/holograms are observed using a laser viewer or other viewing device. All anomalies of diameters within the range of interest must be observable with clearly recognizable fringes or indications throughout the image of the straining block.

7.3 When necessary, adjustments, repairs, or modifications shall be made to the S/H system until it is able to disclose, in the same image, all anomalies of diameters within the range of interest contained in the straining blocks.

8. Report

8.1 Record the date of the machine calibration.

8.2 Record relevant machine operating and setup parameters (including, where applicable, but not limited to line voltage, laser output power, exposure time, shear angle, and differential vacuum) on the calibration report. Where the system can support variable imaging head positions, the location (angle and distance) of the head relative to the calibration fixture should also be recorded.

8.3 Record a brief description of the machine adjustments, repairs or modifications that were made during the calibration process.

8.4 The calibration reports and the actual shearograms/holograms or any record of them should be filed for future comparative reference.

9. Keywords

9.1 calibration; holography; inspection; nondestructive; shearography; tire