Designation: B939 – 21

Standard Test Method for Radial Crushing Strength, *K*, of Powder Metallurgy (PM) Bearings and Structural Materials[1]

This standard is issued under the fixed designation B939; 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 test method covers the equipment and laboratory procedure for the determination of the radial crushing strength of materials using either a plain powder metallurgy (PM) bearing or a thin-walled hollow cylindrical test specimen. This is a destructive test that produces quantitative results.

1.2 *Limitations:*

1.2.1 The principle of this procedure is based on the material being tested having minimal ductility. The permanent deflection of the cylinder during the test should not exceed 10 % of the outside diameter.

1.2.2 The radial crushing strength test results should be used only as a guide if the test specimen has a wall thickness that is greater than one-third of the outside diameter. These test results should then only be used for comparison with data from the test specimens of like materials and similar dimensions.

1.3 *Units*—With the exception of the values for density and the mass used to determine density, for which the use of the gram per cubic centimetre (g/cm^3) and gram (g) units are the industry standard, the values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B243 Terminology of Powder Metallurgy

B438 Specification for Bronze-Base Powder Metallurgy (PM) Bearings (Oil-Impregnated)

B439 Specification for Iron-Base Powder Metallurgy (PM) Bearings (Oil-Impregnated)

B925 Practices for Production and Preparation of Powder Metallurgy (PM) Test Specimens

E456 Terminology Relating to Quality and Statistics

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *MPIF Standard:*[3]

MPIF Standard 55 Determination of Radial Crush Strength (*K*) of Powder Metallurgy (PM) Test Specimens

3. Terminology

3.1 *Definitions*—Definitions of powder metallurgy (PM) terms can be found in Terminology B243. Additional descriptive information is available under "General Information on PM" on the ASTM B09 web page.

4. Summary of Test Method

4.1 Radial crushing strength is determined by subjecting a plain sleeve bearing or a thin-walled cylindrical test specimen to a controlled compressive force applied perpendicular to its central axis under uniformly increasing load until fracture occurs.

4.2 The term "radial crushing strength," as used in this test method is the stress at fracture calculated from the breaking load and the dimensions of the test specimen.

5. Significance and Use

5.1 The radial crushing strength test is a destructive procedure used to determine a material strength characteristic of PM

[1] This test method is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.04 on Bearings.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Metal Powder Industries Federation (MPIF), 105 College Rd. East, Princeton, NJ 08540, http://www.mpif.org.

*A Summary of Changes section appears at the end of this standard

bearings and hollow cylindrical test specimens. These data can be used to grade, classify, and evaluate the materials.

5.2 The PM bearing Specifications B438 and B439 require the use of this test method as an acceptance test for the strength of oil-impregnated sintered bearings.

5.3 This test method may be used by powder producers and parts manufacturers as a lot acceptance test for metal powders and lubricated powder mixtures intended for the production of porous parts.

5.4 Companies in the PM industry use this test as a manufacturing control test because it is appropriate for production practices.

5.5 Radial crushing strength is a property of the PM material but is not a design value. However, experience has shown that the radial crushing strength of a material is approximately twice the ultimate tensile strength.

6. Apparatus

6.1 *Measuring Equipment*—Micrometers, calipers, and plug gages capable of measuring the inside and outside diameters and length of the test specimen to the nearest 0.001 in. (0.03 mm).

6.2 *Compression Testing Machine*—A compression machine readable to 0.1% of the full scale reading, and capable of applying a controlled breaking force to the test specimen. Use the lowest range that can produce a measurable result.

6.3 *Loading Plates*—Two loading plates—ground, flat, hardened steel of a hardness greater than the microindentation hardness of the material being tested and large enough to encompass the entire length of the specimen.

7. Test Specimens

7.1 The test specimen shall be a hollow right circular thin-walled cylinder, with a wall thickness of less than 30 % of the specimen's outer diameter.

7.1.1 When PM bearings are to be tested, the test specimen shall be a plain sleeve bearing taken from a production lot or another bearing that has been machined to a plain cylindrical shape.

7.1.2 When metal powders are to be evaluated, the test specimen shall be produced according to the procedure in Practices B925.

8. Procedure

8.1 Measure the outside diameter, inside diameter, and the length of the test specimen to the nearest 0.001 in. (0.02 mm).

8.2 The test specimen shall be round within 0.003 in./in. (0.003 mm/mm) of the outer diameter.

8.3 Clean any surface oil or other contaminants from the test specimen and the flat surfaces of the loading plates.

8.4 Position the test specimen in the central region of the lower loading plate in the compression testing machine.

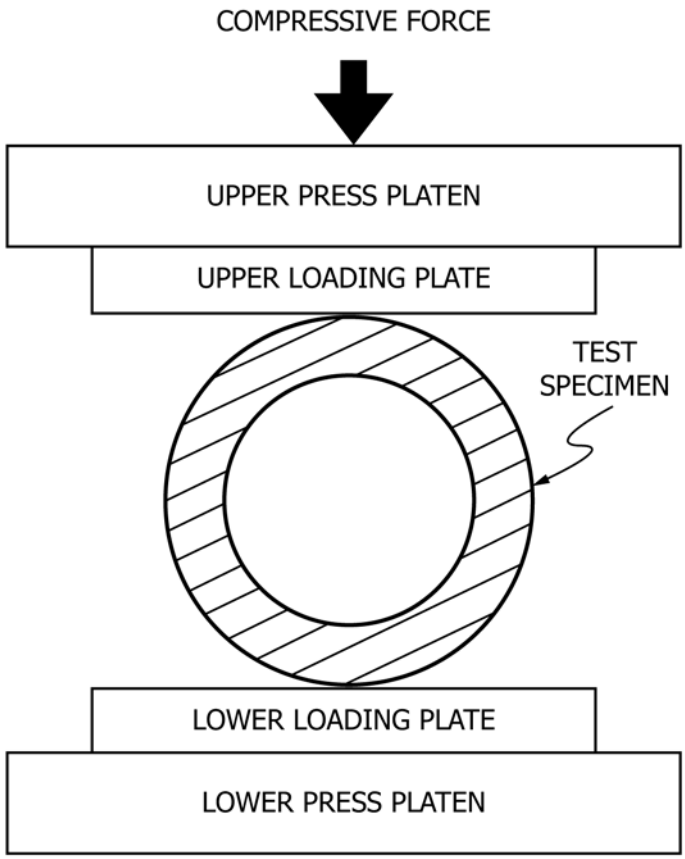

FIG. 1 Diametrical Load Applied to the Upper Plate and Test Specimen

8.5 Bring the upper plate into contact with the test specimen and slowly apply the diametric load at a constant crosshead closure rate that does not exceed 0.2 in./min (5.0 mm/min) (see Fig. 1).

8.6 Use a scale on the compression testing machine that has a precision of 0.1% or better of the crushing load and record, to the precision listed in Table 1, the load at which the test specimen fractures or the first reading at which the applied load drops.

9. Calculation

9.1 Use the following equation to calculate the radial crushing strength of the material in the specimen.

TABLE 1 Precision for the Measurement of the Crushing Load

Inch-Pound (lbf)		SI (N)	
$(D\text{-}t)/Lt^2$	Record Break Load To:	$(D\text{-}t)/Lt^2$	Record Break Load To:
<100	±10	<0.155	±50
>100	±1	>0.155	±5