



Designation: **B611–85 (Reapproved 2005) B611 – 13**

Standard Test Method for ~~Abrasive Wear Determining the High Stress Abrasion~~ ~~Resistance of Cemented Carbides Hard Materials~~¹

This standard is issued under the fixed designation B611; 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 determination of abrasive wear~~ was developed for ranking the high-stress abrasion resistance of cemented carbides, carbides, but it has been successfully used on ceramics, cermets, and metal matrix hardfacings with a hardness over 55 HRC. The feature of this test method that discriminates it from other abrasion tests is that the abrasive is forced against the test specimen with a steel wheel with sufficient force to cause fracture of the abrasive particles. Some abrasion tests use rubber wheels to force abrasive against test surfaces (Test Methods G65, G105, G75). A rubber wheel produces low-stress abrasion while a steel wheel produces high-stress abrasion.

1.2 In summary, this is a high-stress laboratory abrasion test for hard materials using a water slurry of aluminum oxide particles as the abrasive medium and a rotating steel wheel to force the abrasive across a flat test specimen in line contact with the rotating wheel immersed in the slurry.

1.3 The values stated in ~~inch-pound~~ SI 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~~ No other units of measurement are included in this 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

B311 Test Method for Density of Powder Metallurgy (PM) Materials Containing Less Than Two Percent Porosity

[G65 Test Method for Measuring Abrasion Using the Dry Sand/Rubber Wheel Apparatus](#)

[G75 Test Method for Determination of Slurry Abrasivity \(Miller Number\) and Slurry Abrasion Response of Materials \(SAR Number\)](#)

[G105 Test Method for Conducting Wet Sand/Rubber Wheel Abrasion Tests](#)

[G40 Terminology Relating to Wear and Erosion](#)

3. Terminology

3.1 *Definitions:* For definitions of terms found in this test method, please refer to Terminology [G40](#).

3.2 *Definitions: Definitions of Terms Specific to This Standard:*

3.1.1 ~~abrasion resistance, n —the specimen's unit loss in volume per revolution of the steel wheel carrying the abrasive.~~

3.2.1 ~~abrasive wear, n —that wear caused by a slurried abrasive on a rotating surface, contacting the specimen surface under pressure; wear due to hard particles or hard protuberances forced against and moving along a solid surface.~~

3.2.2 ~~wear number; high-stress abrasion, n —the reciprocal of the specimen's total volume loss in units of empressive material removal from a hard solid surface by the action of hard particles rolling or sliding on that surface with sufficient force to cause fracture of the $\bar{3}$ particles.~~

3.2.3 ~~slurry, n —a suspension of solid material in liquid.~~

¹ This test method is under the jurisdiction of ASTM Committee G02 on Wear and Erosion and is the direct responsibility of Subcommittee G02.30 on Abrasive Wear. Current edition approved Oct. 1, 2005; Nov. 15, 2013. Published October 2005. Originally approved in 1976. Last previous edition approved in 2000 as B611–85 (2000) (2005). DOI: 10.1520/B0611-85R05-10.1520/B0611-13.

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.

4. Summary of Test Method

4.1 The test specimen is a flat that is held in a vertical position tangent to a rotating steel wheel immersed in water slurry of aluminum oxide particles.

4.2 The normal force holding the test specimen against the wheel is high enough to cause fracture of abrasive particles that travel through the wheel/test specimen contact. The test metric is the volume of material worn from the test specimen in specified test duration and under specified test conditions.

4.3 The test specimen is weighed to determine mass loss which is converted to a volume loss using the density of the test material.

4.4 The slurry used in the test is composed of a specified mass of 30-mesh aluminum oxide in a specified volume of water.

4.5 There may be a corrosion component to the material removal, but it is considered to be negligible since the test time is only ten or twenty minutes (600 or 1200 seconds).

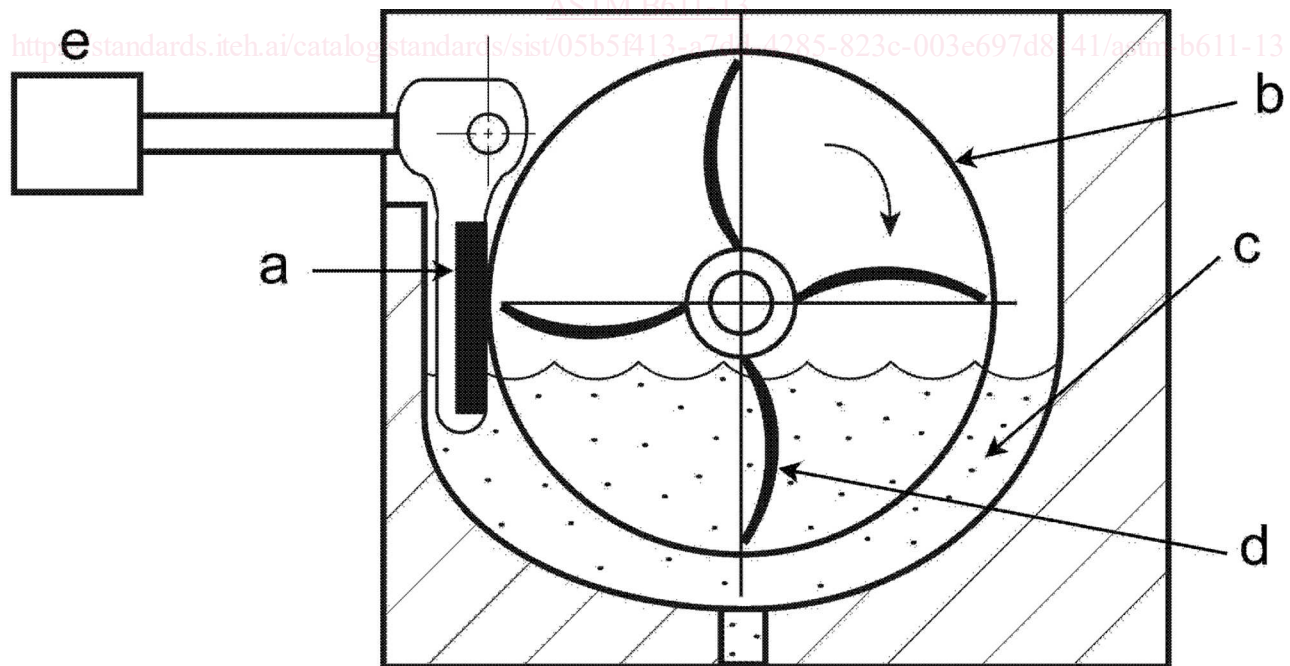
5. Significance and Use

5.1 This test method provides a guide to determine the relative abrasive wear resistance of cemented carbides under high-stress abrasion conditions. The abrasive wear is not a measure of wear characteristics of carbides under all conditions and is not to be misconstrued as indicative of wear when carbides are used for machinery. It does show the difference in resistance to abrasive use for different carbide compositions and can be used to screen new materials for these types of applications. It can also be used as a practical test or as a research method for sorting out these differences. quality control tool for materials destined for high-stress abrasion applications: slurry pumps, comminution equipment, recycling choppers, demolition equipment, etc.

5.2 Most abrasion tests use low-stress abrasion. The abrasive stays relatively intact during testing. High-stress abrasion simulates applications where the force between an abrasive substance and a tool/component will be high enough to crush the abrasive. If this describes an application under study, then this may be an appropriate test method to use.

6. Apparatus

5.1 Vessel, suitable for holding the abrasive slurry and the wheel (see Fig. 1). One suitable vessel is made of 3/16-in. (5-mm) steel.



NOTE 1—"a" is the test specimen; "b" is the steel wheel; "c" is the test slurry; "d" are agitating vanes. They can have a slight curve as shown or flat. They can be from 3 to 13 mm high, but must have a minimum clearance of 3 mm on a side between the vanes and the vessel. They can be staggered so that the vanes on one side make an angle of 45° with the vanes on the other side. The mass producing the normal force is "e."

FIG. 1 Schematic Diagram of Abrasive Wear Resistance Apparatus of Test Rig

The internal dimensions are 8¾ in. (220 mm) high, 9¾ in. (245 mm) long, and 2¼ in. (60 mm) wide, with a 5½-in. (140-mm) radius at the bottom.

6.1 *Wheel, General Description*—made Fig. 1 of annealed AISI 1020 steel, that rotates in the center of the vessel at 100 ± 5 rpm. The direction of rotation is from the slurry to the specimen. Four curved vanes are affixed to either side of the wheel to agitate and mix the slurry and to propel it toward the specimen. The maximum wheel diameter shall be 6.65 in. (169 mm) and the width shall be 0.500 ± 0.005 in. (12.7 ± 0.1 mm). The wheel shall be discarded when its diameter has decreased to 6.50 in. (165 mm) minimum, after repetitive use. In use, a slight burr will form at the periphery. This burr will compensate for wheel wear by widening the wear path in the specimen; it shall not be removed. is a schematic of the test rig. The test specimen (a) contacts a steel wheel (b) on its centerline; the water/grit slurry (c) is held in a slurry vessel; vanes, made from aluminum or steel (d) are on both sides of the steel wheel agitate the slurry. The load (force) is applied by a mass (e) that is constant throughout the test; the slurry can be replenished if needed (Note: slurry may splash out of uncovered machines) during the test, and the test duration and wheel rotational speed are fixed for the test.

6.2 *Abrading Wheel*—The wheel is made from AISI 1020 steel (80 to 95 HRB); the outside diameter is 169 ± 0.1 mm when new and the wheel shall be discarded when its diameter wears below 165 mm. A burr develops during use. It should not be removed. The wheel is not dressed between uses. Four agitating vanes are attached at 90° increments on both sides of the wheel. The vanes must have a minimum radial clearance of 3 mm with the test sample when the wheel penetrates the test specimen to produce a wear scar (the vanes must not contact the specimen during testing). The wheel width is 12.7 ± 0.1 mm.

6.3 *Test Specimen*—The test specimen dimensions are shown in Fig. 2 (from Test Method G65). It should have a surface roughness in the range of 0.1 to 1 µm Ra on the test surfaces.

6.4 *Drive Motor*—A 1 hp motor with a gear reduction unit has been found suitable for use, but other motors (hydraulic or DC motors, etc.) could be used if they have the torque requirements to rotate the wheel with a 200 N “braking” force applied to the outside diameter. The wheel can be directly mounted to the drive or it can be mounted on a spindle which is driven by a motor. Whatever the mechanism, the radial runout of the wheel shall be less than ± 0.01 mm and widthwise runout shall be less than ± 0.05 mm. The motor speed shall be controlled to the specified rpm ± 2 rpm.

6.5 *Specimen Holder, Holder*—to be pressed against the periphery of the wheel. This specimen holder shall be mounted so that not more than 0.002 in. (0.05 mm) of side play occurs at the line of contact between the specimen and the wheel. The specimen holder shall be so placed that the specimen is tangential to the wheel at the center line of the wheel and specimen. A 10-kg weight shall be attached to the other end of the specimen holder lever arm. With a lever advantage of two-to-one, a force of 20 kg is thus applied to the specimen at the line of contact. The centerline of the pivoting specimen holder should be aligned with the tangent point of the system with a new wheel. The sideways movement of the holder should be less than 0.2 mm and it should be designed to place the wear scar in the center of the test specimen. Subsize test specimens can be held in special holders that allow the flat face of the test specimen full wheel contact. If the wear scar runs into the holding device, the test specimen should be considered inadequate in size for testing with the standard procedure.

6.6 *Slurry Vessel*—The internal dimensions of the vessel that contains the slurry are shown in Fig. 3. The vessel can be made from metals or plastic and corrosion-resistant materials are preferred. The slurry must be replaced for every test so a drain or other way of removing the slurry is advisable.

6. Test Specimen

6.1 The specimen shall be at least 3/16 in. (5 mm) thick and have a surface area large enough so that the wear will be confined within its edges. The specimen may be as large as the specimen holder of the apparatus will permit. Dimensional tolerances are not important, but the specimen shall be flat within a maximum of 0.004 in./in. (mm/mm). Surface finish of the specimen is not important, except that ground blanks shall be cleaned with a suitable solvent to remove all oils or waxes, and unground blanks shall be grit blasted to remove all adhering foreign particles.

7. Procedure

7.1 *Specimen Preparation*—The test surface of the test specimen should be flat and not contain errors of form (ridges, waves, bumps, etc.) greater than 2.0 µm. A test specimen can be tested on the front and backside as long as the holder references the specimen from the unworn surface.

7.2 *Specimen Cleaning*—Test specimens should be degreased with a solvent that does not attack the test surface or leave a film. Ultrasonic cleaning for a time from 30 to 90 s in acetone has been found to be adequate for most metals and cermets.

7.3 *Specimen Weighing*—Weigh the specimen on an analytical balance to the nearest 0.0001 g; test specimen to ± 0.001 g three times and take the average weight as the starting weight. **Ferrous materials should be demagnetized before testing.**

7.2 Determine the density in accordance with Test Method B311.

7.3 Place the specimen in a specimen holder and fasten rigidly with set screws and pressure plates.

7.4 Insert the specimen holder into the abrasion wear test machine.