



Designation: G 174 – 03

Standard Test Method for Measuring Abrasion Resistance of Materials by Abrasive Loop Contact¹

This standard is issued under the fixed designation G 174; 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 ranking rigid engineering materials for abrasion resistance in rubbing against a 30- μ m aluminum oxide abrasive finishing tape. Though most solids can be tested, this test method addresses its use for metals, and coatings applied to metals.

1.2 *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:

E 177 Practice for Use of the Terms Precision and Accuracy as Applied to Measurement of a Property of a Material²

E 178 Practice for Dealing with Outlying Observations³

E 691 Practice for Conducting an Inter-laboratory Study to Determine the Precision of a Test Method⁴

G 40 Terminology Relating to Erosion and Wear⁴

G 117 Guide for Calculating and Reporting Measures of Precision Using Data from Inter-laboratory Wear and Erosion Tests⁴

G 132 Test Method for Pin Abrasion Testing⁴

3. Terminology

3.1 Definitions:

3.1.1 *abrasive wear, n*—wear due to hard particles or hard protuberances forced against, and moving along, a solid surface.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *abrasion, n*—the process of abrasive wear.

3.2.1.1 *Discussion*—Terminology G 40 does not define abrasion.

3.2.2 *abrasion resistance, n*—in tribology, the ability of a material to resist damage or attrition by abrasion.

3.2.3 *fixed abrasive tape, n*—hard particles or grains bonded (fixed) to one side of a flexible web with a resin or similar binder. The particles can be of any hard material and vary in size. (This abrasive medium is also known as “finishing tape,” “microfinishing tape,” “microfinishing film,” or “finishing film.”)

3.2.4 *flexible web, n*—plastic, paper, rubber, or other material that is thin enough to conform to a 180° wrap around a 16-mm diameter cylinder under a tension of less than 1.8 kg/cm width.

4. Summary of Test Method

4.1 This test involves rubbing an abrasive tape loop initially in line-contact with a solid surface. The tape abrasion produces a groove in the test surface, and the volume of material removed in a designated amount of abrasive rubbing is measured by mass loss or by calculation from the groove geometry. The continuous loop of abrasive is used for the duration of the test and then discarded. A fresh loop is used for each one-hour test.

4.2 The wear volume produced in this test provides a measure of the ability of a surface to resist wear damage from abrasive substances. The smaller the wear volume in this test, the better the abrasion resistance.

4.3 The test was developed using 30 μ m-mean diameter aluminum oxide abrasive on a 127 μ m-thick polyester support, but other commercially available abrasive tapes could be used. The test has also been used with webs such as paper that are inherently abrasive to many materials.

5. Significance and Use

5.1 This test is useful for screening materials for use in tools that are subjected to abrasion from the material that is being machined, worked, or formed. It has been used to screen tool steels for punch press dies, hardfacings for earth-moving machinery, and wear coatings. This test utilizes a test that is simpler to build and use than those used in the Test Method G 132 abrasion test which, like this test, uses a fixed abrasive counterface to abrade a test material.

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 June 10, 2003. Published July 2003.

² *Annual Book of ASTM Standards*, Vol 03.01.

³ *Annual Book of ASTM Standards*, Vol 14.02.

⁴ *Annual Book of ASTM Standards*, Vol 03.02.

5.2 The one-hour test is intended for metals and materials that are softer than hardened steel (67 HRC), but may be applied to harder materials (see 7.7).

6. Apparatus

6.1 The test apparatus used in inter-laboratory tests is illustrated in Fig. 1. A 132-cm long by 25.4-mm wide abrasive tape is made into a continuous loop with a pressure sensitive adhesive (PSA) butt splice (Fig. 2). The web is tensioned to form a triangle with the 16-mm diameter drive spindle at the apex. The idler rolls can be of any diameter, but a convenient size is about 50 mm radius with flanges to prevent lateral movement of the tape. The test sample shall have the dimensions shown in Fig. 3. It is clamped or attached to the counterbalanced loading arm with PSA foam. The loading arm is pivoted on rolling element bearings. A 200 g loading mass is attached to the pivot arm and centered directly over the line contact between the specimen and drive spindle.

6.2 One idler roller must be adjustable to produce tape tension sufficient to drive the tape with spindle-to-tape slippage of less than 20 m in a one-hour test time. The drive spindle shall be 16 mm in diameter and have a total indicated run-out of less than 20 μm at a rotational speed of 300 rpm.

7. Test Procedure

7.1 *Specimen Preparation*—The test surfaces (7.6 by 32 mm) should have a ground or lapped finish with a roughness less than 0.2 μm Ra. The surface lay shall be aligned with the long axis of the test specimen. When testing molded surfaces or specific finishes, the test samples should have the finish of interest on the test faces.

7.2 *Cleaning*—Cleaning is not needed if the test surfaces are untouched after the sample preparation and no lubricants, and so forth, were used in fabrication. If the surfaces are contaminated, clean in a solvent that will not leave a surface film or degrade the properties of the test surface (acetone is suitable for most metals).

7.3 *Weighing*—If mass change is going to be used as the test metric, weigh the test specimen to the nearest tenth of a milligram and record this as the initial weight.

7.4 *Sample Attachment*—Affix the test sample to loading arm and the 200 g-loading mass over the line where the specimen has tangential contact with the tape.

7.5 *Belt Tensioning*—Tension the abrasive belt over the drive spindle and idler rollers by moving idler rollers. Check the loop for slip with a mark on the tape and spindle. Loops are used only once for one hour.

7.6 *Check Systems Alignment*—Tapered scars will result if the sample is not parallel to the drive spindle. Check alignment by putting pressure sensing media on the spindle and bring the specimen in contact with the spindle. The pressure-sensing medium must show line contact across the sample width. Thin foils (less than 25 μm) can also be used to make sure that both edges of the test sample are contacting the spindles. Put the foil between the spindle and the edge of the sample and pull the foil out. Repeat on the other side. Equal pull force on both sides shows good alignment, and can be measured with a force measuring device. Lock the aligned sample arm in place. Put the loop on and tension it as in 7.5. Turn the tester on for 5 to 10 s and lift the sample arm and check for a uniform wear scar across the sample width.

7.7 *Testing*—Set the spindle rotational speed to 300 rpm and turn the tester on. Start timing or set a time on the machine power to shut off after one hour.

NOTE 1—Some cemented carbides and other hard materials may require a longer time to develop a measurable wear scar. Sometimes these materials require several one-hour test cycles with the tape changed each hour. This is a non-standard test and is not covered by this method.

7.8 *Scar Measurement*—Clean wear debris from the specimen with an acetone or alcohol wipe or other suitable technique. Measure the scar width in at least three places (edge-center-edge) to within 0.1 to 0.25 mm. Calculate sample wear volume using the following equation or other model for calculating a segment of a cylinder (see Fig. 4).

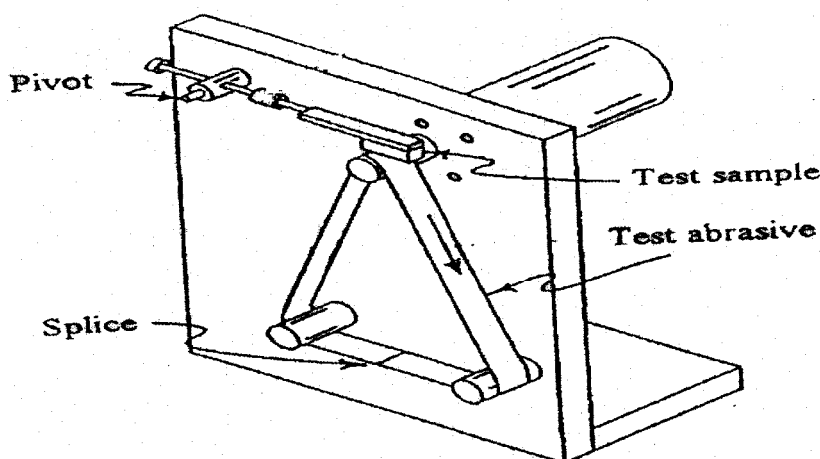
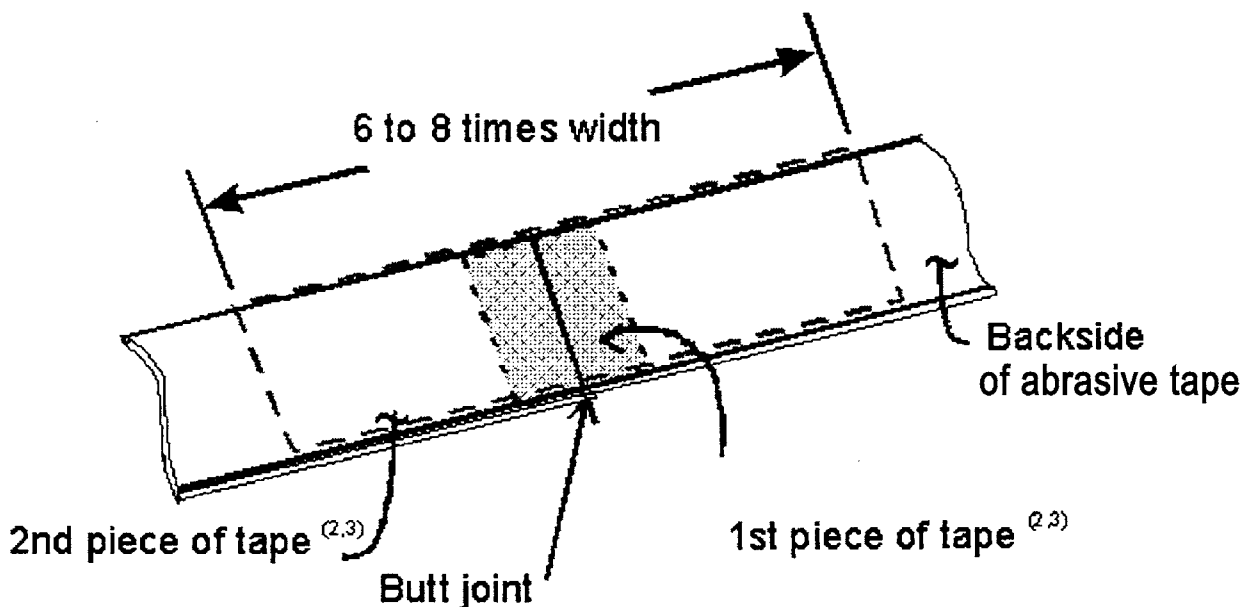


FIG. 1 Schematic of Test Rig

ASTM G 174 - 03

ASTM G 174 - 03



1—8 mil-thick microfinishing film was used in inter-laboratory tests. It was purchased as:

3M Corporation
Imperial Lapping Film 262L
Grade 30 MIC, Mineral A/O
Backing 5 mil Size 1 by 150 by 3 in.

2—Scotch Magic Tape (3M Corp.) was used in inter-laboratory tests

3—3M Corp.
3 M Center, Building 251-2A-08
St. Paul, MN 55144-1000 USA

NOTE—Some tapes may have a release agent on the back that must be removed by abrasion followed by solvent wipe

FIG. 2 Loop Splicing Detail

1—8 mil-thick microfinishing film was used in inter-laboratory tests. It was purchased as:

3M Corporation
Imperial Lapping Film 262L
Grade 30 MIC, Mineral A/O
Backing 5 mil Size 1 by 150 by 3 in.

2—Scotch Magic Tape (3M Corp.) was used in inter-laboratory tests

3—3M Corp.
3 M Center, Building 251-2A-08
St. Paul, MN 55144-1000 USA

NOTE—Some tapes may have a release agent on the back that must be removed by abrasion followed by solvent wipe.

FIG. 2 Loop Splicing Detail

7.9 *Measurement of Mass Change*—If gravimetric measurement is used as the test metric, weigh the sample to $\pm 1/10$ mg and subtract this mass from the initial mass. Take the mass change and convert it into wear volume by dividing by the density for the test material.

NOTE 2—Mass loss is usually not used on tool steels and similar hard materials. Scar measurement is usually more accurate.

8. Report

8.1 Report the following:

8.1.1 Test material including all details on manufacture, treatment, and surface texture,

8.1.2 Abrasive tape used, grit size, grit material, tape thickness, and width.

8.1.3 Conditions: normal force, total abrasion distance, tape speed, number of replicates, test temperature and relative humidity, test metric (scar size or mass change), and

8.1.4 Wear volume (average and standard deviation).

9. Precision and Bias

9.1 *Precision*—The precision of an individual scar measurement can be checked by using mass change and different ways of measuring the scar by physical measurement. If all techniques produce the same wear volume, the measurement will be precise. Physical measurements usually include optical or profilometer measurement of scar width followed by calculations to yield wear volume. Profilometer software is available for the calculation of wear from scar geometry.