Designation: G133 – 22

Standard Test Method for Linearly Reciprocating Ball-on-Flat Sliding Wear[1]

This standard is issued under the fixed designation G133; 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 laboratory procedures for determining the sliding wear of ceramics, metals, and other candidate wear-resistant materials using a linear, reciprocating ball-on-flat plane geometry. The direction of the relative motion between sliding surfaces reverses in a periodic fashion such that the sliding occurs back and forth and in a straight line. The principal quantities of interest are the wear volumes of the contacting ball and flat specimen materials; however, the coefficient of kinetic friction may also be measured using the method described. This test method encompasses both unlubricated and lubricated testing procedures. The scope of this test method does not include testing in corrosive or chemically aggressive environments or extremes of temperature and humidity.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

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

1.4 *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]

E112 Test Methods for Determining Average Grain Size
E1181 Test Methods for Characterizing Duplex Grain Sizes
G40 Terminology Relating to Wear and Erosion
G99 Test Method for Wear Testing with a Pin-on-Disk Apparatus
G115 Guide for Measuring and Reporting Friction Coefficients
G117 Guide for Calculating and Reporting Measures of Precision Using Data from Interlaboratory Wear or Erosion Tests (Withdrawn 2016)[3]
G118 Guide for Recommended Format of Wear Test Data Suitable for Databases (Withdrawn 2016)[3]

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions used in this test method are given in Terminology G40. The following definitions of important terms used in this test method are cited from Terminology G40.

3.1.2 *friction force, n*—the resisting force tangential to the interface between two bodies when, under the action of an external force, one body moves or tends to move relative to the other.

3.1.3 *Hertzian contact pressure, n*—the magnitude of the pressure at any specified location in a Hertzian contact area, as calculated from Hertz's equations of elastic deformation.

3.1.4 *wear, n*—damage to a solid surface, generally involving the progressive loss of material due to relative motion between that surface and a contacting surface or surfaces.

3.1.5 *wear rate, n*—the rate of material removal or dimensional change due to wear per unit of exposure parameter, for example, quantity removed (mass, volume, thickness) in unit distance of sliding or unit time.

4. Summary of Test Method

4.1 This test method involves two specimens—a flat specimen and a spherically ended specimen (herein called the "ball" specimen, but the terms "pin" and "...spherical tip" are also acceptable and in common use) that slide against the flat specimen. These specimens move relative to one another in a linear, back and forth sliding motion ("linearly reciprocating"), under a prescribed set of conditions.

[1] This test method is under the jurisdiction of ASTM Committee G02 on Wear and Erosion and is the direct responsibility of Subcommittee G02.40 on Non-Abrasive Wear.

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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] The last approved version of this historical standard is referenced on www.astm.org.

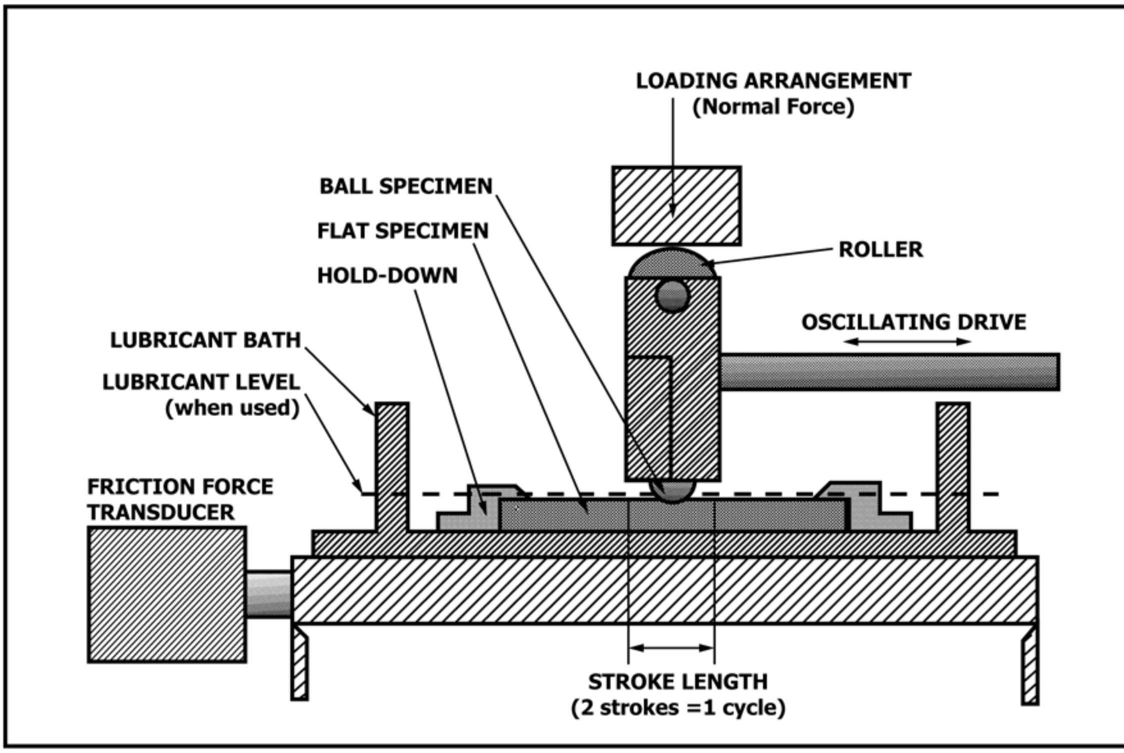

FIG. 1 Reciprocating Test—Schematic Diagram

4.2 In this test method, the load is applied vertically downward through the ball specimen against the horizontally mounted flat specimen. The normal load, stroke length, frequency and type of oscillation, test temperature, lubricant (if any), test duration, and atmospheric environment (including relative humidity range) are selected from one of two procedures.

4.3 Since this test method involves reciprocating sliding where changes in the sliding velocity and direction of motion occur during the test, constant velocity conditions are not maintained. The manner in which the velocity varies with time is determined by the design of the mechanism which drives the ball or flat specimen back and forth.

4.4 Dimensional changes for both ball and flat specimens are used to calculate wear volumes and wear rates.

4.5 Friction forces can also be measured during the test and may be used to assess changes in the contact conditions or the kinetic friction coefficient as a function of time.

5. Significance and Use

5.1 This test method is designed to simulate the geometry and motions that are experienced in many types of rubbing components whose normal operation results in periodic reversals in the direction of relative sliding. The wear resulting from this mode of movement may differ from that experienced by the same materials sliding continuously in only one direction (unidirectional sliding, for example, using Test Method G99) even for comparable durations of contact. This is particularly true for liquid-lubricated tests where the reversal of motion means that the entrainment velocity transitions through zero but also in unlubricated tests in which stress reversal occurs. The normal load(s) and sliding speed(s) to be used during testing are to be determined by the severity of the proposed application or purpose of the testing. Either of two sets of testing conditions (designated Procedures A and B) may be used.

6. Apparatus

6.1 *General Description*—Fig. 1 shows the arrangement for the reciprocating ball-on-flat wear test available on a commercial machine. The ball is rigidly mounted and has a spherical tip which moves back and forth across the surface of a polished flat specimen. Use of a ball (that is, a "spherical tip") alleviates the alignment problems associated with flat-ended pins sliding on flat surfaces. Alternate configurations in which the flat moves and the ball specimen is fixed may be used. A provision is made for applying a uniform normal force (load) to the contact between the ball and the flat. Temperature measurement and control capability is provided to heat and monitor the flat specimen which may either be immersed in a lubricant bath or tested without lubricant. The tangential force can be measured continuously during oscillating contact and used to obtain friction coefficient data.[4]

6.2 *Specimen Drive*—A drive train, capable of providing smooth, repeatable, reciprocating motion to the ball and overcoming the frictional resistance of the specimens at

[4] Machines of this type are described in *A Catalogue of Friction and Wear Devices*, American Society of Lubrication Engineers (now STLE) 838 Busse Highway, Park Ridge, IL, 1973, pp. 50–72.