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An American National Standard

Standard Test Methods for Measuring High Speed Baseball Bat Performance Factor¹

This standard is issued under the fixed designation F 2219; 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.

^{ε1} NOTE—Sections 1, 3, 5, 7, 8, 9, and 10 were editorially updated in February 2003.

1. Scope

1.1 This specification defines a method for determining the Bat-Ball Coefficient of Restitution (BBCOR), Bat Performance Factor (BPF), Ball Exit Speed Ratio (BESR), and a method for estimating the Batted-Ball Speed (BBS). It is applicable to baseball bats of any construction or material. The method provides a quantitative measure of bat dynamic performance that may be used for comparison purposes.

1.2 The BBCOR, BPF, BESR, and BBS are calculated from measurements taken in the laboratory on test equipment meeting the requirements defined in this specification.

1.3 The values stated in English units are to be regarded as the 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:

F 1881 Test Method for Measuring Baseball Bat Performance Factor²

F 1887 Test Method for Measuring the Coefficient of Restitution (COR) of Baseballs and Softballs²

F 1888 Test Method for Compression-Displacement of Baseballs and Softballs²

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *balance point*—the distance to the center of mass measured from the distal end of the bat knob.

3.1.2 *ball exit speed* (V_p), n —outbound speed (in mph), of ball following impact with a bat as defined in this test method.

3.1.3 *ball exit speed ratio (BESR)*, n —ratio of ball rebound velocity to ball inbound velocity plus one-half, as determined by this test method.

3.1.4 *bat-ball coefficient of restitution (BBCOR)*—the COR of a specific ball colliding with a bat as defined in this test method. See *coefficient of restitution (COR)*.

3.1.5 *bat performance factor (BPF)*, n —the ratio of performance a bat introduces to a ball collision, compared to a ball colliding with a solid steel half cylinder as defined in this test method.

3.1.6 *center of percussion (COP)*, n —also known as the center of oscillation, the length of a simple pendulum with the same period as a physical pendulum, as in a bat oscillating on a pivot. Forces and impacts at this location will not induce axial reactions at the pivot point.

3.1.7 *coefficient of restitution (COR)*, n —a measure of impact efficiency calculated as the relative speed of the objects after impact divided by the relative speed of the objects before impact.

3.1.8 *distal node*, n —flexible body property in first mode of vibration (two node case), defined as the furthest node from a reference (hands or pivot point in the case of a bat). The node is where vibrational amplitude is minimized or zero.

3.1.9 *maximum energy transfer point*, n —result of rigid and flexible body properties, point along a bat where maximum batted ball speeds result. For typical bats, this point is located close to the COP.

3.1.10 *moment of inertia (MOI)*, n —a measure of mass distribution relative to an axis of rotation. It is the product of the mass multiplied by the square of the distance to the mass, summed over the entire bat.

3.1.11 *period*, n —the time required for a pendulum to oscillate through one complete cycle.

3.1.12 *sweet spot*, n —produced by a combination of rigid and flexible body properties, a point on a body where an impact results in a minimum vibrational energy at a given reference location (in the case of a bat, hands or pivot point). For typical bats, the sweet spot is generally located between the COP and the distal node.

¹ This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.26 on Baseball and Softball Equipment and Facilities.

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² *Annual Book of ASTM Standards*, Vol 15.07.

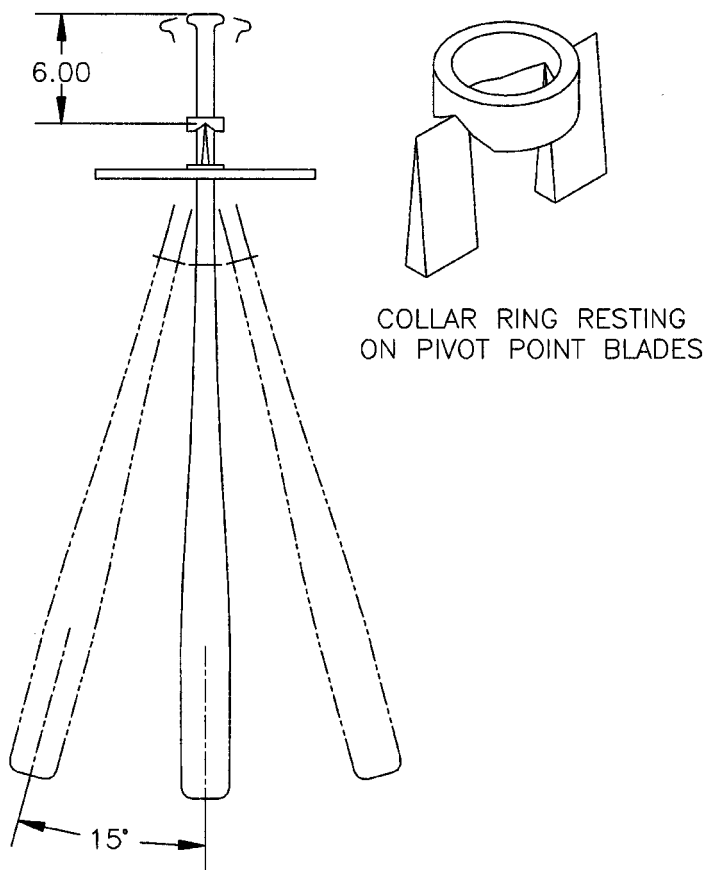


FIG. 1 MOI Fixture

4. Significance and Use

4.1 This test method offers a laboratory means to compare the performance of bats at a greater level of bat-ball impact speeds than provided by Test Method F 1881.

4.2 Use of this test method can provide sports governing bodies a means to compare the anticipated batted-ball speed, thus batted-ball distance for the purposes of controlling the game.

5. Apparatus

5.1 Bat Center of Percussion Test Apparatus:

5.1.1 *Ruler*, suitable for measuring lengths up to 42 in. (1067 mm) to the nearest 0.031 in. (0.79 mm).

5.1.2 *Weight Scale*, suitable for measuring weight up to 48 oz (1360 g) to the nearest 0.0035 oz (0.1 g).

5.1.3 *Electronic Timer*, suitable device sufficiently accurate for measuring time to the nearest thousandth of a second (0.001 s).

5.1.4 *Stand*—A frame large enough to allow a bat held in a vertical position to swing freely (see Fig. 1).

5.1.5 *Collar-Clamp*—A lightweight clamp or collar that can hold the weight of a bat and provide a fixed pivot location. Collar shall be rotationally balanced (see Fig. 1).

5.2 *Test Balls*—Official baseballs approved for play and tested in accordance with the following procedures.

5.2.1 *Compression*—300 to 375 lb at $\frac{1}{4}$ in. deflection (1135 to 1668 N at 6.4 mm). Compression values determined per Test Method F 1888. Balls to be labeled with compression values.

5.2.2 *Weight*—5.0 to 5.25 oz (142 to 149 g).

5.2.3 *Size*—9 to 9.5 in. circumference (22.9 to 24.1 cm).

5.2.4 *High Speed Ball COR*—Shall be measured in a manner similar to Test Method F 1887 except that the impacting surface shall be a solid steel half cylinder of $2\frac{5}{8}$ in. (66.7 mm) diameter and test speed is 132 ± 1.3 ft/s ($40.2 \text{ m/s} \pm 0.4 \text{ m/s}$, approximately 90 mph). COR shall be determined for each ball at the appropriate test speed. Balls to be labeled with COR and test speed in fps.

5.3 Bat-Ball COR Test Apparatus:

5.3.1 *Ball Cannon*—A device capable of shooting a ball at speeds up to 135.0 ft/s (41.1 m/s) with a maximum aiming error of ± 0.125 in. (± 3.2 mm) at the point of impact. The ball shall not have a spin rate in excess of 50 rpm. Typical pitching machines cannot yield the aiming accuracy required by this test method. Cannon exhaust air must not be allowed to pass to the bat. The ball cannon can be any distance from impact location, as long as it can meet the ball aim requirements and provide six valid impacts in 12 shots or less.

5.3.2 *Ball Speed Gate*—A light trap device, or an equivalent, capable of measuring a sphere traveling at speeds in excess of 135.0 ft/s (41.1 m/s) with an accuracy of 1.35 ft/s or better (0.41 m/s). The device shall measure across a length of