



Standard Test Methods for Measuring High-Speed Bat Performance¹

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1. Scope

1.1 A method for determining bat performance by measuring the bat-ball coefficient of restitution (BBCOR), deriving the collision efficiency (e_a), and calculating a batted-ball speed (BBS). It is applicable to baseball and softball bats of any construction or material. The test methods provide quantitative measures of bat dynamic performance that may be used for comparison purposes.

1.2 The BBCOR and BBS are each calculated from measurements taken in the laboratory on test equipment meeting the requirements defined in this standard.

1.3 Bat performance is found in this standard assuming the bat is unconstrained.

1.4 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.

1.5 *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.*

1.6 *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

F1887 Test Method for Measuring the Coefficient of Restitution (COR) of Baseballs and Softballs

F1888 Test Method for Compression-Displacement of Baseballs and Softballs

F2398 Test Method for Measuring Moment of Inertia and Center of Percussion of a Baseball or Softball Bat

F2845 Test Method for Measuring the Dynamic Stiffness (DS) and Cylindrical Coefficient of Restitution (CCOR) of Baseballs and Softballs

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *balance point (BP)*, n —distance to the center of mass from the knob end of the bat.

3.1.2 *bat-ball coefficient of restitution (BBCOR)*, n —COR of a specific ball colliding with a bat.

3.1.3 *batted ball speed (BBS)*, n —the speed that a ball would be hit off a bat in play based on given pitch and bat speeds.

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

3.1.5 *collision efficiency (e_a)*, n —ratio of ball exit speed to the ball inbound speed.

3.1.6 *cylindrical coefficient of restitution (CCOR)*, n —the ratio of the rebound to incoming speed of a ball impacting a solid rigid cylinder.

3.1.7 *dynamic stiffness (DS)*, n —a normalized measure of the ball impact force having units of stiffness (lb/in. or kN/m). It is obtained by dividing the square of the peak force between the ball and impact surface by the ball mass and the square of the incoming ball speed.

3.1.8 *moment of inertia (MOI)*, n —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.

3.1.9 *test sponsor*, n —group, association or individual specifying test requirements including ball specifications, performance measure, and test speed.

4. Significance and Use

4.1 These test methods offer a laboratory means to quantitatively compare the performance of baseball and softball bats.

¹ These test methods are under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and are the direct responsibility of Subcommittee F08.26 on Baseball and Softball Equipment.

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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.

4.2 Use of these test methods can provide quantitative metrics of bat performance.

5. Apparatus and Equipment

5.1 *Test Balls*—Baseballs or softballs as determined by the test sponsor.

5.1.1 Ball specification values are to be recorded and traced to individual balls.

5.2 Bat-Ball Test Apparatus:

5.2.1 *Ball Cannon*—A device capable of shooting a ball at speeds up to 220 ft/s (67.1 m/s, 150 mph). Balls shall be oriented to impact the strike surface between the stitches. Typical pitching machines cannot yield the aiming accuracy required by these test methods. Cannon exhaust air must not cause motion of the bat in the absence of an impact.

5.2.2 *Ball Speed Gate*—Light screens capable of measuring a ball traveling at speeds up to 220 ft/s (67.1 m/s, 150 mph), with an accuracy of at least ± 0.7 ft/s (± 0.2 m/s). The device shall measure across a length of no less than half the ball diameter to avoid centering error. The first sensor shall be located no more than 12.0 in. (304.8 mm) from the bat surface. The second sensor shall be located 6 ± 0.03 in. (152 ± 0.8 mm) after the first sensor (see Fig. 1). The ball speed gate must measure the ball rebound speed.

5.2.3 *Ball Angle Measurement*—Measure and record the ball vertical and horizontal rebound angles within 1° , using at least one of the following or equivalent devices.

5.2.3.1 *Angled Light Gates*—A light trap device capable of measuring the ball rebound angle after impact with a bat (see Fig. 2). The device shall measure across a length of no less than half the ball diameter to avoid centering error. The vertical rebound angle gate shall be mounted at approximately 45° relative to the inbound ball path. The horizontal rebound angle gate shall be mounted at approximately 25° relative to the inbound ball path (to provide room for the speed gates). (Appendix X1.)

5.2.3.2 *High Speed Camera*—A high speed video camera capable of recording the ball rebound path. If a mirror is placed at 45° atop the light box, one video camera can observe both the horizontal and vertical planes. (Appendix X2.)

5.2.4 *Bat Pivot Support*—A turntable, rotating in the horizontal plane, with clamps to support and align the bat in the path of the ball. The rotating clamp and shaft assembly shall not weigh more than 6 lb (2.7 kg) and shall spin freely via ball bearings (see Fig. 1). The MOI of the clamp turntable assembly shall be determined, recorded, and used in the performance calculations. The MOI for the clamp turntable assembly shall not exceed 300 oz-in.² (5498 kg-mm²).

5.2.5 *Bat Speed Sensor*—Device to measure bat rotational speed for at least 100° after impact. Device shall read speeds up to $3000^\circ/\text{s}$ with an accuracy of at least $1^\circ/\text{s}$ (found to be achievable using an optical encoder). Bat speed is taken from the slope of the linear least-squares fit to the bat rotation versus time data between 5° and 95° after impact.

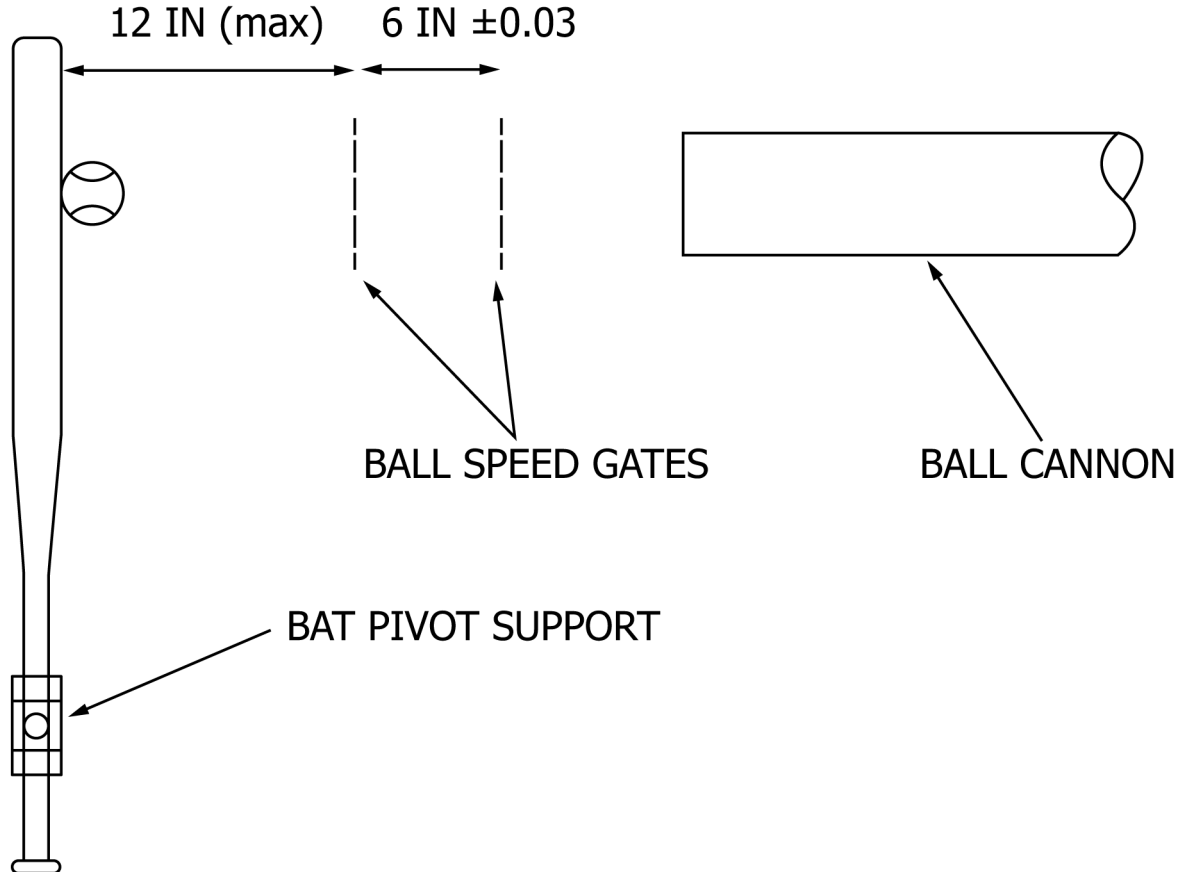


FIG. 1 Bat Testing Machine