



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 ball exit speed ratio (BESR), 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, BESR, and BBS are each calculated from measurements taken in the laboratory on test equipment meeting the requirements defined in this standard.

1.3 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.

1.4 *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 to determine the applicability of regulatory limitations prior to use.*

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

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

¹ These test methods are under the jurisdiction of ASTM Committee F08 on Sports Equipment 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.

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

3.1.2 *ball exit speed (v_r), n*—outbound speed of a ball following impact with a bat as defined in these test methods.

3.1.3 *ball exit speed ratio (BESR), n*—ratio of ball exit speed (v_r) to ball inbound speed (v_i) plus $\frac{1}{2}$, as determined by these test methods.

3.1.4 *ball inbound speed (v_i), n*—inbound speed of a ball prior to impact with a bat as defined in this test method.

3.1.5 *bat-ball coefficient of restitution (BBCOR)*—COR of a specific ball colliding with a bat as defined in these test methods. See *coefficient of restitution (COR)*.

3.1.6 *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.

3.1.7 *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.

4. Significance and Use

4.1 These test methods offer a laboratory measure of the performance of baseball and softball bats.

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 those specifying the test requirements.

5.2 Balls specification values are to be recorded and traced to individual balls.

5.3 *Bat-Ball Test Apparatus:*

5.3.1 *Ball Cannon*—A device capable of shooting a ball at speeds up to 220 ft/s (67.1 m/s, approximately 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.

5.3.2 *Ball Speed Gate*—Light screens capable of measuring a ball traveling at speeds up to 220 ft/s (67.1 m/s, approximately 150 mph), with an accuracy of at least ± 0.7 ft/s (0.2

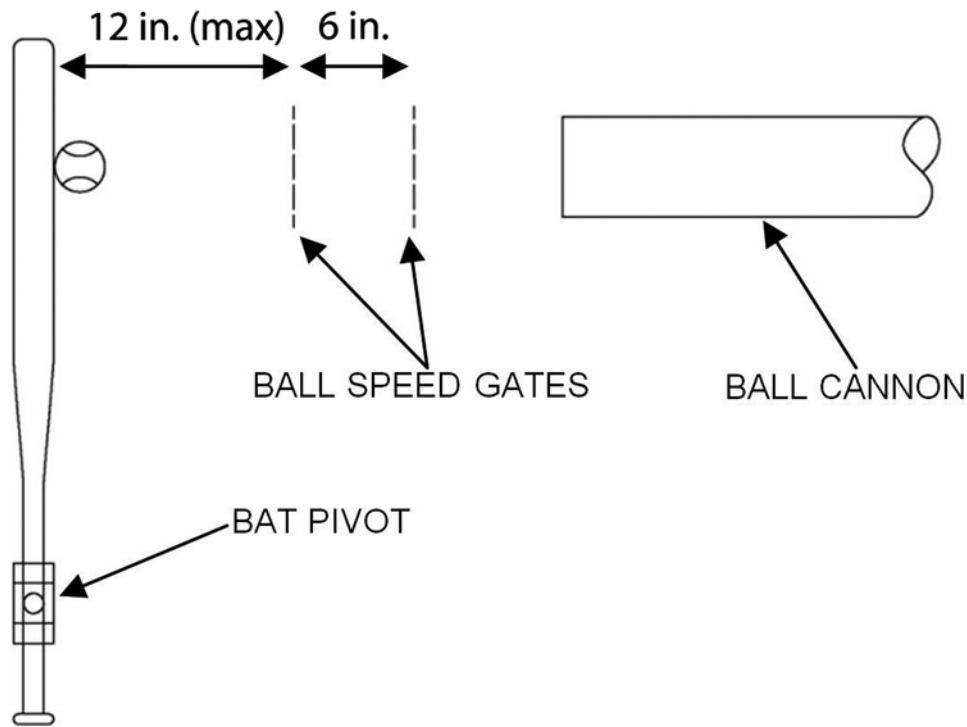


FIG. 1 Bat Testing Machine

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.

5.3.3 *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 actual MOI of the clamp turntable assembly shall be determined, recorded, and used in the performance calculations. The polar MOI for the clamp turntable assembly shall not exceed 300 oz-in.² (5498 kg-mm²).

5.4 *Bat Speed Sensor*—Device to measure bat rotational speed for at least 100° after impact. Device shall read speeds up to 3000°/s with an accuracy of at least 1°/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.

6. Calibration and Standardization

6.1 *Ball Speed Gate*—The distance between the sensors of the speed gates should be measured and recorded. The timers used for speed measurements should be calibrated on at least a yearly basis.

6.2 *Reference Standards and Blanks*—A standard bat and ball shall be used for reference purposes to verify proper machine operation.

7. Conditioning

7.1 *Ball and Bat Conditioning and Test Room Conditions:*

7.1.1 Test balls shall be stored in an environmentally controlled space for at least 14 days immediately before testing. Wood bats shall be stored at these environmental conditions for at least 24 h prior to testing. Non-wood bats shall be stored at these test environmental conditions for at least 2 h prior to testing.

7.1.2 Temperature is to be maintained at $72 \pm 4^\circ\text{F}$ ($22 \pm 2^\circ\text{C}$).

7.1.3 Relative humidity (RH) is to be maintained between 40 and 60 %.

7.1.4 Temperature and relative humidity are to be measured and recorded hourly within $\pm 0.5^\circ\text{F}$ ($\pm 0.3^\circ\text{C}$) and ± 2 % RH over the conditioning and test duration.

8. Procedure

8.1 *Determination of Bat Features and Test Location*—Determine bat balance point (BP) and bat MOI in accordance with Test Method F2398.

8.2 Select a performance variable (BBCOR, BESR, or BBS) to calculate. The choice of performance variable is left to those specifying the test requirements.

8.3 *Bat Test Procedure:*

8.3.1 Ready and calibrate ball speed gates in accordance with the manufacturer's instructions.

8.3.2 Select six test balls meeting requirement of 5.1, and record the actual values of compression, weight, size, and COR of the ball.

8.3.3 Set ball cannon to fire the ball at the desired test speed (60 to 150 mph) as determined by those specifying the test requirements.