



Standard Test Method for Measuring Moment of Inertia and Center of Percussion of a Baseball or Softball Bat¹

This standard is issued under the fixed designation F2398; 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 Method for determining the moment of inertia (MOI), the center of percussion (COP), and the balance point (BP) of baseball and softball bats. These physical properties are used in Test Method F1881, Test Method F1890, and Test Methods F2219.

1.2 The MOI, COP, and BP are measured in the laboratory on test equipment meeting the requirements defined in this test method.

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

1.5 *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

F1881 Test Method for Measuring Baseball Bat Performance Factor (Withdrawn 2014)³

F1890 Test Method for Measuring Softball and Baseball Bat Performance Factor

¹ This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is 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 The last approved version of this historical standard is referenced on www.astm.org.

F2219 Test Methods for Measuring High-Speed Bat Performance

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

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

3.1.2 *center of percussion (COP), n*—also known as the center of oscillation. Forces and impacts at this location will not induce reactions at the pivot point, 6 in. (152 mm) from the knob end of the bat.

3.1.3 *cycle, n*—one complete oscillation of a pendulum supported at the pivot point, 6 in. (152 mm) from the knob end of the bat.

3.1.4 *moment of inertia (MOI), n*—also known as the mass moment of inertia, the measure of the bat's resistance to changes in its rotation rate about the pivot point, 6 in. (152 mm) from the knob end of the bat.

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

4. Significance and Use

4.1 This test method offers a laboratory means to measure the inertial properties of bats, specifically weight, balance point, center of percussion, and MOI, in support of other test methods including the ASTM standards referenced in this document.

4.2 Use of this test method can provide sports governing bodies the means to establish rules regarding the physical properties of bats, specifically MOI.

5. Apparatus

5.1 *Bat MOI Test Apparatus:*

5.1.1 *Ruler*, suitable for measuring lengths up to 42 in. (1067 mm) to the nearest 0.03 in. (0.8 mm).

5.1.2 *Weight Scales*, suitable for measuring weight up to 48 oz (1361 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 1 μ s (0.000001 s).

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

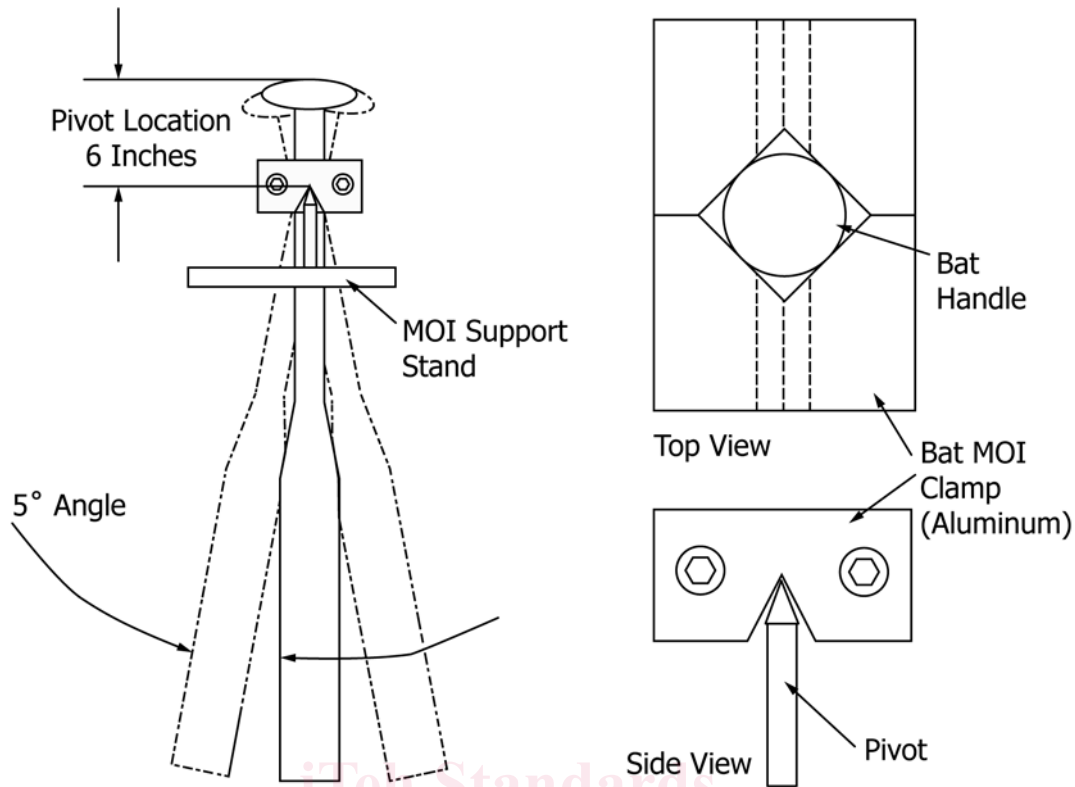


FIG. 1 MOI Fixture

5.1.5 *Bat Collar-Clamp*—A lightweight clamp or collar that can hold the weight of a bat and provide a fixed pivot location. The clamp shall be rotationally balanced and have a maximum MOI of 4 oz-in.² (73 kg-mm²) measured about the bat pivot location (see Fig. 1). The MOI of the clamp shall not change with the diameter of the bat being tested.

6. Calibration and Standardization

6.1 *Calibration Rod*—The calibration rod shall be 1 ± 0.01 in. (25.4 ± 0.25 mm) in diameter by 34 ± 0.1 in. (864 ± 2.5 mm) long, solid aluminum.

6.2 *Target Calibration MOI*—Measure the length and the weight of the calibration rod. Compute the target calibration rod MOI using Eq. 1:

$$I_T = W_c \left\{ \frac{L_c^2}{12} + \left(\frac{L_c}{2} - d \right)^2 \right\} + I_c \quad (1)$$

where:

- I_T = target MOI of the calibration rod, oz-in.² (kg-mm²)
- W_c = measured weight of the calibration rod, oz (kg)
- L_c = measured length of the calibration rod, in. (mm)
- d = pivot distance (6 in. or 152 mm)
- I_c = MOI of the clamp about its pivot point, oz-in.² (kg-mm²)

6.3 *Balance Point Calibration*—Following 7.1, the BP of the calibration rod shall be $L_c/2 \pm 0.05$ in. (1 mm). If the BP of the calibration rod is outside the allowed range, check the calibrations of the scales and support fixture.

6.4 *Mass Moment of Inertia Calibration*—Using the measured properties of the calibration rod from 6.2 and 6.3 and following 7.2 and 7.3, the measured MOI of the calibration rod should be within ±50 oz-in.² (916 kg-mm²) of the target MOI, I_T . If the MOI of the calibration rod is outside the allowed range, then check the clamp location and timer calibration.

7. Procedure

7.1 Determination of BP:

7.1.1 Measure and record the overall bat length to the nearest 0.06 in. (1.5 mm). Place the bat level on the BP fixture as shown in Fig. 2. Record the measured weights (W_6 and W_{24}) to the nearest 0.035 oz (1.0 g). Calculate the BP relative to the knob end of the bat using Eq 2:

$$BP = \frac{6W_6 + 24W_{24}}{W_t} \quad (2)$$

where:

- BP = BP from knob end of the bat, in. (mm)
- W_6 = weight of the bat measured 6 in. (152 mm) from the knob, oz (g)
- W_{24} = weight of the bat measured 24 in. (610 mm) from the knob, oz (g)
- W_t = $W_6 + W_{24}$ = total weight of the bat, oz (g)

7.2 Determination of COP:

7.2.1 Apply the clamp to the bat handle so that the pivot location (point of the vee on underside of the clamp) is 6 ± 0.03 in. (152 ± 0.8 mm) from the knob end of the bat (see Fig.