



# Standard Test Method for Measuring Moment of Inertia and Center of Percussion of a Baseball or Softball Bat<sup>1</sup>

This standard is issued under the fixed designation F 2398; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers a method for determining the moment of inertia (MOI) and balance point (BP) of baseball and softball bats. These physical properties are used in calculations in other key ASTM standards.

1.2 The MOI 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 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. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *balance point (BP)*—the distance to the center of mass measured from the distal end of the bat knob.

2.1.2 *center of percussion (COP)*—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.

2.1.3 *cycle*—one complete performance of the oscillation of the bat, specifically, one full swing of the bat.

2.1.4 *moment of inertia (MOI)*—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.

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

## 3. Significance and Use

3.1 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.

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

## 4. Apparatus

4.1 *Bat MOI Test Apparatus:*

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

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

4.1.3 *Electronic Timer*, suitable device sufficiently accurate for measuring time to the nearest 1  $\mu$ s (0.000001 s).

4.1.4 *MOI 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).

4.1.5 *Bat Collar-Clamp*—A part of the MOI stand that allows quick accurate mounting of the bat without a variable MOI effect due to the clamp with a maximum MOI of 4 oz-in.<sup>2</sup> (0.8 kg-cm<sup>2</sup>) measured about the bat pivot location. 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. Calibration and Standardization

5.1 *Calibration Rod*—A calibration rod tested at two different pivot locations shall be used to determine if the MOI stand is capable of accurately measuring the MOI of a bat. The rod shall be a 1-in. (25.4-mm) diameter by 24-in. (609.6-mm) long steel rod weighing 85.65 oz (2.43 kg). The MOI of this rod measured with the pivot location at 8 in. (20.32 cm) should be 5487 oz-in.<sup>2</sup> (1003 kg-cm<sup>2</sup>) and at a pivot location of 2 in.

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