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# Bat Performance Standards in NCAA Baseball

Starting with the 2000 season, the NCAA requires that bats be subjected to performance testing. Bats are tested by impacting a ball moving at 70 mph with a bat rotating about a point 6" from the knob (toward the barrel) such that the speed of the bat at a point 6" from the barrel (toward the knob) is 66 mph.[1]

The post-impact ball speed is measured at different impact locations along the barrel. Bats are certified for use in officially sanctioned NCAA games if the ball exit speed does not exceed 97 mph at any of the impact locations, corresponding to a BESR of 0.728 (see corresponding article). The 97 mph upper limit was arrived at by testing a large sample of different wood bats, where it was found that the maximum exit speed was 96 mph. The maximum for aluminum was increased by 1 mph to allow for uncertainties in the measurement. This means that *for bats swung with comparable speed*, the ball exit speed is essentially the same for wood and aluminum bats.

However, this does not mean that wood and aluminum bats will necessarily perform identically in the field, because wood and aluminum bats are not swung at comparable speeds. Even for bats with the same weight, the *weight distribution* is generally very different for a wood and aluminum bat; a typical wood bat has more of its weight concentrated in the barrel and farther from the hands.

One way to characterize the weight distribution is the so-called moment of inertia (MOI), which is a measure of how far the weight is concentrated from the hands. A bat with a smaller MOI has the weight concentrated closer to the hands and will be easier to swing. Likewise, a bat with a larger MOI will have the weight farther from the hands and will be harder to swing. Typically, aluminum bats of a given length and weight have a smaller MOI than a wood bat with the same length and weight.

There is now a growing amount of scientific evidence which shows an inverse relationship between the MOI of a bat and the speed with which it can be swung.[1] The smaller the MOI, the faster the bat can be swung. Since an aluminum bat generally has a smaller MOI than a wood bat of comparable length, an aluminum bat can be swung faster and will therefore perform better in the field.

Recognizing the importance of MOI for bat performance, the NCAA supplemented their impact testing with restrictions on the weight and the MOI of bats. The weight restriction is the so-called "-3 rule," which means that a 34" bat must weigh at least 31 ounces. The MOI restriction is also based on length. For example, a 34" bat can have an MOI no smaller than 9700 oz-in;[2] for reference, a typical wood bat of that length has an MOI of about 11,000 oz-in.[2] Even with this restriction, aluminum bats can be expected to outperform wood bats in the field. As an example, consider a wood bat with an 11,000 MOI performing at 96 mph in the test and an aluminum bat with a 9700 MOI performing at 97 mph in the test. Using the Fleisig swing-speed data, one can estimate that with the higher swing speed, the aluminum bat will perform at about 101.5 mph in the field, or 5.5 mph faster than the wood bat. This gives rise to an additional 20-30 feet on a long fly ball.

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**NOTES**

1. The procedures are described in the September 1999 NCAA report (www.ncaa.org/releases/miscellaneous/1999/1999092901ms.htm).
2. See, for example, the paper of Fleisig, et al., published in the journal *Sports Engineering*, vol. 5, pp 1-14, 2002.