Determination of the “Sweet Spot” of a Cricket Bat using COMSOL Multiphysics®

Y. Mulchand[1], A. Pooransingh[1], R. Latchman[1]
[1]The University of the West Indies – St. Augustine Campus, St. Augustine, Trinidad and Tobago

Introduction: In cricket, there is an increasing trend to monitor the performance of the athlete. Busch and James (2007) and Portus (2004) are examples of performance monitoring of the batsman and the bowler. This study focuses on the batsman and involves the determination of the location of the “sweet spot” of a cricket bat. A model was constructed with the structural mechanics module and utilized the Eigenfrequency analysis study. Knowledge of the “sweet spot” is important in delivering an optimal shot that corresponds to the maximum power of the stroke.

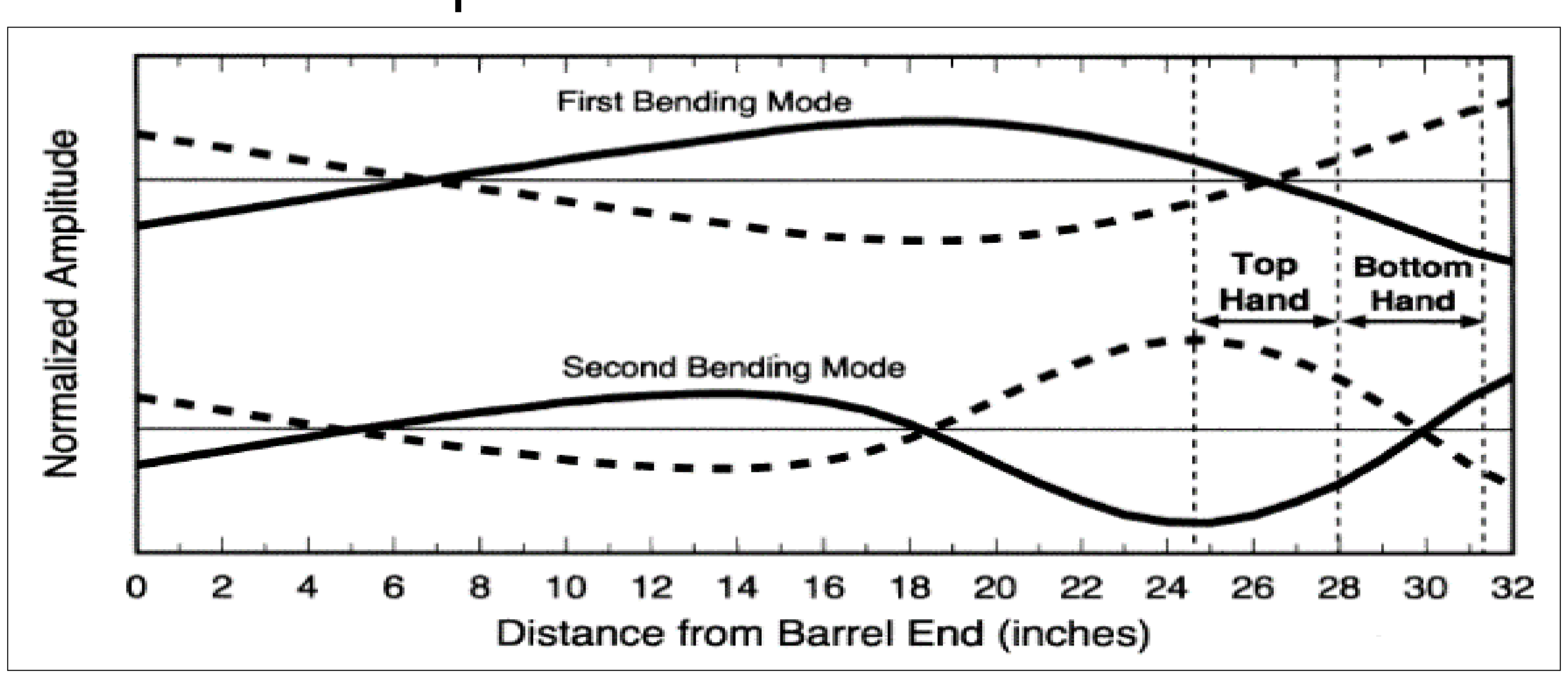

Figure 1. Mode shapes for the first two bending vibrational modes in a 32-inch youth baseball bat (D. A. Russell 2006).

Computational Methods: A 3-dimensional conceptual model of the cricket bat was constructed using the Structural Mechanics Module of the COMSOL Multiphysics software. The structural mechanics module analyzes deformations, stresses and strains of solid structures. Solid Mechanics was choose since it is based on solving equations and computed results for displacement, stresses and strains of the cricket bat. In solid mechanics, the Eigenfrequency corresponds to the natural frequencies of vibrations and the Eigenmodes corresponds to the normalized deformed shapes at the Eigenfrequencies. Eigenmodes and Eigenfrequencies of a linearized model are computed using the following equation from COMSOL:

$$-\rho\omega^2 u = \nabla \cdot s + Fv$$

$$s = S_0 + C : (\epsilon - \epsilon_0 - \epsilon_{inel})$$

$$\epsilon = \frac{1}{2}(\nabla u - (\nabla)^T)$$

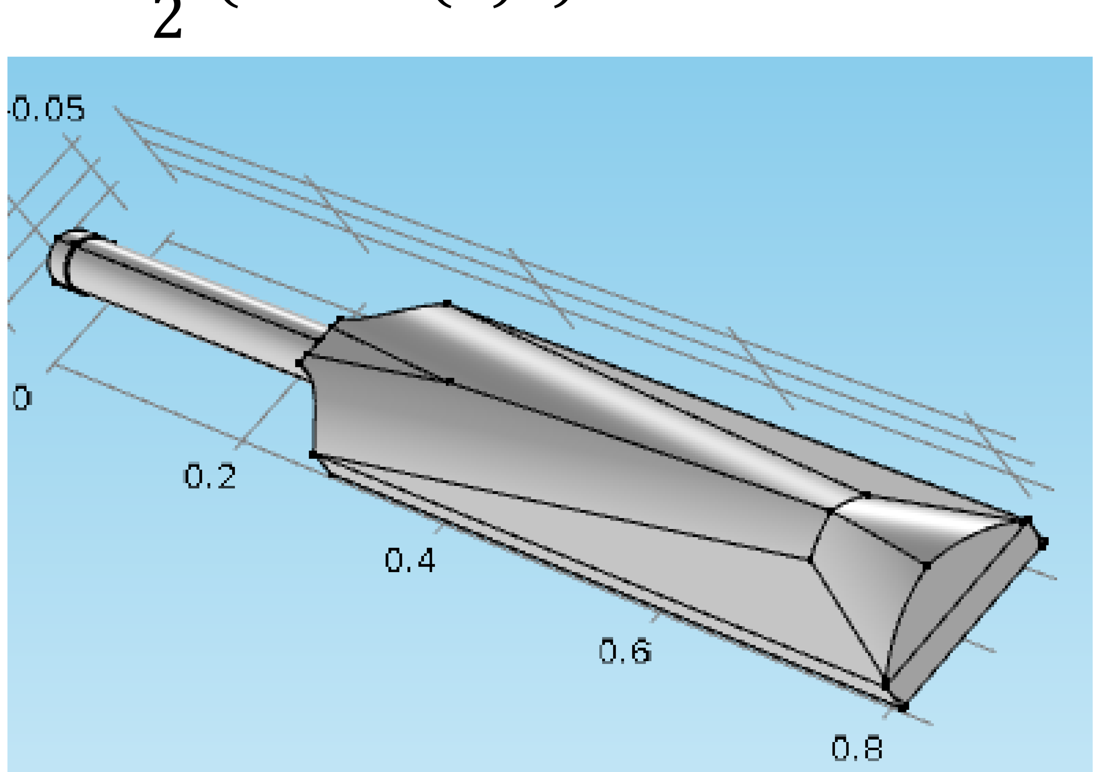

Figure 2. Conceptual model of the Cricket Bat (Back)

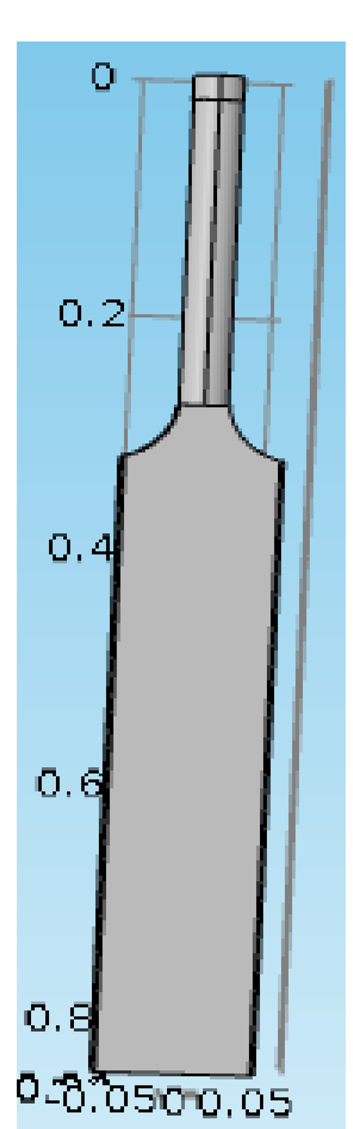

Figure 3. Conceptual model of the Cricket Bat (Front)

Results: The following figures show the Eigenmodes and Eigenfrequencies of the cricket bat model. These Eigenmodes correspond to the normalized deformations of the cricket bat at the Eigenfrequencies. The Eigenfrequencies correspond to the natural frequencies at which these vibrations occurs.

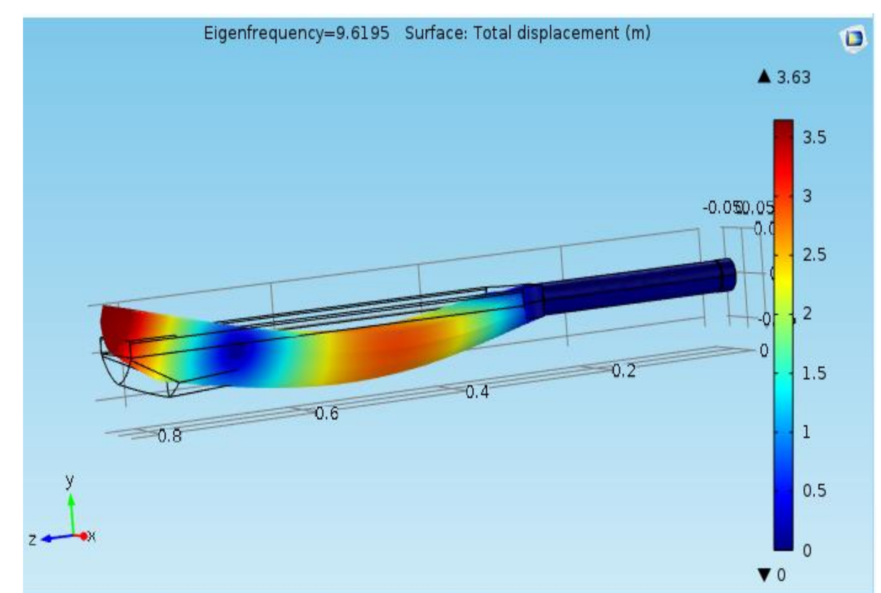

Figure 4. Mode Shape at Eigenfrequency 9.6195 Hz

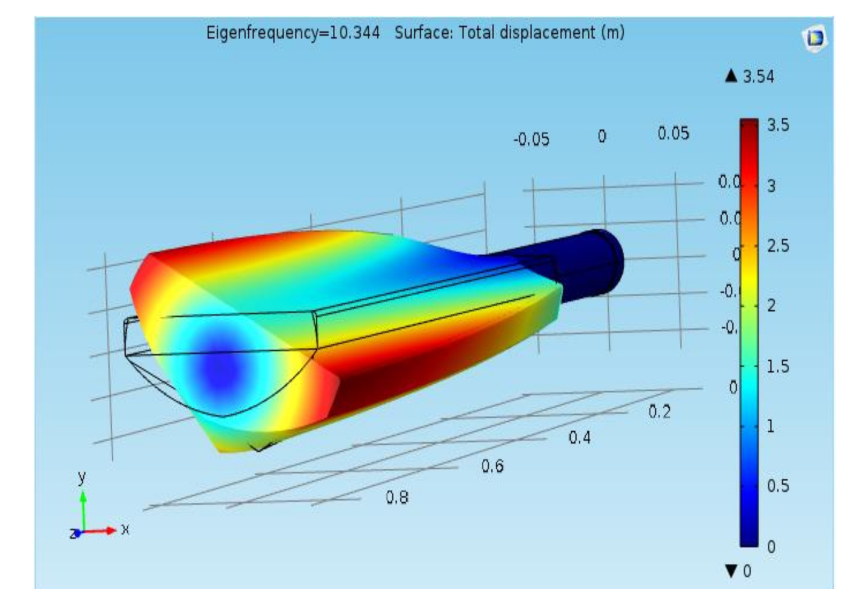

Figure 5. Mode Shape at Eigenfrequency 10.344 Hz

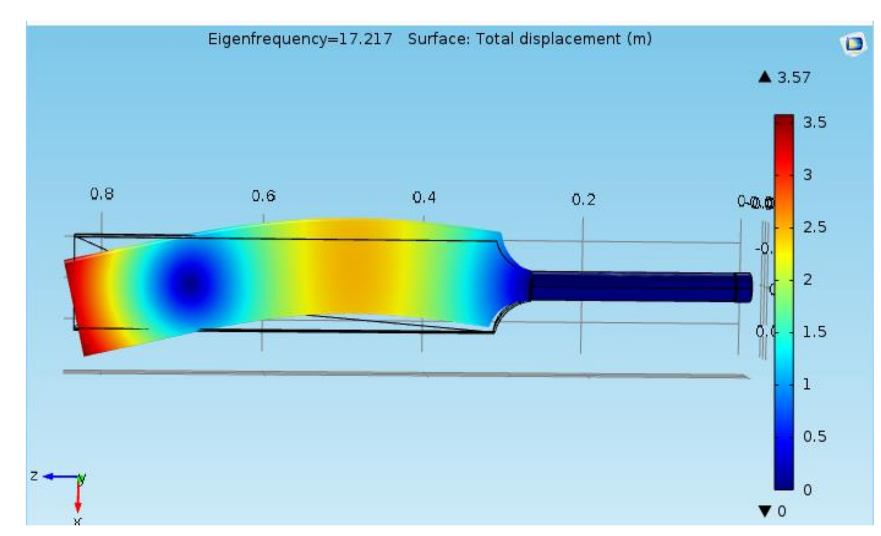

Figure 6. Mode Shape at Eigenfrequency 17.217 Hz

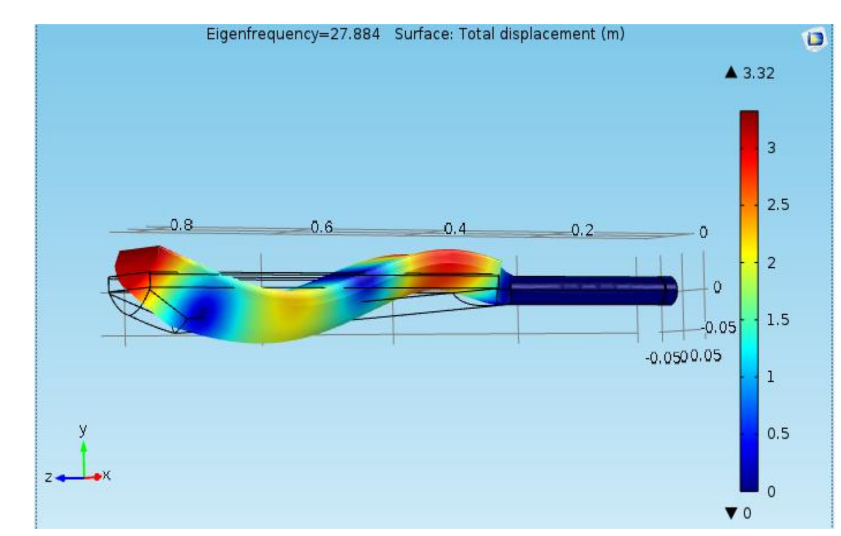

Figure 7. Mode Shape at Eigenfrequency 27.884 Hz

Conclusions: This study shows that the “sweet spot” can be located along the center of the bat, and is more concentrated in the lower mid region of the blade of the bat. Using this model of the bat, it can be concluded that the “sweet spot” is generally located in the region of 10 cm to 15 cm from the toe of the bat. This study can be improved with known dimensions of the cricket bat. Ultimately, it can inform the batsman in improving batting technique to deliver optimal shots.

References:

1. A. Busch and D. A. James, "Analysis of Cricket Shots using Inertial Sensors," in The Impact of Technology on Sport, (2007).
2. M. R. Portus, R. B. Mason, C. B. Elliott, C. M. Pfitzner and P. R. Done, "Technique factors related to ball release speed and trunk injuries in high performance Cricket fast bowlers," in *Sports Biomechanics*, vol. 3, (2004).
3. D. A. Russell, "Bending Modes, Damping, and the Sensation," in *The Engineering of Sport 6*, vol. 1, S. Haake and E. F. Moritz, Eds., Flint, Michigan: Springer, (2006).