Test Methods for Baseball and Softball

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Introduction

- Regulation is good for the game
- Regulation should be non-competitive
- Test measures must work
- Interested groups should work together to develop universal test standards

Outline

- Bat Performance
  - Impact Location
  - Impact Speed
  - Performance Measure
- Ball Response
  - Compression
  - COR
- Bat Durability
- Player Confidence

Bat Performance

- ASTM F1881, Baseball BPF
- ASTM F1890, Softball BPF
- NCAA, Baseball BESR

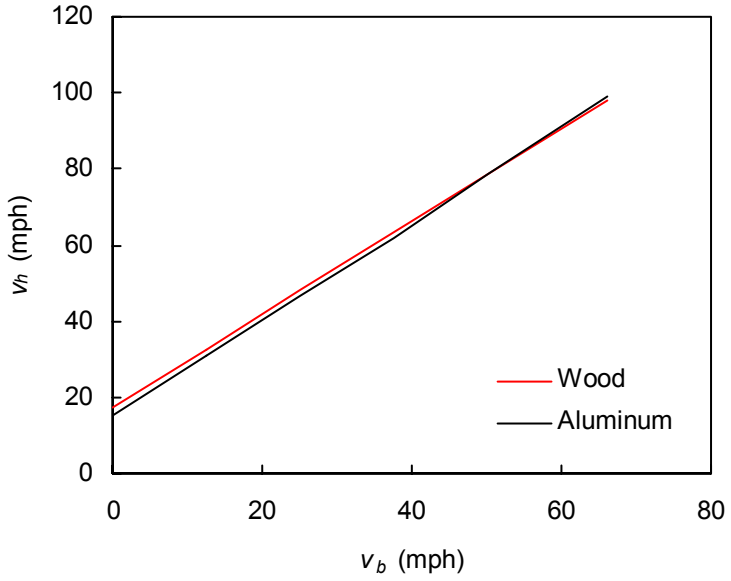
Impact Location

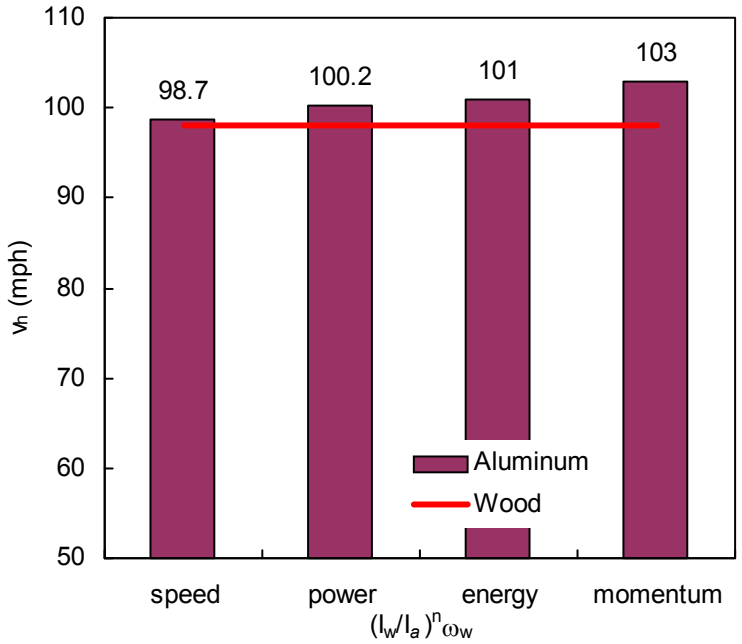
- Center of Percussion (COP)
  - Impact location where reaction force at the center of rotation is zero
  - Assumes rigid body motion
  - Readily determined analytically
- Sweet Spot
  - Impact location producing maximum hit ball speed
  - Must be determined experimentally
  - Depends on bat and ball speed, bat stiffness and MOI

Impact Speed

- Play Conditions
  - –Performance of hollow bats increases with speed
- Mass Moment of Inertia (MOI)
  - –Lighter bats are swung faster in play
- A Simple Model for Swing Speed : $\omega_2 = (I_1/I_2)^n \omega_1$
  - –Speed: *n=0*
  - –Power: *n=1/3*
  - –Energy: *n=1/2*
  - –Momentum: *n=1*

Hit Ball Speed





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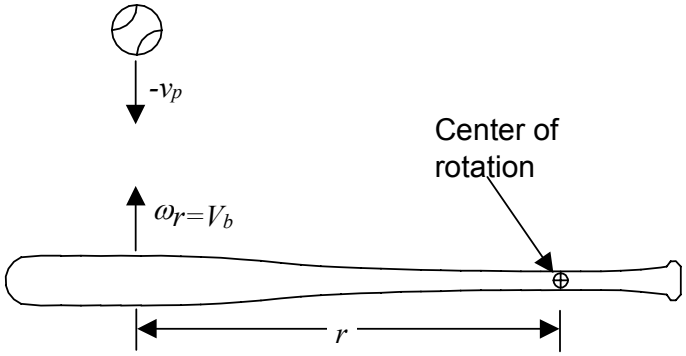
Performance Measure

- COR/BPF
  - ratio of relative speed (after to before impact)
  - does not distinguish between bat and ball speed
  - impact location affects momentum transfer



Performance Measure (cont)

- BESR
  - useful for predicting speed
  - we wish to measure performance
- Hit Ball Speed
  - should consider bat inertia
  - understandable and direct measure

Bat Performance - Suggestions

- Impact Location
  - Experimentally determined sweet spot
- Impact Speed
  - Relative speed of play conditions
  - Initially stationary bat
  - Relative speed related to bat MOI
- Performance Measure
  - Hit ball speed

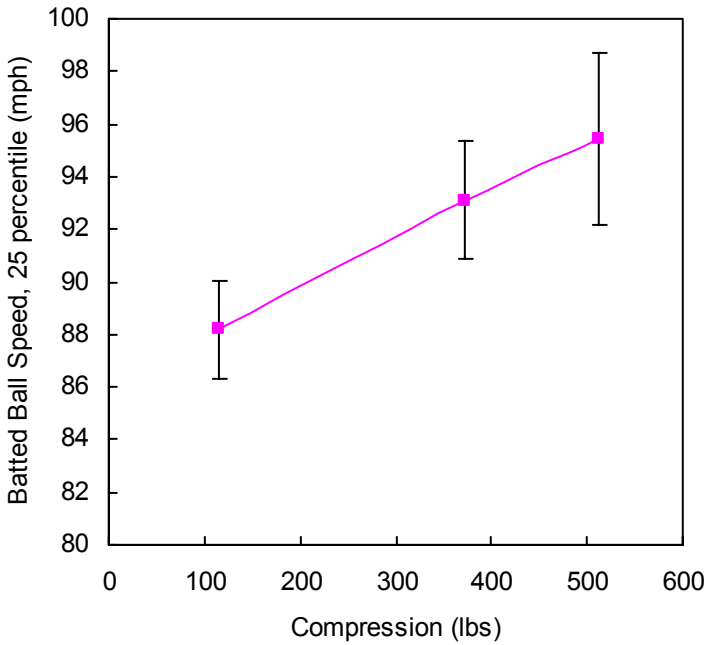
Ball Performance

- ASTM F1887
  - Baseball & Softball COR
- ASTM F1888
  - Baseball & Softball Compression

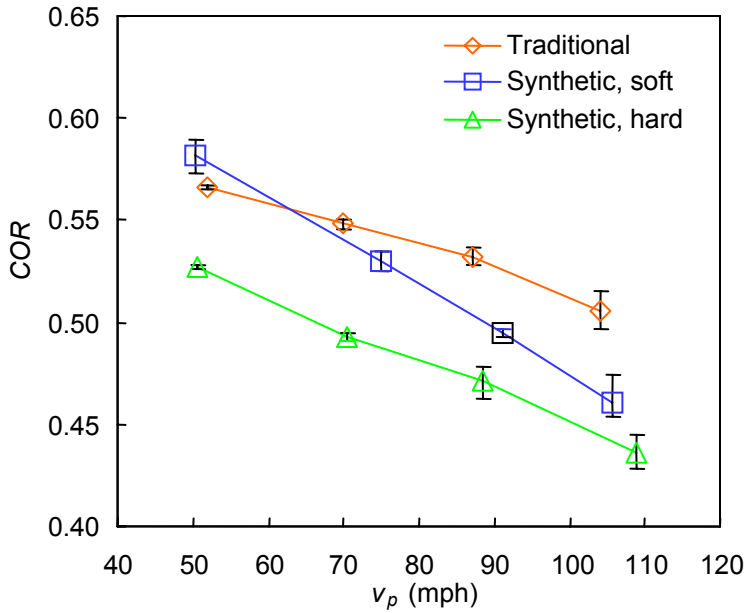
Ball Response

- Compression
  - Hardness
  - Empirical relation to performance
  - Quality assurance
- Coefficient of Restitution (COR)
  - Ratio of rebound to pitch speed
  - Direct performance measure
  - Speed dependent

Ball Compression, 47 COR



COR Changes With Speed



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Ball Performance

- Compression can have a strong effect on hit ball speed with hollow bats
- The rate of a standard ball compression test and impact in play differs by a factor of 10,000
- Compression measured quasi-statically may not relate to compression in play

Ball Performance - Suggestions

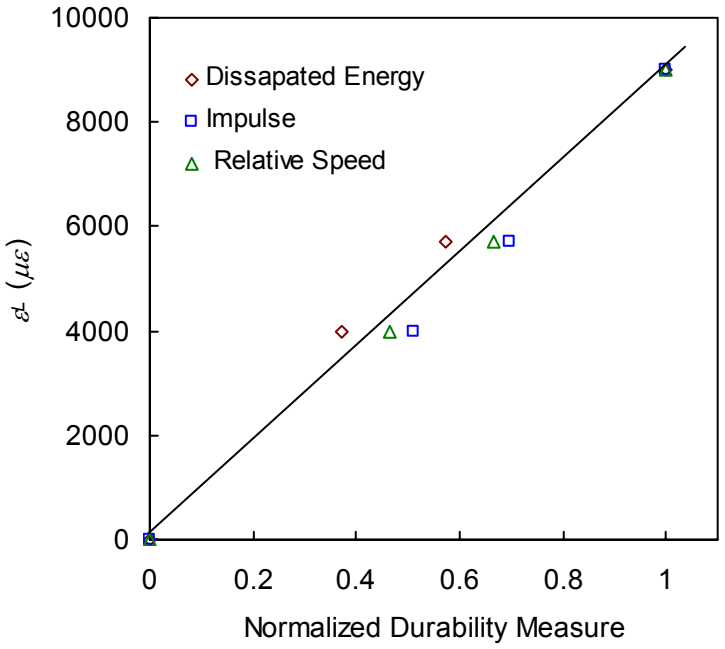
- Combine ASTM F1887 & F1888
- Shoot ball at a stationary load cell
  - Report ball COR
  - Report peak impact force

    Dynamic compression

Bat Durability

- Continuous decline over the past 20 years for solid and hollow bats
- No standard exists

Bat Durability Can Be Quantified



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Summary

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- Regulation should be non-competitive
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- *All* interested groups should work together to develop *universal* test standards