

# Effects of Surface Pace in Baseball

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## Abstract

A baseball travels across different surfaces at different paces. The goal of this experiment is to find a percentage difference in speeds the ball will reflect off a given surface. The energy lost on the turf surface was far more significant than on dirt surface as the turf lost an average of 26% of its energy as compared to just 16% of the energy on dirt. In the Northwest conference, teams play on four turf based infields and five dirt based infields. The results of this study suggest that kinetic friction forces are more significant in reducing ball rebound speed than inelastic collision losses, and that the ball pace across dirt surfaces is faster. These differences can affect player reactions and game play.

## Introduction

- The number of major league dirt infields outweighs the number of turf fields by 28 to 2.
- Players tend to have an opinion about which is fastest, but they do not agree with each other.
- This experiment seeks to compare the loss in energy of a baseball after its first impact with each surface.



Figure 1: Linfield Wildcat infielder Corey VanDomelen makes a routine play on a dirt surface



Figure 2: Linfield Wildcat infielder Joey Cassano makes a play on Linfield's home turf infield

## Experimental Methods

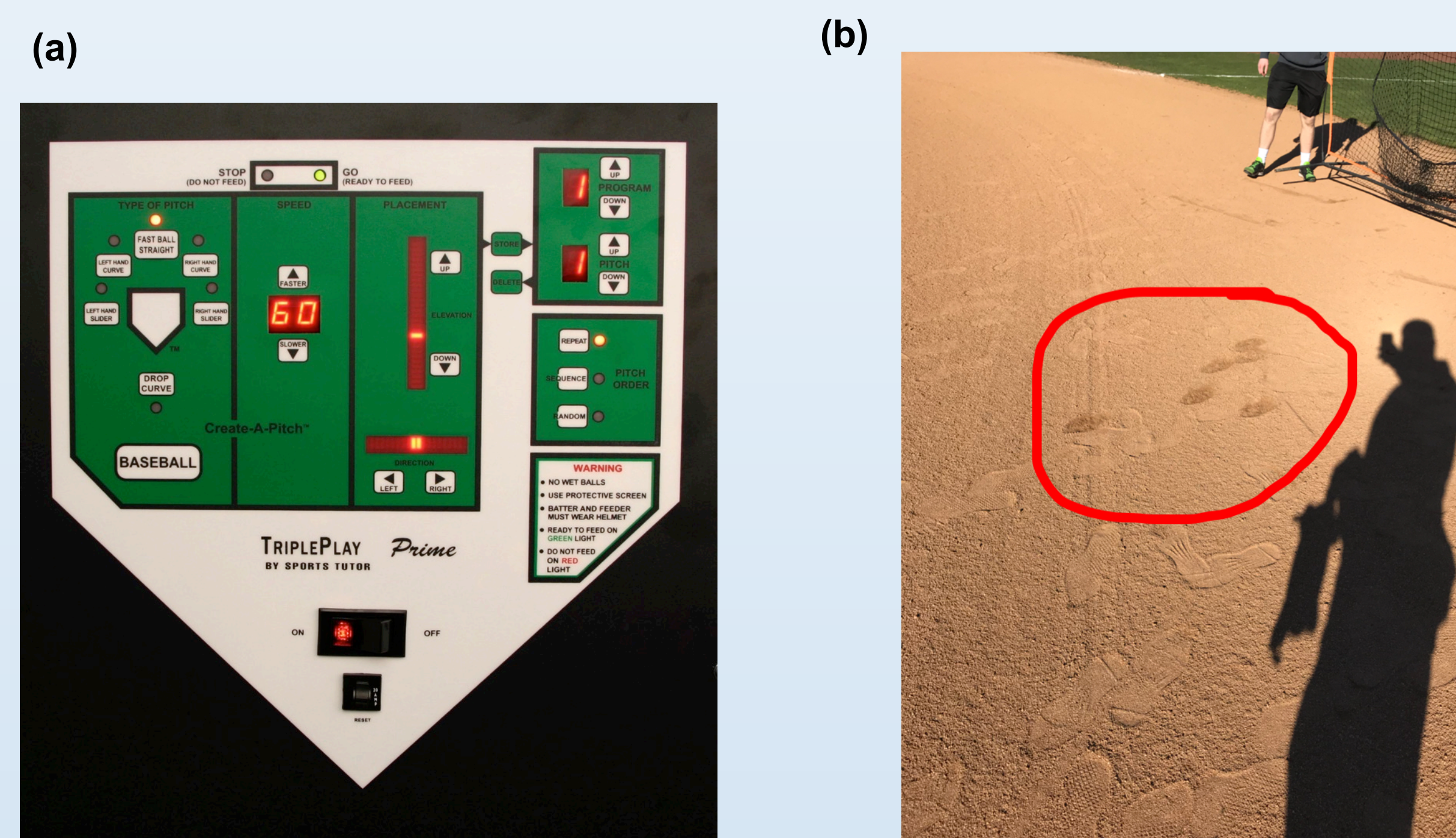


Figure 3: (a) Interface on the Triple Play Prime pitching machine. (b) Photo taken during measurements on a dirt infield. The strike point of the ball occurs between 82 and 86 feet from the pitching machine, which is out of the image to the left. The balls strike at roughly the same location each time as can be seen from their tracks in the dirt surface.



Figure 4: Tracker location of the ball (red marks) over a sequence of video frames, overlaid on the last frame. The ball is highlighted with the blue circle. In each measurement, at least five frames were used both before and after the impact with the ground.

## Theory

- Non conservative forces acting on the ball during interaction with the surface
- Kinetic (sliding) friction and inelastic collision convert some of the ball's kinetic energy to heat
- Since the ball reflects at such a low angle, the gravitational potential energy is generally negligible
- "The reason [turf] steals momentum is rooted in the friction of all that loose [material], which clumps around the ball. Each clump is like a little speed bump [2]."

## Results

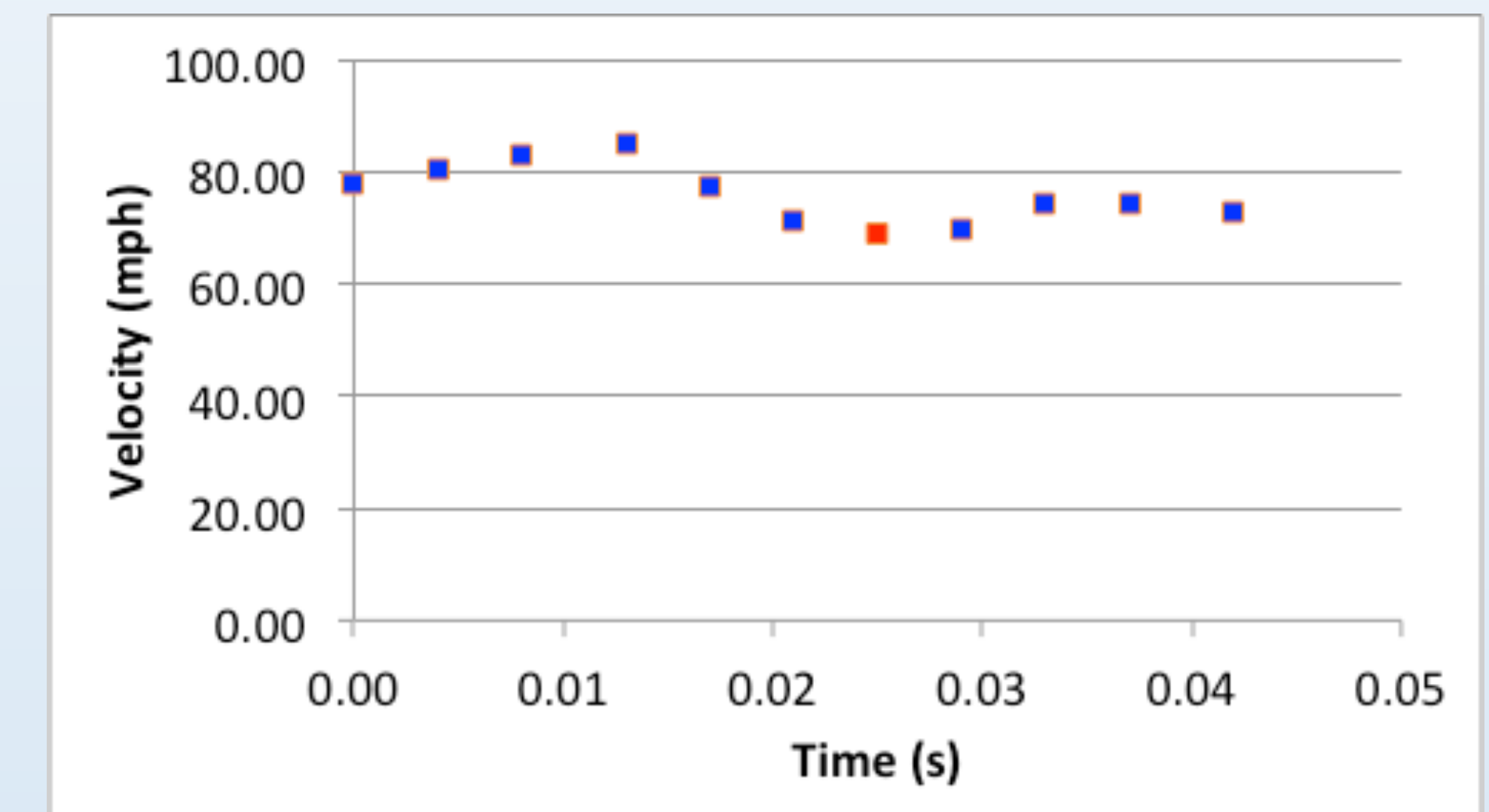


Figure 5: Sample data set from the dirt infield. The graph portrays the ball's velocity over time. The minimum velocity, shown in red, shows the point when it hits the surface and reflects with less energy than prior to impact, therefore leaving the ball with less velocity

	Velocity Before (mph)	Velocity After (mph)	Energy Loss %
Turf Sample 1	66	56	-27
Turf Sample 2	68	59	-24
Dirt Sample 1	76	70	-16
Dirt Sample 2	79	72	-17

Figure 6: Final results of the testing shown in miles per hour.

## Conclusions

- Dirt has a measurably faster surface pace than turf.
- We find that a baseball rebounding on a dirt infield would retain nearly 10% more of its energy after the first impact.
- This agrees with MLB player Troy Tulowitzki who claims, "The turf is extremely slow, making it very difficult to hit a groundball through the infield. It's also inconsistent, [making it] subject to odd bounces" [3].
- Future work includes checking the repeatability of these data for different locations and ball angles.

## Acknowledgements

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### References:

- [1] Photos Figure 1 and 2 from Larry Bird, Linfield College
- [2] Lehrer, Jonah. "The Physics of Grass, Clay, and Cement." Grantland, 8 Sept. 2011, grantland.com/features/the-physics-grass-clay-cement/.
- [3] Knobler, Danny. Blue Jays Must Get It Right in Fixing MLB's Most Hated Turf. Bleacher Report, 11 Apr. 2017, bleacherreport.com/articles/2567806-blue-jays-must-get-it-right-in-fixing-mlbs-most-hated-turf.