[1]

Does Cleat Stiffness Affect Speed?

Christian Viteri

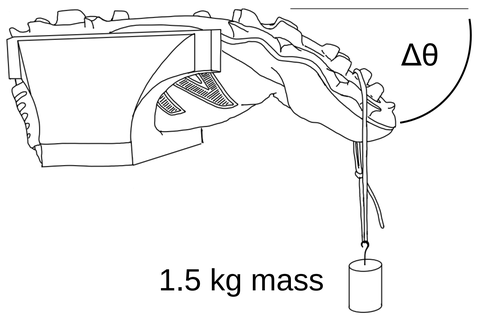
2.671 Measurement and Instrumentation

Massachusetts Institute of Technology

Abstract

Performance in high-impact explosive sports (e.g. American football, soccer, lacrosse) requires traction from spiked athletic shoes, known as cleats. The behavior of cleats in aiding speed generation is unknown, especially as their stiff plastic soles become more pliable. To quantify the effect cleat deterioration has on speed and impact forces, force and acceleration were measured while running with a new and old pair of New Balance Freeze LX cleats. Force was measured on the ball of the foot with an accelerometer on the top. Bending stiffness values were measured by displacement due to an applied force. The average peak force values suggested a significant difference as new cleats exhibited a higher peak force at all speeds; however, both exhibited similar jerk values, suggesting the old pair of cleats produce a similar acceleration change with lower impact forces.

What is Cleat Stiffness?



Cleat stiffness is measured by the angular displacement of the toe in response to an applied force.

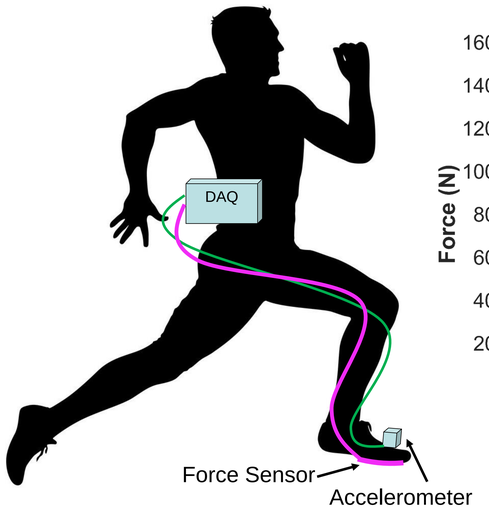
Bending Stiffness: $K = \frac{M}{\Delta\theta}$

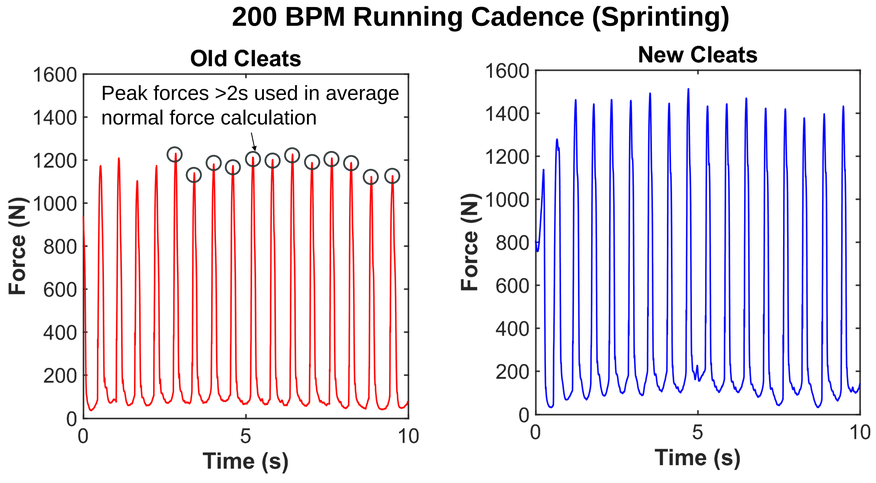
$K_{new} = 0.0577 \pm 0.0006 \frac{Nm}{deg}$

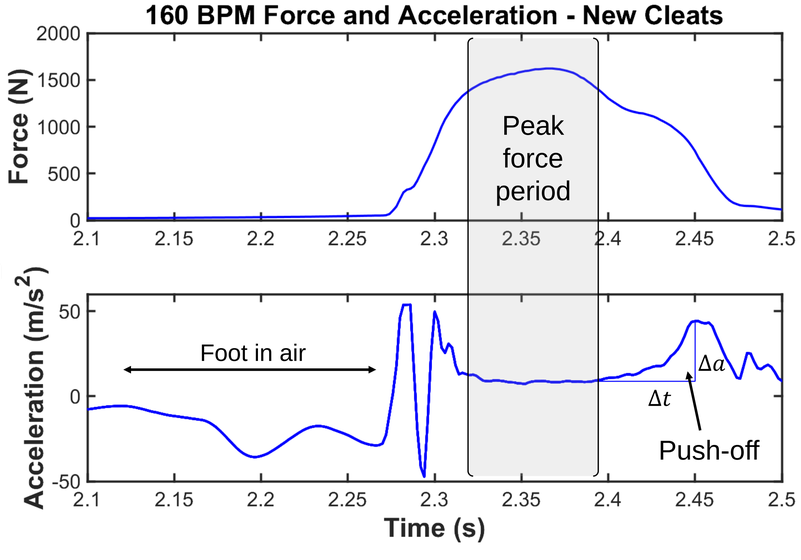
$K_{old} = 0.0461 \pm 0.0003 \frac{Nm}{deg}$

Experimental Design

[2]



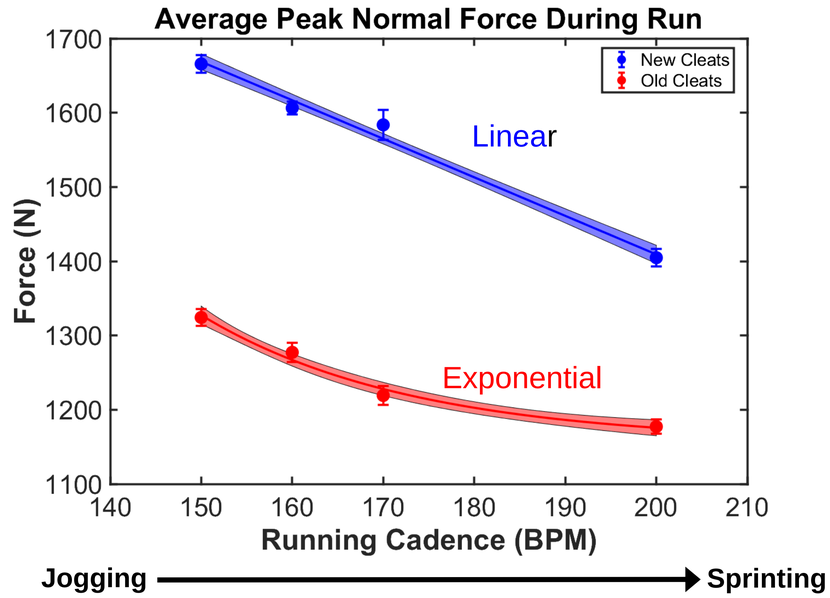


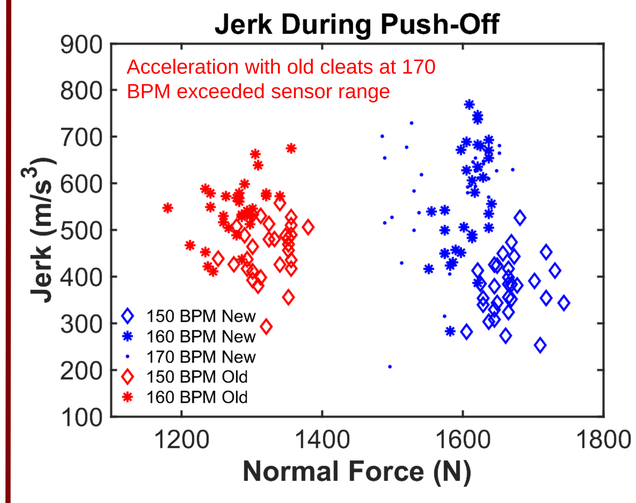


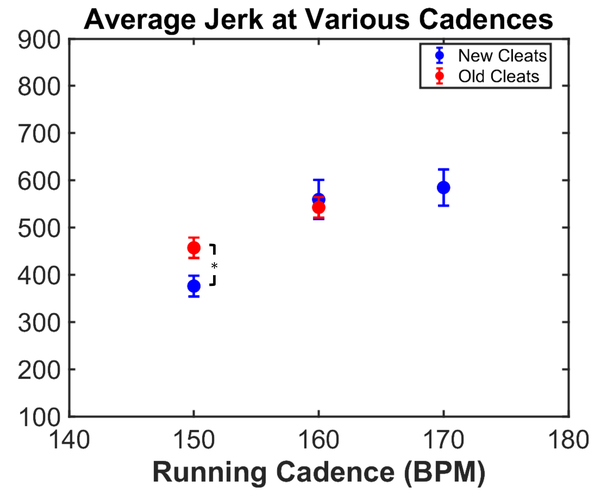
Jerk during the push-off period represents the spring-like behavior of the cleat sole in conjunction with the runner's dynamic behavior.

$$Jerk = \frac{\Delta a}{\Delta t}$$

Results







Conclusions

- New cleats were approximately 25% stiffer than old cleats.
- New cleats exhibited higher normal forces during every run.
- Resulting jerk values were about 13% greater with old cleats at 150 BPM. No significant difference was determined for 160 BPM.
- Users desiring quick acceleration could use new or old cleats; those focused on injury prevention may want to use old cleats to lower impact forces.

Acknowledgements

Thank you to Dr. Barbara Hughey and Dr. Sili Deng for their guidance in the design and execution of this experiment.

References

[1] Reeves, T., 2021, "What Are Good Football Cleats? ✔," CleatsReport | Cleats for Football, Soccer & More [Online]. [Accessed: 18-Nov-2021].
[2] "Black Silhouettes Runners Sprint Men on White Vector Image on VectorStock," VectorStock [Online]. [Accessed: 29-Oct-2021].

December 7, 2021