Penn State's

**Center for
Sports Surface Research**

Supercleat Evaluation

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Supercleat Traction Testing

During athletic competition, athletes' bodies are exposed to a multitude of forces that may ultimately cause injury. One such force is traction. Although a certain level of traction is necessary to prevent athletes from slipping, high levels of rotational traction have been linked to an increase in non-contact lower extremity injuries (Wannop et al., 2011). This increased injury risk is often attributed to the shoe "sticking" to the playing surface as the leg rotates, causing excessive force to the knee and/or ankle joints. This phenomenon is often referred to as "foot fixation".

Both the playing surface and the type of cleated shoe worn by the athlete affect rotational traction. More specifically, it is interaction between the cleated shoe and the playing surface that ultimately determines the amount of rotational traction. While athletes have little influence over the type of turf on which they play, they can control their footwear. It is not uncommon for athletes to select more aggressive cleat patterns which they feel maximize performance, often with a consequence of increased rotational traction. The product "Supercleat" may affect rotational traction by allowing for an easier "release" of the cleats from the surface, thus affecting the forces on the knee and/or ankle joints. While comparisons of traction values among cleat types and playing surfaces can be drawn, it is important to note that there is currently no threshold that separates "safe" from "unsafe" levels of traction.

Additionally, Supercleat may influence linear traction, a force that resists the shoe's sliding across the surface. Linear traction can be broken down into two components: static and dynamic. Static and dynamic traction represent slightly different aspects of the shoe-surface interaction. Static traction is the resistance to sliding or pivoting when there is no movement between the shoe and the surface. Static traction forces tend to resist the initiation of sliding or pivoting. Dynamic traction is the resistance that occurs during a sliding or pivoting motion. Dynamic traction forces tend to resist or decelerate pivoting motions. While comparisons of traction values among cleat types and playing surfaces can be drawn, it is important to note that there is currently no threshold that separates "safe" from "unsafe" levels of traction.

Objective:

The objective of this study was to evaluate the effect of Supercleat application to various cleat types on traction (linear and rotational) and soil accumulation on the bottom of cleated shoes.

Testing Procedure:

Traction Testing

Rotational and linear traction was measured using Pennfoot with a loading weight of 245 lbs (McNitt et al., 1997) (Fig. 1).

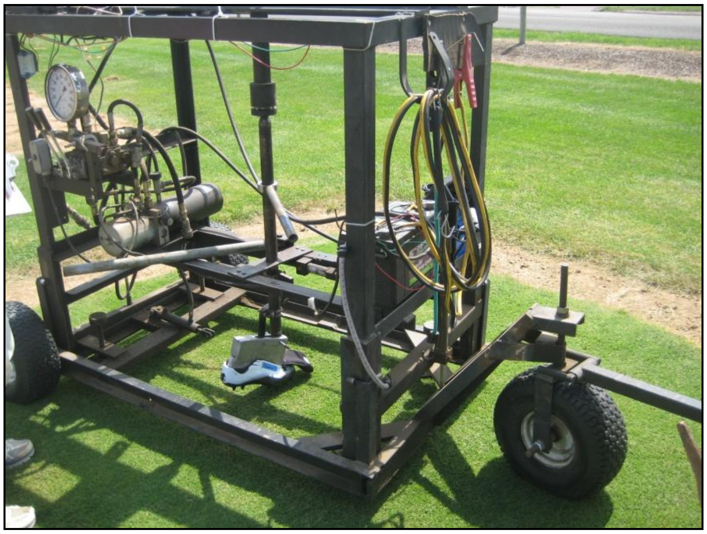

Figure 1. Pennfoot traction testing device

Shoe Types

Two types of footwear were included in the study. All tests were performed with both a seven post screw-in style shoe (Under Armour Fierce III D) and a molded cleat style shoe (Under Armour Nitro III Low CompFit). Both shoe types are shown in Figures 2 and 3.

Figure 2. Testing was conducted using the Under Armour Nitro III Low CompFit shoe (molded) (left) and the Under Armour Fierce III D shoe (screw-in) (right)

Figure 3. Molded cleats (left) and screw-in cleats (right) were tested.

Treatments

- Control
- Supercleat applied to cleat and sole
- Supercleat applied to sole only (screw-in style cleat only)

Supercleat was applied according to label directions (Fig 4). Two coats were applied with five minutes between coats. Supercleat was applied prior to the study and was not reapplied at any time during testing.

Figure 4. Supercleat being applied to the bottom of a shoe

Surfaces

- Natural Turf
    - Bermudagrass (*Cynodon dactylon*) (silt loam soil)
    - Kentucky bluegrass (*Poa pratensis*) (silt loam soil)
    - Kentucky bluegrass (*Poa pratensis*) (high-sand rootzone)
    - Perennial ryegrass (*Lolium perenne*) (silt loam soil)
- Synthetic Turf
    - FieldTurf Revolution (monofilament, sand/rubber infill)

Surface Moisture

All testing was completed under both “dry” and “wet” surface conditions. Under the dry condition, no visible moisture was present on the surface. For the wet condition test, the test area was irrigated for 10 minutes immediately before data collection and moisture remained on the surface throughout data collection.

Soil Accumulation Testing

Soil accumulation testing was conducted on areas containing approximately 50% turf cover. Two types of cleats were tested (seven post screw-in style: Under Armour Fierce III D and molded cleat style: Under Armour Nitro III Low CompFit). One shoe from each pair was treated with Supercleat (sole and cleats) while the other remained untreated and served as the control.

Supercleat was applied to the designated shoes three days prior to testing. To test soil accumulation, a research assistant walked, ran, and changed direction in the test area until a significant amount of soil was observed to have accumulated on the control shoe. Accumulated soil was removed from each shoe, dried, and weighed. Three test areas were included in the evaluation. Test areas one and two appeared to have similar moisture contents while the third test area appeared wetter than the other two areas. The test areas served as blocks in the statistical analysis.

<u>Statistical Analysis</u>

The traction study included three replications of all shoe-surface-surface moisture combinations. The screw-in cleat and molded cleat were analyzed separately due to a difference in the number of treatments (screw-in: *control, Supercleat sole only, and Supercleat sole and cleats*; molded: *control and Supercleat sole and cleats*). The soil accumulation study also included three blocks of each testing condition. Means were analyzed using analysis of variance and comparisons were made using Tukey's Honest Significance Test at the 0.05 level. A Tukey's Honest Significance Test was not performed when the F statistic resulted in a p value of >0.05.

Results

<u>Supercleat - Rotational Traction</u>

For both the screw-in cleat and the molded cleat, the application of Supercleat had little effect on rotational traction (Table 1). The difference in traction between the treatments and the control was less than 1 Newton-meter (Nm) for both shoe types. No statistical difference between treatments was found (screw-in cleat p-value = 0.635; molded p-value = 0.426). Also, the interactions between treatment and turf type and treatment and surface moisture were not significant, indicating that the traction levels of Supercleat-treated shoes and the control were not significantly affected by turf type or soil moisture.

Table 1. Rotational traction results from both shoe types (means within shoe type were not statistically different from one another).

	Screw-in cleat	Molded cleat
Treatment	---------------Nm†	---------------
Control	49.4	47.9
Supercleat – sole and cleats	50.1	47.4
Supercleat – sole only	49.7	--

†Newton-meters

<u>Supercleat – Linear Traction</u>

Static Traction

Static linear traction was measured as the peak amount of force (N) required to initiate linear motion of the footwear divided by the amount of force (N) that was normal to the surface (traction coefficient). For both shoe types, Supercleat application had little effect on static traction (Table 2). No statistical difference between treatments was found (screw-in cleat p-value = 0.695; molded p-value = 0.081). For the screw-in cleat, a statistically significant interaction between Supercleat treatment and playing surface was reported (p-value = 0.023) (Table 3). This significant interaction indicates that the influence of the Supercleat treatment on traction was affected by the playing surface. As shown in Table 3, differences in traction on bermudagrass and perennial ryegrass were the most likely causes of the significant interaction. However, these differences were small and likely have little practical significance.

Table 2. Static traction results from both shoe types (means within shoe type were not statistically different from one another)

	Screw-in cleat	Molded cleat
Treatment	---------Traction coefficient†	---------
Control	1.57	1.53
Supercleat – sole and cleats	1.57	1.56
Supercleat – sole only	1.57	--

†traction coefficient = peak amount of force (N) to initiate linear motion of footwear/amount of force (N) that is normal to the surface

Table 3. Mean static traction values for the playing surface by treatment interaction

Surface	Treatment	Traction coefficient†	
Kentucky bluegrass (sand)	Control	1.68	a
Kentucky bluegrass (sand)	Supercleat – sole and cleats	1.65	ab
Kentucky bluegrass (sand)	Supercleat – sole only	1.62	abc
Perennial ryegrass	Supercleat – sole only	1.61	abcd
FieldTurf	Supercleat – sole and cleats	1.58	abcde
FieldTurf	Control	1.57	bcde
Bermudagrass	Supercleat – sole and cleats	1.57	bcde
FieldTurf	Supercleat – sole only	1.56	bcde
Perennial ryegrass	Supercleat – sole and cleats	1.55	bcde
Kentucky bluegrass (soil)	Control	1.55	cde
Perennial ryegrass	Control	1.54	cde
Kentucky bluegrass (soil)	Supercleat – sole and cleats	1.52	de
Bermudagrass	Supercleat – sole only	1.52	de
Kentucky bluegrass (soil)	Supercleat – sole only	1.51	e
Bermudagrass	Control	1.50	e

†traction coefficient = peak amount of force (N) to initiate linear motion of footwear/amount of force (N) that is normal to the surface

For the molded cleat, a statistically significant interaction between Supercleat treatment and surface moisture was reported (p-value = 0.020) (Table 4). Static traction was lower for the control under wet conditions than all other treatment-surface moisture combinations. Therefore, while surface moisture affected traction on shoes that were not treated with Supercleat, those that were treated with Supercleat were not affected by the surface being either wet or dry.

Table 4. Mean static traction values for the treatment by surface moisture interaction

Treatment	Surface Moisture	Traction coefficient†
Control	Dry	1.59 a
Supercleat – sole and cleats	Dry	1.58 a
Supercleat – sole and cleats	Wet	1.54 a
Control	Wet	1.47 b

†traction coefficient = peak amount of force (N) to initiate linear motion of footwear/amount of force (N) that is normal to the surface

Dynamic Traction

Dynamic linear traction was measured as the peak amount of force (N) required to maintain linear motion of the footwear divided by the amount of force (N) that was normal to the surface (traction coefficient). Application of Supercleat had little effect on dynamic traction for both shoe types (Table 5). No statistical difference among treatments was found (screw-in cleat p-value = 0.764; molded p-value = 0.965). Also, the interactions between treatment and turf type and treatment and surface moisture were not significant, indicating that the traction levels of Supercleat-treated shoes and the control were not significantly affected by turf type or soil moisture.

Table 5. Dynamic traction results from both shoe types (means within shoe type were not statistically different from one another)

Treatment	Screw-in cleat	Molded cleat
	----------traction coefficient†----------	
Control	1.47	1.31
Supercleat – sole and cleats	1.48	1.31
Supercleat – sole only	1.46	--

†traction coefficient = peak amount of force (N) to maintain linear motion of footwear/amount of force (N) that is normal to the surface

<u>Soil Accumulation</u>

The application of Supercleat to the sole and cleats of the shoes reduced soil accumulation by approximately 40% compared to the control (Table 6). While Supercleat did not completely eliminate soil accumulation, under the conditions of this study, it significantly reduced the amount of soil accumulation on the bottom of cleated shoes. The frequency of re-application of Supercleat required to maintain this benefit was not part of this study and is unknown. Additionally, previous testing indicated that Supercleat application had little to no effect on soil accumulation in nearly-saturated areas without turf cover. Therefore, the amount of turf cover appears to influence the effectiveness of Supercleat application on soil accumulation.

Table 6. Soil accumulation on the bottom of cleated shoes

Treatment	Soil Accumulation ------grams------
Control	27.5 a[†]
Supercleat	16.6 b

[†] Means with different letters are significantly different from one another

Figure 5. Soil accumulation at the first test location

Figure 6. Soil accumulation at the second test location

Figure 7. Soil accumulation at the third test location

Summary

Under the conditions of this study, Supercleat application had little effect on rotational and linear traction. Traction values from Supercleat-treated shoes tended to be the same or very similar to untreated shoes. However, under wet conditions, the application of Supercleat to the molded cleat resulted in higher static traction than the untreated molded cleat. Supercleat application reduced soil accumulation on cleated shoes by 40% on areas consisting of approximately 50% turf cover. Based on the results of this study, the application of Supercleat reduces mud accumulation on the bottom of cleated shoes and has little effect on traction, with the exception of a slight increase in static traction with molded cleats under wet conditions.

References

McNitt, A.S., R.O. Middour, and D.V. Waddington. 1997. Development and evaluation of a method to measure traction on turfgrass surfaces. Journal of Testing and Evaluation 25:99-107.

Wannop, J.W., G. Luo, and D. Stefanyshyn. 2011. Footwear traction and lower extremity injury. Footwear Science. Proceedings of the 10th Footwear Biomechanics Symposium. 3(suppl.1):166-167.