

## Frictional requirements of skateboarding shoes during a push-off

Matthew Nevitt<sup>a</sup>, Jeremy Determan<sup>a</sup>, Arthur Felix<sup>b</sup>, and Joseph Cox<sup>a</sup>

<sup>a</sup> *Sole Technology Institute, Lake Forest, CA USA;*

<sup>b</sup> *Department of Kinesiology, Cal State Fullerton University, Fullerton, CA USA*

### Introduction

The push-off is a simple yet repetitive movement skateboarders use to propel themselves from one position to another. Despite its relatively simplistic nature, little is known about the forces acting on a skateboarder's foot as they push-off the ground or how the pressures from these forces change across the foot over time. In addition, little is known about the frictional requirements skateboarders need to successfully push-off the ground. Knowing such information could potentially help footwear designers construct better outsole patterns for use in aiding skateboarders as they push-off the ground.

### Methods and Procedures

Fifteen male amateur skateboarders were recruited to participate in the study. Nine of the subjects were regular footed and the other six were "goofy" footed (right foot forward). Subjects were required to wear the same model laboratory skate shoe (ES EK-01) to ensure the geometrical construction of the shoe outsole did not provide a bias to the ground reaction force data. A large AMTI force platform (Model: BP12001200) was used to collect 3-D GRF and moment data. The platform was placed in the middle of a long runway to ensure subjects had plenty of room to both start and stop their skateboards. In addition, RSscan in-shoe pressure insoles were inserted into the subject's shoes for the experiment. Testing began by having the subjects roll towards the force plate from a resting start position and push-off the plate at a preferred comfortable speed over two surface conditions. The first condition was the normal force platform surface which was shown to have similar frictional characteristics as skate park concrete in pilot testing. For the second condition a strip of skateboard griptape was applied to the force plate to provide a higher friction surface. Each subject performed push-offs on both surfaces and the starting order was randomized across all subjects. GRF and in-shoe pressure data were collected for ten push-offs within each condition. All GRF and moment data were filtered at 100 Hz using a 4<sup>th</sup> order low pass Butterworth filter.

The coefficient of friction (COF) was defined as the ratio of the normal force (VGRF) to the horizontal force (APGRF) required to produce movement between two surfaces (Frederick, 1993). Means and standard deviations (SD) of the APGRF, VGRF, and COF values were calculated across all 10 trials for each subject during both conditions (griptape, no griptape) to yield representative data. To test for differences between the two conditions, a repeated measure one-way ANOVA was conducted on the 15 mean values for each GRF and COF parameter. Significance level was set at 0.05 for both tests and p-values were reported.

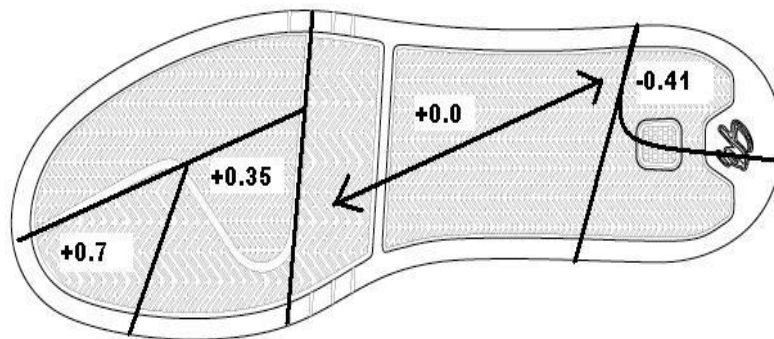
### Results

The results of the force plate and in-shoe pressure data revealed three distinct skateboard push-off styles: heel-toe, mid-foot, and forefoot. Summary results of the COF, APGRF, and VGRF parameters evaluated across all subjects in this study are provided in Table 1. Five out of fifteen subjects exhibited a heel to toe push-off, which was similar to the GRF's exhibited in walking. Five out of fifteen subjects exhibited mid-foot to toe push-off. The remaining five subjects exhibited forefoot only push-offs which were similar to the GRF's seen in sprinting.

The data collected from the in-shoe pressure insoles provided insight as to the exact location of pressure distribution during each skateboard push-off. The average heel-toe push-off began on the lateral side of the heel, transferring up through the mid-foot to the medial metatarsal and ending on the medial portion of the halux. (See Figure 1) The COF data revealed relatively low frictional braking forces with the initial heel strike, which was followed gradually by a propulsive force with the final toe push-off.

Condition 1 No-Griptape				Condition 2 Griptape			
VGRF	APGRF	Brake COF	Prop COF	VGRF	APGRF	Brake COF	Prop COF
1054.9 (286.6)	375.8 (138.6)	0.41 (0.15)	0.70* (0.13)	1038.4 (273.5)	373.4 (133.8)	0.51 (0.26)	1.04* (0.22)

**Table 1. Total Averages for 15 Subjects (SD): VGRF (Newtons), APGRF (Newtons), \*  $p < 0.05$**



**Figure 1. 2-D view of pressure and COF on the outsole of the shoe.**

### Discussion and Conclusions

Friction force differences between the two surface conditions (griptape, no griptape) were minimal. The peak APGRF and the corresponding VGRF were very similar between the two conditions. The braking COF of each surface were also similar; however the propulsive COF values during the griptape surface were significantly greater than the forceplate only condition. The difference in propulsive COF is likely due to the griptape providing a higher friction surface to push-off. The large differences in the GRFs across all subjects are likely related to differences in subject mass. Another cause of variation in the GRF and pressure data could be each subject's distinct skateboarding style. Each subject was instructed to push-off the force plate as they would normally push-off any surface encountered while skateboarding. Differences in anthropometric measurements, such as leg length, could have affected push-off forces. Also, each subject pushed-off the force plate at slightly different speeds which could be a cause of GRF differences among subjects.

The skateboard push-off is the starting point of most skateboarding maneuvers and knowledge of this basic movement could benefit skateboarding footwear manufacturers to create footwear that would enhance skateboarding performance. For this study only the translational friction requirements were considered. Additional analysis on the rotational friction requirements is still needed. A future study involving a non-traction shoe outsole versus a super-friction shoe outsole would also further detail the potential benefits of this study to skateboard footwear manufactures.

### References

Frederick, E.C., et al., 1993. Optimal Frictional Properties for Sports Shoes and Sports Surfaces, *Biomechanics in Sports*, XI: 13-21.