BIOMECHANICA

Test Report:

Effect of Brock underlayment on the stiffness and shock attenuation performance of synthetic turf surfaces.

Test Date: 12 / 2003 **Report Date:** January 16, 2004

Client: Dan Sawyer
Brock USA

Summary

The purpose of this investigation was to determine how the addition of Brock underlayment to a synthetic turf surface affects performance under different loading conditions. The loading conditions of primary interest were (a) impact loads, such as those produced by standard impact attenuation tests and (b) typical loads produced by the athlete when running on the surface
A series of mechanical and impact tests were used to determine the mechanical properties of three commercially available infilled synthetic turf systems (Sand and Rubber Mixed (SRM), All Rubber mix (ARM), Sand Rubber Layered (SRL), both with and without a Brock underlayment. Impact test performance was determined through direct testing. Responses to the loads imposed by athletes were determined using mathematical analysis.

The Brock underlayment was found to have only a small effect on surface characteristics under normal loading conditions, while significantly enhancing impact shock attenuation at higher loads.

Samples

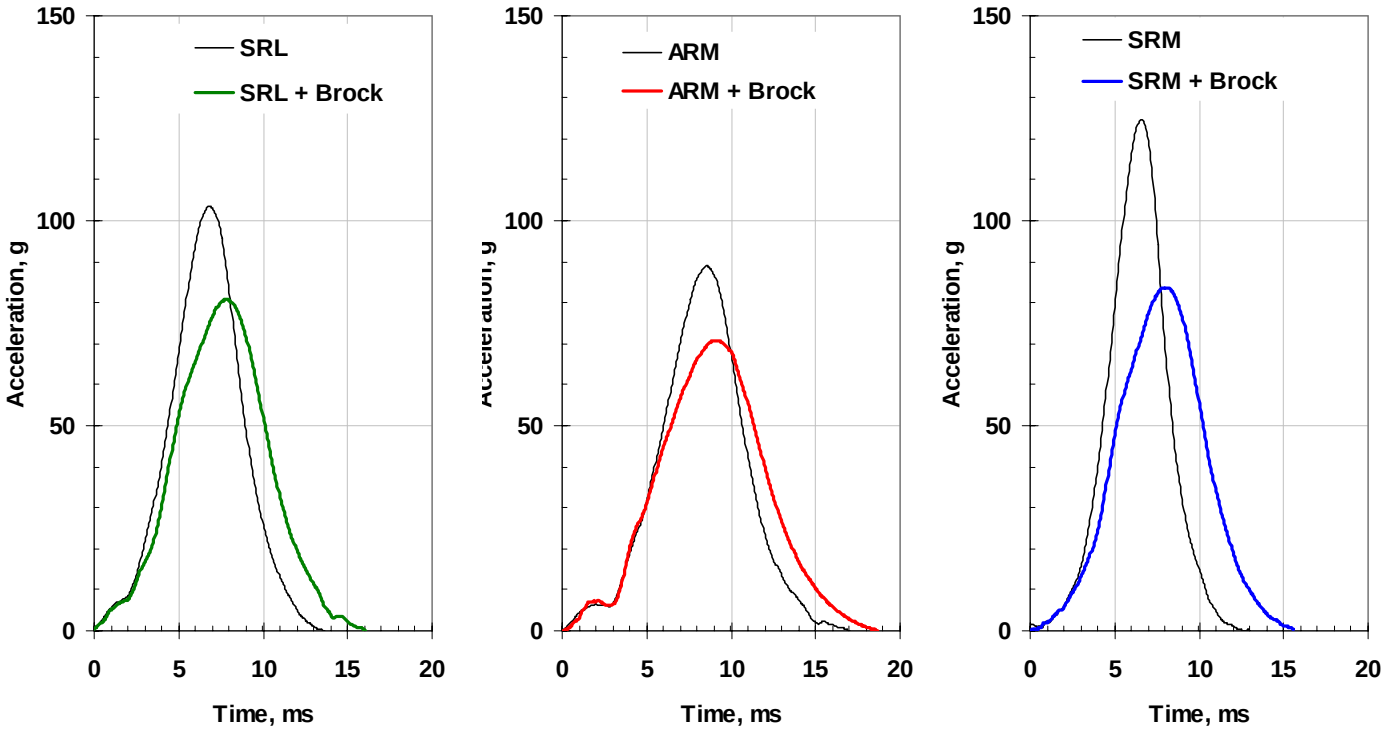
1. **SRL** Sand Rubber Layered in-filled turf system
2. **SRL +B** Sand Rubber Layered with flat Brock underlayment
3. **ARM** All Rubber Mix in-filled turf system
4. **ARM +B** All Rubber Mix with flat Brock underlayment
5. **SRM** Sand and Rubber Mixed in-filled turf system
6. **SRM +B** Sand and Rubber Mixed with flat Brock underlayment

Loading Conditions

A: Head impact (F355-A impact test)
B: Running, heel impact
C: Running, peak forefoot load

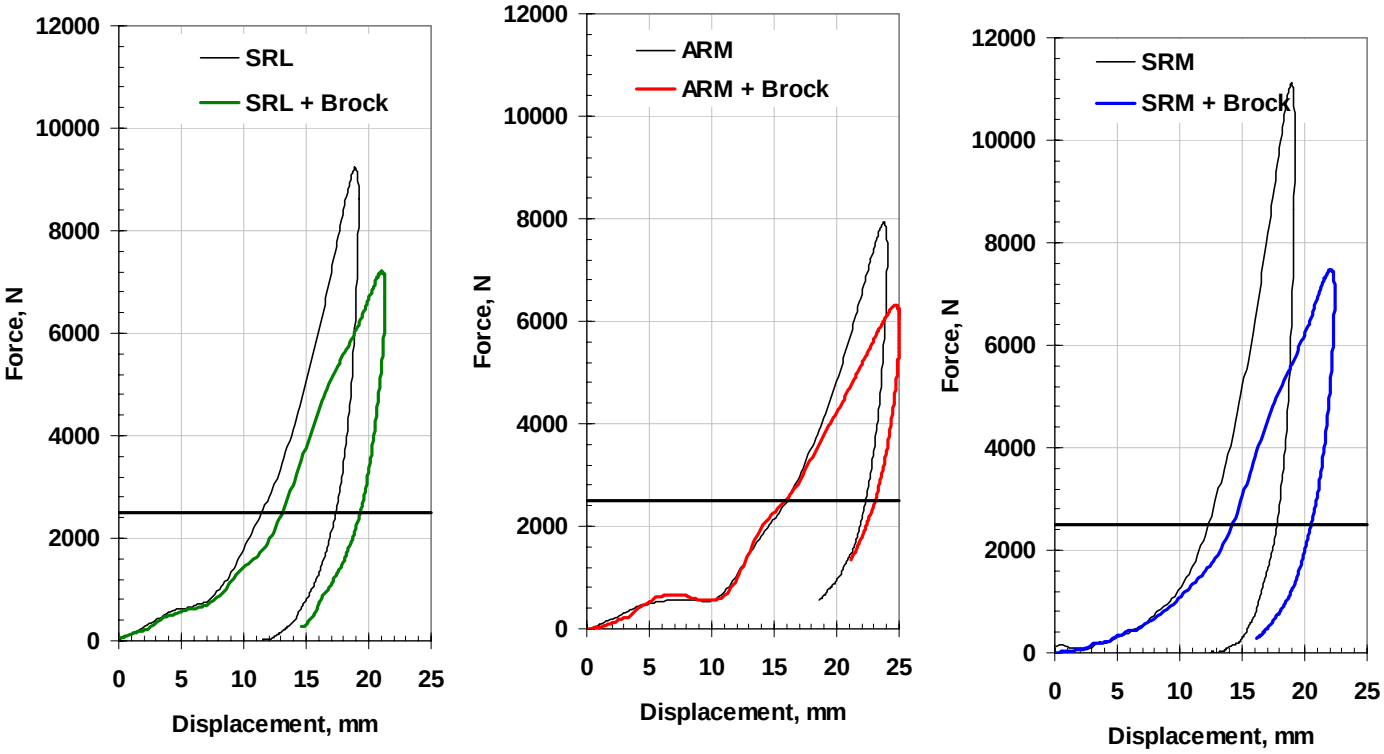
F355-A Impact Test Results

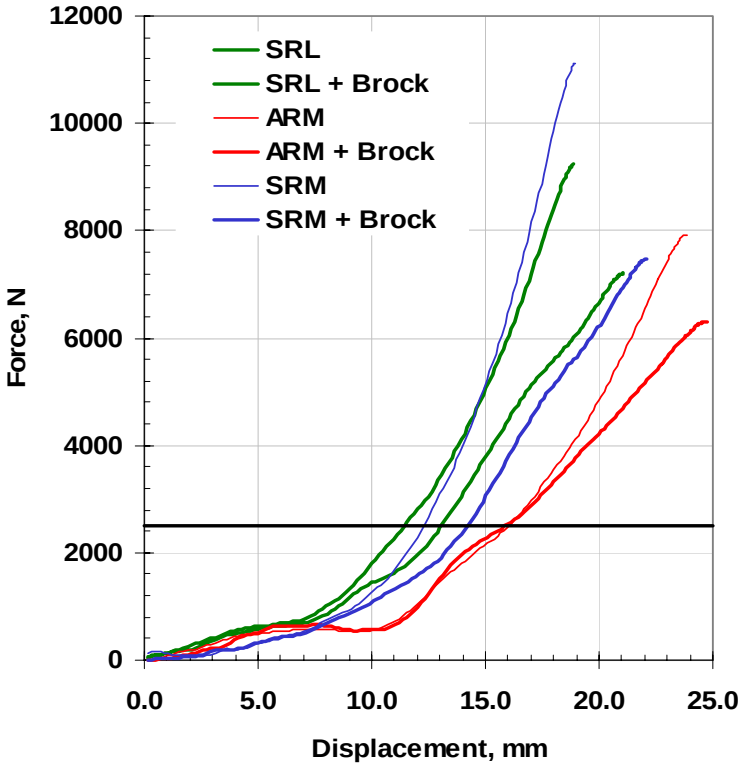
Example Acceleration-Time Curves



#	Sample	g-max	Stiffness kN m^{-1}
1	SRL in-filled turf system	105	791
2	SRL with flat Brock underlayment	81	468
3	ARM in-filled turf system	91	592
4	ARM with flat Brock underlayment	72	369
5	SRM in-filled turf system	129	1198
6	SRM with flat Brock underlayment	85	516

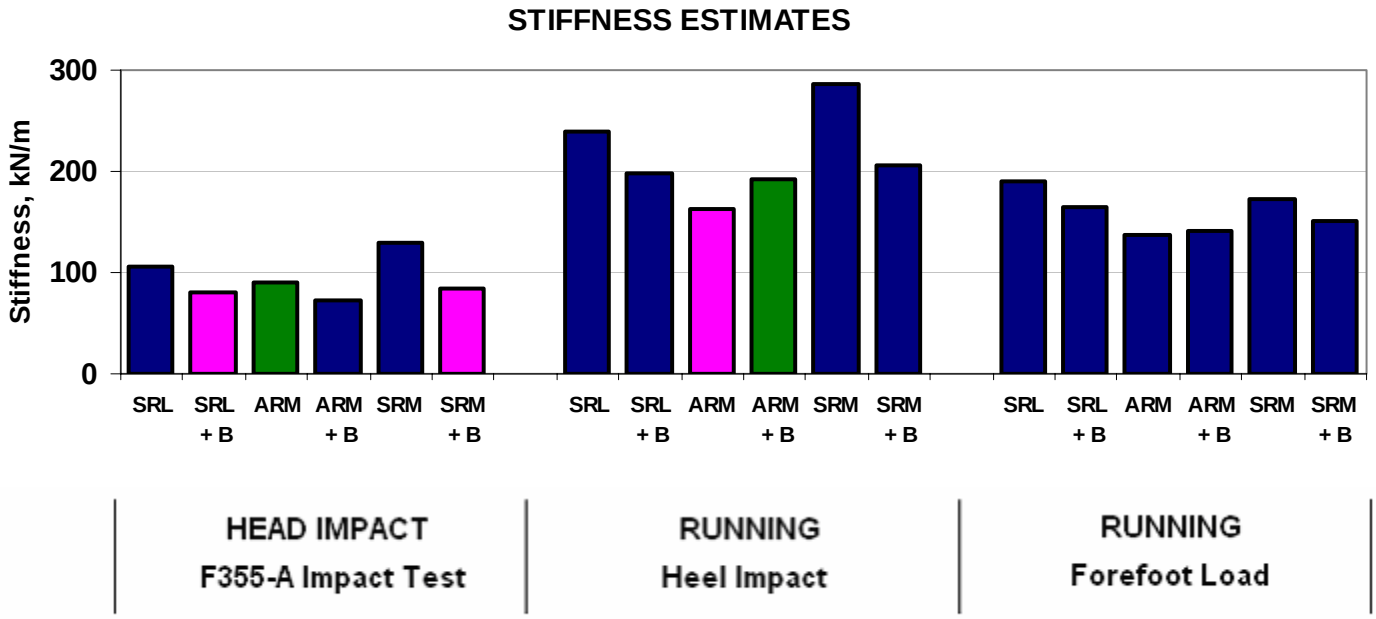
Compressive Force-Displacement Curves





Response to Loading Conditions

Loading Condition	Score		Surface Sample SRL	SRL + B	ARM	ARM + B	SRM	SRM + B
Head Impact F355-A Impact	g-max		105	81	91	72	129	85
	Stiffness	kN m^{-1}	791	468	592	369	1198	516
Running Heel Impact	g-max		18.5	16.9	15.5	16.6	20.1	17.2
	Stiffness	kN m^{-1}	240	199	164	191	287	205
Running Forefoot Loading	Displ.	mm	10.5	12.1	14.6	14.1	11.6	13.3
	Stiffness	kN m^{-1}	190	165	137	142	172	150



Comments

In a previous study (11/4/2003) it was found that the addition of a Brock underlayment to a SRM infilled system did not significantly affect surface stiffness at low loads. The two surfaces also had similar stiffnesses in the range of forces produced by a running athlete. At higher (impact) loads the surface with the Brock underlayment. At high loads, the surface with the Brock underlayment had a lower stiffness and lower g max scores on a standard test of impact attenuation.

In this study had similar findings using a different Brock underlayment (lower density, no feet) and three different synthetic turf surfacing systems.

- At the load levels equivalent to the forefoot of an athlete running on the surface, the Brock underlayment reduced surface stiffness by an average of 9%

- At the load levels equivalent to the heel impact of an athlete running on the surface, the Brock underlayment reduced surface stiffness by an average of 18%

- At the load levels equivalent to a sever impact, such as that used in head-injury related shock attenuation tests, the Brock underlayment reduced surface stiffness by an average of 68%, and improved shock attenuation by an average of 32%

These results suggest that the Brock underlayment will have only a small effect on the performance of typical athletic activities, while significantly enhancing shock attenuation in the event of a severe impact.