ISA Sport USA

DMA Sports Design Group

Athletic Facility Safety Evaluation

G-Max Impact Testing ASTM F-355
HIC Testing EN 1177

Innovative Base Technologies LLC
UltraBaseSystems™
5030 Seminole Boulevard
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June 28, 2011

Prepared Through:

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June 28, 2011

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RE: UltraBaseSystems™ Testing
HIC and G-Max Impact Test Evaluation

Mr. Barlow,

On June 28, 2011 DMA Sports personnel conducted field tests at our laboratory in Lubbock, Texas. The purpose of the tests was to evaluate the shock absorbing characteristics of the UltraBase Systems and synthetic grass systems in accordance with ASTM F-355 (Gmax) and EN 1177 (HIC).

The Standard Test Method for Shock-Absorbing Properties of Playing Surface Systems and Materials (ASTM F1936-98 American Football Field and EN 1177 for international playing surfaces) was followed. The tests were performed using a Triax 2000, tripod mounted G_{max} registration unit (www.triax2000.com). This report presents Background information on the test procedures, Existing Conditions, Test Results and Observations.

Background

The ASTM F-355 Procedure A and ASTM 1936-10 test methods covers the measurement of certain shock-absorbing characteristics, impact force-time relationships and rebound properties of playing surface systems. The test procedure involves dropping a 20 lb missile three times at the same location under a controlled consistent height of 3.28083 feet or 1 meter. The G_{max} testing was developed by NASA in association with the automotive industry to determine the magnitude of sustained force the human body (in particular, the head) could withstand before serious effects would occur.

The G force, or acceleration of the mass that is applying the force, is correlated with the sustained duration of the force. As an example, a fighter pilot may be subject to G forces of as much as 8 times normal gravitational force (8 Gs) for up to several minutes at which time unconsciousness (a blackout) could occur. Relative to athletic fields, a player will encounter G forces of 100 to 200 G's or not more than 1000 for HIC over a period of less than 14 milliseconds. It has been determined that a G force of 200 or 1000

HIC over a period of at least 14 milliseconds is considered concussion level. This is for a single encounter. It has been shown by studies conducted by the AMA, that repetitive blows or encounters of up to four to five during an event reduces the needs to 160 G's.

In the early 70's, the artificial turf companies started to use this standard (G < 200) to determine the safety of their carpet systems. The artificial turf needed to stay inside this envelope, so it was determined by the turf manufacturers that a drop height of 24-inches should be the standard. This particular drop height was established because the artificial turf systems would exceed the maximum allowable G_{max} (> 200 G's) with a drop of 30-inches or more.

As the industry has grown in sports surfacing and playground safety surfacing, so has the performance of these synthetics. Playground surfaces are now required to meet shock absorbency standards from minimum drop heights of 36-inches to as much as 8-feet.

In addition, the old carpet systems were directly accountable for sports injuries related to the carpet itself. Injuries such as turf toe and foot lock, and ankle, knee and shoulder sprains and breaks occurred, along with carpet burns and abrasions that were season long. The new synthetic grass systems offer much better results; achieving G_{max} values of less than 200 from drop heights as much as 48-inches.

Existing Conditions

General Weather Condition: Clear skies

Field Testing Date: 6/28/11
Surface Temp: 87.3° F
Humidity: 77.4%
Base Material: Concrete

Air Temperature: 72.8° F
Turf Backing Temp: 73.5° F
Wind Average Speed: 3.5 mph

The synthetic surface is a Fieldturf Pro Classic with a sand and rubber infill over the UltraBase System. A complete EN 1177 test procedure (IRB Regulation 22) was performed on each of the Locations.

Three consecutive drops were made at each location for each 1 meter drop height, at roughly 1.5 - 4 minute intervals. The second and third drops are averaged together. The data is summarized in the attached table.

Field Results

The HIC test results for the 1.22 meter drop indicated that the sample and turf are well within safe standards, ranging from 904 to 995. The average for the entire system was 983. This range and average meets EN Standards. The data for the Head Injury Criterion (HIC) and P_{max}, the velocity at impact (ft/sec) of the missile, are also shown on the table. This test was performed over a concrete base. You can review these results in Table #1.

REGULATION 22. STANDARD RELATING TO THE USE OF ARTIFICIAL PLAYING SURFACES

IRB PERFORMANCE SPECIFICATION FOR ARTIFICIAL SURFACES FOR RUGBY

Characteristic	Test Method	Requirements
Shock Absorbency	EN	60-75%
H/C	EN 1177	>1.0m

TRIAX 2000 - Data Acquisition and Analysis Report

Test Methods: ASTM F-355 Procedure A, ASTM F 1936-10
EN 1177 International Playing Surfaces

Table #1 (Concrete Base)

Location #	Drop #	Peak/Gmax	Ft. / Sec.	H.I.C	Description of Location	Location HIC Avg	Temp	
1	1	140	13.4	583	Drop height 3.28083 feet or 1 meter	592	22.4 C	
	2	143	13.4	583				
	3	143	13.4	601				
2	1	173	15.4	904	Drop height 4.00 feet or 1.22 meter	982.5	22.4 C	
	2	184	15.4	979				
	3	194	15.4	986				
3	1	226	17.3	1486	Drop Height 5.00 feet or 1.52 meter	1544	22.4 C	
	2	233	17.3	1545				
	3	233	17.3	1543				

Field Results

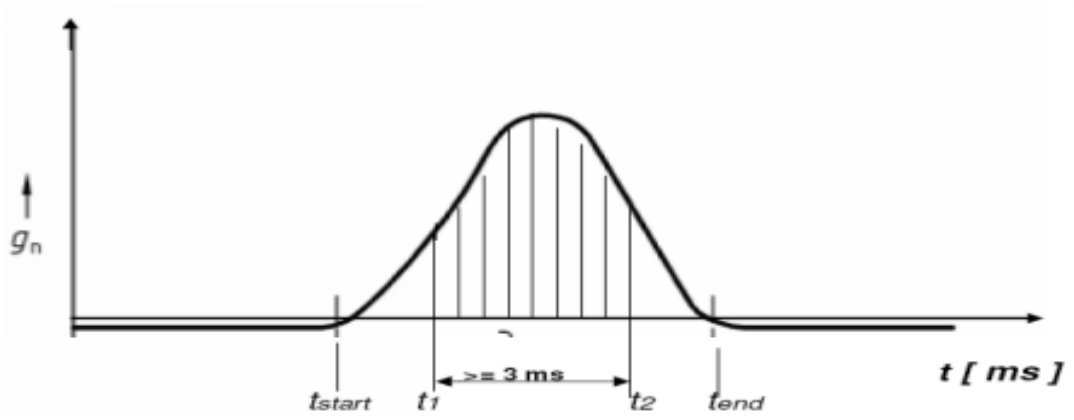
We also tested the system over a standard aggregate or stone base. You can review these results under table #2. In these tests, we tested the system from three different heights of 1 meter (3.2808 feet), 1.22 meters (4 feet) and 1.4 meters (4.59 feet).

The HIC test results for the 1.4 meter drop indicated that the sample and turf are well within safe standards, ranging from 930 to 946. The average for the entire system was 945.5. This range and average meets EN Standards. The data for the Head Injury Criterion (HIC) and P_{max}, the velocity at impact (ft/sec) of the missile, are also shown on the table. This test was performed over a concrete base. You can review these results in Table #2.

Table #2 (Stone Base)

Location #	Drop #	Peak/Gmax	Ft. / Sec.	H.I.C	Description of Location	Location HIC Avg	Temp	
1	1	130	13.5	503	Drop height 3.28083 feet or 1 meter	542	22.4 C	
	2	133	13.5	523				
	3	135	13.5	561				
2	1	163	15.6	864	Drop height 4.00 feet or 1.22 meter	892.5	22.4 C	
	2	167	15.6	889				
	3	171	15.6	896				
3	1	186	17.5	930	Drop Height 4.59 feet or 1.4 meter	945.5	22.4 C	
	2	193	17.5	945				
	3	195	17.5	946				

Figure 1: Impact acceleration / time curve



$$HIC = \left[\left(\frac{\int_{t_1}^{t_2} a \times dt}{t_2 - t_1} \right)^{2,5} \times (t_2 - t_1) \right]_{max}$$

DMA is here to assist you from evaluation of products through engineering design, testing and construction oversight to achieve a successful project.

Yours truly,

ISA Sport USA
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