Understanding
field hardness test reports

SPORTS SURFACE IMPACT TESTING (field hardness) has become an integral part of the synthetic maintenance process. Test results can indicate that a field is in good condition, as well as pinpoint areas of concern.

The Synthetic Turf Council recommends a minimum testing frequency to be at the end of year 1 and the end of year 3. Other industry experts and/or field specifications often recommend annual testing. That's a lot of data! Due to the large amount of data, the test reports may be somewhat difficult to interpret. In this article, we'll break down the field hardness test report, so that the field manager can understand it better and find the information that is most important for success.

The field hardness test report is a two-page report (see Figures 1 and 2). This report includes field conditions and test results from evaluations performed at multiple locations on a single field. In Figures 1 and 2, we have divided the test report into five sections to aid in finding informa-

>> Figure 1.

SPORTS SURFACE IMPACT TEST REPORT

Section 1

Soccer Complex
City, State

Test Date: March 15, 2011 — Report Date: March 18, 2011

Weather Conditions:
Temperature: 43 - 45° F — Humidity: 81 - 87%
Cloudy

Testing performed for Blank High School

Section 2

Test Method:
ASTM F1936: Standard Specification for Impact Attenuation of Turf Playing Systems as Measured in the Field

Summary of Results:
End A is the West end and Side C is the South side of the full-size field (white boundaries).

		Vo fps	gmax	tmax ms	Surface Temp (° F)
Point 1	Penalty Kick Line, End A, Center of Field Total 5.8 cm depth; Infill 3.1 cm depth	11.58	96.0	8.0	48
Point 2	63' from center of field to corner of Penalty Box, Side C, End A Total 5.6 cm depth; Infill 2.8 cm depth	11.58	99.3	7.4	48
Point 3	75' from Half-Way Line to End A, 40' from center of field to Touch Line C Total 5.7 cm depth; Infill 3.0 cm depth	11.70	103.2	7.8	46
Point 4	Half-Way Line, Center of Field Total 5.6 cm depth; Infill 3.2 cm depth	11.37	100.2	8.1	48
Point 5	75' from Half-Way Line to End B, 63' from center of field to Touch Line D Total 5.8 cm depth; Infill 3.5 cm depth	11.30	90.7	8.6	48
Point 6	1/2 the distance from Penalty Restraining Arc to leading edge of Penalty Box at End B, Center of Field Total 5.8 cm depth; Infill 3.4 cm depth	11.64	92.9	7.8	48
Point 7	Goal Line, End B, 5' Outside Touch Line C Total 5.3 cm depth; Infill 3.2 cm depth	11.21	117.3	7.3	46
Point 8	Corner Kick Area (Yellow Field), End B, Side D Total 5.6 cm depth; Infill 2.8 cm depth	11.67	105.2	8.4	46
Point 9	3' from Goal Line to Half-Way Line, End A, Center of Field Total 5.2 cm depth; Infill 2.9 cm depth	11.39	97.7	8.0	43
Point 10	15' from Goal Line to Half-Way Line, End B, Center of Field Total 5.5 cm depth; Infill 3.2 cm depth	11.44	102.3	7.4	46

Section 3

Conclusion:
Under the test conditions reported above, all test points met the requirement of < 200 average G max when tested in accordance with specification F1936.

Test results reported herein reflect the conditions of the tested field at the time of testing and at the temperature reported.

Operator Signature
Duane K. Otto

>> Below: Figure 2.

Section 4

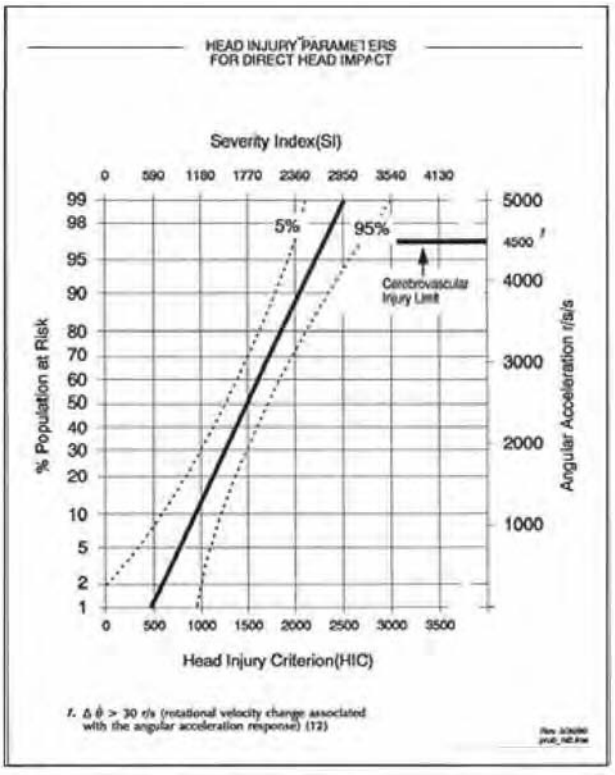
Soccer Complex
City, State

Test Date: March 15, 2011 — Report Date: March 18, 2011

Section 5

Test Point	Drop #	Vo fps	h ft	gmax	HIC
1	1	11.54	2' 1"	86.4	213.1
	2	11.69	2' 1"	93.9	244.5
Penalty Kick Line, End A, Center of Field	3	11.46	2' 0"	98.1	260.8
	Av23	11.58	2' 1"	96.0	252.7
2	1	11.77	2' 2"	88.2	222.7
	2	11.75	2' 2"	97.8	259.5
63' from center of field to corner of Penalty Box, Side C, End A	3	11.41	2' 0"	100.9	273.5
	Av23	11.58	2' 1"	99.3	266.5
3	1	11.27	2' 0"	87.4	219.9
	2	11.77	2' 2"	99.7	271.8
75' from Half-Way Line to End A, 40' from center of field to Touch Line C	3	11.63	2' 1"	106.7	304.8
	Av23	11.70	2' 2"	103.2	288.3
4	1	11.46	2' 0"	84.8	205.2
	2	11.49	2' 1"	97.5	259.6
Half-Way Line, Center of Field	3	11.24	2' 0"	102.9	283.0
	Av23	11.37	2' 0"	100.2	271.3
5	1	11.42	2' 0"	78.2	182.9
	2	11.32	2' 0"	90.0	234.2
75' from Half-Way Line to End B, 63' from center of field to Touch Line D	3	11.29	2' 0"	91.4	237.3
	Av23	11.30	2' 0"	90.7	235.8
6	1	11.50	2' 1"	83.3	209.9
	2	11.45	2' 0"	92.2	245.6
1/2 the distance from Penalty Restraining Arc to leading edge of Penalty Box at End B, Center of Field	3	11.83	2' 2"	93.6	250.7
	Av23	11.64	2' 1"	92.9	248.1
7	1	11.17	1' 11"	99.8	264.7
	2	11.08	1' 11"	116.7	335.4
Goal Line, End B, 5' Outside Touch Line C	3	11.34	2' 0"	117.8	337.8
	Av23	11.21	1' 11"	117.3	336.6
8	1	11.33	2' 0"	92.4	238.6
	2	11.76	2' 2"	103.6	290.9
Corner Kick Area (Yellow Field), End B, Side D	3	11.59	2' 1"	106.7	299.7
	Av23	11.67	2' 1"	105.2	295.3
9	1	11.36	2' 0"	83.5	205.5
	2	11.26	2' 0"	95.8	257.5
3' from Goal Line to Half-Way Line, End A, Center of Field	3	11.53	2' 1"	99.6	273.4
	Av23	11.39	2' 0"	97.7	265.5
10	1	11.78	2' 2"	93.3	238.9
	2	11.44	2' 0"	99.8	268.3
15' from Goal Line to Half-Way Line, End B, Center of Field	3	11.44	2' 0"	104.7	284.2
	Av23	11.44	2' 0"	102.3	276.3

>> Below: Figure 3. Graph from research published in February 1990 by Voigt R. Hodgson, Ph.D., Director Biomechanics Laboratory, Department of Neurosurgery at Wayne State University Detroit, Michigan in his paper titled Impact, Skid And Retention Tests On A Representative Group of Bicycle Helmets to Determine Their Head-Neck Protective Characteristics.



tion and explaining the data. Figure 1 is the first page of the report, and Sections 1 to 3 are found on page 1. Figure 2 is the second page of the report, and Sections 4 and 5 are found on page 2.

Section 1: Basic information regarding when and where the test was performed. Also included are the weather conditions during testing.

Section 2: This section has summaries of testing performed and test results. This is the heart of the test report, and contains the information that will likely be of most interest to sports turf managers.

• Testing Method: Testing is typically performed according to guidelines detailed in ASTM F1936. F1936 provides specifications for equipment to be used, how and where tests are to be performed, and field performance requirements.

• Point: Testing points refer to locations on the field where test measurements are performed. Different locations are specified per ASTM F1936 for different types of fields (football, soccer, lacrosse, etc.). Typically eight test points are specified by the method and two additional points are tested at the discretion of our field technician. If desired, additional points can also be tested and reported.

• Total Depth and Infill Depth: This information can provide insight for evaluating problems or trouble areas. Depths are typically not mandated, but turf manufacturer specifications often indicate acceptable fiber lengths, infill material, and infill depths. Total Depth is the depth from the top of the turf to the backing (synthetic fields) or soil (natural turf fields). Worn or lost turf can cause a harder or softer field and impact performance. Infill Depth is the depth of infill materials that are between the turf fibers. Infill is used to provide desired playing conditions, and can act to protect turf fibers. Typical infill materials include sand, rubber, and other materials. Most, but not all, synthetic fields have infill material. Uneven infill depths can lead to varying hardness and performance. Loss of infill may also lead to turf damage, and is a significant cause of variance in field performance.

• Gmax is the maximum value of G encountered during an impact. G is the ratio of magnitude of missile acceleration during impact to the acceleration of gravity, expressed in the same units (G, being a ratio, is unit less). The number reported here is the average of the second and third drop at each test point. The maximum impact level of <200 average Gmax, has been accepted by the U.S. Consumer Product Safety Commission. ASTM F1936 states that: "According to historical data, the value of 200G is considered to be a maximum threshold. Values of 200 Gmax and above are considered values at which life threatening head injuries maybe expected to occur." Project specifications may require a lower maximum impact level. For example, many experts recommend Gmax values no higher than 170 on fields where sports without helmets are played.

• Vo fps: impact velocity, velocity of the missile (in feet per second) as it impacts the surface of the field. This is not a measurement of the turf, but an indicator of whether test was performed properly. If impact velocity is not acceptable our field technician will rerun tests at the test point.

• Tmax ms: time (milliseconds) to impact maximum (Gmax). Used in calculations for Head Injury Criterion.

Section 3: Statements regarding whether Gmax results are less than 200 and that report reflects condition of field. Signed by field technician.

Section 4: Same as section 1. Basic information regarding when and where the test was performed, at the top of page 2.

Section 5: Test results from the individual test drops at each test point.

• Test point location and individual test results with the average (2nd and 3rd drops) are reported for Gmax and Vo fps (impact velocity).

• Drop height is 2 feet. This is the distance that the test missile is dropped during the test procedure. ASTM F1936 states: "The test method incorporated into this specification (Procedure A of Test Method F355), has been used to test the impact attenuation of athletic fields for over 30 years. The development of this 2-ft fall-height method can be traced back to the Ford and GM crash-dummy tests of

>> **Turf Diagnostics technician** measuring field temperature and infill depth as part of a field evaluation.

the 1960's, medical research papers from the 1960's and 1970's, and a Northwestern University study in which an accelerometer was fixed to the helmet of a middle line backer to measure impacts received during actual play. This study found the typical head-impact to be 40 ft/lb, which is equivalent to the impact generated by dropping a 20 lb missile from a height of 2 feet, the requirement specified in Procedure A of Test Method F 355."

• Head Injury Criterion (HIC) is a measure of the likelihood of head injury arising from an impact. HIC is a measurement of impact severity based on published research describing the relationship between the magnitude and duration of impact accelerations and the risk of head trauma. At the 2012 STMA Conference, Dr. Andy McNitt of Pennsylvania State University indicated a near perfect correlation between Gmax and HIC for sports fields (i.e. high Gmax = high HIC; low Gmax = low HIC). HIC is used to assess safety related to vehicles, personal protective gear, and sport equipment. Because there is limited research regarding sports fields, data from the auto industry and others is used to provide insight into injury risk. The higher the HIC value, the greater the risk of injury (see Figure 3 below).

Turf Diagnostics believes that the Gmax values should be the key indicator of field hardness for the turf manager. Individual test points with Gmax above 200 or a Gmax average of greater than 170 for the entire field suggest that maintenance practices, such as grooming and topdressing, are required.

We also believe that the field manager should pay particular attention to infill depth. For consistency in play, infill depth should be uniform over the entire field. Changes to infill depth over time should also be noted. Infill depth tends to decrease over time and should be replenished as part of a synthetic turf maintenance program. ■

Sam Ferro is the president of Turf Diagnostics & Design, which performs field hardness testing on fields throughout the US as well as testing of soils, sands, aggregates and amendments for natural and synthetic turf fields.