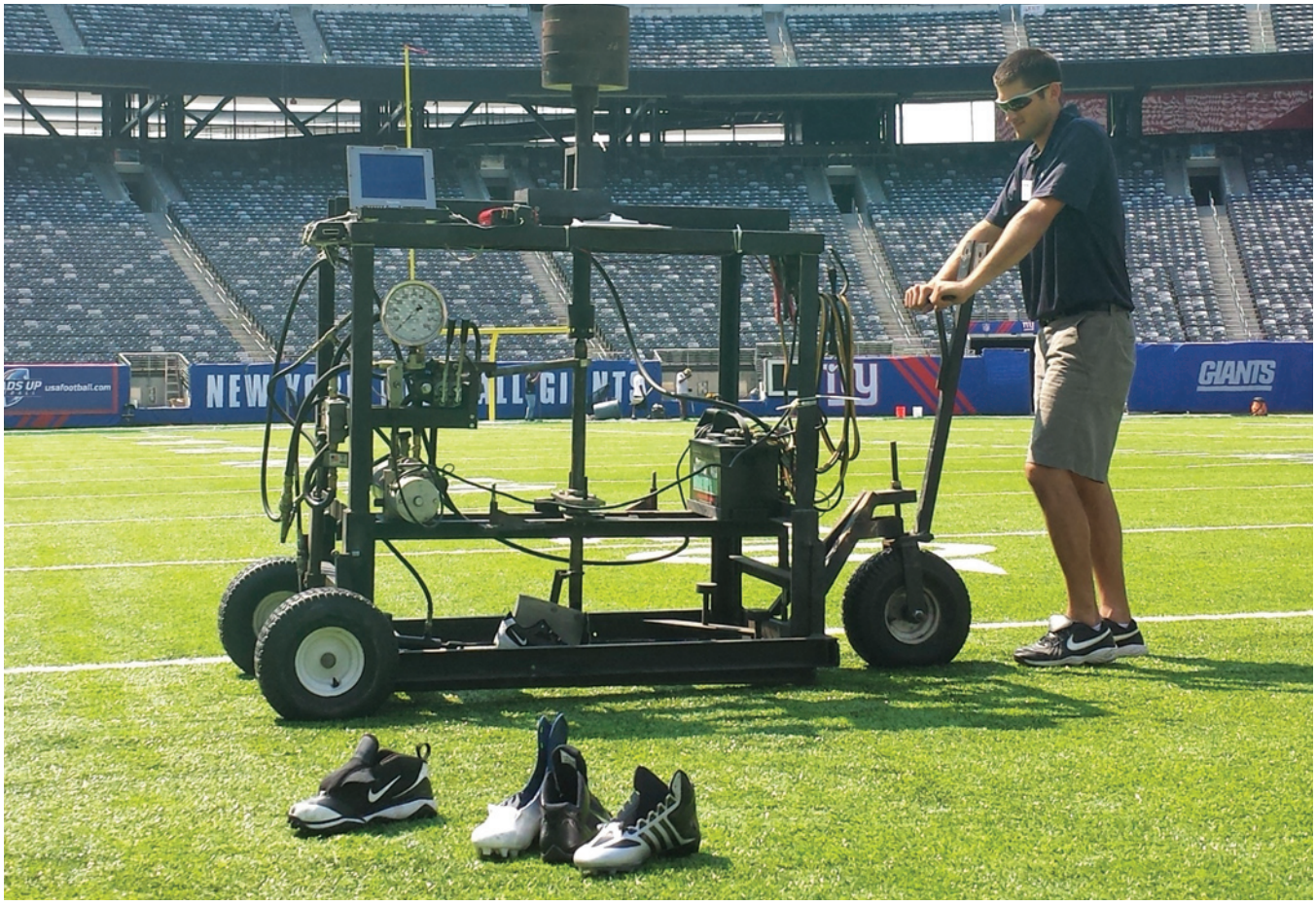

UPDATE ON FIELD SAFETY TESTING

▲ **Penn State's Pennfoot** machine measures both rotational and linear (translational) traction. Rotational traction is more related to injury risk while linear is more related to performance. For rotational traction, Pennfoot measures the amount of force required to rotate the shoe in the turf.

As another football season looms on the horizon, coaches are finalizing game plans they hope will bring them season-long success on the field. Sports turf managers are no different but instead of wins, success means providing playing field conditions that maximize both playability and safety.

The current heightened focus on athlete safety has increased the scrutiny of all potential contributors to athlete injury, including the playing surface. In fact, all NFL fields are now tested and certified before every game using a set of "recommended practices." These recommended practices include tests such as field hardness (Gmax), soil moisture, infill depth, and visual inspections, depending on the surface type.

Much of the increased concern for athlete safety is due to a heightened awareness of the issues surrounding concussions. Research indicates that most concussions are the result of violent athlete to athlete collisions. However, this same research indicates that approximately 10-15% of concussions in American football are caused by the head hitting the surface. Consequently, the hardness of the playing surface can affect injury risk.

By routinely monitoring field hardness levels, management practices can be implemented well before the surface exceeds hardness thresholds. For example, surface hardness of NFL fields is tested with the Clegg Impact Tester. The

» We have measured **Gmax values well over 250 Gmax** (Clegg) on dry, compacted fields. As a reminder, the **NFL threshold is 100 Gmax**.

Clegg quantifies surface hardness by measuring how quickly a vertically-dropped weight stops when it hits the surface. In the NFL, all fields, both natural and synthetic, must be below 100 Gmax in all locations when tested with the Clegg. If hardness levels begin to approach 100, steps are taken to lower these values. Practices that lower Gmax of a surface include topdressing crumb rubber onto synthetic turf fields or needle-tine aerification on natural turf fields.

The Clegg model used in the NFL is equipped with a 2.25 kg missile and is calibrated from 0 to 150 G. A standard Clegg is calibrated from 1 to 1000. The 0 to 150 G calibration of the NFL model has better accuracy over the range of Gmax values typical of natural and synthetic athletic fields. (The NFL Clegg model can be purchased from turf-tec.com for approximately $4,000.)

▲ **Many field managers** are now using a Clegg hammer to regularly measure Gmax on their own.

▲ **The Center for Sports Surface Research** recently measured rotational traction of 30 commercially available shoes on Kentucky bluegrass, bermudagrass, and FieldTurf Revolution. The difference among playing surfaces was minimal compared to the large differences found among shoes.

THE F355

Another device traditionally used to measure surface hardness of synthetic turf fields is the F355. Named after the American Society for Testing and Materials (ASTM) standard that describes its specifications, the F355 quantifies surface hardness using the same principle as the Clegg. However, the drop heights and mass of the weights differ between the devices and the generated Gmax values are not interchangeable. For instance, 100 G as measured with the Clegg is not the same as 100 G measured with the F355. While the NFL uses a limit of 100 G with the Clegg, according to ASTM, a field should not exceed 200 G when measured with the F355.

In the past, the F355 has been used to measure Gmax levels on synthetic turf while the Clegg has traditionally been used on natural turf. However, because both devices use the same principle to measure surface hardness, either can be used, regardless of surface type. A recent ASTM subcommittee round-robin testing event at Penn State confirmed the high correlation between the Clegg and the F355. The round-robin testing included seven testing agencies and 15 surfaces. The full report is available on our website, ssrc.psu.edu.

Regardless of the device used, routine field testing benefits all athletes who use the field and demonstrates a commitment to field safety. Arguments can be made for either device, however, if fields are not being tested, no advantage is gained. Many field managers are now using the much less expensive Clegg adopted by the NFL, which provides a more affordable option for sports complexes that wish to be proactive and regularly measure Gmax on their own.

No surface hardness discussion is complete without addressing the reasons why fields get harder over time. Field hardness on natural turf fields is largely determined by soil water content and compaction. Dry conditions produce a harder field than wet conditions. A dry field combined with a high level of soil compaction produces an even harder surface. Obviously, lack of turf cover can also contribute to higher Gmax values. We have measured Gmax values well over 250 Gmax (Clegg) on dry, compacted fields. As a reminder, the NFL threshold is 100 Gmax.

Not surprisingly, water management and core cultivation are key practices to reduce surface hardness levels. However, core cultivation during the season is not recommended. As a result, in-season techniques to reduce hardness are a bit more tricky. NFL field managers have been experimenting with in-season needle-tine aeration and deep-tine units set to penetrate only a few inches to slightly raise the surface. These techniques have been fairly successful for short-term reductions in surface hardness without sacrificing playability, but care should be taken. If in-season cultivation becomes too aggressive, the surface playability may suffer due to reduced footing.

SYNTHETIC TURF

On synthetic turf, contrary to popular belief, compaction is not a major cause of increased surface hardness. Infill particles are usually very uniform in size. This uniformity limits compaction potential and after an initial, post-installation settling-in period, compaction is minimal.

Instead, what we call "walk-off" crumb rubber is frequently the main contributor to elevated surface hardness levels. The crumb-rubber infill is what provides the cushioning. The small amounts of rubber particles being removed from the field in shoes, on equipment, etc. add up over time. As the crumb rubber layer thins, surface hardness increases. This is especially true in high-use areas. (See article on page XX of this issue for maintaining crumb rubber levels.)

Consequently, infill depth should be measured at numerous locations across the field regularly and compared to your turf manufacturer's recommended infill depth range. Infill should be added when levels drop below the recommended range. Often, the entire field will not require additional infill. For instance, if the field is used for lacrosse, perhaps only the goal mouths will require a few buckets of rubber. In

these situations, rubber can be hand-applied and worked in with stiff-bristled push brooms. Large scale additions of rubber often require repeated light applications of crumb rubber using a topdresser followed by grooming with a drag broom.

Recently, head injuries have received a lot of attention; however, lower extremity injuries can often sideline athletes for longer periods of time. Sometimes the playing field is mentioned as a possible reason for a knee or ankle injury. Often times the type of surface is mentioned as a culprit if the surface is synthetic. If the field is natural turf, the condition of the surface is sometimes blamed.

Another, possibly more important factor, is being recognized as a significant contributor to lower extremity injury. That contributor is the shoe. Remember, the traction between a shoe and the surface is affected by both the shoe and the surface. The aggressive cleat patterns found on many of today's most popular athletic footwear are producing traction levels much higher than we have seen in the past.

A certain level of traction is needed to run, change direction, and perform other maneuvers necessary for sports. However, high levels of what is called "rotational traction" have been indicated in increased knee and ankle injuries. High rotational traction means that the shoe is resistant to rotating within the turf as a player pivots. In essence, the shoe sticks while the leg rotates. If the shoe sticks, ligaments and tendons are put under additional stress, which may lead to increased injury risk.

We recently measured rotational traction of 30 commercially available shoes on Kentucky bluegrass, bermudagrass, and FieldTurf Revolution. The difference among playing surfaces was minimal compared to the large differences found among shoes. Although there is not enough research to set safe and unsafe traction thresholds, our data suggest rotational traction, and therefore injury risk, varies greatly among cleat patterns.

Additionally, cleat pattern appears to play a much greater role than the playing surfaces tested. The database with rotational traction information for each shoe on each of the three surfaces can be found on ssrc.psu.edu. We plan to update this database each year with traction data from newly released cleat patterns. A related study that included multiple shoes on various surfaces has recently been published in the April 2014 edition of *Applied Turfgrass Science*, a peer-reviewed scientific journal. The study can be found on the journal's website, www.agronomy.org/publications/ats.

As we all know, injuries are an unfortunate part of sports. However, a proactive approach to field safety can help minimize injury risk. Routine surface hardness testing, adding crumb rubber when infill levels drop, educating trainers and parents about the importance of shoe selection are all things that we can do to provide the safest field possible. Because at the end of the day, the safety of the athletes using our fields is our number one goal. ■

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