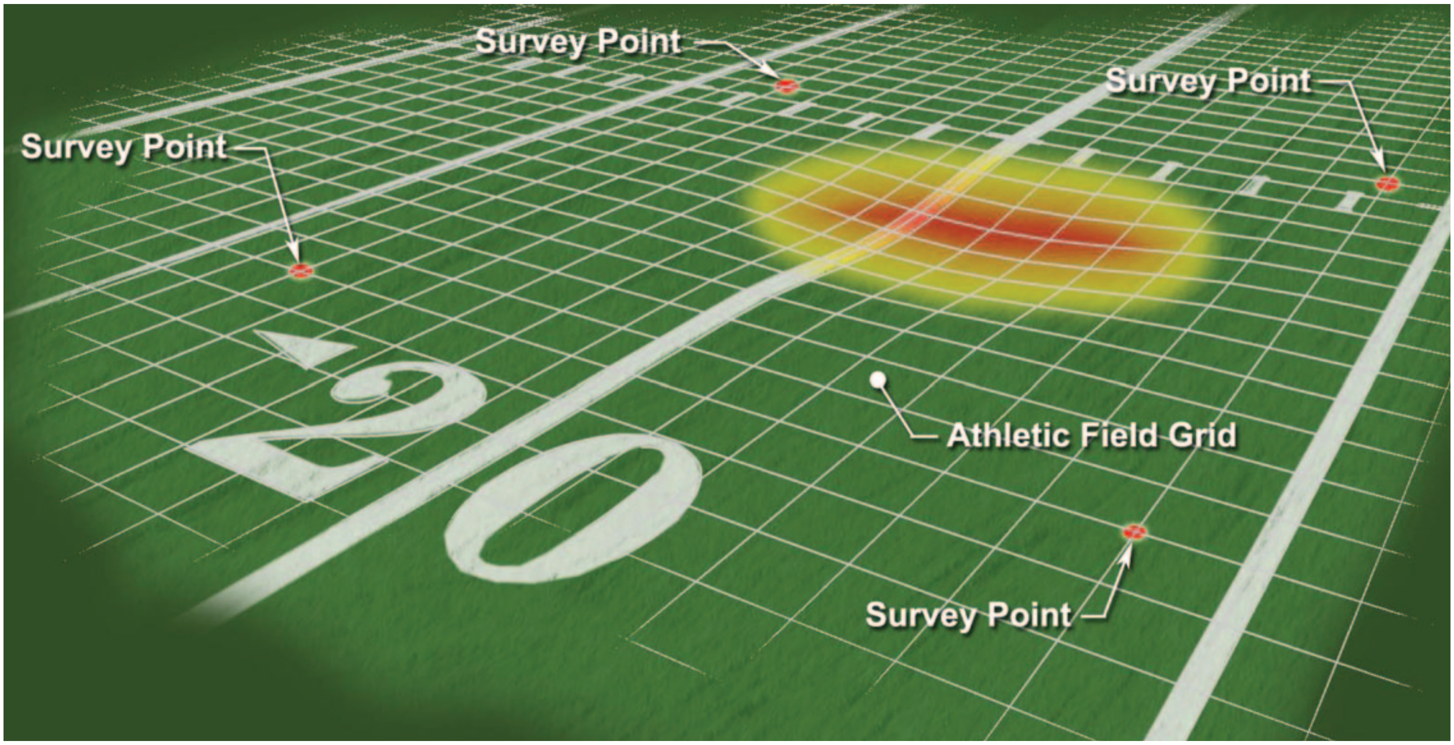


3D scanning and high definition surveying

for synthetic turf athletic fields, running tracks, and sport courts

>> **ATHLETIC FIELD,** running track, and sport court surface plane imperfections may remain using traditional point survey methodology due to the spacing of the survey grid. Laser scanning builds an actual topographic model of the surface plane using thousands of tightly spaced points, eliminating "blind spots" common with a traditional point survey grid. These scanner points can be used to create a graphic image of the surface plane without interpolation between the points, providing a composite and complete model of the athletic field or facility surface.

PROPER CONSTRUCTION of aggregate base courses for synthetic turf sports fields and base pavement courses for running tracks and sport courts is critical in the overall success and quality of the finished sports surfacing. Defects in the underlying construction will be reflected in the finished surface, resulting in athletic facility surfaces that have undulations, inconsistent surface plane, and varying cross-slope.

The finished surface product often represents the most significant portion of the project cost, requires strict planar qualities to meet athletic performance requirements and sport's governing body regulations, and is the finished aesthetic in which sports facilities are inevitably judged. To ensure high quality finished surfacing, determining acceptability of the base construction is a crucial step in the construction of synthetic turf athletic fields, running tracks, tennis courts, and sport courts.

Acceptable subgrade tolerance may vary slightly between various athletic facility consultants and owners for finished planarity requirements; however variations are generally very slight. A specification for a synthetic turf field finished aggregate base course typically will be similar to the following accepted industry standard:

Slope: Not less than 0.5% or as scheduled on the Drawings, consistent over the entire subgrade surface plane with a maxi-

> ◎ **Scanning technology** provides digital terrain modeling as opposed to point by point elevation data. The terrain model creates a detailed record of the actual surface as opposed to point by point information. With digital terrain modeling based upon thousands of closely spaced points, the data gaps with traditional grid as-built surveys are eliminated.

mum deviation from specified slope of 0.1% when measured between two (2) points perpendicular to the crown at an interval between the survey points of not less than of 50 feet.

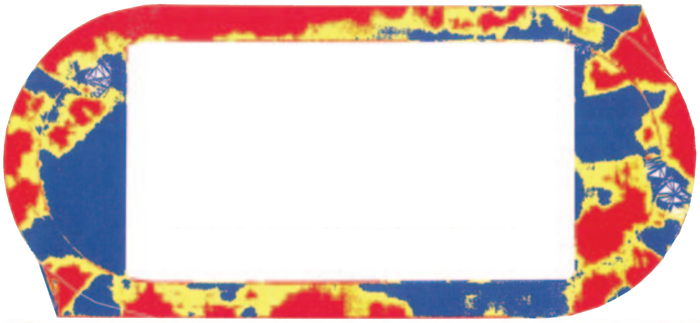
Planarity: The subgrade surface shall represent a true plane free of surface undulation or defect greater than ¼-inch when measured over 10-feet using a straight edge or sting line in any direction on the subgrade or as verified by field survey with a maximum grid interval of 10 feet. All elevations shall be expressed to the nearest hundredth of a foot (0.00).

As evident in the previous example specification requirements for synthetic turf base course construction, the field quality control measurements for acceptance of the synthetic turf field base construction are strict within a specified tolerance range and must be field measured to verify contractor compliance. However, the methodology for field verification as typically included is generally insufficient for proper and accurate confirmation in consideration of the specific and narrow range of the tolerance requirements. The above "visual" methods (straight edge or string line) rely on human judgment and visual interpretation and areas of non-compliance can be easily missed based upon the number of locations selected for visual observation and field survey of the base course.

Visual field observation using "string lines" or a "10-foot straight edge" will provide initial visual evidence related to base planarity acceptability and is commonly used. However, traditional "as-built" surveying will provide accurate elevation data that can be evaluated in consideration of field planarity requirements, slope, as well as relation to design grade and is widely considered superior to "visual observation" alone.

However, areas of undulation, depressions, or other planar deficiencies may still exist between the field survey shots comprising the grid, even at a 10-foot grid interval. Additional drawbacks exist with traditional "as-built" surveying or a combination of both surveying and visual observation, including time delay to schedule and complete the field work, download the survey data and prepare a scale drawing for review, and interpret the data for compliance, which also is subject to "engineering judgment." Further, traditional verification methods may not be cost effective in consideration of the limitations related to the actual accuracy of the evaluation whereby deficiencies may still exist in the completed base construction in spite of the cost associated with the evaluation.

ELA Sport has recognized the "technology lag" of traditional visual observation and surveying for base planarity as compared to the precise tolerances and minimal acceptable variance required for aggregate and paving base construction for athletic facility surfacing. In response to the accuracy limitations and inconsistent results of traditional verification methods, ELA Sport began experimenting with the use of the Leica ScanStation laser scanner to verify as-built aggregate subbase and pavement base for synthetic turf athletic fields and running tracks on several projects in June 2010.



Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
1	-1.346	-0.021	
2	-0.021	0.021	
3	0.021	0.782	

>> **DATA OUTPUT** from the laser scanner may be formatted in a two-dimensional image to depict areas of non-conformance based upon requirements specified by the Owner or Consultant. The graphic model of the running track depicts variation in the track cross-slope from a true and constant plane of 1-percent. The laser scan output has been modeled to depict areas beyond the acceptable range of 0.9-percent to 1.1 percent with areas of shallow slope and areas of excessive slope color modeled for ease of identification.

As a significant advance over popular "total station" survey instrumentation, the ScanStation includes a laser scanner for as-built topographic surveys. The advanced capabilities provides up to a maximum 50,000 points per second instantaneous scan rate with elevation accuracy of 6 mm and distance accuracy of 4 mm for all scan points.

When applied to quality control verification of athletic facility base construction, the laser scan technology provides the following advantages over traditional verification methods:

• Scanning technology provides digital terrain modeling as opposed to point by point elevation data. The terrain model creates a detailed record of the actual surface as opposed to point by point information. With digital terrain modeling based upon thousands of closely spaced points, the data gaps with traditional grid as-built surveys are eliminated. Further, interpolation between grid points (where elevation data is averaged) is eliminated as virtually hundreds of elevation points comprise each grid area in comparison to the four corner points of the grid available through traditional survey methods.

• Data acquisition time is reduced by over 75% as compared to traditional field surveying. Due to the instantaneous scan rate available with the ScanStation, thousands of points can be scanned instantaneously as opposed to surveying each point on the field individually.

• When connected to a laptop computer in the field, almost instantaneous feed back can be provided to the Owner, athletic facility consultant, and contractor. Delays associated with downloading survey data, drawing preparation, and "in office" evaluation can be significantly reduced. Final "hard copy" verification of planarity can be provided in complete, accurate, and final drawing format within 24 hours of the field data collection greatly reducing the time for corrections to be made prior to installation of the final surfacing.

• The field data can be presented in a color coded 3D topographic model and easily compared to the design profile for the athletic facility surface allowing for ready comparison of the as-built condition versus the design condition. Areas of deficiency requiring correction can be readily identified and the volume/area of material required for correction quickly determined.

• With the real time ability to correct planarity issues and with eliminating "data gaps" common in visual or traditional survey verification, corrections requiring cutting and patching the finished synthetic turf or running track surface can be virtually eliminated.

• The time for data collection, visual field verification, and data analysis can be dramatically reduced resulting in cost savings for the quality verification process all while providing more accurate and relevant results. Further, considering the reduction in post surface installation repairs, overall project costs and construction delays can be eliminated and a higher quality finished surface provided.

• The laser scanning technology is also fully compatible with total station surveying permitting integration of the laser scan data with traditional survey data.

The application of laser scanning technology for synthetic turf field, running track, and sport court construction has been undertaken with our survey subsidiary, Land Grant Surveyors (LGS). ELA Sport continues to work with our surveying partner, field and facility contractors, and our clients on the application of 3D laser scanning for as-built planarity verification for a variety athletic facility surfaces.

This new technology was used by ELA Sport on several of our athletic field and track projects during the Summer 2010 construction period with positive results and feedback from our clients and athletic facility builders. Notable projects included survey of the resilient base layer at Villanova University, aggregate base surveys at Crispin Stadium for the Berwick Area School District, Seth Grove Field at Shippensburg University, and the new stadium field at Warwick High School (all in Pennsylvania).

ELA Sport continues to incorporate this advanced survey technology as part of our construction review process and is working to make the highest standard of base quality evaluation available and cost effective from the professional facility level to youth recreational sports facilities. ■

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