

Ground Liner Underlies Reliant Stadium's Engineering Feat

By Alexandria Hayes

If you've heard anything about Reliant Stadium, the new home of the Houston Texans, you've probably heard about its retractable roof (the first in the NFL), removable turf field (the first in the U.S.), or its 72,000 seating capacity (the largest in the NFL). You may have also heard that it took 160,000 cubic yards of concrete, over 17,000 tons of high strength steel and 423 tons of bolts to construct it.

But you probably haven't heard about one unsung hero in the record-setting stadium's construction: the polyethylene liner that reclaims water used to water the turf and prevents ground water from undermining the sub grade. Within the last three to four years, ground liners have been used for outdoor playing fields, but this was the first use of a ground liner for an enclosed stadium.

The stadium had to meet the needs of two tenants with very different requirements. The Houston Livestock Show and Rodeo required a concrete floor and a ceiling from which to rig 89 tons of audio and video equipment. The Houston Texans required a real grass field. Placing a modular, removable turf field on the concrete floor was the solution; the retractable roof ensures the survival of the grass. But having an indoor field that needed to be watered presented potential drainage problems. These were addressed with the underlying ground liner.

Installing a liner for an outdoor field is relatively straightforward: the ground is leveled, the liner is rolled out and the playing surface is built on top. Installing a liner for an enclosed stadium is, as they say, a whole 'nother ballgame, particularly when the entire stadium is being constructed on a 30-month schedule. If the schedule had been more leisurely, it would have been possible to install more of the liner at one time, but with the accelerated schedule Reliant's builders had promised the city, many aspects of the construction had to occur simultaneously. As a result, the liner had to be installed piecemeal.

Aside from the schedule, the primary challenge for the installers was how to attach the liner – which lies beneath the entire field and under the first 20 feet of the bleachers – to the stadium substructures. Where it was possible, high-density polyethylene strips were embedded in structures during their formation and the liner was subsequently welded to them. Where embedding wasn't possible, as in the case of the major foundations, the liner was mechanically attached with a stainless steel batten system.

Six field employees and two project managers worked for eight months among a dozen other trades to install 115,000 square feet of liner. With only 20% of the area available at a time and a constantly changing scope of work, the team engineered the installation “on the fly.” As areas became available for lining (first the periphery, then the under the drainage system, then the flat areas of the field), they mapped out a plan to lay down the liner and attach it to the substructures and other sections of liner that had already been installed.

The characteristics of the liner made it possible for the project to be completed on schedule. A 60-mil thick polyethylene liner had been specified because it is affordable and durable. But its other features – flexibility and workability – allowed the installation team to piece it together, nondestructively testing welds as they proceeded. Sections laid beneath drainage pipes, for example, were put down well before the rest of the field was lined. When the time came to join old sections with new, welding them together was relatively simple. When heavy equipment damaged liner that had already been laid, the damaged piece could be cut out and a new piece welded in place. The liner was also adaptable enough to be attached to the substructures of the building using different techniques.

While the grass grows green in this \$450-million engineering marvel, a simple ground liner will protect its massive support system so the games can go on.

Reliant Stadium's Agru America HDPE Smooth Liner was installed by EnviroCon Systems, Inc., Houston, TX; Christopher Swires and Gregg DeJarnett, project engineers.

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Product Data (Minimum Average Roll Values)		
Property	Test Method	Values
Thickness (mils nominal)	ASTM D5199	60
Melt Flow Index (g/10 minutes)	ASTM D1238-E	0.28
Density (g/cm ³ min)	ASTM D792	0.940
Tensile Strength at Yield (lbs/in. width)	ASTM D638 (Modified)	132
Tensile Strength at Break (lbs/in. width)	Type IV Specimen	240
Elongation at Yield (%)	Gauge length 2 in. break	13
Elongation at Break (%)	1.3 in. yield, 2 ipm	700
Tear Resistance (lbs)	ASTM D1004 - Die C	45
Low Temperature Impact (°F max)	ASTM D746	-103
Dimensional Stability (% change max)	ASTM D1204, 1 hr @ 212°F	±2
Environmental Stress Crack (hrs)	ASTM D5397	200
Puncture Resistance (lbs)	ASTM D4833	108
Carbon Black Content (%)	ASTM D1603	2-3
Carbon Black Dispersion	ASTM D5546	1,2

Product data for Agru America's HDPE Smooth Liner, used in the construction of Reliant Stadium, the first in the U.S. with a removable turf field.



Photo courtesy of EnviroCon Systems, Inc.

A polyethylene liner protects the sub grade under Reliant Stadium. Where it was possible, high-density polyethylene strips were embedded in structures during their formation and the liner was subsequently welded to them. Where embedding wasn't possible, as in the case of the major foundations, the liner was mechanically attached with a stainless steel batten system. Here, the liner is installed under the bleachers.



Photo courtesy of EnviroCon Systems, Inc.

Areas under 30-inch drainage pipes were lined next. The liner was welded to sections that had already been laid. Then welds were nondestructively tested.



Photo courtesy of EnviroCon Systems, Inc.

The liner's flexibility allowed for piecemeal installation. Where heavy equipment had damaged previously-laid sections, damaged pieces were cut out and new pieces were welded in place. Here, the final sections – the flat areas of the floor – are lined.