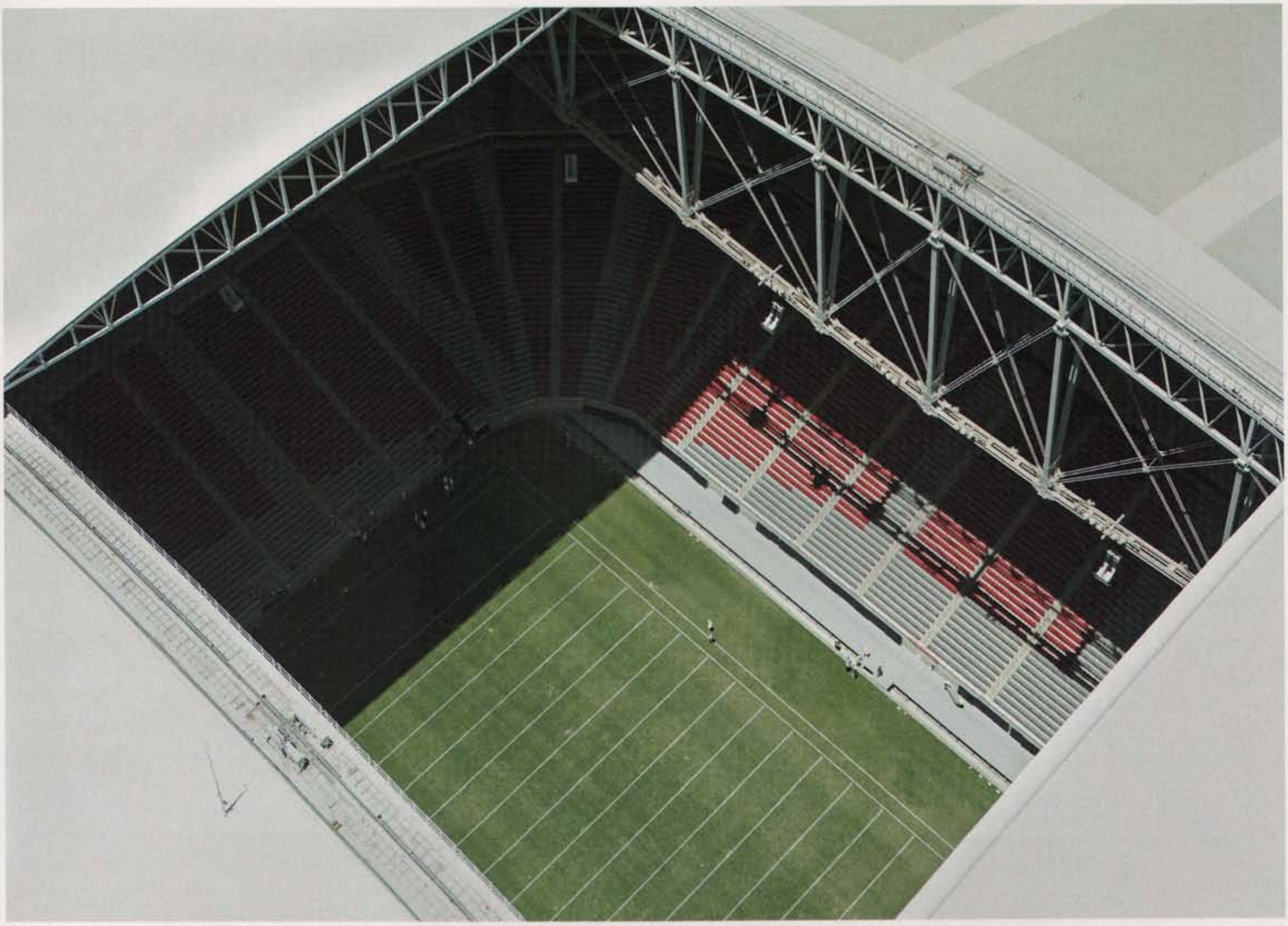

Cardinals Stadium boasts movable field tray

By Mike Lloyd P.E.

When the Arizona Cardinals open their new Cardinals Stadium against the Super Bowl champion Pittsburgh Steelers August 12, the team and their fans will be looking forward to an exciting season in their brand new NFL home.

For CMX Sports Engineers it will be an occasion to reflect on our design of the natural grass turf system for the stadium's movable field tray, the first ever in North America.

As a hometown Phoenix company, CMX has held a long relationship with the Cardinals. In 1990, we served as design engineer and construction manager for the team's training facility in Tempe, which includes three sand-based, natural grass fields.

Later, we oversaw the renovation of the natural grass playing field at ASU's Sun Devil Stadium when the Cardinals hosted Super Bowl XXX in 1996. NFL players have annually ranked the field among the top playing surfaces.

FACTS AND FIGURES

The field is a single movable structural pan and sod assembly with outside dimensions of 234 feet wide, 403 feet, 4 inches long, and 3 feet, 3 inches high. The total weight of the field and tray will be approximately 18.9 million pounds. The stadium door that the field will pass through measures 240 feet wide.

The pan structure supporting the sod and drainage system is about two feet deep and consists of 542 steel wheels riding on 13 parallel steel rails. The center row of wheels will be the guide wheels of the system, with 76 of the wheel sets powered by one-horsepower motors.

The field will travel approximately 740 feet from outside to inside Cardinals Stadium. Estimated time to move the field is about 65 minutes.

The entire 91,916-square foot area will be covered with natural grass turf except for an edge strip of artificial turf three feet wide around the perimeter of the field to allow maintenance staff to keep heavy equipment off the turf.

The 12-million pound turf system will have a uniform depth of 14 inches, consisting of 12 inches of sod and root zone materials with a two-inch drainage mat system at the bottom.

The top of the playing field will be crowned - with the center of the field two inches higher than the sidelines and end zones.

Water will drain through the system to area drains and feed into collector drain pipes running below the field decking.

So, when plans for the team's new stadium were announced, featuring a retractable roof and a movable field, we really wanted to be involved. Consequently, to be selected by the Cardinals and Hunt Construction was a tremendous honor.

Planning

Since a major selling feature of the new stadium would be its ability to host a variety of major events other than NFL and college bowl games, the use of a movable field to support the stadium's multipurpose aspect had always been envisioned.

Although we had recently designed artificial turf systems for the NFL's Baltimore Ravens, Cal-Berkeley and the University of Southern Mississippi, the Cardinals were strong proponents of playing their home games on natural grass. A stationary natural grass field, however, also would create issues. You would not only have to find a way to consistently grow grass inside the stadium, but more importantly, how to protect it when covered over multiple days for other events.

If the field was going to be natural grass, it would need to be moved into and out of the stadium. How, then, should it be designed? The project team first studied movable fields that had been built in Europe and Japan. Early discussions envisioned a field tray made of concrete or steel, operating on either steel or rubberized wheels. The design team created various wheel and tray concepts and developed cost estimates for different systems.

The final consensus was to build a giant steel tray, 234 feet wide, 403 feet long and three feet high with 14 inches available for the turf system, including drains and irrigation piping. The field would be carried by 542 steel wheels, 76 of them powered by one-

horsepower motors over 13 parallel-hardened steel rails. The system's total weight would be 18.9 million pounds.

Unisystems, already on board to design the stadium's retractable roof, and Walter P. Moore Engineers were selected to handle the mechanical and structural components of the tray respectively. CMX would design a natural grass turf system to fit inside.

Once we knew the parameters, we began our design work. While we were aware of other fields where the use of natural grass was adapted for covered stadiums, such as the small movable pallets at Reliant Stadium in Houston, we would be building a one-piece movable field in a single, very large container.

This created some unique challenges, including: What would be its rootzone medium? What type of grass would be best suited to the stadium and the wear and tear associated with NFL games? How would we irrigate the grass in a shallow, confined tray, both inside and outside the stadium? How would we create a drainage system workable both in the stadium on game day and in the field's stored position?

Testing

The project team agreed the next logical step in the design process would be to conduct an in-depth turf experiment. In May 2004, CMX oversaw the construction of two mockup field sections for testing and evaluation at the Cardinals' training facility. The mockups replicated, as nearly as possible, the anticipated field conditions at Cardinals Stadium. Their dimensions, 22 feet, 9 inches in length by 9 feet, 9 inches in width, represented two of the approximately 410 rectangular structural sections that would make up the overall stadium field. They were even sloped identically to the new field's slope.

Inside the mockups, there were eight sections that tested different combinations of natural grass systems including: (1) three types of root zone mix; (2) two types of grass, Tifway 419 and Celebration (each in sodded and sprigged applications); and (3) two types of drainage systems.

The testing also provided Tim Peterson, the Cardinals' talented turf manager, an opportunity to conduct a variety of moisture studies including the water retention capabilities of the various turfs. The data also is helping Tim as he maintains the new stadium's field in addition to his oversight of the teams' three grass practice fields.

The three root zone mixes tested were: (1) a USGA-specification sand stabilized with five pounds of polyurethene fibers and five pounds of polypropylene fibers per ton of growing media; (2) a blend of 80% USGA-specification sand with 10% Axis synthetic beads and 10%

"Worm Gold" organic material; and (3) USGA-specification sand with no additional amendments.

During the experiment, we periodically cut 12-inch square sections in the turf to measure root growth and observe the drainage system. We also conducted Clegg Impact Tests on both the mock-up fields and the adjacent practice fields to determine the general firmness of the various mixes as well as a variety of tests to measure moisture content and retention.

While each of the root mixes performed well, option #1 with its sand and stabilizer fibers proved to be the best. It most nearly matched the impact density of the existing practice fields and was the most effective at retaining moisture for root growth.

For the actual grass, the evaluation team chose Tifway 419. It was thick, green, and firm with a soft texture and deep root growth, and demonstrated superior ability to regenerate after divot damage.

Finally, although there was little visible difference in surface quality between the stolon and sod areas, the test sections planted with stolons provided stronger root growth. We therefore recommended a turf established with stolons, assuming a sufficient growing season in the spring and summer leading up to the stadium's opening.

In addition to demonstrating better root growth, we felt a grass field established with stolons would have less initial thatch, eliminate the chance of introducing a soil barrier layer between the sod and sand root-zone, and provide cost savings. If a sufficient growing season was not possible, sod could be used as an alternative.

For the underlying drainage mat, we selected the "Draincore 2" system by Airfield Systems, which was extremely efficient in collecting and discharging excess water and also provided excellent moisture control.

Installation

In mid-March of this year, the long-awaited installation began. First came the laying of a non-permeable plastic liner to provide a water-tight barrier and protect the structural steel in the tray from rusting.

Next was the placement of two one-inch layers of the drainage mat covered with a woven geotextile fabric, a permeable product that allows water to pass through into the drainage mat while holding sand from the rootzone mix in place. Then, the irrigation system, using a low-profile fitting configuration and Hunter "Ultra" sport sprinkler heads, was laid on top of the drainage mats.

The next step, in late April, was filling the mammoth tray with nearly five million tons of the sand and stabilizing fiber mix. The sand and fibers were mixed offsite and brought in by truck, unloaded and then scooped up by a front-end loader. The mixture was then placed on a long conveyor belt and spread uniformly across the tray.

In early May (and on schedule) the sprigging process began. The stolons used were derived from Tifway 419 sod, grown over 18 months in a medium consisting of a mixture of sand, clay and silt at the Evergreen Turf sod farm in southern Arizona. Installation of the stolons occurred within 12 hours of their harvest.

The sprigging, under the supervision of Valley Crest Contracting, was accomplished using a "hydro cannon" equipped with a fire hydrant-type hose shooting the stolons onto the sand base at a rate of 20 bushels per 1000 square feet.

The stolons were sliced and rolled into the surface by a lightweight disc machine and syringed to prevent drying and to bind them to the rootzone. Wood fiber mulch was added to the surface at a rate of 45 pounds per 1000 square feet.

It was time to water (and water and water) the field and watch the grass grow.

By late May, the grass was beginning to green. By mid-June, it was fully on its way to becoming an established field, and was given its first 740-foot test drive into the stadium, with eight more weeks of growing time before the Cardinals' first game.

We used that time to help in the fine-tuning of the field including fertilizing, rolling and topdressing, and working with the Cardinals to provide a field that will be durable and easy to maintain throughout 2006 and many seasons to come.

This has been CMX's most visible project because the field will be on national display for a Cardinals' Monday night game, the Tostitos Fiesta Bowl, and next year, when Cardinals Stadium will host Super Bowl XLII.

Mike Lloyd, PE, with more than 30 years of experience in the development of sports projects, is President of CMX Sports Engineers. ■

Newest US soccer field opens this month

The newly built Toyota Park in Chicago, the fourth major soccer-specific field in the United States, features a turf-conditioning system underground. The system was installed in November 2005 by Althoff Industries, which built a similar system during the 2003-2004 renovation of Soldier Field.

Located on the Southwest side of the city, the $70 million, 20,000-seat Toyota Park is home of the Chicago Fire, a Major League Soccer franchise whose season potentially stretches from early April to mid-November, depending upon playoff advancement. There are also plans for local high school football teams to use the field as well.

The turf-conditioning system at Toyota Park, manufactured by Uponor North America, circulates a warm, water-and-glycol mixture through underground tubing, made of crosslinked polyethylene (PEX). The intent is to warm the rootzone beneath the grass, so that the playing surface remains soft and forgiving, even at sub-freezing temperatures.

The radiant heating system consists of roughly 28 miles (over 150,000 linear feet) of 3/4-inch Uponor Wirsbo hePEX plus tubing, which serpentines from end zone to end zone, eight inches on center and 10 inches below the 200 by 425-foot playing surface. The only connections are at the copper manifolds, positioned at the south end of the field, where each PEX loop begins and ends, thus moving potential service issues to outside the playing area. The copper headers are fitted with stubouts at the factory for making the PEX connections, saving substantial time on the job site.

A pair of commercial-grade, 150-horsepower boilers, situated in a mechanical room under the concrete stands on the east side of the field, feed the 50%-glycol solution through two heat exchangers and 1,400 feet of four-inch copper supply and return piping, on their way to roughly 400 feet of manifold. Because so much of it is encased in concrete under the stands, the copper portion of the system had to be thoroughly tested at high pressures even before the PEX tubing was completely installed on the field. "We had to be sure there were absolutely no problems," says Althoff senior vice president Christopher Bennett, who supervised both this and the

Project supervisor Chris Bennett (left), senior vice president at Althoff Industries, with John Lavin, shown in early November 2005, with the partially installed turf-conditioning system at the new Toyota Park in the background.


Motorized sled, custom-made for the project by Althoff Industries, carried the loops of PEX tubing from one end of the playing field to the other.

Soldier Field projects. "Once the concrete is poured, it's pretty difficult to fix any leaks."

The glycol solution comes off the two boilers at 180 degrees F, while the use of mixing valves reduces the temperature of the solution to a maximum of 130 degrees F before pumping it into the 168 loops of underground PEX piping that transverse the field. As the outdoor temperature falls, the system automatically boosts the water temperature in the tubing to protect the turf root system.

"It is a closed, reverse-return system that is self-balancing," Bennett says. "The first half of each loop functions the supply line, moving the fluid from the copper manifold at the south end to the far north end of the field. The return line brings the solution back to that manifold, which then moves it to the boilers underneath the stands for reheating and recirculation."

Four heating zones

Like the interior of a home or a large office, the field is segmented into four heating zones, also running the length of the field from goal to goal. Each zone contains 42 PEX loops and two temperature sensors that sit within underground boxes connected to one another with plastic conduit. On sunny days, the demand for warmth varies from zone to zone, depending on the position of the sun. The sensors in each zone communicate an average demand back to a series of control valves, which modulate the flow of warm water in response.

The objective is to keep the root system at a consistently comfortable 65 degrees F, says Bennett. "The field is warm and moist enough that it can actually grow grass in December or even January," he says. "The freezing point for the glycol mixture is minus-25 degrees, so the system can be filled with fluid year-round, without the hassle and expense of draining and re-filling it prior to each season."

But what happens if any of the underground sensors ever need to be repaired? All eight are on a GPS (Global Positioning System), according to Bennett, enabling service personnel to pinpoint the positions of the underground boxes to within 18 inches. "We also provide a complete photo log of the boxes' installation, which should also help in locating them," he says.

To prevent dimpling of surface with shoe prints, Althoff mechanics stood on sheets of Masonite while working on the field surface.

Sports Construction Group, the Cleveland-based contractor responsible for building the playing surface at Toyota Park, began the installation process in early November 2005 by laying a four-inch foundation made of pea gravel. The earth-moving machinery used here was equipped with a laser to guide the grading process, so that the finished surface was flat. In the aftermath of this careful grading, Althoff's 10-man installation crew was not permitted to step onto the gravel while installing the PEX loops.

Bennett and company faced a similar dilemma at Soldier Field in 2003. Their solution then and, again, at Toyota Park was a motorized carrier built from a child's snow sled that could run unmanned the length of the field. The Althoff crew fit the sled with a sheet-metal spool and tethered the sled to motorized pulleys behind each end zone. The Wirsbo hePEX plus tubing was looped around the spool: one end was held at the copper manifold, the other to a reel holding the rest of the 850-foot hePEX plus coil. The sled ran atop numerous 4 x 6-foot Masonite sheets that were laid end to end across the field. As it moved from end zone to end zone, the sled pulled the tubing over a series of plastic tracking rails positioned at intervals. Installers followed the sled down the field, walking on the same plywood planks to avoid dimpling the pea gravel, and snapping the hePEX plus into place on the rails with their shoes.

New rail system

The rail system is a major upgrade over an older method of securing the tubing to the field. The latter involves hand-tying the PEX to a wire grid covering the pea-gravel surface. That process is not only more time-consuming, but also requires more bending and crouching by the installer.

"I don't care how good a shape the installers are in," says Bennett. "With the hand-tying approach, they could have back problems before too long. We have quality people on our team, and if we lose one of them to injury, it may take us awhile to find an equally qualified replacement. With the railing system, we move more quickly with no bending, so no one gets hurt."

Bennett reports that the Toyota Park installation ultimately went as smoothly as Althoff's previous work at Soldier Field, due in part to having the same field team led by John Lavin and Jay Althoff. The entire tubing system was firmly in place after only 5 days. "Speed, getting the tubing down quickly and properly, is a premium value on a job like this," says Bennett. "Because of rains in October, our startup was delayed by a week and a half. Once we finally had an opening in the weather, we had to get the job done before it turned bad again and we found ourselves working in a mud hole."

Only two days after the Althoff crew finished, the PEX tubing was buried in 10 inches of rootzone medium [a mixture of USGA sand and peat moss] and 1-5/8 inches of premium Kentucky bluegrass sod.

The spectacle of 10 grown men chasing a kid's sled up and down a soccer field, as it spins a web of plastic tubing from end to end, is bound to attract attention. "All the other trades have a tendency to stop and watch us," says Bennett, "and that's really kinda cool. At Althoff, we get involved in sorts of construction projects, but a job like this one or the one at Soldier Field gives our guys a little break from the norm, and they get excited about that."

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