PRESERVATION OF LSU TIGER STADIUM: AN AMERICAN ICON

BY AAMER SYED

Fig. 1: LSU Tiger Stadium (1966 era)

HISTORY

The Louisiana State University (LSU) Tigers have one of the most storied football programs in the nation. Winners of three NCAA national championships and fourteen conference championships, the "Bengal Tigers" as they are known are one of the most successful college football programs today.

Located in the state capitol of Baton Rouge along the Mississippi River is the campus of Louisiana State University. Tiger Stadium is an iconic structure on campus and is home to the LSU football team. "Death Valley," as it is often called, is known for being one of the loudest and most difficult stadiums for opposing teams to play.

Construction of this historic stadium began in the early 1920s. On November 25, 1924, Tiger Stadium opened with a capacity of 24,000. Now, Tiger Stadium has increased its capacity to hosting 92,000 impassioned fans (Fig. 1). On game day, Tiger Stadium becomes the sixth largest city in the State of Louisiana.

RESTORATION NEEDS

Constructed in 1936, the north end zone façade was experiencing concrete deterioration on the outer surface due to insufficient concrete cover on the embedded reinforcing steel and cracking that developed, particularly above and below newly installed windows. The façade has undergone minor localized repairs of concrete spalls and surface cracks and was littered with abandoned anchor bolt holes. LSU wanted to restore this façade while maintaining the historic look. The original stadium façade construction incorporated 2 in x 6 in (51 mm x 152 mm) horizontal plank formwork, which is in the exterior concrete surface. It was critical to restore the finish and maintain the formed plank appearance. In addition, the concrete restoration process was complicated due to windows being newly installed prior to the façade restoration.

In a recent article on ESPN.com, the Athletic Director had these comments related to the project design theory, "We (LSU and TAF [Tiger Athletic Foundation]) wanted to bring Tiger Stadium back to life and restore its luster—and then try to find a way to make it exciting for LSU Tiger fans, give it some fresh life with the arches."

RESTORATION PROCESS – INNOVATION AND CREATIVITY

This project was extremely time sensitive. The project team was forced to be innovative and creative in trying to accomplish the project goals. Some of the unique and interesting aspects of the project are as follows:

Laser Scanning

The engineer used laser scanning/imaging for acquiring large scale project data such as general geometry and existing conflict layout to handle the compressed design time frame. In addition to a visual survey, infrared thermography was utilized to detect developing spalls in the surface of the concrete (Fig. 2).

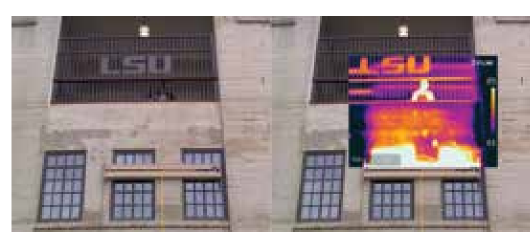

Fig. 2: Thermal imaging for concrete spall detection (before and after)

The contractor implemented Virtual Design & Construction (VDC) technology to provide a 3D model for:

- Purposing site staging and temporary fencing plan;
- Planning and communicating scheduling sequence;
- Providing 3D model video of when the work was completed in each area; and
- Providing 3D model of completed work and in-place quantities for as-built documents.

Because a large volume of pedestrian and vehicular traffic on the project was expected, the contractor made sure that the staging plan submittal was very clear to LSU. A clear visual 3D model of the site plan and planned staging and temporary fencing plan allowed LSU to comment on the plan prior to installation of these measures.

BIM Model for Sequencing Repairs

The BIM (Building Information Modeling) model was used to communicate the planned schedule sequencing for the concrete restoration portion of the project. The project was split up into four phases based on the bay numbers as illustrated in the 3D model of the project (shown in Table 1 and Fig. 3).

A clear 3D model of the façade along with the sequencing and dates allowed LSU to see exactly where and when work would be done on the façade (Fig. 4 and 5).

The 4D component of the BIM model was used for scheduling. The general contractor provided LSU with a video which showed the progression of the concrete restoration work on the north façade. This video showed the dates when the work was completed at each bay as well as the ambient temperature, substrate temperature, surface temperature, and general weather conditions. This video provided LSU with real as-built models that reference accurate information about the schedule of the concrete restoration work.

Table 1: Phasing Schedule

SEQUENCE	BAYS	START DATE	END DATE
One	29-42	April 9	May 14
Two	28-18	May 8	June 14
Three	17-7	June 11	August 17
Four	6-1	July 16	September 20

Fig. 3: Bay sequencing at north end of structure

Overcoming Special Obstacle – Bayou Country Superfest

The Bayou Country Superfest was scheduled for the middle of the project, and the main staging and vendor area was located at the north end zone. This was a major logistical challenge. The Superfest set-up and tear-down activities were scheduled from May 19 through May 30. This event was recognized early in the project, and as a result, Bays 23-42 had to be completed before Superfest activities to meet the project schedule. The contractor mobilized on April 9 (same day as Notice

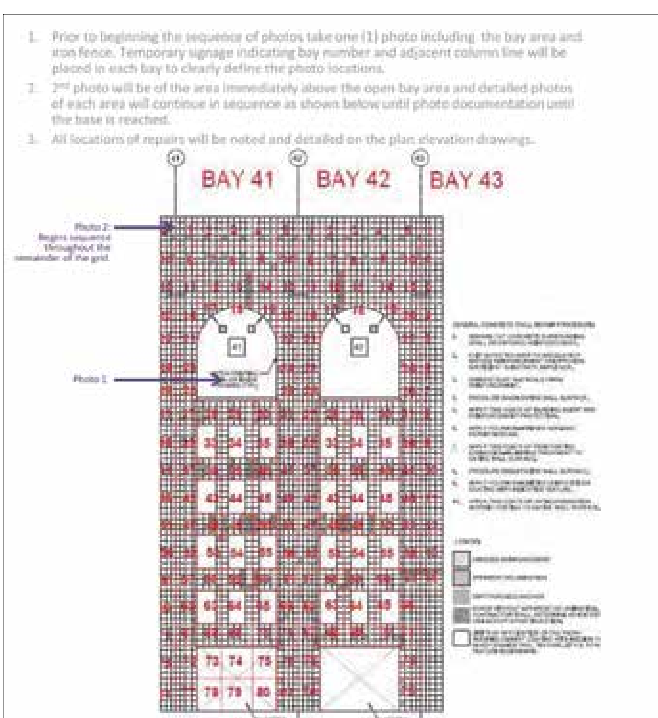

Fig. 4: Detailed repair drawing

No.	Location	Actual Start	Actual End	Ambient Temperature	Substrate Temperature	Surface Temperature	Gen'l Weather Conditions
1	39 - 36 Parapet	5/2/2012 9:00	5/2/2012 12:40	76 - 85	69 - 72	68 - 71	Overcast
2	39 - 36 Middle	5/3/2012 7:00	5/3/2012 9:00	73 - 82	72 - 78	73 - 77	Overcast
3	42 - 40 Parapet	5/3/2012 7:00	5/3/2012 10:00	73 - 82	72 - 78	73 - 77	Overcast
4	34 & 35 Parapet	5/3/2012 7:00	5/3/2012 10:00	73 - 82	72 - 78	73 - 77	Overcast
5	34 & 35 Middle	5/3/2012 11:00	5/3/2012 14:00	85 - 89	82 - 90	83 - 91	Sunny
6	42 - 40 Middle	5/3/2012 11:00	5/3/2012 13:00	85 - 89	82 - 90	83 - 91	Sunny
7	39-36 Lower	5/3/2012 13:00	5/3/2012 15:00	89 - 92	90 - 93	91 - 91	Sunny
9	42 -40 Lower	5/7/2012 7:00	5/7/2012 12:00	73 - 85	70 - 74	70 - 77	Partly Cloudy
10	33 & 32 Parapet	5/7/2012 7:00	5/7/2012 9:00	73 - 80	70 - 72	70 - 73	Partly Cloudy
11	33 & 32 Middle	5/7/2012 9:00	5/7/2012 10:00	80 -80	72 -72	73 -73	Overcast
12	33 & 32 Lower	5/7/2012 10:00	5/7/2012 12:00	80 - 85	72 - 74	73 - 77	Overcast
13	28 & 27 Parapet	5/14/2012 7:00	5/14/2012 11:00	74 -79	73 - 75	74 - 75	Partly Cloudy
14	31 -29 Parapet	5/14/2012 8:00	5/14/2012 12:00	74 -79	73 - 75	74 - 75	Partly Cloudy
15	26 - 23 Parapet	5/14/2012 9:00	5/14/2012 12:00	74 -79	73 - 75	74 - 75	Partly Cloudy
16	26 - 23 Middle	5/15/2012 7:00	5/15/2012 9:00	74 - 83	72 - 74	74 - 78	Sunny
17	28 & 27 Middle	5/15/2012 8:00	5/15/2012 10:00	74 - 82	72 - 74	74 - 78	Sunny
18	31 - 29 Middle	5/15/2012 8:00	5/15/2012 10:00	74 - 83	72 - 74	74 - 78	Sunny
19	26 - 23 Lower	5/15/2012 11:00	5/15/2012 13:00	82 - 83	74 -78	78 - 79	Overcast
20	28 & 27 Lower	5/15/2012 11:00	5/15/2012 13:00	82 - 83	74 -74	78 - 79	Overcast
21	31 - 29 Lower	5/15/2012 11:00	5/15/2012 13:00	82 - 83	74 -74	78 - 79	Overcast
22	22 & 21 Parapet	5/16/2012 7:00	5/16/2012 10:00	78 - 82	73 - 74	75 - 74	Sunny
23	22 & 21 Middle	5/16/2012 11:00	5/16/2012 14:00	78 - 82	73 - 74	75 - 74	Sunny
24	22 & 21 Lower	5/16/2012 14:00	5/16/2012 16:00	78 - 83	73 - 74	75 - 74	Sunny
25	17 -15 Parapet	5/31/2012 8:00	5/31/2012 12:00	83 - 86	74 -76	76 - 76	Overcast
26	20 - 18 Parapet	5/31/2012 9:00	5/31/2012 12:00	83 -86	76 -76	76 - 76	Overcast
27	14 & 13 Parapet	5/31/2012 9:00	5/31/2012 12:00	83 -86	76 -76	76 - 76	Overcast
28	20 - 18 Middle	5/31/2012 13:00	6/7/2012 15:00	86 - 76; 73 - 89	76 - 75; 74 - 78	76 - 74; 73 - 78	Overcast to Rain;
29	17 - 15 Middle	5/31/2012 13:00	6/7/2012 15:00	86 - 76; 73 - 89	76 - 75; 74 - 78	76 - 74; 73 - 78	Overcast to Rain;
30	14 & 13 Middle	6/1/2012 7:00	6/1/2012 10:00	71 -76	72 -73	72 -74	Overcast
31	14& 13 Lower	6/1/2012 13:00	6/7/2012 12:00	82 - 84; 85 -89	75 -75; 77 - 78	75 -76; 78 - 78	Sunny
32	12 & 11 Parapet	6/5/2012 9:00	6/5/2012 12:00	85 -90	74 - 79	75 - 78	Sunny
33	12 & 11 Middle	6/6/2012 9:00	6/6/2012 12:00	86 - 97			Sunny
34	12 & 11 Lower	6/7/2012 8:00	6/7/2012 10:00	73 - 85	74 - 77	73 - 78	Sunny
35	10 - 8 & Rt Elevator Parapet	6/25/2012 7:00	6/25/2012 11:00	81 - 90	74 - 75	74 - 75	Sunny
36	4 - 3 1/3 Parapet	6/25/2012 9:00	6/25/2012 13:30	83 - 94	74 - 76	75 - 75	Sunny
37	7 - 5 & Mid, Lt Elevator Parapet	6/25/2012 13:30	6/25/2012 16:00	94 - 100	76 - 79	75 - 79	Sunny
38	3 1/3 Lower	6/25/2012 13:30	6/25/2012 16:00	94 - 100	76 - 75	75 - 75	Sunny
39	10 - 8 & Rt Elevator Middle	6/26/2012 7:00	6/26/2012 12:30	79 - 99	77 - 79	76 - 80	Sunny
40	7 - 5 & Mid, Lt Elevator Middle	6/26/2012 12:30	6/26/2012 15:00	99 - 101	79 - 79	80 - 82	Sunny
41	4 - 3 1/3 Middle	6/27/2012 13:00	6/27/2012 15:00	99 - 103	82 - 88	83 -87	Sunny
42	9 2/3 Parapet	7/6/2012 8:00	7/6/2012 14:00	84 - 95	76 - 83	79 - 83	Sunny
43	2 & 1 Lower	7/6/2012 8:00	7/6/2012 14:00	84 - 95	76 - 83	79 - 83	Sunny
44	9 2/3 Lower	7/9/2012 7:00	7/9/2012 9:30	79 - 87	76 -75	77 - 77	Sunny
45	2 Parapet	7/9/2012 7:00	7/9/2012 12:30	79 - 92	76 - 78	77 - 79	Sunny
46	1 Parapet	7/9/2012 12:30	7/9/2012 15:00	92 - 96	78 - 79	79 - 79	Overcast
47	9 2/3 Middle	7/10/2012 7:00	7/10/2012 12:00	77 - 96	78 - 78	79 - 81	Sunny
48	2 & 1 Middle	7/10/2012 12:00	7/11/2012 9:00	96 - 83	78 - 75	81 - 78	Overcast

Fig. 5: Repair construction log

to Proceed from Architect) with a mission to complete these bays prior to the start of the Bayou Country Superfest. Although the original repair schedule showed completing Bays 23-42 by June 6, it was completed by May 19, prior to the start of Superfest. This forced acceleration was necessary to get completely out of the way for Bayou Country Superfest to start and complete its operations without any interruptions.

REPAIR PROGRAM

Crack Injection

Cracks in the concrete façade were evident in areas above and below the newly installed windows. The specifications outlined the injection of these cracks using an epoxy gel as the surface seal and a low viscosity resin for injection (Fig. 6). Precautions

Fig. 6: Epoxy crack injection surface seal and ports

had to be taken when installing and removing the surface seal. The engineer required that crack repairs not reflect through the coatings that were to be applied and that the existing surface finish must be maintained. The contractor had to employ a very high level of skill and precision to achieve this provision.

Concrete Spall Repair

Concrete spalls were caused by lack of concrete cover over the embedded reinforcing steel. Through the investigation process, the engineer determined that many of these reinforcing bars were not structural and therefore not critical for restoring their loss of cross section. In fact, many small exposed areas of steel were simply removed. Because the engineer had provided an extremely detailed map of where the spalls were located, the contractor knew the exact boundaries of the repair areas. The specification required that spalled concrete areas be square cut, the concrete be chipped to a specified surface profile provided within the repair area, and the repair area pressure washed to remove dust and loose pieces of concrete. International Concrete Repair Insitute (ICRI) Concrete Surface Profile (CSP) chips were used to make sure the required surface profile was achieved. A bonding agent and non-sag repair mortar were used for the repairs (Fig. 7).

Fig. 7: Concrete spall repair

Countless repairs had been completed over the history of Tiger Stadium. The design engineer investigated all of the existing repairs. Previous repairs that were not sound or did not blend aesthetically with the stadium appearance were removed and replaced using the method outlined above.

Aesthetic integrity was paramount to the project. When spall repairs intersected one of the form lines created by the plank formwork used during the original construction, it was required that the repair contractor employ a technique of duplicating this form line into the repair areas. The workability of the repair mortar allowed the contractor to provide the form lines by tooling them into the repair.

Corrosion Mitigation and Façade Coating

Prior to coating installation, the project included pressure washing the façade and applying a corrosion inhibitor to protect the embedded reinforcing steel from further corrosion. For the coating, the owners wanted the stadium to look like the original concrete and not like a newly painted wall. However, using a plaster or a textured coating would not provide the original look that was required, as it would have masked the substrate. It was determined through several mock-ups that two coats of a cement-based coating with a fine texture could provide a uniform look to the concrete while hiding the repairs and imperfections. This cement-based coating made the concrete substrate look like it had just been placed rather than newly painted. The repair contractor experimented with several types of rollers and application techniques to achieve the required texture (Fig. 8).

After the coating was applied to give the walls a uniform appearance and look like new concrete, a clear anti-carbonation coating was then roller applied to the surface. The two-coat application of this clear coating was used to provide another layer of protection and help the façade maintain a cleaner look by reducing dirt pick up.

QUALITY CONTROL PROGRAM

All concrete repair work was monitored and recorded closely by bay numbers. The products used required certain parameters for temperature prior to installation. Every working day, the ambient, substrate and surface temperatures; relative humidity; dew point; and general weather for that day were recorded in daily logs and input into the 4D BIM model for record documents.

A library of photos documenting all areas prior to repair construction and during each phase of the façade restoration were organized by bay area, and approximately 250 photos were taken each week.

Dust and Overspray Protection Plan

It was a high priority to cover the newly installed windows so that no damage occurred to them during repair construction (Fig. 9). Consideration was given to the high volume of pedestrian and vehicular traffic around the site. Dust and overspray from the construction area was a concern for the project team. At the beginning of the project, a dust and overspray containment plan was prepared and implemented.

Coordination and Management Plan

This project succeeded in large part due to the general contractor's ability to constantly communicate among all parties including the owners, architects, partners and subcontractors. Additionally, the project team was sent a "Friday Pack" each week which included an RFI (Request for Information) log, submittal log, CPR (software for cost tracking) log, updated schedule, drawing log and in-progress photos. This action ensured that all parties involved in the project were on the same page and that there were no surprises upon completion.

Hazards and Mitigation Plan

PTP (Pre-Task Planning) is a task planning technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the worker,

Fig. 8: Façade coating (before and after)

Fig. 9: Dust and overspray protection at façade

Fig. 10: Completed restoration at north end of stadium

the task, the tools, and the work environment. PTP was conducted for each job to help identify:

- Steps involved in performing a task;
- Hazards associated with each task;
- Hazards associated with adjacent work or processes;
- Controls for the hazards identified;
- Appropriate personal protective equipment required; and
- Tools and equipment necessary to complete the task without incident.

The project was successfully completed with 46,000 safe working hours. The two main components of this accomplishment were pre-task planning and subcontractor buy-in of the general contractor's SOR (Safety Observation Report) process. Pre-task planning took place with each subcontractor one to two weeks before mobilization. Everyone on site knew that they had the authority and responsibility to stop any unsafe acts. Unsafe acts and conditions were discussed and resolved immediately when possible.

CONCLUSION

In about 8 years, LSU Tiger Stadium will be hosting its centennial celebrations. It would not have been possible without the advancements the repair industry has made in materials, technology and overall execution of projects. The LSU Tiger stadium repair project (Fig. 10) is a testimony to what the concrete repair industry has to offer. We can be proud of the results.

Preservation of LSU Tiger Stadium
Baton Rouge, Louisiana

OWNER
Louisiana State University
Baton Rouge, Louisiana

PROJECT ENGINEER/DESIGNER
Engensus, LLC
Baton Rouge, Louisiana

REPAIR CONTRACTOR
Python Corporation
Lacombe, Louisiana

MATERIAL SUPPLIER/MANUFACTURER
Sika Corporation
Lyndhurst, New Jersey

Aamer Syed *is Director Product Management – Refurbishment for Sika Corporation and is based at the Lyndhurst, NJ corporate office. Sika Corporation is a worldwide technology leader in concrete admixtures, repair materials, roofing, waterproofing and flooring solutions. Sika has over 100 years of history in construction chemicals including cement, epoxy, polyurethane and silicone based technology.*

Aamer received a B.S. in Mechanical Engineering in 1995 from NED University in Karachi, Pakistan. Aamer completed his M.S. Management Program at Stevens Institute of Technology in 2003. Aamer's work experience includes representing Hilti Corporation for four years. Aamer joined Sika Corporation in 1998 as a Test Engineer. His current responsibilities include overseeing Product Management of Sika's target market refurbishment products.

Aamer is a member of ICRI, ACI, NTPEP, ATSAA and PTI where he participates on various national technical committees. Aamer is also a voting member of ICRI TAC (Technical Activities Committee).