Franklin Field – Restoring America's First Modern Football Stadium

Phases 2 to 6

Abstract

Franklin Field was originally constructed in 1895 as a venue for athletic events. The lower section of reinforced concrete bleachers was added in 1922, and the steel-framed upper grandstands added in 1925. The addition of the upper grandstands created the first modern, two-tiered football stadium, in the United States. Since 1925, Franklin Field has hosted Ivy League sporting events, political events, NCAA Championships, Philadelphia Eagles games, University commencement, and the Penn Relays. After nearly a century of service, the reinforced concrete in the upper and lower grandstands had deteriorated and needed a comprehensive restoration to extend the service life of the structure. This submission addresses Phases 2 to 6 of the restoration program, which were completed between June 2019 and January 2022.

Development of the restoration plan required evaluation of the performance of prior repairs, review of repair options, owner consultation to gauge tolerance for future maintenance, and to determine the owner's desired service-life of the repaired structure. These discussions led to a restoration plan designed to provide a minimum expected service-life of 25 years, with routine condition surveys, maintenance, and replacement of sealants and coatings over time. The repair design for Franklin Field was developed in accordance with the requirements of ACI 562–16.

Extensive repairs were required to address concrete spalling due to reinforcing steel corrosion, with most of repairs located at or adjacent to previous repairs. Repairs were largely designed to be full depth, with the repair material selected to match the original concrete properties. Access limitations at the stadium resulted in all repairs being completed using pre-packaged concrete materials, placed by hand, largely using 5-gallons buckets for concrete transport. The project had an overall budget of $38.3M and was completed on time in January 2022 at a total cost of $37.2M.

Project Team and Contacts

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Penn
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Office of the University Architect
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3101 Walnut Street
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April 26, 2022

RE: ICRI Awards Program
Letter of Permission - Franklin Field Restoration

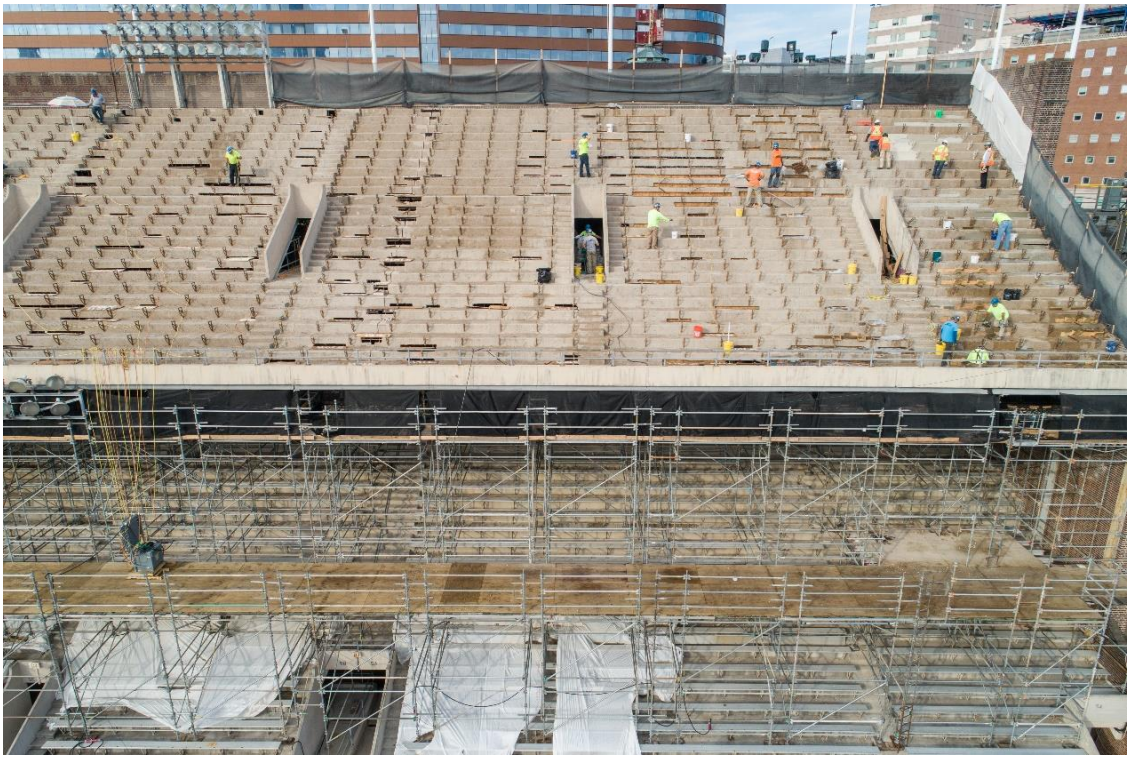
To ICRI Awards Committee,

We are pleased to grant permission to the Franklin Field Restoration team to submit the project for consideration for an award in the ICRI Awards Program. We are enjoyed working with the Franklin Field project team and wish them much good luck in the awards program.

Regards,

Mark A. Kocent, AIA, AICP
UNIVERSITY ARCHITECT
University of Pennsylvania

Franklin Field - Restoring America's First Modern Football Stadium



Title:	**Franklin Field - Restoring America's First Modern Football Stadium Phases 2 to 6**
Location:	**Philadelphia, PA**
Budget:	**$38.3M GMP / $37.2M Final Cost**
Completion:	**May 2019 to January 2022**
Prepared for:	**2022 ICRI Delaware Valley Awards Program**

Project Overview

Franklin Field was originally constructed in 1895 as a venue for athletic events. The lower section of reinforced concrete bleachers was added in 1922, and the steel-framed upper grandstands added in 1925. The addition of the upper grandstands created the first modern, two-tiered football stadium, in the United States. Since 1925, Franklin Field has hosted Ivy League sporting events, political events, NCAA Championships, Philadelphia Eagles games, University commencement, and the Penn Relays. After nearly a century of service, the reinforced concrete in the upper and lower grandstands had deteriorated and needed a comprehensive restoration to extend the service life of the structure. This submission addresses Phases 2 to 6 of the restoration program, which were completed between June 2019 and January 2022.

Development of the restoration plan required evaluation of the performance of prior repairs, review of repair options, owner consultation to gauge tolerance for future maintenance, and to determine the owner's desired service-life of the repaired structure. These discussions led to a restoration plan designed to provide a minimum expected service-life of 25 years, with routine condition surveys, maintenance, and the replacement of sealants and coatings over time. The final repair design for Franklin Field was developed in accordance with the requirements of ACI 562–16.

Extensive repairs were required to address concrete spalling due to reinforcing steel corrosion, with most of repairs located at or adjacent to previous repairs. Repairs were largely designed to be full depth, with the repair material selected to match the original concrete properties. Access limitations at the stadium resulted in all repairs being completed using pre-packaged concrete materials, placed by hand, largely using 5-gallons buckets for concrete transport. The project had an overall budget of $38.3M and was completed on time in January 2022, at a final cost of $37.2M.

Project Narrative

Overview and Site Significance

Franklin Field was originally constructed in 1895 to provide a venue for athletic events, with the original field surrounded by wooden bleachers. The lower reinforced concrete grandstands were constructed in 1922, and the steel supported upper grandstands added in 1925. The addition of the upper grandstands created the first modern, two-tiered football stadium in the United States. The stadium was designed in the classic horseshoe shape with a 9-lane running track. The lower grandstand section was constructed using reinforced concrete beam and column construction, with a nominal 6 in. cast-in-place concrete grandstand for seating. The upper grandstand was supported by a steel frame with seating constructed using a 3-in., reinforced concrete shell. The stadium exterior was constructed with multi-wythe brick masonry with decorative cast stone battlements.

Since 1925, Franklin Field has hosted significant athletic and non-athletic events. Athletic events include Ivy League sports, NCAA Championships, Army-Navy football, the Philadelphia Eagles during the 1960s, and the Penn Relays. The Penn Relays are the oldest and largest track and field competition in the United States, and include thousands of participants from high school, collegiate, and track club-level teams completing in more than 300 events over 5 days. Other events include commencement and serving as a movie set. Additionally, Franklin Roosevelt's speech featuring the iconic "This generation of Americans has a rendezvous with destiny" was made at Franklin Field on June 27th, 1936.

After nearly a century of service, the reinforced concrete grandstands had deteriorated because of long-term exposure, lack of maintenance, and poor performance of prior repairs. The grandstands needed both repairs to address structural concrete deterioration, and a comprehensive plan to extend the service-life of the structure. The current submission addresses Phases 2 to 6 of the restoration program completed between 2019 and 2022.

Restoration Program Development

In 2015, the design professionals began working with the Owner to develop a restoration plan for the grandstands. The initial discussions focused on replacement of the failed coatings and repairs to address overhead spalling that resulted in life-safety concerns. The design professionals recognized the need for the life-safety repairs, but also took a step back to develop a comprehensive long-term plan to both repair and preserve the structure.

The design professionals integrated consideration of the historic significance of the structure with state-of-the-art standards for concrete repair and restoration. Franklin Field is not a designated landmark structure; however, it is in a historic district, and an iconic part of the city. Accordingly, repair materials and techniques that did not change the appearance of the structure were used. The restoration program emphasized the need for a uniform appearance of the repaired structure. Given the age and exposed nature of the structure, it was also recognized that ongoing maintenance would be required to keep the structure in service after completion of the repair program.

Since original construction, several interventions and repair programs were completed at Franklin Field. The most significant being the addition of expansion joints in the 1980s to accommodate thermal movements. Coatings had been applied to the concrete surfaces to minimize water infiltration, these coatings had failed and were not effective. An impressed current cathodic protection system was installed

during a 1990's era repair program. The system was not maintained after installation and was not serviceable at the start of the 2015 evaluation. Overall, the prior repair efforts were well-intentioned programs rendered ineffective due to a lack of maintenance and a failure to replace materials that reached end of service life.

Assessment and Repair Design

The assessment and repair design for Franklin Field was developed to be consistent with the requirements of ACI 562 – Code Requirements for Assessment, Repair and Rehabilitation of Existing Concrete Structures (ACI 562-16). ACI 562 was specifically developed to provide code requirements for both structural and durability repairs in existing concrete structures.

During initial site visits, most of the concrete spalling was observed at previously completed repairs, with lesser amounts of damage in the original concrete. Netting was installed to protect stadium occupants from falling concrete. At typical concrete spalls, numerous repair material layers were visible along with a heavily corroded reinforcing steel. The poor surface preparation allowed the reinforcing steel corrosion to continue, resulting in additional overhead concrete spalls. The previously installed grandstand coatings were observed to be in poor condition due to age-related deterioration.

The geometry of the structure, particularly the netted soffit of the upper grandstand, limited access to quantify the extent of damage on the soffit of the grandstands. A visual evaluation of the soffits was completed from the stadium concourses to estimate the extent of required repairs. Accessible top surfaces were hammer sounded to locate and quantify damaged areas. Estimated repair quantities were used by the construction manager for bidding purposes and to establish a guaranteed maximum price (GMP) for the repair program.

Only limited drawings were available showing the initial construction of Franklin Field, and no information available on the materials used in the initial construction. The available drawings showed both the upper and lower grandstands were reinforced with a single layer of reinforcing steel. The original concrete was found to be in good condition with only limited freeze-thaw damage despite the lack of an air void system.

The concrete spalling was concentrated at the nosing and heel of the grandstands where the continuous longitudinal bars were located, with lesser damage on the vertical risers and horizontal treads. The remaining original concrete was found to be in good condition. Several factors were identified as contributing to the concrete spalling and corrosion damage, these included:

- Carbonation of the concrete, allowing reinforcing steel corrosion.
- Poor surface preparation at previous repairs, a lack of undercutting of the reinforcing steel, and failure to address the anodic ring affect at repair edges.
- Failure of the previously applied waterproofing membrane.
- Failure of sealant and expansion joints allowing water ingress through the structure.

These factors were expected given the age of the structure and observed issues with the prior repairs.

Development of the restoration plan required evaluation of the performance of prior repairs, review of repair options, and Owner consultation to gauge tolerance for future maintenance and the desired service-life of the repaired structure. These discussions led to a repair plan designed to provide a

minimum expected service-life of 25 years, with routine condition surveys, maintenance, and the replacement of sealants and coatings over time.

The repair design recognized a need for both durable concrete repairs to restore the integrity of the structure and a long-term strategy to protect the reinforcing steel and prevent water ingress. The concrete repairs were designed as a series of unit price repairs. The majority of the repairs were intended to be full depth repairs, with a specific intent to minimize partial-depth work. Full-depth concrete repairs were advantageous for several reasons, these include:

- The grandstands were relatively thin at 3 and 6 inches for the upper and lower grandstands, which made partial-depth repairs difficult.
- Full-depth removal completely exposed the reinforcing steel, allowing for verification of corrosion product removal from the existing steel, or replacement of steel with excess section loss.
- Concrete removal was largely completed from the top side, which was easier on workers than overhead removal.
- Monolithic, full-depth concrete placements were expected to be more durable than multi-lift, overhead placements.

The repair process involved the design professionals, working from access staging or the grandstand surface, hammer sounding to identify repair areas and marking extents of repairs. The repair areas were then reviewed after initial concrete removal to confirm the extents of damage and adequacy of surface preparation. Once the surface preparation was approved, repair material placement was completed. The repair materials were pre-packaged concretes that was chosen to match the mechanical properties of the original concrete with minimal shrinkage, and to be compatible with the corrosion protection system.

To achieve the 25-year design service life, several approaches were considered to protect the existing reinforcing steel and mitigate the potential for future spalling. The primary mechanism for protection of the reinforcing steel was the application of a urethane-based traffic bearing waterproof membrane on the grandstand surfaces. The membrane was applied after all prior coatings were removed by hydro-demolition.

Given the historic nature of the structure, the design professionals endeavored for the repairs to be completed with a minimal aesthetic impact. Accordingly, on the grandstand soffits all previously applied coatings were removed, and a mineral paint applied to the soffits after the concrete repairs were completed. The mineral paint provided both a uniform color and a breathable coating to the grandstand soffits.

The waterproof membrane serves as the primary mechanism to prevent corrosion, by preventing ingress of water. The design team also recognized that a secondary corrosion mitigation mechanism was needed. Sacrificial galvanic anodes were selected as they satisfied the Owner's need for a minimal maintenance system. Installed in both the repaired and unrepaired grandstand areas, the anodes will protect the reinforcing steel from future corrosion. The anode size and spacing was selected to provide corrosion protection for the 25-year design service life. The vast majority of the 77,500 anodes were custom fabricated to be installed in the thin concrete grandstands.

Construction

The Owner required a phased construction plan that allowed for full use of the stadium for Penn Relays and commencement, with limited use for football and lacrosse games. The construction plan resulted in 6 construction phases. Phases 2 to 6 of the project (current submission) were completed from 2019 to 2021. The need to keep the stadium open for Penn Relays (late April) and commencement (late May) resulted in a construction start in early June, with work extending until winter temperatures prevented work. The approximate 6-month work window resulted in as many as 90 workers on site at peak times. The 5 subject phases of the project had a GMP of $38.3M and were completed on time in January 2022 at a total cost of approximately $37.2M. Given the uncertainty in initial repair quantities, completion of the repairs without exceeding budget was a major success.

As a quality assurance measure, the project specifications required personnel from both the construction manager, and repair contractor to be certified ICRI CSRT (Tier 1) technicians. The intent was to increase repair quality through education of the personnel providing direct oversight of the repair process.

Long-Term Monitoring and Maintenance

The combination of the waterproof membrane and anodes is intended to provide a redundant system to prevent reinforcing steel corrosion damage. The waterproof membrane and repaired joints prevent water ingress, and if ingress occurs, the anodes prevent corrosion damage.

To monitor the performance of the repaired grandstands, a corrosion monitoring system was installed in each of the final five grandstand sections. The system allows for monitoring of both internal and external temperature and relative humidity of the concrete grandstands and the current generated by the sacrificial anodes. Measurement of the current generated by the anodes provides a direct measure of anode consumption and expected remining service life. An increase in internal relative humidity is a likely indication of coating degradation. Monitoring results will be used by the Owner to plan the anticipated maintenance of the coating system.

Summary and Unique Aspects

Franklin Field is the oldest two-tiered football stadium in the United States, since its completion in 1925, it has been used for a steady stream of sporting, University, and landmark events. To address long-term corrosion-induced deterioration of the grandstands a multi-phase restoration program was completed. The program included repairs to restore the structure, and to mitigate the potential for future corrosion. Inclusion of a monitoring system in the repaired structure will allow for future maintenance work to be rationally planned.

The restoration of Franklin Field had several unique aspects, these include:

- Use of state-of-the-art standards for concrete repair to preserve a historic structure
- Placement of approximately 8,000 bags (~185 cy) of pre-packaged repair materials, mixed on site, and largely placed from 5-gallon buckets
- Installation of approximately 77,500 galvanic anodes for corrosion mitigation
- Monitoring system installed to document changes in the structure and plan for future repairs

References

1. https://penntoday.upenn.edu/news/125-years-franklin-field

2. ACI 562-16 – "Code Requirements for Assessment, Repair and Rehabilitation of Existing Concrete Structures (ACI 562-16) and Commentary", American Concrete Institute, Farmington Hills, MI, 2016, 86 pp.

Project Images

1 – Aerial view of Franklin Field.

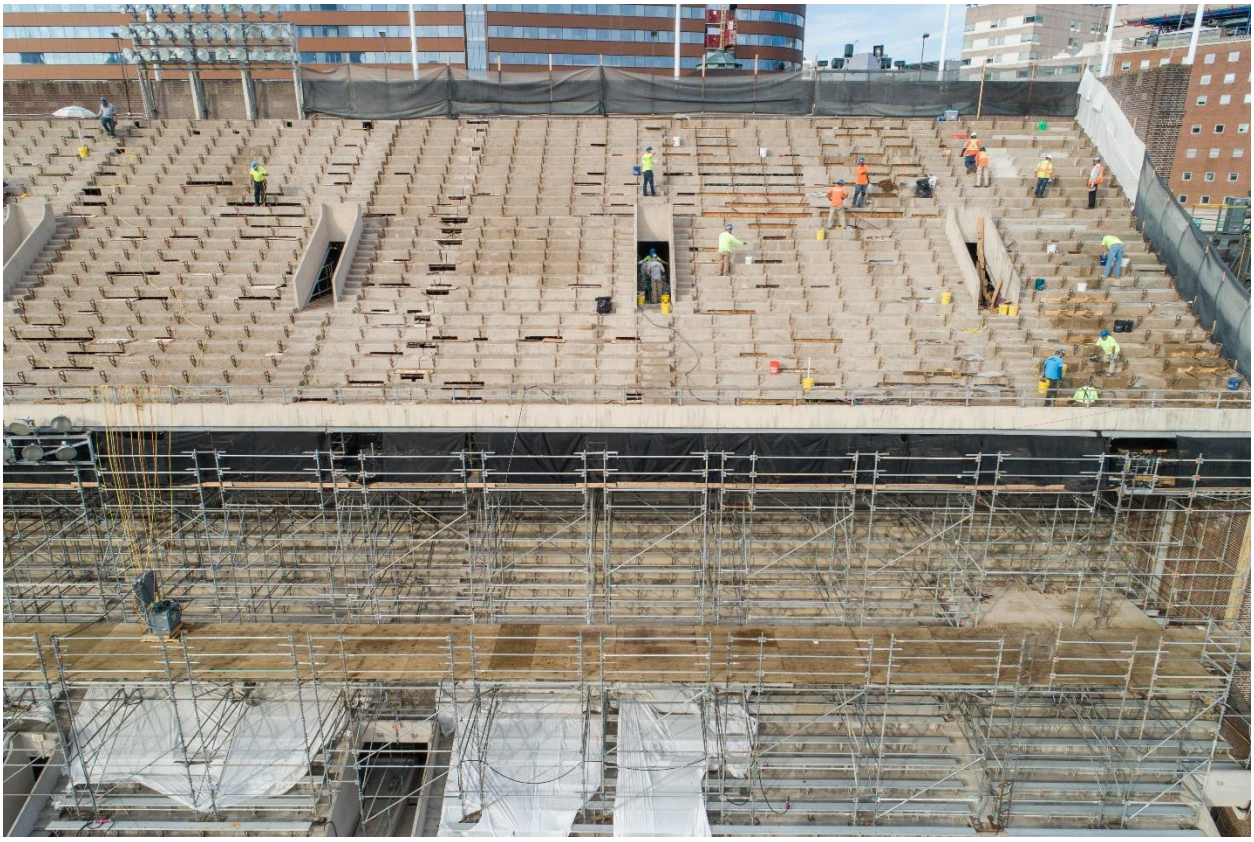
2 – Concrete spall caught on netting prior to repairs.

3. – Concrete spalling at prior repair.

4. - Full depth concrete repair in progress.

5 – Hydro-demolition to remove old coating and paint from seat brackets.

6. – Anode installation on grandstand surface.



7. – Upper south showing extent of repairs and repair progression.

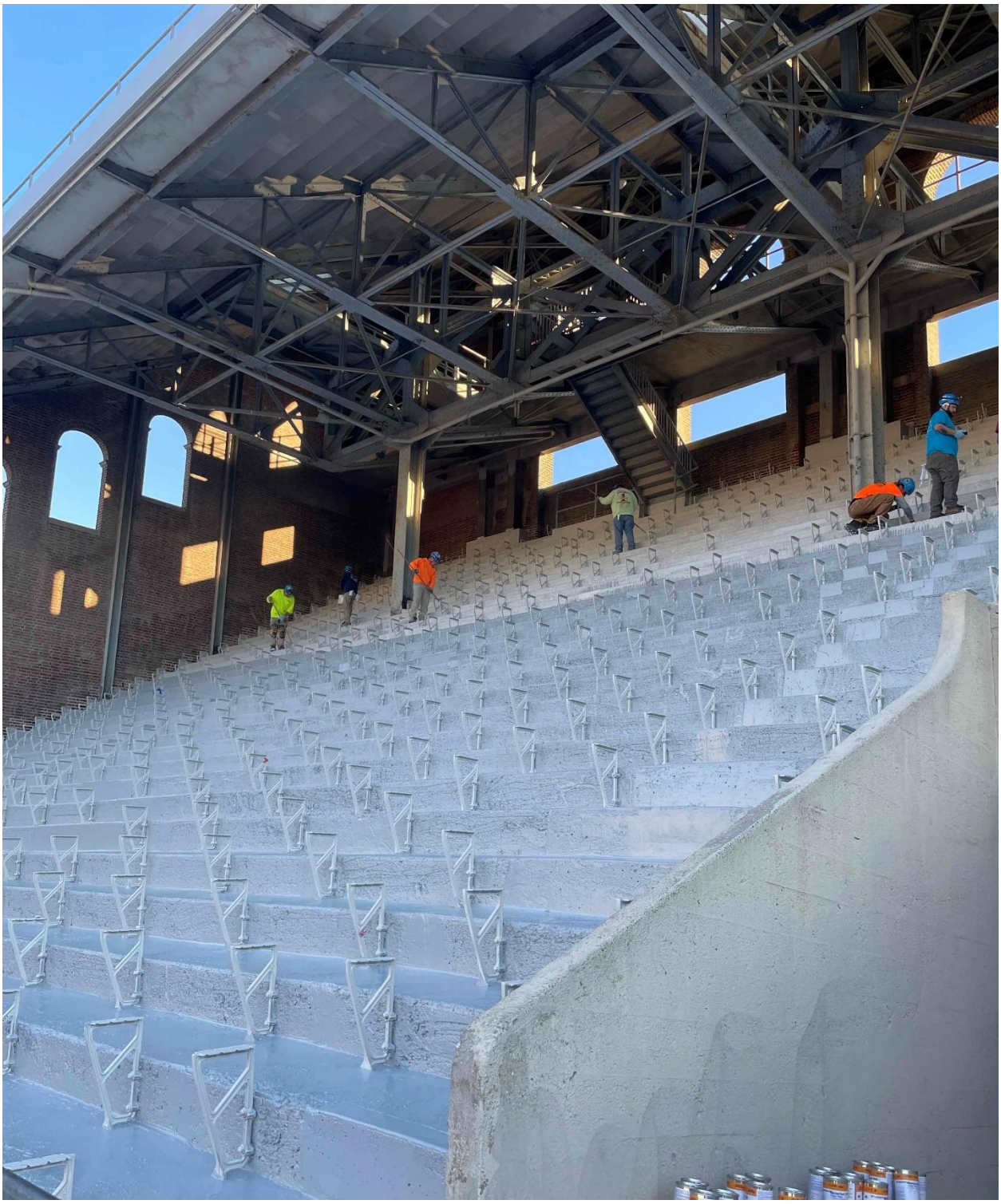
8. – Access scaffold on South St. concourse.

9. – South St. concourse after repair completion.

10. – Lower South after coating installation and bench reinstallation.

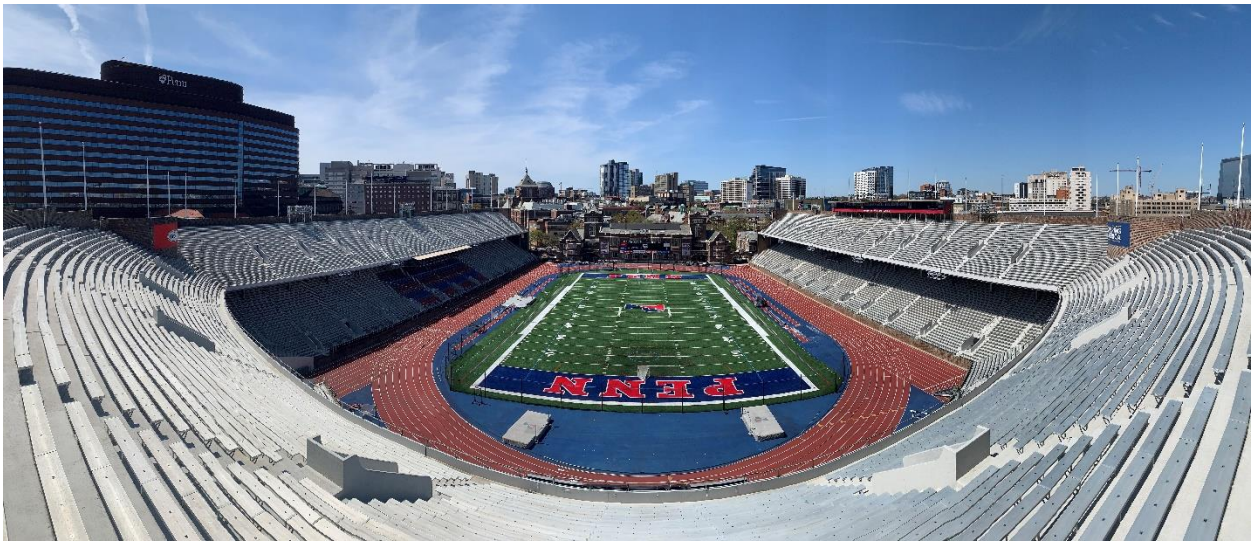
11. – Press row conditions prior to repair.

12 – Press row after repair completion.



13. - Coating application in progress.

14. – Looking east from Franklin Field after repairs.



15 – Panorama of Franklin Field from Upper East grandstand.