AWARD OF EXCELLENCE

FINALIST - 2017 PROJECT OF THE YEAR

SPECIAL PROJECTS CATEGORY

Chase Field Repairs

PHOENIX, AZ

SUBMITTED BY GERVASIO & ASSOCIATES INC.

Fig. 1: Interior view of Chase Field

Chase Field (f.k.a. Bank One Ballpark) is located in Phoenix, Arizona, with a seating capacity of 48,633, and is home to the Arizona Diamondbacks Major League baseball team (Fig. 1). The stadium was constructed in 28 months and completed in 1998. The structural systems consist of reinforced concrete frames supporting concourses/seating areas, cantilevered steel raker trusses supporting overhanging seating areas, high strength threaded rebar tieback anchors connect steel raker trusses to the cast-in-place concrete frame, and precast prestressed concrete seating risers span between raker trusses or concrete raker beams/walls.

PROBLEMS THAT PROMPTED REPAIR

Moisture infiltration resulted in corrosion damage to reinforcing steel, prestressing strands, embedded steel connection plates, structural steel members, connections and steel guardrails/handrails. In 2011, when the stadium was only 13 years old, a facility assessment identified corrosion-related damage to concrete and steel members. It has been under repair ever since.

The reason for the corrosion damage was not weather-related or atmospheric. Phoenix is in a hot, dry desert. Stadium cleaning methodology after each event is a thorough wash-down with pressure washers that caused severe corrosion damage from the following:

- Frequent wetting/drying cycles (over 100 cleanings per year);
- High temperatures (corrosion rates double for every 18°F [8 degrees C] temperature rise);
- High chloride contents from salted peanuts, where the shells are dropped onto the floor and washed down; and
- The stadium was built without any type of waterproof protective membrane in seating areas. Failing joints between precast members

(both caulk joints and building-expansion joints) allowed water infiltration to critical structural members and connections.

Although the original design did not include waterproofing, it did include an extensive "rain gutter" system beneath the precast joints to collect water if joints leaked, diverting it into uninhabited spaces (Fig. 2). Because leaking water never created a "problem" (or puddle) on the floor, the full extent of the leaking was not recognized, but there were efflorescence stains on the columns and raker beams. Further investigation and implementation of repairs led to discovery of the full corrosion extent. Evaluation and testing methods utilized visual evaluation; hammer sounding; ground-penetrating radar (GPR); destructive investigation; petrographic examination; chloride and carbonation testing; and air entrainment, density, and compressive strength testing.

FIRE PROTECTION COMPLICATIONS

Repairs were located in areas requiring up to 3-hour fire ratings. The original fireproofing (spray applied cementitious, or mineral wool), absorbed moisture, never drying out, while holding it against structural elements, thereby promoting corrosion (Fig. 3-5). Repairs included intumescent epoxy coating (¼ to ½ in [6 to 13 mm] thick waterproof epoxy) on all steel raker trusses and threaded rebar anchors to achieve the required 3-hour fire rating (Fig. 6). Instead of moisture-absorbing mineral wool, fire rated building-expansion joints or intumescent tape were used at precast caulk joints to achieve floor-floor fire ratings. A standard UL rated fire caulk assembly was not possible because the bottom side of the joint was over the concrete raker beam/wall and inaccessible.

REPAIRS

A wide range of materials/methods were used and included ready-mix cast-in-place concrete (including corrosion inhibitors, silica fume, and shrinkage reducing admixtures), form and pour, form and pump, hand patching, and epoxy injection. Various protection methods, both integral to the repairs themselves and superficial to prevent continued infiltration, were also implemented to provide the longest life possible.

Raker Truss Tieback Connections

Large cantilevered steel raker trusses support the first 11 rows of seating at the Upper Concourse and are connected to concrete columns with

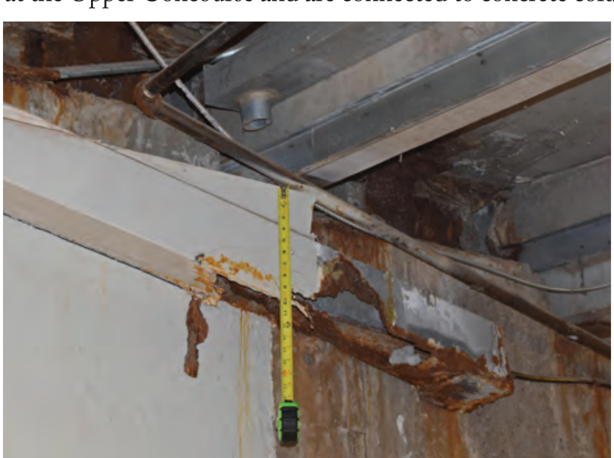

Fig. 2: Bottom side of seating riser at support—seating riser bearings and seismic restraint plates are visible on the bottom side. Moisture penetration through building expansion joint into mineral wool (each side of L-shaped plate) resulted in severe corrosion. Rain gutter system completely corroded through as it enters uninhabited space.

Fig. 3: Raker truss tieback anchor—connection between steel raker truss and concrete frame with sixteen 1-3/8" (35mm) diameter high strength threaded rebar anchor rods. Connection is completely hidden between two masonry walls in a dead space with leaking precast joint directly above. Spray-applied fireproofing absorbs water and never dries out.

Fig. 4: Threaded rebar anchor nut—Severe deterioration of the nut. Corrosion of the threaded anchor rod is not visible due to fireproofing and debris.

Fig. 5: Threaded rebar anchor—large mound at end of tape measure is peanut shells and debris washed through failed joint above.

high-strength threaded rebar. Sixteen threaded anchor rods are embedded into concrete columns and raker beams to transfer the 200,000 lb (90,720 kg) tension force from the steel raker truss to the concrete. The raker truss and tieback connections are concealed in a small inaccessible "dead space," with leaking precast caulk/building-expansion joints directly above. Spray-applied fireproofing absorbed moisture, never drying out, causing severe corrosion.

Fig. 6: Raker truss tieback anchor connection—completed repair with epoxy intumescent fireproofing to achieve 3-hour fire rating and provide corrosion protection to the beam and threaded rebar anchors.

Fig. 7: Precast joint repairs—typical example of demolition required to repair the joints between the precast seating sections. Seismic restraint plates have been completely removed for replacement. Bearing repairs for stems have not started. Nearly every row was affected.

The upper seating level has 32 tieback connections. All locations were investigated, prioritized, and 19 locations have been repaired. None of the anchor rods had experienced enough corrosion yet that repairs were required to restore the rod's tensile strength. Severely corroded nuts required replacement.

Precast Joints

Leaking precast joints resulted in extensive damage to raker trusses, concrete beams/walls, embeds, bearings, seismic connections, tieback anchors and other structural connections. Joint repairs encompassed numerous repair steps, products, and methodologies to properly protect elements from repeated exposure/deterioration.

Much of the repair work involved precast seating risers and structures below them, due to leaking joints between precast sections. Leaking joints included transverse (between ends where they butt together), longitudinally between sections, and building-expansion joints. Damage from frequent power washing and the extreme Phoenix sun ultraviolet radiation resulted in accelerated deterioration of polyurethane joint sealants and building-expansion joint covers.

Precast seating risers are supported at the ends by steel raker trusses or concrete raker beams/walls. Water leaking through deteriorated joints corroded precast connections and supporting structure including threaded rebar anchors. Water also dripped down from the joint onto the top and down the face of the beam/wall, into precast bearing areas, before collection into gutters below. As a result, substantial damage occurred to supporting members.

Precast Connections

Precast is supported by typical embedded plates at bearings. Bearing plates in precast members, steel shims, and bearing plates in supporting members experienced various corrosion levels. Repairs varied from simply sandblasting exposed surfaces of the bearings and epoxy coating, to chipping out both precast and supporting members, replacing bearing plates/pads, re-pouring, sandblasting/epoxy coating exposed surfaces, and recasting (Fig. 7).

To restrain seismic loading, large epoxy-coated steel embed plates, cast into the seating riser's horizontal portion directly adjacent to transverse joints, deteriorated severely (Fig. 8 and 9).

Building expansion joint repairs utilized pre-compressed silicone-impregnated foam expansion material providing a long-lasting waterproof joint, with walking surfaces suitable for high-heeled shoes without metal cover plates.

Prestressed Seating Riser Strand Corrosion

Concrete cracking and spalling was observed on the bottom side of precast seating risers in two locations revealing severe corrosion of prestressing strands. Repairs consisted of installing an epoxy-coated full-length steel channel, bolted to the back side of the seating riser supporting the weight, chipping out concrete exposing corroded strands, sandblasting, epoxy coating, form and pour back, and protection with a urethane deck coating.

Elephant Trunk Door Repair

The main vehicular field access is through the right-field bullpen. Increasing clearance height for large vehicles, a portion of the seating lifts up, similar to half a drawbridge (called the elephant trunk door).

Mobility of this seating riser results in large joints where it butts into the adjoining precast. Years of wash-down resulted in severe deterioration of adjacent concrete beams and columns. Investigation revealed spalling and loss of corbel ties directly under a large girder bearing. This required emergency shoring to support the 45,000 lb (20,410 kg) load throughout the season until off-season repairs (Fig. 10).

COST CONTROL

Because much of the damage is concealed, it's impossible to accurately predict the level of deterioration for each location, and therefore the associated repair/cost. Accordingly, typical repair conditions which repeat throughout each year's repair program had details developed with two or three different scenarios corresponding to varying levels of deterioration: minor, moderate and severe. Each location was identified with an anticipated quantity and level of deterioration. Unit costs were obtained for each item prior to construction. As the repairs progressed, and levels of deterioration were determined, most of the repair details had already been developed and costs established, therefore eliminating delays in waiting for design and their related costs.

The $4,000,000 contract in 2016/2017 contained over 150 individual unit cost items. The drawings identified each unit cost item, carefully defining the scope of work to avoid overlap. For each unit cost repair item, an extensive spreadsheet tracked predicted vs actual quantities/locations, and automatically multiplied these out by the unit costs and projected the actual total costs to compare with anticipated budget. The spreadsheet template was provided by the Owner, and updated by the contractor with actual quantities, resulting in final cost updates weekly. This expedited monthly payment applications, and identified overall project savings that were rolled into additional scope of work. Because this process streamlined and accurately predicted savings, additional scope was added early and completed before opening day.

CONCLUSION

This project consists of over $16,000,000 in repairs performed to the most severely deteriorated portions at Chase Field over the last 6 years. Although repairs were performed during the baseball off-season (October-March), each year events that occur during the construction schedule that required the work be completed/put back together/cleaned-up for the event, only to be torn apart the next day, resulting in mini-phases which had to be completed prior to the event. Repairs are anticipated to continue in upcoming years. ■

Fig. 8: Typical Precast Joint Repairs—Water leaking through building expansion joint between precast seating sections was absorbed by mineral wool fireproofing in the joint, resulting in severe deterioration. Large steel plates are seismic restraints.

Fig. 9: Typical precast joint repairs—seismic restraint plate (embed with bolt) and precast bearing seat assembly (below prestressing strands) after existing plates replaced, rebar welded back, and sandblasted prior to epoxy coating and pour back.

Fig. 10: Elephant Trunk Door Repairs—Water leaking between the door and precast resulted in severe corrosion, requiring emergency shoring during the baseball season.

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SUBMITTED BY
Gervasio & Associates Inc.
Phoenix, AZ

OWNER
Maricopa County Stadium District
Phoenix, AZ

PROJECT ENGINEER/DESIGNER
Gervasio & Assoc. Inc.
Phoenix, AZ

REPAIR CONTRACTOR
Restruction Corp.
Tempe, AZ

MATERIALS SUPPLIERS/MANUFACTURERS
Sika Corp.
Lyndhurst, NJ

Neogard
Dallas, TX