RESTORATION OF PARKING GARAGES AT PHILADELPHIA INTERNATIONAL AIRPORT

BY THOMAS J. DONNELLY JR.

Fig. 1: Parking garages "A" through "F" (elevation view)

In May 2009, a 2-year, $10 million repair program was initiated on six parking garages at the Philadelphia International Airport (Fig. 1 and 2).

The objective of the Concrete Restoration and Repair Program of PHL Garages "A," "B," "C," "D," "E," and "F" at the Philadelphia International Airport was to provide the necessary repair and maintenance to the structures, allowing the 12th busiest airport in the world to continue serving the parking needs of its travelers into the future. The Philadelphia International Airport has approximately 600 daily domestic departures to 125 cities in the United States and approximately 59 flights to 37 international destinations, serving more than 30 million passengers a year.

A Federal Aviation Administration plan to expand the Philadelphia International Airport is estimated at a $5.2 billion effort, which includes extending two exiting runways and building one completely new runway. Additionally, a new commuter terminal and a passenger rail system between terminals are also planned.

EXISTING CONDITIONS

The existing parking structures are a combination of 4 in. (100 mm) precast double-tee beam

Fig. 2: Parking garages "A" through "F" (plan view)

construction with cast-in-place concrete at the washes and crossovers ("A" West and "E"/"F") and 2 in. (50 mm) precast double-tee beam construction with a cast-in-place concrete topping ("A" East/"B," "C," and "D"). There are five internal cast-in-place concrete helix exit and entrance ramps, collectively totaling approximately 3.5 million ft^2 (325,000 m^2) of supported deck area. Conveniently located between the "B" and "C" garages is the Philadelphia Airport Marriott Hotel.

The existing conditions requiring repair included excessive ponding of water (Fig. 3) and drainage issues; vertical and overhead concrete deterioration to columns (Fig. 4 and 5), beams, and precast tee beams; horizontal concrete deterioration in the cast-in-place concrete and precast tee beams; structural connection repairs due to moisture-related corrosion; expansion joint system failures; and control and construction joint replacement. Miscellaneous repair items included painting of structural steel, the installation of new traffic markings, and upgrades to stair/elevator towers.

BID WORK ITEMS AND SCOPE

Following an extensive prequalification selection process, the Philadelphia Parking Authority Bid Package went out to selected contractors for bid. The project bid documents were broken down into base bid work in 2009, including unit price work items and four alternate bids. The alternate bid pricing was established so that the owner could select work in either 2009 or 2010, and the price for each alternate had to be estimated accordingly.

Base bid: included repairs to Garage "C"; Garage "D" trench drain repairs; and the removal of potential hazardous conditions (loose overhead and vertical concrete that could potentially fall during the restoration work) on all garages.

Base bid alternates:

1. "C" Garage repairs—Marriott Hotel Parking Level;
2. "A" West garage repairs—work in either 2009 or 2010, at owner's discretion;
3. "A" East and "B" garage repairs—work in either 2009 or 2010, at owner's discretion; and
4. "E"/"F" garage repairs—work in either 2009 or 2010, at owner's discretion.

- 16 Unit Price work items for 2009 work
- 16 Unit Price work items for 2010 work

The Philadelphia Parking Authority awarded all base bid work items and alternates and the work commenced in May 2009, with a completion date of December 2009 for the base bid and Alternates 1 and 2 and December 2010 for Alternates 3 and 4.

The general scope of work consisted of the following:

- Removal of existing caulk, joint preparation, and installation of new joint sealant system in approx-

Fig. 3: Existing condition—ponding of water

Fig. 4: Existing condition—vertical concrete column deterioration

Fig. 5: Existing condition—vertical concrete column deterioration

imately 131 miles (211 km) of parking deck joints, bid as a lump-sum work item, as follows:
  - Tee-tee joint sealants, estimated at 350,560 ft (106,850 m);
  - Control and construction joint sealants, estimated at 222,050 ft (67,680 m); and
  - Cove joint sealant, estimated at 120,100 ft (36,605 m);
- Installation of a clear penetrating sealer, including surface preparation by shotblasting, bid as a lump-sum work item, for approximately 3.3 million ft^2 (306,580 m^2) of supported deck;
- Installation of an epoxy broadcast traffic deck coating system on the roof level of the "C" and "D" garages, including surface preparation by shotblasting, bid as a lump-sum work item, for approximately 280,000 ft^2 (26,010 m^2);
- Removal and replacement of delaminated concrete from support beams and columns; the underside of precast tee beams; and shallow and full-depth deck repair areas through the installation of conventional concrete, prepackaged repair materials and shotcrete with each item bid on a unit price work item basis, as follows:
  - Vertical and overhead concrete, estimated at 7,415 ft^2 (690 m^2); and
  - Shallow and full depth concrete repairs, estimated at 11,130 ft^2 (1035 m^2);
- Removal of approximately 10,000 ft (3050 m) of existing expansion joint and installation of new expansion joint systems, including reconstruction of approximately 4000 ft (1220 m) of expansion joint blockout prior to the installation of the new system;
- Removal of 100 ft (30 m) of an existing trench drain and installation of a new drainage system, including piping and concrete repairs; and
- Miscellaneous repairs including painting of structural steel, installation of new traffic markings for over 11,000 parking spots, and new exterior glass and aluminum canopies on roof level stair/elevator towers.

Fig. 6: Completed view of "D" garage

EXECUTION

The work commenced in early June 2009. The construction plan was based on accessing two levels at a time in the "C" and "D" garages, with two separate crews of approximately 10 to 15 men working on each garage. For the work in 2010, two levels at a time were accessed again to complete work in the "A" West, "A" East/"B," and "E"/"F" garages. The work was completed using three separate crews of approximately 10 to 15 men. Each two-level area consisted of a phase and each phase had to be 100% completed prior to moving into the next phase. The majority of the repairs were completed the "old-fashioned" way—by mechanical means. Overhead and vertical concrete removal was performed using rolling or electric scaffolds and 15 lb (6.8 kg) compressed air-powered chipping hammers. The horizontal concrete removal was performed with 30 lb (13.6 kg) compressed air-powered chipping hammers. Sealant removal was completed with utility blades and electric caulk cutters. Final preparation of the joint edges was also completed mechanically, using either a 4 or 7 in. (100 or 175 mm) hand grinder, with a combination of diamond cup wheel and carborundum disc grinding blades.

Horizontal concrete placement used a combination of ready mixed concrete delivered to the site and placed with concrete buggies, or approved concrete prepackaged bag materials, which were mixed on site and placed. Vertical and overhead concrete placement was performed with a combination of prepackaged hand- and trowel-applied materials, or a prepackaged shotcrete material. Joint sealant replacement was with a two-component urethane sealant and primer, and they were installed with bulk guns. The concrete sealer was installed with air-powered spray equipment, and the roof-level traffic deck coating system included two lifts of epoxy, each installed with squeegees and sand loaded to refusal, and then back-rolled (Fig. 6).

REPAIR DOCUMENTATION

The documentation of the concrete repair areas was intense and extremely detailed. Each repair location, both horizontal and vertical, was numbered (Fig. 7), measured, and plotted on a drawing to be the "as-built" record document (Fig. 8 and 9). Additionally, a repair log spreadsheet document was produced, which included the size of the repair area; the date each repair area was placed and finished; whether the repair material installed was a prepackaged bag mix (BM) material or ready mixed concrete; and from which truck (TK) the ready mix material came (Fig. 10).

SAFE AND SUCCESSFUL PROJECT

Challenges were faced throughout the project, including a very tight construction schedule, access

Fig. 7: Numbering of repair areas for documentation

issues, increasing work quantities, and weather conditions. Additionally, as anyone who has worked in parking garages can attest, the foreman spent a fair amount of time performing "customer service" (that is, helping customers locate their cars!).

Safety was paramount. Patron or customer safety as well as crew safety are critical on every construction project. The average daily construction crew size was between 25 to 30 men and a total of 59,025 man-hours were completed on the project. The project was completed with zero lost-time accidents and only one reportable accident: a thumb laceration early in 2009.

The contractor, owner, and engineer worked closely together to provide the best end product while minimizing inconvenience to many short-term and long-term travelers that parked in these active garages. Even with these many challenges and demands, the project was completed on time and on budget.

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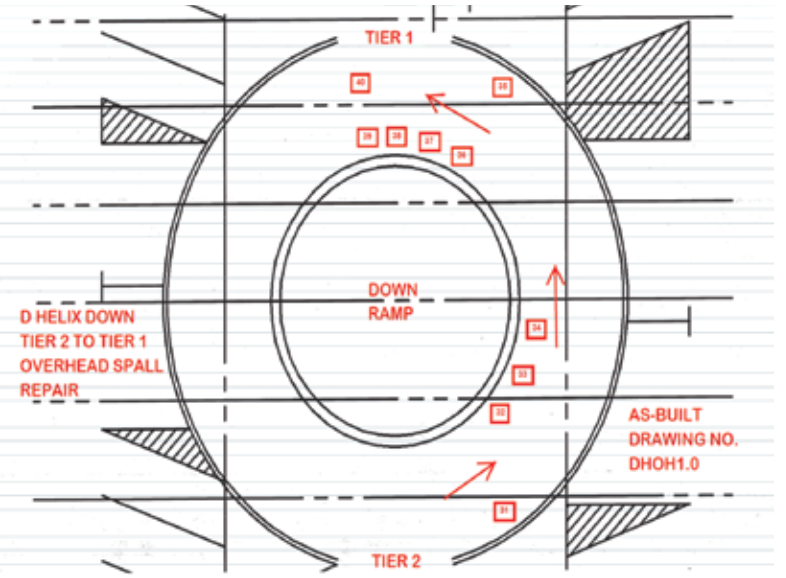


Fig. 8: Sample of as-built drawing

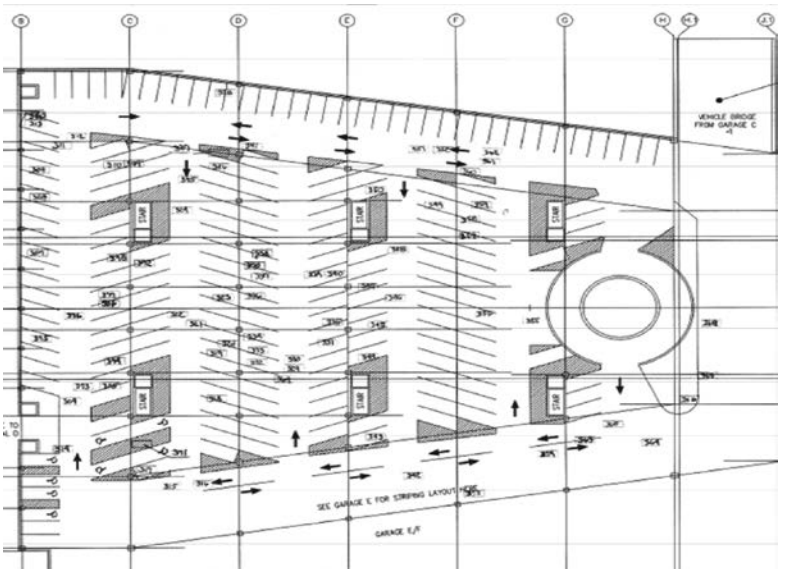
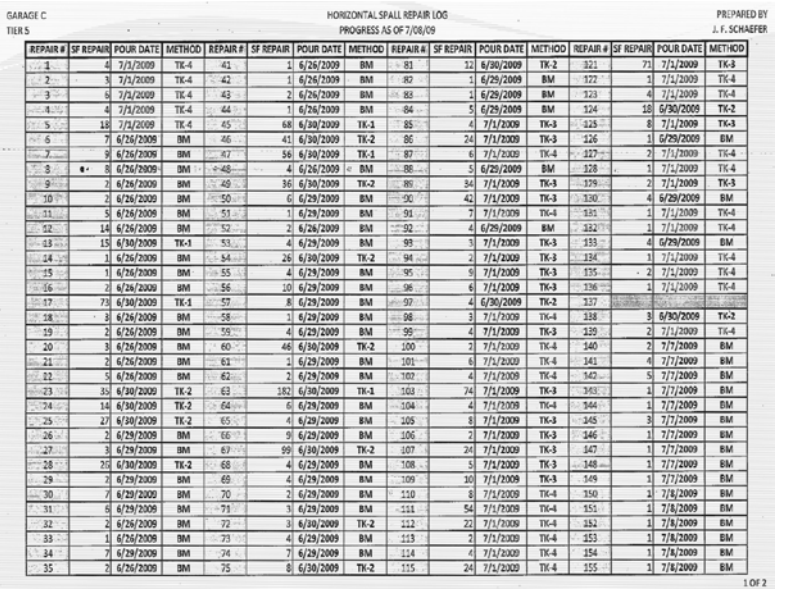


Fig. 9: Sample of as-built drawing



GARAGE C
TIER 5

HORIZONTAL SPALL REPAIR LOG
PROGRESS AS OF 7/08/09

PREPARED BY
J. F. SCHAEFER

REPAIR #	SF REPAIR	POUR DATE	METHOD	REPAIR #	SF REPAIR	POUR DATE	METHOD	REPAIR #	SF REPAIR	POUR DATE	METHOD	REPAIR #	SF REPAIR	POUR DATE	METHOD
1	4	7/1/2009	TK-4	41	1	6/26/2009	BM	81	12	6/30/2009	TK-2	121	71	7/1/2009	TK-3
2	3	7/1/2009	TK-4	42	1	6/26/2009	BM	82	1	6/29/2009	BM	122	1	7/1/2009	TK-4
3	5	7/1/2009	TK-4	43	2	6/26/2009	BM	83	1	6/29/2009	BM	123	4	7/1/2009	TK-4
4	4	7/1/2009	TK-4	44	1	6/26/2009	BM	84	5	6/29/2009	BM	124	18	6/30/2009	TK-2
5	18	7/1/2009	TK-4	45	68	6/30/2009	TK-1	85	4	7/1/2009	TK-3	125	8	7/1/2009	TK-3
6	7	6/26/2009	BM	46	41	6/30/2009	TK-2	86	24	7/1/2009	TK-3	126	1	6/29/2009	BM
7	9	6/26/2009	BM	47	56	6/30/2009	TK-1	87	6	7/1/2009	TK-4	127	2	7/1/2009	TK-4
8	8	6/26/2009	BM	48	4	6/26/2009	BM	88	5	6/29/2009	BM	128	1	7/1/2009	TK-4
9	2	6/26/2009	BM	49	36	6/30/2009	TK-2	89	34	7/1/2009	TK-3	129	2	7/1/2009	TK-3
10	2	6/26/2009	BM	50	6	6/29/2009	BM	90	42	7/1/2009	TK-3	130	4	6/29/2009	BM
11	5	6/26/2009	BM	51	1	6/29/2009	BM	91	7	7/1/2009	TK-4	131	1	7/1/2009	TK-4
12	14	6/26/2009	BM	52	2	6/26/2009	BM	92	4	6/29/2009	BM	132	1	7/1/2009	TK-4
13	15	6/30/2009	TK-1	53	4	6/29/2009	BM	93	3	7/1/2009	TK-3	133	4	6/29/2009	BM
14	1	6/26/2009	BM	54	26	6/30/2009	TK-2	94	2	7/1/2009	TK-3	134	1	7/1/2009	TK-4
15	1	6/26/2009	BM	55	4	6/29/2009	BM	95	9	7/1/2009	TK-3	135	2	7/1/2009	TK-4
16	2	6/26/2009	BM	56	10	6/29/2009	BM	96	6	7/1/2009	TK-3	136	1	7/1/2009	TK-4
17	73	6/30/2009	TK-1	57	8	6/29/2009	BM	97	4	6/30/2009	TK-2	137			
18	3	6/26/2009	BM	58	1	6/29/2009	BM	98	3	7/1/2009	TK-4	138	3	6/30/2009	TK-2
19	2	6/26/2009	BM	59	4	6/29/2009	BM	99	4	7/1/2009	TK-3	139	2	7/1/2009	TK-4
20	3	6/26/2009	BM	60	46	6/30/2009	TK-2	100	2	7/1/2009	TK-4	140	2	7/7/2009	BM
21	2	6/26/2009	BM	61	1	6/29/2009	BM	101	6	7/1/2009	TK-4	141	4	7/7/2009	BM
22	5	6/26/2009	BM	62	2	6/29/2009	BM	102	4	7/1/2009	TK-4	142	5	7/7/2009	BM
23	35	6/30/2009	TK-2	63	182	6/30/2009	TK-1	103	74	7/1/2009	TK-3	143	1	7/7/2009	BM
24	14	6/30/2009	TK-2	64	6	6/29/2009	BM	104	4	7/1/2009	TK-4	144	1	7/7/2009	BM
25	27	6/30/2009	TK-2	65	4	6/29/2009	BM	105	8	7/1/2009	TK-3	145	3	7/7/2009	BM
26	2	6/29/2009	BM	66	9	6/29/2009	BM	106	2	7/1/2009	TK-3	146	1	7/7/2009	BM
27	3	6/29/2009	BM	67	99	6/30/2009	TK-2	107	24	7/1/2009	TK-3	147	1	7/7/2009	BM
28	26	6/30/2009	TK-2	68	4	6/29/2009	BM	108	5	7/1/2009	TK-3	148	1	7/7/2009	BM
29	2	6/29/2009	BM	69	4	6/29/2009	BM	109	10	7/1/2009	TK-3	149	1	7/7/2009	BM
30	7	6/29/2009	BM	70	2	6/29/2009	BM	110	8	7/1/2009	TK-4	150	1	7/8/2009	BM
31	6	6/29/2009	BM	71	3	6/29/2009	BM	111	54	7/1/2009	TK-4	151	1	7/8/2009	BM
32	2	6/26/2009	BM	72	3	6/30/2009	TK-2	112	22	7/1/2009	TK-4	152	1	7/8/2009	BM
33	1	6/26/2009	BM	73	4	6/29/2009	BM	113	2	7/1/2009	TK-4	153	1	7/8/2009	BM
34	7	6/29/2009	BM	74	7	6/29/2009	BM	114	4	7/1/2009	TK-4	154	1	7/8/2009	BM
35	2	6/26/2009	BM	75	8	6/30/2009	TK-2	115	24	7/1/2009	TK-4	155	1	7/8/2009	BM

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Fig. 10: Sample of repair log