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NOTABLE CONCRETE IN BALTIMORE

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Notable Concrete in Baltimore

The concrete community will gather for the ACI Concrete Convention, October 26 to 29, 2025, at the Hilton Baltimore Inner Harbor and Baltimore Marriott Inner Harbor in Baltimore, MD, USA. ACI Concrete Conventions provide an opportunity to consider the contributions of local chapter members and others to the design, construction, and preservation of many outstanding concrete projects. Descriptions of some projects in Baltimore follow:

Avalon Harbor East

Located in the Harbor East neighborhood of Baltimore City, the Avalon Harbor East project, known as Avalon 555 President, is a 24-story mixed-use high-rise apartment complex. Construction started in September 2018 with concrete work finishing by October 2019. The project consists of 400 apartments, including studio; one-, two-, and three-bedroom units; as well as penthouses. The project also includes a seven-story, 340-space parking garage. It has an eighth-floor outdoor terrace for dining along with a pet park/relief area, and a rooftop terrace with grilling stations and an infinity edge pool.

The first seven floors are 35,000 ft^2 (3300 m^2) each and contain retail space, condos, and a parking garage. They have multiple elevations as the parking garage cuts through the building. This added complexities to the construction sequence. Level eight is a mix of condos with 14,500 ft^2 (1400 m^2) of outside living space. It also includes a 35,000 ft^2 transfer slab, with an average thickness of 12 in. (305 mm), and two 40 ft (12 m) transfer girders to support the 17-story tower above. The 17-story tower has 20,000 ft^2 (2000 m^2) of space on each floor. The roof features a 2000 ft^2 (200 m^2) pool supported by two 60 ft (18 m) long post-tensioned beams. The eighth and 24th floors have outdoor terraces with green space. DGS Construction LLC (DGS) placed and finished various areas of architectural concrete including planters, sidewalks, and curbs to create outdoor appeal. In addition, they completed landscape work on the ground floor, including form liner walls with integral color and integrally colored flatwork.

The apartments and parking garage were completed using post-tensioning and reinforcing bars. This included concrete structural slabs, beams, columns, shear walls, parking slabs, balconies, and site concrete work. DGS completed in-house

Avalon Harbor East

three-dimensional (3-D) modeling for the concrete and reinforcing steel on this project. A fully coordinated building information modeling (BIM) concrete model was created, and reinforcing bar detailing, shop drawings, and fabrication barlists were generated directly from the 3-D model. The model helped identify conflicts and find coordinated solutions prior to field construction. This saved costs by proactively resolving clashes. Integral colored concrete was also used in various areas on the first and eighth levels.

The building's corners on President Street were each designed with a feature column. These oval-shaped columns widen from the ground to level three on the exterior of the building. From levels three to five, they gradually become smaller, continuing through the interior of the building. After level five, they continue up the corners as traditional round columns. Working with Doka, who supplied the formwork for the project, DGS designed and produced a custom mold for these columns. These molds were made from polystyrene foam, with the mold in the center and the exterior of the mold square, so that formwork could be positioned around it to hold it secure during concrete placement.

Project credits: AvalonBay Communities, Inc., Owner; Hord Coplan Macht, Inc., Architect Firm; Ehlert/Bryan, Inc., Engineering Firm; AvalonBay Communities, Inc., General Contractor; Schuster Concrete Construction

(DGS Construction, LLC), Concrete Contractor; and Schuster Concrete Ready Mix, LLC, Concrete Supplier.

Elan Brewers Hill

Multi-use neighborhoods have been growing in popularity in urban areas around the United States. Many locations in Baltimore have been redeveloped in accordance with the concept of living, working, and playing in the same area. The Brewers Hill neighborhood is a new addition to that concept. Over the past decade, new luxury apartment complexes, restaurants, shopping, entertainment, fitness facilities, and more have revived the community into a popular destination to both visit and live in. The fifth residential apartment building for the neighborhood, Elan Brewers Hill, began construction in 2020.

The building is an eight-story residential building with a parking garage. The first three levels are cast-in-place concrete with five wood-framed levels over top. The first two floors are parking levels reinforced with epoxy-coated reinforcing bars, and the third floor is a podium slab reinforced with black reinforcing bars on which the wood framing starts. There are also podium slabs at levels four and five. Located on a 3.8 acre (1.5 ha) parcel of land that was previously an ExxonMobil bulk oil storage site, the land was adaptively repurposed for residential development through the Maryland Department of the Environment's Voluntary Clean Up Program. Vapor barrier had to be installed under the slab-on-ground as part of the vapor mitigation system due to the site's petroleum storage history. Each placement had to be smoke tested prior to ensure the installation was airtight to prevent any vapor or chemicals escaping from the contaminated ground into the building.

Schuster had 34 weeks to complete the structural concrete phase of this project consisting of approximately 18,000 yd^3 (14,000 m^3) of concrete distributed over a 135,000 ft^2 (13,000 m^2) footprint while using two tower cranes. The general contractor, John Moriarty & Associates (JMA), emphasized the need to complete the south half of the project, to the expansion joint, which would allow the commencement of wood-framing activities. However, the south half of the building proved to be more challenging due to conflicts between the project's foundations and existing gas lines at the southwest corner. This conflict required a substantial redesign by the structural engineer of record, which included added grade beams to span the gas lines as well as spread footers and adjusted footing elevations. Most of these foundations were dug by hand around the gas pipes to prevent major accidents.

DGS had to be flexible to implement these changes, including quick re-detailing and supplying reinforcing bars without major impact on the project schedule.

DGS re-sequenced the north half of the job multiple times to mitigate JMA's issues with disposal of contaminated dirt due to the site's history. This re-sequencing allowed concrete activities to continue unimpeded and resulted in a successful and timely completion of the project's structural phase. The project contains thousands of linear feet of exposed concrete walls in the courtyard and around the perimeter of the garage that were rubbed to accept paint. A robotic total station assisted with the construction of the unique building geometry with gridlines on different angles and radii. DGS also had to coordinate tower crane time with the wood framer so they could start framing units as soon as possible.

Project credits: Greystar GP II, LLC, Owner; BKV Group, Architect Firm and Engineering Firm; John Moriarty & Associates (JMA), General Contractor; Schuster Concrete Construction (DGS Construction LLC), Concrete Contractor; and Schuster Concrete Ready Mix, LLC, Concrete Supplier.

Exelon Tower-Base Building

The Harbor Point Development Project, located at the entrance of Baltimore's Inner Harbor, is showcasing the city's urban renaissance with plans for several major developments. This type of revitalization is happening in many locations around the Baltimore metropolitan area, creating affordable residences, dining options, and office buildings, in addition to open spaces with neighborhood appeal. The Exelon Corporation, based in Chicago, IL, USA, chose this location to construct its regional headquarters, with construction

Elan Brewers Hill

Exelon Tower-Base Building

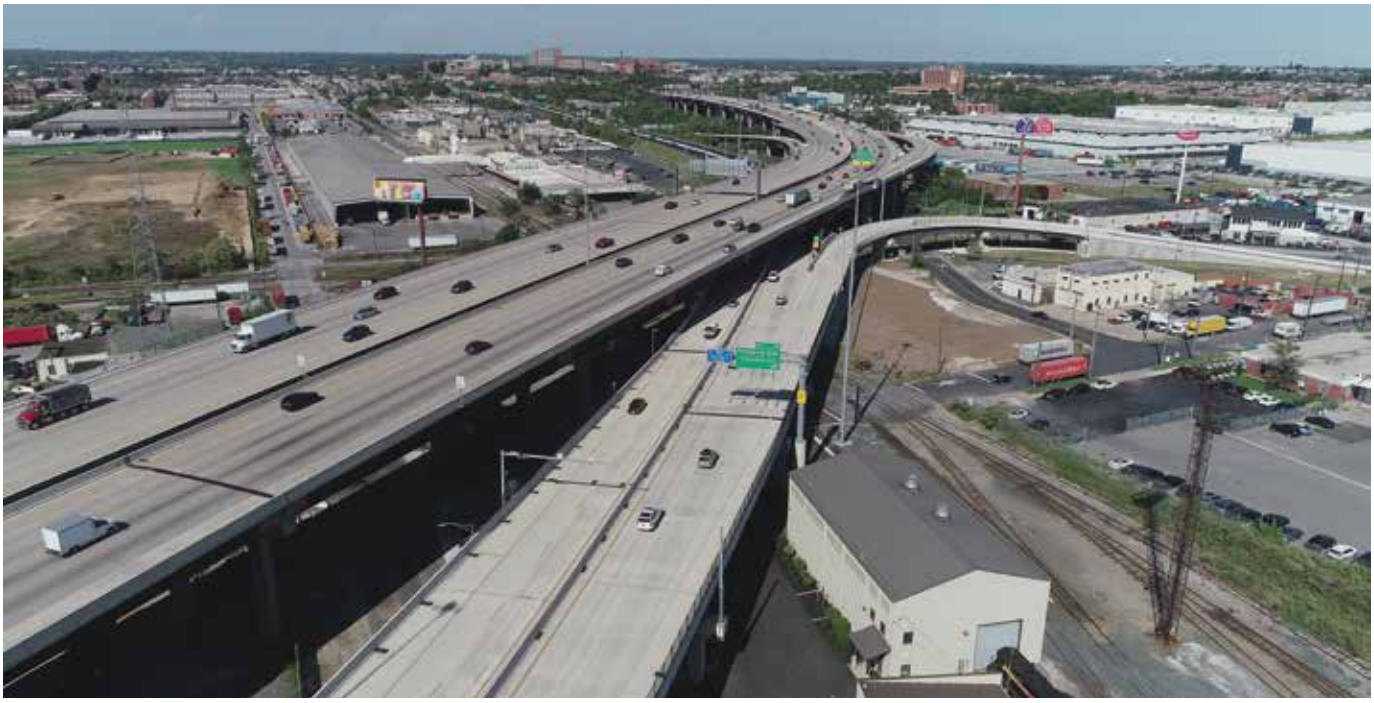
beginning in 2014 after a 2-year delay. The interior design and construction of this project achieved LEED Platinum certification. Approximately 60% of construction materials were harvested or made within 500 miles (800 km) of Baltimore. In addition to the concrete being produced locally, concrete was also made from local resources, had 25% recycled content, and contained low-volatile organic compound (VOC) materials.

The project consists of three sections. The first section is a 23-story tower containing office space for Exelon and 10 residential apartments along with ground-level retail space. The second part is an above-grade parking garage with 750 parking spaces. The top level of the parking garage contains a 65,000 ft^2 (6000 m^2) trading floor. Lastly, the third section is a central plaza area that was constructed in front of both buildings as an open-space area for residents, employees, and visitors to enjoy the waterfront. The site was the former location of a chromium refinery that was in operation for 140 years until it closed in 1985. The soil at the site was found to be contaminated with hazardous waste, which was remediated by removing the polluted dirt and installing a liner to prevent further contamination from seeping in. This caused delays as the site work to prepare for the foundation involved cutting, lowering, and repairing the liner before the pipe piles could be driven into the ground and the concrete pile caps and foundation could be placed. Any digging work that was near the liner had to be done by hand to avoid damage. The tower and garage were built with traditional reinforcing bars and unbonded post-tensioned reinforcement. More than 50 pile caps were placed to begin the foundation; several of those pile caps covered up to 100 piles under one cap to support the structures above. Schuster Concrete Construction found this to be an intricate building to form and place as it had to fit into a tight space and under unusual existing conditions with limited room for construction tolerances. Two tower cranes were used, requiring the development of a tower crane coordination plan to prevent the two cranes from colliding. The central plaza was constructed using pipe piles, with reinforcing bar cages inserted into the pipe then filled with concrete grout before individual caps were placed on top of each pile. The plaza was constructed using lightweight materials, including extruded polystyrene foam insulation under the concrete surface. Schuster also completed much of the site work, such as curbs and the concrete paver base that would support the area's brick pavers. This project required coordination between all contractors and trades given the site issues and other matters that arose during construction.

Project credits: Harbor Point Parcel 2 Holdings, LLC, Owner; Beatty Harvey Coco Architects LLP, Architect Firm; Tadjer-Cohen-Edelson Associates, Inc., Engineering Firm; Armada Hoffler Construction Company, General Contractor; Schuster Concrete Construction (DGS Construction, LLC), Concrete Contractor; Schuster Concrete Ready Mix, LLC, Concrete Supplier.

I-895 Bridge Project (Canton Viaduct/Harbor Tunnel/Approaches)

I-895 Bridge Project was a 2.89 mile (4.65 km) long mega-project to construct two new bridges and rehabilitate the Baltimore Harbor Tunnel (BHT) in Baltimore. The existing 3300 ft (1000 m) long bridge was over 60 years old and the



I-895 Bridge Project

Maryland Transportation Authority's (MDTA's) only structurally deficient bridge in its inventory. The tunnel, also over 60 years old, was included in the contract to combine two major construction projects that had significant impact on I-895 traffic.

The new bridge consists of a 3155 ft (960 m) long, 19-span straight/curved steel girder bridge on I-895 and a new retained fill section at the south approach and along southbound I-895 for the Commercial Vehicle Inspection Area (CVIA). The new Holabird Avenue Ramp (HAR) bridge is a 410 ft (125 m) long, three-span curved steel girder bridge with a 260 ft (80 m) long retained fill section at the end of the ramp.

The I-895 bridge was replaced in two construction stages while maintaining single-lane traffic in each direction. The I-895 bridge crossed 23 railroad tracks, three interstate ramps, three city streets, and was adjacent to several businesses and utilities. I-895 passed under the I-95 viaduct for a length of 800 ft (244 m) where the minimum clearance between I-895 and I-95 was 14 ft-7 in. (4.4 m), and the minimum clearance between the underside of I-895 and the existing railroad tracks was 22 ft-4 in. (6.8 m). Span lengths were increased to minimize the number of piers, requiring up to 96 in. (2438 mm) deep steel plate girder webs. As a result, the profile of I-895 was raised up to 27 in. (686 mm) to maintain the vertical clearance over the railroads. The project employed solutions to overcome challenges associated with utility coordination, railroad coordination, contaminated soil and water, construction staging and access, variable soil conditions, geometric constraints, conflicts with existing bridge foundations, constructability and schedule, traffic maintenance, and staging of the bridge replacement.

MDTA's I-895 Bridge Project contains several concrete elements. These include structural concrete for the I-895 and Holabird Avenue bridge superstructure and substructure components, lightweight foamed concrete fill (LFCF), latex-modified concrete (LMC) overlay for the tunnel and tunnel approaches, concrete pavement for the I-895 approaches and CVIA, and precast concrete elements. Structural concrete was used for all footings; abutment stems and backwalls; pier crash walls, columns, and caps; retaining wall moment slabs and copings; bridge decks; and parapets, which were slip formed. Concrete elements exposed to deicing salts were reinforced with solid stainless steel reinforcement. Mass concrete and winter concrete applications were required to meet the aggressive construction schedule. Surface smoothness tests were required for the bridge deck wearing surface. Over 25,000 yd^3 (19,000 m^3) of structural concrete was placed on the project. LFCF was used for the abutment and pile-supported retained fill section backfill to minimize lateral pressures, eliminate the need for battered piles, and reduce the number of piles in the retained fill sections. Type I LFCF (30 lb/ft^3 density/40 psi strength [481 kg/m^3/0.28 MPa]) was used for most of the backfill (15,225 yd^3 [11,640 m^3]), and Type II LFCF (42 lb/ft^3 density/120 psi strength [673 kg/m^3/0.83 MPa]) was used for the upper 6 ft (1.8 m) of backfill (5700 yd^3 [4400 m^3]). The material was mixed on site and pumped into place. The tunnel LMC overlay was 2 in. (50 mm) thick, and the tunnel approach roadway LMC overlay was 4-3/4 in. (121 mm) thick. An on-site mobile mixer was used for the LMC and placed with a screed machine. The overlay was subjected to a surface smoothness test. Over 1035 yd^3 (791 m^3) of LMC was placed per tunnel, and a total of 1025 yd^3 (784 m^3) of LMC was placed on the approaches. Mix No. 7 portland cement concrete pavement, 10 in. (254 mm) thick, and a 6 in. (152 mm) graded aggregate base was placed on top of the LFCF material at the abutments and the retained fill section at the south approach to the bridge. A total of 2400 yd^2 (220 m^2) was placed. Mix No. 6 concrete was used for the pavement placed on top of the LFCF material at the CVIA. The thickness range varied from 15 to 27 in. (381 to 686 mm), allowing the slab to cantilever off the retained fill section to the longitudinal joint along the southbound I-895 bridge. Several precast concrete components were fabricated and installed on the project. The three retained fill sections used precast concrete panels for the mechanically stabilized earth (MSE) walls (over 26,500 ft^2 [2500 m^2]). Over 3000 linear ft (900 m) of precast concrete trench drains were installed along the retaining walls at the tunnel approaches to collect roadway drainage. A 200 linear ft (60 m) underground stormwater retention structure with inside dimensions of 5 ft (1.5 m) high by 8 ft (2.4 m) wide was installed to collect bridge deck drainage and delay discharge to the existing city storm drain system. In addition, over 2900 linear ft (900 m) of reinforced concrete pipe (15 to 54 in. [381 to 1372 mm] diameter) and numerous precast concrete inlets and manholes were installed throughout the project.

Project credits: Maryland Transportation Authority, Owner; Whitman, Requardt & Associates, LLP, Engineering Firm; Tutor Perini Corporation, General Contractor; Geo-Cell Midwest, LLC, Concrete Contractor; Rowen Concrete, Inc., Concrete Supplier; The Wilson T. Ballard Company, Structural Engineer (responsible for tunnel and tunnel approach overlay); and Swank Construction Company, LLC, Concrete Specialty Contractor (LMC overlay in tunnel and tunnel approaches).

Liberty Harbor East

Liberty Harbor East, an addition to Baltimore's Harbor East neighborhood, is a 170 million USD, 22-story building with 282 luxury apartments, 35 condominiums, seven levels of parking with 575 spaces, and a 47,000 ft^2 (4700 m^2) Whole Foods Market flagship store on the ground level that replaced the existing Harbor East location at the corner of Fleet and Exeter Streets. The ninth-floor courtyard contains a pool that overlooks the harbor and amenity spaces that include a library, study areas, yoga studio, fitness area, dog park, and outdoor theater.

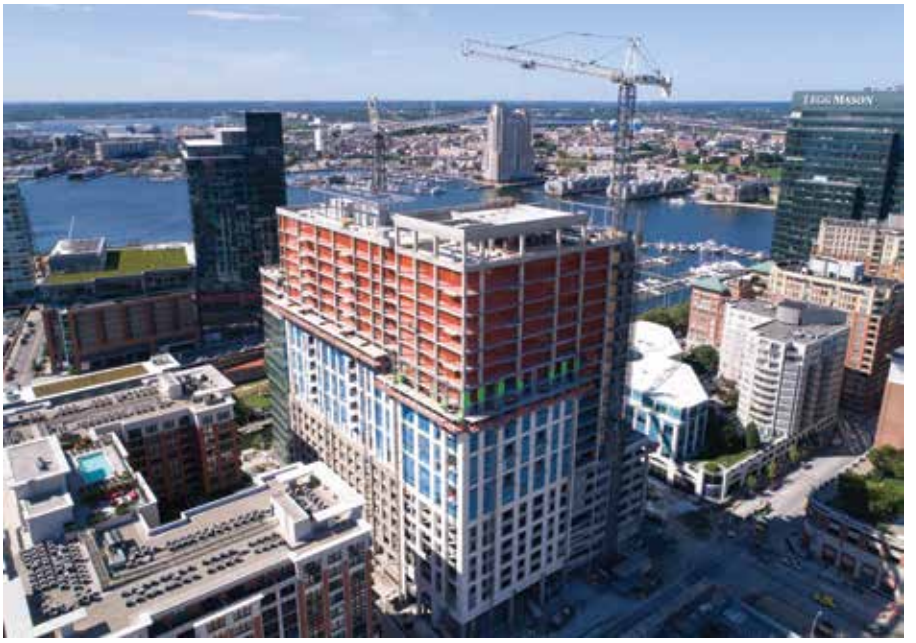
This building is in one of the busiest sections of town for both pedestrian and vehicular traffic, so getting to and around the site posed logistical challenges. Construction of a

new bridge on Central Avenue, which bordered the entire west side of the project across the water to the Harbor Point development, was ongoing during the entirety of the concrete operations, severely limiting access for deliveries and concrete placements. Also, stone culverts dating back to the 1800s were below adjacent streets to the east and west, and they had to be monitored during construction to prevent damage.

A total of about 36,000 yd^3 (28,000 m^3) of concrete, ranging in strengths up to 10,000 psi (69 MPa), were placed throughout the concrete structure.

The project highlights include:

- About 6 million lb (2.7 million kg) of reinforcing bars and 250 miles (402 km) of post-tensioning cables were used;
- A deep foundation system consisting of caissons up to 84 in. (2134 mm) in diameter and 80 ft (20 m) deep, caisson caps, and interlocking grade beams was used to transfer the loads of the building down to bedrock;
- Deep excavations at the elevators required the use of engineered sheet piling to control the soft soil and water infiltration;
- The slab-on-ground is a 12 in. (305 mm) thick conventionally reinforced slab that spans between the caisson caps. The majority of this slab had to be left out and placed after the building was topped out so that Whole Foods could install its underslab utilities and freezer piping. This resulted in the need for mechanical couplers at each column so that the reinforcing bars could be threaded through the existing columns to maintain continuous mats of reinforcement;
- The ground floor loading dock required a wide clear span for multiple bays, so transfer girders up to 7 ft-6 in. (2.6 m) wide and 5 ft-6 in. (2 m) deep were used to pick up new columns for the tower above. These girders were placed with 8000 psi (55 MPa) concrete and required a thermal control plan to minimize the temperature differential between the core of the beams and the outside air;
- Level two was open over much of the Whole Foods footprint, so 35 ft (11 m) high shoring was used from level one up to level three;
- Corrosion-inhibiting admixture was used in all garage slabs;
- The superstructure primarily consisted of 8 in. (203 mm) thick two-way post-tensioned slabs;
- The level nine courtyard is a 16 in. (406 mm) thick conventionally reinforced slab;
- Pour strips were used on each level, some of which had to stay open for up to 16 weeks;
- Undulating slab edges along the south side of the building create a series of outdoor balconies and terraces to maximize the harbor views for the luxury condos;
- Colored concrete was used in architecturally exposed, board-formed concrete at the level nine amenity areas; and
- A topping slab, reinforced with 5 lb (2.3 kg) of polypropylene and polyethylene synthetic macrofibers, was placed over waterproofing and insulation on the elevated slabs above the entire Whole Foods footprint.



Liberty Harbor East

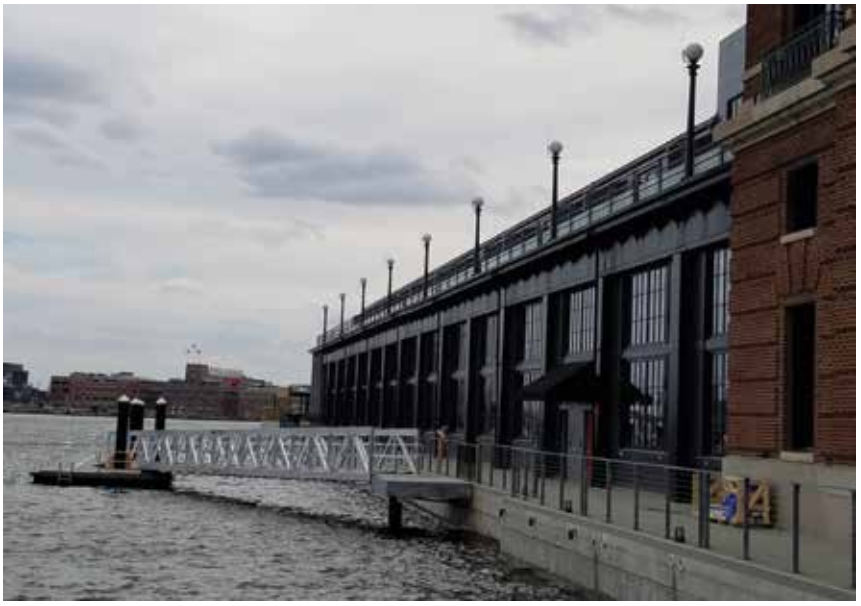
Project credits: Harbor East Management Group, LLC, Owner; Hickok Cole Architects, Architect Firm; Morris & Ritchie Associates, Inc., Engineering Firm; Bozzuto Construction Company, General Contractor; Miller, Long & Arnold Co., Inc., Concrete Contractor; and Vulcan Materials Company, Concrete Supplier.

Recreation Pier Hotel – Pier and Bulkhead Restoration

Baltimore's Recreation Pier is a staple in the city's rich history. The pier and head house structure were originally constructed in 1914 for commercial use in the Fells Point neighborhood of Baltimore. The harbor master's office was a tenant at the pier for a term and vessel cargo from Europe was handled there.

Baltimore was the second leading port of entry to the United States at the time (Connery). The Recreation Pier was used in conjunction with a pier in Locust Point for processing immigrants, linking diverse ethnic groups and communities. The facility functioned as a recreational facility for residents, especially the youth (RecPier.com). Basketball courts were built on the building's roof, and the ballroom was used for dance classes and community events.

Later, it was featured in the Baltimore-based TV series *Homicide: Life on the Streets* as a police station. Disney also



Recreation Pier Hotel – Pier and Bulkhead Restoration

used the facility as a set for their "Step Up" movies (BHC Architects). After the show *Homicide* stopped filming in 1999, the pier remained vacant (*Baltimore Sun*).

In 2014, Sagamore Development, LLC (owned by Under Armour, Inc. CEO, Kevin Plank) acquired the property with the intent of building a world-class hotel, now known as Sagamore Pendry Baltimore.

Because of the pier's rich history, preserving the structure and the head house was important to the owner's vision (The Pendry). It was also a requirement of the Maryland Historic Trust. However, a conditional assessment deemed the pier unrepairable. To preserve the existing concrete pier's historical significance, a new pier was to be built that would envelope the existing pier, restore its structural integrity, and support the future loads of the renovated hotel building.

The Recreation Pier was a concrete pier approximately 500 ft (152 m) long and 150 ft (46 m) wide. Only about half of it was a pier. The north half was constructed using concrete sheet piles and earth fill. The southern half was a concrete pier extending from the fastland.

The existing pier consisted of an 8 in. (203 mm) thick concrete deck resting on concrete caps supported by concrete piles. Due to significant deterioration, the pier could not be used for long-term loading, but a permissible temporary construction load was determined.

A new tie rod supporting sheet pile wall around the existing fastland restored and improved the building's foundation capacity. A concrete closure was formed and placed underwater at the new wall abutment to the existing wall. A concrete edge beam capped the sheet piling and encapsulated the steel hardware. It also served as the new walking surface along the building perimeter.

On the pier, the existing deck was to be the formwork for the new 24 in. (610 mm) thick slab. Holes were saw-cut in the existing concrete deck to drive the new concrete piles through and to insert a precast concrete swimming pool. The holes for the piles were appropriately sized to form the drop panels of the slab. Preserving the existing deck allowed for restoration work on the existing building to begin consecutively.

Prestressed concrete piles were selected as a value engineering alternative to steel pipe piles to improve durability and save 1,000,000 USD. Driving templates were attached to the existing deck, and 24 in. square prestressed concrete piles were driven through the existing deck to 250 tons (227 tonnes) of capacity.

A new concrete edge beam was constructed around the existing pier and temporary batter pile caps provided lateral stability during construction. A heavily reinforced 6 ft-9 in. x 4 ft-5 in. (2 x 1.3 m) concrete transition beam was installed at the south end of the fastland with ten 275,000 lb (125,000 kg) capacity soil anchors to resist wind and seismic loads.

A 195 ton (177 tonne) precast concrete swimming pool was assembled in the contractor's yard with pockets for placing the connections to the supporting piles when in place. The pool was lifted by a 200 ton (181 tonne) barge crane, floated to the site suspended over the water, and set in place on the new piles.

The cutoff tops of the new concrete piles were used to load test the existing pier structure. They were placed in a predetermined pattern on the pier deck to simulate the temporary construction load necessary to use the existing deck as a form for the new slab.

The new 24 in. thick concrete deck was placed in two lifts and encapsulated all the structural steel elements, including the soil anchor pockets, walers and tie rods, and the building column bases. The existing pier was suspended from the new slab with approximately 1650 post-installed adhesive anchors. Approximately 6000 yd^3 (4587 m^3) of concrete were placed during construction.

Project credits: Sagamore Development, LLC, Owner; Beatty Harvey Coco (BHC) Architects LLP, Architect Firm; Whitney Bailey Cox & Magnani, LLC, Engineering Firm; Whiting-Turner Contracting Company, General Contractor; McLean Contracting Company, Concrete Contractor; and Rowen Concrete, Inc., Concrete Supplier.

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