Building a Park over an Interstate

Pittsburgh's Interstate 579 Urban Open Space Cap Project

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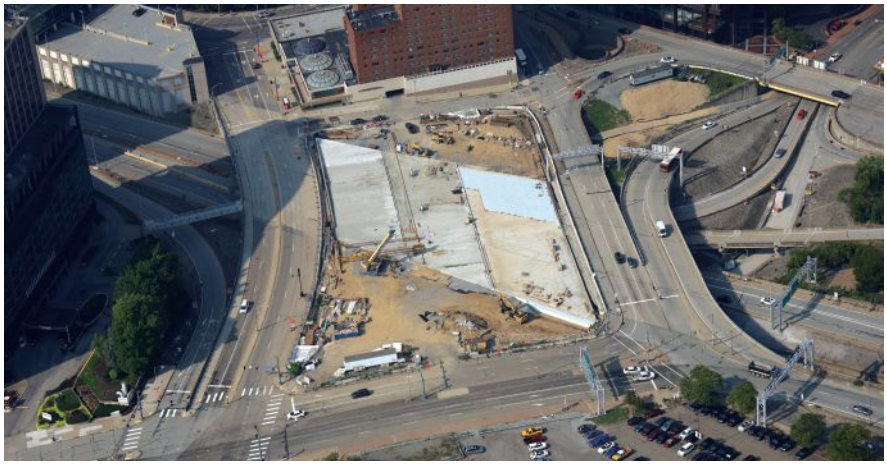
The Interstate 579 (I-579) Urban Open Space Cap project in Pittsburgh, Pa., reconnects the city's historic Hill District with the downtown business and cultural center. Completed in late 2021, this project literally capped (covered) about 300 ft of I-579 and created a 3-acre park that features performance and green spaces, integrates local art, and includes an amphitheater.

The dense urban site and unique park loading for this new structure required an innovative design and construction expertise. There are no design codes for bridges carrying a park, so project-specific criteria were developed to meet the demands that will be placed on the structure.

The Sports & Exhibition Authority of Pittsburgh and Allegheny County acted as the lead design agency alongside the City of Pittsburgh as owner, with oversight from the Pennsylvania Department of Transportation (PennDOT) and review from the Federal Highway Administration. The lead designer for the $32 million project coordinated with federal, state, and local entities, as well as private and nonprofit organizations, to bring this successful project to fruition.

The site of the Interstate 579 Urban Open Space Cap project as construction begins, with the interstate highway running beneath. Photo: HDR Inc.



The Interstate 579 Urban Open Space Cap site in the middle stage of construction, with precast concrete box beams in place over the interstate highway. Photo: HDR Inc.

A New Connection

In the 1950s, as part of the construction of the former Civic Arena and other development activities, entire blocks of homes and businesses in Pittsburgh's Lower Hill neighborhood were demolished. During that time, Crosstown Boulevard was built, creating a "concrete canyon" of tall retaining walls and noisy highway traffic, essentially separating the Hill District from the downtown. In 1972, this highway became I-579. The Urban Open Space Cap project bridged this concrete canyon and created a tree-lined park over the highway, providing a walkable link to a neighborhood that had lost its direct access to downtown.

Project Overview

The new cap structure was constructed between two existing highway bridges that carry local traffic over I-579. The constrained construction site required special attention to minimize lane closures and avoid damaging existing structures. Micropile and drilled-shaft foundations were used to preserve the existing retaining walls along I-579.

Three new bridge units, composed of 126 prestressed concrete adjacent box beams, were placed between the existing crossings. The three units have different span lengths due to the geometry constraints and skew of the substructure units. Other features include redundant waterproofing systems and lightweight

The reinforcement cages for the pier columns are in place and formwork is being constructed. All mild reinforcement on the project is epoxy coated. Photo: Pennsylvania Department of Transportation.

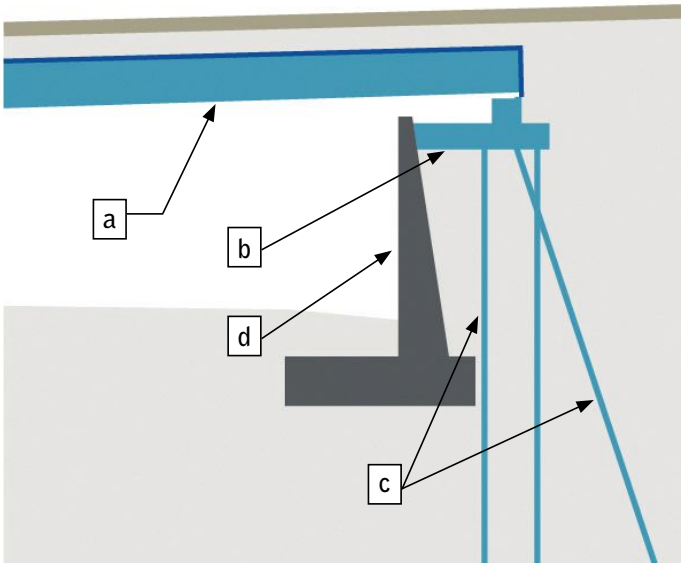
expanded polystyrene geofoam blocks to limit fill weight.

Substructure Design and Construction

The cap structure is supported by semi-integral abutments founded on more than 200 drilled micropiles, which were selected to minimize vibration and enable the use of a smaller drilling rig—an advantage in the limited space behind existing retaining walls.

The piles are offset from the existing retaining wall footings to avoid drilling through the heel. The battered piles are angled backward from the existing retaining walls and resist the lateral loads from the cap structure in tension, rather than in compression as is typical for battered piles.

Lightweight expanded polystyrene geofoam blocks are cut to fit and used as fill material to reduce soil loading on the bridge structures. Photo: HDR Inc.



Cross section of the cap structure. The prestressed concrete box-beams (a) are supported by semi-integral abutments (b) founded on micropiles (c). Micropiles were used to preserve the existing retaining walls (d) along Interstate 579. Figure: HDR Inc.

The piers supporting the cap structure consist of four multicolumn pier bents founded on drilled caissons socketed into sandstone bedrock. Construction of the 42 drilled caissons took place in the gore areas approximately 30 ft below the interstate roadway. The proposed foundations were carefully evaluated to ensure that the necessary work area would be provided and the impact on interstate traffic would be minimized. Where possible, the caissons have a diameter of 3 ft 6 in., but caissons in some locations required a diameter of 3 ft 0 in. to avoid interference with existing retaining wall foundations.

Superstructure Design and Construction

The superstructure supporting the park and backfill consists of standard 48-in.-wide, 66-in.-deep PennDOT prestressed concrete adjacent box beams made continuous for composite dead and live loads. The superstructure is divided into two two-span units and one three-span unit. Separating the beams into three units allowed installation of transverse post-tensioning and permitted slight differential deflection between the units. The location of the piers matches the adjacent roadway bridges. The structure required 126 beams. Because the supports are nonparallel and skewed, the span lengths of the beams range from approximately 54 to 120 ft. The number of special (0.52-in.-diameter) strands varies by unit and ranges from 24 strands per beam for the shortest spans to 72 for the longest.

At each edge of the cap structure, a deck wall retains the backfill for the park.

After evaluation of several possible beam types, precast concrete adjacent box beams were selected for several reasons:

- The precast concrete elements were economical, but also strong enough to support the unique park loading, including up to 5 ft of soil and pedestrian or stage loading.
- Given the structure's location over an interstate highway, minimizing future maintenance was a high priority. Precast concrete beams do not need to be painted and, with an expected 100-year service life, they will withstand the test of time, reducing long-term costs.
- The beams provided a smooth soffit that contributes to aesthetics under the bridge and provides a consistent surface to attach the lighting system.
- The inherent fire resistance of precast concrete beams is an asset for this wide bridge overpassing an interstate highway.

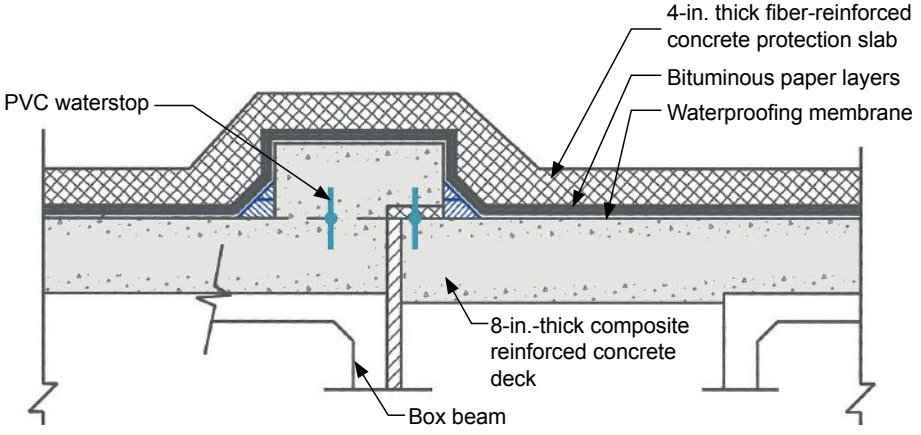
The top "event lawn" portion of the park was designed with a special soil mixture capable of absorbing up to 6 in. of water in a rain event. The minimum thickness of the soil on the cap was about 2 ft; however, the varied park topography meant that the soil depth in some areas would be about 5 ft, adding significant dead load to the bridge beams. To reduce the dead load from soil, expanded polystyrene geofoam blocks were buried in the deepest portion of the park. These blocks weigh 3 lb/ft^3 and satisfy project requirements for resistance to freezing and thawing, buoyancy (when the soil becomes saturated), and compression strength for truck-tire loading.

Determining the design loading for the structure was a unique challenge. The

The finished park on top of the Interstate 579 Urban Open Space Cap reconnects neighborhoods with downtown Pittsburgh, Pa., after being cut off since the 1950s. Photo: HDR Inc.

Some of the precast concrete adjacent box beams have been erected for three new bridge units between two existing bridges over Interstate 579. Photo: Pennsylvania Department of Transportation.

dead loads consist of the self weight of the superstructure and deck, protection slab, earth load, event platform load (not combined with vehicular live load), and a load for utilities attached to the underside of the box beams. Two live-load scenarios were considered when designing the beams. The first scenario considered the standard load-rating vehicles used to determine bridge posting in Pennsylvania (H20, HS20, ML80, and TK527), which approximated the vehicle loading that would be present when construction and maintenance vehicles access the park in the future. The second scenario considered the pedestrian loading that would be present in the final condition. Because the park will be used to host events and concerts, the 150 lb/ft^2 stage assembly area live load from the American Society of Civil Engineers' *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*[1] was used. Both live-load scenarios were considered concurrently with the worst-case dead and earth loads. The vehicular live-load scenario generally controlled the design of each beam.



Cross section of the structure where two units meet at a raised curb, showing the waterstop detail, waterproofing, drainage, and protection layers. Figure: HDR Inc.

After the box beams were erected and transversely post-tensioned, a traditional 8-in.-thick composite reinforced concrete deck was placed on top of the beams. A redundant waterproofing and drainage system was then installed to protect the structure from deterioration and prevent ice from forming and falling onto I-579. The system includes waterstops between structure units, layers of bituminous paper and waterproofing membrane on the top of the superstructure and back face of the semi-integral abutments, a 4-in.-thick fiber-reinforced-concrete protection slab to prevent damage to the waterproofing from future excavation, and a continuous aggregate drainage layer across the sloping superstructure.

"A Time to Celebrate"

For more than six decades, Pittsburgh's Hill District was isolated from the downtown by I-579 and a sea of parking lots. The new Frankie Pace Park, built on a structure that required design innovation, technical expertise, and dedication to the community, has changed that.

"This is really a time to celebrate," said Pennsylvania Governor Tom Wolf at the ribbon-cutting ceremony for the park in November 2021. "A great injustice was done in the '50s, and this is finally, at long last, a way to address that injustice."

Reference

1. American Society of Civil Engineers (ASCE). 2010. *Minimum Design Loads and Associated Criteria for Buildings and Other Structures.* ASCE/SEI 7-10. Reston, VA: ASCE.

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