# JOURNEY ACROSS THE SKYBRIDGE

by Danielle E. Chater and William R. Maples, CDM Smith,
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Driving along the tree-lined lanes of Jog Road, one would not immediately recognize that a new state-of-the-art, energy-efficient, waste-to-energy facility is hard at work processing 3000 tons a day of post-recycled solid waste into 100 MW of electricity.

In order to give the public a full understanding of the benefits of the plant, Solid Waste Authority (SWA) of West Palm Beach, Fla., commissioned the Education Center, a LEED (Leadership in Energy and Environmental Design) platinum building. SWA then took their mission to educate the public one step further by incorporating a guided walking tour so that visitors have a complete experience. The guided tour makes use of the uniquely engineered Skybridge to provide access between the education center and facility's key buildings and control rooms.

## The Skybridge

The Skybridge, a 534-ft-long elevated pedestrian walkway, rises 37 ft above grade and also acts as an educational tool. Its railings are adorned with information about various aspects of the facility, which can be viewed from all vantage points while on the journey across the Skybridge.

The superstructure primarily consists of precast concrete double-tee roof and

View from the Education Center roof garden looking south along the Skybridge with a focus on the supporting V-shaped piers. Photo: CDM Smith.

## profile

**SKYBRIDGE** / PALM BEACH, FLORIDA

**BRIDGE DESIGN ENGINEER:** CDM Smith, Maitland, Fla., and Dura-Stress, Leesburg, Fla.

**BRIDGE DESIGN ARCHITECT AND ARCHITECT OF RECORD:** CDM Smith, Maitland, Fla.

**PRIME CONTRACTOR:** CDM Constructors Inc., Maitland, Fla.

**PRECASTER:** Dura-Stress, Leesburg, Fla.—a PCI-certified producer

**CONSTRUCTION COST:** $1.84 million

pretensioned members simply supported on V-shaped precast concrete columns. The main design reconciles several functional and aesthetic criteria, such as the plant's operational requirements and space limitations, while achieving the design concept of allowing the visitor to recognize that they are moving from the David-sized education center to the Goliath-sized power block. The openness of the V-shaped piers opening upwards towards the sky, and the height of the walking platform, were critical design factors in achieving this sensation.

**The main design reconciles several functional and aesthetic criteria.**

Multiple platforms provide intermediate viewing areas for groups to stop and observe their surroundings. At the platform areas, the wider deck was accomplished by using precast concrete solid slabs cantilevered across precast concrete beams that span between the piers. The viewing platform at the midpoint of the Skybridge doubles as an additional means of egress with precast concrete stairs leading from the platform to grade level.

The roof design uses two precast concrete double tees that slope from east to west to provide protection from driving rain and intense south Florida sun. The two double tees are connected with welded shear ties spaced at 6 ft on center. The high side of the roof on the east opens up to an unobstructed, panoramic view of the main elevations of the facility as well as the green landscaping and solar panels used throughout.

A precast concrete superstructure was selected to provide maximum durability with minimum maintenance. This system also was able to fit the tight assembly window during construction by being fully cast off-site and quickly installed on-site. During the design process, the designer worked closely with the precast, prestressed concrete supplier to take the Skybridge from the conceptual stage to the execution stage while maintaining the architects' vision.

Due to tight footprint restrictions associated with the adjacent buildings, the Skybridge foundations were designed as a cast-in-place (CIP) concrete pile cap on CIP piles. The design of the V-shaped Skybridge piers required significant moment-resisting connections at the pile caps. The piles were designed for tension with threaded tension bars and anchor plates. The pile cap–to–pier connection required close coordination with the precast, prestressed concrete supplier to accommodate the number, location, and development of the tension dowels that were grouted into splice sleeves after piers were erected. Temporary bracing remained in place until the grout reached design strength.

## Execution Challenges

Many obstacles were overcome during the construction and installation of the elements making up the Skybridge.

The first obstacles were space and time constraints. Due to the fact that the Skybridge is nestled between the power block and adjacent buildings, construction sequencing and associated logistics had to be carefully planned. Planning had to consider a very short

The V-shaped piers supporting the deck and roof open up to the sky while meeting height requirements and site limitations. Photo: CDM Smith.

Precast concrete stairs shown during construction will provide egress at the viewing platform. Photo: Dura-Stress.

SOLID WASTE AUTHORITY, OWNER

**BRIDGE DESCRIPTION:** 534-ft-long, multiple-span elevated pedestrian double-tee walkway and roof with precast concrete solid slab viewing platforms

**STRUCTURAL COMPONENTS:** Ten V-shaped custom precast concrete piers supported on cast-in-place concrete pile caps bearing on cast-in-place piles. The piers support seven 8 ft by 32 in. precast concrete double-tee deck members for the bridge and 8 in. precast concrete flat slabs for the observation and staging decks. The roof structure consists of eighteen 8 ft by 24 in. precast concrete double tees (two double tees per span).

**AWARDS:** 2017 Florida Institute of Consulting Engineers: Engineering Excellence Award: Grand Award; 2016 American Society of Engineers: Project of the Year Award; 2016 Design-Build Institute of America Florida Region: Florida Design-Build Award, Industrial/Process/Research Facilities: Honor Award; 2016 *POWER* magazine: Top Plant Award; 2016 U.S. Green Building Council: Leadership in Energy and Environmental Design (LEED) Platinum Certification (Education Center); 2015 *American City and County* magazine: Crown Communities Award for Sustainability; and 2015 PCI Design Award: Best Non-Highway Bridge


Base of precast concrete V-shaped pier showing splice sleeves with ports for grouting. Photo: Dura-Stress.

period of time in which the crane could be used for superstructure installation. This aggressive installation occurred approximately six months after piling placement.

The second obstacle was coordination of the viewing platform and the windows at the power block. The windows needed to be located along the limited 36 ft span of the viewing platform while providing a clear, uninterrupted view to the interior of the building, at a height suitable for all spectators.

The third obstacle arose during the construction phase, when the connections at either end of the Skybridge had to be retrofitted due to variations in finished floor levels. Minor modifications to the waste-to-energy facility resulted in elevation differences between the staging platform and the power block elevator. The staging platform had to be designed to be supported on the Skybridge foundations while accounting for the high movement of the Skybridge relative to the power-block structure, thus creating a wide pedestrian expansion joint. The 2-in.-wide expansion joint with a cover was designed to account for the relative displacement between the Skybridge and the power-block elevator shaft.

Notched double tees are supported by haunches integral to the cross beams of the V-shaped piers. Photo: Dura-Stress.

## *Current Status*

Solid Waste Authority's Palm Beach Renewable Energy Facility has many unique characteristics, with one of its most defining features being the precast concrete Skybridge. It has received numerous awards and accolades for its unique design and innovative structure.

The Skybridge not only performs its most basic function of providing a means of access between the education center and the power block, but also creates a journey of education through time and space across the facility.

Perhaps the most endearing feature of the Skybridge is its ability to bridge the gap between the theory of a sustainable world and the actual reality of living in one.

At the education-center end of the Skybridge, the platform from the roof garden to the bridge was built slightly higher in elevation than anticipated, leading to necessary adjustments in the construction of the Skybridge. The first span of the Skybridge was designed to cantilever over the first V-shaped pier to minimize structural loads on the education center's architectural features. The design of the specialty double tee accommodated the increased dead load caused by placing a concrete topping over the walkway to reconcile the difference in elevations. The concrete topping was installed as a built-up slope over the run of the first section between columns. All other spans of the bridge were simply supported with notched double tees bearing on haunches that were integral to the cross beams of the one-piece V-shaped piers. Expansion joints were constructed over the support beams and reflected through the concrete topping on the walking deck. On the roof deck, the joints were accommodated with flexible covers over the roofing material.

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