Careful design allows the new gift shop on Liberty Island to be easily moved when its lease expires.

Built for Deconstruction

BY PANAGIOTIS KOKLANOS, P.E., LEED AP

VISITORS TO LIBERTY ISLAND, the home of the Statue of Liberty, have long been disappointed by the old gift shop located in a tent at the base of the statue. In 2008, the U.S. National Park Service (NPS) agreed to the construction of a building to house the souvenir stand, but had specific requirements: It needed to enhance the visitor experience (including meeting the need for more restrooms); it had to be inconspicuous despite its prominent location; and most important, it had to achieve at least a LEED Gold certification.

Additionally, since the owners of the new building only had a 10-year lease, they wanted the building to be designed to be easily deconstructable in case they lost their lease and needed to relocate.

As a result, the tent has now been replaced by a 6,400-sq.-ft. all-steel structure at the eastern edge of the existing dining plaza. The new structure is designed to enhance the visitor experience, restoring the grand processional from the ferry to the statue and providing a comfortable space with additional restroom facilities. But it also treads lightly on this small but very visible island, thanks to the creative use of steel framing.

The contract to erect a new retail pavilion was awarded to Evelyn Hill, Inc., the island's retail and food services concessionaire. Evelyn Hill's president, Brad Hill, approached Acheson Doyle Partners Architects to conceptualize a lightweight building with a minimal vertical profile. The building had to be designed to be easily constructed and then deconstructed at the end of its service life—a stated preference of the NPS for historic sites—yet durable enough to resist the harsh marine environment of the island.

Steel's Benefits as the Primary Building Material

Given these logistical issues, structural engineers at Weidlinger Associates, Inc., opted for a conventional structural steel braced frame, with a plywood floor supported on light-gauge steel studs and steel girders. The use of an all-bolted frame allowed for quick erection and inspection, shaving weeks off the project's aggressive construction schedule.

That also ensured the goal of an easily deconstructable building, one that could be disassembled quickly at the end of its service life. Because all required welding was done in the shop and

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▲ Using steel framing facilitated low-impact construction of a new retail pavilion very near the Statue of Liberty. The owner had to build a lightweight structure with a minimal vertical profile that could be both easily constructed and deconstructed at the end of its service life.

▲ Floor framing is on a 32 ft by 32 ft grid; the roof framing employs a 16 ft by 16 ft grid to allow the use of shallower members. The openings are for skylights.

field connections were bolted, no thermal cutting or torching should be required to disassemble the building. The various steel pieces composing the building frame could be easily salvaged and reused on another project, with minimal rework. Also, using typical rectilinear structural framing, plywood and metal joist flooring layout, and façade glazing and solid panel layout minimized the number of connections and atypical conditions required.

Unique Pile Caps and a Raised Floor

Though a slab on grade foundation would have made the most sense from a structural standpoint given the size and function of the pavilion, its island location—specifically the transporting of concrete by barge—caused this option to be cost-prohibitive. Making matters worse, the loading dock

Panagiotis Koklanos, P.E., LEED AP is a senior structural engineer with Weidlinger Associates, Inc., New York, and spearheads the firm's sustainability consulting efforts. He is a registered Professional Engineer in the state of California and an AISC Professional Member. He earned a Bachelor of Science in civil engineering from Syracuse University and a Master of Science in structural engineering and geomechanics from Stanford University.

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The floor is supported by light-gauge steel studs spanning between W24 galvanized steel girders.

All the structural steel girders are a minimum of 18 in. above the ground to allow for visual inspection of the steel pile caps at any time.

nearest the pavilion could not support the weight of a concrete truck. The only feasible route from the service dock to the construction staging site at the opposite end of the island was across the historic lawn directly in front of the statue. Compromising the integrity of the landscape, even temporarily, was not a viable option. Opting for an all-steel structure solved the delivery problem: The majority of the construction materials, already loaded on the truck, could be transported by ferry to the visitor dock closer to the staging area.

For all its advantages, the exclusive use of steel for the pavilion posed unusual design and construction issues. This was especially evident in the design of the building's foundation. A geotechnical investigation by the engineer revealed that the soil beneath the pavilion contained uncontrolled fills and demolition debris from previous construction. Consequently, engineers specified the use of grouted minipiles, which were drilled 30 ft into the ground, to serve as the building's foundation.

Each steel column needed to be supported by a group of three minipiles to ensure the lateral stability of the building frame. In the absence of concrete, engineers needed to design a steel pile cap that could transfer all of the column base reactions to the minipiles below. Steel pile caps, sometimes referred to as "grillages," are most commonly used to support structures in remote locations, such as electric distribution towers. Because the building was relatively lightweight, engineers were able to adapt and customize the design of the steel pile caps to support all of its loads.

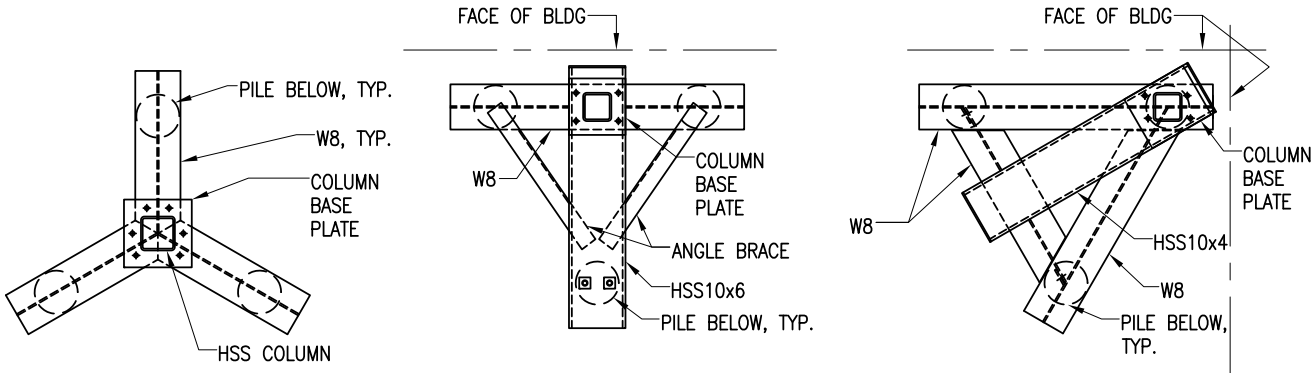
A series of heavy W8s were shop-welded together in such a way that each beam was centered over a minipile. To hide the grillages from view, a variation of the pile cap design was required for each of three different locations: the interior of the structure, along the building's edges, and at the building's corners. The variations are shown below.

A precise field survey of the as-driven locations of the various piles was performed to ensure proper fabrication of each pile cap. Because the minipiles were drilled rather than driven, it was expected that each pile would be placed with a relatively high level of accuracy (within 1.5 in.) at the specified location. The steel pile cap design, however, allowed for a pile installation lateral tolerance of 6 in. The design specified oversized bolt holes covered by steel washers to allow for additional fit-up tolerance in fastening down the pile caps.

The building code required that the design allow for visual inspection of the steel pile caps at any time. In response to this requirement, all the structural steel girders were located with their bottom flanges a minimum of 18 in. above grade. To minimize the number of piles required, a 32 ft by 32 ft structural grid was used at the first floor. To reduce the depth of the roof structure and overall building height, a 16 ft by 16 ft grid was used at the roof level.

The use of 32-ft-long W24 transfer girders at the first level placed the finished floor of the pavilion at approximately 4 ft above grade. To provide proper access to and egress from the elevated pavilion, the architect and

Using all-bolted construction allowed for quick erection and facilitated inspection while also providing a building that will be easily deconstructed at the end of its service life.



Plan detail of pile cap at building interior.

Plan detail of pile cap at building edge.

Plan detail of pile cap at building corner.

▲ Three pile cap configurations accommodate the transfer of structural loads from the steel framing to the minipiles.

engineer designed a wood deck with several ramps and staircases. They specified FSC-certified ipé decking, an extremely durable dark hardwood that can withstand the heavy foot traffic to which the new retail pavilion will certainly be subjected.

The Impact of the Details

Significant value was added to the pavilion through the structural design and architectural detailing. To ensure durability, each component that would be directly exposed to the outdoor elements was hot-dip galvanized, including the first-floor framing, full-height columns, metal roof deck, and pile caps. Because the foundation and frame are steel, the team created a thermal break to interrupt the conductivity between the foundation and superstructure using ¼-in.-thick neoprene bearing pads between the bottom of the column baseplates and the top bearing surface of the steel pile caps. To completely seal off the elevated floor structure from the weather, sheathing was hung from the light-gauge metal floor studs and the cavity between the plywood floor and sheathing was filled with Icynene spray-foam insulation, providing an *R* value of 19 for the assembly.

Weidlinger was in the unique position of serving simultaneously as structural engineer and sustainability consultant. As a member of the design team directly involved in day-to-day design decisions, and having developed a close rapport with architect Acheson Doyle and MEP engineer P.A. Collins, P.E., Weidlinger was able to interject sustainable design concepts and practices into regular working sessions and meetings. Decisions about the materials of the structure and its finishes were assessed based on a qualitative understanding of their embodied carbon and local availability.

From the project's inception, the owner was firmly committed to the sustainability of the new building. Early in the design phase, when the engineer presented the option of pursuing a LEED Platinum rating, the owner readily concurred, even though this exceeded the minimum certification mandated by the NPS and the investment was unlikely to increase retail profits.

Some of the sustainability highlights of the pavilion include: a 1,500-ft-deep geothermal heat pump; a 15,000-gallon rooftop rainwater collection system for sewage conveyance; a Vegawatt system for generating electricity from waste vegetable oil produced in the adjacent concessions building; insulated low-E glazing curtainwall units; and the widespread use of regional and recycled materials.

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▲▼ Each column is aligned with a group of three drilled minipiles with a fabricated steel pile cap. The corner (above) and building edge configurations use W8s and 10-in. HSS, but the pile caps for the interior locations (below) use only W8s.

Ruggero Vanni

▲ Minimal steel framing coupled with skylights and plentiful windows provide a pleasant, light and open retail space.

▼ Nestled in the trees near the base of the Statue of Liberty, the new gift pavilion enhances the visitor experience by offering a subtle yet attractive stopping point on the way back to the dock.


Ruggero Vanni

The structural steel framing members, pile caps, and minipile casings contain more than 99% recycled content; the light-gauge metal floor studs contain approximately 33% recycled content.

Two additional strategic choices helped reduce both the present and future impact of this construction. Designing an exposed ceiling structure with no interior walls within the large retail area minimized drywall construction. Also, the only concrete slabs installed were the housekeeping pads supporting exterior MEP equipment – the rainwater storage tanks, for example – minimizing heavy demolition operations and jackhammering, as well as the need for heavy hauling equipment for transporting waste and debris.

These sustainable design considerations, along with constructability requirements and the challenges posed by the island location, combined to make steel the most feasible and cost-effective construction medium. The exclusive use of steel, however, demanded creativity on the part of the design team and required the contractor to be extra diligent about the accuracy and verification of field measurements. The end result is a durable, energy-efficient, and easily assembled structure that provides visitors with a more convenient and memorable experience. MSC

Owner
Evelyn Hill, Inc., Liberty Island, New York

Architect
Acheson Doyle Partners Architects, New York

Structural Engineer
Weidlinger Associates, Inc., New York

General Contractor
F.J. Sciame Construction, New York