Building a Deck With a Welded Steel Frame

A concrete paver patio and improved drainage were also part of this urban backyard makeover

by Rob Corbo

As part of a large home renovation project in the Castle Point section of Hoboken, N.J.—just across the Hudson River from New York City—our clients wanted to upgrade their small, urban backyard. While the project included new hardscaping, the centerpiece was an elevated deck from which to enjoy the home's spectacular view of New York's famous skyline. The new deck would replace a smaller one built many years ago that had a welded steel frame fabricated on site from mild steel with a low carbon content, and the project architect specced the new one to be built the same way. This was a type of deck construction we had not done before.

Unlike the majority of the rest of Hoboken where we typically work, which consists primarily of attached homes and brownstones, Castle Point is an area where the homes are primarily detached. This meant that there was a 3-foot-wide walkway for access to the backyard, a luxury for us because it meant we wouldn't have to transport our demolition debris and new construction supplies through the house.

In addition to the deck, the project included a new stone-paver patio to replace the existing patio, which was made up of large cast-concrete pads. And, to reduce the effects of winter winds emanating off the Hudson River, we were asked to replace the back door leading out onto the deck and a pair of windows on the back façade.

Footings

Our first order of business was to deconstruct the backyard, breaking up the concrete pads that made up the patio so that the debris could be hauled away. Not only were the pads in poor condition, they had settled every which way over the years, destroying the original pitch toward a central drain that had been installed in the backyard. As a result,

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rainwater pooled in the backyard instead of draining properly.

Next, we removed the original steel steps, landing platform, and small steel deck that were used to access the back door. With the back door access and patio removed, we turned our attention to locating the six footings required for the 11-foot-by-15-foot deck (**Figure 1**).

To support the frame, the architect specified two footings 5 feet 7 inches off the house and a second set of footings 12 feet 10 inches off the house. The footings in both sets were placed 10 feet apart. Each set eventually received an 8-inch steel C-channel beam that ran parallel to the house (north to south) and carried 4-inch C-channel joists running perpendicular (east to west) to the house. In addition, we marked out a pair of footings to carry the east-facing side of the stair platform, then dug footing holes by hand wide enough to receive 14-inch-diameter concrete form tubes, and deep enough—3 feet 6 inches—to get below New Jersey's frostline.

Prior to pouring the footings, we cut and wired together triangular-shaped rebar cages to insert into the cardboard forms. After the building inspector checked the cages and approved our footing design, we pulled out a laser level to check elevations so that we would be able to cut the forms to the proper height before mixing and pouring concrete.

Our benchmark elevation was the height of the front-to-backyard walkway, which needed to be flush with the new pavers where they would intersect. Project manager Danny DoCouto backed off this elevation by 4 3/8 inches to allow for the 2 3/8-inch-thick pavers planned for the new patio and 2 inches of sloped stone base underneath. Then he transferred this elevation to each of the forms and cut them so that the concrete footings would be at the proper elevation and remain hidden beneath the paver patio.

Figure 1. Workers dismantled the existing steel deck and concrete patio pads (A) and replaced an entry door (B). The six new poured-concrete deck footings were reinforced with triangular rebar cages (C).

Paver Patio

With the six footing forms ready to go, we brought in mason Victor Bezama of Unlimited Building Management and his crew, the subcontractor who had been hired to pour the concrete and install the patio. First, though, his crew finished clearing away the rubble that remained from the concrete patio, removed 3 inches of soil, demoed a crumbling 6-inch planting-bed border wall that separated the patio from the lawn area, and removed the first sidewalk pad of the lawn walkway.

Next, they wheeled in a portable mixer and about 45 bags of concrete mix. Each footing required roughly seven bags. Before any additional work proceeded, we

Figure 2. A new linear drain was installed to improve drainage (A), along with a properly sloped QP (quarry process) setting bed for the new concrete patio (B). These measures were needed to capture water draining from the narrow backyard, which is at a higher elevation (C). Upturned pavers mark the locations of the new deck footings (D).

had to develop a plan to improve the property's drainage (**Figure 2**).

Drainage. The backyard lawn was higher than the patio, which caused water to flow off the lawn and toward the house. This problem was compounded by a walkway through the middle of the V-shaped backyard, which acted as a culvert depositing water onto the patio. To make matters worse, a set of tennis courts belonging to nearby Stevens Institute of Technology lay to the south of the property at a higher elevation, and when the tennis court drains became clogged with leaves and debris, even more water flowed down into the yard and inundated the property.

Our plan to address the problem was simple, because there wasn't much we could do without major grading changes, which weren't in the budget. We rebuilt the planting-bed walls so water could enter the patio only from the lawn walkway and installed a linear drain connected to an existing drainpipe that extends the stormwater collection point toward the lawn walkway as much as possible. (We also made it a point to ask the Stevens staff to maintain clear drains.) Finally, and most importantly, we made sure the new patio was pitched properly to the drain, unlike the old patio, which had only a slight pitch and then settled over the years.

Hardscaping. After masons completed the planting-bed border wall, they wheelbarrowed in a mix of crushed stone and stone dust called QP (for quarry process) to create a solid base for the pavers. Working from our benchmark elevation at the alley walkway, we helped them set the drain so that its top would be 2 inches lower than the walkway and the perimeter pavers abutting the house.

Because the drain was offset toward the lawn walkway, there was a long, shallow pitch from the house to the drain 15 feet away. To help achieve the necessary pitch from perimeter pavers to the drain, the masons set up string lines to represent the top surface of the finished patio, then bedded ¾-inch-diameter rigid pipe in the QP 2⅜ inches below their string lines. Then they screeded off these

Figure 3. The steel deck frame is basically free-standing but is connected to the house via a short steel ledger through-bolted to the masonry wall below the entry door (A). A portable lift was used to maneuver the heavy steel beams into place (B). After the 8-inch rim joists were welded together and to the columns, the 4-inch steel joists (C) and railing sections (D) were added to the frame. Once the frame was reprimed and repainted, 2x4 sleepers were bolted to the tops of the joists, and cleats were bolted to the rim joists to provide nailing for decking fasteners (E).

pipes to create a smoothly pitched setting bed for the 2 3/8-by-4-by-8-inch Holland concrete pavers.

The masons laid the pavers in a herringbone pattern. Whenever the layout intersected with a footing location, they left a paver up on edge so that we could easily locate each footing after the patio was completed.

Steel Frame

Right after the footings were poured, I called Joe Monga from Decorative Iron Works in Patterson, N.J., who came to the jobsite to measure for the deck's steel components. First, he and I established the final height of the deck. We decided that the short, 8-inch C-channel house ledger should be installed so that it would be 1 1/4 inches below the entry door's stone sill. This would allow 1-inch-thick composite decking material to slide easily underneath the sill, with a small step up from the deck into the house. Then we established the post heights, using a laser level set to the bottom of the ledger to measure down to the top of each footing.

Eight-inch C-channel was also specced for the rim joists, and Monga cross-checked all rim-joist lengths on the architectural plan with his field measurements for accuracy.

Next, we determined that the 4-inch steel joists should be welded 1 1/2-inches below the top edge of the perimeter 8-inch joists, so that we could bolt treated 2x4s to the top of each steel joist. This would create a wood substrate on top of the steel joists for the screwed hidden fastener system we intended to use for the composite decking.

Figure 4. TimberTech Concealoc hidden fasteners were used to connect the grooved TimberTech deck boards to the pressure treated sleepers (A). The decking had to be notched to fit around the rail posts, which had been welded to the deck frame (B, C).

With all the measurements established, Monga went back to his shop to fabricate each deck frame component. We decided the stairs would be measured for and built after the steel structure was finished. We would have the time, since there was much interior work that would still need to be done. While Joe worked back in his shop, Danny installed the new back door, transom window above, and side window, along with some new interior trim.

Ledger installation. We weren't comfortable with the idea of using wedge bolts drilled into the century-old stone door lintel to install the short section of ledger that would connect the deck frame to the house. Instead, we opened up the interior wall to gain access and drilled a pair of 5/8-inch-diameter holes through the stone lintel spanning the basement door opening directly underneath the entry door for 1/2-inch-diameter through-bolts. Then we bolted the ledger to the house, inserting the long bolts through both the sill itself and a 1/4-inch-thick steel backing plate that we installed behind the stone sill (**Figure 3**).

Next, we placed the six deck posts onto the footings, holding them upright with a single, loosely-threaded nut on one of the anchor bolts. We waited to install the nuts on the remaining three anchors for each column until the frame was welded together. This allowed Joe to make slight adjustments to the steel framing so that everything was plumb and level prior to welding the assembly together.

First, Joe welded the two rim joists running perpendicular to the house to their support columns. He also welded the end of one of the rim joists cantilevering past its support column to the house ledger, adding integrity to the developing structure.

The installation then became a puzzle that Joe welded together in a meticulous way, starting with the two main rim joists that were parallel to the house and attached to the posts and perpendicular rim joists. This was followed by the perpendicular rim joist that attached to the opposite side of the lintel, followed by the last parallel rim joist closest to the house.

During the welding process, the posts self-located into their final positions on top of the footings, and we went ahead and installed the remaining wedge bolts to secure each in place.

Once the posts were secured and all the 8-inch C-channels were installed, Joe welded the 4-inch joists into place, followed by the steel rail system that he had also fabricated back in his shop. Before leaving, he ground smooth the welded joints, brushed on an oil-based primer, and then painted them with two coats of oil-based finish to match the finish that had been applied back in his shop. Then he measured for the stairs, which would also be fabricated in his shop.

Wood framing. To fasten the decking to the deck frame, we needed to first install pressure treated 2x4 sleepers on top of the steel joists. To do this, we drilled 3/8-inch-diameter holes in the C-channel flanges every 24 inches on-center for 5/16-inch-diameter hex-head bolts, which we used to bolt the sleepers to the flanges. To ensure that the bolt heads wouldn't interfere with the hidden fasteners or deck boards, Danny countersunk holes to accommodate the hex heads.

We also needed to install 2x4 cleats along the inside faces of the rim joists to receive the decking fasteners. Instead of drilling holes through the webs of the rim joists, we asked Joe to weld hex-head bolts to their inside faces every 2 feet on-center. Then Danny transferred those locations to the cleats and drilled holes for the bolts.

Then we lifted each cleat into place and secured it with washers and nuts, using a

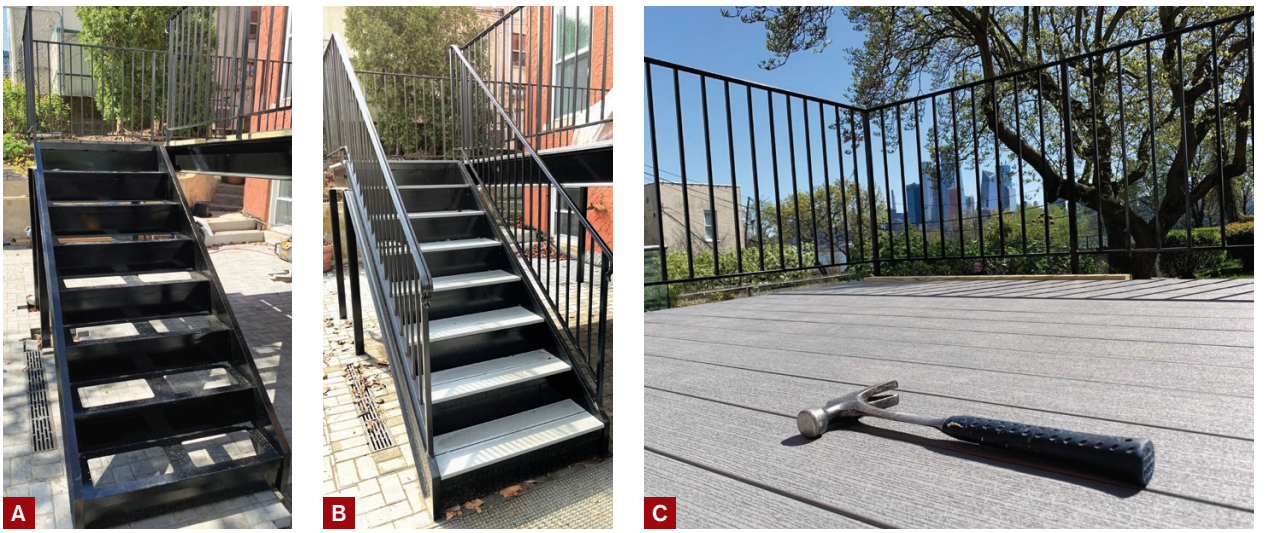

Figure 5. The staircase was fabricated off site, then brought on site and welded to the deck frame (A). Next, the prefabricated railings were welded to the stringers and the upper railing (B). The TimberTech composite treads were fastened to the steel subtreads with screws driven up into the treads from below. The New York skyline is clearly visible from the new steel-framed deck (C).

belt sander as needed to grind down the cleats wherever they stood proud of the rim joist. With all the sleepers and cleats in place, we moved on to the decking.

Decking. The hardest part about installing the decking was finding the right material, because the homeowner wanted to match the color of an existing third-floor deck. Because the decks were far enough apart, the color only had to be close, rather than a perfect match. Still, it was an effort, because we needed decking with grooved edges for a hidden fastening system, and we wanted 12-foot lengths to eliminate seams on the 10-foot-by-12-foot deck. One supplier had the color but only in solid edges, while another had the color and grooved edges but only in 16-foot and 20-foot lengths. Eventually, we found a supplier that had just what we needed: TimberTech Edge Premier maritime gray grooved boards in 12-foot lengths. We also ordered enough square-edged boards for the stair treads.

We installed the decking using TimberTech Concealoc hidden fasteners (**Figure 4**).

Stairs

A week later, Joe returned with a set of stairs that he had fabricated at his shop, and that were ready to be welded to the deck platform. He also brought with him two railings—one for each stair stringer—that he welded into place once the stairs were secured.

At the top landing, the top edge of the framing measured 66 inches above the bottom landing where the stairs bear on the patio pavers. Joe had joined the two 10x8.4 C-channel stringers together with seven 36-inch-long tread-riser assemblies and a single riser at the top fabricated from 9-gauge steel plate. Six of the assemblies and the single riser at the top measured 8 1/4 inches high, while Joe fabricated the tread-riser assembly at the base to have a 7 1/4-inch-high riser. With the treads attached, each riser measures a consistent 8 1/4 inches high.

The treads are made up of two pieces of 1x6 square-edge decking for a total width of 11 inches. The steel tread-riser assemblies measure 10 5/8 inches deep, allowing the treads to have a 5/8-inch overhang with 1/8-inch gaps between the deck boards and at the risers (**Figure 5**).

To fasten the decking to the steel stairs, Joe had drilled holes in the subtreads, two at each end and two in the middle for a total of six holes per board, or 12 holes per tread. The holes allowed Danny to fasten the boards to the frame from underneath, keeping the board faces unblemished. The first set of boards, low to the paver patio, was a challenge, but a right-angle offset driver—and a little bit of cursing—did the trick.

Thanks to the mason, who provided us with a solid, well-drained paver patio, the steel fabricator, whose measurements and fabrications produced a secure and square deck frame, and project manager Danny DoCouto, who nailed the footing elevations and otherwise guided the project to completion, our clients were more than pleased with the result. In construction, it often takes a team approach to accomplish a task well. ❖

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