Elevated Decks

by Bobby Parks

Engineering, slow work conditions, and safety issues add up to high bids for high decks

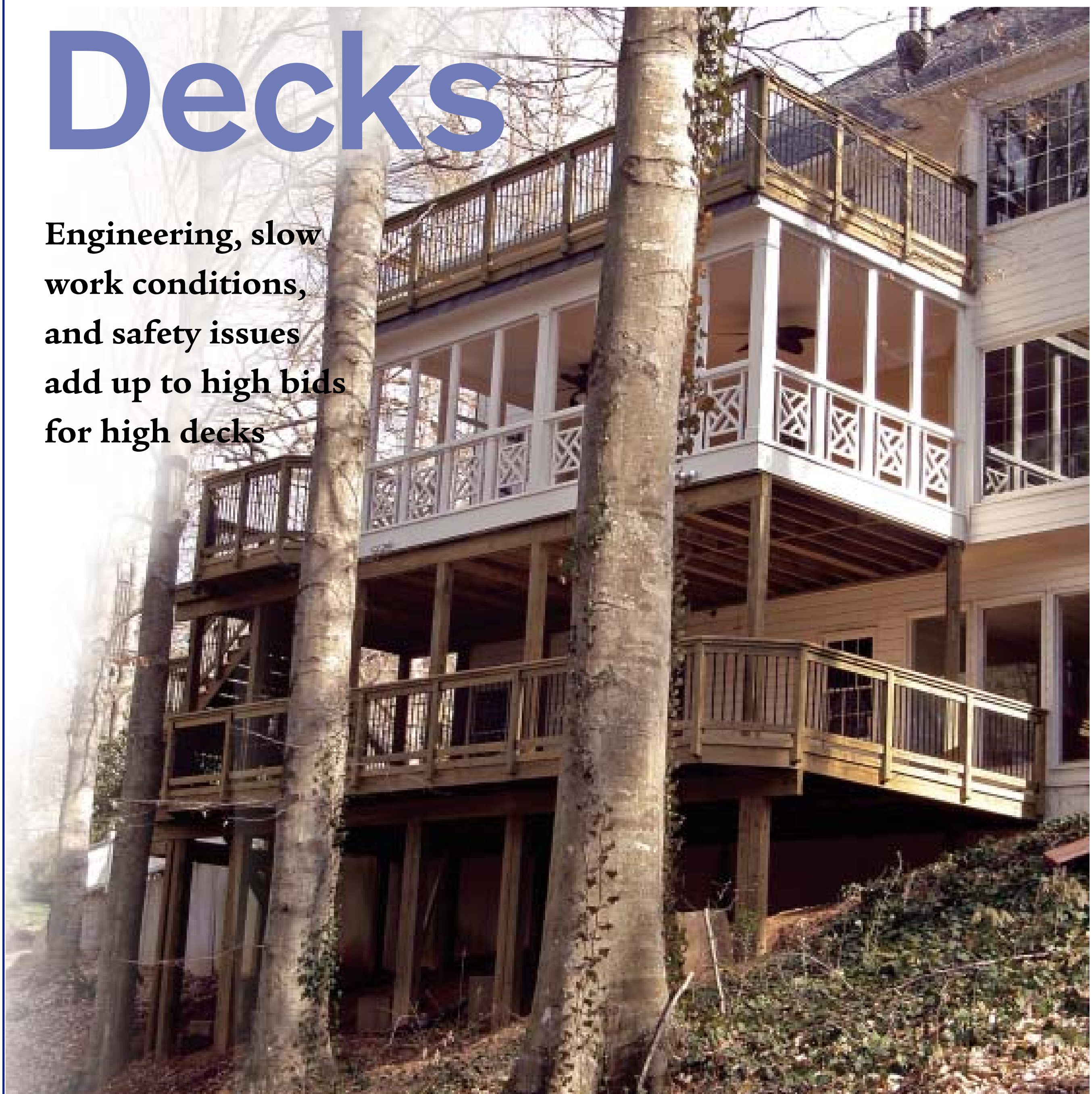

Figure 1. Elevated decks require more thought than ground-level decks. Difficulties of working at a height, safety concerns, increased footing loads, unfamiliar materials such as steel, and a greater need for lateral bracing all contribute to — and justify — significantly higher pricing.

This past year, the company I work for in North Atlanta, Ga., built several elevated decks, two of which were 28 feet high. Because of the height involved, caution and planning are critical when building these decks.

The basic types are stacked multilevel decks (**photo, left**) and single upper-level decks (**Figure 1**). Loading and footings are more complex with stacked decks, but single decks can be more difficult to start building because their columns are frequently taller. Both are often built over sloping ground, which complicates footings.

Consulting both a geotechnical and a structural engineer is crucial. It's not cheap, but the more details you can provide the engineers for review, the less their charges will be. The alternative, risking a deck failure 20 feet in the air, could cost you everything.

Designing for Height

It's important to remember that an elevated deck isn't simply a regular deck on stilts; the large distance from the ground dictates a number of special design considerations.

For example, all decks need lateral stability, but the taller support posts on elevated decks increase the need for bracing. Generally speaking, if the width of a deck (across the house) is less than or equal to the depth (perpendicular to the house), bracing may be required. The wider a deck is compared with its depth, the easier it is to stabilize.

Figure 2. Bringing stairs off the end of the deck saves floor space. Very high decks require landings between levels. Having the stairs reach the ground close to the house, where the grade is highest, keeps them as short as possible.

If the decking boards will be laid perpendicular or parallel to the house, the deck will need angle braces between the columns, along with bracing under the joists. I prefer diagonally installed decking because it significantly stabilizes the structure by tying all the floor joist structure back to the attachment to the house — and it looks clean and cosmetically appealing.

Stairs are an integral part of an elevated-deck design. If stairs will be connecting the upper and lower levels, I like to place them outside and at the ends of the deck to conserve floor space. I find that constructing the stairs perpendicular to the deck out to a landing and then back to the lower deck often works best. To minimize the length of the stair, I try to land it near the house, where the ground should be at its highest grade. If there is no lower deck, you may need to work a series of landings into the design for the stairs to reach the ground (**Figure 2**).

The higher the deck, the more critical railing design is. I consider 42 inches (as opposed to the code minimum of 36 inches) to be a standard rail height for decks more than 12 feet high, because the extra 6 inches makes a significant safety difference. A 42-inch rail hits even tall people at a level that can make the difference between a fall and a recovery.

I also plan for what will be placed on the deck. We reinforce the structure where a heavy grill or other item will add a constant load; doubling or tripling the joists where the grill will be is usually adequate. Supporting a spa requires additional columns and beams that make a continuous load path down to the footings. We also double the joists under spas, and shorten the span between beams. Although these details aren't unique to elevated decks, the greater consequences of failure on a high deck underline their necessity.

But height isn't all about reinforcement and safety; sometimes a higher elevation offers additional design possibilities. On a stacked deck, for example, it's possible to create a porch on the lower level by building a watertight floor between the decks, and by framing and screening the walls. Extending the waterproofed upper deck beyond the lower deck will help to protect the porch from blowing rain.

Big Footings

The importance of consulting both a geotechnical and a structural engineer before beginning an elevated deck is worth repeating. The structural engineer details the plans, but the geotechnical engineer comes on site. Even though the local building inspector checks the footing holes, I ask the geotechnical engineer to determine the soil's bearing capability. With an elevated deck, the last thing you want to deal with is a settling footing. It's much better to spend the time and money up front to cover yourself.

It's likely that typical-size footings won't be adequate for a single elevated deck — and it's certain that they won't support a stacked deck. To handle the increased loads, the footings need to be wider and deeper than usual, and reinforced with additional rebar. (For more on footing design, see the January/February 2007 issue of *Professional Deck Builder*.)

Width and footing thickness should be engineered, and here's where the advice of a geotechnical engineer is invaluable. On sloping sites, the footing has to be deep enough to transfer loads, without having a tendency to slide or roll toward the outer slope. To prevent sliding on a slight slope, the bottom of the footing may need to be 2 to 3 feet below the downhill side of the pier; on a steep slope, that depth may be as much as 6 feet, or even more.

To keep the base of the column from sitting in the dirt and corroding away, I make sure the top of the footing is raised above grade by extending it with 16-inch- or 18-inch-diameter piers that project 6 inches or so above grade (**Figure 3**). These large-diameter piers allow for a larger footing. They're also less prone to toppling or rotating under load than are more slender piers. I use # 4 rebar to join the footings and the piers.

We dig the footings using shovels because moving digging equipment onto the site of an existing residence causes lawn and property damage. Where soil conditions dictate deep footings, say 6 feet, we'll dig down to 3 feet at twice the footing width. This creates a ledge we can stand on when digging the bottom 3 feet. We've been known to shorten shovel handles while working in a tight spot. It's awkward and difficult but often the only option we have.

On steep slopes, we key the footings into the ground (**Figure 4**) by digging the uphill half of the footing hole several inches deeper than the front to gain additional bite in the ground.

Figure 3. Piers rising above grade keep steel columns out of the dirt. Making them a larger diameter provides a larger target for locating the column, and helps to spread the load on the footing. Attaching columns with 1/2-inch bolts and wedge anchors adds stability and resists wind lift.

Figure 4. Footings for stacked decks need to be larger to support the increased loads. On sloping sites, special measures need to be taken to prevent the footing from sliding downhill; two such are digging a deeper footing, and digging the uphill side of the footing in deeper to provide a keyway.

Figure 5. Scaffolding is essential to provide a safe and efficient workplace at a height. Be sure to rent enough to scaffold the sides and the width of the deck, and have extra walk boards to facilitate material handling.

Scaffolding

As the elevation increases, so does the overall level of difficulty of building decks. For one thing, scaffolding gets more extensive. And the higher the work zone, the more time it takes simply to move people, tools, and material.

On a deck just 12 feet up, for example, one carpenter standing on the ground can still hand lumber to another on the framing or a scaffold. As heights approach 20 feet, however, the crew has to pass material from man to man on successive scaffold levels. Even lighter, smaller objects, like tools and hardware, take more time to move — usually with a rope and bucket.

I have found that multiple sections of pipe scaffolding with leg adapters, stabilizers, bracing, and walkboards work well on most sites (**Figure 5**). We start out with scaffolds along what will become the two sides of the deck; the sections can be relocated as needed during construction. Allow for extra walkboards on all levels to assist in transferring materials to the deck level. Scaffolding even helps with demolition of an existing deck, making the process faster and safer.

On sloped sites, you need to create a stable, level base for the low end of the scaffold; we use timber cribbing. Scaffolding always needs to be tied to the house and together. The crew fastens eyebolts to the house to secure the scaffold.

Figure 6. Multiple joists provide a continuous load path between upper-level and lower-level wood columns. Diagonally laid decking adds lateral stability.

In most cases, the crews raise the columns and beams from the scaffolding. On a new construction site, cranes or forklifts may be used to handle steel columns and other materials. For existing residences, however, heavy equipment may not be an option because of tight lots, or risk of damage to the landscaping or driveway.

Stacking Decks on Wood Columns

For single-level decks up to 12 feet in height, I prefer to use 6x6s as columns. Beyond that elevation, my company uses steel columns, with some exceptions.

For multilevel decks, I prefer to stack the different levels using 6x6 posts in a continuous load path that incorporates the lower level's floor framing. This approach allows the crew to work its way up one level at a time, with no need for scaffolding: After the first level is framed and decked, the crew has a platform from which to build the next level.

Where one post stacks atop a lower level, we nail four or more floor joists together and run them directly over the lower column, and directly under where the upper column will land (**Figure 6, page 5**). This supports the upper deck structure and provides a solid-wood load path from column to column. We fit two thicknesses of solid bridging between the quadruple joist and the joists to either side, over the beam. Strapping ties the upper and lower columns together with the beam, creating a continuous tie to resist wind lift. At the house, fabricated steel brackets on both sides of the quad joist attach it to the ledger.

The size and number of decks that are being built and stacked determines the column layout. Tighter spacing of the columns can distribute loads over more footings and let you stack wood columns on wood floor framing without worrying about concentrated loads crushing the wood.

We anchor the 6x6 columns to the footings using brackets the engineer calls out for the circumstance (**Figure 7**). To attach the main beam, the crew notches the tops of 6x6s to fully receive the doubled 2x10 or 2x12 beam (**Figure 8**). That leaves a section of the post about 2 1/2 inches thick that comes flush with the top of the beam. We double-bolt each post-and-beam connection with 1/2-inch galvanized bolts.

Another option for supporting upper decks is to use independent 6x6 columns (they can be up to 20 feet in height) that go through the lower deck's framing adjacent to the lower deck columns, distributing the upper-deck loads directly to the footings. You can stabilize the longer 6x6 by tying it into the first-floor framing and bolting it to the lower-level column. Steel columns can be used in this same fashion.

Using double columns from the footings to the first-level beam gives the structure a larger bearing base; and using twice the number of bolts where the beam bears on both columns assists with locking in the beam against beam roll.

Figure 7. Using approved column bases takes on more importance on stacked decks. Be sure the ones used can handle the increased loads.

Figure 8. Notching 6x6 columns to receive a doubled 2-by beam provides a spot to positively anchor the beam to the column using bolts.

Steel Columns

Many jurisdictions require steel columns for decks above a certain height. For decks higher

Figure 9. For decks elevated 13 or more feet, steel columns are needed to provide rigidity. Have the footings in place to determine column height before ordering.

than about 13 feet, it's advisable to use steel regardless, because of the added stiffness of the column and its connections (**Figure 9**). This should be engineered. Our structural engineer specs 4-inch or larger schedule 40 square tubing on high decks.

I keep the column count as low as possible on elevated single-level decks, while allowing for the loads, because I want to handle as few steel columns and footings as possible. Those things are heavy — 16 pounds per foot for a 4-inch column, and 20 pounds per foot for a 5-inch column.

You need to factor in the turn-around time for steel-column orders, to minimize delays on the job. I like to establish the deck level on the house and pour footings before ordering the columns.

With the footings done and scaffolding erect, it's time to build. We usually get the beam to the top of the scaffold before raising the columns. It's best if the beam is built up of long 2x10s or 2x12s, which can be raised to the top of the scaffold and then assembled. That way, the columns don't get in the way of raising the beam, and the beam spanning the two scaffolds helps to brace them. It's possible to span greater distances using a treated glulam or steel I-beam, but those require the use of a crane.

To raise a column from scaffolding, the scaffolding has to be set up and secured to the house. We wrap the top of the column with a heavy-duty nylon strap, which is hooked to a 5/8-inch rope that runs to a block and tackle affixed to the scaffold's top. A slipknot keeps the strap from sliding past the saddle welded to the column's top.

Place the column perpendicular to the house, its top over the footing and its base closer to the house. Hoist slowly while two men on the ground move the base end of the column toward the footing. This relieves stress on the

SAFETY, FIRST AND LAST

Although in general I'm able to leave work at work, elevated decks make me lie in bed at night worrying about getting through the job with everyone on the crew intact.

Scaffolding and safety harnesses alone don't eliminate the possibility of serious injury. Management must stress safety and make sure that crew leaders buy in, too. Everyone involved has to understand the risks and difficulties of working at a height, and have a working knowledge of scaffolding safety and the proper use of a safety harness.

Equally important is communication. When undertaking a potentially dangerous task, such as raising a 300-pound column, every person on the job site has to know what he's expected to do and not do. Talk the process through before starting. Try to anticipate the difficult points and plan how to work through them. Encourage questions, and be particularly careful that any new people on the crew fully understand the entire process.

Figure 10. Bracing the beams on steel columns is done first with temporary 2x4s tied to the ledger, then more permanently using joists.

scaffolding. Raise the column until the base can be set on the footing.

When the column is correctly placed on the footing, we tie it off to the scaffold and drill into the pier for 4-inch-by-1/2-inch wedge anchors and bolts through the column's base plate. Then we bolt the column to the footing.

With both columns set, the crew drops the beam into the saddles on the columns, and braces it to the house — first with some 2x4s running to the ledger, and then with joists (**Figure 10**). Angled 2-by bracing fastened to stakes in the ground is also used as needed. Raising shorter columns in place may simply require a couple of men on the scaffolding with ropes or straps and a couple of men on the ground to help.

Using steel columns to stack decks can be a problem because code doesn't allow for steel columns to bear on wood. On two-level decks, however, it is possible to use square steel columns if you have brackets welded to receive the beam for the lower deck. The benefit of one continuous column is that you don't have to worry about beam roll or the crushing stress created by stacking structure on structure.

Bidding

When pricing elevated decks, you've got to allow for several items you don't encounter on most other decks. In addition to typical charges, I include the cost of a structural engineer and a geotechnical engineer; the cost of scaffold rental, as well as set up and teardown; and the extra cost of steel columns. And if you're stacking decks, don't forget the cost of the fabricated brackets to tie the quad joists to the ledger.

Footings can be surprisingly costly, particularly those on sloped sites. Of course, footing requirements vary geographically, but I allow as much as $500 per footing on some sites. I also include the cost of raising steel columns, which usually takes 4 to 5 man-hours per column.

Over and above these line items is an elevation charge. This is an attempt to cover the slowdown in production that occurs when crews work at high elevations, and to pay them a premium for doing such work. As a general rule, I add $2 per square foot at 12 feet in elevation, and another $2 per square foot for every 2 feet in elevation above that.

And sometimes, I walk away from a project. For example, if very large beams are required and there's no way to get in with a crane, it's just not worth the risk. ❖

Bobby Parks is the vice president and operations manager at Archadeck of North Atlanta, Ga.