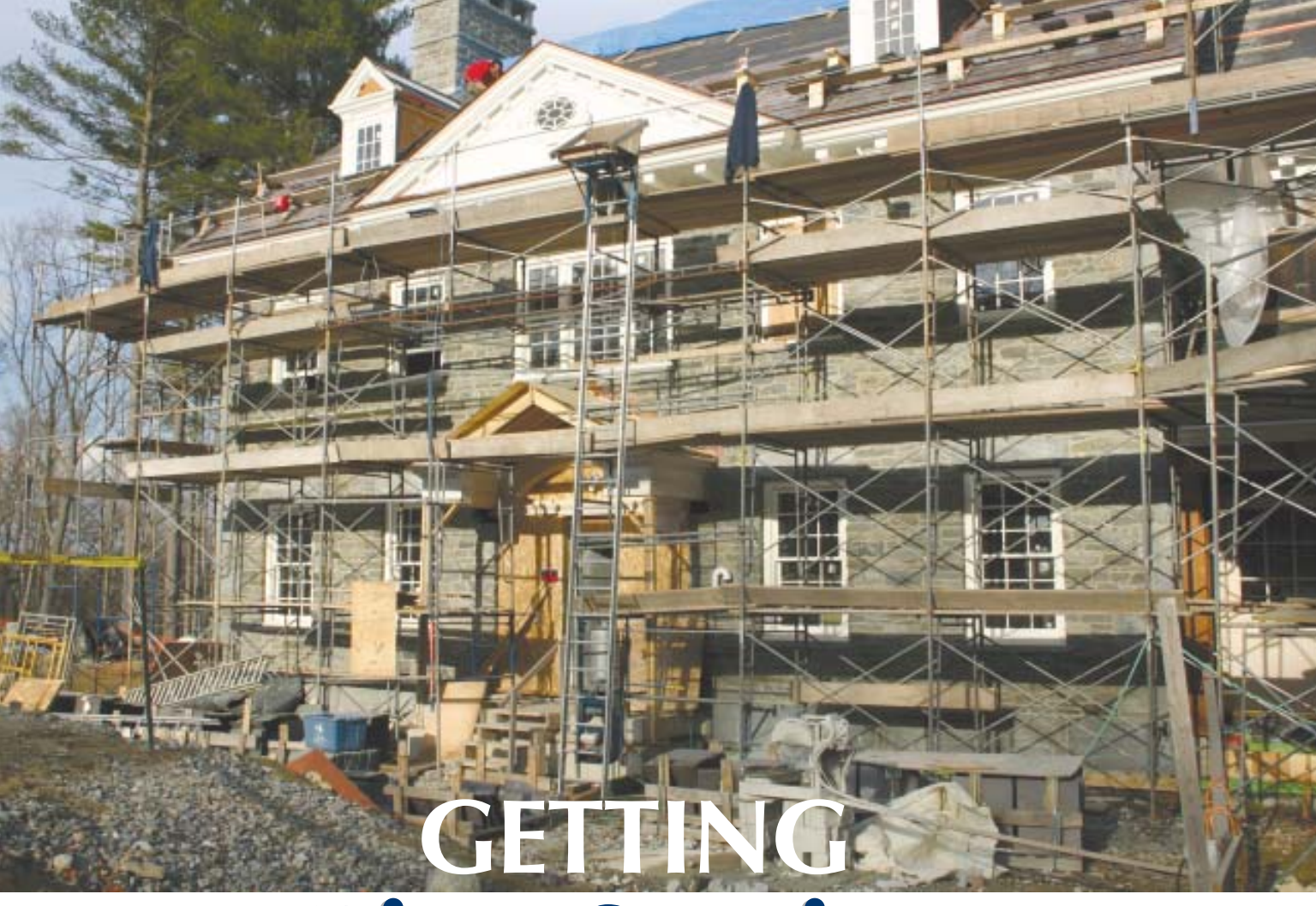

GETTING Pipe Staging Right

Erected properly, scaffolding brings safety and convenience to high work. Done wrong, it can bring disaster

by Mike DeBlasio

As a masonry contractor, I set up and use fabricated frame scaffolding every day. It's an integral part of my business. Frame scaffolding — also called "pipe" or "tubular" scaffold because it's made from welded steel tubing — provides an easily erected elevated work platform with enough area to move freely and sufficient protection to prevent missteps.

But it's safe only if properly erected and not abused. OSHA tracks scaffold-related fatalities, 23 percent of which are incidents involving frame scaffolding. (Other types of scaffold typically used in residential construction include pump jacks, step- and extension-ladder jacks, roof brackets, and various kinds of aerial lifts. This discussion is limited to frame scaffolding.) The top five hazards are falls, unsafe access, falling objects, electrocution, and collapse.

I don't believe in accidents. I focus on preventing injuries and property damage by providing proper training and by using tested staging components. We have worked a commercial job in safety and comfort using tubular staging that was more than 330 feet high. Once the staging is properly erected and planked in, it's

Figure 1. Screw jacks should be considered basic equipment for safe, level setup (right). Although the steel base plates distribute the weight to help prevent tip-overs, they should never be used without a minimum 1-square-foot wood mudsill. Stability is enhanced when frame legs share a common mudsill (far right).

like working on a living room floor, and that's just how I like it.

Safety Training

When it comes to staging, safety and training are of foremost concern. Staging looks simple — and, in fact, it is. But it is absolutely critical to be aware of its limits. The SIA (Scaffold Industry Association, www.scaffold.org) offers training courses at a number of different levels through its local members. As a member, I've picked up reams of good information from SIA's newsletter and its regional conferences.

I have a little mantra: "If in doubt, shout." I often call my local staging supplier with questions. Most suppliers have an engineer on staff or will contact the manufacturer for you. OSHA offers a great publication, too: "A Guide to Scaffold Use in the Construction Industry / OSHA 3150." (You can download it for free at www.osha.gov.)

OSHA safety provisions stipulate that any work performed more than 10 feet above a lower level must be protected by guardrails or a fall-arrest system. Furthermore, employers must provide training for each employee who works on the scaffold. And, finally, a "competent person" must oversee the scaffolding's erection and dismantling and inspect it for visible defects before each day's use and following any occurrence of possible damage to any component.

Competency requires training, provided by a qualified person. In this article, it isn't my intent to replace appropriate training, but to present an overview of some of the methods and equipment we use when working with pipe staging.

Figure 2. Rigid ties prevent toppling as scaffold height increases. As a general rule, ties must be used when scaffolding reaches a height four times the narrowest dimension of the base frame (20 feet for common 5x7 frames). In masonry, the author uses expanding anchors to make the attachment.

Setup

The fundamental key to trouble-free scaffold assembly is to begin with a firm and stable foundation. Always use proprietary steel base plates or adjustable screw jacks on all first frame sets (see Figure 1). Screw jacks are particularly useful for leveling the first frame set on an irregular grade — and they are the only leveling system you should use. Never use stacks of wood or concrete block under the legs to level

Figure 3. Pipe frames come in several configurations for staging various building heights. Here, short ledger frames are stacked above taller, walk-through frames on a multilevel scaffold.

the frame, because wood blocks can slide or topple and concrete block can shatter when loaded.

The base plates or screw jacks should be placed on wood "mudsills" having a minimum 1-square-foot dimension. Typically, we use 18- to 24-inch lengths of 2x10 lumber under each plate. Whenever it's practical, we shovel the grade level across frame ends to minimize excessive jack adjustments (no more than 12 inches), which can introduce instability.

Once we've leveled and squared up the first frame set, we nail the plates to the mudsills. Always use base plates and mudsills, even when setting up staging on a wood deck, concrete slab, or asphalt paving, to prevent the tubes from punching through the surface under a heavy load. And never use scaffold planks for mudsills or vice versa. It's a good idea to clearly label mudsill planks as such to prevent their misuse.

As scaffold height increases, safety codes require you to physically secure the scaffolding to the building structure vertically at four times the narrowest base dimension. So, for a 5-foot-wide frame, you tie in at the

Figure 4. Stair systems provide safe scaffold access when ladders are impractical. Handrails install separately and should never be omitted. Hooks and locking pins secure stair components to the frame (above left). The starting tread of a scaffold stair system or any platform access should be no higher than 24 inches above the base level.

Figure 5. The author's elevator-style mechanical lift has a 400-pound capacity. The cargo box swivels out for vertical travel and in for loading and unloading (left). For safety, a lock-out switch prevents activation if the guardrail gate isn't latched shut (inset). Safety tape surrounding the lift area alerts workers on the ground to a falling-object hazard (right).

20-foot height, and at every 20 feet of height thereafter. According to OSHA, these vertical ties have to be repeated at horizontal intervals no greater than 30 feet starting from one end of the staging. Those are minimum specifications; we tie in at a height of 16 feet and at 16-foot intervals thereafter, and at every third frame horizontally.

Ties have to resist movement both in compression and tension, so they have to be rigid — wire alone isn't suitable, although #9 wire is acceptable for tensioning a tie against the wall. Tie-in brackets come in various types; most clamp on to the staging and are bolted to the building (Figure 2, page 3). Naturally, bolt placement is important. On wood walls, we locate solid framing and bolt into that, not just into the sheathing. Masonry walls often require drilling for expansive bolt anchors; in that case, we locate the anchors in the mortar joints and repoint the holes after the scaffolding is removed.

Standard staging frames come in heights ranging from 2 feet to 6 feet 6 inches and measure 5 feet wide. Staggered frame heights are useful for setting up a level base course on steeply sloping grade and for adjusting tower height to overhead work (Figure 3, previous page). Narrower frame sections are also available in 4-foot, 3-foot, 30-inch, and 24-inch widths, for staging narrow spaces.

Erecting frames is easiest if you start with the braces on the bottom locks first, then tilt the frames up toward one another and connect the top brace locks. We immediately plumb, level, and square the first frame set, because it makes aligning and stacking successive frames much easier. After we set up a run of starter frames, we stretch a string line from one end to the other at a common attachment point — typically the bottom lock studs — then use the screw jacks to adjust all the frames to the line.

Access and Accessories

Frame ledgers may look like ladders, but they're intended only for supporting planks and platforms, and should never be used for climbing or scaffold access. True ladders are fine for climbing three or four frames high, or from 20 to 24 feet, provided that the ladder is properly supported and secured, and that it extends at least 3 feet above the upper landing level. If your staging has multiple work levels, you need a dedicated ladder for each level. Access to any working platform higher than 24 inches above the base should be provided by a properly affixed step or ladder.

On multilevel scaffolding, we don't bother with ladders. Instead, we install prefabricated staging stairs. Stairs are more convenient and efficient than ladders, and they're safer. They allow you to carry small items in one hand and still grasp a handrail with the other (Figure 4, previous page). Stair sections and hand railings are separate components, but one should never be used without the other. Hand railings belong on both sides of every stair and surrounding stair openings at all landing points.

Lifting and loading. When it comes to loading bulk materials onto the work platform, whether block, bricks, siding, or roof shingles, a mechanical lifting system dramatically increases crew safety and efficiency (Figure 5). Portable hoists and platform hoists are great conveniences and are capable of lifting hundreds of pounds at time. But it's

Figure 6. Mobile lifts and other heavy equipment can overload scaffolding in a single drop. Always transfer materials by hand and distribute the load evenly over the platform.

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Figure 7. A grade stamp is the only indication that a solid lumber plank is suitable for scaffold use. Readily recognizable engineered scaffold planks, like the aluminum and plywood version shown here, remove any element of doubt.

important to remember that each grade of scaffold — light, medium, and heavy-duty — is manufactured with a specific duty rating, calculated at pounds per square foot distributed evenly over the platform. Aerial lifts, forklifts, front-end loaders, and cranes are capable of overloading a platform in a single drop (Figure 6). Always consider the aggregate weight of personnel and materials using the platform and never exceed the maximum safe load.

Planks and Platforms

Planks take a lot of abuse in a staging system, so it only makes sense to choose and treat them with care. Look for planks specifically grade-stamp certified for scaffold use (Figure 7). Common framing lumber doesn't meet the minimum stress grade required. Large red knots, irregular or short cross-grain, and other unseen defects make framing lumber extremely dangerous to use as staging.

Engineered (laminated) lumber scaffold planks and proprietary system platforms cost more than regular framing lumber, but are well worth the extra money. Work platforms manufactured from aluminum or plywood and steel use integral hooks to connect to the frame, helping to hold it square. The hooks typically include an additional means of locking to prevent wind uplift, a real concern. Strong winds can cause stacked frame sections to separate vertically, which is why you never want to omit the toggle pins that secure the coupling pins on both sides of connected frames (Figure 8). No component in the system should be thought of as optional or unnecessary.

Safety guidelines require that every working level be fully planked from one side of the scaffold to the other, with no gaps greater than 1 inch. Proprietary planks and platforms are sized to conform to this standard when used in multiples. Toeboards prevent loose materials from falling off the work platform and have to be at least 4 inches high. You can buy or rent a metal version, but we simply lean staging planks on edge along the frames' uprights and wedge them against the last plank on the platform (Figure 9, next page).

Side arms and end arms extend the width and length, respectively, of the

Figure 8. Wind uplift and frame separation are serious concerns. Never omit the toggle pins that secure both ends of the couplers between frames.

Figure 9. Falling objects present a huge safety hazard on the job site. Toeboards prevent tools and materials from being knocked off the scaffold and should always be installed before loading and using the platform. Full-width planking prevents both drops and falls.

work platform. We regularly use side arms to offset workers toward the wall and we use the main platform to stage materials and mortar trays (Figure 10). Side arms can be set in 16-inch intervals, hooking on to the frame ledgers at a point lower than the platform to place tools and materials at a convenient working height. When setting up, keep in mind that the wall surface should be no more than 14 inches from the open, working side of the scaffold. Any farther, and you have to provide guardrails. And remember that side arms should be used to support only personnel, not materials.

Also keep loading in mind when designing your scaffold. Light-duty scaffold planks top out at 25 pounds per square foot, medium-duty at 50 pounds per square foot, and heavy-duty at 75 pounds per square foot, applied uniformly over the entire span area. Proprietary planks are rated accordingly. As a rule, plank deflection must not exceed 1/60 of the span when loaded, which equates to 1 3/8 inches over 7 feet.

Water and fungal rot can degrade even approved planking, so we keep our planks dry when they're not in use. We store them indoors in such a way that air can circulate freely around them. We also inspect the planks before every use for any signs of decay or damage. When I find a suspect plank, I don't leave it lying around; I cut it up into scrap.

Guardrails. Work platforms higher than 10 feet above the base level must have two parallel guardrails placed approximately 19 inches and 42 inches above the work platform (Figure 11, next page). Actually, we're even stricter than that: In our company, any staging more than 6 feet above the ground must have a guardrail. Cross braces are not guardrails, so at every working level of a multilevel scaffold, we install proprietary metal railings or 2x4s held in place with #18 tie wire. Around the top platform level, clamp-on tubular steel mounting posts adapt the guard railings.

Don't forget the open platform ends, which also require guardrails.

Figure 10. Side arms (above) extend the width of the platform and may be offset from the main platform for working convenience. Frame ledgers provide height adjustment in 16-inch increments.

Figure 11. Work platforms higher than 10 feet above the base level must have two parallel guardrails placed approximately 19 and 42 inches above the work platform to prevent falls (far left). Even platform ends must be closed (left). The full platform and high railings on this slate roofing job supply an unbeatable degree of comfort, convenience, and efficiency.

How Much Is Enough?

If I can't fit the staging I need for a job in my pickup truck, I turn to a scaffolding rental company for the equipment. These outfits deliver and pick up for short money and provide components that are properly stored and inspected for continued use. A rental company can also provide occasional specialty equipment that you don't use often enough to justify purchasing.

Estimating scaffold needs. Although the basic assembly in a frame scaffold system consists of two frames and two cross braces, a 1:1 ratio, the ratio shifts in favor of the cross braces in multiple assemblies, to 1:1.8. That's a good general ratio to apply when calculating scaffolding. Never skimp on bracing.

Sometimes bracing can create a barrier between you and the work surface, or it can't be installed because of a structural obstacle. In such cases, plan to use straddle braces or straddle frames instead, which are specifically designed to provide access and clearance around obstructions (Figure 12). Putlogs — trusslike staging beams used to bridge over projecting obstructions and to keep passageways open below the staged area — must be firmly attached to the staging frame with proprietary hangers or clamps. Putlogs give a frame scaffolding system an enormous amount of adaptability (Figure 13, next page).

Figure 12. Don't submit to the temptation to remove or simply not install braces on the working side of a scaffold. Instead, use straddle frames, which replace the brace function while still providing good access to the work surface. These walk-through frames allow unimpeded traffic flow beneath the staging.

Things To Watch For

I have worked as a consultant on a number of lawsuits related to scaffolding tragedies. I've seen nearly everything go wrong that can, including overload failure, a wall that fell on its staging and caused it to fail, faulty erection, component failure due to rust and mishandling, and improper use of staging components.

Remember: When you erect staging, you're not the only one who's going to use it. You have to be aware of traps like

Figure 13. Putlogs — essentially tubular steel trusses — allow you to scaffold around structural obstacles like this projecting roofline (left), or to maintain clear passage beneath a work platform (below). Special brackets connect the putlogs to the frame (below left).

Figure 14. Full planking prevents sideways shifts and treacherous gaps in the platform.

poor access, planks without proper overlap, open ends of work platforms, unstable anchoring points, and missing bracing. Work platforms must be completely decked in; they should not consist of just one or two planks (Figure 14). Even where restricted by stair penetrations or obstacles, walkways should never be narrower than 18 inches.

Inspecting components. You never want to use the rusty staging lifted out of the mud and weeds behind your uncle's garage. Advanced corrosion reduces the tube-wall thickness to an unknown and therefore unsafe level of performance. It takes ultrasonic testing to accurately determine whether the wall thickness is compromised, so I keep it simple: If the tubing shows deep pits and flaking rust, I cut it up and say goodbye.

Other things my crew is trained to watch for include cracked or broken welds; broken, missing, or inoperable cross-brace lock devices; splits in the tubing; voids or holes in the tubing from accidental impact, cutting, or abrasion; out-of-round tubing (a forced fit between proprietary frames is a good indicator); bent legs; bent cross-members; and out-of-square frames (Figure 15, next page).

Don't mix staging frames from different manufacturers unless they fit together without forcing and all connecting points provide an exact match. Tube diameter can vary just enough from one maker to another to prevent common use of the coupler pins. Some tubes are drilled to receive coupler toggle pins at 30 degrees and others at 90 degrees, an obvious and unacceptable mismatch (Figure 16, facing page).

Furthermore, the vertical spacing between brace locks may not be equal or in the same location from one brand of frame to the next. This makes it difficult or impossible to level the frames and hook up the cross braces.

Figure 15. This bent crossmember could compromise the structural integrity of the entire frame, so it was removed from service (far left). The author points to tubing dented by an attempt to force-fit together unlike or damaged frame units (left).

Figure 16. Unlike frames must not be combined unless they provide an exact match between coupler and toggle pins, braces, tube diameter, and, most important, structural load ratings. In the photo at right, one maker's walk-through frame is compatibly stacked on the ledger frame of another. Sometimes, though, brace mounting locks are welded to the frame at different spacings from one maker to the next, making the two brands incompatible. In the photo at far right, the wire tying this brace between two unmatched frames is a real no-no.

Most important, the duty rating may not be the same from one make to the next. All manufactured scaffold components must be capable of supporting four times the maximum intended load, but since different frames may have different ratings, the odd frame in the assembly could become a weak link.

Words to the Wise

When it comes to scaffolding, there are no stupid questions and you can't be too careful. So I will close with a few final tips:

Beware of electrical service drops and power lines. Refer to the chart published in OSHA's guide and elsewhere for proper safe clearances for staging and personnel. Your power company will come out and sleeve the lines, usually at no charge.

Start with a good foundation. Check the soil condition: Is it compacted cut or loose fill? In urban work, the sidewalk may be hollow. Don't take a chance by assuming a slab is solid; we use a minimum 2x10 mudsill, 18 to 24 inches long, beneath screw jacks or base plates.

Never use concrete block or wood shipping pallets to build up your base. Concrete block on edge can fold over or be punched through and pallets can collapse.

Always use screw jacks on the base frames to level and plumb scaffolding.

Pull a string line across multiple frame assemblies to establish a common level.

Mike DeBlasio *is a masonry contractor in Littleton, Mass.* *Thanks to Alan Kline of Lynn Ladder & Scaffolding for assisting with this article.*