Replacing 18th-Century Windows

by Noah Woodruff

Threaded rod and epoxy secure the replacement windows in this historic stone building

We see a lot of old buildings in our work in eastern Pennsylvania and western New Jersey. Many are built of stone, which has a unique elegance but also presents some production challenges — for example, how best to install windows and doors, the components most likely to fail.

On a recent project, we were asked to repair the windows and doors of a 1760s Georgian stone building. In some cases, we were able to replace just the thresholds, sills, and sash, but many of the openings required complete replacements. In doing this kind of work, we've found that taking cues from the original construction helps us integrate modern materials and techniques.

For example, the window frames in late 18th and early 19th century stone buildings in our area are usually assembled from the same few parts: the window buck, or frame; the interior casing; and the sash. The bucks are made from two side jambs, a head jamb, and a sill, all mortise-and-tenoned together. The jambs are usually each made from a thick piece of wood profiled to include both the upper and lower stops, and sometimes the exterior back band — all molded from a single board.

Figure 1. The old window frames were mortise-and-tenoned together (A). The top jambs had "ears" — extensions that allowed the window frame to be mortared securely in place (B). Where the stone got in the way, the original carpenters cut off the ears and inserted wood pegs for keying the bucks to the masonry (C).

Figure 2. To remove a window frame, the author pounds out the peg securing the corner joint (A) and removes the side jamb (B). For windows whose jambs were in reasonable condition, only the sills were cut out (C).

Figure 3. The replacement units (A) came with beaded interior casings tacked into place (B). The replacement sills matched the profile of the originals (C); they came primed and cut to length, but the carpenters had to scribe and cut out the returns on site.

Most likely, the assembled bucks were installed as the walls were being laid up. The sills and heads had “ears” that extended into masonry pockets on each side, allowing the frame to be mortared into place (**see Figure 1, page 2**). If the stone courses didn’t line up with the head, the carpenters inserted a large peg into the side of the jamb to serve the same purpose as the ear.

The interior casings are typically beaded and applied directly to the buck to act as a stop for the bottom sash; the bead on one side is removable to allow the sash to be taken out. After the walls were finished, the casing would be installed and loosely scribed to the surrounding stone window well. The fit didn’t have to be perfect because a finish would later be applied to the sides and top of the well — either plaster or, in formal spaces, wood panels.

Removing the Old Windows

We wanted to leave the interior plaster intact, so we worked from the outside. The first step was removing the sills, which virtually fell out. Once the sills were out, we cut the nails holding the casings to the bucks with a Sawzall. We could then slip the casings from between the plaster and the buck, leaving a clean line of plaster inside.

With the casings removed, it was easy to knock out the pegs holding the side jambs to the head and pull out the sides of the buck (**Figure 2, page 2**). If the masonry was loose, the head jambs came out easily, but sometimes we had to cut through the ears to get them out.

Several of the frames were in decent condition except for the sills. On these windows, we cut through the tenon that extended from the jamb into the sill, then removed the sill, leaving the jambs in place.

New millwork. The replacement window frames were milled from white oak; the new sash and interior casings are Spanish cedar (**Figure 3**).

Attaching to Stone

After years of experimentation, we’ve settled on threaded rod and epoxy for securing window and door frames to stone.

Figure 4. The author's crew used two types of epoxy — a two-part from Hilti (left) that is installed with a proprietary gun and a single-part from Sika that is delivered with a standard sausage gun (right). The long nozzle on the Hilti gun was helpful for injecting the epoxy through the thick window bucks.

On the job shown here, we used $\frac{1}{2}$-inch stainless-steel rod and two brands of epoxy, Hilti and Sika (**Figure 4**). We ended up preferring the Hilti system for one reason: The two-part adhesive comes with an extra-long nozzle that makes it easier to squirt the epoxy into the stone through the thick window bucks. This was helpful for the windows whose original side jambs remained in place. Unfortunately, though, each pack of epoxy includes only one tip and our local supplier doesn't stock them, so on complicated jobs like this we have to plan ahead and order extras. We go through a lot of tips because the particular Hilti epoxy we use sets up quickly — especially when the weather is warm.

The Sika epoxy is a one-part formulation

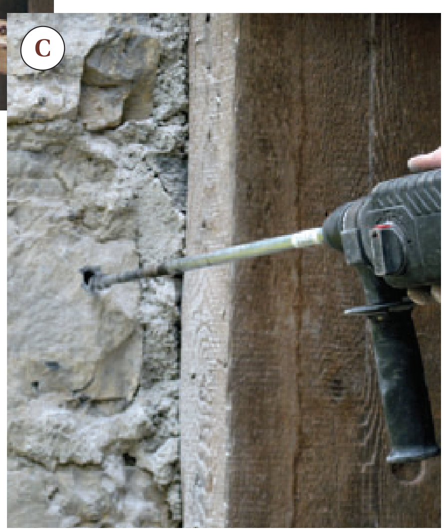

Figure 5. To attach a new wood window frame to the stone with threaded rod, the author first drilled a hole large enough to accommodate the washer and nut, using a wood countersink (A). To avoid ruining the bit, he continued drilling through the wood with a $\frac{1}{2}$-inch masonry bit until he hit the stone. Then, with the frame out of the way, he continued drilling with a $\frac{5}{8}$-inch masonry bit, making a hole large enough for the $\frac{1}{2}$-inch rod and the epoxy (B). To ensure a good bond, he cleaned the hole with a wire brush (C) and compressed air (D).

Figure 6. Before replacing the sills of the original window frames, the crew made sure the head and jambs were in plane (A), then clamped them in place (B) and drilled the holes for the epoxy anchors (C). With the jamb bolted in place, the mason repairs the window well before the primed sill is installed (D).

and comes in a tube that fits a standard caulk gun. You have to use a bulk-loading sausage gun to get the epoxy out fast enough; standard ratchet and dripless guns don't have enough thrust. While the tips are not as long as Hilti's, Sika does provide an extra tip with each tube.

The process of anchoring the bucks starts with locating the holes for the threaded rod. The stone courses determine the placement and number. Ideally, we like the threaded rod to penetrate the stone at least 3 inches, so we look for stones that are at least twice that width to avoid cracking them.

Once the holes are marked and the window buck is in its exact position, we countersink a 1⅜-inch-diameter hole in the jamb deep enough to conceal the nut and washer and allow some room for the Abatron epoxy filler we use to finish the surface before painting (**Figure 5, page 4**).

Next we switch over to a hammer drill and complete the hole through the wood and into the stone. For the old jambs, we chuck up a ⅝-inch-diameter masonry bit and continue into the stone to the required depth. With the replacement bucks, we finished drilling through the wood jamb with a ½-inch-diameter bit, creating a tight hole for the threaded rod where it passes into the window frame.

When the ½-inch bit hit the stone, we removed the new window buck, switched to a ⅝-inch bit (which allows room for the epoxy), and kept drilling to the 3-inch depth. It takes a little longer to pull the window buck out of the opening before continuing to drill, but it's worth it because that ½-inch hole in the wood frame helps lock the windows into place when we eventually install them. With the old jambs that remained in place, there was a little more wiggle between the rod and the oversized holes in the buck. By staggering the holes on the buck and squirting some epoxy into them during final installation, we eliminated some of the slop.

After the holes are drilled in the stone, they have to be thoroughly cleaned for the epoxy to bond well. We used a blow nozzle and a brush attachment on the hammer drill.

On projects where there are a lot of holes to epoxy, we've learned the hard way — through many wasted tubes and redrilled holes — that installing the threaded rod is a two-person operation. One guy fills the holes and the second guy inserts the threaded rods. Working this way allows us to apply several tubes of epoxy with just a single tip. But even so, it seems like you can never have enough tips.

Securing the Old Jambs

We started the replacement work with those windows that needed only new sills. The first step was checking the bucks to make sure they were square and in plane — not too likely after 200 years of settling (**Figure 6, page 5**). Correcting problems at this stage would make it easy to fit the new sash easier later on.

Using pipe clamps and 2x4 spacers, we held the jambs in exact position before drilling the anchor holes. Then, with the long Hilti nozzles, we squirted in the epoxy and inserted the threaded rod, being careful not to overtighten the nuts at this stage, which might distort the jambs. After the epoxy set up, we mortared the gap between the jamb and the stone, then made minor adjustments to the nuts, bringing the jambs into final position. Once all the bucks were fastened, we finished the holes with an Abatron epoxy filler.

Scribing the Sills

We used the original sills to establish the width of the replacements and to mark the first rough cutout for the extensions. We used a belt sander to quickly bevel the return, then scribed the sills in place (**Figure 7**). Because of the irregular stone surface, removing the material to the scribe lines was a bit tedious. A jigsaw was out of the question. What worked best was a combination of a multi-tool, a chisel, and a grinder fitted with a chainsaw blade. We used the multi-tool to kerf up to the scribe lines, then a chisel to waste the bulk of the stock. The grinder with the carving wheel did the final tweaking. Be careful the first time you use this setup in a grinder — it can chew up the work very quickly.

Anchoring the Sills

To give the new sills a fighting chance to last as long as the originals, we made sure

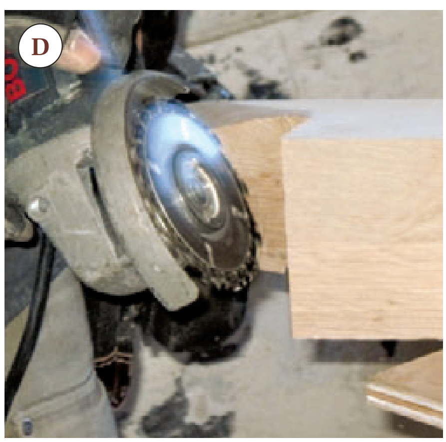

Figure 7. After scribing the replacement sills in place (A), the author used a multi-tool to kerf to the lines (B), then a chisel to remove the waste (C). A grinder with a carving blade was useful for matching the three-dimensional stone surface (D).

that all cut edges — as well as the bottoms of the jambs — received two coats of oil primer. We also isolated as much wood as possible from the masonry with Vycor peel-and-stick (**Figure 8**).

The original bucks had been held in place with ears that extended into the masonry from each end of the sill. We achieved the same effect by drilling ⅝-inch holes about 6 inches deep in the ends of the sills and inserting threaded rod, which we secured with polyurethane glue. We fastened the sills to the bottom

Figure 8. Threaded rod glued in holes in the ends of the replacement sills (A, B) served the same purpose as the wood extension "ears" on the original sills — providing anchorage in the masonry (C). The old jambs were first epoxied to the stone, and the new sills attached from the bottom with lag screws driven at an angle from beneath (D).

Figure 9. To provide a tight fit for the new interior casing, which would have to be installed from outside, the author temporarily positioned the replacement buck (A) and scribed an offset line on the plaster in the window well (B). He then removed the frame and cut the line with a grinder (C).

Figure 10. Before the new window frame could be installed, the casing had to be pocket-screwed together (A), then positioned from outside and tacked into place (B). The window frame, protected on all four sides with peel-and-stick membrane, was then set in the opening (C) and secured in its final position in preparation for installation of the epoxy anchors (D).

of the jambs with Timberlok screws; later, the threaded rod extensions were mortared into place.

Installing the Replacement Windows

Installing the replacement bucks was a multi-step process. We first set the units in the openings and temporarily shimmed them into place so that we could scribe the sills. Early on, there had been a discussion about whether the millwork shop should mortise-and-tenon the sill to the buck, which is the way the originals were made. Ultimately we all concluded that the units would resist moisture better without all that through-joinery, so instead we had the sills attached with Timberloks. This made it easy to remove the sills for scribing.

We also scribed the sides of the interior window well for the replacement casings (**Figure 9, page 7**). Once we were satisfied with the fit, we pocket-screwed the interior casings together and fastened them in place, followed by the window buck itself, which we wrapped on all four sides with peel-and-stick (**Figure 10**). We secured the window unit in exact final position with clamps and temporary braces, then drilled the holes for the epoxy anchors.

Job Costs

This job cost the client $41,000 for millwork, $37,000 for carpentry, $12,000 for painting, and $10,000 for masonry. The carpentry number includes nine full window-buck replacements, four sill-only replacements, three window-buck repairs, three door-buck replacements, the fitting of 16 pairs of new sash, and the installation of a new basement door, two louvered windows, a replacement transom, and scaffolding for the front, back, and one side of the building.

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