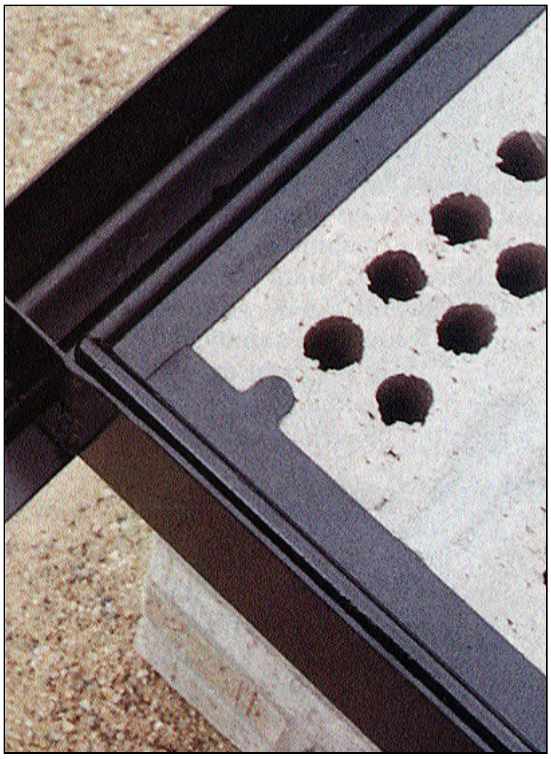
How to construct a chimney crown

Make sure it allows for expansion and contraction and sheds water

By Carolyn Schierhorn



This steel crown form features a built-in drip edge and ½x½-inch support tabs in each inside corner. The tabs rest on the masonry, while the form itself abuts the outside edge of the masonry. Adjustable crown forms can fit any size chimney—up to the length of the form rails, which generally are 2 to 8 feet long; however, no more than two-thirds of the length of the form should extend beyond the chimney.

Whether made of precast or cast-in-place concrete, a properly constructed chimney crown (also called a cap or top plate) sheds water and seals the top of the chimney. By trapping air in the space between the flue liner and the masonry, the crown also enhances the chimney's insulation (except in areas governed by the Uniform Building Code, which requires this space to be grouted).

But much of the time, chimney crowns are poorly built, says Dale Deraps of Advanced Chimney Techniques in Jamestown, Mo. In fact, poor crown construction is a leading cause of chimney deterioration and failure.

Many crowns consist of a thin mortar wash that erodes quickly, shrinks, and cracks, causing moisture penetration. A large area of mortar, placed horizontally, will not resist weathering and temperature changes as well as concrete. In addition, crowns commonly end flush with the edge of the chimney, enabling water to run straight down the masonry.

Crowns sometimes butt up against the flue liner, failing to allow for its thermal expansion. Not only can moisture enter through this unsealed connection, but also vertical expansion can lift the crown, causing damage to the masonry courses below.

What's more, masons sometimes neglect to establish a bond break between the crown and masonry. Differential expansion will cause cracking and water penetration. And some crowns rest on combustible supports such as plywood or tar paper, which can burn and sag. Since plywood absorbs water, it also can expand and crack the crown.

Chimneys frequently suffer water damage, freeze-thaw erosion, spalling,and efflorescenceas a result of faulty crown construction, keeping chimney repair specialists busy. “For lack of a good crown, I’ve taken large chimneys straight to the ground and rebuilt them,” Deraps says. “These are $10,000 to $12,000 jobs.”

Water penetration will shorten the life of masonry or steel fireboxes, which often require extensive repairs in less than 10 years, adds Jerry Isenhour of Concord, N.C.-based The Chimney Doctor Ltd., who is technical director of the National Chimney Sweep Guild (NCSG). Smoke chambers also are frequently damaged by water. “Water penetration will erode parging and wash out mortar joints,” he says.

Ahrens Chimney Technique

Integral fiber reinforcement may be added to the chimney crown concrete during mixing.

BIA guidelines

The Brick Institute of America (BIA), which receives numerous complaints about “disintegrating” brick near the top of chimneys, has issued the following guidelines for chimney crown construction (Ref. 1 and 2):

- Never use mortar as the crown material
- Make sure precast concrete crowns are at least 2 inches thick at the thinnest part
- Reinforce cast-in-place concrete crowns
- Make sure the crown extends at least 2½ inches beyond the outside chimney wall; a drip edge, or groove, should be incorporated on the underside of this overhang—at least 1 inch from the chimney wall
- Slope the crown downward from the flue liner to the edge of the chimney wall
- Don’t let the crown touch the flue liner
- Use a sealant between the flue liner and the crown
- Maintain the required distance between the top of the installed crown and the top of the flue liner, as dictated by local building codes
- Make sure there is a bond break between the crown and the masonry to allow for differential expansion


Heat-Fab Inc.

This steel crown form features integral clamps for fast and easy adjustment.

Precast versus cast-in-place

Precast concrete crowns are easy to install and provide consistent quality, but they generally are used only in new construction or on smaller jobs, such as 16x16-inch chimneys.

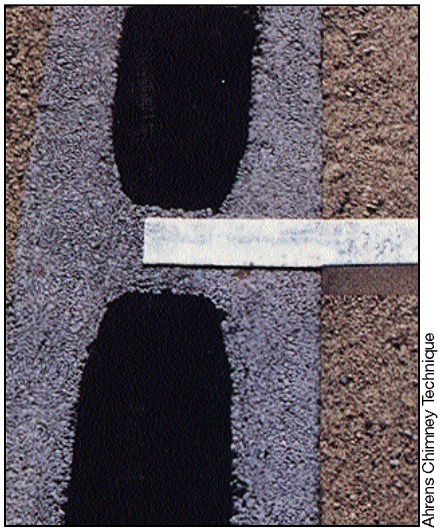
Chimney repair work usually is done by specialists who typically are small contractors, notes NCSG executive director John Bittner. The heavy weight of concrete (150 to 155 pounds per cubic foot) makes hoisting large precast crowns impractical. It’s much easier to carry 50 to 70 pounds at a time and build a 450-pound crown in stages.

What’s more, adjustable steel forms make it easier to construct cast-in-place crowns today. Masons traditionally have built wood forms by hand—a time-consuming process that must be repeated whenever the form wears out or the mason tackles a chimney of a different size. Steel forms require only half the setup time that wood forms do. Using C-clamps or built-in clamps, they can be adjusted in seconds to fit any size crown—up to the maximum length of the form.

Steel forms also last forever if properly maintained. Oil them before each use with a standard form oil. And clean the concrete residue off after each use.

Buying the right form

Steel form manufacturers generally offer form rails in 2- to 8-foot lengths, which refers to the maximum length of crown the form will create. Don’t use a large



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To construct the crown support grid, cut the ends of angle irons in half so they can lay flat on the masonry.

form on a 16x16-inch chimney, where 4 or 5 feet might be sticking out and the form will be out of balance. Follow this rule of thumb when buying a form: No more than two-thirds of the length of the form should extend beyond the chimney.

Another consideration when buying a form is how easily it can be attached to the chimney and stripped out after the concrete has set. One manufacturer produces a form with a small ½x½-inch tab in each corner that rests on top of the masonry, while the form itself abuts the outside edge of the masonry (see photo, page 000). This type of form is simple to install and can be stripped out easily because only the small tabs are covered by concrete.

A second type of steel form requires the contractor to strap angle irons or brackets to the chimney before positioning the form rails. This type may be more time-consuming to install.

A third type of form rests right on the masonry, allowing about ¼ inch around the chimney's perimeter to become embedded in concrete. This type may be harder to strip out unless a good release agent is used. Additionally, if the masonry isn't level, the form will wobble and the crown will have imperfections.

Also, look for a steel form with a welded-in drip edge to save set-up time, Deraps suggests. It produces an accurate and consistent drip edge.

A chimney crown needs a drip edge so that water drips away from the chimney, not down its surface. Water can run horizontally, but it can't run horizontally and then back up again.

Creating the drip edge

Install the steel crown form according to manufacturer's directions. If the form doesn't have a built-in drip edge, you can create one by placing a bead of caulk on the form. Alternatively, some contractors create the groove by placing a cotton rope in the form, which gets stripped out later. The drip edge should be located at least 1 inch from the chimney wall on the underside of the crown.

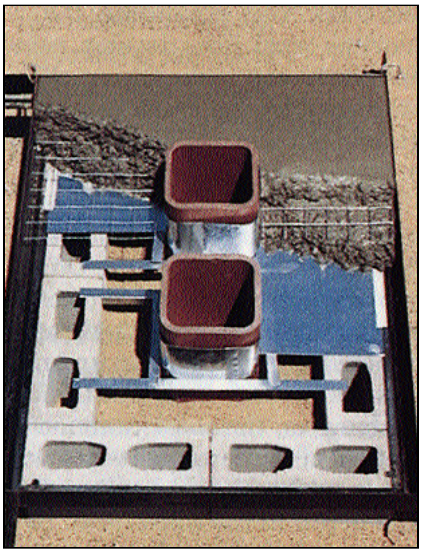

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Photo shows components of chimney crown in place: Flat metal plates cover the grid and masonry, serving as a bond break and as support for the concrete; flues are wrapped in metal sleeves to allow for silicone expansion joints; and wire mesh reinforcement in the concrete inhibits cracking.

Support system and bond break

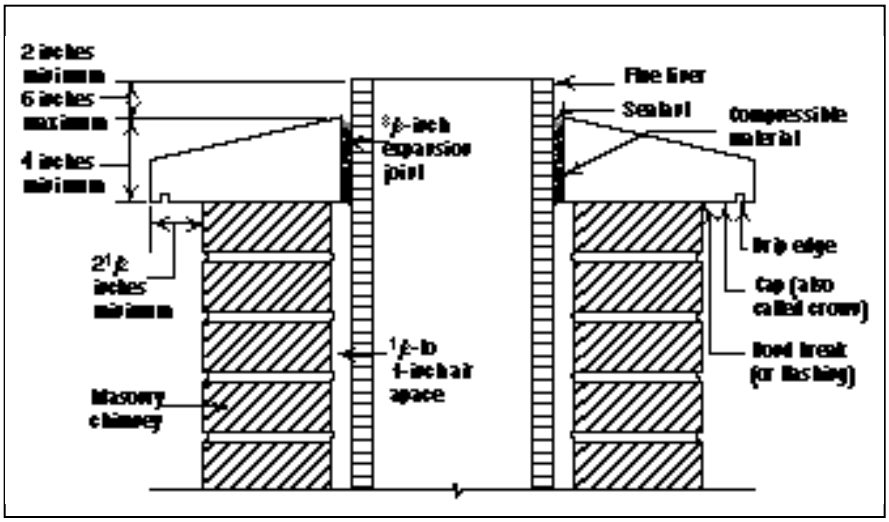
Next, install the crown support system, which covers the open area between the flue or flues and the masonry and serves as a bridge from masonry to masonry. If contractors were to pour concrete without this support, the whole chimney would become filled. The support system also establishes a bond break between the concrete and masonry. It's important to have a bond break because masonry and concrete expand and contract at different rates.

To construct the support system, use angle irons of the appropriate length, cutting the ends in half so they can lay flat on the masonry (see photo, above left). With these angle supports, build a grid that goes around the flue liner and across the span of the chimney. Then lay flat metal plates on top of this grid. (Reinforced cement backing board may also be used, but don't use combustible materials such as plywood or tar paper.) Place tape around the perimeter to seal the plates to the form.

Also, wrap the flue liner with a compressible material to allow a ¼- to ⅜-inch separation between the concrete and flue liner. "The tile needs to be able to move up and down slightly, as well as expand outward, so it doesn't crack the crown," Bittner says. Like the masonry and concrete, the flue liner and concrete have different coefficients of expansion.

One manufacturer recommends placing metal sleeves around the flue liner, which remain in place and allow room for the silicone expansion joint. But Isenhour prefers to use ¼-inch-thick ceramic wool. "It can be either stripped out and the space siliconed over, or left in and siliconed over; it has the necessary flexibility," he says.

Put in an expansion joint that will be flexible and hold the bond break ¼ to ⅜ inch away from the flue. This expansion joint should be made of silicone sealant,



A chimney crown should slope downward from the flue and extend beyond the chimney wall.

which seals out water but allows some movement, and may be added when the concrete is cast.

Don't wrap tar paper around the flue liner to act as an expansion joint, as some masons do. While allowing for expansion up and down, it doesn't let the flue liner expand outward enough and will crack the crown.

Whether cast-in-place or precast, the crown should be seamless and finished so water will not collect on the top surface. The crown should be at least 4 inches thick to avoid premature cracking.

Make sure the flue liner extends at least 2 inches beyond the top of the chimney, but check local building codes for the requirements in your area. This extension permits attachment of a rain hood and keeps ice and snow that accumulates on the crown from dropping into the flue. To avoid excessive cooling and condensation, don't project the flue liner more than 6 inches above the crown.

For a cast-in-place concrete crown, one manufacturer recommends a rich concrete mix of 1 part portland cement, 2 parts concrete sand, and 2 parts coarse aggregate. It may also contain an integral water repellent.

Isenhour uses a batch mix that, per cubic foot, consists of 21 pounds portland cement, 42 pounds dry masonry sand, and 63 pounds of aggregate no larger than ¼ to ½ inch. To this mixture, he adds 3 tablespoons of an air-entraining admixture.

Add reinforcement

A properly constructed chimney crown should not crack; but if it does, reinforcement can prevent the crack from expanding. If a hairline crack does develop, reinforcement can make the crack manageable; the crack can be ground out and caulked to prevent it from separating any further.

Integral fiber reinforcement may be added to the concrete during the mixing stage. One supplier advocates this type of reinforcement because it is three-dimensional, reinforcing up and down, as well as from side to side.

However, the most common method of reinforcement uses wire mesh, which should be placed mid-depth in the filled form. Be sure to select the right gauge and size. If the screen of the wire mesh is too small, bonding will not occur from one side of the mesh to the other. For chimneys, use at least a 1x1-inch mesh for optimum bonding through the holes.

When casting a crown in place, take the time to do the work accurately. Altering the crown after it is cast will make it look sloppy and fit poorly.

Fill the form with concrete, making sure that the wire mesh reinforcement, if used, is positioned properly. Don't let the mesh extend to the edge of the form or the outside surface. To prevent rust, there should be a 1-inch clearance between mesh and form and mesh and flue tile.

Cast the concrete so it slopes downward from the flue on all sides, shaping it with a wooden float. "You have to stay with it awhile and play with it," Isenhour points out. "You can't just dump it there and leave it."

Then Isenhour uses the rough side of a brick to smooth out rough spots and small surface cracks.

Finish the crown using magnesium and sponge floats to smooth the top and sides and a broom to make the texture more uniform. Tap the sides of the form gently with a hammer to release trapped air bubbles. A vibrator connected to the form also will force out the air bubbles.

Then cover the crown with plastic and allow the concrete to set overnight. Since weather conditions affect the curing rate of concrete, check the concrete for hardness before removing the forms.

To strip the form, follow manufacturer's directions. Be sure to scrape the form rails clean and oil them lightly for storage.

Use a tool called an edger to chamfer the edges of the concrete crown to the desired angle. Besides enhancing the crown's appearance, this increases its strength. Left sharp, the edges of a cured concrete crown may chip.

References

1. "Residential Chimneys Design and Construction," BIA *Technical Notes on Brick Construction*, Number 19B, Brick Institute of America, 11490 Commerce Park Dr., Reston, VA 22091.

2. "Proper Chimney Crowns," *Engineering and Research Digest*, BIA.

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