



Figure 157—You can use a cardboard pattern to scribe the outline for mid-wall saddle notches.



Figure 158—This preservation crewmember is using a log scribe and a dummy log to make a saddle notch for the Horse Prairie Cabin in the Beaverhead-Deerlodge National Forest, Northern Region.

Log Repairs

If the building condition and historic assessment reveals that only a portion of one log or only a portion of a few logs are deteriorated, repair those logs rather than replacing them. Stabilizing and repairing a log preserves more of the building's integrity, including historic tool marks.

In some cases, large logs or timbers of the species originally used to build the cabin no longer are available. Repair prevents the need to substitute a different wood species, which would affect the visual integrity and lessen the historic value of the cabin.

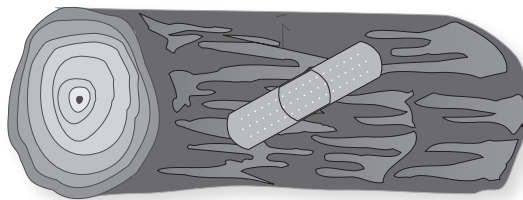
You sometimes can accomplish log repairs without removing the log from the building. Repairs usually are cheaper and quicker than log replacements, especially if the logs are hewn or have complicated notches or large diameters.

Log repairs nearly always damage or destroy adjacent chinking and daubing. This damage isn't a problem because chink-

ing and daubing are relatively easy to repair, and people normally repair or replace them many times during the life of a log building.

Repair work is easily hidden on painted or stained buildings: just coat the new work with paint or stain that matches the surrounding paint or stain. Repair and replacement work on unpainted buildings will be obvious for a few years, but eventually will weather to match the original logs. If someone treated the original logs with a linseed oil mix or a linseed oil mix with paraffin (see the [Using Paint, Stain, and Oil](#) section of this guide), recoat at least the entire repaired log, and preferably the whole building, after you complete repairs.

You can repair logs using epoxy patches, wood splices, or a combination of splices and epoxies. Repairs to logs are always visible to some extent. Perform the repair neatly with tight joints and do not attempt to camouflage the repair in any way other than by matching the surrounding paint, stain, or coatings.



Epoxies

Epoxy (see figure 109) is a useful log repair material that you can use as filler, as glue, or to solidify slightly decayed wood. A variety of liquid epoxies are available. All of them consist of separate containers of resin and hardener which you must mix before use. Epoxies resist decay and insects. Although epoxy is moisture resistant, it tends to cause adjacent wood to retain moisture because it blocks evaporation. Epoxy used in the wrong location actually can worsen wood decay. Epoxy repairs are most successful in areas where they are protected from moisture.

Be sure to select an epoxy product that meets the needs of the repair. Freshly mixed epoxy can be as thin as water to penetrate wood, or thick and viscous to stay put on vertical surfaces. Cured epoxy can be hard and brittle or soft and flexible. Cure time can be slow to enable deep penetration into porous wood or fast to enable a quick return to service. As epoxy cures, it generates heat. Thicker applications generate more heat, which can make the cure time faster. Epoxies for wood repairs are formulated to be compatible with the strength and flexibility characteristics of wood. Do not confuse these epoxy materials with epoxies formulated for other uses. Some epoxies accept dye and thickening agents.

Before using any type of epoxy, read the mixing instructions carefully. Wear disposable gloves and eye protection. Work in a well-ventilated area (outdoors or in a room with exhaust ventilation). Follow the respirator precautions on the safety data sheets (SDS), including when you grind or sand the cured material.

You can use epoxy to consolidate logs with slight surface deterioration. Mix the epoxy and brush it on the deteriorated area. The deteriorated log absorbs the epoxy, which fills the voids and stabilizes the log. Use epoxy sparingly, because it dries with a shiny finish. Drips and excess epoxy on the log surface are very noticeable.

You also can use epoxies to consolidate and repair small areas of rot inside a log if its outer surface still is sound. To consolidate a log without removing it from the building, drill small holes into the log in locations that you can conceal with chinking or daubing. Then, saturate the rotted area by pouring the liquid through a funnel into each of the holes.

Repair more extensive interior rot by removing the log from the cabin and using epoxy filler and epoxy adhesive to affix wood patches (figure 159). You may need to open the log to

Types of Epoxy Commonly Used for Wood Repair

- **Epoxy consolidant**—A liquid that soaks into wood and then hardens, solidifying the wood. The liquid penetrates dry wood better than wet wood.
- **Epoxy paste filler**—An adhesive paste made using thickener and additives to give the cured material strength and flexibility similar to wood. Paste filler is available commercially or can be made by mixing wood flour, sawdust, or silica into liquid epoxy. Filler consistencies range from that of mayonnaise to stiff mashed potatoes. You can dye some fillers to match the log. Always read the manufacturer's instructions to see what additives are appropriate for the epoxy.
- **Epoxy primer**—A liquid used to prepare a surface for good adhesion of epoxy paste filler. Be sure to review the manufacturer's directions, because some epoxies don't require primer.
- **Epoxy adhesive**—A liquid used to glue two pieces of wood together.

repair the rot, then rejoin it using the techniques in the [Structural Wood Splicing](#) section of this guide. Epoxy filler and patches won't work on logs with interior rot through more than a third of their diameter.

You also can use epoxies in combination with wood splices. Epoxy adhesives generally require only sufficient clamping pressure to keep the two pieces together without gaps and to prevent them from moving until the epoxy cures. The length of time you need to clamp the splice depends on the type of epoxy and the temperature. You roughly double the cure time for every 18 °F drop in temperature from 68 °F and cut it in half for every 18 °F rise in temperature from 68 °F.

Both the splice and the original log must be reasonably dry (about 6- to 20-percent moisture content) so that the adhesive bonds properly. Read the mixing instructions carefully, wear disposable gloves and eye protection, and do not breathe the fumes. For information on how to use epoxies as adhesives, see the [Structural Wood Splicing](#), [Surface Wood Splicing](#), and [Crown End Repairs](#) sections of this guide.

Epoxy isn't appropriate for all log repairs. For instance, you shouldn't use epoxy to conceal checking, for large surface patches that are exposed to view or weather, on logs with extensive decay, or on logs that are near collapse or have collapsed.

Figure 159—Preservation crewmembers chiseled out the rotted interior of this heavily coped log at Badger Cabin (Lewis and Clark National Forest, Northern Region). The author (left front) and crew replaced the removed material with epoxy, sawdust, and wood slabs. The rot was more extensive in the center of the log than at the ends. The outside of the entire log was sound. The crew split the log in half so that they could repair the interior, then rejoined the log using techniques in the [Structural Wood Splicing](#) section of this guide.



Structural Wood Splicing

Several methods of splicing (joining sections of wood together) are useful for log repair. The [Surface Wood Splicing](#), [Crown End Repairs](#), and [Log Purlin End and Rafter Tail Repairs](#) sections of this guide discuss different splicing methods.

Structural wood splices must be sturdy enough to support the building or a portion of the building. Figure 160 shows nine tenon, dovetail, scarf, and lap joints that people use successfully for log repair. Secure splice joints by using epoxy

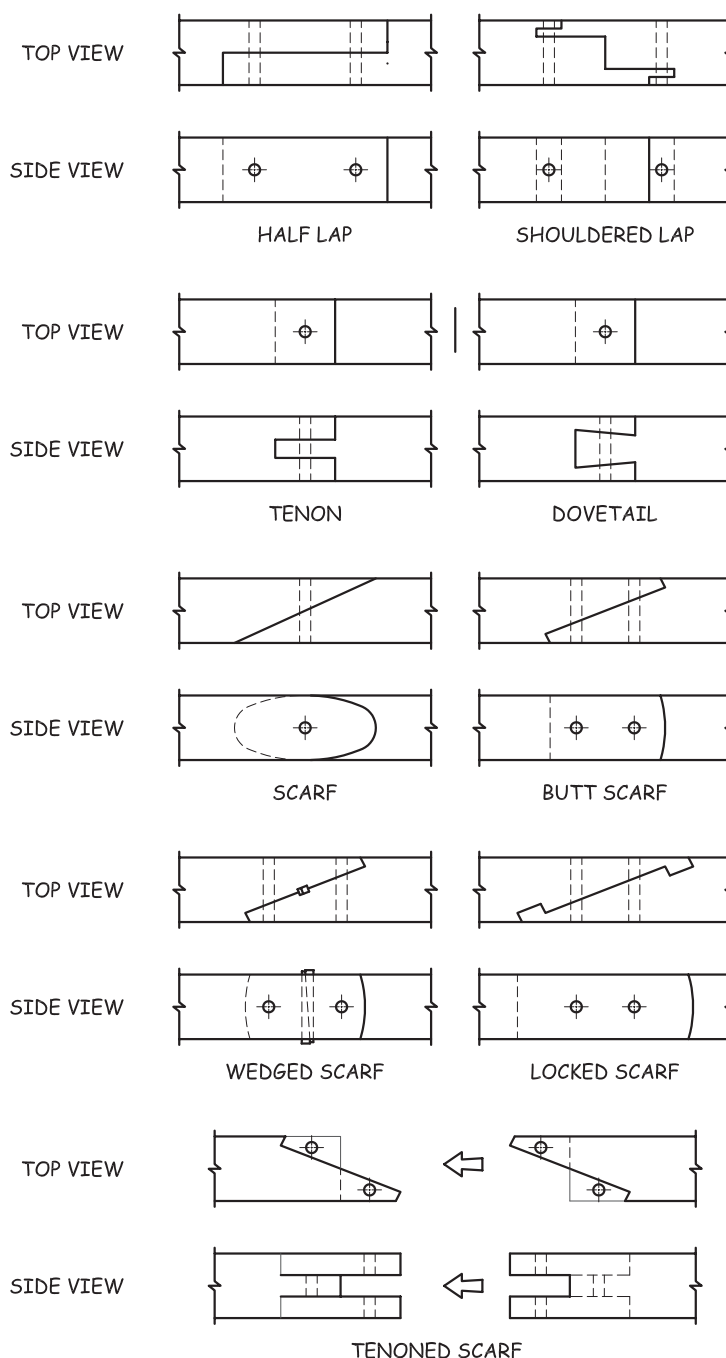


Figure 160—These line drawings show the configuration of nine fairly common splice joints in top and side views. You pin or dowel together each joint.

adhesive, wooden dowels, split-ring connections, bolts or all-thread and nuts, log or lag screws, or a combination of these fasteners. Figure 161 shows a split-ring connection being prepared for a lap joint.

You can secure a splice with either wooden or fiberglass dowels. Wooden dowels are relatively cheap and easy to find. After the repair, wooden dowel ends resemble knotholes. Fiberglass rods are gray and will stand out on logs that aren't painted. If you use fiberglass rods on unpainted logs, drive them below the finished surface, insert a wooden plug, and plane the plug flush for an appearance similar to a wooden dowel.

The stacked logs in a wall normally are subjected mainly to compression loads. The logs above window and door

openings have minor tension loads. Sill and spandrel logs have tension loads if the foundation isn't continuous. For the compression loaded, stacked logs in walls, nearly any splice that holds the two pieces of log together will work to keep the building together. Of course, some splices are more durable, less noticeable visually, or more historically appropriate than others.

Logs subjected mainly to tension loads or combination tension and compression loads, such as posts, joists, rafters, purlins, or trusses, are a different matter. Never splice these structural members without first checking with a structural engineer to ensure that the splice will hold the load to which the log will be subjected. Without proper load analysis, you may find that your repair efforts are wasted when the roof caves in because the rafter breaks at the splice.

Figure 161—This photo shows one-half of a lap joint that the preservation carpenter will secure using split-ring connectors and bolts. She cut circular grooves for the split-ring connectors around the bolt holes that she drilled completely through both halves of the joint. One split-ring connector rests in its groove and another rests beside its groove. She will cut matching grooves in the other half of the joint, fit the two halves of the lap joint together, thread long bolts through the joint, and tighten the connection using nuts with washers. Split-ring connectors transfer the load between the two halves of a joint better than bolts alone.



Surface Wood Splicing

A surface splice is the appropriate repair technique if the building condition and historic assessment identifies a large surface area of deteriorated or damaged wood that extends less than halfway through the log. You accomplish surface wood splicing, usually referred to as a “Dutchman” repair, by cutting out the decayed area of the log, making a matching wood replacement plug or splice, and installing the new plug or splice (figure 162).

If the splice is long, consider easing the removal effort by scoring the deteriorated wood to the depth of the rot with a chain saw and knocking out the rot with a hammer (figure 163). Be careful not to cut adjacent logs. After cleaning out the deteriorated area, carefully cut smooth edges for the splice. Use one of the patterns shown in figure 164 to minimize the visual effect of the patch and any gapping that might occur because of differential shrinking or swelling between the patch and the original log.

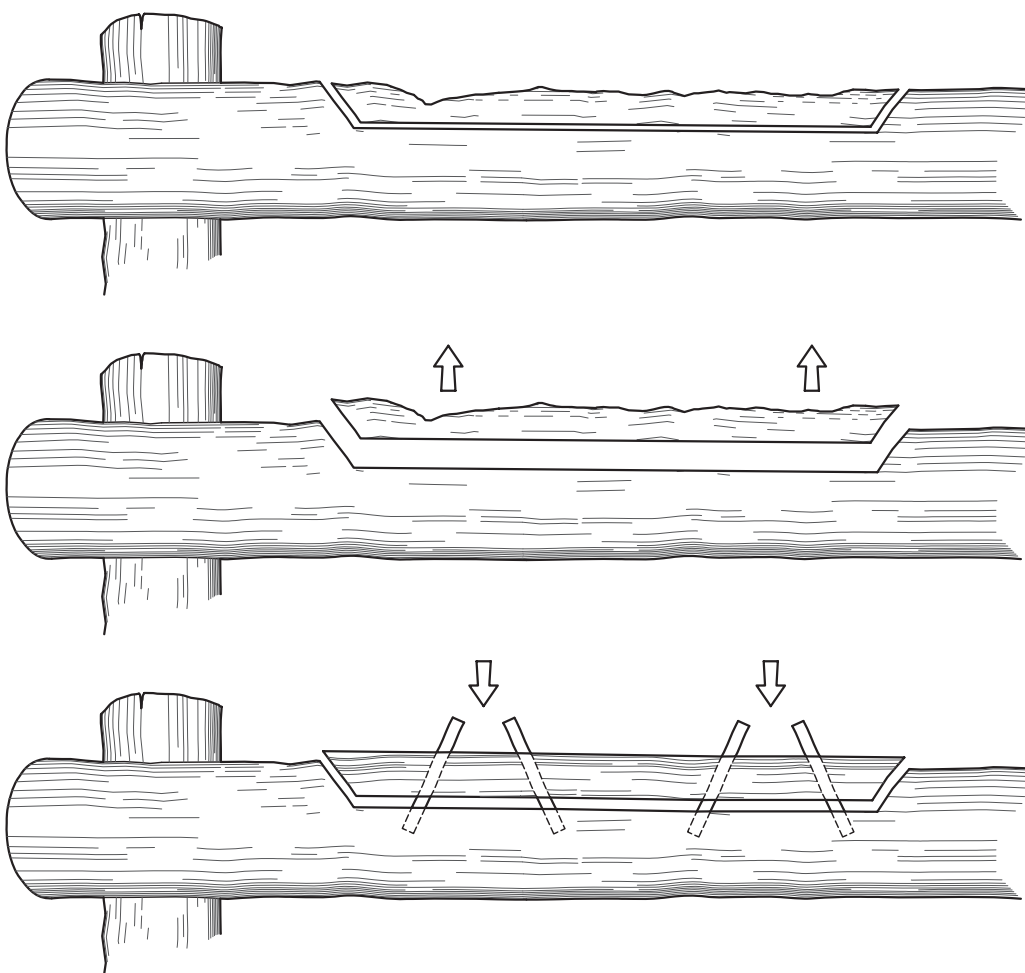


Figure 162—A Dutchman repair consists of removing a deteriorated section of log, making a matching splice, and attaching it to the log.



Figure 163—You can use a hammer to knock the rotted wood off a log after scoring the area with the tip of a chain saw.

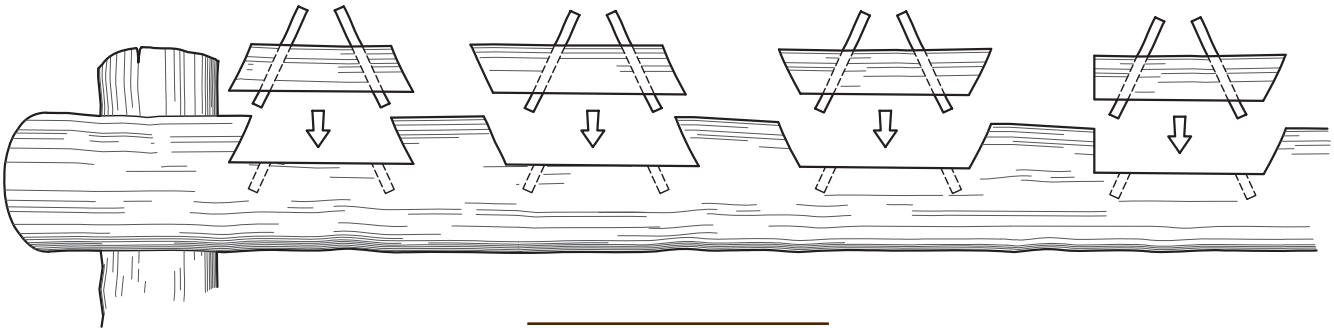


Figure 164—Cut clean edges for a log splice in one of these patterns. This drawing also shows the angle for attaching dowels.

Cut the plug or splice from a log of the same species as the log you are patching. Match the direction and pattern of the wood grain and the shape of the cut out area (figure 165). Make a pattern from a board or use a profile gauge to aid with cutting the splice to fit exactly into the cut out area. Trim the plug or splice as necessary to fit exactly into the log you are patching. Don't worry if the splice extends beyond the original log surface a little, as long as the ends of the splice fit snugly into the log with no gaps.

When you've completed shaping the plug or splice to exactly fit the existing log, apply epoxy adhesive to the cut surface of the existing log. Clamp the patch into place and let the epoxy cure. If necessary, use screws to help hold the patch in place until the epoxy cures.

After the epoxy cures, create a permanent attachment between the patch and the existing log using dowels. With the clamp still in place, drill paired diagonal dowel holes through the patch and into the existing log. Use wooden dowels at least $\frac{3}{4}$ inch in diameter. Drill the holes for the dowels only slightly larger than the diameter of the dowels and extend them into the existing log a little less than one-half the remaining depth of the log. After drilling the holes, coat the dowels with epoxy adhesive and place them into the predrilled holes. Use a rubber or wooden mallet to drive the dowels to the bottom of the holes. Wipe off any excess adhesive.

After the epoxy cures, remove the clamps and screws and do any final trimming necessary to remove excess dowel material. Shape the surface of the patch to match the existing log. Figures 166 through 173 show the entire Dutchman repair process.

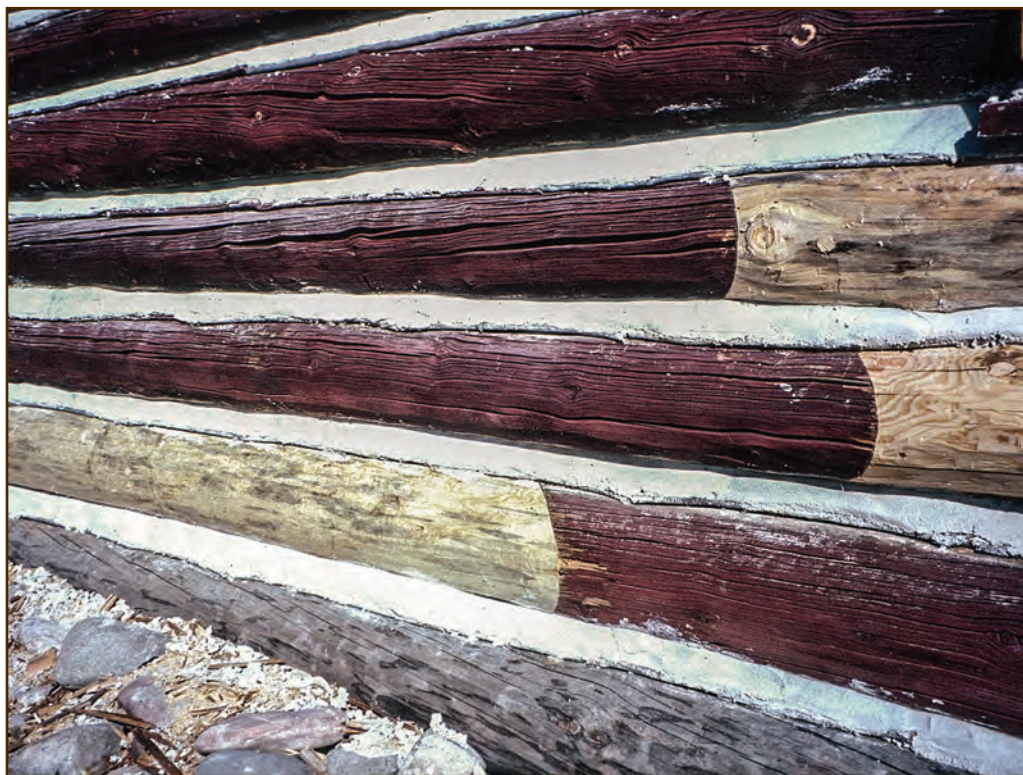


Figure 165—This photo shows several trimmed Dutchman splices on exterior logs of the Judith Guard Station (Lewis and Clark National Forest, Northern Region). Although the species and diameter of all patches match well, the middle splice does not match the original log grain pattern as well as the top and bottom splices do.



Figure 166—This whitewashed cabin has a small, deteriorated area beneath one of the windows.



Figure 167—Preservation carpenter Bernie Weisgerber, now retired from the Forest Service Northern Region Historic Preservation Team, used a mallet and chisel to remove the deteriorated wood, which was more extensive than it appeared at the surface. Notice that he removed the chinking and daubing adjacent to the deteriorated area so that he could more easily access the damaged area.



Figure 168—The preservation carpenter used a reciprocating saw to cut a clean edge at an angle on the end of the cut out area.

Log Repairs



Figure 169—There is a small epoxy patch at the back of the finished cut out area. The log is dry and the epoxy and surrounding wood will be well protected from moisture in this location once the preservation carpenter replaces the chinking and daubing.



Figure 170—The preservation carpenter cut a board to match the length and angles of the cut out area as a pattern for cutting the splice.



Figure 171—The preservation carpenter removed the original windowsill and cut the top of the splice down for the windowsill. He applied epoxy adhesive behind the patch and secured the splice to the original wall with a band clamp. The splice fit perfectly into the notch. Next, he drilled the dowel holes.



Figure 172—The ends of the angled dowels are darker ovals that are visible toward the ends of the splice. The epoxy has cured and the preservation carpenter has removed the band clamp.



Figure 173—The preservation carpenter has repaired the chinking and daubing and applied whitewash to the patch, which is just barely noticeable. The whitewash didn't penetrate the new splice as well as the original logs. By the time the cabin needs another application of whitewash, the splice will have weathered and will absorb the whitewash more uniformly.

Use a process similar to a Dutchman repair to reattach a crown end piece that you removed to free a mid-wall log for replacement (figure 174). The only differences are that the crown end piece you will reattach is the original crown end piece that you removed, and it's on the end of the log rather than in the middle. Gluing, clamping, and doweling procedures are the same.

You can also use a splice to repair the entire length of a log or the full diameter of one end of a log. Half-log splices replace all or part of the outside face of a log (figure 175); end-to-end log splices replace the full diameter of a portion of a log (figure 176). Both types of splices are useful for buildings with heavily coped logs and for buildings with intact historic interior finishes that you shouldn't disturb. Because these splices are quite large, orient the finished splice vertically to prevent

moisture from entering the splice and becoming trapped in the repair. If more than one-half of the log is deteriorated, you usually are better off replacing the entire log.

End-to-end log splices require you to remove and replace the deteriorated end of a log. To make an end-to-end repair, cut off as much of the log as necessary to remove all the rot. Find a new log that matches the species and diameter of the cut off end as closely as possible. Cut a half lap that is 18 inches to 2-feet long into both the remaining existing log and the replacement log section. Splice the two together to create one log. This repair is easiest when you remove the log from the building, but you can do shorter repairs while the log is in place. Because this repair is major, use two to three splitting connections with all-thread running through the rings to secure the half-lap splice.

Figure 174—Preservation crewmembers removed the bottom of a crown end log on the barn at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region) to free the log below it for replacement. The new log (lighter color) is in place. The piece that the crew removed is glued and doweled back into position and is held in place by a band clamp while the epoxy adhesive cures. Next, the crew will trim the dowels and stain the replacement log and dowel ends to match the existing logs, providing a nearly invisible repair.



Figure 175—This photo shows several types of splices in various stages of completion on a cabin with coped logs. The lower two logs on the end of the cabin and the third log up from the bottom on the side of the cabin contain nearly completed half-log splices that extend almost the full length of the logs. Above the half-log splices on the end of the cabin are two logs that preservation crewmembers cut to receive face splices. The crew will apply face splices without removing the logs from the cabin. A couple of other logs further up the end of the cabin show evidence of rot; the crewmembers also will treat these with face splices.



Log Repairs



Figure 176—Preservation crewmembers replaced the ends of the porch sill logs at the Gates Park Station cabin (Lewis and Clark National Forest, Northern Region) using end-to-end log splices. They replaced the porch foundation, spandrel log, posts, and floor boards at the same time.

Use half-log splices when one face of a log has extensive deterioration that doesn't extend past the middle of the log. To make a half-log repair, remove the log from the building, set it securely on sawbucks, and cut the log in half lengthwise to remove the deteriorated face. Find a matching log and cut it in half lengthwise. Splice the two together to create one log (figure 177). Because this repair is quite extensive, secure the splice using several split-ring connections (figures 178 and 179) with all-thread bolts in the center of the rings that extend completely through the old log and the splice. You can do this repair to a heavily coped log while it remains in place, but doing so is quite difficult (see figure 175).

Split rings, when used correctly, create a repair that is as strong as the original log. [One manufacturer's design manual for split rings](http://clevelandsteel.thomasnet.com/Asset/Design_Man_Teco.pdf), which includes spacing and load charts, is available at <http://clevelandsteel.thomasnet.com/Asset/Design_Man_Teco.pdf>. Recess the bolt, nut, and washer into the log and cover them with a glued-in plug (figure 180). Orient the grain of the plug in the same direction as the grain of the log for a neater, less noticeable repair.

If the original logs are painted, stained, or sealed, apply a matching finish to the splice. Repair the chinking and daubing as explained in the [Chinking and Daubing](#) section of this guide.



Figure 177—This photo shows a half-log splice in progress. The crew has not yet completely shaped the pale new wood to match the wood it will replace. This splice doesn't include the end of the existing log because the end was sound, and the crew didn't need to repair it. Using a half-log splice allowed the crew to keep the historic interior finish intact. It is always best to retain as much historic material as possible.



Figure 178—The center guide rod on a drill bit for split-ring connectors is the same diameter as the threaded bolt that goes completely through the old log and the splice. Clamp the old log and splice together, then drill the hole for the bolt completely through the log and splice. Take the old log and splice apart. Drill the ring depressions separately into the meeting surfaces of the old log and the splice. Place the guide rod of the split-ring connector bit into the bolt hole to keep the ring bit centered as you drill the ring depressions.



Figure 179—Preservation crewmembers recessed split-ring connectors halfway into this splice. They also will recess the connectors halfway into the old log. Next, they will put the splice and log together, thread the bolt through the matching center holes in the splice and old log, and secure the connection with nuts and washers.



Figure 180—This closeup photo of the outside of a spliced log shows the recessed bolt, nut, and washer of a split-ring connector. The plug that the preservation crew will glue in place to cover the recessed bolt and nut sits on the log beside the recess.

Crown End Repairs

Crown end repairs are the most frequent repairs preservation carpenters do on log buildings. If your building condition and historic assessment identified rot in the ends of the logs beyond the notches, you may need to replace all or part of the crown ends (figure 181). Often, a crown end needs only a small Dutchman repair, but sometimes you must replace the full crown end into the notch or beyond.

Follow the directions on Dutchman repairs described in the [Surface Wood Splicing](#) section of this guide. If only the top, bottom, or side of the log is deteriorated, only cut off that part and replace the piece, much as you would a mid-log splice.

If the deterioration extends into the notch or beyond, cut off the rotted end (figure 182), making sure to remove all the rot and a couple of inches of sound wood so that you have a solid attachment point for the repair.

Save as much of the removed crown end as possible to use as a pattern to replicate the notch and crown. Use the techniques described in the [Selecting and Preparing Logs](#), [Round Logs](#), [Hewn and Sawn Logs](#), and [Shaping a Log](#) sections of this guide to find and shape a replacement portion of log to match the original crown end. As with other repairs, you may need to do several rounds of fitting and shaping until the new crown end fits in place well.

You can attach the new crown end with epoxy and hidden dowels, exposed dowels, log screws, or lag screws. Installing hidden dowels requires precise patterning and a good deal of skill and craftsmanship. To use hidden dowels, drill two holes only slightly larger than the diameter of the dowels 4 to 6 inches into the original log. Drill corresponding holes into the new crown end. Ensure that the total length of each pair of dowel holes is a little more than the length of the dowels. Coat one end of each of two wooden dowels

How To Mark a Guideline

Making a perpendicular cut to remove the end of a log is difficult. Here's how to use a guideline to help keep your cut straight:

1. Knock out any chinking and daubing that are in the way.
2. Wrap a length of steel band or a strip of thick asphalt building paper around the log a couple of inches beyond the edge of the deterioration.
3. Align the edges where they overlap.
4. Draw a line along the edge of the band or tar paper. Now you have a guideline for making a straight cut all the way around the log.



Figure 181—This cabin with battered crown ends required several crown end repairs. Preservation crewmembers have completed two full crown end replacements and a splice and have begun a partial crown end replacement. They have inserted the dowels into the original log and will attach the replacement end next.

Log Repairs

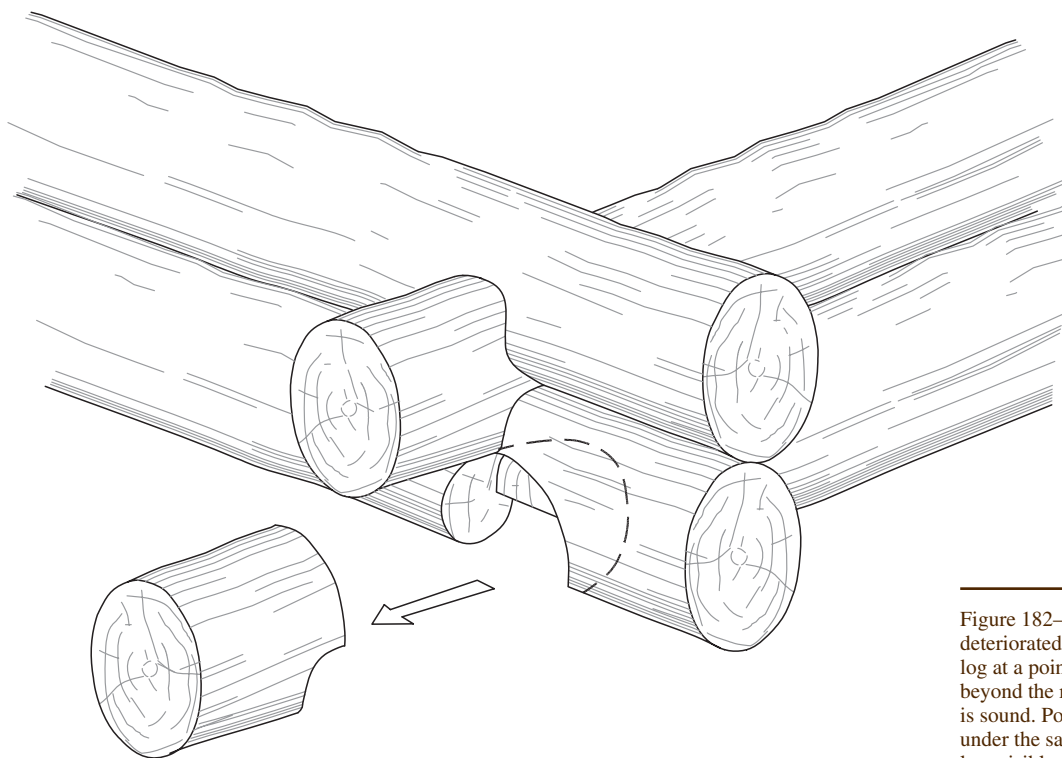


Figure 182—Cut a completely deteriorated crown end off the log at a point a couple of inches beyond the rot where the wood is sound. Positioning the cut under the saddle makes the joint less visible and provides some protection from moisture.

or fiberglass rods with epoxy adhesive and insert them into the holes in the original log. Coat the cut face of the original log and the exposed dowel ends with epoxy adhesive and fit the new crown end in place (figure 183). Clamp or screw the two pieces together until the epoxy dries and then remove the clamps or screws.

To use exposed dowels, coat the cut face of the original log with epoxy and fit the new crown end in place. Clamp, tie, brace, or temporarily screw the two pieces together (figure 184). Ensure that the temporary connection is sturdy enough to prevent the pieces from shifting while you work on them. Drill two diagonal dowel holes that are only slightly larger than the diameter of the dowels through 4 to 6 inches of the replacement crown end and 4 to 6 inches into the original log. Drill one hole from the right side of the log and one from the left side. Coat wooden dowels or fiberglass rods with epoxy and insert them into the holes, similar to doweling an original crown end piece that you removed to access a rotted mid-wall log (see figure 174). Use a rubber or wooden mallet to pound

the dowels all the way into the holes. Wipe off any excess adhesive. When the epoxy cures, remove the clamps, ties, braces, or screws and cut any protruding dowel material flush with the log.

Use log screws or lag screws only as a last resort if you cannot use dowels to attach new crown ends. Use epoxy adhesive to attach the new crown end to the original log and then install the screws at an angle up through the underside of the new crown end into the original log above it (figure 185). The author does not recommend using this fastening system because any differential movement between the logs will stress the joint and can lead to failure of the repair.

After you attach the new crown ends, repair the chinking and daubing, as necessary, as explained in the [Chinking and Daubing](#) section of this guide. If the original logs are painted, stained, or sealed, apply a matching finish to the new crown ends.

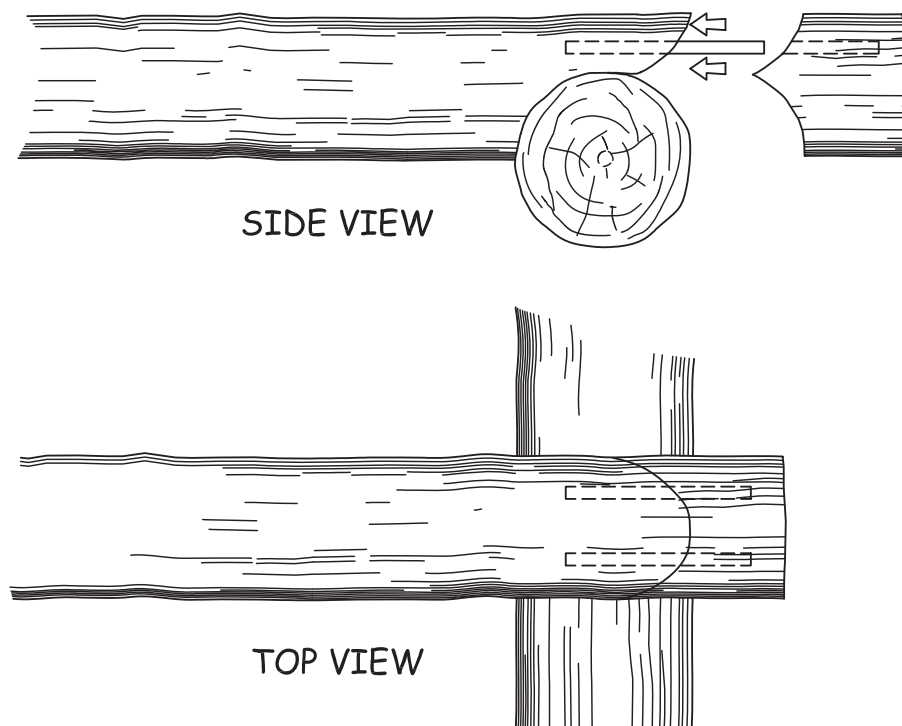


Figure 183—This drawing shows how to use dowels to connect a replacement crown end to the original log.

Figure 184—Kirby Matthew, now retired from the Forest Service Northern Region Historic Preservation Team, drives one of two temporary screws. He's using the screws, a tie board, and epoxy adhesive to hold the replacement crown end in place while he drills holes for the permanent dowel connection.

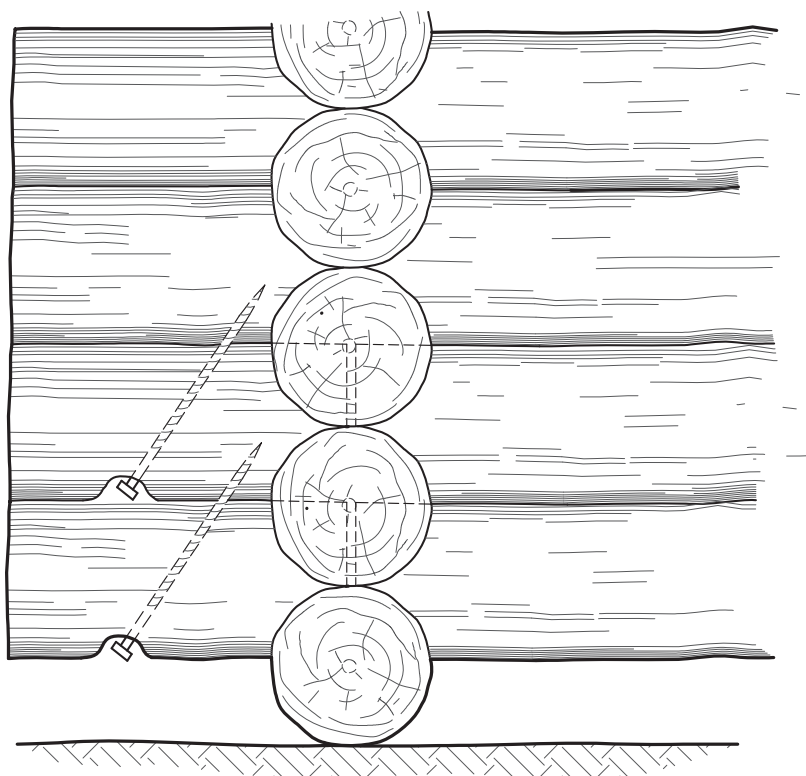


Figure 185—This drawing shows how to use lag screws or log screws to secure replacement crown ends to a cabin. Use dowel attachments if you can. Only use screws if you can't use dowels.

Log Purlin End and Rafter Tail Repairs

Log purlin ends and rafter tails often extend to or beyond the drip edge of a cabin's roof. They are subjected to frequent moisture that leads to rot. You may be tempted to cure this problem by simply cutting off the ends of the logs to minimize their exposure to the weather; don't do it. Removing these ends significantly changes the appearance of the cabin and ruins its historic value. Instead, replace the rotted purlin ends or rafter tails with new purlin ends or rafter tails that match the originals.

Usually, only the ends of the purlins or rafter tails are deteriorated, but sometimes the rot creeps back to the gable log or plate log. Cut the rotted purlins or rafter tails back to sound wood. If the rot extends beyond the gable log or plate log inside the building, you need to replace the whole rafter or purlin.

You probably will have to remove the roofing and sheathing that covers the rafter tails (figure 186) or purlin ends to make repairs. Chances are good that the sheathing is deteriorated, too. If so, don't save the sheathing to reinstall—just replace it after you fix the rafter tails or purlin ends. Likewise, it usually is better to replace the roofing than to try to reuse the old roofing.

After you cut off the rotted end, shape the remaining original log to receive a spliced replacement end. In most cases, use a doweled and glued half lap joint (see figure 160) to connect the spliced end to the original log. Cut the existing log and spliced end so that the lap is about a foot long, if possible. Orient the joint vertically or diagonally to allow moisture to drain out of the repair.

If the rot extends nearly to the gable or plate log, use a modified butt scarf joint (figure 187). A butt scarf joint enables you to replace the top and overhanging end while the sound bottom of the original log continues resting on the gable or plate log. Do not put any loads on the roof while you make this sort of joint; you could overload the bearing capacity of the cut purlin or rafter and cause it to break. After you complete the repair, the roof will support normal loads.

To find and shape a replacement purlin end or rafter tail log, use the techniques described in the [Selecting and Preparing Logs](#), [Round Logs](#), [Hewn and Sawn Logs](#), and [Shaping a Log](#) sections of this guide. Use a saw to cut straight joint lines. Finish shaping the joint with a chisel and mallet (figure 188), if necessary.



Figure 186—Preservation crewmembers removed the sheathing and roofing from these rotted rafter tails. The penetration of the awl into one of the rafter tails shows the depth of the rot. The crew will have to remove about a foot from the ends of these rafters.

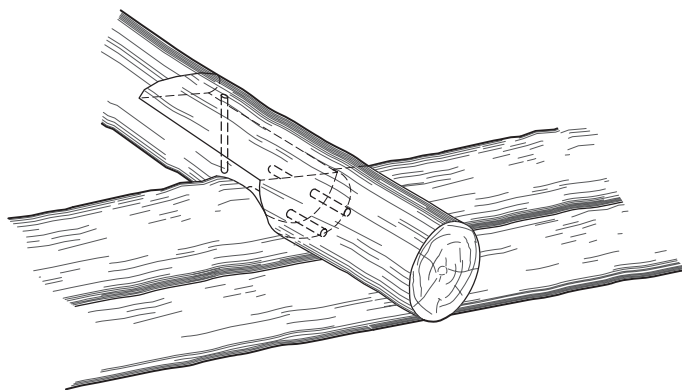


Figure 187—This drawing shows a modified butt scarf rafter tail joint. Hidden dowels join the two pieces horizontally and an exposed dowel joins them vertically. You cover the exposed dowel when you replace the roofing.

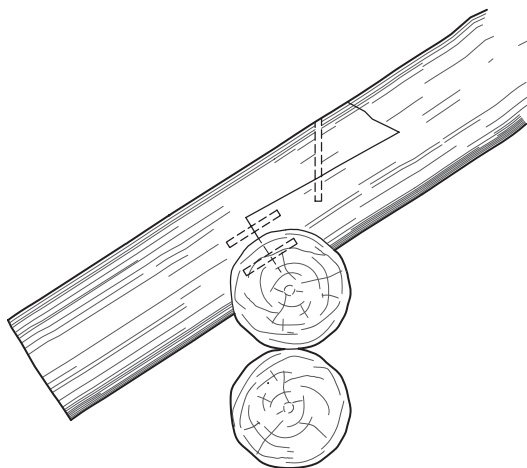


Figure 188—A preservation crewmember used a saw to cut the shape for a half lap joint on this purlin end, and a chisel to smooth the face flat.

To attach the new log end, use techniques similar to those explained in the [Epoxies](#) and [Crown End Repairs](#) sections of this guide. Shaping and positioning the joint is a little different, as shown in figure 189. Insert the dowels perpendicular to the half lap joints (figure 190) rather than angling them, as with crown ends.

When the epoxy adhesive cures, remove the clamps, trim the new log, if necessary, to match the existing rafter or purlin, and cut any protruding dowel material flush with the log (figure 191). If the original logs are painted, stained, or sealed, apply a matching finish to the new spliced purlin end or rafter tail. See the [Sheathing](#) and [Roofing](#) sections of this guide for information on replacing the sheathing and roofing.



Figure 189—Preservation crewmembers cut these rafter tails to the same pattern to make shaping and attaching the replacement rafter tails easier. They oriented the joints with a vertical splice cut to maximize the strength of the joint and to allow any water that might enter the joint to drain.



Figure 190—This photo shows three stages of rafter tail replacement using a lap joint. On the left, a preservation crewmember checks the fit of the replacement rafter tail. In the middle, the crewmember applied epoxy adhesive to the cut faces of the existing log and clamped the replacement rafter tail in place. On the right, he inserted the glued dowels into the drilled holes.

Log Repairs



Figure 191—Preservation crewmembers replaced all the rafter tails on this building. The crew trimmed the dowels flush with the rafter tails, but the dowels still are clearly visible as darker spots. Next, the crew will stain the rafter tails using the same product as the original rafter tails. Finally, they will install new sheathing and roofing.

Chinking and Daubing

Chinking fills the horizontal spaces between logs and daubing is the finish layer that usually looks like dried mud or mortar. People sometimes use the terms interchangeably but shouldn't; these materials have different functions. The author previously mentioned chinking and daubing styles and materials in the [Styles: Not All Log Buildings Are Created Equal](#) section of this guide, and explains them more completely in the [Chinking, Daubing, and Coping](#) section of [Appendix E—Log Building Origins and Styles](#). Figure 192 shows a number of ways that people have historically filled and finished spaces between cabin logs.

Do not repair chinking and daubing until all replacement logs have seasoned and you've completed all log repairs and replacements and removed all structural jacking and shoring. The only exception to this rule is that you must replace any packing between coped logs as you put the logs into the building. Retain any existing chinking and daubing that remains in good shape after you complete log repairs; repair only what is missing or cracked.

In most cases, replace missing chinking in kind. Usually the original chinking consists of local materials, such as rocks, moss, or leftovers from building the log structure. People sometimes used manufactured materials, such as oakum, for chinking. In some cases, people added chinking after occupying the cabin; this chinking might consist of such household castoffs as newspapers, magazine pages, or fabric scraps. You shouldn't replace this sort of chinking in kind. Replace missing or damaged historic chinking that attracts insects or holds moisture (paper, cloth, moss, clay, and so forth) with oakum to minimize the potential for infestations and rot. Never replace chinking with steel wool; steel wool can be easily ignited by exposure to flame or electrical current and will burn vigorously, especially if the building is struck by lightning.

Use oakum made from lightly oiled hemp or jute fibers for cabin chinking. Oakum eventually will dry out. Replace it when you make log or daubing repairs. Oakum also is an appropriate material for sealing voids to prevent rodent or bat

intrusions (figure 193) in historic buildings. Use a stick, putty knife, or slotted screwdriver to push the oakum into voids.

Replace wood chinking with pieces of wood that are of the same species and are about the same size as the original chinking. Remove bark from the chinking unless bark remains on the original chinking. If someone in the past used wood quarter rounds, sticks, or strips instead of or in addition to daubing, the same guidance applies: use wood of the same species and as near to the original size as you can find or make.

Daubing is, by design, the least durable portion of a log building. Log buildings expand and contract a little with moisture and temperature changes, and something has to give. What normally gives is something that is easy to replace: daubing. If you replace daubing with a material similar to the original daubing, the building will function as it was designed to.

Do not replace historical masonry daubing mixes with modern elastomeric daubing materials or with daubing that has a higher proportion of Portland cement than the original. Spray foam and expandable foam aren't appropriate daubing. Commercially available modern daubing products, such as Perma-Chink, Log-Gevery, or Log Jam, also are unsuitable for use on historic log buildings. The color and other visual and physical characteristics of commercial daubing products are incompatible with historic log surfaces. They aren't likely to adhere properly to the old logs and usually fail within a few years.

It's not always possible to replace daubing with the precise material that the builders originally used, particularly if the original was a manufactured material that no longer is available. In these cases, you should replace the daubing with a material that is as similar to the original as possible. For instance, Atco 1821 or 1823 tar in tubes is the most similar material to historic tar daubing available today. Apply it using a caulking gun on a pleasant day—too cold and the tar won't stick, too warm and the tar will run (figure 194). Be prepared to wear a good deal of tar by the time you complete the application.

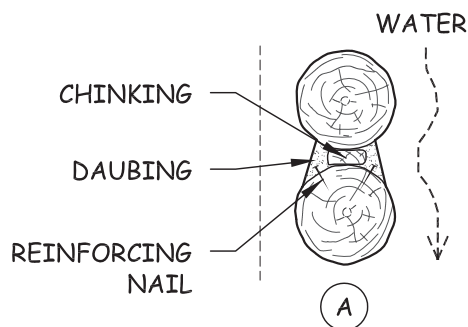


Figure 192—This series of drawings shows many of the ways that people historically filled and finished the spaces between cabin logs. Historic chinking and daubing styles include:

- A. The components of typical chinking and daubing. This shows how a well-sealed joint keeps water running down the face of the logs from entering the building, as well as keeping wind, rodents, and bugs out of the cabin.
- B. Wood chinking and “struck” style daubing with nail reinforcement on round logs.
- C. Stone chinking and “beaded” style daubing with nail reinforcement on round logs.
- D. Stone chinking and “flush” style daubing on hewn logs.
- E. Wood chinking and “weathered” style daubing on round logs.
- F. Wood chinking, “struck” style daubing on one side, and a wood strip on the lower border of the “weathered” style daubing on the other side of round logs.
- G. Stone chinking, “flush” style daubing on the hewn side, and “weathered” style daubing on the round side, both with nail reinforcing.
- H. Round logs with moss filler between quartersawn poles cross-nailed to the joint.
- I. Round logs with oakum chinking between round poles cross-nailed to the joint.
- J. Round logs with a quartersawn pole used as interior chinking and as backing for the “weathered” style daubing on the exterior.
- K. Coped round logs with masonry filler and small quartersawn poles nailed to the joints.
- L. Coped round logs with oakum filler.
- M. Coped round logs with moss filler and tar daubing.

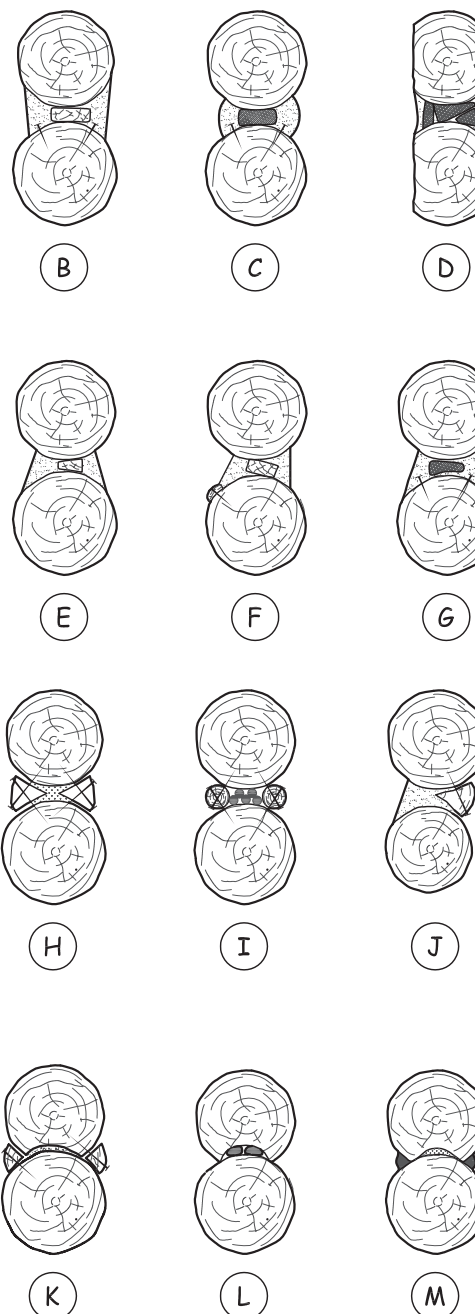




Figure 193—Preservation carpenters stuffed oakum into all the spaces between logs in the attic at the Moose Creek Wilderness Station Office/ Cookhouse building to keep bats out. Before crewmembers filled the voids and replaced the roof with shakes over continuous sheathing, several hundred bats occupied the attic each summer, creating an undesirable guano mess.



Figure 194—This worker is using a caulking gun to apply tar daubing between the logs of the Horse Prairie Cabin (Beaverhead-Deerlodge National Forest, Northern Region).

For masonry daubing, use a daubing formula and tooled finish that matches the historic daubing (figure 195). Photos taken during the condition and historic assessments of any areas of original daubing will be valuable tools for matching the color, texture, and configuration of the original. If no one took photos during the assessment but some areas of original daubing remain in place, take several photos now for later reference and be sure to save some sample pieces if you can.

The daubing on some cabins has been patched so many times that it is hard to tell which material is the original. If cabins of a similar age are located nearby, you may be able to examine the daubing for similarities that can provide clues. Older daubing, in general, tends to be a lime mix (rather than a cement mix) using local sand and sometimes other local materials as fillers.

If you don't know the historic mixture, analyze the original mortar daubing so that you can mix the replacement mortar

to match the original material as closely as possible. Engage a mortar specialist to conduct a scientific analysis to get the exact ratio of components or do your own rough analysis as explained below.

Mixes typically include lime and sand or clay. Many late 19th- and early 20th-century log buildings contain Portland cement as part of the original daubing. If your daubing is soft, then Portland cement probably is not present. If the daubing is hard, it contains Portland cement. Some mortars include straw or animal hair for reinforcement and crack resistance. Note the color of the sand and other materials. Pure white chunks in the mortar usually are lime. The sand in the original daubing probably came from a local creek or other local sand source. If you can't get the sand from the same source, ask about different sand mixes at your local sand and gravel plant.



Figure 195—The daubing on this Wyoming Game and Fish cabin in Sunlight Basin appears to contain tiny fossilized seashell fragments from the local limestone. To duplicate the appearance of this daubing, you'll need to locate the source and use the same material when you mix daubing for repairs.

To do a rough mortar analysis yourself, you need a handful of daubing. Try to get an intact chunk of daubing that is not weathered. If the daubing is weathered, most of the fines in it probably have leached out, so you won't get an accurate analysis. Crush the daubing to about cornmeal-size particles. Take a good look at the crushed daubing. Identify and record any visible reinforcement fibers or other materials.

Pour the crushed daubing into a straight-sided quart jar with a lid. Add water to nearly fill the jar, screw the lid on firmly and thoroughly shake it. Then, set the jar on a flat surface and wait. The sand settles out first, the binders (lime and Portland cement) stay in suspension for a while, and the fibers may float to the top. After the binders settle and the liquid is nearly clear, determine the ratio of sand to binder by measuring the height of the layers. The lime and Portland cement are so fine that you probably will not be able to figure out the ratio between the two.

When you know the approximate ratio of sand to binders, mix several test batches of daubing based on that ratio and the mortar mix formulas that follow. Experiment with modifications until you find a formula that reasonably matches the original daubing. Be sure to write down everything as you mix and try test batches so that you can duplicate the successful formula. Figure 196 shows the differences in appearance of several mortar formulas containing lime and cement.

You can find the type S hydrated lime in these mortar mixes at hardware or mortar supply stores. Type S hydrated lime products need shorter soak periods before application than other types. Do not confuse hydrated lime, which needs air to carbonate and set, with hydraulic lime, which sets under water. Hydraulic lime rarely is found on Forest Service cabins.



Figure 196—These mortar samples show the difference in appearance when you make mortar using various combinations of lime and white or gray cement. The preservation specialist used the same sand and water for all the samples.