Underscribing

It is not that difficult to get notches and grooves to fit tightly the day they are scribed—all it takes is a steady hand on the scriber, and careful cutting. The real challenge to handcrafted log construction is to keep those fits tight over time—over the life of the building, which can be hundreds of years.

And, in particular, we need to keep the fits tight the first five years— while the logs are drying and shrinking, and the house is *settling*. The problem is that as the logs dry out and shrink in diameter, the long grooves stay tight, while the corner notches get a bit loose.

This problem is caused by the fact that logs shrink in diameter, but do not shrink not much in length.

If corner notches get loose, then the fits become worse because the logs are free to twist. Tight corner notches restrain logs, and help keep them in place. But as logs dry, shrink, check, notches get loose, and the logs twist, gaps get bigger. If we can prevent the corner notches from getting loose, then we have a much tighter home now, and in the future.

There have been two approaches tried by handcrafted log home builders to keep corner notches tight over time:

1) Some have tried altering the shape of the notch itself, so that it tends to tighten up as the logs shrink—the *shrink-fit notch*.

2) The other approach has been to make the notches extra-tight at first, knowing that the corner notches will be shrinking, and this is called *underscribing*.

CHAPTER TOPICS

Underscribing Keeps Corners Tight

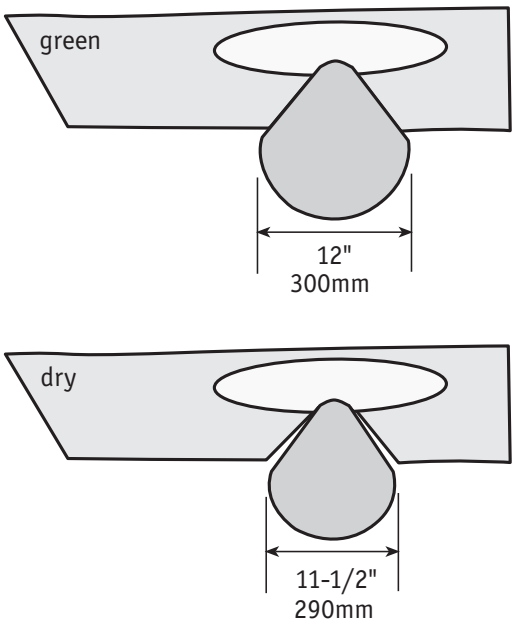


Figure 1: When the logs are green, the notch fits perfectly (top); but then the log below shrinks in diameter, the hole in the log above (the notch) stays the same width. The hole is still 12" when the logs are dry, but ***the log below is no longer big enough to fill the hole in the log above!***

This happens because logs shrink significantly in diameter, but do not shrink much in length.

The log above is not shrinking in length (the notch stays about 12"); but the log below shrinks 1/2" in diameter, and so it isn't big enough to fill the 12" hole.

See Disc 1, Box 1 of my DVD series, ***Building Log Homes*** for a time-lapse animation of this happening.

Starting in 1982, Del Radomske, a log builder and log home teacher in British Columbia, began experimenting with ways to keep corner notches tight over time. He knew that logs fit perfectly when they were green, but noticed that they did not fit very well when the logs eventually dried. In his buildings, he noticed, the grooves stayed tight and most of the corner notches got loose *(Figure 1)*.

Radomske imagined that if he could take a dry log building apart, remove a fraction of an inch from all the groove edges, and then put the walls back together, then the notches and the grooves would all be tight. He wanted to remove the wood that was preventing the corner notches from fitting tightly after the building had finished shrinking and settling.

Obviously, taking log homes apart in 4 or 5 years is not practical, and Del's great insight was that if he took a little extra wood off the grooves *at the start*, then when the logs eventually dried this would accomplish the same goal. As he saw it, the grooves were too tight in log homes after settling was complete—they were so tight that they wouldn't let the corner notches slide down the saddles, and so the corner notches got gaps *(Figure 2)*.

Underscribing is a technique that helps solve this problem: the notches and grooves are scribed using slightly different scribe settings *(Figure 4)*. Before Radomske, logs were always scribed with one scribe setting. After Radomske, we now use one setting for the groove, and a slightly different setting for a log's notches. The result has been significantly tighter corner notches over time.

Because of the way Del first visualized the problem— "the long grooves are too tight"— he calls this technique *overscribing* (he *opens up* his scribers to scribe the long grooves). Because I scribe the grooves first, and then I *close down* my scribers so the notches will be a bit tight, so I call the technique *underscribing*—I *underscribe* the corner notches.

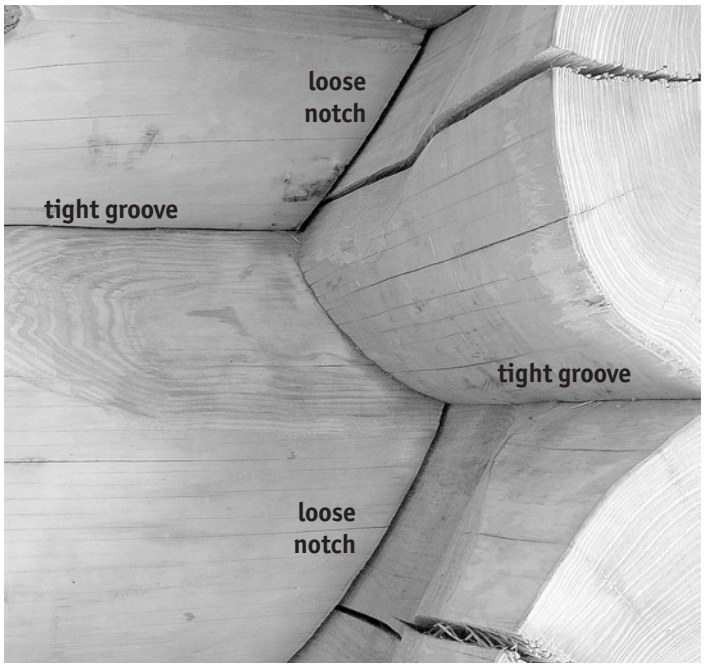


Figure 2: This building was not underscribed. As logs the logs dried, the long grooves stayed tight, while corner notches got gaps. Underscribing helps solve that problem—underscribing helps keep both notches and grooves tight over time.

Overscribing the groove and underscribing the corner notches are two names for the same thing. The long groove (*lateral*) of the new log is scribed, and then the scribers are closed down a small amount, and the log's corner notches are scribed with a slightly smaller setting. This leaves a little "extra" wood in the notches. The difference between the groove scribe setting and the notch scribe setting is called the *underscribe (Figure 4)*.

Scribe Settings for Notch & Groove are Different

We used to scribe each log with *just one* scriber setting—the notches and groove got the same scribe setting. But this made the notches gap when the logs shrunk.

Radomske tried using two different settings, and he started out small at first— a ⅛" (3mm) gap in the grooves. By the time he had two rounds on the building, he reports, the ⅛" gap in the grooves had already closed—the logs were visually tight because the notches had compressed into the saddles enough to close the small gap in the grooves. And he found that ⅛" of overscribing was not enough to keep the notches tight over time. Del built another house with ¼" (6mm) underscribe, and watched it for several years. Then he tried ⅜" (10mm) and said he was getting better results.

Figure 3: The groove is scribed, then the scribers are closed down slightly, and the notch is scribed. Perhaps you can see that the notch scribe line is a little above the groove scribe line—the difference in height is the underscribe amount for this notch.

All the Weight Starts on the Notches

At first, in an underscribed building, all the weight of the building is on the notches, and not much is on the grooves. As the logs dry and shrink, weight is slowly and gradually transferred from the notches and is shared with the grooves.

As some of the weight is transferred off the corners, the wood of the saddle rebounds, keeping the notches tight. In order for underscribing to work, the corner notches must withstand great weight without crushing. Notch edges must be so strong that the wood of the saddle is compressed *(Figure 5A)*. Compressed wood will rebound, while crushed wood is forever crushed *(Figure 5B)*.

Underscribing also requires that the notch slide down the saddle to a new position that is as wide as its original position, *before* it shrank. In order to slide, there must not be a hang-up at the top of the notch. To allow for sliding, either we leave a gap at the top of the notches, or we leave a wood seal that is so thin that it can easily crush and never cause the notch to hang up (*compare these two methods—they are shown in Color Figure C-22 and in Figure 15 on page 123*).

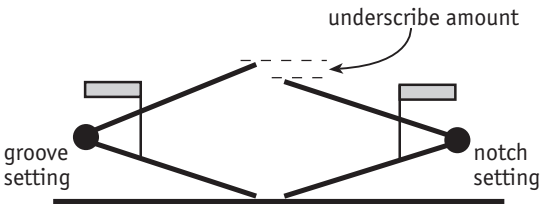


Figure 4: Find the widest gap between two logs and set your scribers at that point—this is the groove scribe-setting. Scribe the entire long groove. Then close the scribers a bit and scribe the corner notches. The difference between the groove setting and the notch setting is called the underscribe.

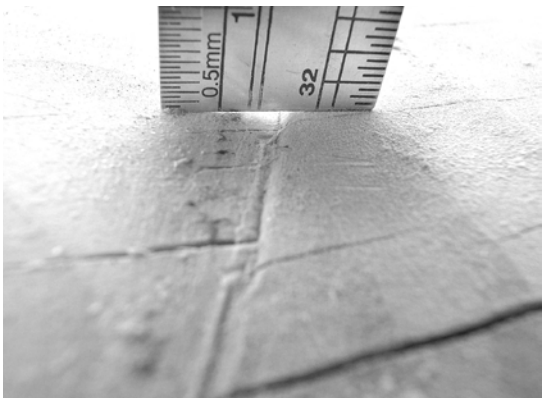


Figure 5A: A properly compressed saddle. The notch of the log above has compressed the wood of the saddle. This wood will rebound over time, and help keep the notch tightly fitted as the logs dry and shrink.

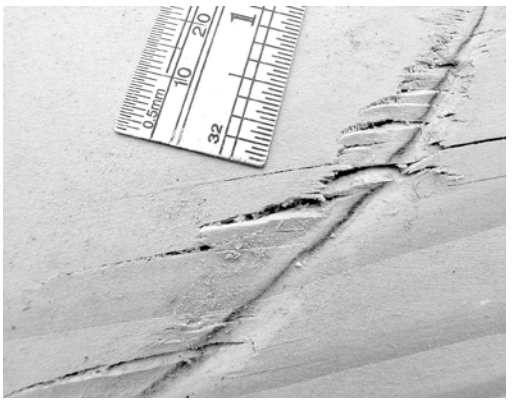


Figure 5B: Too much underscribe (7/8" (22mm)). The wood of the saddle has crushed and will never rebound. This is an underscribing failure.

How Much to Underscribe

The amount of underscribe you should use depends on: the diameter of the logs you use; and the amount of radial shrinkage your logs are expected to have from the time you scribe them to the time the logs reach equilibrium moisture content (*EMC*) with the local environment.

The trick is to estimate how much diameter your logs will lose as they dry out over the first 5 years, or so. It takes about 5 years for logs to come to equilibrium with local conditions—much more on this topic in Chapter 9— *Settling*.

New . . . and Old . . . Underscribing, Compared

In the last edition of this book I described underscribing pretty much as I learned it from Radomske. This edition has significant differences, and I want to tell you why I have changed.

With Radomske's underscribing methods, notches that had more weight on them were to get larger underscribe amounts; and notches that had less weight on them were to get smaller underscribe amounts. These were core principles of Radomske's method.

But these methods did not work for Accelerated Log Building. In 1999 I started to build log home shells with an entirely new method that I patented, called *Accelerated Log Building*. I soon found that I could not use traditional underscribe methods: I could not use the underscribe amounts found in the last edition of this book. I could not find a way to apply the original underscribe method of using a larger underscribe amount on long logs, less underscribe on logs that have lots of notches, or using less underscribe the higher the log is up the wall.

But . . . I could not immediately see *why* Radomske's original methods wouldn't work. In fact, if the old underscribe methods were correct, then they *should* have worked for both one-log-at-a-time methods and my Accelerated methods. I hate an unsolved puzzle, so I started working to try to understand what the problem was. Now, after 11 years of experimenting and testing, I think I am using a better underscribe method. It is also simpler to use, and it works for both one-log-at-a-time log construction and Accelerated building methods.

My new underscribe method is based on log shrinkage. My new underscribe methods are *not* based on weight or compression, which varies with log length, number of notches, and the height of a log in the walls.

The 2006 edition of this book considered *both* shrinkage and compression, and had a chart that reflected the impact of both. But now I consider *only* shrinkage when deciding how much to underscribe. And I'm getting better results.

Hint I am now using just ***one*** underscribe amount for all the notches in a building.

To state the new method clearly: I am now using only one underscribe amount for an entire house. No matter how many corners, no matter how long or short the logs, and no matter whether a log is low or high on the wall, I am using just one underscribe amount for all the notches in a house. The underscribe amount is based on radial shrinkage of the logs; and the long-term goal is to have the corner notches slightly tighter than the long grooves.

Radial Shrinkage

Look up the tree species you are using in the *Wood Handbook*, Table 3-5 (available for free download from my website or from the USDA Forest Products Laboratory). Find the radial shrinkage from green to ovendry for your species. Then find the equilibrium moisture content (EMC) for your local climate. On page 141 of this book there is an EMC map of the lower-48 of the USA, and from my website you can download a publication that has EMC data for most the world:

www.LogBuilding.org

Next, you need to reduce the radial shrinkage amount you find in Table 3-5, because your logs are not going to dry (or shrink) down to 0% moisture content (*ovendry*)—your logs are going to stop drying when they get to your local EMC. EMC is usually between 4% and 13% moisture content, and depends on your local climate.

As an example, if you are using Eastern white pine, total radial shrinkage is 2.1% (from Table 3-5). But, if you are building your house in a location that has 10% EMC, then your logs will not shrink 2.1% (which is the shrinkage from green to 0%), they will shrink only about 1.4% (the shrinkage from green to 10%).

A 20" diameter white pine log that shrinks 1.4% will lose a bit more than ¼" of diameter (in metric: a 51cm white pine will shrink about 6mm). And I'd probably use ⅜" (9mm) to underscribe all notches.

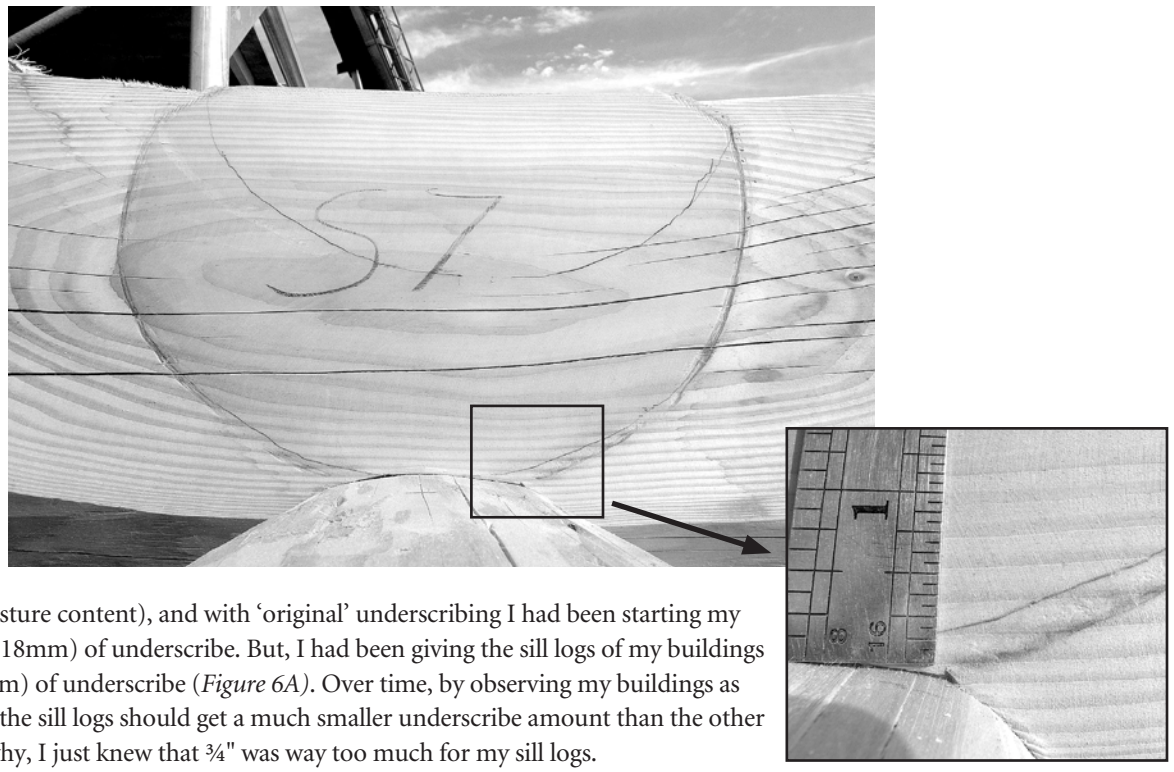
Figure 6A: Sill logs, showing the underscribe amount. For sill logs, the difference in height between the three-quarter-sill-log flat and the half-sill-log flat is the underscribe amount.

Figure 6B: In the building yard, about 100% of the weight of the building is on the notches, and little weight is on the grooves. In this photo you can see that the notch has compressed the saddle, and this is the result that we want.

Here you can see that the notch slid about 1/4" (6mm) down the saddle. In the detail picture, the scribe line is above, & the dent made by the notch, after it slid down the saddle, is below.

Sill Logs

Although they have no grooves, you still need to underscribe the notches of the three-quarter-log sills where they cross over the half-log sills. In the last edition of my book I noted that I was getting better results if I underscribed the three-quarter-log sills only *half* of the amount shown in the chart in the old book.



As it turns out, this was one of the clues as to how much underscribing should be used. It just took me a few years to realize it!

I use 12" (30cm) top diameter and 18" (46cm) butt diameter Douglas fir logs (radial shrinkage of about 2.7% from green to my local equilibrium moisture content), and with 'original' underscribing I had been starting my buildings with about ¾" (18mm) of underscribe. But, I had been giving the sill logs of my buildings *half* this amount, ⅜" (9mm) of underscribe (*Figure 6A*). Over time, by observing my buildings as they dried, I realized that the sill logs should get a much smaller underscribe amount than the other wall logs. I didn't know why, I just knew that ¾" was way too much for my sill logs.

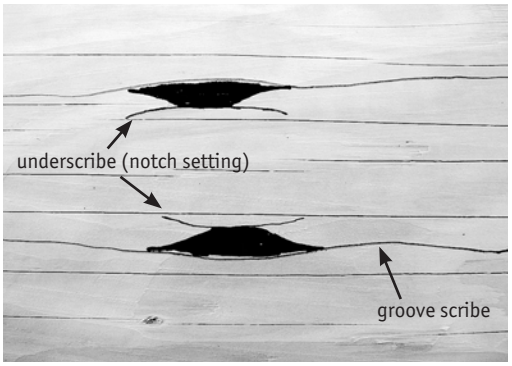


Figure 7A: Tabs can be scribed to hold up underscribed logs at the right gap. The short scribe lines inside the groove were scribed with the notch scribe setting (underscribe). I marked the wood that is to be left as tabs with a black felt pen to make them easy to see.

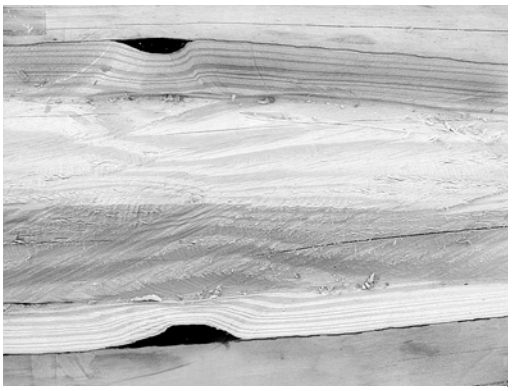


Figure 7B: Tabs in a long groove that has been cut and sanded. (This is not the same log as Figure 7A.) These tabs are about 1 inch (25mm) long.

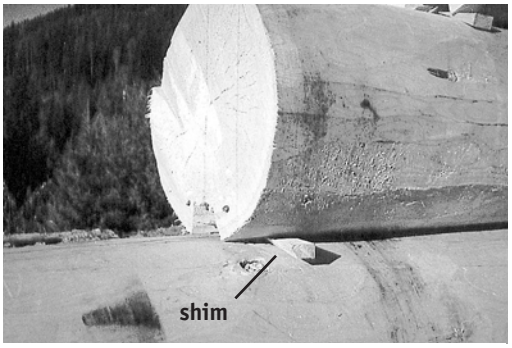


Figure 7C: Wooden shims or wedges can hold up the end of the log that has no notch—this keeps an even gap in the groove from end to end. This is a substitute for tabs.

And now, I've discovered, ¾" is actually too much for *all* the notches, not just too much for the sill logs. And ⅜" (9mm) of underscribe is about right for the whole building. In every corner, and from the bottom to top of the walls—all my notches get about ⅜" (9mm) of underscribe. (These figures are for my logs, and in my climate.)

Climate & Moisture Content Affect Underscribe Amounts

There are other conditions that affect the amount you should underscribe, but it is difficult to quantify exactly how much effect they have.

Use less underscribe if you are using dry or dead-standing logs—but you must test the logs with an electronic moisture meter to determine how much drying they still have left. Never use the weight of wood to guess at moisture content (MC). The amount of underscribe is proportional to moisture content as long as the wood has a moisture content that is less than fiber saturation (about 30% MC). Logs that are drier than 30% need a smaller underscribe amount than if those same logs were green.

Climate (ie, EMC) also affects drying and the underscribe amounts. A log home in a damp, coastal climate requires less underscribing than a log home in a desert. Finally, log homes at high elevations may need slightly less underscribing.

But keep in mind that underscribing is not an exact science, at least not yet. The basic underscribe comes from the table of radial shrinkage, and is then reduced by your local EMC. But experience and observation also figure in. Underscribing definitely improves the fits over time, but it is difficult to calculate exactly how much a log should be underscribed when you consider all the variables: EMC, elevation, the starting moisture content of the tree, and the fact that all trees have two diameters: butt and tip, and they will shrink different amounts, depending on their diameters. All we can do is make an educated guess, and luckily this is good enough. Underscribing works: it *does* keep corner notches much tighter over time.

One-Notch Logs Need to be Held Up

Some logs have less than two notches—for example, logs that extend from a corner to a door opening; and some logs have no notches at all, like those between a door and a window. You need a way to hold up the ends of logs like these.

One effective technique is to scribe small *tabs* at the end, or ends, that have no notch. These tabs are portions of the long groove that are scribed with the same scribe setting as the notch *(Figures 7A & 7B)*. The tabs prop-up these special logs, and keep an even gap in the groove, and the tabs are sometimes cut off later when the door or window opening is cut to its final width.

The tabs can usually be about 1" to 2" (25-50mm) long, though you could make them shorter for short logs.

Instead of tabs, you can use wooden shims or pieces of conveyer belt at the log ends that have no notches *(Figure 7C)*. You can pull the shims out over time to keep the gap in the long groove even, but they usually just conveniently crush on their own as needed.

Make Sure There Are No Future Hang-ups

You must be precise when scribing and cutting underscribed logs because there is no good way to test for the eventual fit, or find possible future hang-ups.

When we scribed logs with equal scribe settings (that is, no underscribing) we could see exactly how it fits when we put the log on the wall. If there was a problem, we knew it immediately. But, when you put an underscribed log on the wall, the grooves are a bit loose (*Figure 8*), and there is no perfect way of knowing whether there is an extra bit of wood somewhere that will be in the way in four or five years.

You should also use a scriber that marks both the top and the bottom scribe lines, not a scriber that holds only one pen or one pencil. You need *both* lines in order to get the log back in exactly the right place. With both sets of lines, just match up the notch so it on the scribe lines on the saddles at both ends.

Figure 8: Looking down the inside of an underscribed long groove. No future hang-ups in sight here. There is a long, consistent-size gap in the groove of the log. The height of this little gap is equal to your underscribe amount.

How Long Will There Be Gaps?

The most common question about underscribing is: what do you do with the gaps in the long grooves? The answer is simple—there are no visible gaps by the time the roof is on the building.

There are some builders who use more radical underscribe amounts than I do. But for me, the gap in the grooves are closing by the time there are 3 or 4 rounds of logs above them. The grooves are visually tight when there are about 4 or 5 rounds of logs in the walls. The long grooves of the top several rounds in a building start to appear tight when the roof is on.

When I was using the old underscribe methods, and was reducing the underscribe until it was only about 1/16" (less than 2mm) for the notches of the topmost logs, those notches opened up 5 years later. That was not enough underscribe to keep them tight. Now, with the new underscribe, I use the same underscribe amount all the way from the bottom logs to the top plate logs, and the notches high on the walls are now staying tight.

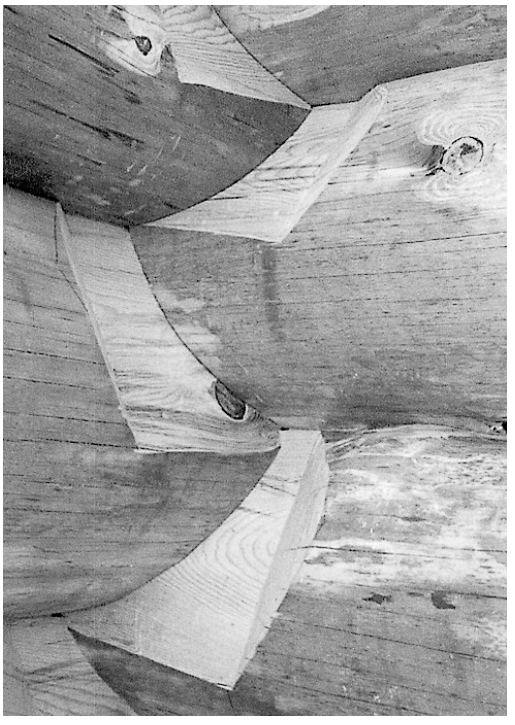


Figure 9: The shrink-to-fit, or Beckedorf "butterfly" notch. The saddle, instead of being flat or slightly concave, is convex—that is, the saddle is higher in the center. This is a photograph of a corner in the log home that I live in.

Settling

The shrinkage and compression in an underscribed building is identical to shrinkage and compression in a building that is not underscribed. This means that settling will also be the same—allow about ¾" per vertical foot of logwork (6%). There is no extra weight to cause more compression, there is no extra shrinkage, and the safety factor is the same, and so the settling allowance is the same.

Shrink-fit Notches

The other method that has been tried to keep notches tight over time has been to change the shape of the saddle—creating a high spot near its center. Invented by Lloyd Beckedorf, the *butterfly* notch, has not been adopted by professional builders as widely as underscribing has been. My own experiences so far with it have shown me that with my logs, in my climate, and using my building techniques, underscribing is more effective for me than shrink-to-fit notches. The shrinkage I get in log diameter has not seemed to bring the log back to a fat-enough part of the saddle to keep the notch tight over time for me.