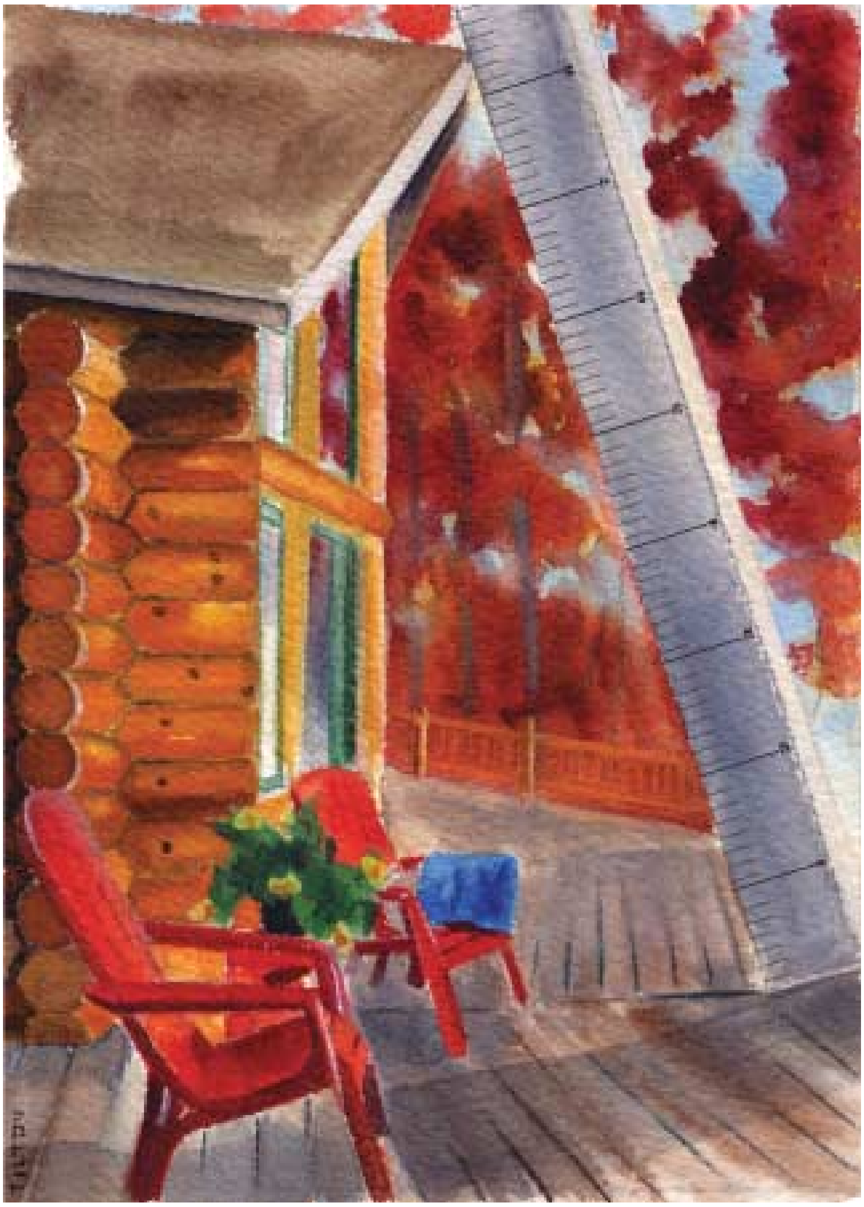
Honey, I Shrunk the Logs

UNDERSTANDING AND DEALING WITH SETTLEMENT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Just about every log-home company talks about it, uses it to their advantage in their marketing and has a "better" solution than their competition for dealing with it. Every full-log home has to deal with it to some degree. It's primarily the result of moisture evaporation in logs, commonly referred to in the log-home industry as settling.

In simple terms, settling is the decrease in overall height of a log wall due to log shrinkage. The soon-to-be-released International Code Council "Standard on the Design and Construction of Log Structures (Log Standard)" defines settling as the combination of three separate mechanisms: radial shrinkage, slumping and compaction.

Generally, the most important, radial shrinkage is a decrease of the log's diameter due to evaporation of the moisture in the wood cells. This drying causes the majority of settling.

Compaction and slumping are typically a concern only with cope-style logs. Swedish-cope logs or cope-style logs have a cross section similar to a pie with a missing piece. The logs are oriented so that the cope, or missing piece, is on the bottom side of the log bearing on the log below it. In most cases, the cope is purposely cut so that the corners of the cope are the only portions of the top log that contacts the bottom log, and there is a small air gap between the logs in the middle of the cope. As the log dries, the cope opens up (the missing piece of the pie gets larger), and the top log sits lower on the bottom log. This reduction in height is called slumping.

If the contact points between log courses are narrow and loads that the log wall are supporting are high, the wood fibers may be crushed. This crushing of wood fibers is called compaction. Logs with large bearing areas or flat-on-flat surfaces (such as a D-profile log) are generally not subjected to slumping and compaction.

Wood cells are long and narrow and oriented parallel to the long direction of a log. The cells are like fire hoses. If they are filled with water, they are mostly round, but when the water is released, they lose their shape and shrink. It's this shrinking of the wood cell that causes the overall log to shrink. Wood cells also act like fire hoses in that the greatest percentage of dimensional change happens radially (in terms of diameter) with little or almost no change longitudinally (the length of the hose or log). So logs or studs (such as 2-by-6s) carrying load in the long dimensions (typically oriented vertically, such as in a column) change very little in dimension—so much so that it can be ignored for practical purposes. However, if the logs are carrying load perpendicular to their long dimension (typically oriented horizontally), the dimensional change is significant and has to be dealt with.

Why does all this matter? Log homes are built with a combination of horizontal and vertical logs. If the differing dimensional changes of these logs are not properly addressed in the construction of the house, bad things happen. Windows crack, doors don't close, the roof leaks, beams break, and loft floors have tsunami-like swells in them.

Many log-home manufactures and contractors are well versed in the design nuances of log settling and have successful and even patented methods of dealing with it. A word of caution: Even though the system is patented or unique, it may merely be a complicated solution to a simple problem—in other words, a marketing gimmick.

Except for log compaction, settling is the direct result of the logs drying. Since all logs were once trees, and all trees use water as part of their photosynthesis food-making process, logs start their log-home destiny wet. Numerous tree species are used in the log-home industry, and each species has its own wood-cell equilibrium moisture content.

To keep things simple, most wood-cell shrinkage does not begin until the moisture content (MC) of the wood drops to below an average of 27 percent (actual range could be anywhere between 18 and 35 percent). According to the Log Standard, four climate zones exist in the United States, based on temperature and humidity (dry, moist, warm-humid and marine). Logs in these climate zones will have average final moisture contents of 10, 13, 14 and 15 percent respectively. Other factors, such as how the house is heated, may also affect the final moisture content of the logs.

The greater the difference between the beginning and final moisture contents of the logs, the more settling will take place. With a 9-foot wall this settling may range from 1/2 inch to as much as 4 inches. It can easily be seen that when the horizontal log walls of the house settle 4 inches and the log posts that support the roof don't settle at all, there will be problems.

In theory, the solution to settling is easy. Since the log walls decrease in overall height, any and all other parts of the house that are not log walls need to be made to act like a log wall. Adjustable screw jacks can be used under logs or steel posts. Slip joints can be created around window, door and chimney openings. Cabinets need be attached to only one log.

Some issues are not so easily dealt with, however. Rigid plumbing pipes running up to the second floor need special flexible joints. Common and typically inexpensive interior load-bearing stud walls need to be designed as beams supported by adjustable posts with a non-load bearing wall built around the post-and-beam support system. Stairs that have strict code requirements about the height between each step may have to be slightly shorter in anticipation of final settled floor heights.

Full-log gable ends are another concern. (The gable is the triangle portion of the wall formed at each end of the roof, with the bottom corners of the triangle formed by the eave and the apex of the triangle formed by the ridge or peak of the roof.) Full-log gables are constructed where there may only be one course of logs at the eaves and 20 courses under the ridge of the roof. If each log settles 1/8 inch, the eaves will settle 1/8 inch and the ridge will settle 2-1/2 inches. Obviously, this is not a good situation, and this type of construction needs to be avoided. Viable solutions are to use a non-settling log system (discussed below) or a stud-framed wall with half-log siding applied to match the full logs.

Another option to deal with settling is to force the log walls to behave like the non-settling portions of the house—in essence eliminate settling in the logs. In many instances, this approach may be less expensive than the combination of settling jacks, slip joints and other modifications necessary for a settling home.

The Log Standard states that if settling is less than 0.05 percent of the total log wall height (1/2 inch for an 8-foot wall) the log wall can be constructed and designed as a non-settling wall; however, this percentage must be mathematically verified by engineering analysis, empirical testing or field survey of existing homes.

Non-settling log walls can be accomplished several ways. The first is to construct the house out of logs with the same average moisture content as the climate zone the home is being built. In other words, if the final moisture content is predicted to be 14 percent, then build the house with logs that have 14 percent moisture content. This is much easier said than done as even the most rigorous kiln-drying schedules seldom bring the core moisture content of logs below 19 percent. Air-drying is a viable alternative, but it also seldom brings the core moisture content of logs below the 19 percent.

It's best to ask the manufacturer how the moisture content is measured, as the average moisture content is crucial. ASTM D4444 defines average moisture content as the moisture content at a depth of 1/6 the diameter at that point. If the outer inch of the log is dry, that doesn't mean the core is dry, and shrinkage may still happen. As for the ends of the log, it's back to the fire-hose analogy. The ends of the log are like the end of the fire hose in that water dries very quickly from the ends; measuring moisture content at the end of the log will likely provide erroneously low moisture contents.

A second option for a non-settling system is to use an anti-settling fastener, such as a fully threaded lag screw or other specifically designed anti-settling fastener, such as the tested and proven WT screw from SFS Intec. In any case, the fastener has to be engineered and or empirically tested to be a proven anti-settling device. Testing has shown that placing standard log-home screws on an angle does little to thwart settling.

Laminated logs may also be used. Similar to a glued laminated beam, laminated logs are composed of layers of wood pieces, usually 1-1/2 inches thick, glued together and milled to the shape of a log. Since the laminations are thin, drying is easily accomplished in a dry kiln, and like plywood, the laminated layers counteract each other to produce a dimensionally stable product.

Finally, walls could also be built with standard stud-frame construction and covered in half-log siding.

The good news is that when the Log Standard is released (likely this spring), state and county jurisdictions will have a standard available to them to help enforce proper log-home construction. Until then, avoid settling issues by using a reputable manufacturer and builder, or a knowledgeable engineer or architect. The Log Homes Council's member directory (www.loghomes.org) is a great place to start a search. **LHI**

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