Hold Everything

FASTENERS HELP LOGS COMBAT ENEMY FORCES

Why are fasteners so important in log construction? The quintessential log cabins of America's frontier didn't have them.

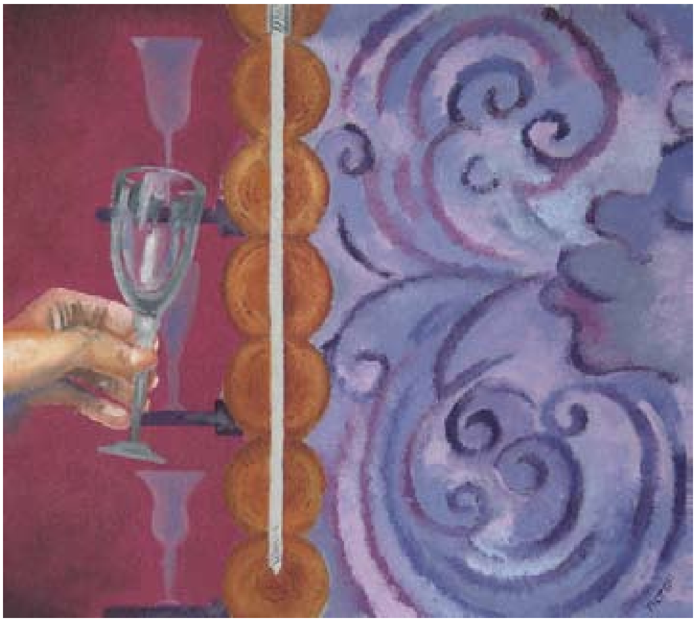
The forces acting on a house, be it log, stick-framed or cave, haven't changed since man decided that shelter was a good idea. In chemistry it's called entropy, the tendency of a system to move from order to disorder. The point is that gravity, weather and plate tectonics remain constant and are doing everything they can to bring a log house to a greater state of disarray, i.e. falling down and decaying.

What has changed since the time of frontier cabins is research that has improved the understanding of how a home works structurally and what it takes to make it stand. Society has also decided that safety is important. One hundred fifty years ago, if your log roof fell down during a snowstorm, you either died and didn't have much to worry about, or you endured severe frostbite and rebuilt a new roof with bigger, stronger logs.

Modern society has deemed such a trial-and-error approach to home building as unacceptable. I'm sure mortgage companies and attorneys had some say in the matter as well. In any case, what worked 30 years ago will probably still work today, the caveat being that in our endeavor for a safer place to call home, building codes have gotten stricter—not to mention we no longer live in 15-by-20-foot log cabins.

If a structure were analyzed with gravity as the only external force acting on it, fasteners would be less critical. (Gravity forces, which act in the direction of gravity, can also be thought of as forces created by weight; e.g., the weight of the snow on the roof, the weight of the logs themselves, the weight of a cast-iron stove, etc.) Think of the toy Lincoln Logs houses that you made as a kid. The only force acting on those was the weight of the logs themselves—at least until big brother's G.I. Joe tank launched a perfectly aimed Converse shoe missile at it. The Lincoln Logs structure was assembled without any sort of fastener and stood just fine. External lateral forces, such as wind and earthquakes, did not exist in the playroom, and the height of the structure was typically limited by how good Santa was that year and how many log pieces came in the set.

Continuing with those toy logs, it must be noted that they were analogous to a full-size handcrafted, chink-style log home. Two things are noteworthy: First, the logs are continuous from corner to corner; second, the corner notches help keep the logs in place.



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Imagine a Lincoln Logs set without corner-to-corner continuous logs. Some logs would merely be filler logs and not have any corners. Obviously, the toy would lose some of its appeal, as building any sort of structure would be incredibly challenging because the logs would have to be perfectly balanced on top of one another. Any slight imbalance in the construction, and the logs would move out of place, and the structure would fall down.

Most milled-log homes, such as those made with D-style logs or Swedish-cope logs, do not have continuous logs that span corner to corner. Add in some window and door openings, and the structure would be too unstable without the use of fasteners. If lateral forces, such as wind and earthquakes, are considered, the design requirements become even more complicated. (Lateral forces push or pull on a building in a direction that is parallel to the ground. Wind blows on the side of a house, and during an earthquake, the ground moves back and forth under the structure, causing the structure to be shaken in a back-and-forth motion.)

THE FORCE THAT A 90 MPH WIND CREATES ON A STRUCTURE TWO STORIES TALL AND 40 FEET LONG EQUALS THE WEIGHT OF FOUR MID-SIZE SUVS.

Back to the toy logs, if the picture of the log house on the toy's packaging has been meticulously replicated on the bedroom floor and all the figurines appropriately placed, it's ready for mass destruction. Besides big brother's shoe missile, destruction usually took place in a lateral or sideways blow. The house wasn't stepped on but kicked. Stepping on it would merely crush the preformed plastic roof trusses, while kicking it had a havoc-wreaking, though somehow entertaining effect that scattered the logs all over. The effect of lateral loads is clearly seen.

Undoubtedly, the strength of a human kick relative to a small toy house is not in proportion with real world lateral forces and full-scale homes, except for a large explosion or maybe a Class 5 tornado. The point is that lateral forces need to be dealt with, as they can be devastating. The way we deal with gravity and lateral forces in log homes is with fasteners.

Fasteners perform several functions in a log home. They provide uplift (the opposite direction of gravity) resistance from wind forces. Generally, this is caused by uplift created by the wind, though lateral forces can create uplift forces as well.

Fasteners also hold the logs laterally in place, both in the plane of the wall and perpendicular to the plane of the wall. Lateral or horizontal movement between log courses may be caused by several phenomena, including wind, earthquakes and log warping. Twenty years ago, log homes were smaller than today, most being second homes. Current architectural trends in log-home design feature three or more stories, walkout basements, 10 to 20 corners (compared with a traditional four-cornered home), structural log trusses and intricate roof layouts. Small cabins are still a hot item, but homes ranging from 2,500 to 10,000-plus square feet tend to be the norm in today's market.

The force that wind creates on a structure may range from 10 to 50 pounds per square foot (psf). A wall two stories tall and 40 feet long has a resultant force of 16,000 pounds (the same as the weight of four mid-size SUVs), assuming a mild 20-psf wind load (approximately 90 mph). Seismic forces can be 10 times this amount. Fasteners have to resist these forces.

FASTENERS ABLE TO RESIST SHEAR FORCES BETWEEN LOGS ARE NECESSARY TO RESIST RACKING OF THE STRUCTURE. ONCE THE STRUCTURE IS RACKED, IT STAYS THAT WAY.

Fasteners are not responsible for resisting all of the lateral loads. Friction between log courses, especially when a tongue-and-grove or full-scribe system is used, provides significant resistance to lateral forces. The problem in the engineering world is quantifying how much friction exists, and many engineers ignore the strength contributions of friction between logs.

Imagine the variability with friction. Just about every hiker or hunter has slipped on a barkless wet branch or log. A few sprinkles of rainwater, and a peeled log is just as slippery as an icicle. On the opposite end of the friction spectrum is a full-scribed, handcrafted log that fits the log below it perfectly. It would probably take a skid steer or small bulldozer to create movement between the logs. To my knowledge, no known methodology or standard exists for quantifying friction between log courses, and so it gets ignored. Consider friction as cushy safety factor.

Corners. Ah, yes, corners. They add strength to a house, right? Indeed they do, but not as much we all think. Corners are intermediary joints that transfer load from a given wall to an intersecting wall. Think of an empty cardboard box all packaged up for shipping. It is a relatively rigid cube that maintains its shape for all practical purposes. Imagine that same cardboard cube with the folding top pieces free to flop along their hinges. The box is still relatively strong, though the sides or walls may be a little weaker because the top is not taped shut (similar to a house without a roof).

Now imagine the box with the top open and all the vertical corners cleanly cut with a utility knife. It has no rigidity and literally falls into a flat pile of cardboard. Without being able to transfer load from one wall to another through the corners, the box does not stand—regardless of the strength of the walls. The same holds true for house.

The actual engineering phenomenon associated with the corners is much more complex than this. Simply put, it is the intersecting wall that is truly adding strength to the structure, not the corner. The more rigid the intersecting wall, the stronger the house. Since friction is generally assumed to be zero, fasteners are typically relied on to make the wall rigid.

Back to the box. This time, imagine it fully taped up for shipping and all the corners intact but with some large openings in all

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the sides or walls of the box. At least one of the openings should be almost as large as the wall itself; e.g. a garage door. The box does not collapse under its own weight but can easily be twisted, racked or crushed. This is what happens to a log house when openings are placed in the log walls. Fasteners become extremely critical in walls with large openings because there is not much wall space to utilize the fasteners.

What is it the fasteners are actually doing? Back to the toy Lincoln Logs one last time. This time, I got to play with them. I built an overly tall square structure without any windows or doors to show the effects of lateral loads (my finger) on the structure. Gently pushing on the side of the house either moved it sideways if it was on a smooth surface (my desk) or racked it if it was on a rough surface (carpet). Racking is the engineering term for the house profile going from square to trapezoid. The side walls are slightly angled, while all the logs remain perfectly horizontal. This is caused by the logs courses slipping between each other. If I pushed hard enough while the house was on the rough surface, the house started to tip over.

MOST MILLED-LOG HOMES, SUCH AS THOSE MADE WITH D-STYLE LOGS OR SWEDISH-COPE LOGS, DO NOT HAVE CONTINUOUS LOGS THAT SPAN CORNER TO CORNER.

The need for fasteners able to resist shear forces between logs is necessary to resist racking of the structure. Once the structure is racked, it stays that way. The need for fasteners with high shear strength must also be noted in order to keep the structure from sliding. In this example, the structure slid on my desk; in the real world, however, the structure has to be designed to prevent its sliding off its foundation.

Clearly, the need for uplift resistance can be seen when a strong enough lateral load is applied. No one wants a house tipping over. The structure's own weight often lessens this concern, but in tall or narrow homes, this is a very real concern.

As complicated as some log homes appear, it literally comes down to the fasteners in the log walls to ensure the structure doesn't blow over, slide off the foundation, rack out of shape or tip over when the wind blows or the earth shakes. Ensuring proper fastener placement and selection, therefore, is paramount. **LHI**

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