BY ROB PICKETT

Log Fastening Solutions Part II

Everything you need to know about the fasteners that hold your logs together

Editor's note: In the last issue we discussed the fastening techniques commonly used in log construction. In this issue we discuss forces acting on log walls and factors affecting log wall connections.

Fasteners serve practical and structural purposes. In a practical sense, they help maintain alignment as the logs are attached and they restrict the twisting of logs as the wood seasons (dries). The structural purpose of fasteners, however, is to resist forces placed on the log wall so it acts as one unit rather than a collection of individual pieces. The repeated fastening of one log to another allows the wall to act as a whole.

When the wind blows, the earth shakes or snow falls, these forces of nature put stress on a structure. The forces (or loads) are measured in pounds per square foot. Loads not only put stress on the individual structural components (roof, walls or floors), but on the connections that hold those components together.

Each individual component — and the connections associated with it — resists stresses from the loads and transfers them to other components, then to the foundation and eventually to the earth where it dissipates.

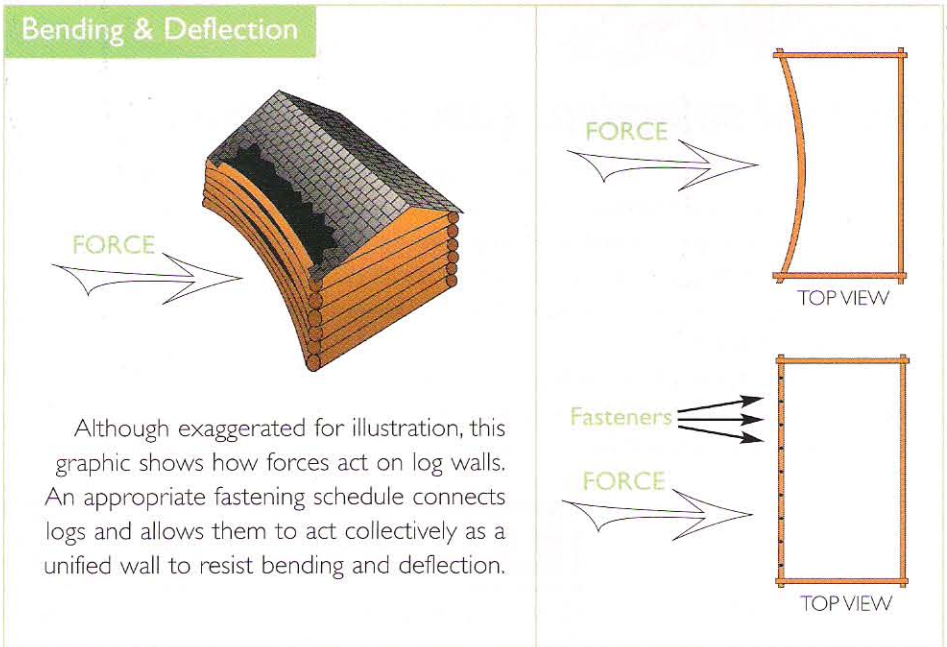
FORCES ACTING ON LOG WALLS

Vertical loads consist of the weight of the roof structure (dead load) plus the loads imposed on the roof by wind and snow accumulation (live loads). Vertical loads are easily dispersed through solid log walls and carried down to the foundation. Where connected to the log wall, upper level floors also transfer their dead and live loads to the wall. And then there is the dead load of the logs themselves.

Log wall connections become more important when loads are imposed perpendicular to the wall surface (such as by wind and seismic activity). This is called **horizontal, or lateral, loading**. Lateral loads vary in intensity and frequency of occurrence by geographic proximity. For example, West Coast areas have greater requirements in response to earthquakes, while Gulf and Atlantic Coast states are more concerned with hurricane winds. While walls and support posts carry vertical loads to the foundation, lateral loads are transferred to the foundation by a combination of connections and supporting structures.

In examining the rigidity of a log wall against lateral loading, three types of reactions are recognized: Bending, overturning and racking.

Bending. Just as a long bookshelf bends under the weight of heavy books, a log that is only fastened on the ends can bow under pressure from continual loading. When log courses aren't fastened together, each log resists the load independently, (see diagram). By adding fasteners, the log courses resist the load together as a unit and distribute it

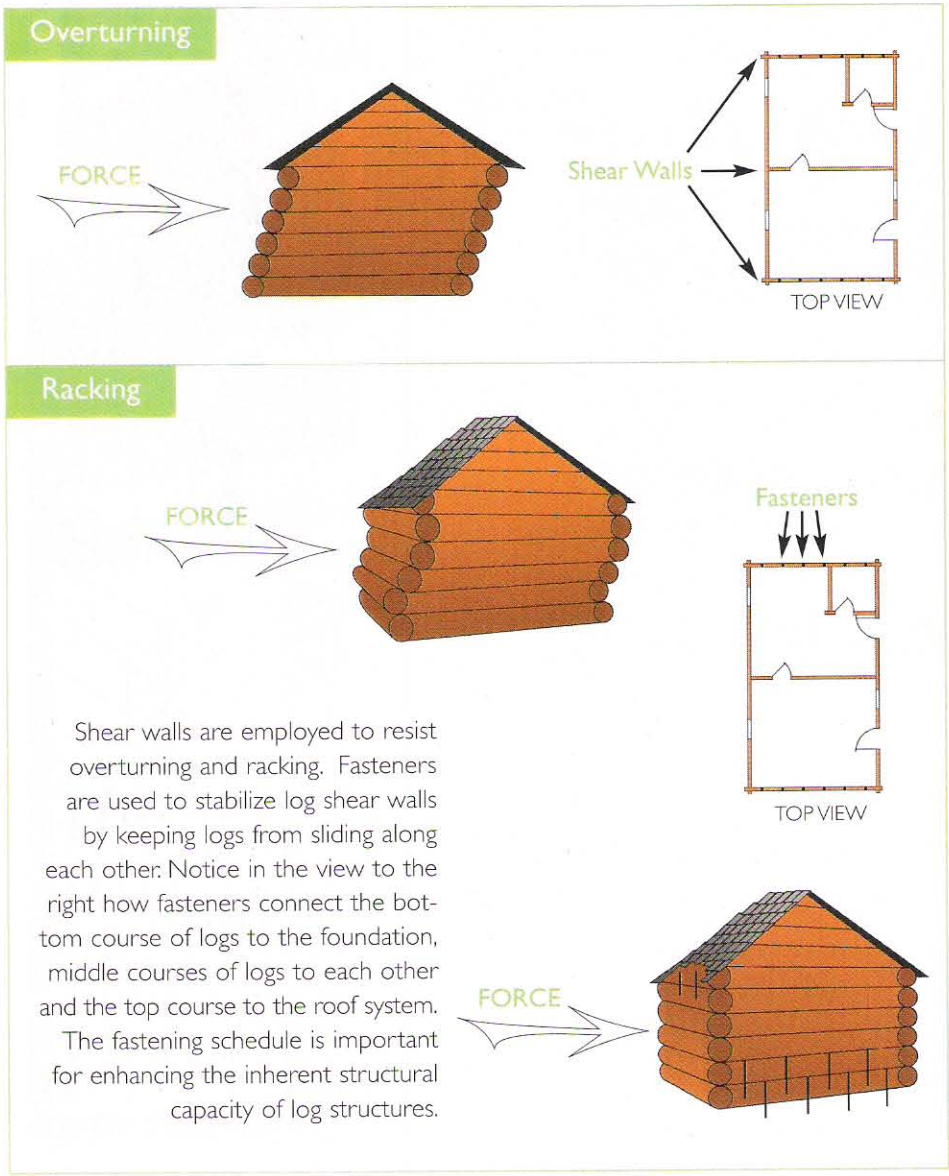


Although exaggerated for illustration, this graphic shows how forces act on log walls. An appropriate fastening schedule connects logs and allows them to act collectively as a unified wall to resist bending and deflection.

throughout the wall rather than just along one log. Acting similar to a built-up beam, the log wall transfers the lateral loads to the wall's bearing points (the corners, for example). Using a simple beam calculation, a designer can determine if the log wall can span from corner to corner or if it will need intermediate support (using interior walls or stiffening posts).

Overturning. Overturning force is developed when the building is not wide enough or does not have sufficient support from perpendicular walls, floors and the roof (see diagram). While the geometry of the building is particularly important, perpendicular (shear) walls at corners and intermediately along the wall are crucial for resisting overturning.

Racking. Deformation of a perpendicular wall due to shear force is known as racking. Lengthening the wall and specifying the number, type and placement (a.k.a. the fastening schedule) of fasteners in the perpendicular shear wall are the primary methods used to resist racking. The wall length is set for adequate transfer of loads to the foundation and has a direct impact on the fastening schedule, as does the presence and location of openings for doors and windows.



Shear walls are employed to resist overturning and racking. Fasteners are used to stabilize log shear walls by keeping logs from sliding along each other. Notice in the view to the right how fasteners connect the bottom course of logs to the foundation, middle courses of logs to each other and the top course to the roof system. The fastening schedule is important for enhancing the inherent structural capacity of log structures.

The fasteners are specified as needed to keep log courses in the shear wall from sliding along each other as lateral forces act on the exterior walls.

FACTORS AFFECTING LOG WALL CONNECTIONS

Fastener type, quantity and spacing are determined by the extent of the vertical and lateral loads a log wall must withstand. The load is resisted by the sum of all the fasteners in a given assembly of timbers. It's not unusual to use more than one type of fastener in a log wall to accomplish the required connections, especially where loads are above average. A connection design is drawn up to map out the fastener schedule. Factors that impact the connection design include:

Wood species. The strength of a connection varies with the physical characteristics of the wood being used. These characteristics are assessed to accommodate connector calculations.

Seasoning effects. Change in moisture content will also determine the extent of dimensional change in an individual log or the differential settlement over the height of the wall because logs in a wall shrink at different times, rates and amounts. The fastening system can be used to hold individual members in place (to shrink around themselves) or to accommodate differential settlement. The latter involves several options from oversized lead holes to constant pressure to proprietary fasteners designed for this movement.

Wall sealing system. The wall fastening system must be developed in response to the nature of the weather-tight seal between the logs. If the wall is designed to allow settlement, the fastener keeps the logs as tight to one another as possible, so as to maintain sufficient pressure to compress dry, preformed foam gaskets. When the fastener is designed to hold the log in place (non-settling), the wall sealing system must be designed to expand (recover) to the expected

movement of the individual logs.

Type and direction of loading. Connections must resist both the shear and withdrawal effect of loads placed on them.

Resistance to lateral loads is often called the "shear" value of the connection because one piece of wood is holding the fastener and the fastener holds the other, and the line where the two pieces of wood contact is called the shear plane. If the connection is one log to another, the connection is in single shear; if three logs are connected the fastener is in double shear (two shear planes.) Either way, appropriate fastener diameters must be selected to resist shear movement (to keep logs from sliding laterally along other logs.)

Withdrawal forces are those that cause nails, spikes, screws and lags to pull out of wood (in a bolted connection, this force becomes a tension load on the bolt rod.) The withdrawal resistance is measured in terms of the pounds of force required to pull the fastener out of the wood. Fastener values are typically given in pounds per inch of the fastener's penetration into the holding log, so the length of fastener is designed to match the calculated force.

THE SYSTEM AS WHOLE

When it comes down to it, there is no "best" fastener or fastening system. The log wall system integrates several components that are selected based on their response to expected vertical and horizontal load conditions, assembly methods and the properties of the logs themselves. One component, such as fasteners, can hardly be singled out as the only point of comparison between log building systems. That comparison requires a view of the whole picture. Companies selling log building systems typically have a construction manual and/or details that do a good job of providing this.

Rob Pickett is a technical consultant specializing in log building systems. He dedicates this article to Bill Moffatt, who co-wrote "Fasteners For Log Walls" with Rob for the Log Homes Council. This expanded presentation is written in Bill's memory. "He was a great friend and contributor to the log home industry and the Log Homes Council."

— Rob Pickett.

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