Shrinkage...

A Special Consideration in Multi-Story Wood-Frame Construction

By George Amundson

The cost escalation of construction materials in recent years has forced many developers to consider alternative options when planning new buildings. One material that has become more favorable to developers in certain markets is wood. Because wood is an economical alternative to higher priced structural components like steel or concrete, many new facilities are designed as wood-framed structures.

Wood is one of the earliest structural components used and has proven to be a sturdy material from which to form a building. It has been desired for its aesthetic value, its structural capabilities and its insulation value. However, wood does have its limitations. Wood-frame buildings are typically limited to four stories and an engineered design is needed for any wood-framed structure over two stories. These limitations are derived from the structural considerations of both the vertical and lateral load capacities of wood. In addition, concern must be given to fire safety and sound transmission when constructing a wood-framed structure. Another consideration that deserves special attention is shrinkage.

Shrinkage occurs as wood dries over time. In a typical one to two-story structure, it is relatively easy to accommodate for the effects of shrinkage. However, special consideration is required for wood-framed structures over two stories, as the cumulative effect is much greater. Adding to the problem, quicker growing, soft woods are becoming more common due to the growing demand of wood for construction.

The effects of multi-story shrinkage, if not accounted for, include buckling and cracking of the interior drywall and wall finishes. The buckling and cracking tend to affect larger expanses like stairwells, shafts, vaulted ceilings and atriums. There are also effects from differential shrinkage. This occurs when wood-framing is used in conjunction with other structural components, such as concrete, pre-cast concrete, masonry or steel, that expand and contract differently. Examples of this include elevator shaft walls, connecting links, wall separation and exterior masonry. If floor joists are supported by a wood frame at one end and a masonry load bearing elevator shaft at the other end, the shrinkage of the wood-frame wall will cause movement that is different than where it is supported by the masonry shaft. This type of shrinkage can be accounted for by framing the joists independent of the masonry wall. Another specific example occurs with the construction of senior housing campuses. It is typical to have a wood-framed housing structure connected to a steel-framed town center and a light gauge framed skilled nursing component with a wood roof structural span shared by all of the components. The different structural components will expand and contract at varying levels causing differential shrinkage that must be accounted for.

The shrinkage that occurs in wood is dependent on the moisture content of the material and the moisture content of the local atmosphere. The fiber of the wood will dry (and subsequently shrink) until the saturation of the fiber reaches the point in which it matches the local atmosphere. This is called the equilibrium moisture content (EMC). While in extremely wet conditions it is also possible for the wood to expand or swell, shrinkage is much more likely to occur (especially in northern climates). Since the amount of shrinkage that occurs is directly related to the type and moisture content of the wood being used, dryer wood, preferably kiln-dried, can greatly reduce the amount of shrinkage occurring in a structure. A typical 2" x 4" framing member will lose 0.026" of thickness and take two years to dry out. This means that, depending on the moisture content of the wood, a typical four-story wood-frame structure can shrink anywhere from 1 3/16" to 3".

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Compensating for the effects of shrinkage can be accomplished through a number of methods, including: the use of expansion joints on sheetrock, breaking up large surfaces with band boards and extending brick veneers past windows. It is important to leave a 3/8" gap at the bottom of drywall and around rough openings. Another method that greatly reduces shrinkage is the utilization of engineered lumber. Engineered lumber, which is designed and manufactured for specific structural purposes, has a much lower moisture content than typical dimensional lumber and reduces the effects of shrinkage in wood-framed structures. It also has greater strength which helps to reduce load compression effects on higher structures. The only drawback is that engineered lumber is more costly than typical dimensional lumber.

In addition to the selection of materials, there are additional things that the contractor can do to reduce the effects of shrinkage. One that is applicable to the northern climate is to perform the framing during winter months. Winter is much drier than summer and snow is much easier to control than rain. Contractors must heed caution in winter months though. If PVC plumbing is being installed it can expand up to 7" per 100 feet as the piping warms up. However, this can occur no matter what structural components are used for framing.

Another preventative factor that is often overlooked is the storage of lumber at the construction site. Lumber stored onsite is exposed to changing weather conditions and the moisture content can be affected. Even if the building has been designed to account for shrinkage and the lumber required by the design is procured, the moisture content can be altered by improper storage.

Human error also comes into play with the coordination of lumber at the construction site. Leaving lumber exposed onsite could lead to framers grabbing the wrong material. If a lower quality material is used that differs from the material specified for the framing, the effects of shrinkage could be amplified. You also face the risk of human error during the actual construction. While this may not affect shrinkage per se, it can have an impact on the overall quality of the building. One way to reduce human error, both the potential use of wrong materials and accommodating errors during construction, is the use of panelization. Panelization is simply the process of using prefabricated wall sections instead of constructing them onsite. In any case, proper vigilance by the contractor is needed to avoid costly mistakes during construction.

With the resurgence of wood as a popular structural component in three to four-story structures, special consideration must be given to shrinkage. With proper engineering and a knowledgeable contractor who is vigilant onsite, the effects of shrinkage can be greatly reduced.

About the Author:

George Amundson is a project superintendent with Adolfson & Peterson Construction and has over 35 years of industry experience working with wood-frame construction.

George's knowledge of wood-frame construction stems from his extensive experience supervising the construction of high profile senior housing projects, including:

- Presbyterian Homes of North Oaks
- McKenna Crossing at Shepherd's Path
- Boutwell's Landing Senior Housing Campus
- Croixdale Senior Housing
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