Due to wood's hygroscopic characteristics, shrinkage of the wood framing may have adverse effects on plumbing, electrical, and mechanical systems.

by Laura Loziuk and James Richardson

In recent years there has been increased interest in wood frame construction for high-rises and skyscrapers, or tall wood buildings (TWB). The movement, brought on in large part by a desire to promote greener building practices, also has the added benefit of being more cost-effective. This shift has been reflected in government policies as well as the model building codes, with the ICC (International Code Council) creating a committee to "investigate the feasibility of and take action on developing code changes for tall wood buildings" (Code Council Ad-Hoc Committee on Tall Wood Buildings) in 2015. In January of 2019, the ICC approved numerous changes for the 2021 International Building Code (IBC) to allow increased height restrictions for timber construction.

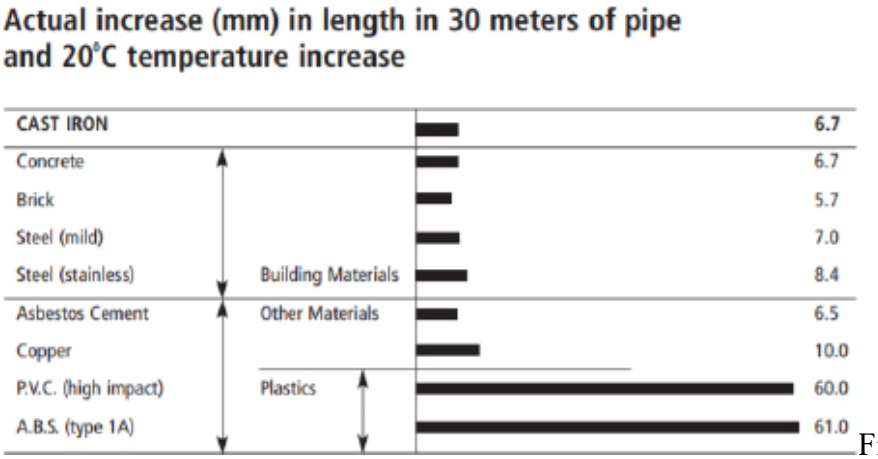


Figure 1

As is often the case with building materials, there are trade-offs associated with TWB. This article's focus is on wood's hygroscopic characteristics. This means it has the ability to absorb and release moisture, which also can change the dimensional characteristics of wood and thereby creating costly damage to a building if not properly accounted for. In 2017 this was the case in a four-story wood-framed construction apartment building in Columbus, Ohio.

During the course of construction, the building was left open and exposed to the elements, which included rain. This resulted in the wood getting very wet for too long, which meant absorption by the wood. Before the project could be "dried in," the temperature had dropped, which can affect the length of PVC pipes (see Figure 1). Most of the plumbing rough-in was completed in this condition.

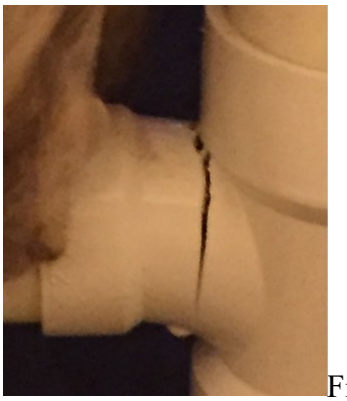


Figure 3: Cracked PVC fitting (Picture by James A. Richardson Jr.)


Figure 2: Wood framing settled onto the PVC pipe. (Picture by James A. Richardson Jr.)

As soon as the project was dried in, heaters were brought in and drywall started. However, the combination of compressing the wet wood and drying out the wood and the expansion of the PVC pipes due to the temperature difference between when they were installed and when the building was heated resulted in substantial damage to the installed system. In some areas this meant it deformed the PVC, causing it to sag (see Figure 2), and in other areas it completely cracking fittings—22 sanitary tees to be exact (see Figure 3). In the end, the contractor had to go to back and install costly expansion joints, which resulted in a change order.

Importantly, the movement of the building also caused firestopping to become dislodged in many locations (see Figure 4). Fortunately, this was identified before building completion, but this is not always the case. Improperly constructed wood-framed buildings can affect the integrity of the fire-rated separation and is a life safety hazard for building occupants. The IBC now addresses shrinkage:


Figure 4: Movement of the PVC pulled the firestopping out of place. (Picture by James A. Richardson Jr.)

IBC 2303.3.3: Shrinkage Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the building official shows that shrinkage of the wood framing will not have adverse effects in the structure or any plumbing, electrical, or mechanical systems, or other equipment installed therein due to excessive shrinkage or differential movements caused by shrinkage.
Design for structural shrinkage must be addressed in the system design by the engineer of record or the installing contractor. These design considerations are similar, but not identical to, compensation for thermal expansion and contraction of piping systems.

Compensation for expansion, contraction, or building settling is often accommodated by the use of offsets or expansion joints or by using material that has a much lower coefficient of expansion than PVC, such as cast iron soil pipe.

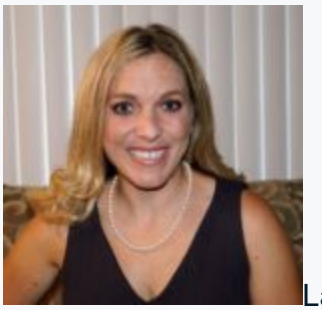
Thermoplastic piping systems have greater coefficients for thermal expansion, and the result is that in taller building construction, considerably more attention must be directed toward thermal expansion control/design measures. Some have suggested that for horizontal runs in walls that oval holes should be used to allow for the expansion; however, this won't solve the resulting decrease in the slope of the pipe. A more plausible solution may be to avoid horizontal pipe offsets, include thermal expansion/contraction measures in the vertical stacks, and some use of oval penetrations where piping extends to the fixture.

Other considerations for taller construction relate to the movement caused by the effects of wind. Swaying in response to wind gets greater as the building grows taller. In many cases, building owners believing that thermoplastic pipe is a better product, which could be true based on the application, have found it was much more costly due to the repairs required after replacing an existing cast iron system. Many existing high-rise structures were designed with cast iron piping systems, which were able to accommodate movement attributed to winds. When replacing an existing cast iron system with a thermoplastic piping system, the designer must also accommodate movement attributed to wind, especially in taller buildings.

Tall wood buildings are a movement that is advancing, and as with everything "new" there are some growing pains. Solutions can sometimes be difficult to find, but they are available, and more will come to the surface as time goes on. One good first step would be to understand the climate conditions of where the structure is to be built and understanding how all of the different materials will act upon one another under these conditions. Another step would be to match the products going into the building with the materials it is being made from. This may mean using materials like cast iron soil pipe with expansion joints as the pipe is a rigid material, but it utilizes a flexible joining system while the expansion joints are there to compensate for the expansion and contraction of the wood. These are just a couple of possible ways or at least avenues to explore to accomplish the construction of a TWB.

About the Authors

James A. Richardson Jr. has more than 29 years of experience in the plumbing/construction industry. Jim has experience working for non-union and union contractors, and he worked as a contractor as well as a plumbing inspector for a health department and currently a building department. He has the Ohio Board of Building Standards Plumbing Inspector Certification, Plumbing Plans Examiner Certification, Residential Mechanical Inspector Certification, and Commercial Mechanical Inspector Certification. He is a member of the American Society of Sanitary Engineering, American Society of Plumbing Engineers, Ohio Building Officials Association, Central Ohio Code Officials Association, Ohio Association of Plumbing Inspectors, the International Code Council. He also served on the 2018 International Code Council Plumbing Code Action Committee.



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