Fire Safety Challenges of Tall Wood Buildings

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In December, 2013, the Fire Protection Research Foundation (FPRF) published a Final Report of a Phase 1 Study regarding the fire safety challenges of tall wood buildings. The paper will provide an overview of timber construction by describing the different types of timber construction as well as historic and current examples of tall timber buildings.

The overall objectives of the research were to:

- Characterize the fire performance of tall wooden structures.
- Define the necessary design and material requirements to achieve a level of safety and property protection equal to or above steel structures.
- Communicate the results to serve as a guide for architects, engineers, and code officials

For a more comprehensive understanding of the research project, please refer to the published which is available from the FPRF. [1]

Introduction

Recent architectural trends include the design and construction of increasingly tall buildings with structural components comprised of engineered wood referred to by names including; cross laminated timber (CLT), laminated veneer lumber (LVL), or glued laminated timber (Glulam). Construction is currently underway on a 10-story apartment building in Melbourne, Australia, with taller structures up to 30 stories under design in Norway, Austria and Vancouver. These buildings are cited for their advantages in sustainability resulting from the use of wood as a renewable construction material. Claims have been made that they are designed to be safer than buildings fabricated using structural steel due to the formation of an insulating char layer that forms on the perimeter of a laminated wood beam when exposed to a fire.

[1] http://www.nfpa.org/research/fire-protection-research-foundation/reports-and-proceedings/building-and-life-safety/fire-resistance/fire-safety-challenges-of-tall-wood-buildings

The Fire Protection Research Foundation initiated the project to gain an understanding of the performance of tall wood buildings under credible fire scenarios to ensure the safety of the occupants to emissions and thermal hazards, as well as the property protection of the building and nearby structures. The goals of the Phase 1 study were to gather information and data from relevant studies and analyze the knowledge gaps. In addition, a framework prioritization of research needs was produced.

Prescriptive Code Requirements

In the USA, such buildings would typically be classified as Type IV construction. The *International Building Code* would typically limit such buildings to a height of 20 meters (65 feet) unless the building is protected with an automatic sprinkler system in which case the height limit would be 20 meters (65 feet) and 26 meters (85 feet), depending on the occupancy classification. In addition, the number of stories in such buildings would be limited to a maximum of 5 stories (6 stories if protected with an automatic sprinkler system), again depending on the occupancy classification. Using either alternative methods or performance based design concepts, the current trend is to exceed the prescriptive height limits.

Fire Performance

Due to the minimum size of the wood members, the structural elements will have an inherent fire resistance rating. This has been proven by research and fire testing along with historic fire experience of what has traditionally been referred to as heavy timber construction. However, the literature search has identified the need to address some other areas to assess the overall fire performance of the building. These include;

- System level testing – current testing is on individual structural elements and typically does not include the connections
- Use of composite assemblies such as steel, concrete, and wood
- Connections between composite assemblies
- CLT delamination
- Penetrations where the testing includes combustible base assemblies
- Concealed combustible spaces

Impact On Other Code Requirements

While the topic of concealed combustible spaces is identified above, their impact on other fire protection systems should be evaluated. For example, NFPA 13 permits sprinklers to be omitted from certain concealed combustible spaces. Should these omissions be permitted in high-rise buildings of wood construction? Fire alarm cable is typically run in concealed spaces. Is it possible for a fire to occur in a concealed combustible space that might impact the survivability of the fire alarm system?

One of the common methods of minimizing the risk in concealed combustible spaces is to compartmentalize the spaces with what US prescriptive codes refer to as draftstopping. Another research effort has recently questioned the overall effectiveness of draftstopping with

respect to the materials being used and the ability to construct effective draftstopping.[2] Part of the rationale of the draftstopping requirements is to slow down the fire spread in a concealed combustible space to allow time for fire suppression personnel to access the space and suppress the fire. In a high-rise building scenario, are the existing draftstopping requirements adequate?

Summary

This Conference paper is a very brief summary of the FPRF Project, Phase 1 along with some additional comments regarding gaps in the existing literature. For a more comprehensive report, one should refer to the FPRF report.

[2] The reference research has been performed by Koffel Associates and has not yet been made available to the public.