FIRE SAFETY CHALLENGES IN TALL WOOD BUILDINGS

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EXTENDED ABSTRACT:

1 INTRODUCTION

Timber is becoming a more desirable construction material as architects and engineers learn that timber has potential benefits in sustainability and construction. Traditional schemes for timber buildings as low-rise (two-stories or less) and mid-rise (three- to five-stories) are now being extended with construction of high rise timber buildings (six-stories or greater).

These new high-rise designs attempt to maximize the use of timber as a renewable resource and feature exposed timber elements throughout the structure. Some designs explore the potential to reach heights in excess of 30-stories.

While these buildings present ambitious designs for the future vision of tall timber structures, designers are currently limited by prescriptive building code requirements that restrict the potential for tall timber buildings, as height and area limitations are limited, based on perceived fire safety concerns. With the recent research efforts in fire, the potential for changes in code becomes increasingly possible.

2 METHODS

This study presents results for Phase 1 of a multi-phase project sponsored by the National Fire Protection Research Foundation. Phase 1 seeks to evaluate the current knowledge of fire in timber construction, identify gaps in knowledge, and reflect on the gaps. Some research and development priorities have been identified that are expected to provide a better understanding of the timber fire safety and its potential in using it for the design of taller wood buildings. More specifically, Phase 1 is comprised of two tasks:

Task 1 – Literature Review which seeks to characterize the fire performance and case studies of timber as it relates to the design of tall buildings, focusing on testing data on timber structural components in fire; on-going research studies; relevant fire incidents; existing design guidance; and global case studies of high-rise timber framed buildings.

Results from Task 1 – Literature Review are used to inform the Task 2 – Gap Analysis.

Task 2 – Gap Analysis seeks to identify the gaps in knowledge that need to be explored to better understand the performance of timber, the tools available to design timber buildings, particularly tall buildings. The gap analysis discusses specific areas of research or testing protocols that are needed to increase the confidence in the use of tall timber building design.

While the knowledge and understanding of fire performance in timber buildings is fairly well known, the Task 2 – Gap Analysis, seeks to identify further design and material gaps in knowledge that need to be explored to better understand the performance of new and innovative tall timber structures. The analysis identifies specific gaps in areas of research necessary to better understand the fire safety challenges, including - structural component and sub-system fire tests; compartment fire dynamics; economic impact; and societal impact.

3 RESULTS

3.1 TASK 1 – LITERATURE REVIEW

Key findings in the literature review primary revolve around fire testing. It is found that recent developments in standard and natural fire testing of cross laminated timber (CLT) can result in establishing structural performance and fire behavior in timber compartment fires. Also important, recent research with timber-concrete composite floors has helped to improve the understanding of composite systems.
The study introduces and describes other ongoing research studies that provide technical information and advice to designers of tall timber buildings. This includes a list of technical guides that include tools to predict timber performance, to be used in the design tall timber buildings.

Additionally, fire incidents are summarized and case studies of existing and proposed tall timber buildings are presented, including Stadthaus, Life Cycle Tower and Forte.

3.2 TASK 2 – GAP ANALYSIS

Gaps in structural component testing include evaluating the effects of composite systems in timber buildings, better understanding the fire performance of structural connections in timber building systems and better understanding of charring rates in general, and delamination effects in CLT structures.

Other gaps in knowledge relate to concerns regarding how compartment fire dynamics might differ. This requires a better understanding of the contribution of timber to a compartment fuel load and its impact on fire intensity, and determining if, and under what conditions, timber structural panels might self-extinguish in a fire scenario.

Economic gaps discusses the issue regarding the financial implications of first costs, the impacts to fire protection systems, long term costs or savings, and post-fire losses or business continuity interruptions.

While the analysis highlights specific gaps in knowledge where further research and testing is necessary, the study emphasizes the importance of effectively defining and communicating the true risks and hazards and the associated timber design solutions to designers, code officials, regulators, and greater society.

4 CONCLUSION

This study presents broad recommendations that are intended to cover gaps in analysis, as well as uncover potential gaps in analysis. Based on the resources presented in the Task 1 – Literature Review and Task 2 – Gap Analysis, recommendations for future research and testing include the following:

- Fire testing of new and innovative timber and hybrid solutions;
- Full-scale fire testing of mock up tall timber frames;
- Natural fire testing in full-scale tall timber frames;
- Economic analysis to quantify construction, operation and costs of taller timber buildings; and
- Emphasis on effective better defining the risk problem, risk communication and education.

Ultimately, greater experience with combustible construction has the potential to increase the understanding of fire safety challenges and performance of taller timber buildings. However, it is the effective communication of this understanding to develop fire protection solutions to manage the risks and hazards that is critical to demonstrating fire safety in tall timber structures.