Presentation Title:

PERFORMANCE BASED DESIGN OF FIRE SAFETY IN HIGH-RISE TIMBER BUILDINGS

Presenter

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Bio:
Between 1985 and 2012, Robert has held Principal and management-level posts in the Department of Fire Safety Engineering and Systems Safety, and in the school of Fire Protection Engineers Lund University which Robert founded.

Robert has also been in charge of starting an MSc program in Risk Management and Safety Engineering that commenced in 2001.

He has been an active partner in initiating a Master of Science education in fire safety engineering, a joint program between Lund University, Edinburgh University and Gent University.

Robert worked part-time for the Swedish National Board of Housing, Building and Planning and was responsible for the formulation of the performance based Swedish building code regulations in fire protection in 1994.

He founded the Swedish Chapter of the SFPE 1996, he became an SFPE Fellow member in 2006 and has served 10 years on the board including being the President in 2010.

Robert has received the following notable awards: SFPE John L. Bryan Mentoring Award. 2012. Swedish Chapter award for excellence in Fire Protection Engineering 2013. Royal Gold medal, size 5, for achievements in Fire Protection Engineering and for the Fire Service, May 2014.

Co-Presenter

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Carl has an MSc in Risk Management and Safety Engineering and a BSc in Fire Protection Engineering from Lund University, Sweden. Carl has technical and practical expertise in all aspects of performance based fire engineering and risk management. He is a Senior Fire Engineer and the Manager for RED Fire Engineers in NSW, Australia. He has a great passion for fire safety design in complex buildings and constructions using CLT/timber.

Presentation Abstract

The construction industry throughout the world is pushing the development of more buildings being constructed completely in timber to a much greater extent than ever before. The construction of a building with all (or most) structural elements made out of combustible materials, such as engineered timber products, create many fire safety challenges. This abstract presents the major challenges and proposes an approach on how to address the fire safety risks in design, construction and maintenance of a high-rise timber building. A high-rise building is considered to be sixteen storeys or more.

In a timber building, intensive fire scenarios can be anticipated if timber is being exposed in floors, walls or ceilings. This is also to be expected where protective layers are lost and timber becomes exposed at a later stage in a fire scenario. Delamination of laminated timber layers with secondary flashover fire scenarios will have a serious impact on the structural redundancy of the loadbearing structures which will be exposed to more challenging fires than in a traditional high-rise building if the fire is not suppressed in its early stages.

There is still no internationally recognised design approach or standard to achieve conformity of the fire safety design using engineered timber in high-rise buildings. A time equivalent approach of using charring rate calculations applied for the time equal to the prescribed fire resistant time in a furnace test (ISO 834, AS 1530.4 etc.) is widely used to meet prescriptive fire resistance requirements. There are many limitations to this approach with one major limitation relating to the extinguishment of a fire. In a high-rise building constructed using combustible materials, a design meeting the fire resistance criteria through charring calculations or furnace testing of specific elements are not sufficient to demonstrate that the building design can withstand a 'burnout' scenario. If self-extinguishment of a fully developed fire is not addressed in the design, the building will be completely reliant on fire brigade intervention to mitigate the collapse of the building. High-rise buildings pose more challenges for the fire brigade and thus fire brigade intervention should not be relied upon in a robust design.

It is evident that a risk assessment approach is necessary in order to overcome the many challenges with fire engineered timber high-rise buildings. To address the fire safety risks associated with high-rise engineered timber buildings the following aspects of fire safety design should be prioritised:

1. Fire dynamics for different geometries and fire compartments in a building:
    a. Fuel contribution from combustible elements
    b. Available ventilation to the fire
    c. Fire behaviour in different scenarios
    d. Self-extinguishment
2. Fire spread via:
    a. Cavities between timber elements
    b. Penetrations in fire separations
    c. External openings
    d. External walls
3. The spread of fire to and from neighbouring property
4. Robustness and sensitivity of the required fire safety measures in a building

The risk assessment of the proposed building, in relation to the addressed fire scenarios, must consider consequences and the likelihood of the appropriate scenarios in order to demonstrate that an acceptable level of fire safety can be achieved.

One of the most important aspects of fire safety design to limit the size of a fire in a building is compartmentation, which is not completed until the end of the construction. During construction, rigorous control schemes for installation of timber elements, penetrations, cavities between connections etc. are of highest importance.

After the completion of a high-rise timber building, it is imperative that the movement and the vibration in the building do not compromise fire compartmentation over time. Continuous maintenance must be in place for both active and passive fire safety systems in a high-rise timber building. The practicality of this maintenance must be considered early in the design, such that critical areas are accessible after completion.

The fire safety in high-rise timber buildings is complicated and requires a holistic risk assessment to address the many challenges. There are also many uncertainties in the fire dynamics and behaviour of the material in the structure which must be addressed to meet an acceptable level of safety.

Learning Objectives

The listeners will be made aware of the main differences when constructing a high rise building using engineered timber compared to non-combustible materials. We will highlight how the construction industry addresses fire safety in structural elements for high rise buildings internationally and why the traditional approaches alone are not sufficient to address the fire safety challenges for high rise timber buildings.
We will present a risk assessment approach and give examples of how this can be assessed during design, construction and maintenance.