Effectiveness of Water Mist System for the Protection of Mass Timber Buildings: Test Results

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Abstract

In recent years, North American building regulations and codes have begun allowing the construction of mid/high rise wood frame buildings with the advancements in new technologies and mass timber products, such as Cross Laminated Timber (CLT). The International Building Code (IBC) has recently accepted the proposed changes for IBC 2021, which allow maximum of 9 storeys of exposed mass timber construction for residential and business occupancies with sprinkler protection. The proposed changes also allow exposed mass timber for all occupancies with varying height limitations as long as sprinkler protection is provided.

Sprinklers are the most commonly used fire protection system in buildings due to their proven effectiveness in limiting the severity of fire and fire spread beyond the fire origin. In application to mass timber structures, however, there are concerns that sprinkler systems could create post-fire water damage and mold problems in mass timber structures. As an alternative solution to sprinkler system, water mist systems are considered for the protection of timber buildings because they use much less water compared to sprinkler systems.

A study was conducted by National Research Council Canada to experimentally investigate the performance of water mist suppression systems in fire scenarios involving mass timber structures, with a focus on residential occupancies. A series of fire suppression tests were conducted using high pressure water mist systems (HPWM) and low pressure water mist system (LPWM) in comparison to conventional sprinkler systems to substantiate potential benefits of water mist systems in minimizing post-fire water damage.

Selected HPWM, LPWM and sprinklers system were tested in a residential fire scenario to investigate the performance of the fire protection systems in:

- Controlling and suppressing the fire
- Protecting mass timber structures
- Minimizing post-fire water damage on the test assemblies

The test program employed the test room set-ups and fuel packages based on the standard test protocols provided by UL 2167. As shown in Figure 1, the test room (approximately 8.53 m (L) × 4.27 m (W) × 2.4 m (H)) was constructed with light-weight wood frames and sheathed with non-combustible materials on the walls and ceiling. The floor of the room was non-combustible material (concrete). At the corner where the fuel package was located, the walls and ceiling were built with CLT panels (made from Canadian spruce/pine/fir) with dimensions approximately 2.4 m (L) × 2.4 m (W).

Ten fire suppression tests were carried out using HPWM, LPWM and sprinkler system. Two nozzles were installed in the room as shown in Figure 1, and the activation times of the nozzles were monitored. Temperatures in the test room were measured throughout the test in various locations in the room, and smoke obscuration, gas concentrations of oxygen, carbon monoxide and carbon dioxide were also measured. Post-fire damages made on the CLT panels were observed, and moisture contents on the surface of the CLT panels were also measured before and after the fire test.

This presentation will discuss the following findings from the experiments;

- The performance of the water mist system varied depending on the nozzle type and the operating pressure.
- While the two nozzles were activated for the sprinkler system tests, the water mist system did not activate the 2nd nozzle. This indicated that the water mist system was more effective in cooling the smoke in the room while using much less amount of water relative to the sprinkler system.
- When tested with a practical delay time ranging 1-5 min, the fire at the corner developed very quickly, involving the whole CLT ceiling panel in particular with a 5 min delay. However, the water mist system even with the delayed activation was able to extinguish the fire effectively.
- When designed for property protection rather than the life safety, the water mist system performed effectively, leaving no damage on the CLT panels.

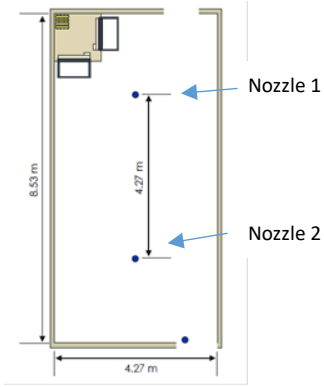

Figure 1 Test room

KEYWORDS: water mist system, sprinkler system, mass timber buildings, suppression