Hot Issues in Fire Engineering

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Fire Engineering Approach for Protecting Historic Buildings : The Correct Route

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There are growing interests in protecting historical buildings all over the world, particularly in the Far East [1]. Governments have been engaging in inter- departmental activities [2] after the signing of the ICOMOS Paris Declaration on "Heritage as a Driver of Development" at the XVII Assemblée Générale in 2011 [3]. In Hong Kong, the Development Bureau has new initiatives on Heritage Conservation Policy, and fire safety is an important issue.

Preserved historical buildings might be always crowded. There are similar problems in evacuation [4-6] in large halls in China. Furthermore, large amount of combustibles are stored in temples. A small fire would ignite the combustibles to give post-flashover big fires [1]. Historical buildings might even be totally destroyed, and such unfortunate incident had happened in Korea [7]. Effective active fire protection systems must be set up for detecting the fire, giving out early warning signals and extinguishing the ghee fire in a short time.

An ordinary sprinkler system will discharge too much water and destroy the historical artefacts. Therefore, sprinkler systems are not suitable to be installed in historical buildings, as discussed in a recent conference on protecting historical buildings in the Asia-Oceania region. A few years ago, it was proposed that water mist fire suppression systems should be installed to protect valuable treasure items including historic buildings and itself [8]. As only a small amount of water is discharged, the effectiveness of suppressing ghee fires should be studied carefully with full-scale burning tests. If the system fails to work as expected, heritage buildings will be destroyed [7].

No fire codes are worked out specifically for historical buildings in Hong Kong and other parts of the world. Fire Engineering Approach (FEA) (known as performance-based design PBD) is adopted [9,10]. However, the author and other international experts have warned that there are many flawed concept [11-13] in fire hazard assessment in FEA/PBD projects which involve historical buildings. For example, only smoke spread is considered for small wood buildings. Computational Fluid Dynamics (CFD) packages freely downloaded [14] without

in-depth verification and validation were used. However, fire spread over burning wood surface was not included.

For fires that break out in temples, the emission of toxic gases and smoke under fire suppression system is another concern. Water mist fire suppression systems were proposed. Water would scrub the soot particles in dark smoke and other soluble gases. Smoke damage would be reduced. It seems good [15] to the occupants and valuable artefacts in historic buildings. However, water mist fire suppression system will give a higher carbon monoxide concentration, making the environment more hazardous. Suppression of applying water mist would stop many intermediate combustion reactions. As a result, more carbon monoxide and other toxic gases will be generated. Carbon monoxide concentration increased rapidly to the dangerous level of over 3000 ppm after water mist is discharged. More attention should be paid on suppressing fires with water mist in the confined space of historical building.

As there are no prescriptive fire codes for historical buildings, FEA appears to be the only solution. When applying FEA, many problems surface and many mistakes are made. These common mistakes [16] are:

- The design fire is below 5 MW;
- The application of CFD is not supported by experimental justification, and scale models are not even used.
- No fire spread phenomenon is included in historical buildings with wood structures;
- No physical model experiments, such as bench-scale, intermediate-scale, full-scale and real-scale tests, are carried out to understand the possible fire hazard scenario.

Education of engineers is another concern. Higher education institutions are always challenged not to provide vigorous training to undergraduates, postgraduates and doctoral degree graduates.

The conclusions are:

- It is challenging to apply FEA for historical buildings.
- The practical aspects of FEA can only be worked out by in-depth research. Some research activities are done in China, but there is none in Hong Kong.
- As many other FEA projects, firefighting strategy and rescue strategy are not evaluated. The occupational safety and health effect on firemen should be taken into consideration.
- To work out appropriate fire safety management.

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