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Using CFD Model to Assist Safe Evacuation Analysis and Means of Egress Evaluation in Adaptive Re-use of Historical Large-space Building

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Abstract

In adaptive re-use of historical buildings, it is often a challenge for designers to make the design comply with building safety codes for the new purpose. This project demonstrates that in the process of repurposing a hangar into a public gathering occupancy for various events, how a CFD-based fire modeling method, coupled with a timed egress modeling tool, played a key role in evaluating the smoke control system design and various emergency evacuation scenarios.

Introduction

Adaptive re-use of historical buildings has become a sustainable trend in urban development, which allows structures to retain their historic integrity while serving new occupants and modern needs. However, making the building comply with building safety codes for the new purpose is often a challenge for architects and engineers. In traditional practice, architects and engineers typically perform code compliance analysis to evaluate the new design and often have a hard time making decisions when the case was complicated. In the past design research on historical building reuse that involved multiple design variables, there was little valuable study that confirmed the validity of the design based on the computer simulation and the code. Although Building Information Modeling (BIM) has been widely adopted in the design process, integrating architectural BIM, CFD, and Timed Egress Simulation has rarely been tried, especially in repurposing a building for new use. Therefore, we are interested in exploring the benefit of this approach in the adaptive reuse of historical buildings and paving the way for further study on an integrated building simulation approach.

This project involves a hangar, built in the 1940s, as one of the largest freestanding wooden structures in the world. An operational closure was determined recently and the new plan was to develop it into a combination of commercial, educational, and recreational open-space uses.

This study intends to evaluate the effects of potential fires inside the hangar, i.e. to determine during a fire emergency inside the space, if occupants in the re-used hangar would be able to safely evacuate before the space becomes untenable.

Research Methodology: Fire Modeling & Timed Egress Simulation

The hangar is approximately 1,072 feet (327 m) long by 292 feet (89 m) wide by 192 feet (59 m) tall. It will be repurposed as assembly use for a variety of public events, including recreational events, trade shows, etc. The approach of this study is to calculate the required safe egress time (RSET) and the available safe egress time (ASET) based on the existing building layout and proposed mechanical smoke control system design, to determine if occupants in the space with modified means of egress system can safely evacuate during a fire emergency, in compliance with the life safety requirements in the International Building Code (IBC) (ICC, 2015).

Smoke control system design

Large spaces are commonly provided with a smoke control system. According to IBC, the smoke exhaust method should be able to maintain a height of the lowest accumulating smoke layer at least six (6) feet (1.83 m) above any walking surface that forms a means of egress within the smoke zone.

As part of the remodeling design for this hangar, a smoke control system, specifically, a *natural smoke*