Use of Evacuation Simulation to Develop a Disaster Management Plan in Super Tall Buildings

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1. Introduction

• Speaker: Mr. Doo Chan Choi

✓ 2005 : Graduated from Worcester Polytechnic Institute (MS Fire Protection Engineering)

✓ ~ 2012 : Rolf Jensen Association (=>Jensen Hughes)

✓ ~ 2016(Present) : KF UBIS Co., Ltd (Korea)
✓ ~ 2016(Present) : Adjunct Professor – Gachon University Fire Protection Engineering Department (Korea)
1. Introduction

1) Disaster Management in a Super Tall Building

2) How Computer Simulation Can be Utilized and Applied to Support Well-Defined Disaster Management Plan Development for a Super Tall Building Project from Design Phase to After Construction Phase.
2. Super Tall Building

- **What are Super tall and Mega tall Buildings?**

  - There is no absolute definition of what constitutes a “tall building.”
  - The CTBUH defines “super-tall” as a building over 300 meters (984 feet) in height, and a “mega-tall” as a building over 600 meters (1,968 feet) in height.
2. Super Tall Building

✓ Multi / Mixed Occupancy Type
✓ Various Occupants
✓ Small/Mid Size Town or City
✓ Minor Probability of Disaster Scenarios
✓ The Severity of the Disaster Will be Greatly Amplified.

= Unique, Innovative and Well-Engineered Management and Planning is required.

Source: www.emporis.com
3. Project Building

- **Lotte World Tower**
  - Seoul, Korea
  - 555m Height
  - 123 Floors
  - Total Floor Area: 807,613 m²
LANDMARK OF KOREA

117-123F
OBSERVATION DECK
World’s Tallest Observation Deck

108-114F
PRIVATE OFFICE
Office Space for VVIP

76-101F
HOTEL
World-class 6 Star Hotel

42-71F
RESIDENCE
Business Space for Creativity & Innovation

14-38F
PRIME OFFICE
Global Business Hub

5-12F
PODUM
One-stop Lifestyle with Arts & Culture
- Number of Occupants: over 15,000
- Construction Completion: End of 2016

at 555m
- Building the Most Safe Building
  ✓ Defend in Place
  ✓ Area of Refuge
  ✓ Safety Enhancement
  ✓ Redundancy

: Active/Passive Systems, Exit Capacity
4. Disaster Management Overview

In general, a disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community’s or society’s ability to cope using its own resources.

There can be various emergency situations from a minimal accident or fire case to major hazard impact on the building and occupants. If fail to response, a disaster can arise from these hazard events in super tall buildings and the severity of the disaster will be greatly amplified.
## Disaster Scenario

<table>
<thead>
<tr>
<th>Building / Service</th>
<th>Human Related</th>
<th>War / Terrorism</th>
<th>Nature (Weather)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling</td>
<td>Bomb</td>
<td>Biological</td>
<td>Typhoon</td>
</tr>
<tr>
<td>Chiller</td>
<td>Fire</td>
<td>Chemical</td>
<td>Earthquake</td>
</tr>
<tr>
<td>House Water</td>
<td>Kidnapping</td>
<td>IED Terror</td>
<td>Major Flood</td>
</tr>
<tr>
<td>Electrical</td>
<td>Medical</td>
<td>Radioactive</td>
<td></td>
</tr>
<tr>
<td>Fire Safety</td>
<td>Lost Child</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevator</td>
<td>Security</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td>Violence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Emergency Evacuation Concept (CTBUH)

Total emergency evacuation means that the total building population is evacuated immediately.

Staged emergency evacuation means that a part of the building population is immediately evacuated.

Fractional emergency evacuation means that only a very small group or fraction of the building population is evacuated/rescued.
### Super Tall Building Evacuation Concept

<table>
<thead>
<tr>
<th>Total/Full Evacuation</th>
<th>Staged Evacuation</th>
<th>Fractional Evacuation</th>
</tr>
</thead>
</table>

![Total/Full Evacuation Diagram](image1)

![Staged Evacuation Diagram](image2)

![Fractional Evacuation Diagram](image3)
4. Disaster Management Overview

5 Features Using Simulation Study

1) Fire Life Safety Engineering Analysis and Performance Based Assessment

2) Elevator Assisted Evacuation (Life Boat Evacuation) Study

3) Major Focus of Disaster Management with Evacuation Simulation Study

4) Disaster Management Response Plan/Procedure

5) Evacuation Training/Drill/Education
5. Fire Life Safety Engineering Analysis and Performance Based Assessment

- Original Purpose of Fire / Egress Simulation
- ASET VS REST -> Life Safety Assessment based on PBD
Fire Simulation

ASET (Available Safety Egress Time)

X Sec

Egress Simulation

RSET (Required Safety Egress Time)

Y Sec

‘ Safety Building ’
**• Fire Simulation (FDS)**

**• Egress Simulation (Pathfinder)**

**Result**

<table>
<thead>
<tr>
<th>45f (Officetel)</th>
<th>Fire Simulation (ASET)</th>
<th>Egress Simulation (RSET)</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>POINT 1</td>
<td>12 min</td>
<td>2 min</td>
<td>Pass</td>
</tr>
<tr>
<td>POINT 2</td>
<td>12 min</td>
<td>2 min</td>
<td>Pass</td>
</tr>
<tr>
<td>POINT 3</td>
<td>12 min</td>
<td>2 min</td>
<td>Pass</td>
</tr>
<tr>
<td>POINT 4</td>
<td>7 min</td>
<td>2 min</td>
<td>Pass</td>
</tr>
<tr>
<td>POINT 5</td>
<td>4 min</td>
<td>50 sec</td>
<td>Pass</td>
</tr>
</tbody>
</table>
6. Elevator Assisted Evacuation (Life Boat Evacuation) Study

- Elevator Design and Plan
- Simulation Study
- Performance Criteria
  - YES
  - NO
- Design Confirm
Scenario 1 (Stair Only)

Scenario 2 (Stair XX% EV XX%)

Scenario 3 (Stair XX% EV XX%)

Scenario 4 (Stair XX% EV XX%)

Scenario 5 (Stair XX% EV XX%)
Exit Stair / Evacuation Elevator Using Ratio Analysis

→ Evacuation Plan Optimization
7. Major Focus of Disaster Management with Evacuation Simulation Study

- Ideal Design vs Real World
- Human Factor
- Disaster Management / Responder
  - Decision Making
  - Response During Emergency
피난안전구역
Emergency Zone
화재 등 비상 상황 발생 시 피난안전구역으로 대피하시기 바랍니다.
发生火灾或其他紧急情况时，请尽快躲避到避難安全區

40F
8. Disaster Management Response Plan/Procedure

- Emergency
- Response
- Evacuation Elevator
- Area of Refuge
- Ground/Exit Floor
Fire Department Access Plan
9. Fire Evacuation Training / Drill / Education
Super Tall Building Evacuation Scenario Module Selecting Program

Based on the selecting program, over 144 evacuation scenarios can be developed for training and education purpose.
10. Conclusion

- Simulation can be used to develop detail of Disaster Management and Emergency Response Procedure/Process
- Establish Goals
- Save Cost and Time vs Actual Training / Drill
- Training, Education and Practice Reference / Back-up Data
Thank You!

Q&A
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