Abstract a faster and safer evacuation plan

ABSTRACT

To study the fire & smoke behavior and effects of escape route design and time taken on evacuation process in commercial buildings . The software that going to be used for smoke and fire spread and evacuation modeling are pyrosim and pathfinder. This help to identify and reduce the safety problems. Smoke modeling and Evacuation modeling both are interlinked to each other in considering safety of a building . The smoke spread and emergency evacuation plan are considered as a essential component of a building design that has to be considered before or after construction process. The increase of employee in workplace areas leads to construction of taller high-rise buildings. This study stats evacuation scenarios modeling in a 3-floor building was tested. In order to make the importance of evacuation time to occupants during an evacuation process, and make a faster and safer evacuation plan for the building. The evacuation scenarios is simulated, using a modeling software to represent movements of occupants in the building (Pathfinder). This study make improvement in the evacuation time of the quickest way to occupants, redirects more occupants towards the exit, resulting in minimizing the total evacuation time.

1. Introduction

Fire safety of commercial buildings has attracted extensive attention in recent years due to the occurrence of many fires accident. The generated smoke reduce the visibility for human evacuation and also contains toxic gases such as carbon monoxide, carbondioxide in fires. Smoke is more danger to people's evacuation and rescue activities. In elevators and staircase is not only a evacuation passageway, it is also a possible way for smoke and fire to. Therefore, it is importance to study smoke movement in the stairwell of commercial building fires. Smoke can spread vertically to top floors through the stairwells or elevators.

The fire smoke causes casualties mainly due to the characteristics of its toxicity, high temperature and the light shielding2-3.

(1)Toxicity of smoke: Toxicity of smoke is the main reason of casualties in a fire. According to the statistics of NFPA, every year, 2/3 to 3/4 death in fire due to inhalation of too much poisonous smoke, among which 60% to 80% people lost their lives in the place far away from the fire resource.. It shows that the rapid spread of toxic gases in a fire caused a wider range of accidents. Toxicity of smoke mainly comes from CO. CO after respiratory tract by inhalation through the alveoli into the blood circulation, combined with hemoglobin to form carboxy hemoglobin, which led to the hemoglobin lose the ability to carry oxygen. It mildly poisoned are dizziness, headache, Nausea, blurred vision and other symptoms; while severe poisoning patients have a cherry red skin, disturbance of consciousness, some fell into deep shock or even go into the cadaverous syncope state, die of lung failure or heart failure.

(2)Smoke in high temperature: Human will get tired and dehydration in high temperature. When the heat exceeds the tolerance of human, they die.. Generally speaking, nobody can breathe air hotter than 65 .

(3)Light-shielding property of smoke : Smoke is the mixture of solid particle and liquid drop. Light was weakened as it went through the smoke. The light weaken property of smoke determines the drop of visibility in a room filled with smoke, which is a great trouble of evacuation in a fire. Visibility refers to the maximum distance of the object can be seen by normal eyesight.

3. METHODOLOGY

3. 1 FIRE LOADING

The fire loading of a building or compartment is a way of establishing the potential severity of a hypothetical future fire. It is the heat output per unit floor area, often in kJ/m2, calculated from the calorific value of the materials present. Fire loading is used for evaluating industrial safety risks.

An empty room with cement floor and ceiling, cinderblock walls, and no flammable materials would have approximately zero fire loading; any fire entering such a room from elsewhere will find nothing to feed on. However, nearly anything that makes a room useful (such as furniture, electrical appliances, or computer equipment), or attractive (such as wood paneling, acoustic tile, carpeting, curtains, or wall decorations), will increase the fire loading. Some usages inherently carry high fire loading as a side effect (an art gallery and studio, for example, is likely to contain large amounts of canvas, paints, solvents, and wooden framing). Buildings under construction or renovation tend to carry high fire loads in the form of construction materials, solvents, and fuel for generators.

3. PYROSIM -FIRE MODEL SIMULATION

The building involved in this fire incident was a 3 story residential building with a flat roof.. The structure had exterior dimensions of 54 m by 18 m and a height of 9. 14 m (19 ft) above street level. The first floor and second floor each had an interior floor area of 864 m2. The interior walls were composed of concrete.

The fire started in the pantry room and was due to handheld electrical appliance that was present in pantry area . The nearest fuel source was the wooden table located in the pantry room. Based on these sources of information. The ground floor contained furniture composed of polyurethane foam. The furniture items located in the middle of the ground floor . Other combustible items and furnishings such as tables, stools, bookshelves, and carpet were present in the all other floors. To simplify the analysis and specification of the design fire, only the large furniture fuel items is included in the simulation because they were considered to have contributed the largest amount of energy in this fire scenario.

The primary fuel packages were located in the basement. The numbered labels indicate the order in which the fuel items were burning: 1) Electronics item, 2) the secondary furniture fires, and 3) wall fire. The duration of the fire simulation is 10 min (600 s).

Materials:

Whereas the fires were represented as fuel sources with a constant area, from a heat transfer perspective, it is important to define the material properties of the ceiling, walls, and floors (density, thermal conductivity, specific heat, and thickness) to account for heat transfer and energy storage. In this study, the material properties of Concrete were specified on the finished ceilings, walls and floors in the structure.

3. 1. FDS model description

Fire dynamics simulator (FDS) is a computational fluid dynamics (CFD) model that describes the flow of smoke and hot gases from a fire. It solves numerically the Navier–Stokes equations appropriate for low-speed, thermally driven flow on smoke and heat transport from fires.. Now, the model has been applied for performance-based fire safety designs, designs of smoke control systems. It will also become a useful tool in fire investigation and fire scene reconstruction.

Table 3. 1 Fire modeling input parameters

Parameter

Description

Simulation Time

10 min

Grid Cell Size

10 cm

Ambient Temperature

25 ? C (77 ? F)

Material: wood

Thermal conductivity: 0. 36W/(m· K)

Density: 900kg/m3

Specific heat: 1. 6 kJ/(kg · K)

Heat of combustion: 13. 6 kJ/kg

Material: Concrete

Thermal conductivity: 1. 8 W/(m · K)

Density: 2280kg/m3

Specific heat: 1. 04 kJ/(kg · K)

Thickness: 25cm

4. FDS FIRE & SMOKE FLOW VISUAL

Fig 4. 1 smoke spread t - 0s

Fig 4. 2 smoke spread t - 30s

Fig 4. 3 smoke spread t -140s

Fig 4. 4 smoke spread t - 180s

5. EVACUATION

This study consists of 3 floors, with a total height of 9. 14m. The building use is business, i. e., the model is an office building. The method employed in this study presents the application of evacuation modeling techniques in order to simulate total evacuation of a tall high-rise building, in which a continuous indoor evacuation model is applied by using Pathfinder simulation software .

The calibration of input parameters is conducted based on experimental data, thus providing a more realistic evacuation scenario. The reason of using experimental data is to eliminate the effect in which the model depends on the modeler's experiences and assumptions

Fig. 5. 1 Factors which influence evacuation process

Table 5. 1 characteristics of the building

Characteristics

Number

Floors

G+3

Stairs

2

Elevators

2

Table 5. 2 characteristics of the stairs

Characteristics

Description

Nominal Width

1420 mm

Tread Depth

280 mm

Riser Height

180 mm

Number of Steps

18

Table 5. 3 Walking speed of the occupants

Occupants

Mean (m/s)

SD (m/s)

Range (m/s)

Walking occupants

1. 29

1. 00

0. 29-2. 29

People with disabilities

0. 8

0. 37

0. 1-1. 68

Fig. 5. 4 Evacuation 3D model

Fig. 5. 4 Evacuation simulation T-0s

Fig. 5. 5 Evacuation simulation T-30s

Fig. 5. 6 Evacuation simulation T-120s

Fig. 5. 7 Evacuation simulation T-147s

Fig. 5. 8 People density

6. RESULT AND DISCUSSION

Smoke hazard is the main harm to employee in the workplace fire. Through simulation we can get these:

· Each condition we assume will jeopardize the safety of passengers in a short time in train compartment fire, the temperature/CO concentration/visibility/smoke sinking will over critical state. Therefore we should evacuate employee to safe area quickly.

- The doors and windows of building should easy to be opened. If the doors and windows are closed the smoke concentration rise and smoke sink rapidly.
- Air conditions will make fire to be worse. If air conditions are turn on the heat release rate will be faster the temperature will rise more quickly .
- time taken for the smoke spread in ground floor is 220s
- time taken for the smoke spread to whole building is 600s
- Evacuation time taken by employee is 146. 3s
- temperature of the building raised from 25oc to more than 250oc . this lead to fatal and injury .
- HRR is more important because it lead to increase in temperature of the place .
- Due to smoke the visibility only 2. 5m. This cause difficult for evacuation.
- Smoke concentration is more so when we inhale it , it cause death.

7. Reference

2Liu C. F., Pen N., 2003. Numerical Simulation of Smoke Movement in Train Compartment Fire Accident. Journal of Thermal Science and Technology

2, p. 352.

3 Tang Y., Geng Q., 2007. Optimization of Air Velocities Design Parameters of Air-conditioned Compartment Based on Thermal Comfort. Applied

Energy Technology 11, p. 28.