

2012 International Symposium on Safety Science and Technology Simulation of fire and evacuation in high-rise building

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Abstract

The development of high-rise building in china is described. The high-rise building fire risk analysis is introduced, and the high-rise structural fire accident in Shanghai is analyzed. Based on the plan of Shanghai high-rise building, in this paper a high-rise building which has the same plan in a city is selected to study the movement and evacuation of it using CFAST and Building EXODUS (V40.6). The purpose of the simulation is to study the advantage and weakness of this structural form of high-rise building.

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Keywords: high-rise building; fire; evacuation; simulation

1. Introduction

With the rapid economic development of the society, the process of urbanization is accelerating. City area is declining, high-rise buildings which cover an area with less volume rate of large features have sprung up in the city. Incomplete statistics show that in China, as of 2010, buildings more than 24 meters high-rise buildings, 9 816 in Shanghai, 7 502 in Guangzhou, 5 725 in Shenzhen, and 5 591 in Beijing, ranked respectively 3rd, 5th, 7th, 10th, and 11th in the world. High-rise buildings and super high-rise buildings has provided spacious, convenient to our working and living space, but it also have the threat of fire safety [1].

High-rise building fire spread speed, stairways, elevator shaft in high-rise building well, pipes, ducts and electricity wells of vertical shafts, if fire-resistant partition processing is not good, when the fire broke out just like a towering chimneys become ways of the rapid spread of the fire; Evacuation of high-rise building is difficult, normal elevator does not use during the fire, stairs are the only channel for vertical evacuation of persons, due to long distance of vertical evacuation of high-rise building required evacuation time longer, after the fire, as the personnel-intensive, more slow down the stairs to evacuate; High-rise building fire fighting is difficult, (the height of) high-rise buildings can be dozens of meters, even hundreds of meters, once the fire broke out from the outside, fire-fighting is very difficult, mainly because fire fighters is difficult to close the fire point, ordinary fire-fighting vehicles (are limited), at present Chinese fire-fighting vehicle has a maximum height of 101 meters, but only a few throughout the country, most of the trapped personnel based on the self-help[2].

More and more attention is paid to high-rise building fire protection safety and fire safety evacuation. Study on evacuation of high-rise buildings, to improve the safe evacuation of high-rise building performance and reduce casualties caused by the high-rise has strong realistic significance [3].

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2. Description of Shanghai high-rise structural fire

Shanghai high-rise residential building construction without a license violation in the fire building 10 rooms north out of the window before the combination of layers concave gallery southwest corner, landed during the welding of metal melting, ignited fire disaster by falling below polyurethane foam fragments, debris, nylon, and bamboo plates. Polyurethane foam pieces, debris after being ignited immediately aroused walls polyurethane insulation spray combustion, spread and level up very fast, causing fires. After wall surface spray of polyurethane insulation material combustion, fire quickly spread through the entire building, due to building evacuation channel is limited, main live residence of building was older retirement teachers, in the rescue process, fire ladder can not reach the top of the building, ladder plus high pressure gun only arrived two-thirds height of the building, fire was so large that helicopter aircraft cannot get near, which blocked the smooth progress of work. Finally caused 58 people deaths and 17 people were badly injured in the tragedy.

3. Fire and evacuation simulation

A fire broke out in Shanghai high-rise residential building once again reminds us of the importance of high-rise building fire protection. Because the spread of the fire was an extremely complex process, evacuation of human physiological and psychological (are) constantly in change, and the fire of fire spreading characteristics from outdoor to indoor, domestic code for fire protection design of study on compartment fire, evacuation simulation software development for indoor fire, this type of fire is the first domestic case. Thus, using existing flue gas simulation software and the personnel evacuation simulation software is difficult to reproduce the fire and personnel evacuation situations. According to the statistics, a fire of tall buildings in Shanghai 5–28 floor plan, 5–28 with two evacuation stairs on the north side, the staircase on the west side of front have a fire front room, staircase on the east side of the former common room before, three households in the east, three households in the west, six people through east and west, south side of the channel into the evacuations of stairs. Under 5–28 layer structure modeled on the information described in this article, select a city of a similar construction form 28-story high-rise building using flue gas simulation software CFAST and personnel evacuation software Building EXODUS (V4.06) qualitative and quantitative evaluation that consists of a corridor and staircase tower high-rise building advantages and disadvantages on the evacuation of building structures [4].

3.1 Fire simulation by CFAST

After fire occurs, due to flue gas spread of way and personnel evacuation of route is basically consistent, selected senior building of east, and west, and south three sides of corridor and the east and west on both sides of fire stairs occurs fire, flue gas most easy spread to local [5], so when in flue gas simulation CFAST, east, and west, and south of within channel, and west fire stairs and fire front room and the east fire stairs and combined room of regional respectively division; Senior buildings is characterized by separate households in each suite, each suite contains the bedroom, the kitchen, the living room is a good interval, smoke spread slowly, each suite is divided into a region. CFAST effects of zoning are shown as Fig.1.

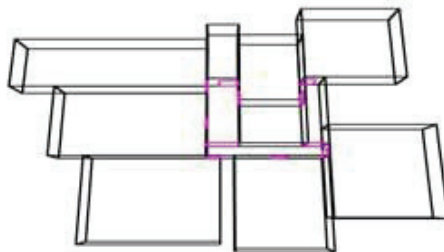


Fig. 1. Divided zone of assumed building for CFAST model.

This article aims to introduce three kinds of fire to this smoke flow of architectural forms, and its influence on evacuation. Fire (a) as a separate research building staircase to the east on the north side of firing a fire, regardless of the other rooms caused by fire; Fires (b) for the purpose of considering all on fire in the room at the same time (that is, similar to the fire spread quickly), assuming that there is no automatic sprinkler system in the selected building; Fire (c) while considering all the room is on fire (which is similar to the fire spread quickly), assuming that the selected building has automatic sprinkler system. Results of the study are as follows.

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