



Journal of Applied Sciences

ISSN 1812-5654

science
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The Study for the Emergency Management of Evacuation Imitation along the Commercial Pedestrian Street

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Abstract: In the disaster management system, using informationalized technology to deal and prevent with the disaster has already become an important way. When disasters occurred, the refuge roads play an important role for ensuring the safety of the crowd and reducing the damage. At present, the refuge road in urban business central district in disaster emergency management is still lack of sufficient research. Especially the study on the disaster evacuation management simulation research. The study concentrate on the simulating the crowd evacuation when the earthquake happened in the commercial pedestrian street in ChongQing Sha Pingba district. With the consideration of characteristics of the space and the crowd. And then select the main factor which will affect the evacuation efficiency and qualified to establish the model. The simulation provides the city visualization of three-dimensional space crowd emergency evacuation process and under such circumstances the different escape time of different aged group. Responding the shortage of when the commercial pedestrian street facing the emergency evacuation in directly. In order to let the disaster management department help the refugee population develop more targeted, effective and safe way of emergency evacuation. And by the perspective of emergency management, make control and improve of the city planning of commercial pedestrian street at the same time. Further more, the simulation can be docking to the next higher level which will promote the improvement of the urban disaster management mechanism.

Key words: Emergency management, public refuge, anylogic, simulation, commercial pedestrian street

INTRODUCTION

With the rapid growth of the urbanization, the effect of the accumulation of the city center and the effect of its scale is given full play. Meanwhile, the complexity of the mountainous environment in Chongqing restricts the level expand of the city space, so the multidimensional intensive space become an inevitable choice in the development of the CBD for the mountainous city like Chongqing. The arrangement of the commercial pedestrian streets in Chongqing is mainly based on linear street space connected with the small planar squares and the buildings most lying on the both sides of which are used as the refuge roads, are becoming intensively, compositely and three-dimensionally. Owing to the lack of the large refuge squares, once an earthquake happens, the pedestrian streets become the necessary roads for the great many of the refugees. Several examples have verified the refuge roads play an important role for ensuring the safety of the crowd and reducing the damage when the earthquake happened. Therefore, how to make full safe use of the refuge roads becomes the major problems

concerning the rescuing refugees in time of disasters. For the most of the urban earthquake emergency management research at home and abroad based on the management of earthquake information management process of macro as a whole, Most of the current information management of disaster management is based on a large amount of historical data, Shows the location of the defending, in order to let disaster reduction management institutions for disaster assessment and design plan and in a wide range of areas within the whole tracking, arranging transport route for emergency material, equipment, etc. Very few micro practices involving crowd evacuation safety after the earthquake.

The study is focus on the analysis of the factors which determine the efficiency of the commercial pedestrian street in a way when the earthquake happened., the impact factor is quantified and a more accurate model is set up in AnyLogic by inputting the quantitative data, the simulation object, the outputting of the block diagram and flow chart of data analysis from several aspects. Building a shelter evacuation simulation. In the final, Evacuation simulation results through visual

link, intuitive performance for refuge when combined with the weak area of roads and the surroundings and the congestion caused by the staff. thus to put forward the management strategies for the management department, improve the city commercial pedestrian street ability to cope with disasters and emergency evacuation.

MATERIALS AND METHODS

This passage deals with the research means supplied by the software Anylogic to make simulational imitation. A evacuating model is set up through inputting both quantization influencing factors and evacuating target. Meanwhile, this imitationism used to show the weakness of the evacuation route and to make a clear analysis of the chart of the crowded area and the visual evacuation process (Fig. 1) with this very model.

The advantages of Choosing Anylogic for the imitation of the evacuation route for the refuge lie in:

- The software has the opened structure system, according to the requirements of the secondary development, so as to a high level of disaster management information system to achieve docking, for example with the GIS system, spreadsheet, database, etc, to form a complete platform to solve large complex project. Realizing a complete coverage of information management system
- Library provides a number of virtual simulation which is used to generate all kinds of simulation objects, the crowd can be a detailed three-dimensional descriptions and by editing each object's size and field of vision, that may occur while the acceleration and deceleration capability, external space environment in the process of escape obstacles such as walls, flower beds, stairs, simulating the process of mixed discrete, continuous and behavior and makes the simulation process descriptions of people become more accurate

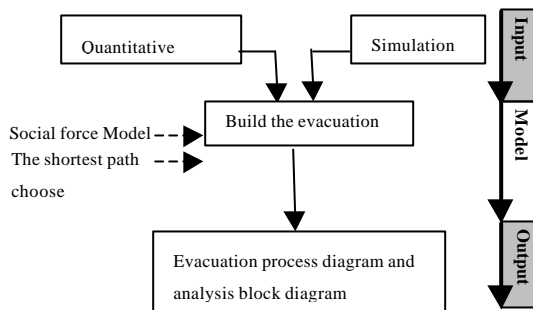


Fig. 1: AnyLogic working program diagram

- AnyLogic pedestrian model library is based on sociology model which possesses the characteristics of continuous microscopic simulation agent. Although large amount of calculation in practical application, but the error is smaller

STUDY OF CASE

Data based: To simulate the evacuation time, carries on the related basic data preparation: (1) Location (2) Road network information (3) Refuge stronghold (4) Population distribution data (5) Distribution of commercial residential building and (6) Analysis impact factor

The environment characteristics of the commercial pedestrian street: This commercial pedestrian streets are located in the center district of Sha Pingba in Chong Qing ,covers an area of 8000?. The designers use the present city streets as the commercial pedestrian streets and expect them can work as a city square. But the area of the inside square which is surrounded by tall buildings standing in great numbers is a little bit small, so once an earthquake happens, refugees can only evacuate outside. This study select the first one of the evacuation roads to conduct a study (Fig. 2). The of both sides of this road is so little that the entrances and the exits of the underground mall under are regarded as flat ground (Jing *et al.*, 2003). There are several square flower terraces for people to enjoy the view. And the entrances and the exits of the commercial and redential complexes on both sides are directly jointed with this road.

Falling objects affected areas: The falling objects affected areas is material scarce and in earthquake situation make more worse. During the earthquake, seismic shear waves and speed of the role that can lead to outdoor aside, mount thing and building the fall of fittings and so on and in the direction of a certain level of velocity. And also by the fall will fall range thing properties, construction height, level such multiple velocity complex factors which influence decision. Due to the related material restriction and when the earthquake happened to fall the things their own complexity, comprehensive commercial commercial walk street actual condition, this paper will fall things falling average range as 3 m (Li, 2010).

The number of people in Residential complex and underground mall estimated.

The Chinese "the store building design rules" (JGJ 48-88) the article 4.2.5 regulation: store business part of the calculation of the evacuation Numbers, according to each layer business hall and serve for the customer the area of the room number multiplied by Conversion coefficient (people/m²) to determine.

For in the actual operation process, according to the calculated standard number far outweigh the actual, to

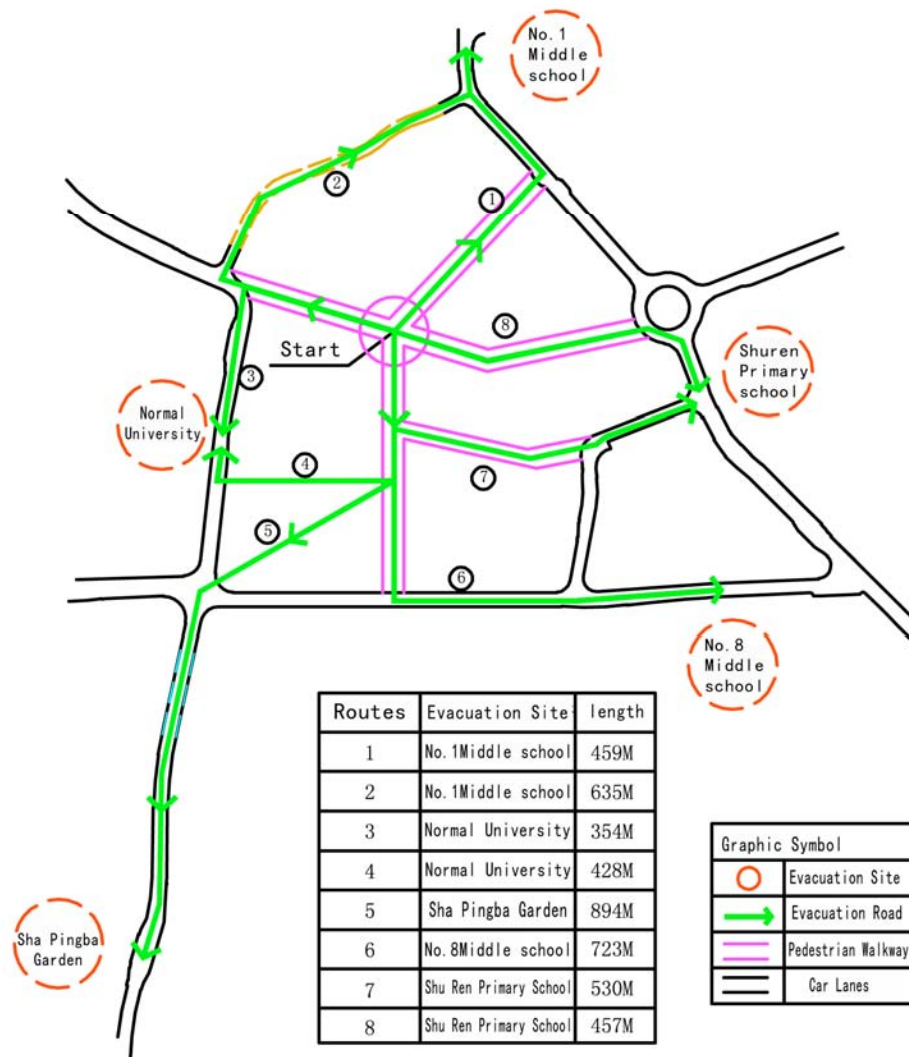


Fig. 2: Eight evacuation routes

Table 1: Different layers of the conversion coefficient (people/m²)

| Category | 1st-layer | 2nd-layer | 3rd-layer | 4th-layer |
|------------------|-----------|-----------|-----------|-----------|
| shop | 0.85 | 0.85 | 0.77 | 0.6 |
| Underground-mall | 0.85 | 0.8 | - | - |

Table 2: Groups of people walking parameters (m sec⁻¹)

| Category | Pace (m sec ⁻¹) | Average pace (m sec ⁻¹) |
|------------------------|-----------------------------|-------------------------------------|
| The Old | | |
| Elderly woman | 1.08 | 1.09 |
| elderly man | 1.1 | |
| The Middle-aged | | |
| Middle-aged woman | 1.99 | 1.9 |
| Middle-aged man | 1.91 | 1.9 |
| The Young | | |
| Young-woman | 2.01 | 1.99 |
| Young-man | 1.96 | |

(Jing *et al.*, 2003). The scholar Jing Jiansheng points out in the research that the store business hall in the calculation of the total number of time, generally supposed to the total area of the business hall divided by 2, then multiplied by the number of conversion coefficient (people/m²), can generally good and accord with the actual situation.

$$\text{Inside the hotel estimated} = \text{average occupancy rate} \times \text{total number household} \times 2$$

$$\text{Residential part of the estimated} = \text{number of households} \times \text{layers} \times 2.6$$

bring disaster prevention simulation of defects and actual situation radically different. Many scholars make their efforts to make more precisely conversion coefficient

The composition of the evacuation and their walking parameters: The author were selected both weekends and working days of four times to research for the section of

research, using photographic record every five minutes record in the total number of the culture of the number three respectively, take average measured multiple times, to estimate the old, the middle-aged and the young in crowd is in percentage of 1:3:6. This table simulation of

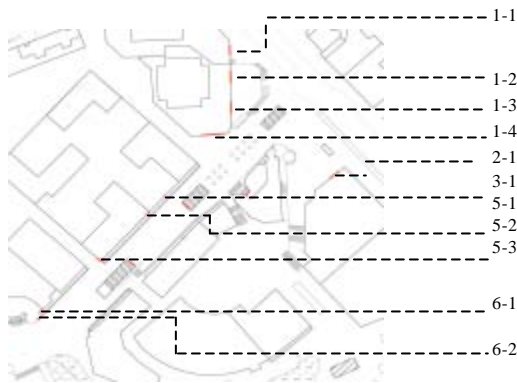


Fig. 3: The location of the evacuation gate

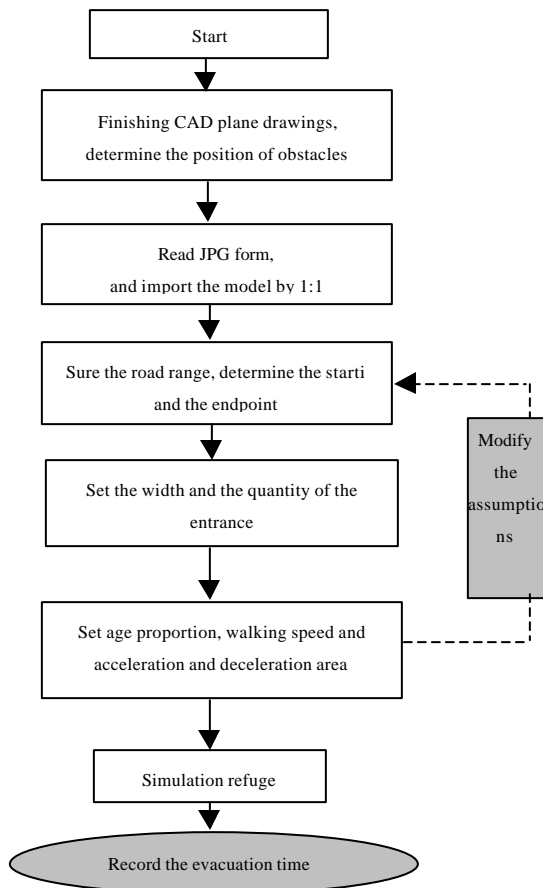


Fig. 4: AnyLogic operation flow chart

the average walking parameters is studied by Chen (2005) came from Shanghai university.

The location, width, quantities of entrance of the commercial and residential buildings, underground mall:

Anylogic simulation: Anylogic have established a virtual prototyping model consists of discrete and continuous and mixed behavior of the simulation and is one of the few provides the pedestrian popular library for advanced simulation platform in the world. Because of Anylogic pedestrian simulation is based on social force model development and it set the crowd in the software itself already after types include some of the characteristics of the factors, including pedestrians and other pedestrians are attracted by each other, pedestrain to the specific goals interact with the obstacles, walls and other objects. At the same time it also contains the phenomena of the self-organization in populations, as well as panic factors affect on the crowd evacuation. Based on the above platforms, the researchers generally do not have to separately consider the factors between human interactions

In the AnyLogic simulation the following are restricted:

- In falling objects affected areas, the dispersed crowd will be rejected, when someone enters the area, it shall make him back to the normal evacuation road due to the certain force
- In the simulation process, the path of the personnel evacuation is acquiesced to use the shortest path by the software
- In the individual sections when the population of the congestion is more than 300 people, it sets 30% of them will walk to another designated section forward and reach the final
- In the most crowded area five positions are settled to detect and record the numbers in different moments and generate charts
- Pedestrians shall march at the speed of above 0.53 m sec⁻¹ upstairs, 0.62m sec⁻¹ downstairs which is different from that on the flat ground
- Pedestrians walk through the building entrances as 150 people/minute

RESULT AND DISCUSSION

Anylogic analog video record: As shown in Fig. 5, it is the process of the evacuation simulation at 5'48", red, blue, green small point respectively represents the old, the middle-aged, the youth three kinds of people are evacuating in the perfect condition.

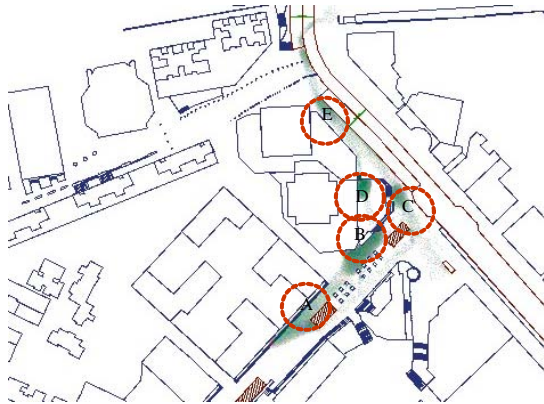


Fig. 5: Main congestion area

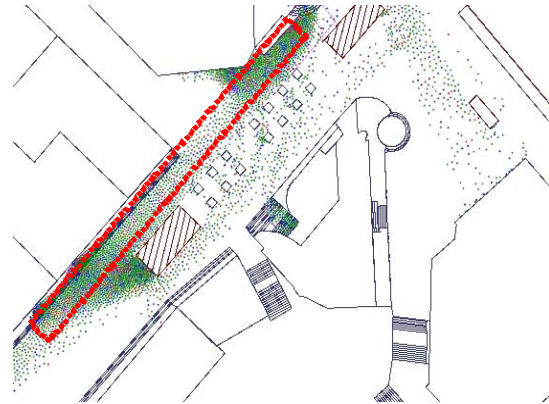


Fig. 7: The range of Falling objects is ignored

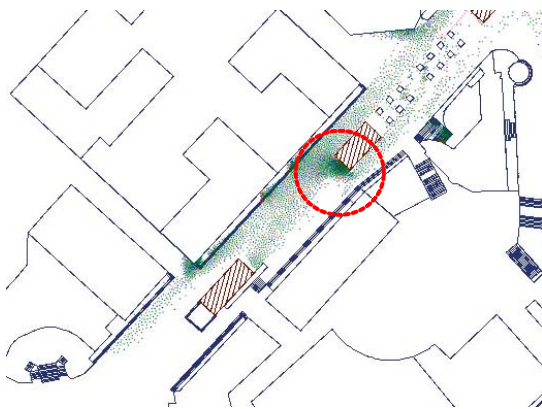


Fig. 6: the position effect on evacuation

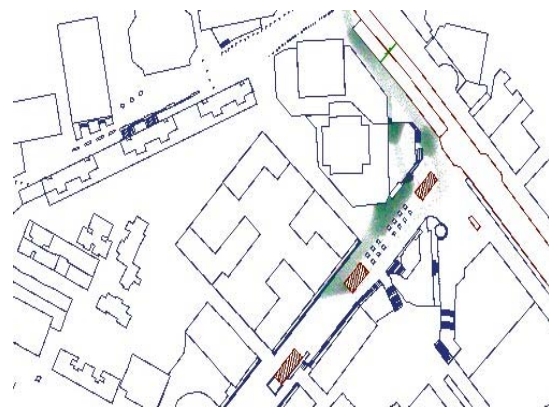


Fig. 8: The complete time

As shown in Fig. 6, due to the function of the conjunct refugees in the underground mall and the commercial residential complex, it will become congestion at about 1'46" in the district A:

- As shown in Fig. 5, it is the process of the evacuation simulation at 5'48", red, blue, green small point respectively represents the old, the middle-aged, the youth three kinds of people are evacuating in the perfect condition
- As shown in Fig. 6, due to the function of the conjunct refugees in the underground mall and the commercial residential complex, it will become congestion at about 1'46" in the district A
- As shown in Fig. 7, due to large population refuge at the same time when disaster happens, the falling distance of the falling things set before has already lost the effect to the refugees
- According to the Anylogic simulation we can see that in the picture Fig. 7, when at 5'48", the crowds

inside buildings have been already evacuated completely, but due to large crowd stranded in the street, the whole evacuation process has to continue.

The advises based on the AnyLogic images: According to the analysis by Anylogic we can see that there are mainly these effects to the ultimate whole evacuation time:

- In district A, due to in the early period there are large refugees gathered because of the design of the entrance of the underground mall and the entrance of the commercial and residential mixed, the current of the crowd is obstruct, hindering the flow passage. Therefore, the inward and outward set in the commercial pedestrian street. Especially large residential and commercial mixed buildings and underground mall entrances and etc. Tend to cause escape during evacuation paroxysmal gathered

themselves together, Suggestions goes to expand the export width of the inward and outward, try to avoid this kind of entrance too gathered in the planning.

- When the earthquake occurred, architectural degradation will harm the pedestrians in the evacuation process, From the simulation, in the event of a disaster when a lot of people caused crowded, inevitably fallen into the scope, So the proposal within the scope of the commercial pedestrian street is limited space, on the entrance at the top of the commercial facilities set safe shelter, setting up the grey space to a certain extent to ensure the safety of shelter evacuation.
- At the end of the simulation of evacuation, due to the width of walking road in relatively reduced, it result in D and E in a lot of crowd evacuation people surrounded. Suggesting is to avoid that suddenly die off in evacuation road during the planning. If it cannot be avoided, the place where the evacuation path close to the city road, should set up the movable sidewalk protective measures, after the disaster (due to the earthquake occurred, considering the vehicles can't run) can be temporarily removed, let the pedestrians evacuate to the road at the fastest speed, to broaden the width of the evacuation road

CONCLUSION

The special natural environment in the mountainous cities and the rapid urbanization together with the associated Central agglomeration efficiency and economical scale make up the three-dimensional space of multi-dimensional organizations intensively which has become an inevitable and important choice for the development of central business districts in mountainous cities. The line space in the shopping streets for the pedestrians in urban central areas in the mountainous cities is to become most important as shelters when disasters such as earthquakes occur. This will be one of the greatest problems when a large number of people trapped in the disasters pass the roads to reach the safe emergency shelters in the course of the evacuation and relief process.

According to their space environment features and crowd construction features, this article takes the

commercial pedestrian street in Chongqing Shapingba District as an example. Considering the types of earthquakes as main disasters, It determines the main factors which influences the efficiency effect during the process of evacuation and relief.

Based on quantitative processing and using Anylogic software for description of putting in data, it establishes models for realistic simulation to work out the visual evacuation process and the relationship of jam road units area number and the time line, as well as the ideal State and the total time in an effective evacuation. According to the analysis above , evaluation of the pedestrian safety evacuation capacity, identifies the deficiencies in their evacuation procedures. For the proposal to guarantee efficiency, the secure evacuation of the recommendations and measures for the purpose in turn makes the city disaster prevention plan and specific implementation of the design in a three dimensional environment more and more practical and effective for the intentional purpose and target goal of the construction for a far more safely guaranteed social environment.

ACKNOWLEDGEMENT

This study was supported by the National Natural Science Foundation of China (No.50908238), "State Key Lab of Subtropical Building Science, South China University of Technology" (No. 2012KB22)

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