Fire emergency evacuation model of light rail station based on BIM technology

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Abstract. Urban light rail undertakes the mission of escorting passengers to arrive safely. Once a fire accident occurs, it will inevitably have a great negative impact. Therefore, how to effectively carry out emergency evacuation tasks in fire accidents has become one of the problems facing the development of urban rail transit. Based on this, this article first introduces the relevant characteristics of BIM technology and the corresponding advantages, and further its use in urban light rail stations. The application advantages of emergency evacuation strategies are briefly analyzed; then the requirements for the construction of BIM emergency evacuation models are studied; finally, through field investigations, a specific urban rail transit light rail station is taken as an example to construct a BIM building information model for this light rail station. Applying BIM technology to fire protection work in light rail stations, it is expected to improve the efficiency of emergency evacuation of passengers in light rail stations.

1. Introduction
With the continuous construction of urban rail transit operation lines and the growth of passenger flow, how to effectively carry out the personnel emergency evacuation task in the case of sudden accidents has attracted the attention of the general public. Because most urban rail transit stations in China have relatively small space and basically closed interiors, usually the stations are crowded with people. After a fire occurs, the architectural design defects in urban rail transit stations are an important reason for the ineffective evacuation of people. The unreasonable design of exit and entrance evacuation passageway and fire-fighting facilities in station buildings affects the evacuation efficiency of personnel and thus poses a threat to the life safety of personnel. Sudden situations are inevitable, but the relevant person in charge can take precautions before they happen. If computer simulations are used at the beginning of station design or construction to assist designers in finding design flaws in buildings, the frequency of certain irreversible accidents can be reduced. However, BIM technology can effectively integrate the three-dimensional model of the station and realize real-time data sharing of the whole life cycle of the station. This technology provides new research ideas and technical means to solve fire-fighting problems, and provides new countermeasures and new ideas for emergency evacuation of urban rail transit stations.

In recent years, scholars have carried out extensive research in the field of emergency evacuation based on BIM Technology, and achieved certain achievements in theory [1-5], and achieved a lot of phased success in practice [6-8]. Based on the above researches, it is found that the information
The extraction of the light rail station model is not comprehensive and fails to give full play to the full strength of BIM technology, which leads to the situation that relevant data and information cannot be transmitted and shared in real time. Therefore, it is worth further exploring how to feedback the results of computational simulation through BIM technology to improve the efficiency of fire emergency evacuation in urban light rail stations.

2. BIM (Building Information Modeling) Technology

2.1. Summary
BIM, also known as N-D modeling, virtual model or virtual prototype technology, is a model-based intelligent process, which can be defined as a collaboration platform. In the whole project construction life cycle, it uses digital information model to process, produce, communicate and analyze construction projects. Its development objectives include solving collaborative problems, responding to intensive information, reducing project time and cost, improving construction performance, and supporting the evaluation and analysis of smart buildings to more effectively design, build, and operate the building's infrastructure. The BIM model contains data related to physical and functional characteristics, and the technology is considered as a new platform for delivery of construction projects and an innovation. Fully understanding and recognizing the value of BIM makes it possible to apply it in the field of emergency evacuation of light rail stations.

2.2. Advantage
After the light rail station fire, the safety of life and property depends on the progress of emergency evacuation. BIM technologies into orbit traffic emergency evacuation work, can adopt the related data of the model for fire engineering design, often use the method of simulation for the emergency evacuation in the work is not enough, and will update information to the design of the construction site, kept from concept to the construction of intelligent building model, the light rail station with BIM technology can better understand the future operation and fire control maintenance. In the light rail station operation stage, BIM technology can reduce the risk of evacuation and fire-fighting, save the cost of emergency evacuation, and achieve better results.

3. Information construction requirements of BIM model for emergency evacuation in light rail stations

In the BIM building information model, relevant data related to evacuation already exist, and information unrelated to personnel evacuation can be appropriately simplified. The following analyzes the functions and roles of various buildings or constructions in emergency evacuation and escape in the station, so as to determine whether information in BIM emergency evacuation model building needs to be deleted, so as to improve the effectiveness of the work. All aspects of information in the model are sorted out in the form of tables, as shown in Table 1. In this table, the component information of the model is presented intuitively. The influence of these components on emergency evacuation is also marked in order to increase the modeling efficiency.

Table 1. Statistical table of BIM model modeling requirements for emergency evacuation of light rail stations.

| Name       | Information requirements                                           | The key information                                      |
|------------|-------------------------------------------------------------------|----------------------------------------------------------|
| platform   | Physical properties and raw material properties (dimensions, spatial location and building materials) | Corresponding platform area, platform pillar size and position |
| stairs     | Physical properties and raw material properties (dimensions, spatial location and building materials) | The width, depth, height and number of steps              |
| station hall | Dimensions, space position and building materials               | Area of paid area and non-paid area of station hall, size and |
| Location                      | Dimensions, space position and building materials | Aisle width                          
|-------------------------------|--------------------------------------------------|--------------------------------------
| channel                       | Dimensions, space position and building materials | Width of entrance and exit and escalator width of station exit and entrance building |
| Inlet and outlet              | Dimensions, space position and building materials | To simplify the modeling              |
| Management and equipment room, living room | Dimensions, space position and building materials | Fire grade and fire limit parameters of fire door and fire shutter |
| Fire door and fire shutter    | Dimensions, space position and building materials | The location, content and other information of the evacuation sign at the station |
| guidance sign                 | Physical properties and raw material properties (dimensions, spatial location and building materials) | Width of evacuation passage for brake unit |
| turnstile                     | Physical properties and raw material properties (dimensions, spatial location and building materials) | Height of barrier                     |
| Isolate the rail             | Physical properties and raw material properties (dimensions, spatial location and building materials) | Information about the materials used in billboards |
| advertising board            | Dimensions, space position and building materials | Physical properties of fire emergency equipment (including fire hydrants and extinguishers) |
| Emergency equipment (including hydrants and fire extinguishers) | Physical properties and raw material properties (dimensions, spatial location and building materials) |

### 4. Establishment of BIM emergency evacuation model for light rail stations

#### 4.1. Data exchange flowchart

In this study, a real light rail station is selected as an example model, and the station structure is an elevated two-layer side platform. Exert the coordination advantage of BIM technology, export its data (DXF format), further combine the information in Pyrosim fire simulation software, and finally establish the fire model. The data exchange process is shown in Figure 1. The introduction of the BIM model into the fire simulation and evacuation simulation software can facilitate the modeling. Meanwhile, there is abundant information in the relevant software with relatively obvious advantages, which is a qualitative improvement for the previous fire management mode.

![Figure 1. Flow chart of data exchange of light rail station](image-url)
4.2. Structural model of building

Usually, for light rail stations, the actual structural parts of their buildings include walls and columns, etc., so the spatial positions of these components must be added to the model. The corresponding structural model is established based on the template of an urban rail transit light rail station. The first and second floors of the station are station hall and platform respectively. A single entrance and exit connects the station hall floor. The BIM model of the station is shown in Figure 2.

![Figure 2. BIM model of emergency management of a light rail station is displayed](image)

4.3. Infrastructure model

Facilities in the station, such as entrance and exit gates, emergency evacuation signs, ticket machines and isolation railings, belong to the category of infrastructure models. Some of the infrastructure models inside the station are mainly described in figures 3, 4 to 5, and relevant data in these infrastructures can be helpful for emergency evacuation strategy.

![Figure 3. Modeling display of escalator](image)
5. Conclusion
In this paper, the fire scene of urban light rail station is simulated, and the corresponding model is established. At the same time, the traditional fire model is optimized. The three-dimensional building information model of urban light rail is established by using the modeling software Revit of BIM Technology. All kinds of information contained in the BIM building model of urban light rail station starts from each stage of rail transit planning, and the design and construction staff are constantly improving. The construction quality and meticulous degree of BIM model are related to the success of urban light rail emergency evacuation model. Therefore, in order to help the emergency evacuation strategy of the station more efficient and further enhance the evacuation efficiency of the station, it is necessary to model the evacuation strategy of the urban light rail station. Due to the limitation of the model conditions, the evacuation situation of passengers inside the train compartment of Urban Rail Transit under the condition of train fire in urban rail transit station is not deeply considered in this paper. In the follow-up study, the evacuation situation can be refined, and the train entrance and exit should be set as the boundary.
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