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Research on urban disaster relief road system planning

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Abstract. This paper summarized the principles of urban road system planning from the aspects of traffic demand, comprehensive planning and emergency response. Then it analyzed framework system of disaster prevention and relief roads in Japan and Taiwan. It summarized the enlightenment of the experience of Japan and Taiwan to the establishment of the road system for disaster prevention and relief in China. It included the establishment of the road system for urban disaster prevention and relief theory, the standardization of the content of urban disaster prevention and relief planning, and the improvement of the road management system and mechanism for urban disaster prevention and relief. The theory of road system for disaster prevention and relief to guide the planning practice, so as to ensure the safe and sustainable development of China's cities.

1. The introduction

In recent years, cities around the world are facing more and more frequent natural disasters. China is also one of the countries with the most serious disasters in the world. However, China's urban disaster prevention and mitigation infrastructure was relatively weak. Cities are highly developed and densely populated areas. Major disasters such as floods and earthquakes had caused huge losses to urban economic and social development. It had sounded a tight bell for China's disaster prevention and posed severe challenges, and the occurrence of several super-large disasters had also made the whole society pay more attention to urban disaster prevention, reduction and relief. Small and medium-sized disasters, such as fires, blizzards, rainstorms and traffic accidents, also occurs frequently, constantly affecting the normal operation of the city. In order to reduce the loss caused by disasters and improve the disaster prevention and reduction capacity of cities, it was urgent to establish a complete and reliable urban disaster prevention, reduction and relief system. This paper discussed the planning principles of urban disaster prevention and relief road system from the perspective of disaster prevention and relief, in order to improve the urban disaster prevention and reduction theory and support the urban practice. This paper summarized the experience of the current planning of the road system for disaster prevention and relief. It attempted to explore the prospect of future research on road planning for disaster prevention and relief, and provided suggestions for future research on road planning for urban disaster prevention and relief in China.



2. Principles of urban disaster prevention and relief road system planning

2.1. Road traffic volume demand principle for disaster prevention and relief

The traffic volume of the road for disaster prevention and relief needed to meet the basic requirements of the daily use of the city and disaster relief. It was also the core principle to maintain the patency and accessibility of the road traffic system. In order to ensure the normal operation of urban disaster prevention and relief road traffic volume. It was necessary for roads to have an effective passable width, unobstructed and accessible roads, and maintain barrier-free barrier and other characteristic. Road accessibility referred to the connectivity between the residents' own location and the shelter in the event of early warning or disaster, namely the accessibility of the residents' evacuation [2]. The patency and accessibility of the refuge road can meet the effective width of people's smooth passage in the process of evacuation. At the same time, it had the characteristics of barrier-free and provided the basic conditions for convenient and rapid evacuation. Therefore, it was necessary to ensure the effective width and barrier-free characteristics of roads to provide sufficient traffic volume for disaster relief. The concept of accessibility similar to that of accessibility was first proposed by American scholar Hansen in 1959 and was defined as the opportunity size of interaction between nodes in the traffic network [3].

2.2. Principles of comprehensive road planning for disaster prevention and relief

Comprehensive planning should be carried out for urban disaster prevention and relief roads. A road network system should be formed to closely connect disaster prevention and refuge places and residential areas. When planning and designing, we should consider the traffic jam when the building collapsed and the time efficiency of relevant rescue, emergency, fire control and relief materials delivery after disasters. Designated or set up refuge road and disaster relief channel, according to the length and width of the road, and the construction conditions on both sides [4]. The urban shelter and road for disaster prevention and relief constitute the system of the shelter. Urban refuge road is an integral part of the refuge system. The road for disaster prevention and rescue is an important link of safe refuge, and ensuring safety is the most important basic principle for planning and constructing evacuation places for refuge [5, 6]. Safety design of refuge road system should pay special attention to smooth traffic, accessibility, disaster prevention, barrier-free, fire control and traffic control [7]. The main goal of evacuation road planning and design is to enable residents to safely and quickly arrive at the shelter along the path of least obstacle when they take refuge [4].

2.3. Emergency response principles for disaster prevention and relief roads

Different secondary disasters may occur when disasters happened such as frequent road disruptions. Therefore, it is very important to establish a road emergency response system for urban disaster prevention and relief. The alternative road in the refuge circle system is the material space safeguard measure in the emergency response system. Emergency organization is also an important mechanism for responding to sudden changes during disasters. The organization mechanism makes plans and carries out risk assessment before disasters, and optimizes and rectifies the roads with actual problems, so as to achieve the function of safety and disaster prevention. Safety means that people can safely reach the refuge place through the refuge road in the process of asylum. Road safety in disaster rescue is to ensure that the rescue organization can reach the rescue point safely, smoothly and quickly in the process of road traffic. The disaster prevention of emergency response means that no secondary disasters occur in the refuge road network, and the environment and buildings around the refuge road have disaster prevention characteristics to ensure the safety and accessibility of the refuge road.

3. Japan and Taiwan urban disaster relief road system

3.1. Japanese urban disaster prevention shaft planning system

The disaster prevention axis in Japanese urban disaster prevention system is also called "disaster prevention environment axis" or "basic safety axis". It refers to the urban space integrated with roads

and other public facilities for disaster prevention and flame-retardant buildings along the way, which can be used as a refuge passage with flame retardant function, so as to improve the overall disaster prevention efficiency of the region. Disaster prevention axis is composed of different types of disaster prevention space [4]. The disaster prevention axis in Japanese cities is usually divided into two levels: the main axis of disaster prevention (width shall be more than 30m) and the secondary axis of disaster prevention (width shall be more than 24m), which correspond to the urban trunk road and secondary trunk road in urban planning respectively. The disaster prevention axis is divided into four levels in detail (table 1), namely, basic safety axis, disaster prevention environment axis, medium scale road and zoning road [4].

Disaster prevention axes of different levels correspond to regions with different road widths and spatial network scales. The existing road and planar space network system with disaster prevention characteristics should be formed to ensure the safety of urban disaster prevention and relief. The disaster prevention shaft had also been applied in our country's disaster prevention planning. For example, comprehensive disaster prevention axis was considered in Nanjing comprehensive disaster prevention planning. The selected factors included convenience of connection, reliability of road facilities, connectivity with municipal government and command center, and convenience of connection with disaster preparedness center [8]. The secondary disaster considered by Japanese disaster prevention shaft was mainly fire. So the flame retardant belt was set up as a safety barrier. Flame-retardant zones referred to urban zones that can prevent or delay the spread of fire. The space types and object facilities consisted of roads, squares, open Spaces, buildings, planting, etc. [4].

Table 1. Disaster prevention axis indexes of Japanese cities at all levels

Disaster prevention shaft grade	The width of the road	Space network scale
Basic safety shaft	More than 16 m	2km×2km
Disaster prevention environment axis	More than 16 m	1km×1km
The scale of road	More than 8 m	250m×250m
Division road	More than 6 m	--

3.2. Japan's road planning system for disaster prevention and relief

Japan's integrated disaster prevention work was mainly realized through "regional disaster prevention planning". They paid attention to the systematicness and comprehensiveness of disaster prevention. It not only emphasized the arrangement of disaster prevention physical infrastructure (disaster prevention hard power: buildings and blocks). More attention had been paid to the construction of integrated disaster prevention system in the whole region and the improvement of regional disaster prevention capacity (disaster prevention soft power: people and system) [9]. The road system of disaster prevention and relief consisted of two functions: evacuation road and rescue road. It was usually required to have rescue transport, emergency evacuation, fire, shelter and other functions. Different road levels had different contents, requirements and precautions.

Japan's disaster prevention road planning system still relied on the urban trunk roads for planning. According to the demand of effective width of road, different levels of road had different width requirements. For example, Japan had designated the width of disaster prevention road as 15 meters in the outline of the enterprise plan of urban disaster prevention and structural countermeasures and the manual of urban disaster prevention affairs. Urban disaster prevention and relief road system included urban disaster relief trunk road, urban evacuation trunk road, secondary trunk road and block evacuation passage [4].

3.3. Urban disaster relief road system in Taiwan

Scholars in Taiwan had made a more detailed study on the road system for disaster prevention and relief. The disaster prevention and relief road system was the disaster prevention space system which started to operate first. Road system was the connection channel between disaster prevention space systems. Therefore, the normal functioning of each spatial system required the normal operation of the road

system [10]. The importance of the disaster prevention road system was reflected in the planning level. The first requirement was to establish a complete, unobstructed road network system covering the whole region. The planning and construction should also conformed to certain principles [11].

The urban planning disaster prevention space of Taipei city included six systems, the road was a subsystem. The disaster prevention road system was divided into four levels according to the road level: emergency channel, transportation and rescue channel, fire channel and emergency refuge channel (table 2) [12]. Some scholars in Taiwan had also divided the disaster prevention and relief and refuge path system into three levels: disaster relief road, refuge road and alternative road. Disaster relief needed to use the shortest time on the road to reach the disaster area or refuge point. It was the delivery of relief supplies, equipment and personnel, fire activities, relief points of the material delivery road. The refuge road should enable the asylum seekers to reach the refuge area quickly and safely. The alternative road was the backup road when the refuge road loses its function. The width of road for disaster relief should be designed to take into account the width required for the entrance and exit of fire truck and the erection of ladder truck. The refuge road needed to consider ergonomics, surrounding conditions (such as building height, land use) and connection with the refuge point [13].

Table 2. Classification of disaster relief roads in Taipei city

The road level	Urban planning space names
Emergency road	Over 20 meters of planned road access and express road access and bridge access
Rescue road	Roads above 15m are planned
Auxiliary road	Roads above 8 meters are planned
Emergency escape route	Roads under 8 meters

4. Enlightenment on the establishment of China's road system for disaster prevention and relief

At present, China's urban disaster prevention planning is often carried out as a special planning in the overall urban planning. The disaster prevention road system is only a subsystem of disaster prevention planning. In the literature database retrieval, few scholars discussed the overall establishment of the disaster prevention system from the technical and management aspects of the disaster prevention road system planning alone. Japan and Taiwan had relatively mature road system planning in the field of urban disaster prevention theory. It can be used for reference in our country's urban road planning. The central urban area with high density of population and high degree of completion was weak in disaster prevention and relief of surrounding roads. The establishment of China's road system for disaster prevention and relief should be carried out from the following three aspects, drawing on the experience of Japan and Taiwan

First of all, we must establish the theory system of urban disaster relief road. In reference to the foreign theoretical system of disaster prevention and relief road, we should establish a suitable theoretical system of disaster prevention and relief road according to China's national conditions. According to the level of "country - province - city - county - town - village", the planning needs and principles of disaster relief roads are considered step by step in the design. The planning system of disaster prevention road is considered from the Angle of refuge circle.

Secondly, the content of urban disaster prevention planning must be standardized. The road system planning for disaster prevention and relief should be included in the urban disaster prevention planning. In comprehensive disaster prevention planning and special planning, urban planners, traffic designers and other professionals should cooperate and coordinate to complete the planning of urban disaster prevention road system. At the stage of planning and design, a detailed survey of the current situation will be carried out to make a thorough investigation of the basic situation of urban roads. In this way, the feasibility and effectiveness of road system planning for disaster prevention and relief can be improved.

Finally, we must perfect the urban road management system and mechanism. The road management department for disaster prevention and relief will be an effective guarantee for the smooth development and implementation of urban road planning for disaster prevention and relief. In the disaster prevention and relief road management system to build disaster relief organizations, disaster relief plan and arrange rescue team. In order to prepare for an emergency or disaster emergency rescue operations can be carried out in an orderly manner. The management organization shall also be responsible for the daily management and risk assessment and inspection of disaster prevention and relief roads. The agency will periodically screen roads for problems.

5. Conclusion

The experience of Japan or Taiwan should be used for reference in domestic disaster prevention planning. The lifeline system of road system for disaster prevention and relief is established based on the perspective of urban security development. This will be a long and arduous task for both experts and government departments. The establishment of the road system for disaster prevention and relief needs the attention of the whole society. It also needs planning, transportation, disaster prevention and other professional and multi-party to contribute to the safe and sustainable development of the city. Disaster relief road system is not established overnight. It needs to be built and improved step by step systematically, from the aspects of organizational system, disaster prevention planning and the configuration of related facilities. At the same time, advanced science and technology and smart city and other theoretical methods should be combined for scientific management of disaster relief road. Connect static planning with dynamic traffic. The organization should conduct dynamic, visual and data management and sharing of disaster prevention and relief road system. In this way, the whole people can get the convenience of using disaster prevention and relief roads in the emergency of daily life, and make contributions to the safe development of Chinese cities.

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