Study on Road Safety Design for Urban Disaster Prevention and Refuge

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Abstract. Urban disaster prevention and refuge road is the primary evacuation and rescue passageway space when the disaster happens. The safety design of urban road for disaster prevention and refuge can guarantee the safety rescue, evacuation and escape. As the lifeline system of disaster prevention and relief, the urban disaster prevention and relief road supported the carrier of people and materials movement during the disaster, and was the life channel to maintain the normal operation of the city during the disaster. It played an important role in the disaster prevention and reduction system.

Keywords. Disaster prevention and refuge road, Disaster prevention and reduction, Safety design, Resilient city

1. The introduction
Reasonable planning of disaster prevention and refuge road, on the one hand, so that people in the disaster can be efficient and safe to reach the refuge. It can also provide the relief department with convenient and convenient access to life, which plays an important role in ensuring people's life safety. This is the core content of comprehensive disaster prevention and reduction. How to plan a road traffic system that can not only adapt to the normal use of the city, but also play a role in disaster prevention and relief road is a challenge faced by academic research. Reasonable refuge road safety design is urgent and important, especially for China's urban construction to improve to a high quality stage. Which is particularly important and urgent for the study of urban disaster prevention and relief road planning. The basic principle of planning and designing urban disaster prevention and relief road is the safety of refuge action. Therefore, the road for disaster prevention and refuge should meet the needs of comprehensive road design and planning, so as to ensure the goal of disaster prevention, reduction and relief.

2. Theoretical research on urban disaster prevention and safety design
Urban disaster prevention and safety design is usually divided into four stages: pre-disaster prevention, pre-disaster preparation, emergency rescue and post-disaster reconstruction. Urban disaster prevention and relief road system is mainly studied in the first three stages. The city's road traffic system may be damaged first, when an earthquake strikes the city. These factors that must be considered in earthquake disaster prevention, such as the earthquake resistance, substitutability, complementarity, repeatability,
reliability, patency and maintainability of the traffic system [1]. The task of disaster relief and material transportation was undertaken by the urban transportation system. In order to minimize the loss caused by the disaster, the efficiency, accessibility and safety of the road transportation system were the key factors to ensure the rescue. Therefore, disaster prevention and refuge road planning should be combined with urban disaster prevention and safety design theory. To form a comprehensive and integrated planning system, so as to respond to urban disasters from pre-disaster preparedness and disaster rescue. Based on the above stage requirements, the author tried to explore the relevant theories and methods, including the theory of resilient city disaster prevention and the system of urban refuge circle. It will provide theoretical support for the research on the design of road safety for disaster prevention and refuge.

2.1 Resilient city theory
Holling, a Canadian ecologist, first applied the idea of resilience to systems ecology in 1973. "Resilience" means "returning to the original state" [2]. At present, the research scope of disaster prevention and reduction planning under the theory of resilient city has been extended to the public security of the whole city. It covers production safety, disaster prevention and reduction, nuclear safety, fire and explosion, social security, counter-terrorism and many other aspects [3]. Guo Xiaodong etal. proposed the concept of resilience from the perspective of disaster risk reduction. It basically covered three elements: the ability to mitigate the impact of disasters or emergencies; second, the ability to adapt to disasters or emergencies; the third was the ability to recover efficiently from disasters or emergencies [4]. The concept of "resilience" had evolved from the initial engineering resilience to ecological resilience and then to evolutionary resilience. Then Holling deduced it to the adaptive cycle theory's promoting effect on the cognition of system action mechanism [5, 6].

The performance characteristics of urban road safety design for disaster prevention and refuge before and during disasters were exactly consistent with the characteristics of resilient city theory. The theory of resilient city can be used as the theoretical key point of urban disaster prevention planning. This will form an adaptive cycle mode of urban disaster prevention and refuge road from the aspects of engineering resilience, ecological resilience and evolution resilience. Based on the theory of resilient city, the safety design of urban road for disaster prevention and refuge will continuously feedback and improve disaster prevention and relief strategies in the process of disaster prevention and relief.

2.2 Refuge circle system
Scholars in Japan and Taiwan introduced the concept of shelter circle system in disaster prevention planning. It provided a point, line and planar integrated disaster prevention area for urban planning. This system will fully guarantee the safety of people's evacuation and rescue operations in times of disaster or emergency. Refuge circle system was the core of disaster prevention space planning. It included planning urban road network system, living areas, neighborhood units, all kinds of buildings and other aspects.

The refuge circle system was a spatial hierarchy concept. The basic refuge circle referred to the proper configuration of refuge place and rescue facilities within walking distance, which was the basic unit of refuge. When a large-scale disaster happened, the disaster prevention and relief points within the basic refuge circle could provide facilities for command, refuge or emergency rescue. According to the spatial functional framework diagram of disaster relief circle, disaster relief roads need to provide road traffic conditions for disaster relief workers to reach the disaster area or refuge points in the shortest time. It was also responsible for the delivery of relief supplies, equipment and personnel, and fire activities, the important task of the delivery of relief points. The function of the refuge road was to make the asylum seekers meet the minimum disaster threat and reach the refuge area safely. The alternative road was the standby road when the disaster prevention and shelter road loses its function [7].
3. Safety design of urban road for disaster prevention and refuge

3.1 Safety design of urban road space for disaster prevention and refuge

Dai Shenzhi put forward the connection between disaster prevention and refuge road and the nature of land use in urban planning. This divided the urban land into "target area", "disaster prevention and refuge stronghold" and "disaster prevention and refuge channel" from the perspective of disaster prevention and refuge. Disaster prevention and refuge stronghold was formed by disaster prevention and refuge corridor and target area. This will be a safe, fast, efficient and systematic disaster object evacuation, transfer and placement [11]. Researchers usually started from the level of road system to explore the layout of disaster prevention and refuge road, and put forward the standard of section width required by different levels of roads and the distance to the refuge. Scholars had also carried out relevant studies on fire-resistant zones and other aspects in the safe space design of road layout (table 1). The improvement of shelter space and road space system was the most critical content of disaster mitigation. It was also the most closely related to residents [12] [13].

| Object facilities                  | Area for promoting cremation resistance | Content requirements                                                                 |
|-----------------------------------|----------------------------------------|---------------------------------------------------------------------------------------|
| Flame retardant belt              | About 45 m                              | Roads and rivers containing flame retardant belts; The height of the cremation resistant building is greater than 7m |
| Along the main escape route       | About 30 m                              | The width of the main escape road is more than 16m; The height of the cremation resistant building is greater than 7m |
| Wide area around the refuge       | About 120 m                             | Wide area refuge place above 10ha; The height of the cremation resistant building is greater than 7m |

3.2 Safety design of urban road entrances and exits for disaster prevention and refuge

In the book "urban seismic disaster prevention planning" [14], it was pointed out that the urban arterial road network in the earthquake area should have at least three exits. This required that the curvature coefficient (the ratio between the actual traffic distance and the direct distance between the two points) of the two main routes from the urban entrances to the earthquake relief key areas should not exceed 1.4, and in the case of partially interrupted traffic, the curvature coefficient should not exceed 1.8[1]. Some scholars put forward the establishment of "earthquake disaster relief traffic management system", including "disaster relief emergency traffic action system" into the overall disaster prevention system. Wu Shuiwei and other scholars proposed a series of studies on the functional framework and contingency plan of the emergency response system for earthquake prevention and relief in urban areas. He Mingjin, Li Weiyi, Chen Jianzhong and other scholars had also made many meaningful explorations on disaster prevention research at the block level [15-17]. Usually, there were no less than four entrances and exits for small and medium-sized cities. There were no fewer than eight in large cities, especially megacities. They connected the streets of the city with the highways outside [18].

3.3 Urban disaster prevention and refuge road morphological safety design

Common urban road layout patterns included grid, circular radial, free and mixed in the urban disaster prevention refuge road form safety design aspect. The four types of road network layout had their own advantages and disadvantages. The disaster avoidance road network should be coordinated with the urban development intensity in the safety design. The design proposal should avoid the impact of a single plot of land to produce traffic bottlenecks, resulting in large-scale traffic congestion or disruption. Network road structure should be adopted in the whole city to form multiple circuitous routes or redundant routes. This will reasonably connect the roads of emergency refuge and evacuation places.
with those of fixed refuge and evacuation places, and form a complete refuge road system [18]. The structure of road network played an important role in shaping the accessibility spatial pattern of emergency shelters. The passage time cost generated by the road grade was different, and the degree of promoting the accessibility of the road grade was also different [19]. Most of the traffic was freely distributed in mountainous areas, and the accessibility and direction of traffic were not as good as those in plain areas. Refuge road was also a natural evacuation, isolation and refuge places in times of disaster. Road system planning and design should have adaptability, flexibility and variability. In this way, it can meet the basic traffic capacity of the city under different circumstances [20].

4. Conclusion

Road traffic congestion in China's big cities has become a serious urban problem. In general, the awareness of disaster prevention and refuge road safety design in China's mega-cities and large cities was generally low. The design considered the safety design of the road from Shelter system and so on. It will establish a safe and reliable lifeline system integrating disaster prevention and rescue for urban development, thus ensuring the safety of the public. This paper summarized the problems existing in the current disaster prevention and refuge roads and made targeted optimization and revision in the planning. At the same time, we need to do a good job in daily disaster prevention preparation, publicity and education, so as to disseminate the correct knowledge of refuge and escape for the public, so as to avoid being unprepared for emergencies. At the same time we need to do a good job in daily disaster preparedness and publicity and education work. Management need to disseminate the right knowledge of evacuation to the public in case of emergency.

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