

Study on Optimization of Earthquake Transportation Emergency Management System

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Abstract Earthquake transportation emergency management is to study the traffic management of disaster area after the earthquake. Based on the assessment of traffic response demand forecasting and emergency response capability, this paper develops the relevant traffic contingency plans, and implements traffic emergency decision-making, organization and management measures in emergency rescue. All of these can minimize human injury, property damage and consumption of resources. Optimized earthquake transportation emergency management system can be divided into traffic emergency decision-making command system, traffic emergency demand forecasting system, traffic emergency passing capability assessment system, system of traffic emergency plan's integrating and implementing, traffic emergency support system, traffic emergency capacity enhance system. This paper describes the process of traffic emergency model.

Key words Earthquake rescue; Traffic system; Emergency management; Management system

1 Introduction

China is one of countries suffering earthquake disasters seriously, and its destructive earthquakes occurred in the 20th century accounted for one-third of worldwide, the death accounted for 50%, up to 60 million people^[1]. The early 21st century, in less than two years time, Wenham earthquake and the earthquake in Yushu happened, causing tremendous casualties and property losses in China. The two earthquakes both occurred in the mountains, so the traffic is the common difficulty faced in the rescue. Rescue after the earthquake is an extremely complex system. The research on how to clear the traffic in the shortest time, choose the reasonable transportation route and means, deliver the earthquake casualties and transport relief supplies, and enhance the built of post-earthquake emergency management system of traffic, has important theoretical and practical significance.

Some experts and scholars in China and abroad have done research on traffic management after the different earthquakes. Chiang and Jin studded up network chart of earthquake versus water supply system, transportation system, power supply system, communication system, medical ensuring system, which demonstrated that transportation system is playing the very vital role^[2]. Chang and Nojima brought forward Ds indicators to assess the Overall function of post-disaster traffic system for Kobe earthquake^[3]. Wang Zhitao and others established decision-making information system with function of transportation system management, path analysis and searching, by ArcGIS Engine' network analysis Interface Technology according to post-earthquake relief^[4]. Liu Chunguang and others conducted reliability analysis to urban transport network, and provided decision for the best location of Post-earthquake rescue team and Road Section need to be strengthen and reconstruct^[5]. Earthquake transportation emergency management research focused on the assessment of traffic situation in urban post-earthquake, statistics analysis and evaluation on traffic damage in non-urban areas and remote mountain areas is very few. While there isn't any systematic research on traffic emergency management of suburb areas after earthquake blank currently.

2 Contents of Earthquake Transportation Emergency Management System

It is not a long time to research on traffic emergency management in China. Although we have achieved a certain success, the comprehensive capacity of traffic emergency management is weak, particularly in the treatment of traffic emergency in the earthquake relief work. It exposes many questions, such as insufficient preparation, slow response, and improper treatment and ill balanced. It is concretely represented in the following aspects:

- (1) Imperfection of transportation emergency decision-making guiding system, and also lack of unified traffic emergency command organization after the earthquake.
- (2) The transportation emergency demand forecasting is not very prompt and accurately, also the method isn't scientific.
- (3) The transportation emergency capability appraisal way is not perfect; and the result is not very

precise.

(4) The contents of each department's transportation contingency plan are similar, but mutually independent. And they have not been induced in the unified transportation emergency management system.

(5) The transportation emergency safeguard system operates alone basically, and each department carries on the communication and coordination with difficulty in the short time.

3 Optimization of Traffic Emergency Management System

After the earthquake, unblocked, reliable, safe transportation network is prerequisite and foundation of effectively organized evacuation, rescue and reconstruction work. Building traffic emergency management system of post-earthquake which consists with China's national conditions is of great significance. Traffic emergency management system of post-earthquake Include: traffic emergency decision-making and command system, traffic emergency demand forecasting system, traffic emergency passing capability assessment system, traffic emergency plan implementing system, traffic emergency support system, traffic emergency capability improvement system. These six systems are an organic whole. Emergency decision-making and command system is guarantee of other five systems' normal operation. Traffic emergency demand forecasting system and traffic emergency passing capability assessment system is the base of traffic emergency plan implementing system. Traffic emergency plan system is the fundament ion of traffic emergency support system. Traffic emergency capability relies on the coordination of other systems. The flow chart of optimized traffic emergency management system is showed in Figure 1.

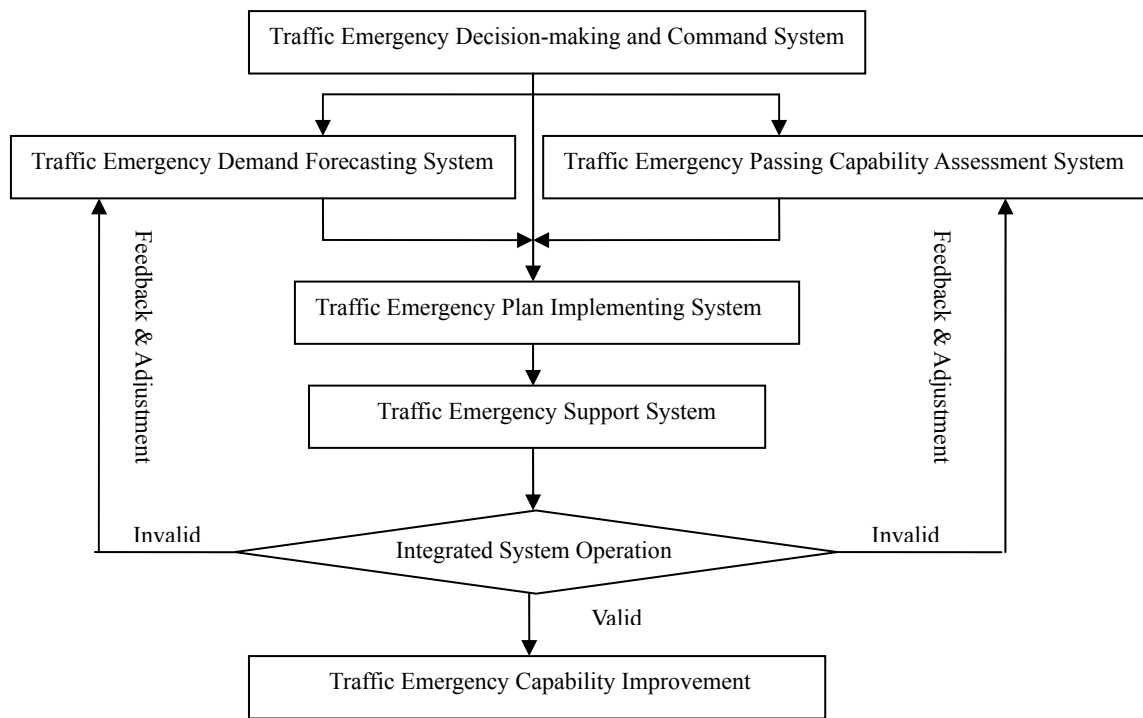


Figure 1 Optimized Traffic Emergency Management System after Earthquake

3.1 Optimization of transportation emergency decision-making guiding system

Transportation emergency decision-making guiding system is a system that can clear the levels of transportation emergency, advance optimization model and emergency plans of traffic arrangements coordinate the action of transportation, public security, fire protection, traffic police, first aid, civil defense and other sectors, restore the traffic within the shortest time, and improve the traffic capacity. The main content of this system can be listed as follows:

(1) Optimization of traffic emergency guiding organization

Because of the time pressure of post-earthquake emergency, especially within the "golden 72 hours"

of life rescue, we must have a high efficient and sensitive command organization, so as to make a uniform arrangement to manpower, materials, machinery for transportation emergency support ensure the traffic emergency task can be smoothly and quickly completed. We should set up transportation emergency rescue command center which consists of experts and scientists in the fields of earthquake, transportation, fire protection, traffic police, public security, first aid, civil affairs, so as to ensure the scientific decision-making and efficient command and the lifeline of post-earthquake is Unblocked.

(2) Building transportation emergency rescue command platform

Existing transportation emergency rescue command platform has some questions, like command is single, information resources is scattered, information exchange is weak, and technology structure is complex. Traffic emergency rescue command should centered for the traffic emergency rescue command system of disaster relief, connect with others emergency rescue command platform, like national, Ministry of Transport, other ministry, other emergency response agencies, and other rescue units. Thus can form top to bottom, left and right convergence, information sharing, mutual focus, mutual support, safe and smooth, convenient and efficient transportation emergency rescue command system

(3) Optimization of traffic emergency guiding mechanism

The rescue transportation practice implemented in Wenchuan proved that earthquake relief is complicated, diverse, and difficult. Law of the People's Republic of China on Protecting against and Mitigating Earthquake Disaster and National Earthquake Emergency Plan only referred to the traffic requirements of emergency transportation security, but not mention the transportation emergency relief of serious natural disaster. So we should establish the law about emergency and disaster reduction, though of which can provide emergency procedures, specify disaster relief resources, define the functions of relevant government structures and the relations among government, institutions and personal, fix the scale and means of asset acquisition and compensation, guide the work of disaster relief and mitigation, protect the property and safety of people.

3.2 Optimization of transportation emergency needs forecasting system

Rational prediction to the traffic demand after earthquake is the foundation of establishment of transportation contingency management pre-arranging plan and traffic control, as well as the important guarantee to make the rescue successfully. Due to destruction of roads, traffic control and the particularity of relief goods supply, transportation changes intensely after earthquake. In the emergency stage after earthquake, transportation mainly involves moving out of serious injury and carrying in rescuers, medicines and food. Transporting of special emergency vehicle will be the dominance of traffic in the early stage after earthquake; in the recovery stage after earthquake, the task is primarily to make sure the smooth transportation of relief goods for settling down disaster victims, as time goes by, traffic control measure will get loose step by step, transportation of private cars will get back the proportion in the division of traffic mode gradually.

The process of traffic demand forecast can be divided into four stages, those are traffic emerge and attraction, traffic distribution, model split, traffic distribution by analyzing related information about earthquake, evaluating the situations of casualties and property loss as well as the traffic volume of personnel, equipment, medicine and food that needed for rescue, using existing fairly matured four stages of macro model, and that can be amended according to the characteristics of transportation system under the condition of earthquake and can be used to evaluate traffic demand after earthquake^[6].

3.3 Optimization of transport passing capability assessment system

After the earthquake, the transportation system of the stricken area is destroyed and it causes the decrease of the transportation capacity in the stricken area, as result, serious traffic congestion will happen in some sections, which will undoubtedly create some obstacles to emergency rescue. So the traffic condition of the stricken area is one of the most concerned questions for the disaster emergency commander. It is critical to collect the information about the weather, road conditions and traffic flow conditions (traffic flow, the rate of the flow, interval travel time) of the stricken area, and then predicate and assess the emergency response capacity of the transportation timely. The actual capacity of the road after the disaster should be amended based on the capacity when the road is well according to the road damage situation. The destruction of roads, the collapse of houses, landslides and interference from the pedestrian should all be considered when amending the actual capacity of the road after the disaster to ensure the accuracy of the assess^[7].

Given that transportation resources are limited after the earthquake and the characteristics of post-earthquake emergency response, Optimal path analysis should be used in order that Post-earthquake emergency rescue can achieve the goal of time optimal, the optimal path, minimum cost,

and maximum capacity^[8]. Transport emergency control programs should be proposed according to the concrete steps of the rescue, including providing green channel for the emergency vehicles, proposing traffic guidance strategies, telling the related departments the best route to the site of the incident, adjusting the emergency response and rescue measures based on remote sensing images, video, images and feeding back information at any time, informing the relevant departments the information about traffic accidents and the rescue needs according to the different rescue needs and the division of labor in different departments, and assessing the traffic emergency response timely and organize the rescue work.

3.4 Optimization of transport emergency implementing plan system

Emergency response plan is the specific arrangements made in advance about the duties of the emergency response agencies, personnel, technology, equipments, facilities, resources, and the commands and coordination of the rescue, and it is based on the identification and assessment of potentially significant risk, types of accidents, the likelihood and occurrence of the process, the consequences and impact of the severity of the accident^[9]. Roads, railways and civil aviation departments have developed a traffic emergency and security plans, provincial, city and county also have developed a corresponding contingency plans for major emergencies. Chinese earthquake emergency plan should integrate the emergency plans of local government and the emergency plan of management stations of other industries. After the earthquake, it should integrate local and industrial managing department's contingency plan according to practical situation. And it should involves emergency organization and operational mechanism, forecast and early warning, emergency response, damage control handling, information issuing, emergency ensuring and management of supervising. In order to avoid traffic jams, it should start up contingency plan with prompt response, orderly organize, harmonious operating and clear division. during the time of saving lives after the earthquake, the air traffic emergency plan should start first, road traffic contingency plans and rail transport contingency plans should be combined to used, have a clear collaborative relationship with the relevant authorities, set up an information processing system which response fast, and form a standardized emergency response procedures to ensure the supply lines of food and water and reliable logistics chain ,so that the national interests and safety of the people can be protected.

3.5 Optimization of emergency safeguard system

After the earthquake breaks out, the traffic control department should start necessary traffic control. In the light of the rescue green channel and traffic guidance mode that are provided by the decision system, the traffic control department also assists other departments to carry out emergency rescue at the top speed and clear the way in the shortest time in order to make the road network traffic normal faster. The traffic control department also feeds back the on-site traffic obstacle situation and demand variations of all departments to the emergency decision system in time so that the decision making body can modify the emergency rescue plan in time and conduct emergency rescue better.

First of all, consolidating linkage between the emergency safeguards departments. Combined service force and linkage should be conducted genuinely between the Transportation and Public Security, Health Department, Meteorological Department, traffic Police, Road Management, and other related departments to improve participation of all related departments and build a sound management system. Making sure that the information situation is collected, the duty assurance is coordinated and the basic preplan is evaluated to improve the effectiveness of the disposal of the preplan.

Secondly, enabling advanced dispatch and command system for traffic emergency communication. In the traffic emergency response process, the effective enforcement of the emergency preplan, reducing casualties to the maximum extent and ensuring a smooth road network all depend on advanced traffic information to the utmost extent. Making the most of the good sides of emergency communication in earthquake relief work— maneuverability, Security and Reliability, real-time smooth, to make sure that everything in different zones and different communication networks is under unified control, command and organization, thus providing smooth, reliable and good communication service.

Thirdly, improving the level of transportation guaranteeing professionals. In the transportation guarantee of WenChuan and YuShu earthquake relief work, most of the drivers lacking of driving experience in mountain areas and not suiting to plateau climate are significant causes for the hard collection and organization of vehicles. To make sure that the task of emergency traffic guarantee can be fulfilled in time, fast and efficiently, men who have high political quality, strong organizational coordination ability, high professional level and bold in bearing hardships and contribution must be chosen to build a efficient and capable emergency guarantee team .And the team will be rectified and formatted according to the emergency guarantee task to improve the effectiveness of emergency

communication support.

Fourthly, developing the construction of the system of transportation emergency guaranteeing. The traffic transport mobilization hardly takes any effect if it just depends on the administrative instructions, relationship coordination and agitprop. The root causes for the hard collection of vehicles in transportation in earthquake relief work lies in the fact that we have no powerful legal arms to back on and that there is no compensation implementing regulations for related traffic support to act as a protection. The characteristics of traffic emergency support determines that a fully professional rescue team can't be built up just like that in earthquake, fire and marine salvage. We can only rely on the social mobilization mechanism to kick the goal of emergency transportation support. Using the social mobilization mechanism fully, and calling up various transportation resources in the whole society to participate in and undertake the task in emergency transportation support, hence a reinforcement team for emergency transportation support is formed quickly, and supply capacity for emergency transportation support is guaranteed.

3.6 Optimization of the ability to restore traffic emergency system

Transportation is a pioneering and foundational industry. It's the important precondition and basic guarantee of earthquake relief work. The most destructive power of the heavy earthquake of Wenchuan and Yushu is reflected by the transportation break-off. Because of the major mountainous and hilly terrain, less well-developed economics, professional rescuer and material reserve in transportation industry cannot fulfill the recovery needs after large scale disaster; it is hard to recover the transportation in a short time.

The first thing is to rush to repair channels for rescuing lives. The vital traffic arteries that have strategic signification to earthquake relive work must be cleaved at all costs and as soon as possible. A pre-arranged planning of rush repair should be constituted to make the process have regulations to abide by.

Second, the tie-in projects should be perfected. The engineering facilities, which connect transit lines of railway, road and airlines, including airports, stations and storehouses, should be renovated. So as to the access road that connecting railway, highway and airport and the same to the loading fields, platforms, wharves and fuel filling installation that will affect the transport capacity.

Third, the equipments for emergency of transportation should be stored. The storage of equipments for transportation include rush repair tools for bridges, tunnels and traffic hub, road maintenance apparatus, road clearing tools and rescue equipment, such as skid-proof equipment, and so on. These equipments should be distributed rationally with great variety and proper numbers.

4 Conclusions

The transportation emergency security after the earthquake has heavy duties and responsibilities; transportation emergency management involves many departments, making emergency management more complicated. But the post-earthquake emergency management system of traffic solved the problem to some extent. Through the analysis from many aspects and the analysis of the importance of emergency management, this paper describes the emergency transport model and developed contingency plans. It is expected to shorten the response time of emergency rescue, improve the effectiveness and reliability of emergency response for earthquake relief and provide a guarantee to restore the smooth flow of road. With the frequent occurrence of the earthquake disaster in China, which bring the traffic emergency management with new challenges, it is urgent to strengthen road traffic emergency management after the earthquake, establish and improve mechanisms for emergency traffic management system and to improve earthquake preparedness and response capacity. In order to control, reduce and eliminate the serious social harm caused by the earthquake, and to restore the normal order of road traffic timely, enhance the capacity of road traffic emergency. Therefore, it could meet the requirement of earthquake relief and reconstruction support to protect the normal operation of the socio-economic development after the earthquake.

References

- [1] Li Jing, An Shi, Cui Jianxun. Road Traffic Emergency Security System[J]. Journal of Harbin Institute of Technology University (Social Science), 2009, 11(6):139-145 (In Chinese)
- [2] Chiang, W.L.Jin. The Counter Measures for Urbanization Integrated Disaster in China[M]. Peking: Chinese Construction Industry Publisher, 1992:94
- [3] Chang, S.E., N.Noijima. Measuring Post-Disaster Transportation System Performance: The 1995

- Kobe Earthquake in Comparative Perspective[J].*Transportation Research Part A*, 2001, 35:475-494
- [4] Wang Zhitao, Wang Ling, Zhang Xiuyan. Nonlinear on Urban Traffic Analysis System Based on GIS for the Optimal Path after the Earthquake[J].*Wuhan University of Technology (Transportation Science & Engineering)* 2008,32 (5) :814-817 (In Chinese)
- [5] Liu Chunguang, Du Wei, Zhai Tong. Reliability of the Seismic Cabality of Urban Transportation System[J].*Earthquake Engineering and Engineering Vibration*, 1999, 19 (2):95-99 (In Chinese)
- [6] Chen Yanyan, Shi jiangang. Four-stage Correction Method for the Forecast of Traffic Demand after the Earthquake[J].*Highway and Transportation Research*, 2004, 21 (8):78-81 (In Chinese)
- [7] Zhao Chenggang, Feng Qiming. *Lifeline Earthquake Engineering*[M]. Beijing: Earthquake Press, 1994 (In Chinese)
- [8] Shao Mingyang. Research on the Capacity of Transportation System after the Earthquake[D]. Harbin: Institute of Engineering Mechanics, China Earthquake Administration, 2009 (In Chinese)
- [9] Liu Tieming. *The built of Emergency Response System and Emergency Plan Setting*[M]. Beijing: Enterprise Management Press, 2004 (In Chinese)