Review on the Study of Road Traffic Emergency Evacuation in Foreign Countries

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Abstract: From road traffic analysis point of view, the overseas road traffic emergency regional evacuation are involved in the process of regional evacuation modeling thought, regional evacuation traffic demand predictor of traffic management and control strategies and evacuation area has been developed for evacuation planning model and simulation software system of review for a method, region. And reviews the previous related research in regional evacuation problems in the process of modeling, combined with various regional evacuation traffic management and control measures, put forward the construction of regional evacuation traffic integrated modeling framework of thought. To for our country road traffic emergency regional evacuation traffic regulation planning, regional evacuation traffic plan and provide valuable reference and suggestion.

Keywords: Road traffic; Emergency traffic; Regional evacuation

1. Introduction

From dealing with natural disasters and man-made disasters abroad perspective, put forward the concept of disaster emergency management of disaster emergency management. According to the time sequence is divided into the following four stages: mitigation, preparation, response and recovery stage. As the key strategy of disaster emergency management response, regional evacuation is the meaning of the safe time the movement of workers from the danger areas, moving to a safe location. In this process, managers need to predict the spatio-temporal evolution of the impact of disasters, designated evacuation area, issued evacuation instructions, the estimated response form, evacuation traffic demand and evacuees to guide the evacuation of nearby evacuation channels and update traffic signal to effective evacuation traffic.

The research on evacuation involves a very wide range of content:

From the scope of the evacuation, the evacuation can be divided into internal evacuation of buildings, transport of internal evacuation, community evacuation and regional evacuation. According to evacuation occurs with or without notice may be divided into notice evacuation and no notice evacuation. The former is mainly for such as earthquakes, typhoons and other can approximately predict the location and time of occurrence of the disaster, while the latter mainly for terrorist attacks and toxic substances in the process of transportation leakage and other disasters, due to these types of disasters are difficult to predict the location and time of occurrence and the evacuation is often occurred in the case without notice.

From evacuation traffic control measures angle, on the whole can be divided into demand control measures and supply control measures. Demand control measures is mainly refers to the phases and priority of the affected area evacuation area step by step and in a planned evacuation, to control the traffic demand in a certain extent; supply control measures, is to consider how the existing evacuation network infrastructure to control, thus to maximize the utilization of the existing road resource, the measures mainly include: evacuation route assignment, certain sections of the retrograde Lane set and key evacuation channel signal control adjustment etc..

From the evacuation modeling perspective, including the macro and micro model of evacuation model. The macro model is mainly used to solve the lower bound of the evacuation time, without considering the behavior of the individual evacuation model. The macro representative mainly includes: Based on the macro model of dynamic network flow model and macro model of traffic assignment model based on the dynamic network flow model. According to the traditional method of graph theory, the evacuation area as evacuation route as nodes, arcs, thus solving the optimal problem. Traffic assignment model based on sparse Sanzhe often assume that emergency managers completely obey the command, so, according to the forecast of traffic demand, can according to the static traffic assignment model dynamic system optimal evacuation demand, will be assigned to the road network, which calculates the evacuation time bounds. The micro

model can be calibrated and individual Interactions between dispersion behavior and evacuees. Microscopic model is often through the simulation method, considering evacuation on the basis of individual behavior and its interaction, evaluation evacuation measures of effectiveness and evacuation time required.

From the evacuation algorithm of solving the model point of view, the majority can be divided into based on linear programming optimal evacuation scheme solving method and solving method, which is based on the heuristic algorithm. The former can be through the strong constraint conditions, to get best solution evacuation, but with the expansion of network scale, decision variables and constraints of increased, often computationally expensive, or cannot be solved. The latter often can't get the optimal evacuation plans, but suboptimal evacuation plan, but its computational cost is relatively low can applicable to large-scale evacuation network problem solving.

Regional evacuation as an important part of emergency management has attracted extensive research and study the problem is multi angle and multi level. In this paper, only for road traffic emergency regional evacuation modeling issues are reviewed, from road traffic emergency evacuation key issues involved, mainly divided as the following aspects: regional evacuation modeling framework review, regional evacuation traffic demand forecast review, regional evacuation traffic control measures to review and has been developed for regional evacuation model and simulation software review.

2. Summary of Road Traffic Emergency Evacuation Modeling Framework

From traffic analysis point of view. The effects due to natural and man-made disasters caused by regional evacuation modeling problem, foreign began about the latter stage of the seventies of the 19th century. Early work focused on the hurricane evacuation problem. Then, people begin to pay attention to the man-made disaster evacuation modeling problems, especially on March 8, 1979, Pennsylvania Law . In Pennsylvania at Three Mile Island nuclear accident, nuclear power plants in the area around the evacuation problem attracts more and more attention. At present there are still focused on hurricane regional emergency evacuation modeling problem. Lewis was first described by Hurricane traffic demand forecast method. The method and the urban traffic demand forecast method is relative. He proposed the evacuation traffic planning of some key issues, including evacuation traffic and evacuation traffic demand estimation and the evacuation of the empty between estimated and traffic control methods proposed.

Southworth according to the regional evacuation modeling are reviewed. It is pointed out that the regional evacuation modeling process should be divided into the following five stages: evacuation traffic demand prediction model; II evacuation response time sub model; (3) evacuation destination choice model; (4) evacuation traffic routes submodel; the evacuation plan setting, analysis and correction. Franzese and Han proposed a modeling framework for another hurricane evacuation, called the accident management decision support system. In this framework, the hurricane evacuation analysis is divided into the following steps: according to the disaster, the evacuation area into the emergency response area and pre district protection area, the determination of the number of emergency; the evacuation of the population area, including residents, tourists and some temporary population; the population based on behavior analysis to estimate the actual evacuation, this step includes: the estimated time of departure, the end of the selection and use of vehicles. The three step output rate estimation is a dynamic OD form, the OD form with the evacuation network together, the input to the traffic model, to estimate the evacuation performance. The traffic model and the Oak Ridge National Laboratory developed OREMS evacuation traffic model is consistent with the traffic model. Be able to compare and evaluate different path allocation scheme and an end point selected scheme, traffic control strategy, traffic management strategies, evacuation response rate and evacuation of time. The system used a evacuation start time curve to represent the short-term traffic demand distributions.

Liu pointed out that the evacuation plan for emergency preparedness is very important. However, for the future prediction of traffic evacuation scenarios it is difficult to give a reasonable, because for evacuation, which is characterized by highly dynamic and uncertain, so the effective real-time evacuation traffic management of traffic system based on the maximum and reduce the loss of life and property it is very important. In view of this, the author proposes a real-time traffic management based on the model reference adaptive control modeling framework, combined with dynamic network modeling technology and adaptive control technique. In this framework, evacuation traffic network is regarded as a dynamic system. The detection data acquisition system through the existing state and to get the emergency placement. In the system, pre implantation of a dynamic traffic assignment model, dynamic prediction system based on optimal target Desired traffic condition. The model for adaptive control provides a reference point. Would be expected to achieve the traffic state and obtained through the test data the network traffic input to the adaptive control model, to generate real-time traffic control strategy. The control strategy eventually will lead to traffic flow expected traffic state transition.

Liu proposed a regional evacuation of integrated control system framework, the system can also perform different control measures, including traffic route guidance, retrograde Lane development, phased evacuation and evacua-

tion channels signal control. The system has double control framework, network layer will be traffic assignment to different evacuation channel, select sections of the realization of retrograde Lane operation and calibration of different community evacuation evacuation sequence. Channel layer will network layer decision as input, to calibrate the serious problem of control point and along the main evacuation channel to realize the optimal signal timing. From evacuation modeling framework of evolution, we can see that foreign evacuation modeling framework to the dynamic traffic assignment problem from the static traffic assignment problem with transition gradually, evacuation traffic control measures from a single and advance planning to integrated and in real time.

3. Review of Regional Evacuation Traffic Demand Forecasting Method

Regional evacuation planning process, we must first clear transportation demand, on demand forecasting based on to design effective evacuation traffic management control measures. Regional evacuation traffic demand forecasting is to estimate the evacuation trip generation and the evacuation process in these generated will be occurred when. In order to achieve this goal and need to the following question: how many people in the danger zone need to be evacuated, how they are distributed, and how many vehicles will be involved in the evacuation; and when they will be evacuated. These problems are reflected in the evacuation traffic demand forecast of three stages, is following evacuation of the end of the selection, evacuation path allocation as well as the implementation of various evacuation traffic management and control measures on the premise and foundation. The evacuation traffic demand forecast includes the following three types of information:

Each cell of the total evacuation demand. The population consisted of resident population, temporary population and special facilities. The total evacuation demand dependent on many factors, such as land use types, evacuation times and evacuation type. The evacuees in response to the evacuation instruction. This will affect general sparse distributed traffic demand will be in when, to what kind of style loading to the evacuation road network. Previous studies is divided into three: dynamic loading curve, regression model of evacuation response time distribution and evacuation decision-making behavior. Traffic mode choice. This is mainly dependent on the socioeconomic characteristics of the evacuees.

4. Regional Evacuation Traffic Control Measures

Regional evacuation traffic control measures mainly for the needs of control measures and supply control measures. The former is mainly refers to the phased evacua-

tion, while the latter includes: evacuation routing path allocation, retrograde Lane Setting and key evacuation channel signal control. The following are reviewed.

4.1. Evacuation route assignment

In the limited capacity of the regional road network access, evacuation can be carried out smoothly, depends on whether the measure reliable. Evacuation path allocation is reasonable use of the limited network capacity typical means. At present, abroad on evacuation path allocation research is mainly divided into three:

The network flow model. The method will be defined as the evacuation area node path defines arcs, which can be regional evacuation problems will characterize. Dunn evacuation path allocation problem is the minimum cost flow problem. Cova path planning was proposed based on the concept of evacuation Lane traditional optimization methods of graph theory, established the extended minimum cost flow model this model, conflict stopped at an intersection to minimize the total travel distance at the same time, and limits the interleaving at the intersection. The output of the model includes maps of each intersection traffic way possible, the effectiveness of the method is verified by the specific evacuation practice. In short, this kind of model are included two kinds of constraints: limit the actual traffic flow and the conservation of each section of each node is less than the highway capacity. However, some traffic evacuation phenomenon, For example, the delay caused by obstruction, queuing formation and dissipation, in these models can not be reflected.

Dynamic traffic assignment model.Sattayhatewa and ran for the nuclear power plant accident evacuation, proposed a DTA evacuation route assignment model and the output of the model results are in each period, each section of the rate of inflow and outflow rates. Constraints on the model is the basic network flow constraints, including: the road node flow and the flow conservation conservation and constraint propagation Liu flow will also DTA was applied to the real-time evacuation traffic management, and presents the model reference adaptive control framework.DTA model to generate the expected traffic and the corresponding control strategy, as a reference point for adaptive control. In a word, DTA model can well reflect the evacuation traffic flow dynamic.

Other models. The model mainly refers to the widely used selection model based on the simulation of the path, these models are based on current network conditions to simulation of driver's route choice model. Examples are: NETVAC1, the model allows drivers in each period of each intersection, the traffic conditions ahead based on path selection; in addition to CEMPS and the model of path selection mechanism from the early Immediate-Congestion-Based mechanism, have transition to shortest path mechanism based on these are essentially belongs to the "myopia" of evacuation route choice model.

4.2. Design of the area evacuation retrograde Lane

Refers to the design lane, the lane changing all or part to the disaster area for safety to the direction of the lane. The design can greatly affect the performance of the lane evacuation network. In the study of the southeast United States hurricane evacuation, PBS&J on the four lane highway two different lane design strategy: to two lanes disaster area all and only change the direction of a driving direction of the transformation. The results show that the risk to the two lane on the conversion of all the driving direction, relative to the normal conditions of two lane evacuation, the evacuation network performance is increased by nearly 70%; only one lane driving direction conversion, about evacuation performance increased by 30 to make the network. Some simulation results also show that the retrograde lane design is effective for improving the evacuation performance.

Although retrograde Lane Design in practice has been affirmed, but few literatures focus on disaster condition, whether the which lane direction for implementation of conversion. In this issue, Tuydes etc. presents a section group of technology to realize the design of retrograde lane, to calibrate network which lane in the implementation of the reverse driving, can improve the overall network evacuation efficiency. By means of the method of optimal dynamic traffic assignment to obtain the optimal capacity distribution. Network flow is described by the cell transmission model.

In subsequent work, Tuydes during the evacuation of the retrograde lane design do the further research. In order to deal with optimal dynamic traffic assignment model is computationally expensive problem, Tuydes also present a heuristic algorithm, simulation, distribution and the tabu search algorithm is used, to study the large-scale network evacuation retrograde lane design problem solving.A dynamic traffic distribution optimization framework. This study used dynasmart simulation software are presented Mahmassani Sbayti. Research results illustrate the how in the emergency evacuation during the dynamic generation of retrograde lane control strategy.

4.3. Phased evacuation

Phased evacuation is also a commonly used control evacuation traffic flow measures. And retrograde lane design and compulsory route selection control method is different, phased evacuation does not change the topology of the network, but mainly by within a certain time window, reasonable distribution of evacuation traffic demand to maximize use existing evacuation network. In a staged evacuation, in accordance with the prediction of the impact of disasters, the evolution and other related factors, evacuation of the entire region is divided into some small regional evacuation. Managers give regional emergency degree higher priority to evacuation in.

The main problem is how to different stages of the evacuation of the evacuation zone distribution of evacuation priorities. Once the evacuation instructions issued, the evacuation process demand generated depends only on the evacuation reaction of.Chen and Zhan in 3 different structure of the road network, using micro simulation software PARAMICS, and compared the evacuation and staged evacuation the performance of.Mitchell and Radwan on some regional parameters affecting the evacuation decision stage, such as population density, road capacity, evacuation distance shelter distance and the distance and the main evacuation route. However, in their study, staged evacuation is essentially qualitative. So far, Tuydes and Ziliaskopoulos carried out a staged evacuation and optimization design of the most relevant research. They proposed a mixed integer linear programming model, At the end of the study, the destination path selection and the regional evacuation arrangements were optimized simultaneously, but their research only provided the time for each traffic district to start the evacuation, but did not consider the response of the evacuation instructions.

4.4. Signal control of key evacuation routes

For emergency evacuation, PBS&J pointed out that a good signal timing plans can increase the branch entering or leaving the main road traffic capacity and eliminate bottlenecks in their connection point. Many and evacuation planning related literature will arterial signal control as a whole evacuation control part of the strategy. At present most of the studies by simulation software to evaluate various signal with evacuation strategy effectiveness.

Pass by Chen microscopic traffic simulation software, CORSIM, evaluated the Washington D. C. The two major evacuation channels of different signal timing plans: red flash solution. This method makes each intersection of imported vehicles follow the first come first service principle. This method realizes the main road and intersecting secondary road between fairness, but the winner of the road traffic capacity has not been fully developed, and the parking, resulting in each intersection delay increases. 2 yellow flash solution. This method gives the trunk road traffic to maintain a continuous stream of priority, more full use of the main road traffic capacity. The disadvantage is the cause and the main road intersection of roads to produce large delay. If the delay is too long, the driver will not obey the traffic rules. (3) the minimum green scheme. Signal control by a longer period, but only for non road to improve the green light time shorter. 4 peak day scheme. The scheme is usually used for various peak periods of control measures.

Sisiopiku using signal optimizing synchro simulation software established the Birmingham, Alabama, a small region of the optimal signal timing scheme. They then

applied the CORSIM simulation software, test the different evacuation plan, and evaluation of the signal timing optimization planning performance impact on evacuation. Results show that signal timing optimization can greatly reduce the vehicle delay and improve the evacuation rate.McHale uses also a signal timing optimization software, TRANSYT -7F generated optimal signal timing scheme, then the CORSIM simulation to evaluate effect of emergency vehicle priority strategy to the normal operation of traffic.

5. Review of Foreign Regional Evacuation Model and Simulation Software

In traffic engineering field research of evacuation modeling problem often presents a combination of evacuation route choice and traffic simulation two. Most of them can be estimated evacuation response time and destination and path selection, and each step of the time, you can also characterization of road section and intersection traffic flow of temporal and spatial distribution.

Many models can provide repeated experimental environment for route choice behavior for analysts, the choice including "myopia" and set beforehand. Analysts or to control the route choice behavior based on the intersection of green time and adjust the steering details, or more control logic directly using the route choice preference function combined with the intersection to control the route choice behavior. The former regional evacuation model is mainly divided into two categories: the first category model formed by the mobile vehicle or limited to individual vehicles based on traffic flow with the simulation, forming relatively simple evacuation route selection logic. Second kinds of models, called "dynamic traffic assignment", more attention to the route selection process. It depends more on the traffic flow on the set, while at the same time trying to traffic demand in accordance with section and intersection The traffic capacity of the distribution, which is known as the "macro" traffic simulation.

6. Conclusions of the study

At present, the research on the regional evacuation planning is very abundant, but there are still some shortcomings:

Review regional evacuation area in the past research results, the majority concentrated in the proposed model to estimate the evacuation clearing time. These models have MASSVAC, NETVAC, DYNEV and orems. They also are the evacuation traffic demand as input, but few model evacuation traffic generated to estimate the integration to their evacuation model. In addition, past research mostly assumed that once managers issued evacuation orders, the evacuees completely obey the command, so previous evacuation model input is only by drawing on experience

of evacuation traffic load curve, which is often not consistent with the reality.

Evacuation traffic demand prediction is effective for regional evacuation traffic management and control of the basic premise. The Atlantic coast in western developed countries, especially the United States, the hurricane disaster is very serious, the relevant regional evacuation research content is also very rich. After the hurricane disaster, American emergency management departments were a lot of investigation and research, and in the evacuation demand accumulated a large amount of data and analysis results. At present, our country emergency evacuation system is not perfect, and in emergency evacuation planning process, evacuation traffic demand forecast, should also draw lessons from traditional planning method.

The lack of a comprehensive modeling framework to effectively integrate various evacuation control measures. If multiple evacuation control measures are also in the evacuation process is performed, then between the different measures must exist between and in same time-space road network of distribution patterns of traffic flow. How to effectively for evacuation integrated modeling is a new theoretical problem.

Evacuation network traffic flow characteristics have not been fully characterized. Effective evacuation control strategy of generation, require to truly capture the evacuation process, time-varying evacuation traffic demand, evacuation network traffic flow propagation and potential queue formation and dissipation processes. And to the network flow model and static traffic assignment model, were unable to reflect the evacuation network traffic flow dynamic. Previous optimal evacuation control strategy design, there is also a some unnecessary or impractical assumptions. For example, phased evacuation decision should consider evacuate evacuation instructions, rather than assuming emergency management can completely control the evacuation of the evacuation start time.

Anyway, at the present in our country disasters occur frequently, and from the point of view of road traffic study area evacuation problem has not been sufficient attention and in reference to related research results, on the basis of the western developed countries, from road traffic analysis point of view, is established, which contains a variety of traffic management and control measures, including the integration of regional evacuation traffic management control framework, regional evacuation planning involves a series of related theory research and simulation model development will become an urgent need.

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