

The Application of Highway Safety Audit on the Rebuilding and Extending

Sha Sha

Civil Engineering Department of Sanjiang University, Nanjing, China

Email: 38681251@qq.com

Qiang Wang

Jiangsu Province Communications Planning and Design Institute Limited Company, Nanjing, China

Email: 80190956@qq.com

Abstract—Road conditions are closely related to traffic safety and the professional designed roads can guarantee the driving safety as far as possible. The proportion of Road Reconstruction and Extension will enlarge more and more in the near future. The original road should be surveyed carefully in the construction. It can not only save money, but also guarantee the driving safety after engineering completion. Therefore, we should consider the long-term economic benefits and take steps to increase traffic security. Firstly, we should identify factors of the original road which influenced road safety in the past so that we can improve them in the reconstruction. Secondly, we should avoid bringing new potential safety hazards to the reconstruction. This paper give an example of reconstruction of the Huaijiang Section of The Beijing-Shanghai Expressway. Some suggestions are given to improve the traffic safety in the design. Road safety evaluation will be valuable if it is introduced to the road reconstruction and it will improve combined revenues of road reconstruction of China.

Index Terms—road safety, road reconstruction, reconstruction of the Huaijiang section of the Beijing-Shanghai expressway.

I. BACKGROUND ANALYSIS

China's highway transport is characterized by the flexibility, wide coverage and so on. It takes the leading position in all kinds of comprehensive transportation modes, and shows the great economic and social benefits. But at the same time, it can be clearly seen that China has become the country with the largest number of the death from traffic accidents in the world, and its average number amounts to three hundred every day. The traffic accident has become an "endless war". The ownership of auto in China takes 2% in the world, however, the number of the accident death has accounted for 5% of the world. All of these indicate the large number of people's lives and economic loss.

Highway is the fundamental infrastructure of the traffic system, though the statistical results of most countries around the world show that the responsibility of the accident mainly lies in the people and cars, in fact, the

driver's carelessness and error is mostly due to the difficulties caused by the highway conditions. Pavement performance, geometric design parameters, transect constitution, surface drainage and the highway's interchange, setting of bridge tunnel, traffic engineering and facilities along the line greatly affect the safety of road transport.

The public and project builders hope that these projects of the highway rebuilding and extending can greatly improve the safety of highway traffic, and provide good service for residents to travel in a relatively long time. This requires the in-depth research and discussion on the highway design, construction and management and so on by comparing with the existing highway problems, and then to take the effective and feasible measures to improve, not just referring to the existing standards and simply extending for the original highway.

II. ANALYSIS OF SIGNIFICANCE OF HIGHWAY SAFETY AUDIT

Highway safety audit is to evaluate the existing plan, research and design of the highway facilities as well as the potential elements that influence the safety of highway from the perspective of the safety of the highway users [1].

As for the design of highway extending, the designers need to know that what kind of measures can reduce the highway traffic accidents, how these measures affect the environment, what the cost of the measures is, what the possibility of the cost's efficiency, which the most efficient measure is, etc [2]. It is not easy to come up with a concise and clear answer to these questions. Because the effects that the different reconstructions of highway extending with the same measure may be probably different. This requires designers to conduct a comprehensive investigation of the original highway, find out the spots where the accidents often occur and its reason, and try their best to put forward the economic and feasible solutions. And in the process of designing, they not only pay much attention to the accident spots, but also avoid the hidden dangers that may appear in the reconstruction, which may become the new accident spots after the completion of the reconstruction [3]. As

for the answers to these questions, only through the highway safety audit can they be understood.

III. INTRODUCTION OF CURRENT MEASURES ON HIGHWAY SAFETY AUDIT

In China, there are a few cases about the application of highway safety audit into the highway extending reconstruction. However, in the foreign countries, its highway safety audit usually adapts the measures including cost-effectiveness analysis, cost-benefit analysis, comparative analysis [4].

A. Cost-effectiveness Analysis

It is a technique that in a certain period, in order to achieve a certain security goal, ranks the costs of the various optional safety measures with the same safety function, and takes the safety measure with the lowest cost as the selected standard. It only considers determining or achieving the security objectives, and a price of using safety measures, but not the economic benefits of these safety measures. The premise condition to use is to hope to gain the most security benefit objective under the given and limited social resources or in the jurisdiction involved decision makers, or to spend the lowest cost to achieve the objective in the guide of the certain safe goals.

B. Cost-benefit Analysis

It refers that during the period of the security measures, according to the discount rate, the cost and benefit of all safety measures are reduced for the present worth, and then the proportion of the present worth of benefit and cost is calculated, that is benefit cost ratio. If the ratio is greater than 1, the safety measure is worth adapting. The higher the ratio is, the higher the rate of return is by comparing the benefit with cost. It is a kind of technique to compare and evaluate the cost and benefit of a safety measure in a certain time. It directly tests whether the cost of the measure matches its benefit, focusing on the evaluation of the safety measure from the aspect of quantity. This technique originates in the research on the economic feasibility of the public facilities such as dam and highway.

C. Comparative Analysis

It refers to the contrast of two or more security measures, explaining their similarity, difference and reason. Comparative analysis on the security measures from the different aspects including time, space, process, content, form, internal structure, external contact and so on. For example, it can put the security measures with the same time and different sites into the comparative analysis, and also can contrast those with the different times and same spot. Through comparative analysis of the relevant security measures, it helps people to know the relationships of all kinds of security measures as well as their differences and effects in different environments.

IV. APPLICATION OF HIGHWAY SAFETY AUDIT IN EXTENDING PROJECT OF THE SECTION FROM HUAIAN TO JIANGDU IN BEIJING-SHANGHAI EXPRESSWAY

A. Overview of Extending Project of the Section from Huaian to Jiangdu in Beijing-Shanghai Expressway

Beijing-Shanghai expressway is the main section of the national highway. It starts with the junction of Wangxin, Huaian in the north, and ends with Dujiang, Yangzhou in the south, connecting with Ningtong expressway. The whole length of the route is 153.45 kilometers (excluding Zhengyi junction with 2.0 kilometers), using the plain-hill area four-lane, with the speed of 120 km/h, and roadbed width of 28 m.

Since the Beijing-Shanghai expressway was opened to traffic in 2000, the traffic volume of Beijing-Shanghai highway has rapidly grown. By 2005, the average annual growth rate amounted to 15.94%. As the rapid development of social economy influenced by the project area, the traffic volume of Beijing-Shanghai expressway still maintains a high growth rate, and its traffic condition and safety have not already adapted to the needs of traffic development.

In 2008, Department of Communications of Jiangsu Province approved the extending project of the section from Huaian to Jiangdu in Beijing-Shanghai Expressway with the total mileage of 154 kilometers. After the expansion, the width of roadbed is 42m, and the design speed is 120 km/h. This project has been started in 2009, and completed in 2012, with three years limited for the project.

B. Analysis of Influence of Road Factor on Traffic Accident

According to data analysis of the traffic accident, there are some related road factors concerning the original traffic accidents in the section from Huaian to Jiangdu of Beijing-Shanghai expressway.

1) Linear factor

In the section of the radius of 6000 ~ 6500 in plane curve, there are more traffic accidents, and in that of 8500 ~ 9000, the degree of the accident severity is much higher. In the interchange, the service area without acceleration and deceleration lane or the section without enough length of acceleration and deceleration lane, the accident rate is higher.

2) Shoulder width

Due to the large volume of traffic and large proportion of all kinds of trailer and large container cars, some parts of this section is insufficient in the shoulder. In the night or bad road condition, the accidents including tailgating and side scraping often occur because the driver has a weak sight or improper measures. In the part that the shoulder width gradually gets narrow, there are more traffic accidents.

3) Pavement performance

Some of the asphalt pavements have ruts, and in the rainy days, it is easy to form water logging in ruts and reduce the friction between the vehicle tire and pavement,

which influence the vehicle's stopping distance and direction control, or form the reverse ultra-high to affect the traffic safety.

4) *Imperfect safety facilities*

For example, as the mark information is not clear, the vehicle is easy to miss exits, which causes the drivers to break the rules for U-turn or retrograde, leading to traffic accidents. The isolation facilities are damaged to some degree, this impacts the effect of the highway's enclosed isolation, etc.

C. *Potential Safety Problems after Extending Highway*

After the extending, the width of the highway becomes larger. The problem caused by both the increase of lane number and separation of sub grade is to increase the portion of confluence segment in the main section, and make it more complex in terms of traffic conditions. Implementing the confluence segment in the highway with the unidirectional double-lane, the drivers need to change the lane just one time, but in the highway with the unidirectional four-lane, the drivers inside need to change the lanes three times to leave the main way. In the condition that the proportion of the car passing reaches 60% to 70%, it will lead to serious phenomenon of keeping out the signs. If the volume of traffic is much larger, the vehicles will be very difficult to diverse, which is possible to cause traffic accidents.

Road conditions are improved; traffic flow turns to be unlimited; the big and small cars drive on different lanes; the number of driver's operation times of acceleration and deceleration operation reduces, which may cause that the driving behavior becomes drabber and driving fatigue problems may be more serious than before. Especially in the specific time, people's physiological function drops gradually to the minimum value, the driver is easier to be fatigue, thus they are possible to underestimate the factors of the traffic accident with slow reaction, causing the traffic accident.

D. *Supplement of Highway Safety Audit for Design*

1) *Route*

The quality of designing Beijing-Shanghai expressway (from Huaian to Jiangdu) is high, and the majority of geometric design is consistent with the standard specification. Therefore, extending highway is consistent with the standard of the geometric design, which can guarantee requirement for the safety of the linear.

2) *Roadbed, pavement and drainage*

The Beijing-Shanghai expressway's roadbed and drainage (from Huaian to Jiangdu) comply with the requirement of specification, and it can basically ensure the vehicle's safe driving.

3) *Route intersection*

The setting of the route intersection of Beijing-shanghai expressway (from Huaian to Jiangdu) is basically reasonable, but there are the hidden danger in some parts of the exits and entrances of interchange, for example, the span bridge keeps out the exit ramp and the sign of limiting speed; the driver is not easy to find it; and Chuzhou hub is close to the Liudong service area, etc. Therefore, it is necessary to pay much attention to

improve the road communication and the security situation nearby service area.

4) *Traffic engineering and facilities along the line*

The safety facilities of all traffic engineering are set up with systematic and perfect signs, marking, signs for the line of sight, isolated gate and protecting screening. Some sections are equipped with continuous median barrier (being added for other sections in the extending project). Side guards are set in the sections with bridges and high embankments; Interchanges have the signs of warning and direction. Edge line of most lanes and the section with diverse and confluence are set with continuous reflective protuberance road signs. Shunt triangle end in most exits has the anti-collision facilities.

But there are still some problems. It is found that the number of traffic signs in the accident spots is quite smaller and even there is no sign there. Therefore, in the extending project, it is necessary to add more signs.

As for the problems of fatigue driving that may be caused after the project, it is suggested that the warning signs should be set in the sections with the liner and slotted curve, which can alleviate mental fatigue well, so as to prevent the traffic accident.

In addition, in order to strengthen the driving safety of the confluence in the main way, some suggestions are put forward in the following.

- Setting the direction sign. It is suggested to set up a sign of portal frame type away from the ramp in 2 and 1 meter.
- Measures to limit the speed. It is suggested to set up Zollner's lines on the declaration lane and ramp surface with the distance of oblique line being 2 meters.
- Improving the stadia. It is suggested to set up the reflective membrane in the guardrail end and a sign of portal frame type.
- Protective facilities alone the side of the way. It is suggested to increase the barriers in the exit.

V. CONCLUSION AND PROSPECT

Researches on Highway Safety Audit in domestic have received widespread attention; the department of communications has also put forward the corresponding industrial standard. But the theoretical results of this study haven't yet achieved full mature methodological conclusion, and in the actual project, the guidance role is still very limited. Highway Safety Audit is a complex and worthy eternal subject to discuss, especially in the period that there are many existing road reconstructions in domestic. The mature of the theory and its application in the road construction have the great social and economic value on the whole road transport system. It is expected that highway safety audit will be the necessary procedure in the process of Chinese road construction in the future [5].

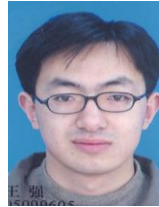
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Sha. Sha was born on August 23, 1981 in Jiangyin City of China. She achieved Bachelor's degree of engineering from Civil Engineering College of Southeast University in July 2003. She successfully achieved Master Degree of Engineering from School of Transportation of Southeast University in March 2006. And she received the Lecturer title in 2009. So far in 2006, she works as a teacher in Civil Engineering College of Sanjiang University. Her research interests are road design and building material.



Qiang. Wang was born in Rushang City of China on December 23, 1980. He obtained Bachelor Degree of Engineering from Civil Engineering College of Southeast University from September in July 2003. And he got the Engineer title in 2009. So far in 2003, he works in Jiangsu Province Communications Planning and Design Institute Limited Company. His research interests is road design.