

# Research on Technique of Highway Traffic Black-spot Analysis

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**Abstract:** On the basis of the research of the predecessors on the problems existed in the road traffic safety of our country and the accident causes component, the analysis and study on the formation mechanism and same features of the road traffic accident black spots of our country are made by comparing definition of black spots with other countries. Introducing action of MATAC method ,such as: the data collecting, processing, analysis and resolving method of road traffic accident black spots ; some traffic accident black spots on highways of second class and above in Chongqing and Sichuan province were identified by MATAC method which emphasizing the analysis on the influence and general feature of traffic type, season and climate etc.

**Keywords:** Black-spots; MATAC Method; Influence factor; General feature

## 1. Introduction

With the gradual formation of China's highway network, the scale of road traffic and usage is increasing, but it also brings a serious negative impact. Traffic accidents have become one of the negative effects, and it has become a more and more serious social problem for every country in the world. It is urgent to study the mechanism of traffic accident by using a new and reliable method of traffic accident analysis.

## 2. Black Spot Definition

Traffic accident is a random event, causing a lot of factors, but if a traffic accident occurs somewhere, and the same type of accident, it should be taken into account the characteristics of the road and the inherent law of the accident. Accident black spot refers to in a certain period of time, the occurrence of traffic accident index has statistical significance than the position of the prescribed threshold (points, segments or zones) [1].

### 2.1. The Definition of the MATAC Manual in Holland

The number of accidents occurred within 3 years is 6 or more locations (intersection) as well as the first 3~5 years in the same position as the total number of accidents for at least 10 or similar accidents for at least 5 consecutive sections known as black spots.

### 2.2. Definition of Norway

Long 100m within 4 years of the road traffic accident occurred 4 or more casualties of the traffic accident called the road black spots, long 1km of the road within 4 years of the occurrence of more than 10 casualties of traffic accidents, also known as road black spots.

### 2.3. Definition of Australia

In the "Road Safety Engineering Guide" of MONASH University in Australia, the location of the accident in the road system is not acceptable.

According to the comparison of the definition of accident black spots, combined with the actual study of traffic accidents in our country, we have a common reaction to some of the characteristics of road black spots:

In a certain period of time, the occurrence rate of a specific location or road section is higher, and the density of the accident is larger.

Have direct relation with the road alignment, horizontal aspect index, traffic operation environment and so on. It can improve the road facilities and optimize the road performance.

The road traffic system is composed of people, vehicles, roads and environment, in which the defects of one or several factors can increase the chances of accidents, and the people are the leading factors .The complete system, operating highway safety, improve comprehensively from the four aspects: person, vehicle, road, environment. But for road black spots, road facilities, the improvement of a clear and direct role, is the first choice to improve measure.

## 3. Black Spot Analysis Method - MATAC Method

The aim of the black spot analysis is to reproduce a series of scenes before the accident as accurately as possible. There are many factors that affect the occurrence of traffic accidents, so it is not easy to reproduce a series of conditions and procedures before the occurrence of the accident. If the analysis process step by step system, then the probability of success of the simulation scene will be

greatly increased. The MATAC method is a reliable, practical and valuable analytical method based on the complex relationship between human, vehicle, roads and environment factors. Its purpose is through research in some specific climatic conditions and weather, road in a certain position or sections is occurred the common characteristics of traffic accidents, found the problems existing in the road design, in order to improve the design ideas and methods.

MATAC method of the core is a complete and coherent analysis process such as (1): collect data on all accidents -- Analysis of the main types of accidents and accident characteristics -- the analysis conclusion -- assuming the cause of the accident, test the hypothesis that the cause of the accident, establish the cause of the accident, putting forward the solving measures. MATAC method is divided into seven steps, each step is an independent operation[2].

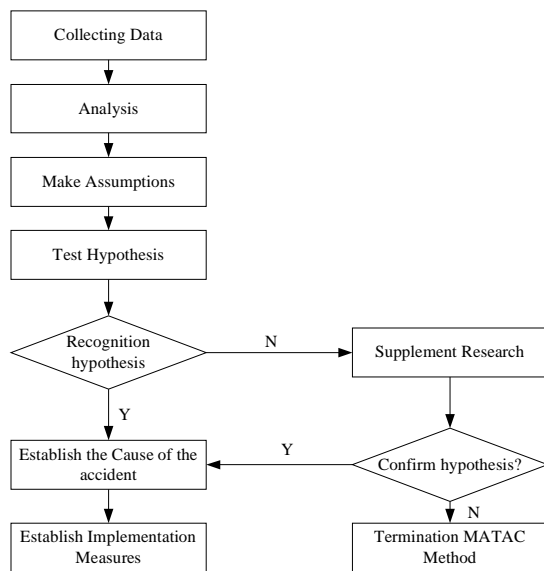


Figure 1. MATAC method step decomposition

### 3.1. Collect and Collate Data

In order to carry out MATAC analysis, we must first identify and select black spots, and fully grasp the situation of road traffic accidents, so the collection and collation of data is required.

#### 1) Black spot identification and selection

Black spot identification is selected on the road because of the accident multiple and more abnormal position, in order to take the corresponding measures to deal with. Common identification methods are: accident frequency method, the absolute number of times, the equivalent total number of accidents, the relative accident rate method, mathematical statistics, identification index method,

quality control method, etc.. In this paper, the improved method of accident frequency selected target sections according to “The Road Traffic Accident Prone Locations Identified” (2006) [3] requirements, according to the 1km for a statistical unit road segment, press type calculation section average number of accidents:

$$\lambda = \frac{\sum m_i}{n} \quad (1)$$

In the formula, the average number of accidents; the number of accidents for the  $i$  of the road section;  $n$  for the total number of road sections. The confidence level is 95%, and the critical value of the accident number is:

$$R = \lambda + 1.96\sqrt{\lambda} \quad i = 1, 2, \dots, n \quad (2)$$

The accident a unit in the statistics of the actual number of accidents and the number of road accidents, the critical value of  $R$  contrast, if greater than  $R$ , the section of the unit for the accident black spots [4].

#### 2) Accident Data

Accident data is the most basic data of accident black spot analysis, including the time, place, accident form, accident type, cause of accident.

#### 3) Traffic Data

Traffic data is obtained by observing the traffic flow on any section of the road, traffic data is composed of the average annual traffic volume, the maximum hourly traffic volume, the average running speed of vehicles, the vehicle mixing degree and so on. If the data acquisition cycle is long, the workload of analysis is large; if the cycle is too short, it is not conducive to a comprehensive and accurate reflection of the road traffic changes in the year. Acquisition year for the 1~3 is more reasonable [5].

#### 4) Field Data

Field data is traffic accident site conditions, including pavement, cross section of road construction, road alignment, ramps, traffic safety facilities, traffic control, intersection, road type, at the same time should also include the natural factors, such as weather conditions. In the latter stage of the study, the data needed to be added such as traffic behavior.

#### 5) Other Data

Other relevant accident data, such as the vehicle track map, is required to describe the traffic accident, added in the location map shows the characteristics of the accident.

### 3.2. Analysis

Analysis is the core of the MATAC process, which aims to find the leading causes of traffic accidents through the analysis of many factors affecting the traffic safety.

First of all, according to the accident information, it has been classified the traffic accidents to a road accident prone points, such as road grade, season, road sections, weather conditions, etc. Specific implementation should be based on specific circumstances to determine the actual classification criteria. And then analyze the common

characteristics of each type of accident, such as the time of the accident, the weather condition, the traffic environment and so on. Then consider whether there is a correlation between the common characteristics of each type of accident and the traffic accidents, which can be inferred from what is the common feature.

### 3.3. Put forward Hypothesis

Based the above analysis inference, to compare all kinds of inference, because some of these inferences is relevant, and some of them are contradictory, and there may be different types of traffic accident is caused by the same reason, finally proposed the hypothesis about the causes of the accident.

### 3.4. Hypothesis Test

The number of accidents, the fatal accident rate of 2 statistical indicators to test the traffic accident causes, proposed the hypothesis. Field investigations were conducted to test the hypothesis and the actual situation of the degree of compliance, while in the survey may also find other reasons for the proposed assumptions and did not foresee the factors.

In the field of each type of traffic accident on the assumption that the reasons for the investigation, to all positive, negative or think the cause of the accident has a certain relevance of the findings were recorded. On the spot inspection also pay attention to the following points  
In person at the scene of the accident, observed the surrounding traffic environment, such as the speed of the situation, the lane distribution, intersection delay and so on.

Survey performed not only in and traffic accidents occur at the same time, weather conditions and other conditions, but also select different period were, the gap between the two is helpful to analysis, it is pointed out that may be the cause of the accident.

The traffic behavior of road users with multiple points of accident should be observed closely.

The residents of the accident near the interviews can also get some additional information.

### 3.5. Supplementary Investigation

If the field investigation is still unable to provide sufficient evidence, it is a supplementary investigation.

Collect more information such as the accident, such as the study of the traffic police investigation report, or when the conditions of the parties to the accident investigation.

Frequently, the road users of accident prone points were interviewed.

To carry out investigation and Research on the traffic behavior of the main types of accidents, the specific use of traffic conflict technology and the driver's operation model is analyzed.

When supplementary investigation still cannot provide enough evidence to support the hypothesis that the assumptions and the accident occurred does not have obvious correlation, MATAc end of the analysis.

### 3.6. Establish the Cause of the Accident

If the field survey provides sufficient evidence to prove the assumptions made by MATAc, then we can get the reason for each type of accident. It is important to compare the different developments that have been made in the field survey, as these are likely to be complementary or contradictory to each other. Different types of accidents may be caused by the same reason, according to the results of field surveying, analysis of the inherent relationship between the factors derived from each hypothesis, and ultimately establish the cause of the accident.

### 3.7. Propose Solution

Propose solutions to the cause of the accident, and evaluate the corresponding measures to prove its feasibility.

## 4. MATAc Method to Analyze the General Characteristics of Accident Black Spots

### 4.1. Different Levels of Road Black Spot Accident Type Distribution is Different

As shown in Figure 2, distribution types of accidents occur in the accident black spots., freeway accident number is large, accounted for the total number of incidents is about 75%, and the serious and major accidents number of smaller, account for 10%, but caused by big or major accident death and property loss of the larger [6]; secondary road is to be dominated by a major accident, accounted for the total number of incidents of 42%, 45%, followed by general accidents accounted for the total number of accidents, 33% and 35%. Serious accidents accounted for the total number of accidents, 20%, 15%.

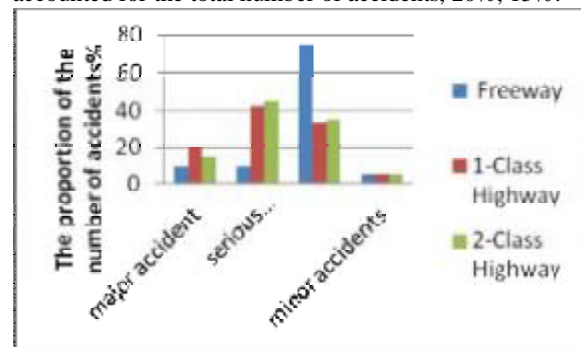


Figure 2. Distribution of the number of accidents by type

### 4.2. Black Spot Accidents Affected By the Season

Figure 3 shows the accident black spots on the number of accidents in cloth, shows that the highway by the seasonal effect is more obvious, from January to April and other

affected by the bad weather caused by traffic accidents is relatively high, 8 months to December accident number is relatively stable, may to July accident minimum number; and, throughout the year of secondary roads traffic accident black spot distribution is more balanced. Figure 4 for the month of the fatal accident rate, high speed, first grade highway April ~8 month and October ~11 month fatal accident is relatively high, the annual death rate of the two highways is relatively stable.

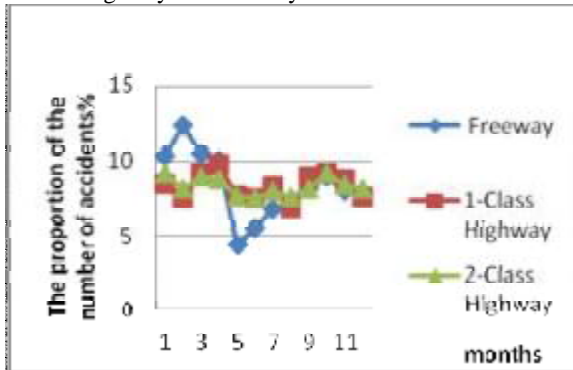


Figure 3. The number of accidents on a monthly basis

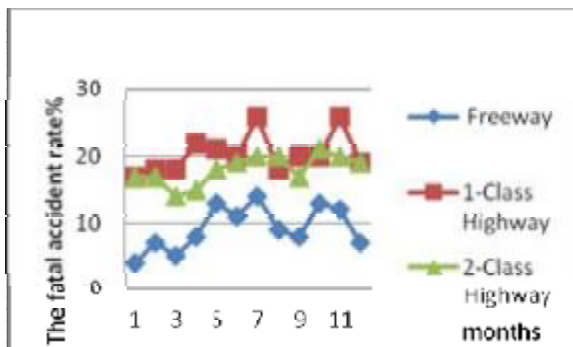


Figure 4. Monthly distribution of fatal accident rate

**4.3. Black Spot Accident**

Through analysis of road alignment on accident black spot, level of road accident black spots mainly distributed in general slope bends, general slope and plain straight sections, accounts for about 95 percent of the total number of black spots accidents, as shown in Figure 5, from the fatal accident rate of view, highway occurred in general slope, general bending steep slope section of the fatal accident rate is higher, and first and second grade highway occurred in general sharp bends, steep peace straight sections, and deaths caused by the accident rate is also high, at more than 15%, up to a maximum of 35%.

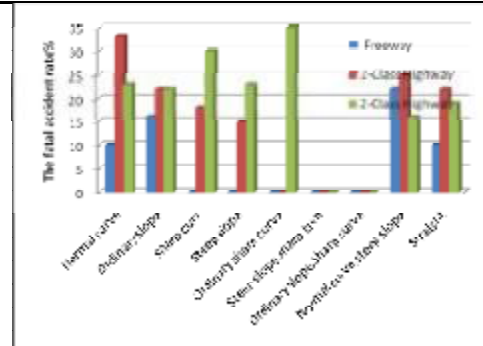


Figure 5. Road line distribution of fatal accident rate

**4.4. Different Levels of Road Accident Black Spot Intersection and the Distribution of Different Sections of the Road**

The location of the accident is divided into two categories, the intersection, the road accident black spots on the road is located about 96%, one or two road accident black spots occurred on the road about 70%, occurred in the intersection about 30%. This mainly associated with all levels of road traffic management and control factors: highway has relatively perfect traffic engineering facilities and traffic safety facilities and strict control of vehicle access [7], prohibit pedestrians and non motor vehicles entering; and secondary roads belong to open or semi open road and relative Import and export does not control or control is not strict, especially in some urban road intersection more, and often traffic language system imperfect, pedestrians and non motor vehicles and motor vehicle driving are mutually staggered, evoked intersection accidents. Therefore, we should pay attention to the first and second grade highway access management [8].

**4.5. Special Weather Has Significant Impact on Accident Black Spots**

According to in different weather conditions in the statistics of accident black point, sunny days accounted for the main part, about the accident total number of 65% ~ 75%, followed by rain and cloudy, in the total number of various highway respectively at around 15% and 10%. In addition, the fog has 10% in Expressway. Figure 6 shows from the fatal accident rate of view, accident black spot by special weather affects larger, compared with other weather conditions, rain, snow, fog and other weather caused by highway fatal accident rate higher, of which the fog caused is the highest, the fatal accident rate of 30%, first and second grade highway in rain, snow and cloudy is relatively high.

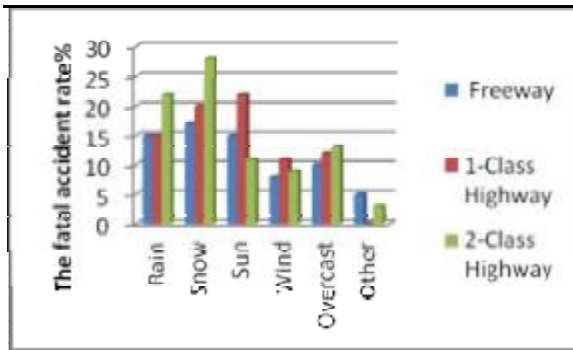


Figure 6. The fatal accident rate is distributed according to the weather condition

## 5. Conclusion

The elimination of accident black spot is the most effective measure to reduce the road traffic accident, and the establishment of the accident black spot analysis system is very necessary to effectively improve the efficiency of accident black spot analysis and improve traffic safety. The main analysis method is MATAAC method, it is the effective tool to improve the operational safety of the road, the basic design process and steps of the MATAAC method are briefly introduced in this paper. At all levels of road traffic accident black spot common characteristics are: the general accident probability larger, accounting for higher level of road accidents, the proportion of the total number, the highway is the most prominent; highway, a road accident black spot accident af-

ected by season, climate fluctuations larger, secondary roads by season, climate cause lethal volatility is relatively stable; road accident black spots are mainly distributed in long straight line, curve and longitudinal slope of a large section of and these positions to death rate is higher.

## References

- [1] Zhang Dianye, Black spot analysis and highway traffic accident[M].China Communications Press,2005,01.
- [2] He Yong, Guide for highway safety design[M].China Communications Press,2011,12.
- [3] Xiao Shen, Guo Xiucheng, Song Junmin. Study on road traffic accident black spot identification method [J]. Journal of Highway and Transportation Research and Development, 2003, 20(4) : 95-97. ( in Chinese).
- [4] Guo Xiucheng, Sheng Yugang, Pan Zhaoyu.etc. Analysis of general characteristics for highway traffic accident black-spots[J]. Journal of Southeast University (Natural Science Edition), Sept.2007, Vol. 37, No. 5.
- [5] Guo Xiucheng, Sheng Yugang. Black spot analysis technology of highway traffic accident[M]. Nanjin: Southeast University Press,2009: 55-56.
- [6] Pande Anurag, Abdel A Mohamed, Liang Hsia. Spatiotemporal variation of risk preceding crash occurrence on freeways[ C /CD ]. TRB, 2005: 5- 10.
- [7] Chadbunchachai Witaya, Owtanapanich Wichuda, Anaboriboon Yordphol .An alternative approach to road safety problem in developing countries: a public participation approach to identify black spots location a case study in Thailand [C/CD]. TRB, 2004: 4104- 4108.
- [8] Guo Z, Gao J, Kong L. The road safety situation investigation and characteristics analysis o f black spots of arterials highway s [J]. Advances in Transportation Studies an International Journal Section A, 2003, 1: 9- 20.