Characteristics of freeway traffic crash in China

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Abstract

Freeway should be the safest type of highway because of its highest design standard. However, in China, the well publicized freeways' crashes particularly the once involved multiple fatalities certainly do not give the general public that positive impression. This paper will present the results of the studies conducted by Beijing University of technology on the safety of freeways. Based on the data collected at several freeways in China, it is clear that the current freeway operation is not as safe as it should be. Comparing to other developed countries, the freeway traffic fatality rate is much higher. Through detailed substantial data analysis, this paper examined the distributions of crash type, crash frequency by time and space, crash violation and crash causes. Many of unique characteristics of traffic crashes on freeways in China were discussed.

Key words: Freeway safety, Crash data, Crash characteristics

1 Introduction

By the end of 2005, China completed more than 41,000 kilometers of freeways, which puts the country just behind the United States in the world in freeway mileages. According to "*National Freeway Network Development Plan*", China will have about 85,000 kilometers of freeways in 20 years. As the freeway mileages increase so do traffic crashes in China for the past few years. The effort made on the freeways' efficiency and safety lags far behind freeways' construction (MOC, 2005).

Freeway should be, and has been the safest highway comparing to other types of highways due to its highest design standard. Whereas these years Chinese government was forced to pay more attention to freeway safety problems due to its leading fatality rates regardless of its luxury infrastructure criteria.

Considering a lot of possible factors influencing the occurrence of crashes, the research team at Beijing University of Technology started the project by collecting many freeway crash data. The information of the crash data was including the location, time, crash type, cause and severity items etc. Based on the surveyed crash data, this research has carried on substantial and exhaustive analysis. A series of valuable conclusions have been drawn, for instance the characteristics of spatial distributions, temporal distributions, causes and types of crash on freeways etc. The conclusions which this research drawn can offer beneficial reference and theoretical basis for accident prediction model (APM) establishment and crash prevention, and traffic safety management of freeway.

As we all know traffic crash is rare, dispersed, but with statistical analysis on long-time aggregated crash data, we found the crash distributions on freeways have the some special characteristics and same patterns. Some important crash characteristics and typical crash distribution patterns of the freeway in China were introduced in this research. The findings and crash characteristics include:

(1) Traffic crash indices analysis of freeway
(2) Spatial distributions analysis
(3) Temporal distributions analysis
(4) Crash types analysis
(5) Crash causes analysis

One thing that should be emphasized is that although we investigated many freeways and collected lots of crash data, furthermore we got many charts, figures and tables through statistical analysis, but we can not present the tables and figures one by one here, so only the typical ones were introduced, so did the conclusions. Each part was explained with 1-2 figures or tables.

2 Traffic crash indices analysis of freeway

The rapid expansion of freeway networks in China has significantly enhanced the efficiency of the highway system, which also made a huge impact on economic growth and people's life style, but it also brought a very disturbing fact – a rapid increase in traffic crashes.

As shown in Table 1, Total crashes on freeway increased from 2877 in 1994 to 36257 in 2003 suddenly, which have increased by 11.6 times during one decade, and 28.9% of average annul growth. Injuries increased from 1157 to 15213 from 1994 to 2004, which have increased by 12.1 times, and 26.4% of average annual growth. From 1994 to 2004, fatalities keep fast growth too, which increased from 538 to 6235, and increased by 10.7 times, and 24.9% of average annual growth (He Y., 2005). In addition, total crash, injuries, fatalities and economic loss are more severe in view of the freeway mileage percentage of all highways. As exhibited in Table 2, freeway mileage accounts for 1.64% of total highway mileage in 2003, however crash is responsible for 9.30%, and fatalities for 6.54%, and injuries for 4.61% of the total, while the economic loss was responsible for 30.93% of the total especially.

Table 1 Freeway crash index comparison between 1994 and 2003

Index	Total crashes	Injuries	Fatalities
1994	2877	1157	538
2003	36257	15213	6235
Multiple increased	11.6	12.1	10.7
Annual growth rate	28.90%	26.40%	24.90%

Table 2 Index percent of freeway accounts for total highways in 2003

Index percent of freeway accounts for total highways				
Mileage	Total crashes	Fatalities	Injuries	Economic loss
1.64%	9.30%	6.54%	4.61%	30.93%

Generally speaking, no matter considering the time development, or comparing with other types of highways, the safety situation of the freeway in China is severe. And it can be forecasted that the safety problem on freeway in China will become more and more severe along with the development of the economy and society, as well as the increase of vehicle number and the traffic mileage of freeway. It is can be easily explained just as shown in Figure. 1, the fatalities of the freeway increased with the increase of the traffic mileage of the freeway constantly (MPS, 2005).

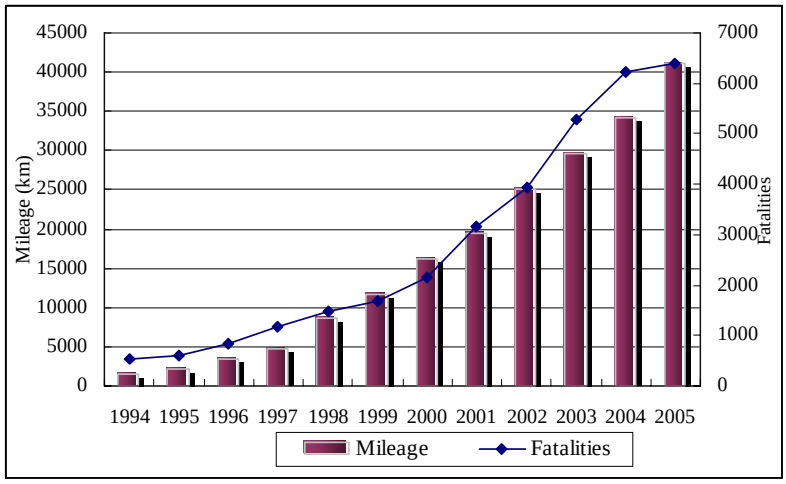


Figure 1 The traffic mileage and fatalities of the freeway in 1994-2005

3 Spatial distributions

3.1 Crash distribution in urban and rural section

Figure 2 (a), (b) are crash spatial distributions of 3 years. From the charts it can be seen there is an accumulated distribution section along the road, which is different from other parts distinctly, and through investigation, we know the special section is in or near the big city, and other parts are in rural areas. The higher crashes of urban freeway are not only impacted by huge traffic volume but also contributed by the different traffic composition, road user behavior from rural freeway section and so on. So if the APM was established, the different distribution patterns of urban and rural freeway should be considered.

As shown in Figure 2 (a), the urban section length accounts for 24.6% of the total, but the crashes take 70.2% of the total. In Figure 2 (b) the urban section length is 24.5% of the whole freeway, the crashes take 54.6%. So it can be said the different traffic environments and characteristics between urban and rural areas impact the traffic safety greatly.

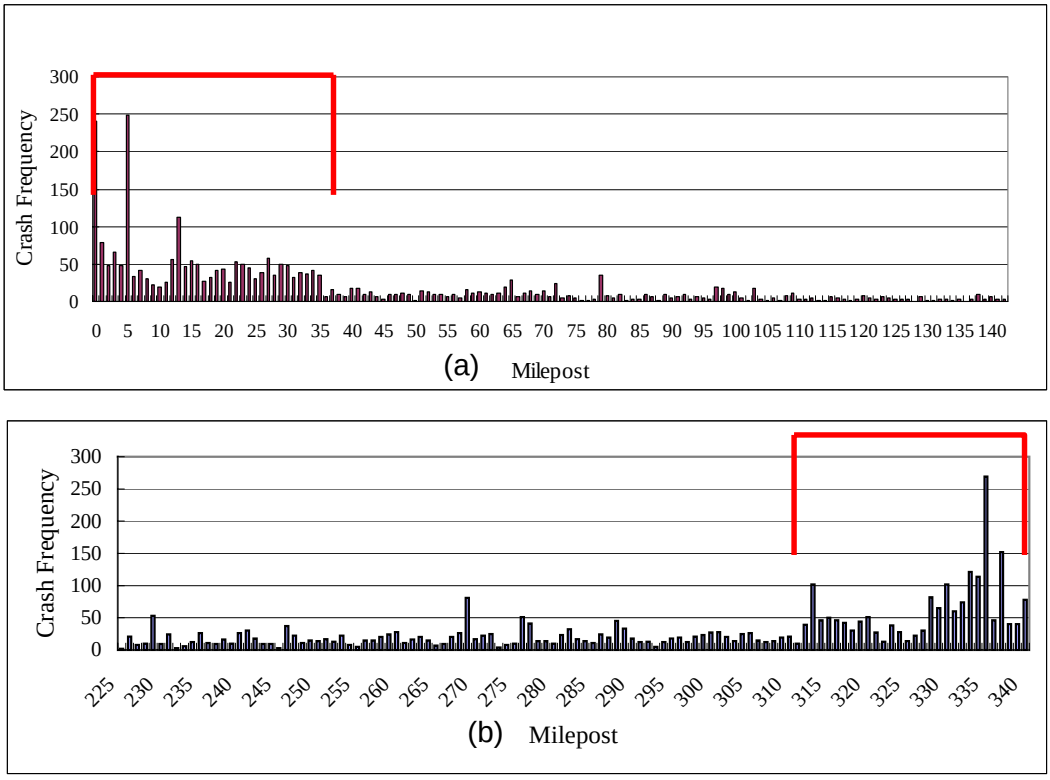


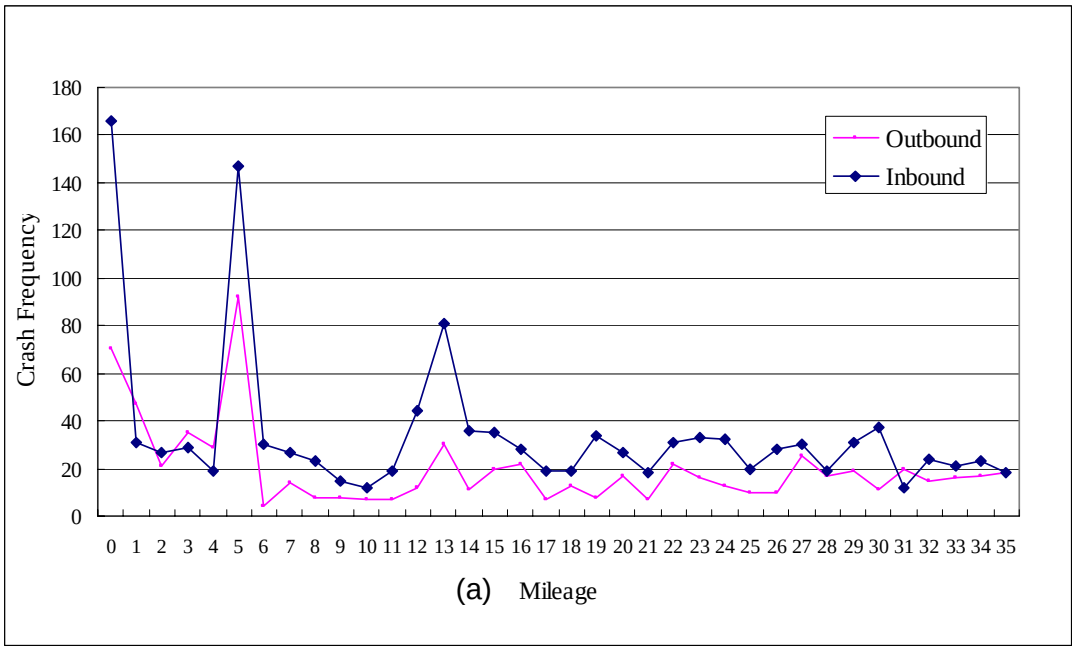
Figure 2 Ununiformity of crash distribution between urban and rural section.

3.2 Directional distribution

Figure 3 depicted a special pattern: the crash distributions of two directions in urban section are different despite the road alignments and traffic volume and so on are the same. Is this casual? The answer is no.

It can be seen from the Figure 3 the inbound direction (enter the city) have more crashes than the outbound direction (exit the city). The longer the freeway is the more obvious phenomenon is. The higher inbound crash rate is the result of driver fatigue which commonly referred as “end effect” in China. According to the police states, many of these crashes occurred when exhausted drivers wanted to reach their destination city and fallen asleep at last leg of their travel (Sun, X. D., 2005 and 2007). Furthermore the drivers can not adapt themselves to the new change of traffic environment in the suburban and urban section is another important reason.

As illustrated in Figure 3 (a), the crash percent of inbound is 63.9% of the total, and in Figure (b) the crash percent of inbound direction accounts for 55.5% of the total.



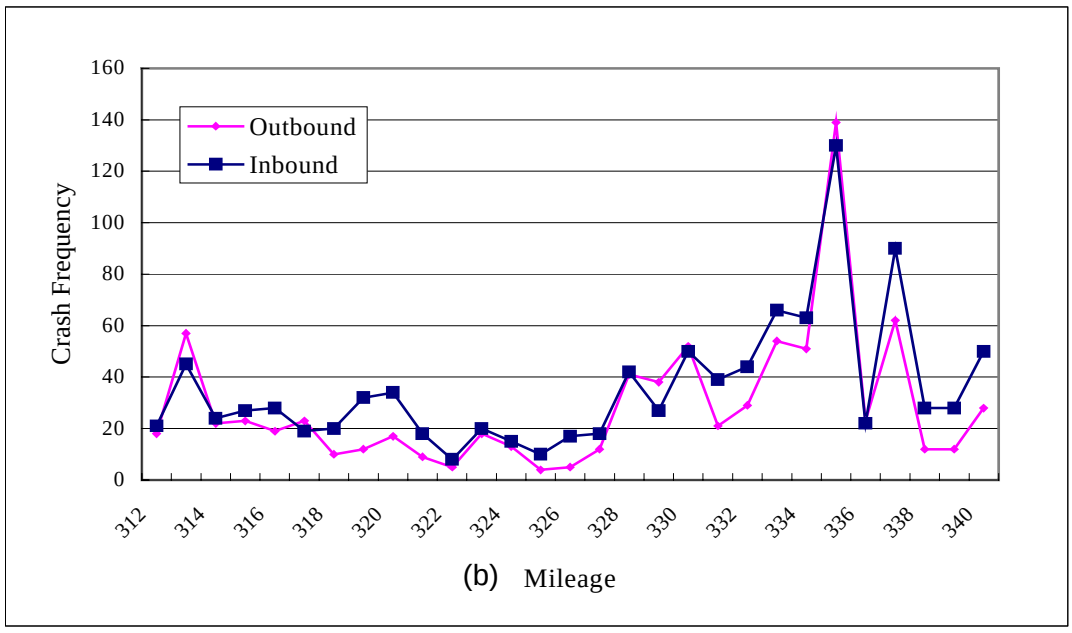


Figure 3 Asymmetric crash distributions of two directions.

4 Crash Temporal distributions

4.1 24-hour distribution

Figure 4 showed crashes hourly distribution pattern. Total crashes were higher at peak hours, but fatality crashes happened frequently at night. We classified one whole day into two periods: daytime (08:00 AM to 20:00 PM) and night (20:00 PM to 08:00 AM). Results showed that proportions of crashes, injuries and fatalities during night were 27.3%-34.1%, 29.3%-40.6%, and 55.4%-77.5% of the total separately.

The crash hourly distribution pattern was coherent with the traffic volume hourly distribution pattern. In the daytime, the volume was larger, the crash frequency also increased. At night, the majority of traffic flow was large vehicles, and visual condition turned obscure, which were aggravated by those negative factors, such as large vehicles' poor mechanical performances, overloading, and fatigue. Consequentially, once accidents took place, the damage was very severe. This is why peak of fatality occurred during night regardless the heavy traffic flow of daytime.

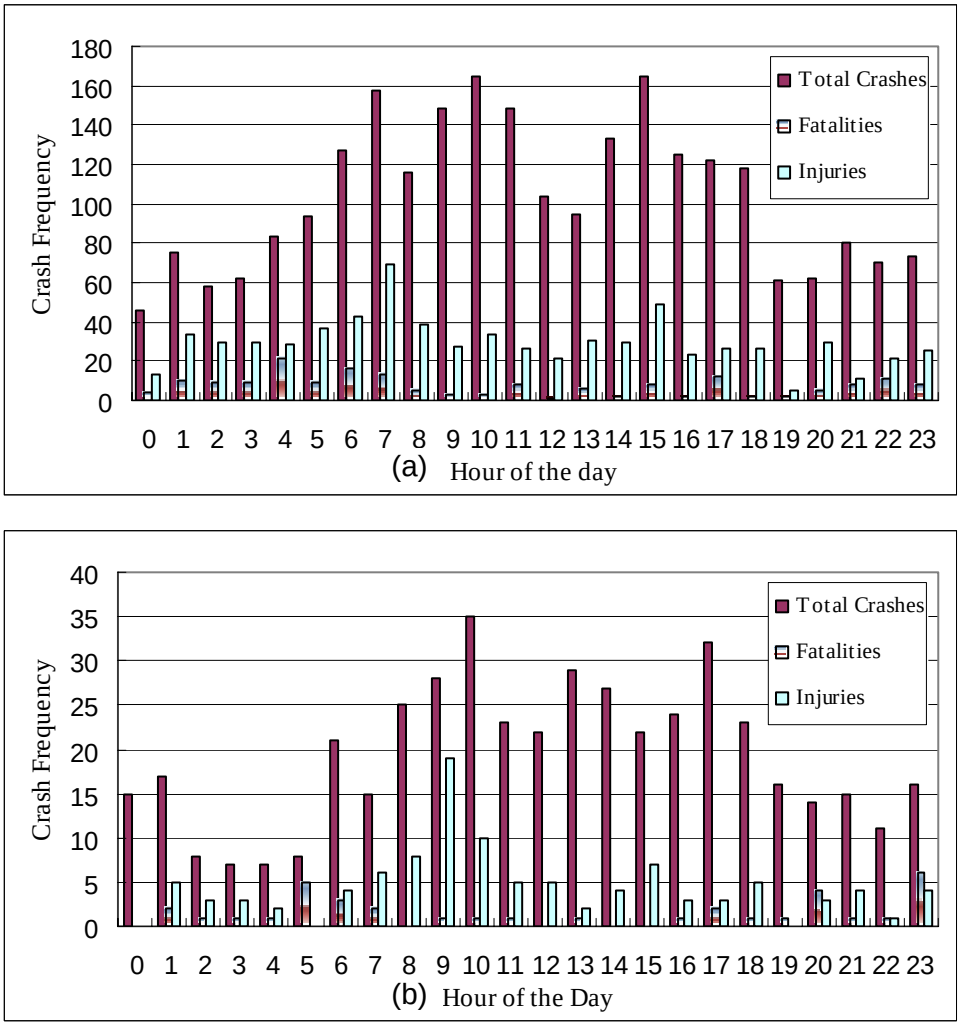


Figure 4 Hourly distributions of crash including fatalities and injuries

4.2 Monthly distribution

As shown in Figure 5, the crash distribution of month is special, and there are more crashes in August to October, in which the crashes account for 25% - 36% of the whole year, and the average proportion of crash in those 3 months is 32% of the total. The main phenomenon described above may be due to two aspects: one is those monthly volume of traffic are heavy, the other is that the temperature is higher in summer, which usually lead to the vehicle performance unstable, so the mechanical breakdowns and tire burst etc take place frequently. Besides, another important reason is that in this period drivers easily feel tired and fatigue.

In addition the crashes in January are relatively higher too, the possible reason is the overloaded due to “Chinese New Year” heavy transportation task. While the distributions of fatalities and injuries are random.

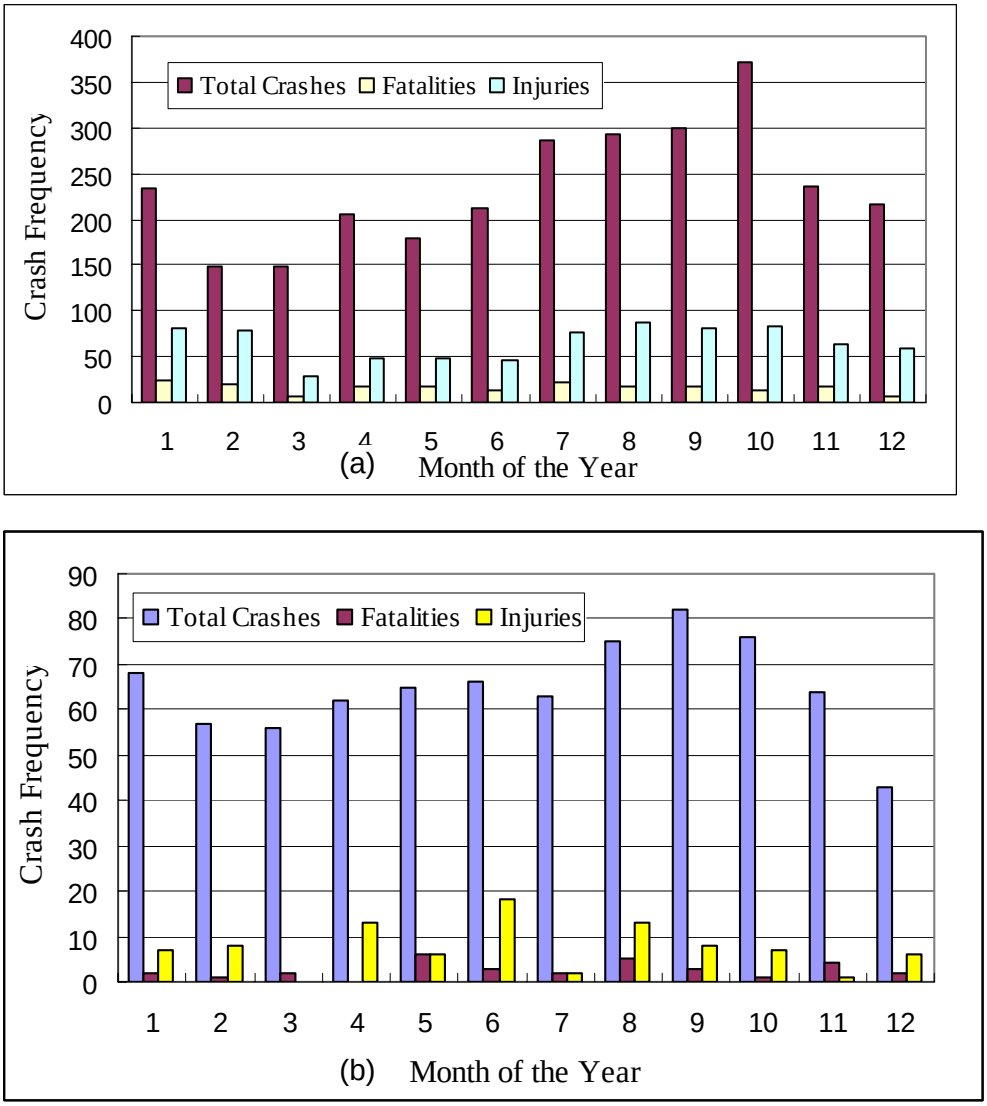
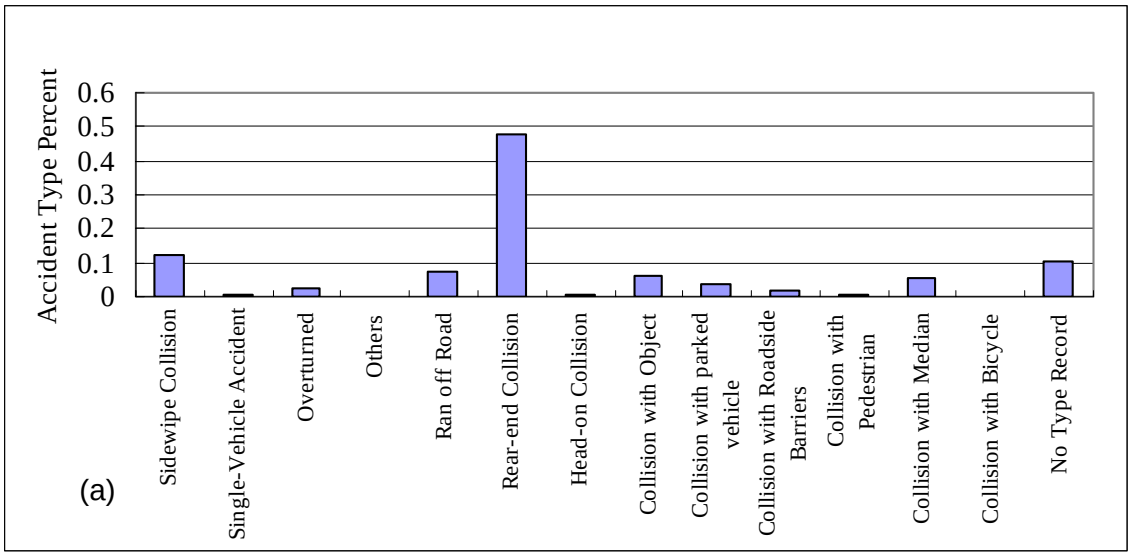


Figure 5 Monthly distributions of crashes including fatalities and injuries

5 Crash types

Figure 6 illustrates the percentage distribution of crash types. Similar to freeways elsewhere in the world, rear-end collision is the most common type of crash. The temporal distribution of rear-end collisions manifests the usual trend: the majority of them occurred during the peak hours when freeways are most congested under the bumper-to-bumper traffic flow condition. While collision with the object and sideswipe collision are in the next place. Besides we can also see there is a higher percentage of collision with pedestrian in mountain areas, which accounts for 6%-10%. Lack of passages and overpasses is the direct reason, which inevitably leads to more people walk across or along the freeway for saving the distance and time regardless of safety.



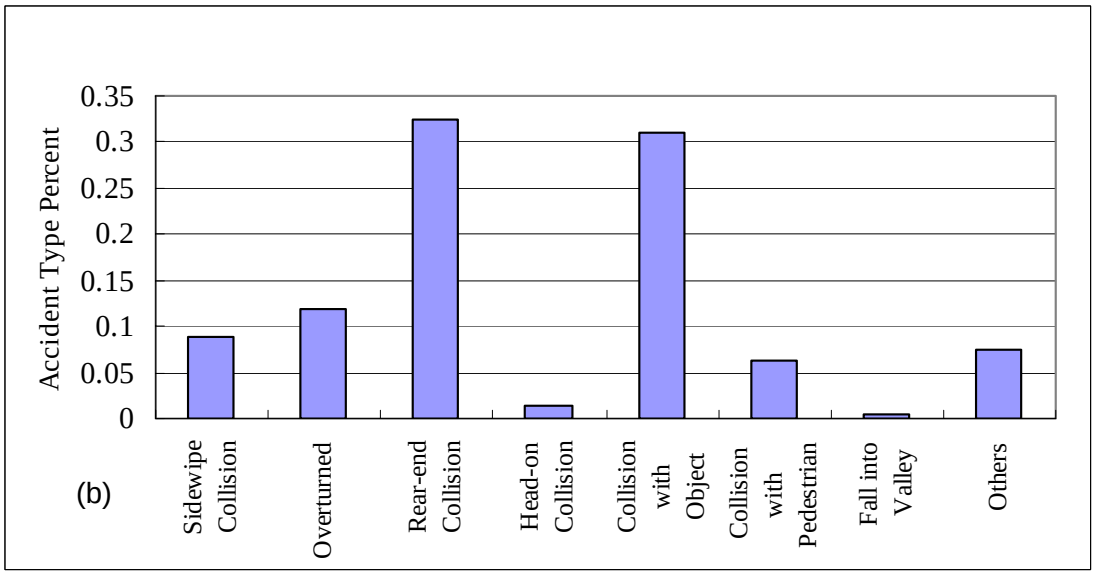


Figure 6 Distribution of crash types

6 Mortality and crash causes

According to police records, improper operation and no keep the space are the main causes of crash, which are responsible for more than 60% of all the crashes as shown in Table 3. As we all know no keep the space often results in the higher frequency of rear-end collisions, so the percentage of crash causes and crash types are consistent. Mortality refers to the ratio of fatalities to total crashes in a kind of cause. On studying it can be seen the mortalities of illegal parking, pedestrian crossing, fatigue driving, and poor vehicle conditions are higher. Illegal parking and pedestrian crossing are also two very unique phenomena, which do not frequently occur on other freeways in developed countries.

Table 3 Crash causes percent and mortality

Causes of Crashes	Percent	Mortality
Tire burst	3.28%	2.22%
Improper operation	36.31%	5.92%
Over-speed	4.12%	22.12%
Overload	0.36%	20.00%
Mechanical failure	1.06%	3.45%
Drive after driving	0.47%	15.38%
Conversely driving	0.44%	16.67%
Fatigue driving	3.42%	36.17%
Poor vehicle conditions	0.84%	43.48%
Illegal lane changing	13.00%	0.28%
Illegal back	2.33%	0.00%
Illegal turn around	0.36%	0.00%
Illegal parking	1.64%	35.56%
Illegal driving	0.25%	14.29%
No keep the space	30.63%	1.66%
Pedestrian crossing	0.98%	70.37%
No attention	0.51%	7.14%
Total	100.00%	

7 Conclusions

Based on detailed substantial crash data analysis of freeways in China, as well as some important information investigated from field police, many crash characteristics and special distribution patterns of freeways were obtained in this research. The conclusions are listed just below:

(1) Generally speaking, traffic crashes on freeway often happen in such special locations where traffic flow fluctuate frequently, for example interchange area, toll station and service area etc;

(2) Regarding a same freeway, crash happened in urban section much more than that in rural section; besides in urban section the crash rate of inbound direction is higher than that of outbound direction, namely it exists the "end effect ";

(3) There are two obvious peaks of traffic crash in 24 hours, and the fatalities happened more randomly in the dark hour; the monthly distribution of crash are concentrated on Jan., Aug., Sept. and Oct.;

(4) Rear-end collision, collision with object, sideswipe collision take a great percentage in the crash types; while The mortalities of illegal parking, pedestrian crossing, fatigue driving, and poor vehicle conditions are the higher ones, which should arouse attention.

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