

## Influence Regularity of Fog on Expressway in China

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### ABSTRACT

There are serious potential hidden perils to drive on expressways in foggy weather, and traffic safety is also an important worldwide problem under the same weather condition. Nowadays, the police close the expressway to avoid crash in China, which actually takes completely the expressway traffic capacity as the price. By analyzing the state that national main expressways were affected by fog in the past two years, we can conclude countrywide fog frequency, the characteristic and the period of time of main expressways affected, and summarize the influence rule of fog on expressways, all which are beneficial to provide the reference and guide for the expressway weather forecast, a guarantee for improving the driving safety in foggy weather, and a basis for identifying and monitoring the expressway sections where the fog is always appearing, and targeting to take effective management and control measures.

**Keywords:** Fog; Influence regularity; Expressway; Forecast; Safety.

### 1. INTRODUCTION

Expressways exclude the interference of pedestrians and non-motor vehicles, which have wide roads, observable signs, and clear markings with heavy traffic and rapid speed[1]. In recent years, with rapid development of the expressway construction in China, the impact of weather on traffic is becoming increasingly serious. At the same time, the meteorological departments are also difficult to forecast the sudden fog timely and accurately, so it is easy to happen heavy and serious traffic accidents on expressways.

The main obstacle of driving in foggy weather is the low visibility. A decline of visibility will cause the reduction of traffic information, and the increase of other interference information, all which easily make drivers hesitate and neglect, and affect drivers' visual and psychological state. As a result, it is difficult to distinguish the former vehicles' taillights, road markings and traffic signs, and easy to cause traffic accidents.

Secondly, the fog also has a great influence on road surface. National research shows that[2], when the visibility < 300 m, and the relative humidity > 99 percent, the wet road surface is just like being added a lubricant. At that moment, the friction coefficient between the road surface and car tyres becomes smaller, and vehicle braking performance turns to be worsen, so traffic accidents are easy to happen.

Therefore, so far as expressways are concerned, the foggy weather easily results in a chain collision accident, and makes expressways be closed and traffic be interrupted.

#### 1.1 Cause traffic jam

The fog is random and unexpected as its main characteristics. When it occurs suddenly, and transportation and police departments haven't taken measures, traffic accidents are easy to happen and result in a traffic jam. All these have a strong impact on life and property safety of drivers and passengers.

#### 1.2 Cause expressways closed

At present, national expressways are short of steady meteorological monitoring and efficient management strategies in foggy weather. The police generally only take negative methods such as closing the expressway and forbidding entry, which will result in a large number of vehicles stranded, the transport disruption and a huge loss of operating income.

### 1.3 Cause serious accidents

Based on the statistics and analysis of traffic accidents data, the accidents that happen on expressways in foggy weather mainly have the following characteristics[3]:

#### 1.3.1 Big probability

Because of heavy traffic and low visibility, any driving negligence could cause accidents. According to statistics, the accident rate in foggy weather is nearly 10 times of normal conditions.

#### 1.3.2 Serious consequence

Because of the rapid speed on expressways, once a traffic accident happens, the following vehicles are often too late to take measures, which usually results in a chain collision. Therefore, the vicious accident ratio is quite high in foggy weather. According to incomplete statistics, accidents whose losses are more than 100,000 yuan are nearly 75 percent of the total, and their severity is 7 ~ 8 times of normal conditions.

#### 1.3.3 Chain collision accidents

Chain collision accidents are about 60 percent of the total accidents. Among these accidents, the rear-ended accidents are more than 40 percent, and grazing collision accidents are only 20 percent. According to analyse the rear-ended accidents on expressways, 85 percent accidents happen in foggy weather, and often cause a chain reaction. As a result, bad accidents occur.

In order to improve the accuracy of the expressway traffic weather forecast, reduce and prevent traffic accidents in foggy weather, this paper analyses the state that national main expressways were affected by fog in 2006 and 2007, and summarizes the influence regularity of fog on expressways. All these are beneficial to protect people's lives and property safety.

## 2. FOG OVERVIEW

In the past two years, the foggy weather occurred mainly in east central China, and some regions had the higher frequency of fog, such as the Shandong Peninsula, the northern China Plain, the south of the Yangtze, the Sichuan Basin, Yellow River and Huai River, as well as Huai River basin in Jiangsu. And Shandong and Hebei were most seriously affected by fog. According to the road state information statistics of national main roads[4], the foggy weather occurred concentratedly from October to January in the past two years(see Figure 1), and the average fog days was more than 25 days in those three months. The expressways were affected least in August, only 2 days.

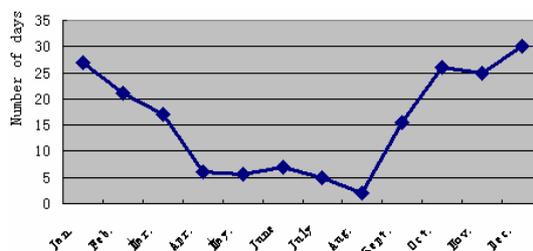


Fig. 1. Mensal average fog days in the past two years

## 3. EXPRESSWAY ORDERING AFFECTED BY FOG

According to the weather forecast provided by the National Weather Service[5], the annual average fog days was 187 days in the past two years. There were 8 expressways where the annual average fog days exceeded 50 days in 2006(see Figure2), and 6 expressways in 2007(see Figure3). Among these expressways, the top 5 expressways were Jingzhu, Jinghu, Qingyin, Jingkun and Jingfu expressways in the past two years, and these five expressways annual average fog days were all more than 60 days.

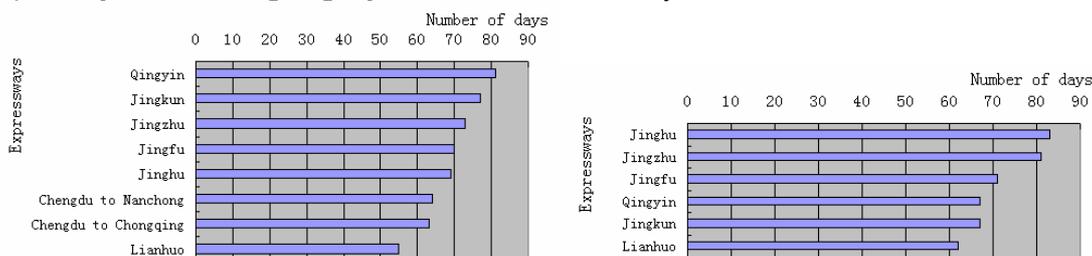


Fig. 2. Expressways ordering affected by fog in 2006(annual average fog days≥50)

Fig. 3. Expressways ordering affected by fog in 2007(annual average fog days $\geq$ 50)

**4. TIME DISTRIBUTION OF EXPRESSWAY INTERRUPTION**

According to the road state information statistics of national main roads[4], the time period when foggy weather caused expressway interruption is mainly from 9 p.m. to 3 a.m. of the next day. Take the time period from September 1st to November 26th in 2007 for instance(see Figure4), there were 60 fog days, but expressway interruption times were as many as 380.

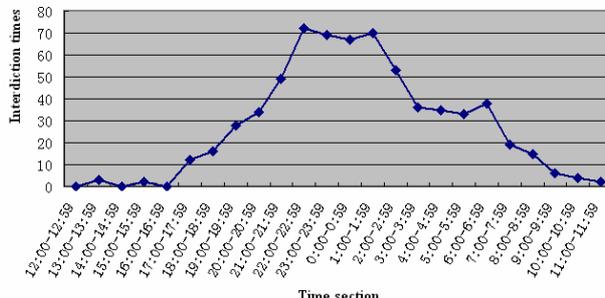


Fig.4. Time distribution of expressway interruption from Sept. 1<sup>st</sup> to Nov. 26<sup>th</sup> in 2007

**5. FOG FREQUENCY DISTRIBUTION OF NATIONAL MAIN EXPRESSWAYS**

On the centralized periods of the foggy weather, taking the Qingyin and Jinghu expressways for instance, we can find separately the fog frequency distribution of this two expressways.

**5.1 Qingyin Expressway**

Qingyin expressway[6] is one of horizontal lines of “five vertical and seven horizontal lines” in the national expressway network. It is over 1610 km from Qingdao in Shandong Province via Hebei, Shanxi, Shaanxi to Yinchuan in Ningxia Hui Autonomous Region (The section from Shanxi to Shaanxi were completed and opened by the end of 2007, so the data in that section was excluded).

*5.1.1 Mensal influence times of fog on Qingyin expressway*

Qingyin expressway was seldom affected by fog in April and August. On the contrary, it often was affected from November to January, and its mensal average fog days were more than 12 days(see Figure5).

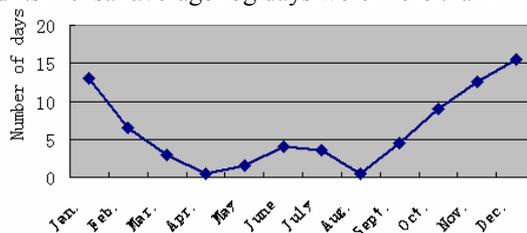


Fig. 5. Mensal average fog days on Qingyin expressway in the past two years

*5.1.2 Regions state affected by fog*

By analyzing the percentage of different provinces affected by fog, we can conclude that Shandong province was most seriously affected which accounted for 55 percent of the total, followed by Hebei province accounting for 38 percent(see Figure6).

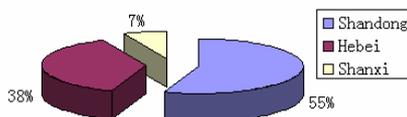


Fig.6. Percentage of different provinces affected by fog on Qingyin expressway in the past two years

*5.1.3 Fog affecting trend*

As shown in Figure 7, the road section from Gaomi to Zhangqiu was less affected than other sections in Shandong province. Fog affecting ratio of Hebei section was lower than Shandong section, but basically the whole line of Hebei section was all affected seriously. Fog affecting ratio of Shanxi section was also lower than Shandong and Hebei sections. Generally speaking, Qingdao and Jinan-Shijiazhuang sections were most seriously affected by fog on Qingyin expressway.

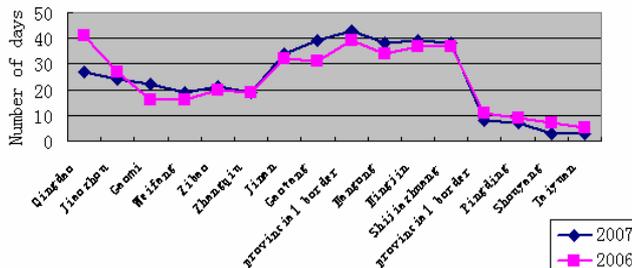


Fig.7. Trend of fog affecting Qingyin expressway in the past two years

## 5.2 Jinghu Expressway

Jinghu expressway[7] is one of vertical lines of “five vertical and seven horizontal lines” in the national expressway network. It is over 1262 km from Beijing via Tianjin, Hebei, Shandong, Jiangsu to Shanghai.

### 5.2.1 Mensal influence times of fog on Jinghu expressway

Jinghu expressway was seldom affected by fog from May to August. On the contrary, it often affected from October to January, and its mensal average fog days were more than 12 days(see Figure8).

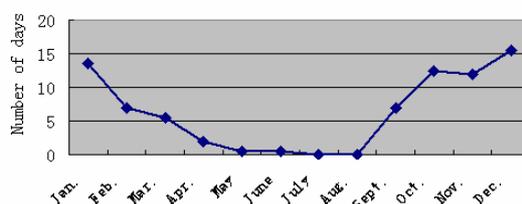


Fig. 8. Mensal average fog days on Jinghu expressway in the past two years

### 5.2.2 Regions state affected by fog

By analyzing the Percentage of different provinces affected by fog, we can conclude that Shandong province was most seriously affected which accounted for 27 percent of the total, followed by Hebei province accounting for 25 percent(see Figure9).

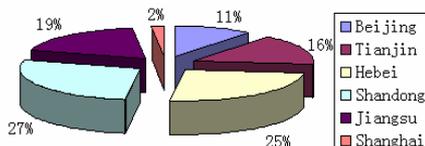


Fig.9. Percentage of different provinces affected by fog on Jinghu expressway in the past two years

### 5.2.3 Fog affecting trend

As shown in Figure10, the road section of the north of Jinan was more seriously affected than the south in Shandong province. Fog affecting ratio of Hebei section was lower than Shandong section, but basically the whole line of Hebei section was all affected seriously, which hadn't very big southern and northern differences like Shandong section. The fog frequency of Jiangsu section decreased sharply from north to south along Jinghu expressway. And Shanghai section was seldom affected by fog. Generally speaking, Tianjin-Jinan section was most seriously affected by fog on Jinghu expressway.

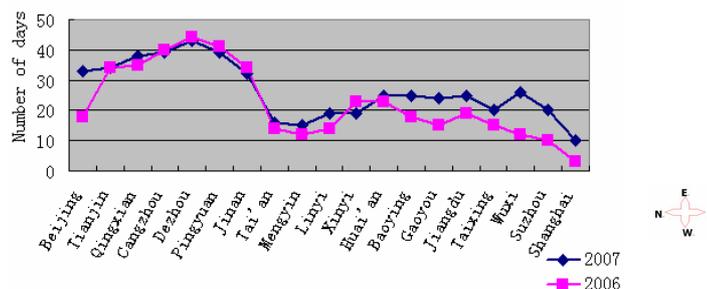


Fig.10. Trend of fog affecting Jinghu expressway in the past two years

By analyzing the fog days of different provinces in the past two years, Shandong and Hebei were most seriously affected, which also tied in with that Shandong and Hebei sections had higher fog frequency just like previous analysis.

## 6. Conclusion

Based on comparing fog occurrence frequency in different provinces, sorting the fog frequency of expressways, as well as analyzing the characteristics of main expressways affected by fog, we can conclude the time distribution of expressway interruption and fog frequency distribution of main expressways, and summarize the influence rule of fog on expressways, all which are beneficial to supervise the important time and road sections, take effective measures to control them, provide the reference and guide for the expressway weather forecast, provide technical support for driving safety, as well as protect people's lives and property safety.

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