CHINESE RURAL ROAD TRAFFIC SAFETY CHARACTERISTICS ANALYSIS AND TRAFFIC SAFETY COUNTERMEASURES

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ABSTRACT
Depending on the alignment data of the western rural road by the “GIPSI-TRAC” highway alignment gathering vehicle, the observation data about the vehicle composition, running speed on the typical rural road section, the traffic accidents and archives of the major traffic accidents for the consecutive five years, the major traffic accident statistics of the death number than or equal to 10 in an accident for the consecutive three years, and the investigation of the accident-prone sections in rural road, the article analysis the traffic accident characteristics and traffic features of the rural road, particular focus on the analysis of major accidents; The paper presents the rural roads feature such as composition of complex traffic, the lack of typical models, low-speed, low technical indicators highways, and summarizes the accident form, accident vehicle type, and accident location and other characteristics in the rural road; To reduce the probability of accident occurrence and improve traffic safety of the rural road, the author brings up some suggestions on the safety countermeasures of the rural road.

1 INTRODUCTION
In recent years, Chinese rural road net were developed rapidly, as of the end of 2010, rural road traffic mileage reached to 3.51million km and 87.5% of the Chinese total highway mileage. And at the same time, the security problem was becoming more and more serious. Nearly three years, accidents in rural road accounted for about 40% of the total road accident, the ratio that number of accidents in rural road, deaths, injuries, property loss accounted for the corresponding data has increased year by year. Based on investigations of vehicle composition, speed, road technology index of rural road, rural highway traffic environment, the traffic safety status and the cause of accidents were analysed in this paper, and the traffic safety countermeasures were put forward in order to reduce rural highway accidents and improve safety level.

2 RURAL ROAD TRAFFIC CHARACTERISTICS ANALYSIS
Rural roads are the lines connecting the adjacent townships and villages, they are collector highways for short distance transport. Therefore, rural roads traffic characteristics are significantly different from the arteries.
2.1 Vehicle Components
Investigation and analysis show that, vehicle types on rural roads were complex, in addition to cars and trucks which were common on the arteries, also included vehicles of poor safety performance, such as motorcycles, farm tractors, bicycles, tricycles, small trucks; the proportions of different vehicles were not much difference. As shown in Figure 1, the proportion of cars was the highest, but only for 33.33%.

![Figure 1: Vehicle composition analysis diagram of rural road of mountain area](image)

2.2 Operation Speed
Since the technical indicators of rural roads were low, and performances of vehicles were bad, the operation speeds were low. According to spot speed observation of 3rd stage rural roads and the following, the average operation speed on curves was 32.86km/h (the maximum radius was 90m, the minimum radius was 10m, and the curves whose radius between 15m and 45m accounted for 45%), shown as table 1; the average operation speed on straight segments was 39.50km/h, shown as table 2. There was a big difference among different vehicles; the velocity difference between cars and agricultural vehicles was 23.75km/h. The large velocity difference caused overtaking, avoidance, brake more frequently, easier to initiate the rear-end collision, scratch and other types of traffic accidents.

<table>
<thead>
<tr>
<th></th>
<th>Car</th>
<th>Large bus</th>
<th>Small truck</th>
<th>Large truck</th>
<th>Motorcycle</th>
<th>Motor-Tricycle</th>
<th>Agricultural vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>V85</td>
<td>43.75</td>
<td>39</td>
<td>36.5</td>
<td>29.25</td>
<td>32.5</td>
<td>29</td>
<td>20</td>
</tr>
<tr>
<td>Average of V85</td>
<td>32.86</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Table 2: The operation speed of various vehicles on curves* (km/h)

<table>
<thead>
<tr>
<th></th>
<th>Car</th>
<th>Large bus</th>
<th>Small truck</th>
<th>Large truck</th>
<th>Motorcycle</th>
<th>Motor-Tricycle</th>
<th>Agricultural vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>V85</td>
<td>48.38</td>
<td>40.50</td>
<td>43.25</td>
<td>36.63</td>
<td>37.75</td>
<td>33.50</td>
<td>36.50</td>
</tr>
<tr>
<td>Average of V85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>39.50</td>
</tr>
</tbody>
</table>

* The maximum radius was 90m, the minimum radius was 10m, and the curves radius between 15m and 45m accounted for 45%.

2.3 Technical indicators
According to geometric technology indexes analysis of 434.91km rural roads in western, the radius of 10% curves did not meet the limit requirements that design speed was 30km/h, shown as Table 3. The longitudinal gradient of 15% investigated segments did not meet the limit requirements that design speed was 30km/h, shown as Table 4.

Table 3: The segment proportion curve radiuses met the limit requirements in specification

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Limit in Specification (m)</th>
<th>Chongqing</th>
<th>Guizhou</th>
<th>Yunnan</th>
<th>Panzhihua</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Suiyang</td>
<td>Fenggang</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>30</td>
<td>89.7%</td>
<td>92.6%</td>
<td>94.4%</td>
<td>99.4%</td>
<td>93.1% 95.2% 92.7%</td>
</tr>
<tr>
<td>30</td>
<td>65</td>
<td>62.2%</td>
<td>75.4%</td>
<td>74.4%</td>
<td>85.6%</td>
<td>75.1% 73.7% 73.6%</td>
</tr>
<tr>
<td>40</td>
<td>100</td>
<td>41.3%</td>
<td>57.5%</td>
<td>59.7%</td>
<td>65.3%</td>
<td>58.2% 52.2% 55.6%</td>
</tr>
<tr>
<td>60</td>
<td>200</td>
<td>16.2%</td>
<td>22.5%</td>
<td>26.9%</td>
<td>29.6%</td>
<td>23.8% 19.9% 19.0%</td>
</tr>
</tbody>
</table>

Table 4: The segment proportion longitudinal gradient met the limit requirements in specification

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Limit in Specification (%)</th>
<th>Chongqing</th>
<th>Guizhou</th>
<th>Yunnan</th>
<th>Panzhihua</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Suiyang</td>
<td>Fenggang</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>6</td>
<td>64.6%</td>
<td>100.0%</td>
<td>77.8%</td>
<td>91.0%</td>
<td>100.0% 61.3% 88.6%</td>
</tr>
<tr>
<td>40</td>
<td>7</td>
<td>73.4%</td>
<td>100.0%</td>
<td>83.3%</td>
<td>98.4%</td>
<td>100.0% 74.4% 3.9%</td>
</tr>
<tr>
<td>30</td>
<td>8</td>
<td>81.7%</td>
<td>100.0%</td>
<td>87.3%</td>
<td>99.9%</td>
<td>100.0% 84.8% 2.5%</td>
</tr>
<tr>
<td>20</td>
<td>9</td>
<td>88.8%</td>
<td>100.0%</td>
<td>92.3%</td>
<td>100.0%</td>
<td>100.0% 91.6% 2.0%</td>
</tr>
</tbody>
</table>

The corners and slope were followed of mountains and valleys at poor topographic areas due to lack of construction funds, some limits in specification were breached, and the necessary facilities for traffic safety were lacked of, as a result the hidden danger of traffic safety were formed.

Therefore, the reinforcement of rural roads and safety engineering is the important means to raise rural road traffic safety level in next stage of rural road construction.
3 RURAL ROAD ACCIDENTS CHARACTERISTICS ANALYSIS

3.1 Accident form

As shown in Figure 2, the analysis of rural road accidents shows that the side crash was the main accident form which accounted for 35.69% of the total number of accidents. The second were hit pedestrians and rear collision which accounted for 17.36% and 13.29% respectively.

![Figure 2: Analysis chart of characteristics of rural road accidents](image1)

As shown in Figure 3, the analysis of catastrophic accidents of rural road shows that hit pedestrians and falling car and head-on collisions were the main catastrophic accident form which accounted for 34.5% and 24.1% and 20.7% respectively. As shown in Figure 4, the highest proportion of catastrophic accidents is hit pedestrians mainly to minors under 18 years of age and over 60 years old (79.2%). The children under 6 years of age accounted for 33.3%.

![Figure 3: Analysis chart of characteristics of rural road accidents](image2)
Figure 4: Age statistics of death caused by hit pedestrians

As shown in Figure 5, the analysis of the past three year’s catastrophic accidents (death of ten or more persons in an accident) shows that falling accidents accounted for 66.67% and following by roll over. Falling into water or falling down precipice is the main accident which causes group of casualties. In addition, roll over which happened on continuous downhill with sharp curve or brake failure also accounted for 20.83% of catastrophic accidents.

In conclusion, we can strengthen education of traffic safety and the guardianship of the elderly as well as children and the safeguarding nearby water or precipice. These above measures play an important role in the prevention of catastrophic accidents.

Figure 5: Catastrophic accidents analysis of the past three years

3.2 Accident vehicle
As shown in Figure 6, according to the survey about rural road accidents, the main accident vehicles are motorcycles and agricultural vehicles. Motorcycles with two wheels accounted for 37.38%. The second is agricultural vehicles which accounted for 17.50%. Both total 54.88%.
Figure 6: Analysis of accident vehicle

As shown in Figure 7, the analysis of catastrophic accidents of rural roads showed that motorcycle accidents were more prominent which accounted for 33.3%. As shown in Figure 8, the catastrophic accidents analysis of the past three years (death of ten or more persons in an accident) showed that the main accident model was medium coach which accounted for 29.20%. The second was bus which accounted for 20.80%.

Figure 7: Analysis of catastrophic accident vehicle
Therefore, we can focus on supervising motorcycles and large or medium buses to reduce the severity of accidents.

### 3.3 Accident location

As shown in Figure 9, the analysis of catastrophic accidents of rural road showed that the curve or the bent slope causes 57% accidents accounting for a large proportion of 39%. Straight sections caused 39% accidents. As shown in Figure 10, further analysis found that the majority of accidents of straight sections were occurred in the village sections or intersections. The total number accounted for 64% of accidents of flat sections.
As shown in Figure 11, the catastrophic accidents analysis of the past three years (death of ten or more persons in an accident) showed that the curve was the characteristic section that was likely to cause accidents, especially sharp bend on steep slope. The second was generally curves. This showed that curves have a large impact on the safe operation of the rural road. The reason of the accident causing by curves mainly included the following three situations. Firstly, the speed was so fast that it was easy to drive out of the road under the effect of centrifugal force. If the outside of curves was nearby water or precipice it will cause vicious falling accidents. Secondly, when cars drive onto curves it was common that the steering wheel was so large that cars lose control and fall from the inside of curves. Thirdly, trees or houses or mountains inside of curves lead to limited stadia and had an influence on the driver’s judgment of the road condition. It maybe caused falling accident at the same time of an emergency avoidance collision.
SAFE COUNTERMEASURES FOR RURAL ROADS

As shown in Figure 12, person, vehicles and roads are the three major factors affecting traffic safety; the analysis of catastrophic accidents on western rural road (58 accidents) showed that these accidents which were related to people accounted for 89.66% and 32.76% were related to road. Besides, about 36.21% were related to vehicles. Site investigation of catastrophic accidents showed that person is an important factor to cause rural road accident. Therefore, strengthening the safety education of rural residents is the basic way to improve the level of rural road safety. However, it needs a long time to improve the rural residents’ safety consciousness. It is a process of long-term infiltration and cannot be effective soon. Recently, we still need to improve safety level of road from the management of the car and the improvement of road environment, etc.

Based on the characteristics of rural traffic as well as the analysis of characteristics of traffic accidents, we put forward safety countermeasures on rural road from the perspective of preventing great accident.

1) Strengthening propaganda or education among rural residents and enhancing careful of infant children and the old man to reduce malignant accidents because of crossing road.

The level of rural residents’ education is low in rural areas of China. So expecting drivers knowing and obeying rules is relatively difficult in rural areas by low level of education.
Therefore, the traffic safety propaganda and education is indispensable to improve traffic safety consciousness in the rural areas. Publicity and education work must take flexible way. We should arouse the masses’ interest and attract them to participate actively instead of passively. Besides leaflets, posters and the traffic safety class, we can also take full use of videos, movies, literature evening party which can be accepted by rural residents easily.

(2) Strengthening the supervision of the vehicles in rural areas and paying more attention on motorcycles and agriculture vehicles and medium coaches. We should focus on supervising medium or large coach from the perspective of preventing group of casualties.

The supervision of rural road includes a lot of situations. For example, strengthening the management of unlicensed cars; further controlling illegal manned of agricultural vehicles; encouraging school bus operation according to the actual situation; the comprehensive government of operation evaluation and management in rural. Motorcycle safety is systemic problems. We can bind motorcycle sales and registration and insurance and license training.

(3) Strengthening the comprehensive treatment of the hidden danger section, especially those sections which are easy to cause catastrophic accidents. The analysis of rural road accidents shows that the curve nearby water or cliff and village sections and continuous downhill are easy to cause accidents. Especially there are villages, schools and markets at the end of continuous downhill.

The technical indexes of rural road are low and lack of necessary safety facilities in china. As a result, we should increase capital investment and improve the local road alignment. Especially for the above sections which are easy to cause catastrophic accidents, the comprehensive treatment could be strengthened.

5 CONCLUSIONS

Improving the rural roads traffic safety level is very important to rural areas economic development and rural residents' life and property security. Based on analysis of traffic characteristics and accidents characteristics of rural roads, safe countermeasures was proposed including safety education, vehicles supervision and comprehensive treatment of the hidden danger sections, in order to promote the level of rural roads traffic safety improvement.

REFERENCES


