Causes and Prevention Measures of Secondary Rear-end Accidents in the Rescue of Highway Traffic Accidents

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Abstract

With increasing number of highway traffic accidents, rescuers are challenged with increasing number of rescue missions, which make rescuers dangerous in the rescue work. In the process of rescue of the highway traffic accidents, secondary rear-end accidents specially lead to the casualties of rescuers and others. There are large number of rescuers who have hurt or even died in secondary rear-end accidents. It is obvious that there is excess tight connection between the cause of traffic accidents and secondary rear-end accidents. Through the research of the highway traffic accidents and their characteristics, we find out the causes of traffic accidents in this paper and then analyze the causes of secondary rear-end accidents in the emergency rescue of highway traffic accidents. By analyzing the causes, we also put forward the practical and effective preventive measures and the management measures at the site. The aim of this paper is to ensure the safety of rescuers, to regulate the program of dealing with the kind of traffic accidents for the traffic accident emergency rescue team and to make suggestions about emergency rescue of traffic accidents in the future. Meanwhile, we hope our suggestions can reduce secondary accidents and resulting life and property losses from the masses and rescuers effectively.

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Keywords: highway; traffic accidents; emergency rescue; secondary rear-end accident

1. Introduction

Until 2008, the highway mileage has reached 6433 km in China. According to data from the research centre of highway traffic safety engineering in the Ministry of Transportation, death toll due to traffic accidents in China has already dominated the top of the world. In recent years, there are increasing numbers of emergency rescue of highway traffic, because of more highway traffic accidents. In the process of rescue of the highway traffic accidents, secondary rear-end accidents specially lead to the casualties of rescuers and others.

2. Manifestations of secondary rear-end accidents in the highway traffic accidents

According to the research of secondary rear-end accidents in the highway traffic accidents, we find the reasons why secondary accidents happened are as follows:

- First point: Secondary tailgating happens on the highway.
- Second point: Gas leakage from the tank leads to the fire and explosion accidents.
- Third point: Leakage of dangerous chemical from tank car results in accidents.
- Fourth point: Other accidents occur to vehicles and their carload in accidents.

It is the largest and most serious causes that accidents resulted from Leakage of dangerous chemical from tank car as well.

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as vehicles and their carload in accidents among these reasons of rear-end accidents. Meanwhile, they also cause the highest mortality. According to statistics, there are 38 firemen sacrificing in China during the period from 2006 to 2010. Then, 7 of them die from vehicle collision in the process of rescue of the highway traffic accidents.

3. Causes of real-end accidents

3.1 Causes of traffic accident

The major causes of traffic accident are driving violations, effect of road condition, weather, mechanical stoppage and some special factors[3]. According to statistics, the accidents caused by fatigue driving and furious driving are major[3], owing to drivers keep repetitive posture and even speed constantly. The time when accidents happened focuses on the night (i.e. the number of the death in accidents at night accounts for 55% of total number) because poor roadway visibility, lack of lighting facilities for long distance and fewer reference substance on the highway. Meanwhile, the effect of bad weather is significant (i.e. the number of the death in accidents in the situation of heavy fog and sleet respectively accounts for 5.1% and 1.6% of total number, 4.2-5.2 times and 1.2-3.1 times more than other situations respectively[4]). From that point of type of vehicles, accidents of trucks account for 46.98% and accidents of bus account for 39.08% of all the highway traffic accidents in 2007. This is due to overload, driving violence, and imperfect management of safe transportation lack of maintenance which leads to bad property, poor quality of cans, insecurity, bad handling stability and malfunction.

3.2 Analysis of causes of secondary rear-end accident

The examples of secondary rear-end accidents which lead to casualties of rescuers in the process of rescue of the highway traffic accidents from 2006 to 2012 are stated as follows.

Table 1. Secondary rear-end accidents which lead to casualties of rescuers in recent years

| Time     | Death | Position | weather  | environmental conditions | Accident conditions | Types of vehicles | Guard | Driving condition |
|----------|-------|----------|----------|--------------------------|---------------------|------------------|-------|------------------|
| 3:20 p.m.| 1     | Commander| Cloudy   | Low visibility for burning straw | knocked down when binding hose | truck | No | speeding         |
| 4:40 a.m.| 1     | Combatant| Foggy    | Low visibility at night | knocked down when taking equipment | bus | Yes | Speeding & fatigue driving |
| 2:20 a.m.| 1     | Combatant| Cloudy   | Low visibility at night | knocked down and skidded on guard | truck | Yes | Speeding & fatigue driving |
| 8:20 a.m.| 1     | Commander| Foggy    | Good visibility in the morning | knocked down and skidded on guard when commanding | truck | Yes | Speeding & fatigue driving |
| 5:42 a.m.| 1     | Commander| Cloudy   | Low visibility at night | knocked down when rescuing | truck | Yes | Speeding & fatigue driving |
| 6:26 a.m.| 1     | Commander| Heavily foggy | Low visibility for fog | knocked down when rescuing | truck | Yes | Speeding & fatigue driving |

The causes of secondary rear-end accidents which lead to casualties of rescuers is as follows:

- First point: Poor guard measure. In 5 of the cases, the rescuer established the warning line but it didn’t work.
- Second point: Fatigue driving: In 5 of the cases, the wreckers are in the condition of fatigue driving.
- Third point: Low visibility: In 3 of the cases, the time of accidents is in the morning or at night which is of low visibility. And one of them happened in the foggy day.
- Fourth point: Speeding: All the wreckers are in speeding driving.
- Fifth point: Poor vehicle performance: Except for a case of bus, the type of accident vehicles is truck in 5 of the cases.
- Sixth point: Poor road and weather condition: The weather is cloudy or foggy in all the cases, which leads to bad road condition.

According to analysis of 6 cases of secondary rear-end accidents which lead to casualties, the rescuers were all knocked
down by vehicles crossing the warning line when conducting the rescue on the road. Because traffic accidents usually happen in the rainy or foggy days and at night, rescue operation is conducted in the situation of poor visibility, which results in high probability of rear-end. It easily leads to water film phenomenon in the fleet days on the highway and this will cause brake out of order when speeding in low visible condition. In the negative effect of poor guard measures, speeding or fatigue driving which leads to inattention, retardation of thinking, desensibilization, relative visual impairment, drivers’ capacity for emergency management will decrease, which results in ignoring the sign of warning easily and causes secondary rear-end accidents. Owing to the great bulk and weight of truck and bus, it is dangerous once accidents happen and it will lead to casualties easily. We can conclude that it would cause severe traffic accidents which lead to casualties if secondary rear-end accidents happen.

4. Preventive measures of secondary traffic accidents

4.1 Preventive measures in the process of rescue of secondary rear-end accidents in China

When severe traffic accidents on the highway happen, accident section of highway should be blocked to protect the safety of rescuers. It’s a crucial step that setting up warning area in order to guarantee the success of rescue action and the safety of rescuers. It is commonly used that setting up warning signal stick, conical accident signal column, explosion-proof light alert rope, warning flashlight, warning isolation strip, warning brand, 500 meters warning lights equipment and Handle microphone equipment. It is necessary to set up warning line on both of dual carriageways in the place of 500 meters from the accident location. Both of dual carriageways should be blocked because the vehicles on the accident direction of highway are impossible. We should set up warning area, conduct traffic control to guarantee the success of rescue operation, safety of rescue zone and smooth traffic on the accident road. These are important protective measures to avoid secondary accidents in the process of traffic accident rescue.

4.2. Preventive measures in the process of rescue of secondary rear-end accidents overseas

According to statistic, there are 17 American firemen sacrificing due to secondary rear-end accidents in the accident rescue operation on the highway from 1995 to 1999. During the whole year of 2000, there are 9 firemen dying for the aforementioned reason. In order to improve the awesome situation, American fire departments took action of establishing standard program of emergency rescue on the highway. In this program, it has ruled the function of departments which take part in emergency rescue. It also requires detailed communication before rescue on the topic of guard. It is necessary to control the traffic stream by setting up guard before rescue operation. It is necessary to prepare emergency rescue lane for parking temporarily specially, for not parking recovery vehicle on the main lane of highway. The firemen should take some protective measures, including wear protective suit with reflection of light. The management department of highway should notice the information of accident by radiograph to remind drivers to alter the route immediately which is effective to avoid traffic jam and secondary rear-end. In order to alleviate the drivers’ fatigue, the traffic department build washboard-like band between adjacent lanes to waken drivers by shaking vehicles when crossing the line. In the rainy or foggy days, visible signals and acoustic signals don’t work as usual. Then regular lumps are set up on road in the dangerous section of highway to make drivers focusing attention when vehicles run over these lumps. Owing to perfect monitoring system of highway and advanced satellite positioning technology in the USA, it would provide guidance of new route for follow-up vehicles. Meanwhile, they develop accident alert system, such as VANETs system, to avoid secondary rear-end accidents.

4.3. Prevention of secondary rear-end accidents

According to analysis of accident reasons, reformation of hardware facility would decrease secondary rear-end accidents, such as strengthening the development of engineering facilities of highway, increasing communication facilities and monitoring devices setup beside the roads, and speeding up the building of warning system of abnormal event on the highway. Referring to the protective measures of rescue team, it is major measure to avoid casualty in the process of rescue operation on the highway that selecting the right path out, right parking position and setting up efficiency guard.

4.3.1 Selection of the right path out and parking position

Table2. Selection of the right path out and parking position

| Road condition of accident section | Selection of driving path | parking position | merits and demerits |
|-----------------------------------|--------------------------|-----------------|-------------------|
|                                  |                          |                 |                   |

Retrograde movement in the front of accident lane
Accident lane is in danger of crush, but smooth usually

Opposite lane is clear
Prograde movement on the opposite lane
Clear road and safe driving is convenient for handling large-scale accidents, but it is in danger of rear-end

Accident lane is blocked off
Opposite lane is of stoppage, but not blocked off. Opposite lane is clear.
Prograde movement on the accident lane
There is possibility of traffic jam, but it is safe to drive and park.
Prograde movement on the opposite lane
Clear road and safe driving is convenient for handling large-scale accidents, but it is in danger of rear-end

Accident lane is blocked off
Opposite lane is of stoppage, but not blocked off
Prograde movement in the front of accident lane
There is possibility of traffic jam, but it is safe and convenient for handling large-scale accidents
Prograde movement on the opposite lane
There is possibility of traffic jam, but it is safe to drive and park and convenient for handling large-scale accidents

Both of lanes are blocked off
Retrograde movement in the front of accident lane
It is in danger of crush, but smooth usually
Retrograde movement on the opposite lane
It is in danger of crush, but smooth usually. It is convenient for handling large-scale accidents.

4.3.2 Increase the number of warning points

It is required to confirm the exact location of traffic accident ahead of rescuing. Firemen should enquire the situation of accident from the police nearby and seek for opinions of path out at first. Then arrange reasonable path out in response to situation. It is should be avoided to drive to highway or be retrograde driving blindly. When setting up the warning line, rescuers should inform the traffic police and management department of highway to control the site of accident effectively, delimit the alert area and improve the efficiency of guard.

- The first warning line (A point): Contact with the closest toll station from the scene and ask them to note the passing vehicles to slow down or pass round from exit ramp nearby. If there is severe accident happening, the toll station should be closed and forbid the vehicle drove toward the site of accident.

- The second warning line (B point): Set up a conical accident signal column in front of every section of road from 2 kilometers away from the site of accident. Set up warning brand of Accident Ahead from 1 kilometer away from the site of accident. Meanwhile, warning signal stick, conical accident signal column, explosion-proof light alert rope, warning flashlight, warning isolation strip and warning brand should be used for guard.

- The third warning line (C point): Set up warning brand of Road Closed from 700 meters away from the site of accident. Set up warning 2-3 layers of deceleration strip and electronic roadblock at the same time from 500 meters away from the site of accident. Meanwhile, arrange steel fence on the roads and place 500 meters warning lights in a higher position. The guard personnel set up warning by the way of noticing the passing vehicles using handling microphone. Conical accident signal columns should be placed in the center of road and the separation distance should be less than 15 meters. In the range of 100 meters away from site of accident, the separation distance of conical accident signal columns should be less than 4 meters.

The picture below is the diagrammatic drawing of setting up warning line in different road conditions.
Breakdown lorry runs to the site of accident in retrograde motion in front of accident lane. The method is always used in the situation that accident lane is blocked off. The merits are clear road and short time to arrive at the scene to launch the rescue operation immediately. Demerit is danger of crushing. In the process of driving, patrol wagons clear the way and all the vehicles of rescue should turn on warning light. Patrol wagons warn frontal vehicles continuously by vehicular microphone.

Breakdown lorry runs to the site of accident in prograde motion from behind of accident lane. The method is always used in the situation that accident lane is of stoppage, but not blocked off. The merits are that driving and parking are relatively safe and that opposite lane is clear as common. Demerit is possibility of traffic jam. When traffic jam happens, rescuers need to prepare light forcible entry tools and lifesaving tools, and arrive at the site of accident immediately. It is necessary to strengthen guard at the back of breakdown lorry.
Breakdown lorry runs to the site of accident in prograde motion on the opposite lane. The method is always used in the situation that accident lane is blocked off and opposite lane is not blocked off yet. The merits are that driving and parking are relatively safe and that it is convenient for handling large-scale accidents. Demerit is possibility of traffic jam. When traffic jam happens, rescuers need to prepare light forcible entry tools and lifesaving tools, and arrive at the site of accident immediately.

Breakdown lorry runs to the site of accident in retrograde motion on the opposite lane. The method is always used in the situation that both of lanes are blocked off. The merits are clear road and short time to arrive at the scene to launch the rescue operation immediately. Demerit is danger of crushing. In the process of driving, patrol wagons clear the way and all the vehicles of rescue should turn on warning light. Patrol wagons warn frontal vehicles continuously by vehicular microphone. The breakdown lorries should park on the left sequentially when arriving at site of accident.

4.3.3 Coordinate with department of traffic police and executives patrol

It’s necessary to coordinate with department of traffic police and executives patrol in the process of setting up guard. Unify the warning signal. If any vehicle crosses the warning line, the guard personnel of next warning line and rescuers in the scene must be informed immediately. The site of rescuing should do some preventive work of secondary rear-end.

4.3.4 Increasing mobile rescue vehicles

Mobile rescue vehicles warn and notice passing vehicles continuously by vehicular microphone. When rescue vehicles park on the accident lane and conduct rescue operation, increase mobile rescue vehicles in retrograde or prograde motion on accident lane from the scene with slow speed. When rescue vehicles park on the opposite lane, increase mobile rescue vehicles in retrograde or prograde motion on both of lanes from the scene with slow speed.

5. Conclusion

The happening of secondary rear-end accidents threatens the safety of rescuers, drivers and crew. It also causes enormous pressure to traffic rescue work and threatens the trip safety of the people. Prevention of secondary accidents in the process of traffic accident rescue guarantees the success of rescue operation. So it is important section of traffic safety management of highway. It will improve the efficiency and confidence of rescuers of highway traffic accidents that taking effective measures to decrease the possibilities of secondary rear-end. It is of practical significance to confirm that the rescue of highway traffic accidents is effective and quick.
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