Characteristics of Heavy Vehicle Crashes on Japanese Motorways

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Abstract: The paper analyzed contributory factors and characteristics of heavy vehicle crashes which occurred on the whole Japanese motorways. It was found from the analysis that the crashes caused by heavy vehicles peak late at night and in the early morning, which is different from that by other vehicle types, one in the morning and the other in the evening. The dominant contributory factor is distraction or failed to look properly accounting for more than 80%. The dominant crash type is vehicle-vehicle rear-end crashes accounting for 65%, followed by 15% for single vehicle trucks and 12% for vehicle-vehicle crashes of side impact. The fatality rate of crashes caused by heavy vehicles tends to be higher than that by passenger cars. It is highest at 8.1% for crash into the congestion queue, followed by 7.0% for crashes in free flow. Comparing the fatality rate for crash into the queue by vehicle type, heavy vehicle yields nearly 3 times of passenger cars.

Keywords: Heavy vehicle, Crash, Traffic accident, Safety, Motorway

1. INTRODUCTION

With compulsory introduction of speed limiter for heavy vehicles in a 3-year period from 2003 to 2005, the number of fatal and injury crashes of heavy vehicles on Japanese motorways decreased by 40% from 2004 to 2009. Nevertheless, once heavy vehicle related serious accident occurs on a motorway, it is likely to cause casualty and result in closure to traffic for several hours, causing severe damages to and impacts on not only related vehicles but also other parties and even social society. Therefore, it is important to analyze the contributory factors and characteristics of heavy vehicle crashes so as to propose effective countermeasures to reduce heavy vehicle crashes.

This paper analyzes contributory factors and characteristics of heavy vehicle crashes which occurred on the whole Japanese motorways.

2. DATA ANALYSIS

In consideration of the gradual introduction of speed limiter on heavy vehicles, the paper analyzed 4-year crash data from 2006 to 2009 collected by 3 motorway operators with the help of motorway police. The crash data is limited to casualty crashes, i.e. fatal, seriously and slightly injured, caused by heavy vehicles i.e. the first party in the crashes. For comparison, the crashes with the second party being a heavy vehicle are also addressed even if the first party is a passenger car. The heavy vehicle dealt with in the study consists of 1) buses of number of passengers more than 29, 2) normal trucks of gross weight less than 8 ton or maximum loading weight less than 5 ton, 3) large trucks of gross weight more than 8 ton or maximum loading weight more than 5 ton with less than or equal to 3 axes, and gross weight less than 20 ton with less than or equal to 4 axes, 4) specially large trucks of gross weight more than 20 ton with 4 axes or more.

3. FACTORS AND CHARACTERISTICS OF HEAVY VEHICLE CRASHES

3.1 Transition of Heavy Vehicle Crashes

Figure 1 shows the trends of fatal and injury crashes by vehicle type occurred on Japanese motorways from 2004 to 2009. The number of fatal and injury crashes caused by heavy vehicles has decreased since 2006 when the speed limiter has been introduced to heavy vehicles. The number caused by passenger cars increased largely in 2009 when the holiday special toll discount was introduced for passenger cars on weekends and holidays in the end of March 2009, causing large increase in the number of passenger cars and traffic demand, and severer traffic congestion. Compared to the number of crashes caused by passenger cars, it decreased in 2009 after the introduction of the holiday special toll discount, indicating it was not affected by the holiday special toll discount.

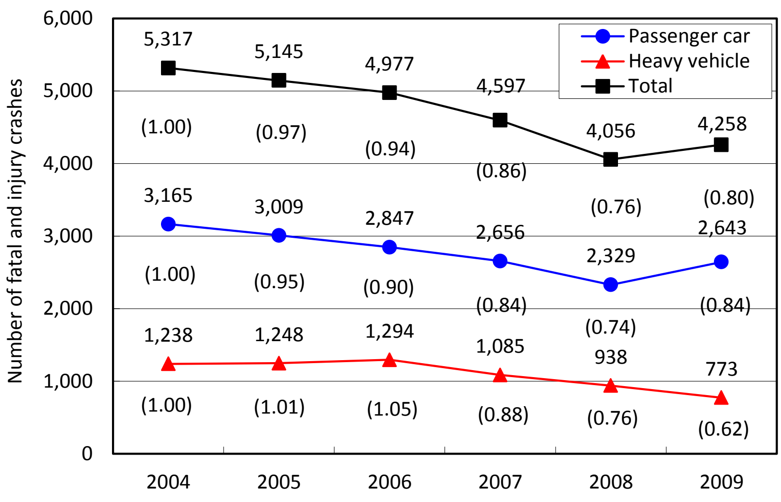


Figure 1. Fatal and injury crash trends on Japanese motorway, 2004-2009

3.2 Factors and Characteristics of Heavy Vehicle Crashes

3.2.1 Time of Day

Figure 2 shows the distributions of crashes caused by heavy vehicles and all vehicle types by time of day. The crashes caused by heavy vehicles peak at 2 a.m. – 6 a.m., i.e. late at night and early morning, while the crashes caused by all vehicle types have two peaks, one at 8 a.m. – 10 a.m. in the morning and the other at 4 p.m. – 6 p.m. in the evening. This is probably because most of heavy vehicles travel on motorways in night time in order to get toll discount to cut transportation cost.

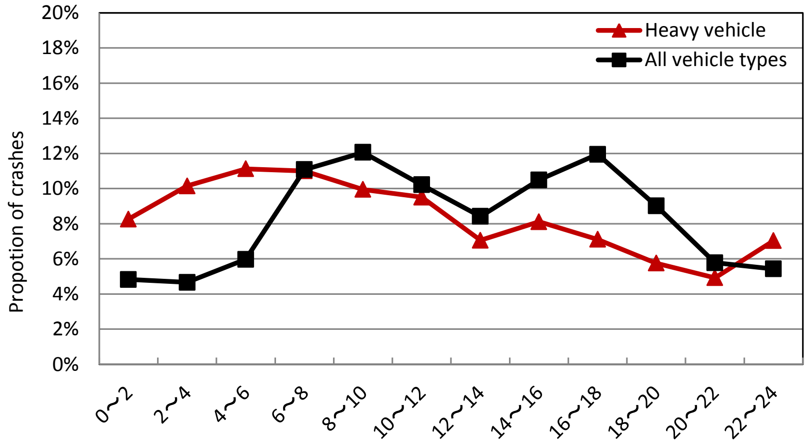


Figure 2. Distribution of crashes by time of day and vehicle type

3.2.2 Contributory Factors

Figure 3 describes the proportion of contributory factors of crashes caused by heavy vehicles in crash peak (2 a.m. – 6 a.m.). Contributory factors are collected at the scene of the accident and are the motorway police officer's view of the reasons for the accident. It is seen from the figure that the dominant contributory factor is distraction or failed to look properly accounting for more than 80%.

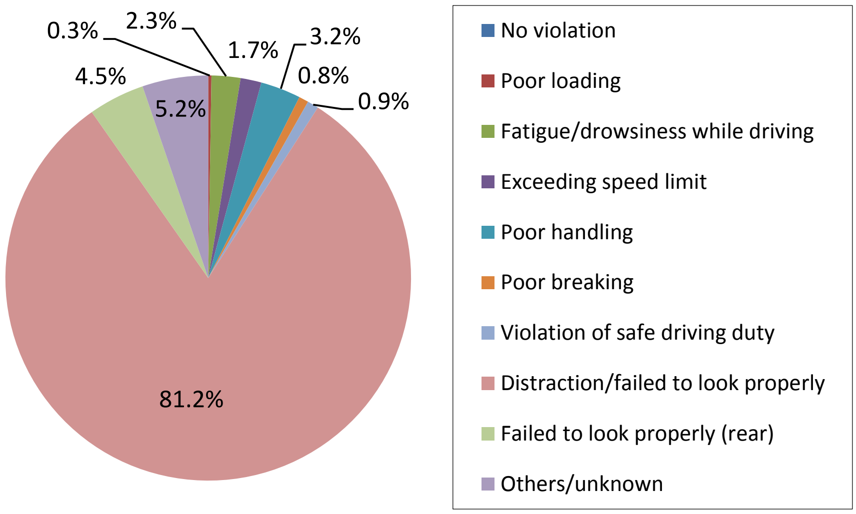


Figure 3. Proportion of contributory factors in crash peak (2 a.m. – 6 a.m.)

3.2.3 Crash Types

Figure 4 shows the proportion of crash types which occurred on Japanese motorways. The crash types include single vehicle crashes or vehicle-structure crashes, It is seen from the figure that the dominant crash type is vehicle-vehicle rear-end crashes accounting for 65%, followed by 15% for single vehicle trucks and 12% for vehicle-vehicle crashes of side impact.

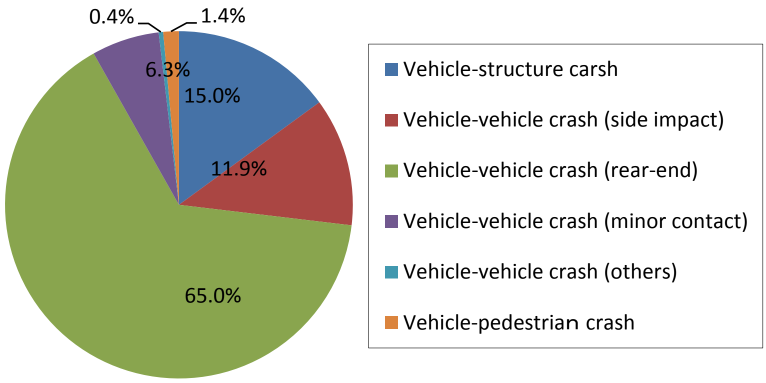


Figure 4. Proportion of crash types

3.2.4 Crash Speed

Figure 5 shows the proportion of crash speed by crash type. It is seen that for each crash type crash speed of more than 80 km/h accounts for nearly 70%.

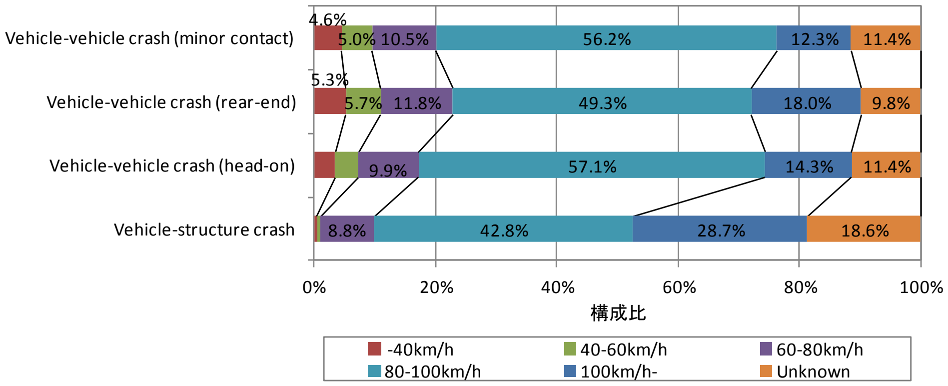


Figure 5. Proportion of crash speed by crash type

3.2.5 Congestion Related Crashes

Figure 6 shows the fatality rate of congestion related crashes by vehicle types. The fatality rate is defined here in the study as the ratio of the number of fatal crashes to total number of fatal and injury crashes. The fatality rate of crashes caused by heavy vehicles tends to be higher than that by passenger cars. It is highest at 8.1% for crash into the congestion queue, followed by 7.0% for crashes in free flow. The fatality rate inside the queue is lowest at 2.7%. Comparing the fatality rate for crash into the queue by vehicle type, heavy vehicle yields nearly 3 times of passenger cars. The value of the fatality rate in different conditions can be explained by the crash speed of the first party and the relative speed between the first and second parties.

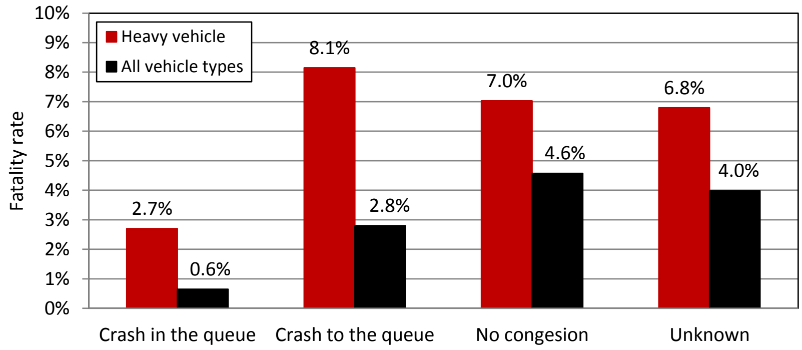


Figure 6. Fatality rate of congestion related crashes

3.2.6 Crash Severity of Vehicle Types and Crash Parties

Fatality rate by crash party (first and second party) and vehicle type (passenger car, small trucks, and heavy vehicle) is shown in Figure 7. Heavy vehicle related crashes bring about higher fatality rate than passenger cars and small trucks regardless of the first and second parties of crashes. Looking into possibility of fatality for different crash parties as described in Table 1 shows that a crash between passenger car and heavy vehicle tends to give highest possibility of fatality to passenger car at 83% -96%, much higher than 62% of heavy vehicle to heavy vehicle crashes and 60% of passenger car to passenger car crashes.

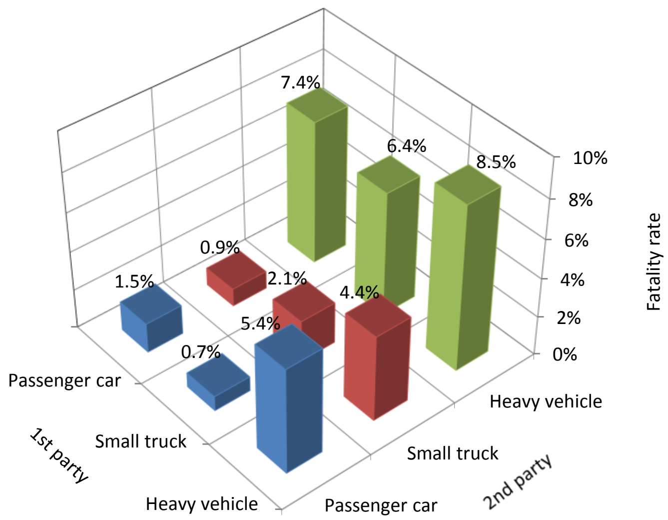


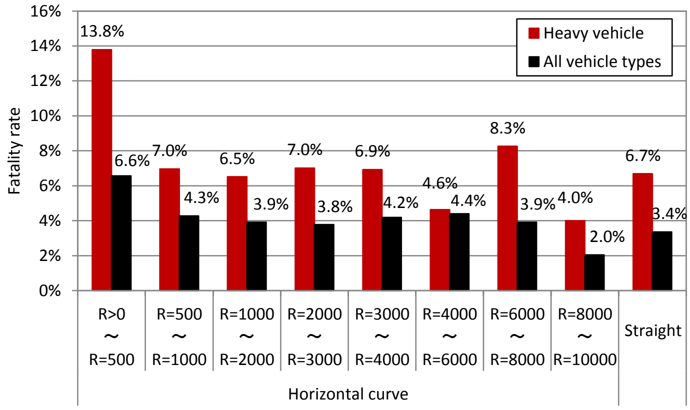
Figure 7. Fatality rate by crash party and vehicle type

Table 2. Possibility of fatality for different crash parties in vehicle-vehicle fatal crashes

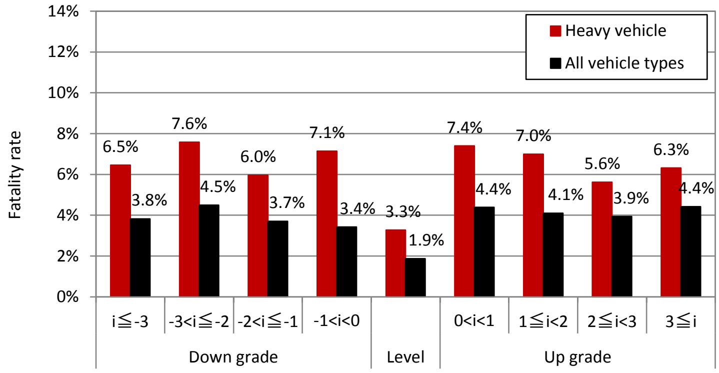
Crash type	Fatal crashes			
	1st aprty	2nd party	Others	Total
1st party (pc)×2nd party (pc)	41	24	4	69
	59.4%	34.8%	5.8%	100.0%
1st party (pc)×2nd party (hv)	63	3	0	66
	95.5%	4.5%	0.0%	100.0%
1st party (hv)×2nd party (pc)	4	75	11	90
	4.4%	83.3%	12.2%	100.0%
1st party (hv)×2nd party (hv)	58	23	13	94
	61.7%	24.5%	13.8%	100.0%

3.2.7 Relationship of Crash Severity and Highway Alignment

Figure 8 shows the fatality rate by highway horizontal and vertical alignment. For all horizontal and vertical alignment, the fatality rate of heavy vehicles is higher than other vehicle types. Sharp horizontal curve is likely to yield higher fatality rate while for vertical alignment there is no particular difference except for the level, which keeps lower fatality rate at level.



(a) Horizontal alignment



(b) Vertical alignment

Figure 8. Fatality rate by highway alignment

3.2.8 Characteristics of the Crashes Occurred Outside of Mainline

Figure 9 shows the proportion of crash types by crash speed for crashes caused by heavy vehicles occurred outside of mainline. Figure 10 plots the fatality rate for different crash type. Here outside of mainline consists of service and parking areas, toll plazas of interchanges and mainline, and acceleration and deceleration lanes and ramps of interchanges, junctions and service and parking areas, etc. It is seen from the figures that as crash speed is greater than 60 km/h, more than half of accidents are single vehicle crashes with side barriers and so on, and the fatality rate of the single vehicle crashes is nearly 10% indicating one in 10 such crashes results in death. Since speed limiter is not effective for low speed, it is necessary to apply effective speed management and control measures such as uneven pavement and optical bar from hard viewpoint or ITS technology like automatic warning function from navigation system or ISA (Intelligent speed adaptation) system from soft viewpoint.

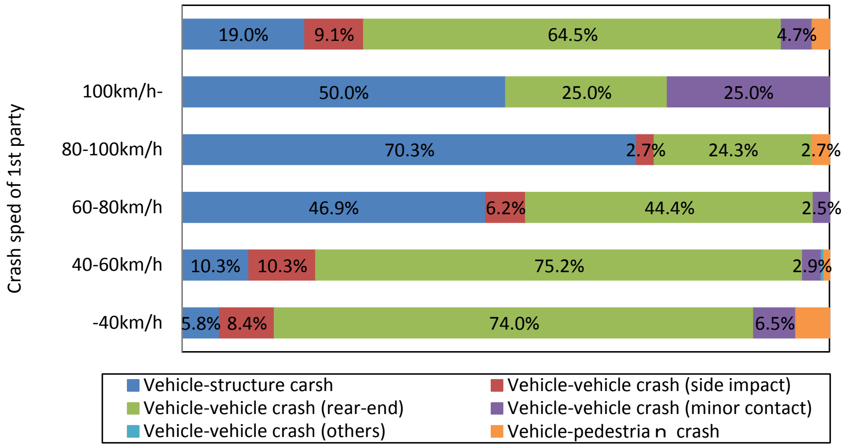


Figure 9. Proportion of crash types by crash speed for crashes outside of mainline

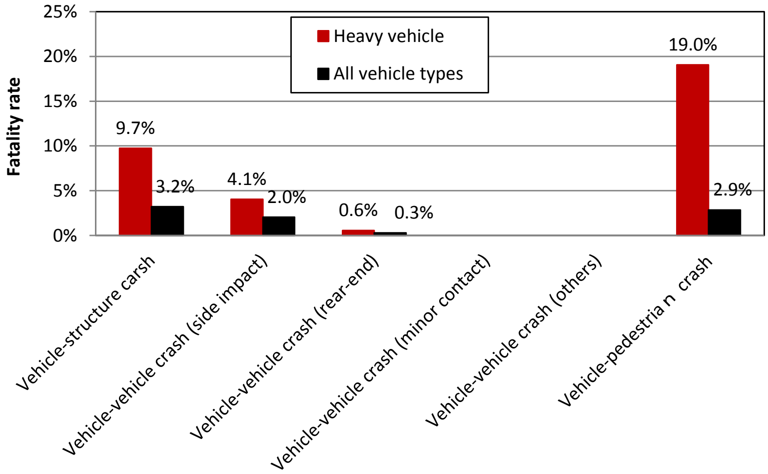


Figure 10. Fatality rate of crash types for crashes outside of mainline

4. CONCLUSIONS

The paper analyzed contributory factors and characteristics of heavy vehicle crashes which occurred on the whole Japanese motorways. It was found from the analysis that the crashes caused by heavy vehicles peak late at night and in the early morning, which is different from that by other vehicle types, one in the morning and the other in the evening. The dominant contributory factor is distraction or failed to look properly accounting for more than 80%. The dominant crash type is vehicle-vehicle rear-end crashes accounting for 65%, followed by 15% for single vehicle trucks and 12% for vehicle-vehicle crashes of side impact. The fatality rate of crashes caused by heavy vehicles tends to be higher than that by passenger cars. It is highest at 8.1% for crash into the congestion queue, followed by 7.0% for crashes in free flow. Comparing the fatality rate for crash into the queue by vehicle type, heavy vehicle yields nearly 3 times of passenger cars.

Based on the analysis results, it is important to take effective measures from the viewpoints of truck drivers' education and operation management, road infrastructure and vehicle safety technologies. Especially ITS technologies is effective to reduce heavy vehicle related crashes.

REFERENCES

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