DEVELOPMENT OF SAFETY CONCEPT TRUCKS; ASV CONCEPT L AND ASV CONCEPT C

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ABSTRACT

To realize a dream of "zero-nize" the fatalities and injuries in traffic accidents, or even accidents themselves, related to commercial vehicles, future concepts for both large truck and small delivery truck, with a name ASV concept L (long haul truck), and ASV concept C (city use) were studied.
The newest available traffic accident statistics data in Japan was used for analyses to know the characteristics of accidents each types of commercial vehicles are involved. The result showed the accidents related to large trucks and one related to small trucks are quite different. Among the accidents related to large trucks used mainly for long haul use, which consist 15% of all fatalities, almost 50% of the fatalities are car occupants. For the small trucks used mainly in city for delivery purpose, almost 40% of the accidents are with pedestrians and cyclists.
From these analyses, it was concluded that the following three areas are the most important areas to tackle with.
1 .Frontal collision between car and large trucks
2. Rear-end collision of large trucks
3. Small truck accidents of pedestrians and cyclists at intersections
In ASV concept L, Energy Absorbing Front Structure was proposed to reduce a damage of car occupants and 50% decrease in fatalities in such accidents may be possible with the structure. Pre-crash Safety System is to cope with rear-end collision. With millimeter-wave length radar, objects are found and the system gives warning to the driver. In case driver takes no avoiding maneuver, the system automatically applies brake to reduce the impact speed.
In ASV concept C, Body Structure for Pedestrian Safety was proposed. Blind-spot Monitoring System for vehicle front, rear and below to assist the driver, Ultra-thin Pillar for better frontal view and Pedestrian Detection and Warning System were proposed.

INTRODUCTION

Fatalities in traffic accidents in Japan have been decreasing for this 10 years and it came to the number 7,358 in 2004. On the other hand, injuries and number of accidents have been increasing. This trend is also true for the accidents which involved commercial vehicles, i.e. large trucks, medium trucks and small trucks (See Figure 1). Reduction of traffic accidents and their casualties is worldwide target and Japan is one of the countries which have tackled to achieve the target. In January 2003, Japanese prime minister announced his vision of halving the fatalities in traffic accident in ten years, and various measures are now under way. Final target is to "zero-nize" the accidents, or realization of accident free society. To reach this final target, there must be some big jumps which are something different from current measures.

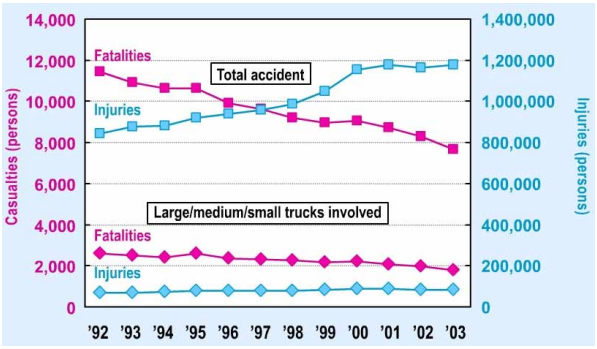

Figure 1. Changes of casualties in traffic accidents.

VISION ON SAFETY IMPROVEMENT

Hino Motors, Ltd., a commercial vehicle manufacturer in Japan holds a vision of achieving the zero casualties in accidents which involve commercial vehicles (See Figure 2). Here, to realize this vision, safety concepts; both for large truck and small truck were studied.

Figure 2. Vision on safety improvement.

ANALYSIS OF COMMERCIAL VEHICLE ACCIDENTS

Using the most recent available accident statistic data in Japan, traffic accidents which involved commercial vehicles were analyzed for each truck category. Here, the large truck is with the GVW of more than 8 tons, medium truck is with the GVW of 7 tons to 8 tons, and small truck is with the GVW of less than 7 tons.
Result shows that the contents or types of accidents differ from category to category because of the difference in use; large trucks are mainly used on highways and trunk routes, small trucks are mainly used for delivery purpose, and medium trucks are just between these two (See Figure 3).
In accidents involved large trucks, which make up 13% of all traffic accident fatalities and 53 % of all fatalities related to commercial vehicles, passenger car occupants hold the largest shear and it is almost 50 %. This leads to the fact that the first priority in the safety of large truck shall be given to the accidents with passenger cars. Type of accident most frequently happen in passenger car to truck accident is frontal collision. From the analysis, 90 % of these frontal collisions occur as a result of departing lanes of passenger cars. In frontal collisions higher relative speed easily result in fatal accidents. Next there comes the rear-end collision. The rear-end collision, especially the high speed accidents on the highways, can result in fatal accidents for passenger car occupants.
In accidents involved small trucks, which make up 5 % of all traffic accident fatalities and 22 % of all fatalities related to commercial vehicles, pedestrians and cyclists hold the largest shear and should be given the first priority. In pedestrian accidents, accidents on intersection in daylight time are most common, and accidents at right turn maneuver are most frequent. (Japan is in left-hand traffic, and the right turn means the turn across the opposite traffic lane.)

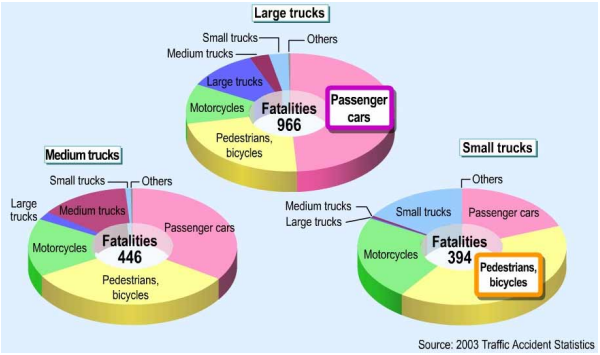

Figure 3. Fatal accidents which involve commercial vehicles.

STUDY ON SAFETY CONCEPT

Based on the result of accident data analysis, safety concepts both for large truck and small truck were studied. Basic idea was as follows. To operate the vehicle safely, it is most important that the vehicle is easy to operate for every person; for male and female, for young and elderly person. So, for the basis of safety concept trucks, "Universal Design" concept was applied for the cab interior and driving devices. Upon this base, appropriate safety systems both in active safety and in passive safety were built up (See Figure 4).
In active safety, assist of driver's recognition and judgment, using intelligent traffic system technology was studied. "No blind spots around the vehicle" is the main concept in this facet (See Figure 5).
In passive safety, "compatibility" was studied. In passenger car in general, compatibility is the idea to keep equivalent safety level for both cars in case of collision between small-size car and large-size car. Compatibility in commercial vehicles is a little different. In the case of large truck, it is the matter between passenger car and large truck and the compatibility is to reduce the risk of passenger car occupants in case of collision. In the case of small truck, it is the matter between pedestrian and small truck. And the compatibility is to reduce the damage of pedestrian in case of pedestrian accidents.

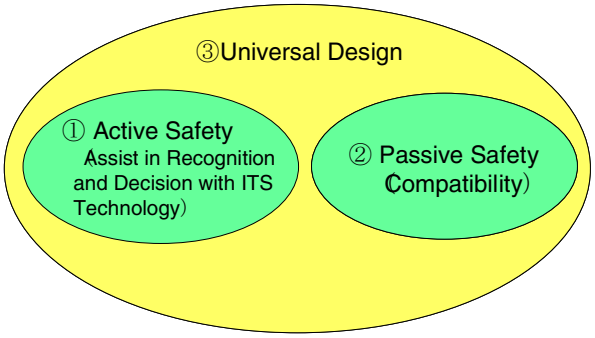

Figure 4. Safety concept of future trucks.

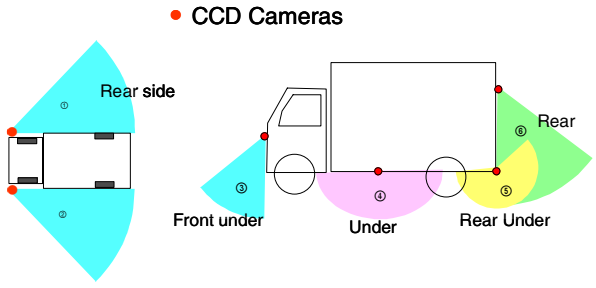

Figure 5. No blind spot around the vehicle.

Safety Concept of Large Truck: ASV concept L

In the study of safety concept of large truck: ASV concept L, area of the study was focused on long-haul, cargo truck. Protection of passenger car occupants in case of frontal collision, mitigation of damage in case of rear-end collision and support of visibility in highway cruising are main topics. Systems included in the concept are introduced in the following (See Figure 6).

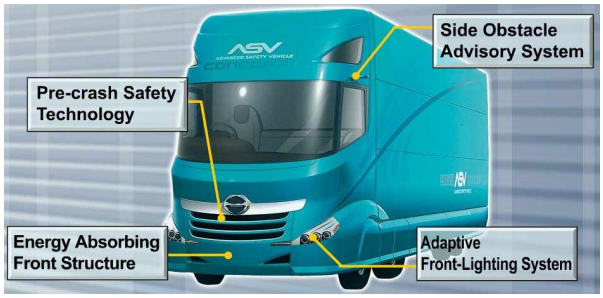

Figure 6. ASV concept L.

Energy Absorbing Front Structure

ASV concept L has energy absorbing front structure which aims at the reduction of impact and damage to the passenger car in case of frontal collision (See Figure 7). This energy absorbing front structure has two functions. One is to absorb crash energy of passenger car, and another is to put the opposing car aside in offset collision case which is most common in the frontal collision. This can reduce the damage which can be expected in subsequent events in the accident (See Figure 8). In our estimation, this structure has potential to cope with frontal collision up to 90 km/h and saves the 50 % of fatalities in the type of accidents, compare to the 15 % with front under-run protection device in ECE regulation (See Figure 9). To put this structure into practice in the long-haul truck, relaxation of the restrictions on total vehicle length shall be discussed. Our study showed that 500 mm crash stroke is necessary to provide sufficient effectiveness. This is basically to reduce, not the damage of the truck driver, but damage of opposing car occupants, and to make the technology become widely used, load capacity shall not be reduced from the one current trucks have. Discussion among the users, legislative, and manufacturers is necessary.

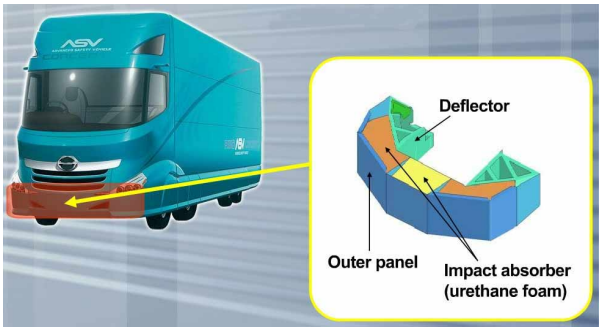

Figure 7. Energy absorbing front structure.

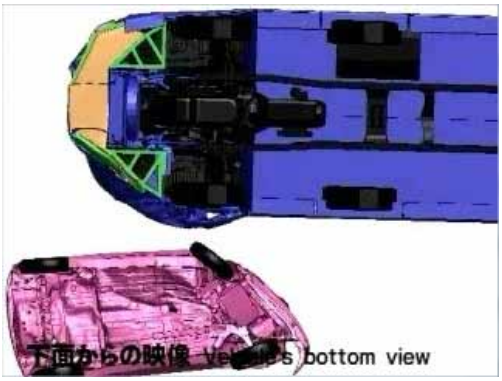

Figure 8. Simulation result.

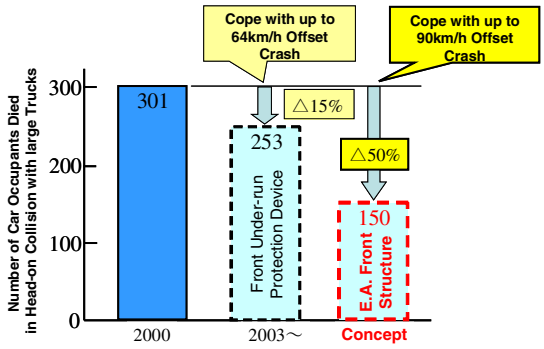

Figure 9. Estimation of reduction in fatalities.

Pre-crash Safety Technology

To reduce the fatalities in rear-end collision of large trucks, the pre-crash safety technology was proposed. Millimeter wave radar detects obstacle ahead and if there is any possibility of collision, gives warning to the driver. If driver does not take any avoiding maneuver, the system automatically applies brake force and reduces the impact speed and thus mitigates the damage to the obstacle (See Figure 10).

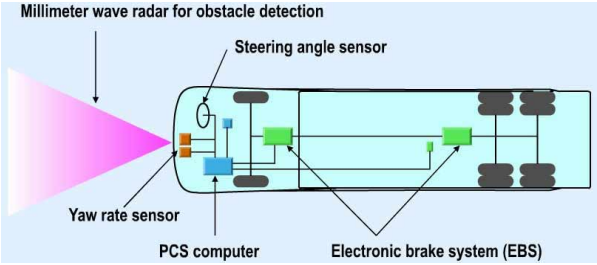

Figure 10. Pre-crash safety system.

Adaptive Front-lighting System (AFS)

Adaptive front-lighting system (AFS) aims to offer drivers better view compared to the traditional head-light system, in case of driving curve or turning an intersection at night. The proposed system has a function to direct the main head-light beam to the direction where the vehicle will be, according to the steering angle. In addition, based on the maneuver of large truck at an intersection, additional sideward lamp is turned on when the vehicle makes turning with certain low speed and with turning lamp activated (See Figure 11, 12, 13).

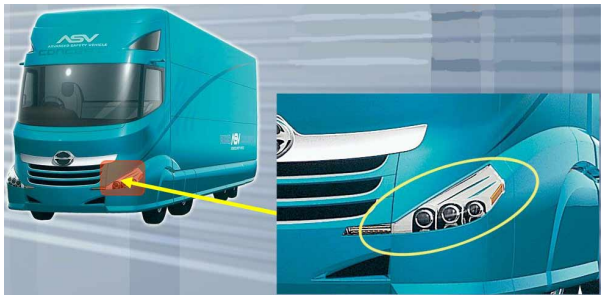

Figure 11. Adaptive front-lighting system (AFS).

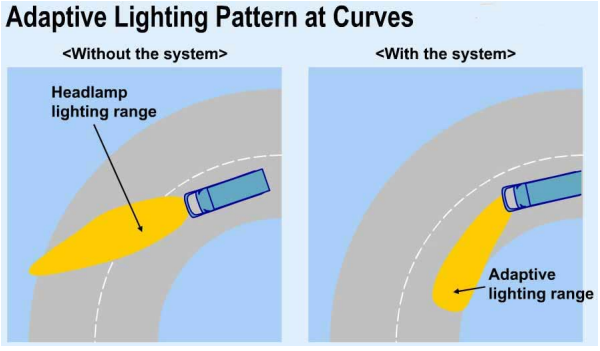

Figure 12. Function of AFS at curves.

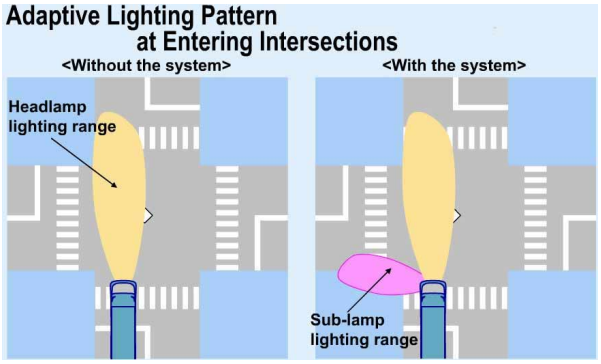

Figure 13. Function of AFS at intersections.

Side Obstacle Advisory System

Side obstacle advisory system informs presence of vehicles on adjacent lane when driver intends to make a lane change. ASV concept L is equipped with cameras on the right and left of the cabin instead of current mirrors. By analyzing the view of the cameras, only the objects which are approaching to the vehicle on adjacent lane are detected and the system gives warning to the driver (See Figure 14, 15).

Figure 14. Side obstacle advisory system; cameras.

Figure 15. Detection of objects.

Safety Concept of Small Truck: ASV concept C

In the study of safety concept of small truck: ASV concept C, area of the study was focused on delivery truck mainly used in urban area. Protection of pedestrians in case of pedestrian accidents is the main topic. Systems included in the concept are introduced in the following (See Figure 16).

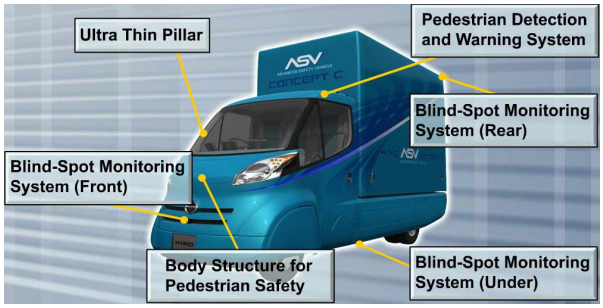

Figure 16. ASV concept C.

Ultra Thin Pillar

Ultra thin pillar is to improve the visibility of pedestrians and cyclist in the right and left turning maneuver. When the section of the pillar is thinner compared to the width of right and left eyes of the driver, objects behind the pillar do not hide behind the pillar because of the parallax of right and left eyes (See Figure 17, 18).

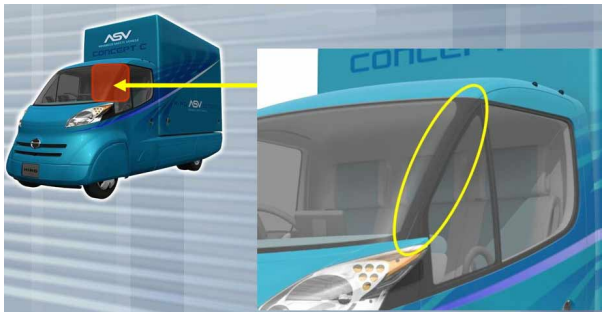

Figure 17. Ultra thin pillar.

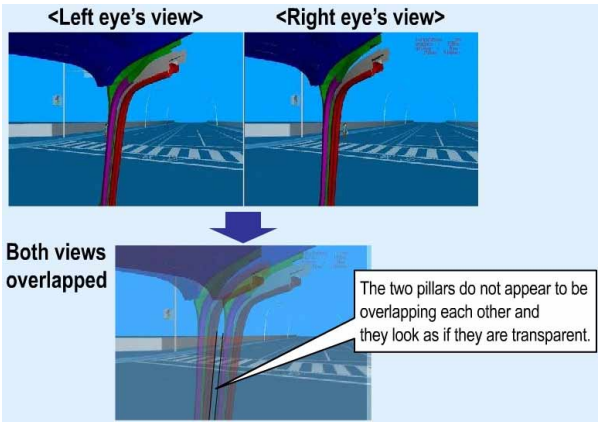

Figure 18. Function of ultra thin pillar.

Pedestrian Detection and Warning System

Pedestrian detection and warning system detects pedestrians in the right and left turning maneuver and warns the driver when there are pedestrians. Stereo cameras on both right and left side of roof take images of side-rear of the vehicle. From the image data processing, only pedestrians are extracted and the direction and movement of the pedestrians are analyzed. If there is possibility of contact between pedestrians and the vehicle, the system warns the driver with sound alarm (See Figure 19, 20).

Figure 19. Pedestrian detection and warning system; stereo cameras.

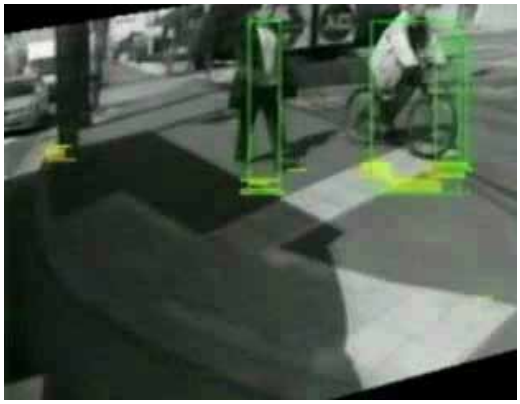

Figure 20. Detection of pedestrians.

Blind Spot Monitoring System (Front, Rear and Under the vehicle)

To realize the concept of "No Blind Spot around the Vehicle", Cameras are used to support the driver's visibility and to detect objects and warn the driver. Wide angle camera on the front of vehicle is effective when the vehicle going out from narrow alley surrounded by walls. With the image data processing, system detects objects approaching the vehicle from left side and right side and warns driver (See Figure 21, 22). Wide angle camera on the rear-end of the vehicle provides the view on the back of vehicle where drivers usually have difficulty to confirm the safety, and if there are any moving objects system gives warning to the driver (See Figure 23, 24). Wide angle camera on the bottom of the vehicle takes the first photograph when driver stops the vehicle and removes the key. When driver returns to the vehicle and inserts the key again, the camera takes the second photograph. If there is any difference between the first and the second photograph, the system warns the driver of the possibility that something entered beneath the vehicle. It is also possible to disable the engine start (See Figure 25, 26).

Figure 21. Blind spot monitoring system; front camera.

Figure 22. Detection of objects by front camera.

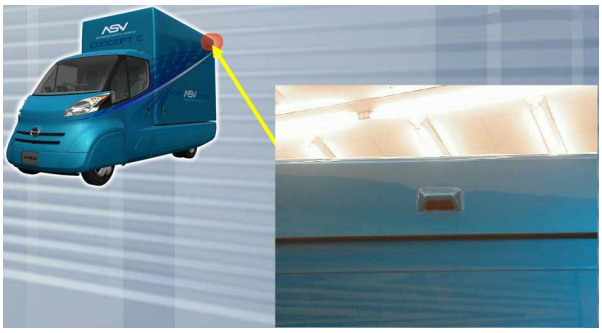

Figure 23. Blind spot monitoring system; rear camera.

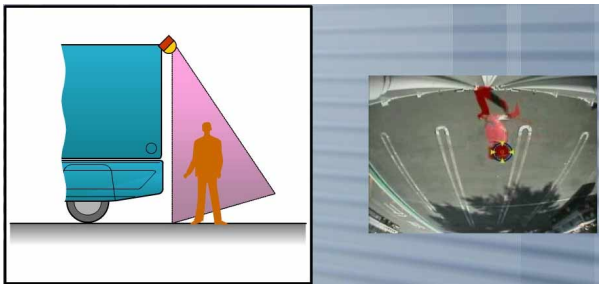

Figure 24. Detection of objects by rear camera.

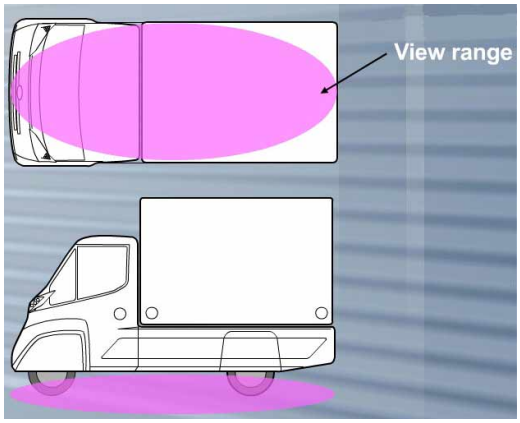

Figure 25. Blind spot monitoring system; bottom camera.

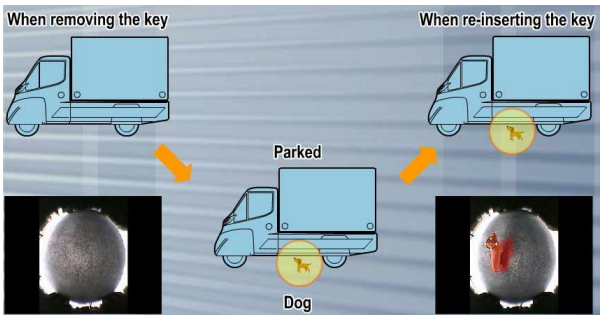

Figure 26. Detection of objects by bottom camera.

Body Structure for Pedestrian Safety

The rare event of collision with pedestrians, the bonnet structure with high impact absorbing capacity protects the pedestrian's head (See Figure 27).

Figure 27. Body structure for pedestrian safety; head impact test.

CONCLUSION

Based on the analysis of most recent traffic accident statistic data, safety concepts of both large truck and small truck which aim at the realization of "zero traffic accident" are studied. In large truck, protection of passenger cars, and in small truck, protection of pedestrians is the first priority. To realize the "accident free society" it is necessary to expand the ideas beyond the limit of current vehicles. The shape of the future truck may have different shape from the current one. The system proposed here in the concepts will be realized one by one. Discussion with people from wide area; users, legislatives, manufacturers is most welcomed.