Submitted by the expert Japan	Informal document GRSP-64-41 (64th GRSP, 11-14 December 2018 agenda item 38(a)(b)(c) and 30(a))

Pedestrian Safety Research in Japan

MLIT / NTSEL

Ministry of Land, Infrastructure, Transport and Tourism

National Traffic Safety and Environment Laboratory

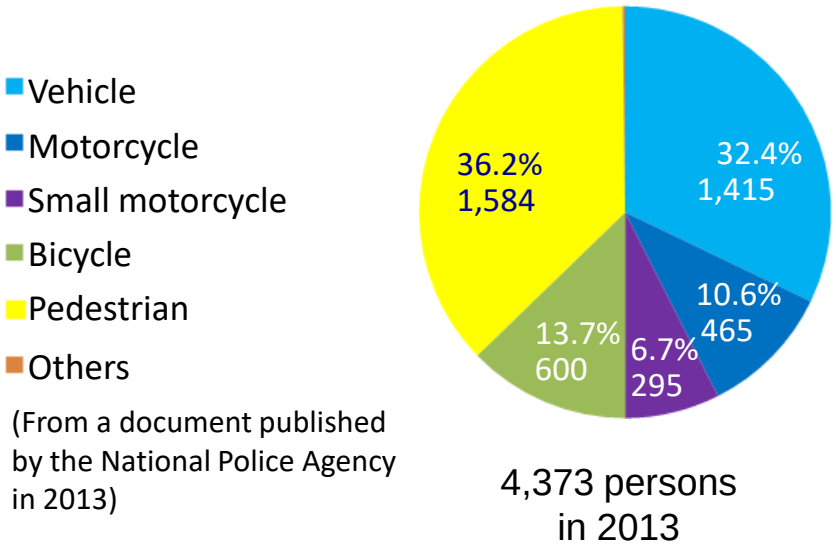
Macro Traffic Accident Study

Already Reported in GRSP59-21

Traffic accident fatalities by mode

Accident data

- Macro accident data for 2013
- Fatal accidents



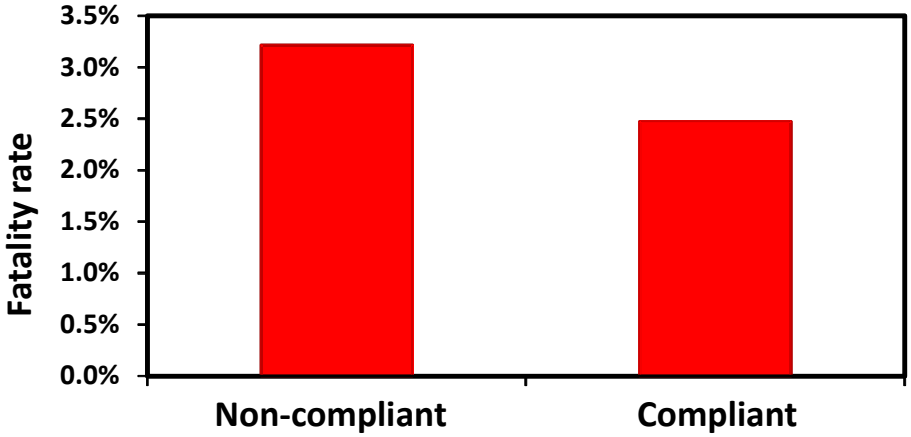
(From a document published by the National Police Agency in 2013)

4,373 persons in 2013

Effects of the pedestrian safety standard

Accident data

- Macro accident data for 2012 - 2013
- Fatal pedestrian accidents
- M1 category vehicles
- Compliant/non-compliant with the pedestrian safety standard

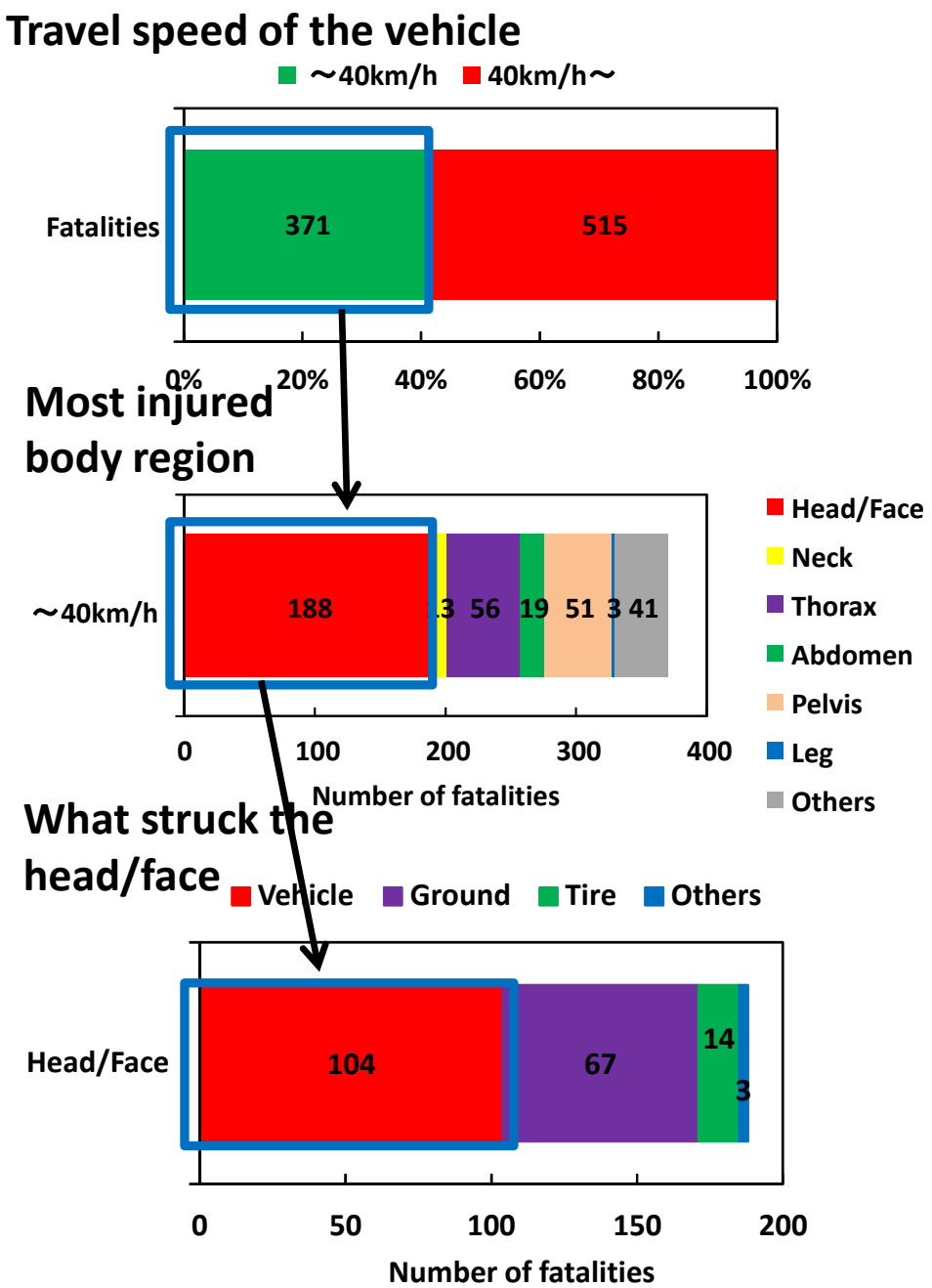


*From a document of the 3rd vehicle safety meeting for FY2014 conducted by MLIT

- Pedestrians accounted for the largest proportion of traffic accident fatalities.
- Pedestrian safety standard is effective for reducing fatalities by traffic accidents .

Macro Traffic Accident Study

Already Reported in GRSP59-21



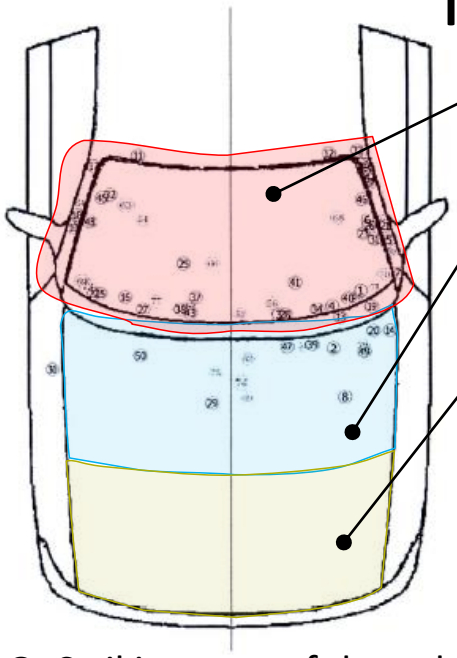
Accident data

- Macro accident data for 2008-2012
- Pedestrian fatal accidents
- Passenger cars (mini vehicles, sedans, mini vans) compliant with the pedestrian safety standard
- 42% of pedestrian fatal accidents occurred at 40 km/h or below.
- Of the fatal accidents that occurred at under 40km/h , the head/face was the most injured body region, in 51% of the cases.
- In 55% of the fatal accidents, the head/face was hit by external parts of the vehicle.

There is potential to reduce pedestrian fatalities by further improving the pedestrian safety of vehicles.

Micro Traffic Accident Study

Already Reported in GRSP59-21



O : Striking area of the vehicle in accidents with AIS2+ head injury in the micro accident survey

*From a report on the results of detailed traffic accident research and analysis through medicine-engineering collaboration for vehicle safety in 2013 conducted by MLIT

Accident data

- Micro accident data for 1993 - 2012
- Pedestrian accidents with AIS2+ head injury
- Passenger cars and trucks with hood
- Accidents excluding children aged 10 or younger /below 140 cm in height

Striking area	No. of cases	Proportion
Hood	15	21 %
A-pillar periphery	23	32 %
Lower wind shield glass frame periphery	24	34 %
Upper wind shield glass frame periphery	2	6 %
Wind shield glass	6	9 %
Fender	1	1 %
Total	71	100 %

Lower wind shield glass frame and A-pillar peripheries are the major areas that struck the head in pedestrian accidents with AIS2+ head injury.

-> Many were outside of the test areas of the pedestrian safety standard.

Micro Traffic Accident Study

Other accident data

- The AIS data of 70 accidents when the head of the pedestrian impacted the front window shield glass.

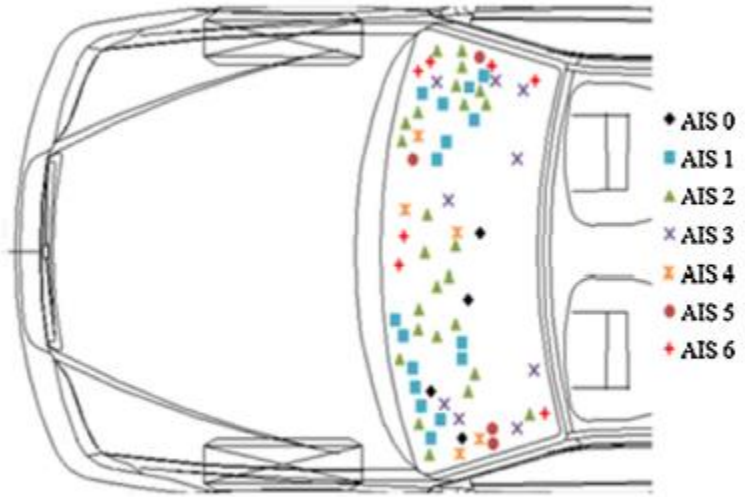
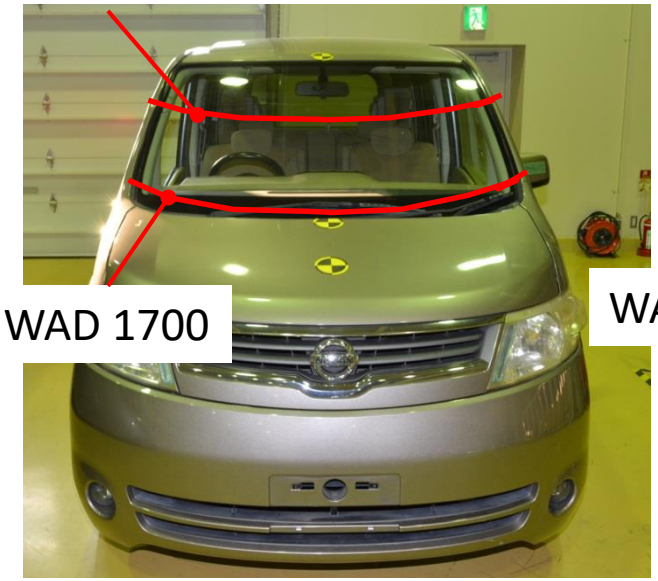


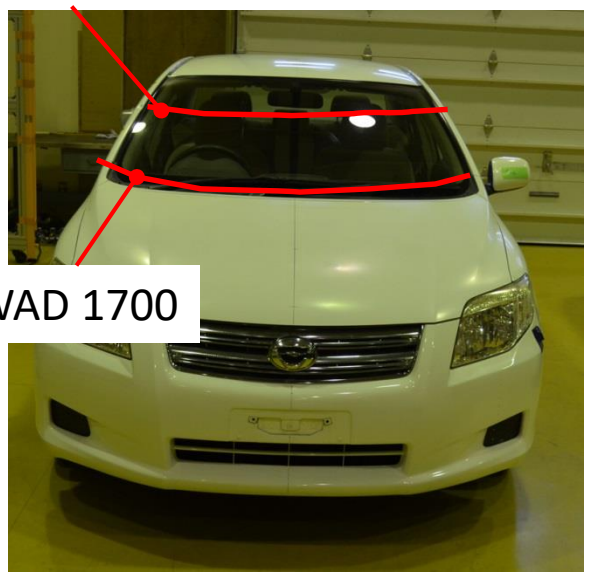
Fig. 2. Distribution of pedestrian impact locations on vehicle windscreen for the 70 well-documented pedestrian accident cases.

From Debasis, S., et al. “Brain injury tolerance limit based on computation of axonal strain”, Accident Analysis and Prevention 92(2016) 53-70

Most accidents which AIS larger than 4 were around A pillar or lower boundary of the glass.

WAD Conditions of Vehicles



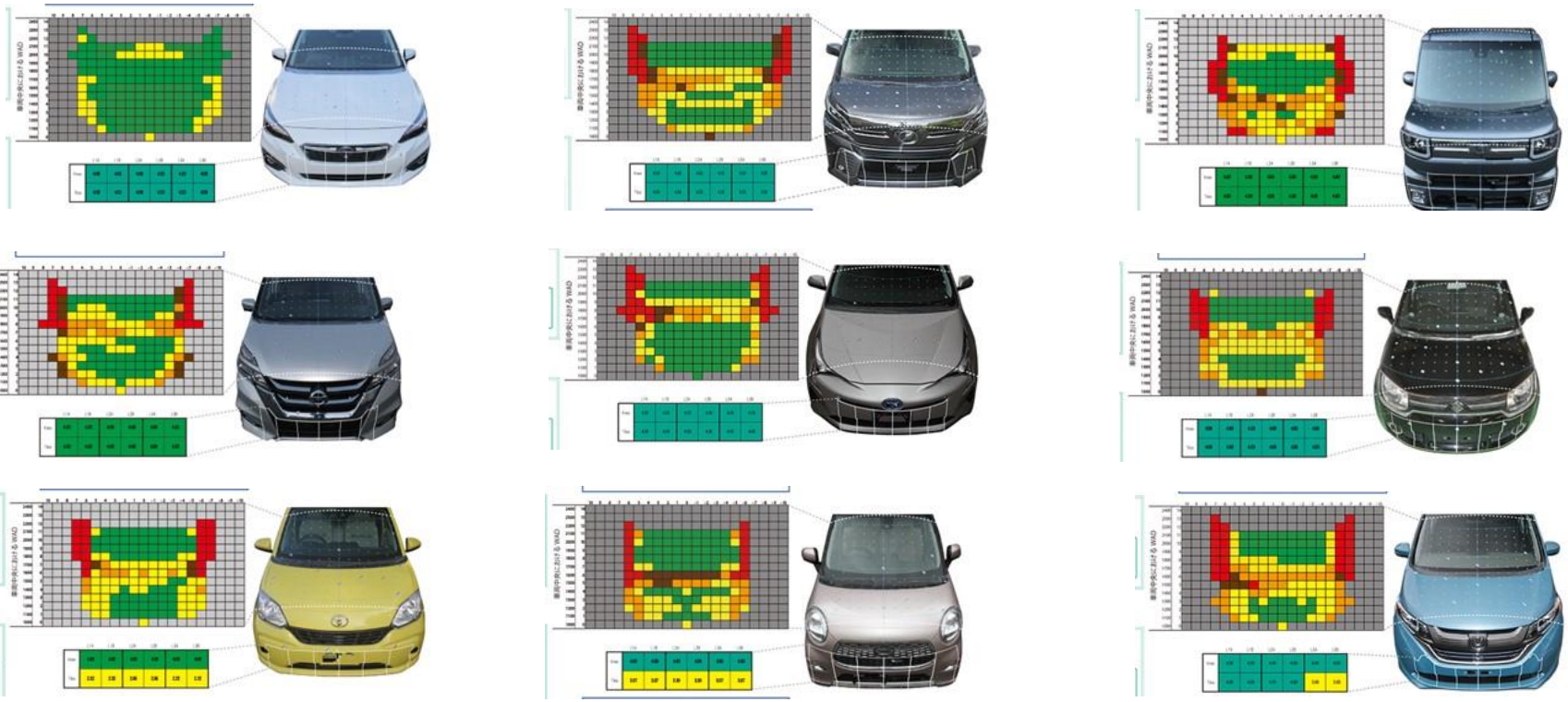


The rearward boundaries of the head impact test area were smaller than WAD 1700, which is the test area using a child head impactor.

→ In almost all adult pedestrian accidents, the pedestrian's head strikes the front window shield glass or A pillar.

J-NCAP Pedestrian Head Safety Test Results(2016)

Vehicle equipped with pedestrian airbag



From J-NCAP homepage (http://www.nasva.go.jp/mamoru/)

The procedure is the same as E-NCAP

The results of the areas around the A-pillar and cowl were worse than those of the other areas.

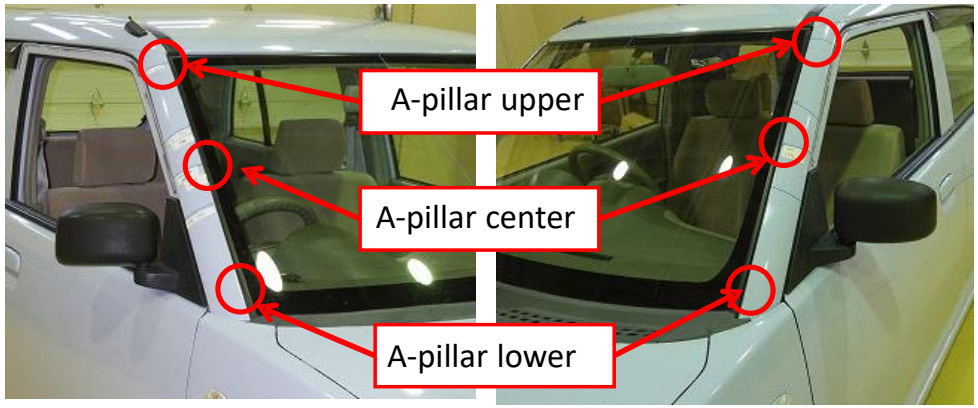
Pedestrian Head Protection Tests

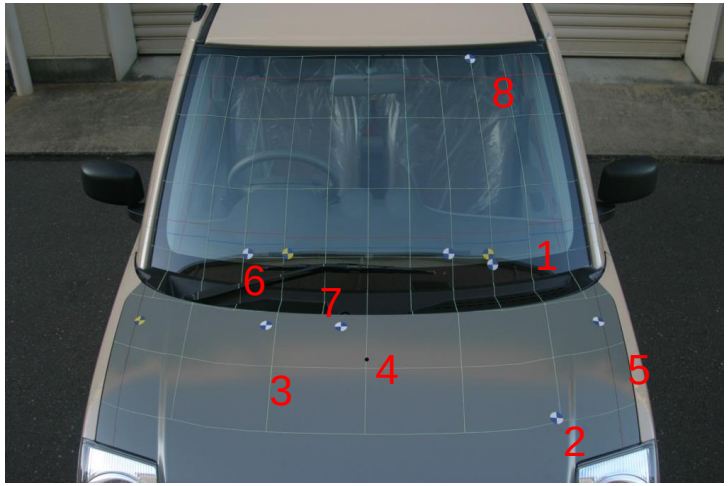
Already Reported in GRSP59-21

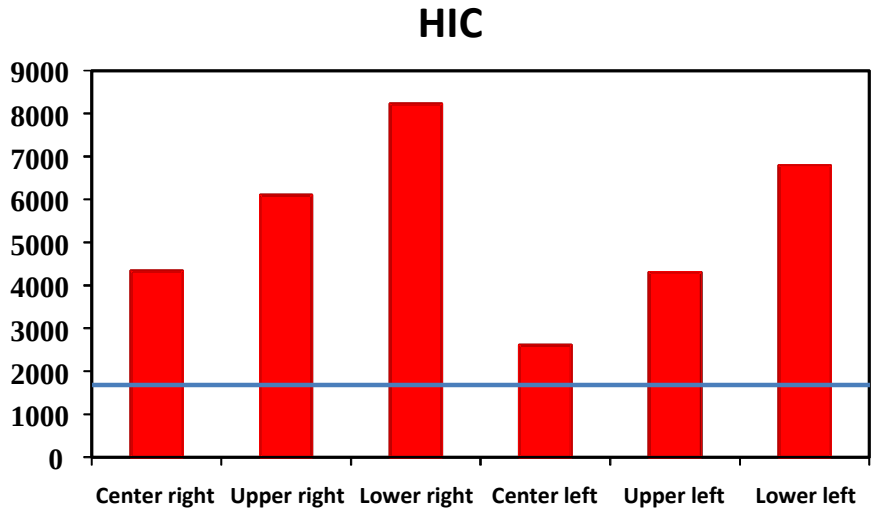
- We conducted pedestrian head protection tests in which the impactor struck the center of the A-pillar (worst-case condition).
- We conducted the tests according to the R127 specifications except for the test area.
- The tested vehicle was compliant with the pedestrian safety standard.
- Several tests were conducted with the same vehicle (the results of the second , third, and all subsequent trials might have been affected by the preceding tests).

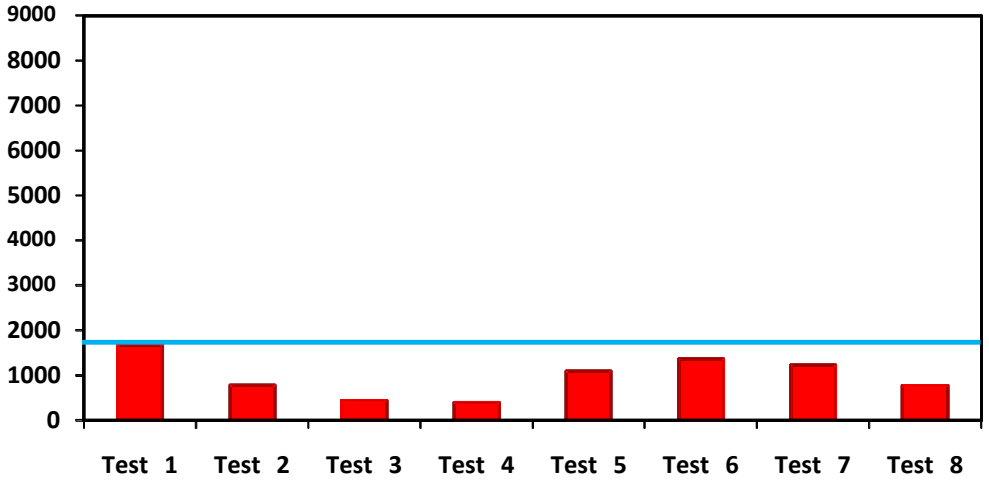
Test Results

Already Reported in GRSP59-21









- HIC was above the threshold in all A-pillar tests
- In the J-NCAP test results of the same vehicle, HIC was below the threshold in all test areas.

Pedestrian Head Protection Tests

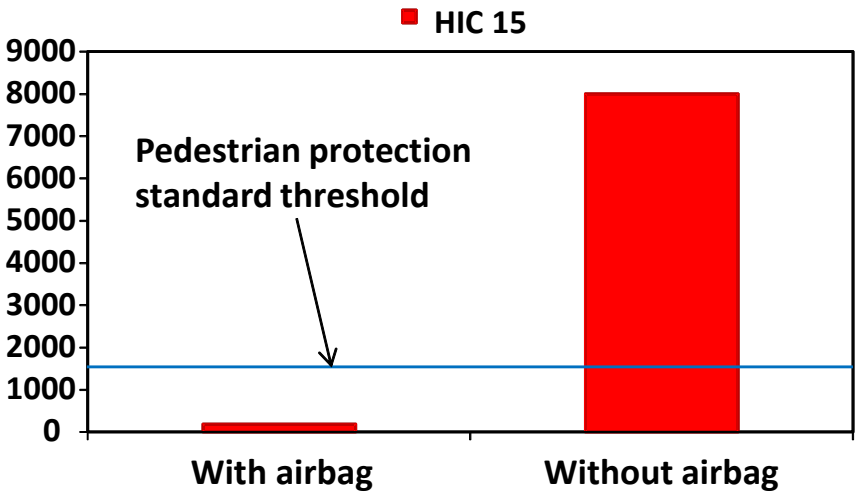
Already Reported in GRSP59-21

- We conducted pedestrian head protection tests in which the impactor struck the center of the A-pillar (worst-case condition).
- We conducted the tests according to the R127 specifications except for the test area.
- The vehicle was equipped with a pedestrian airbag.
- Tests were conducted with/without the airbag.
- The pedestrian airbag was forcibly deployed at the timing when its performance was sufficient.

Effects of Pedestrian Airbag

Already Reported in GRSP59-21

With pedestrian airbag **Without pedestrian airbag**

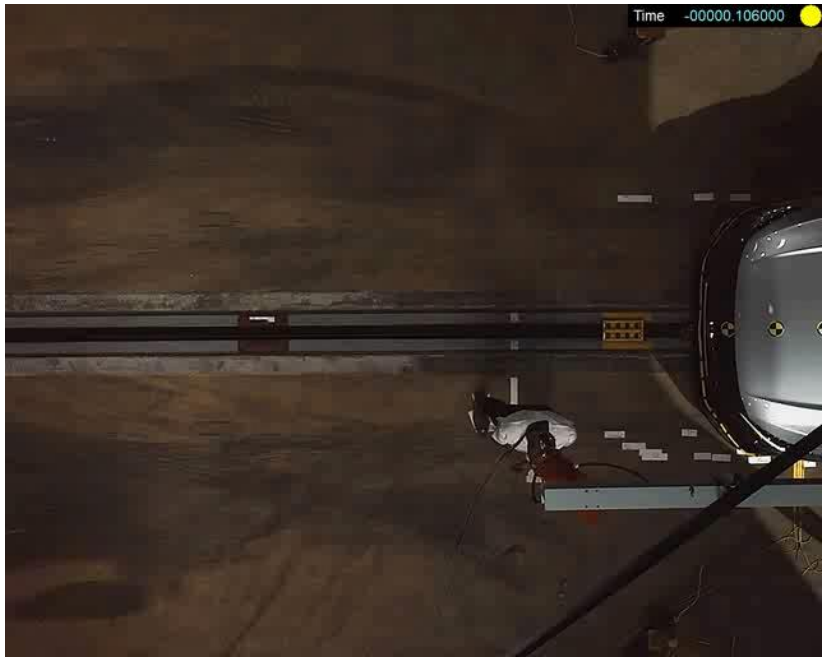


- With the pedestrian airbag, HIC was far below the threshold.
- Without the airbag, HIC was far above the threshold.

  ->The pedestrian airbag is effective for protecting the pedestrian's head in a collision, potentially reducing the number of fatal pedestrian accidents.

Performance of the Pedestrian Airbag

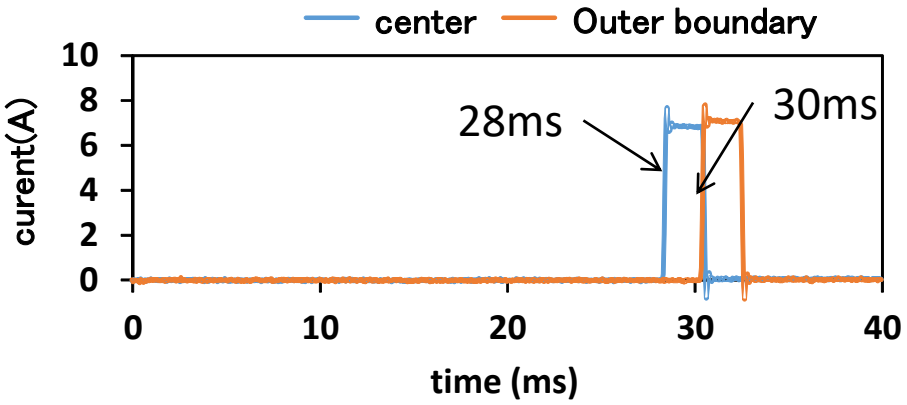
- We plan to confirm that the pedestrian airbag is deployed under the condition that the pedestrian head strikes the A-pillar. In this condition, the pedestrian impact is out of the bumper test area of UN R127.
- We conducted the pedestrian dummy impact test with the vehicle equipped with the pedestrian airbag under the condition that the dummy head struck the A-pillar.
- The pedestrian airbag was deployed under the condition that the pedestrian struck the corner of the vehicle, which was at the outer part of the test area.



Verification Tests of Pedestrian Airbags

- We plan to confirm that the verification performance test using the Leg Impactor can be done at the outer part of the bumper test area of UN R127.
- We conducted the pedestrian leg protection test with the vehicle equipped the pedestrian airbag at the center of the vehicle and at the outer boundary of the sensing area, which was outside of the bumper test area.
- The timing of the firing signal of the pedestrian airbag was almost the same.
- The verification performance at the outer boundary is almost the same as that at the center, and the verification performance test could be done at the outer area of the bumper test area.

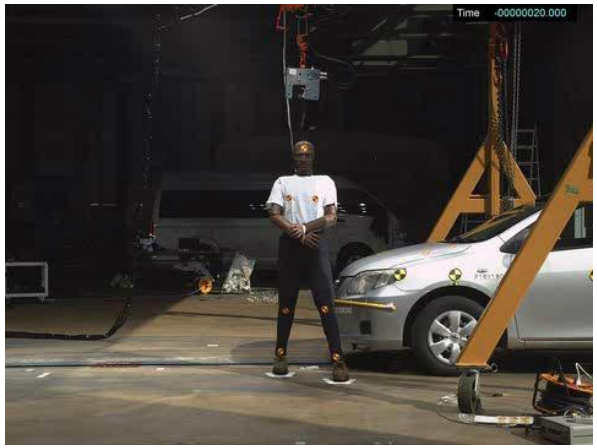
Firing signal of the pedestrian airbag



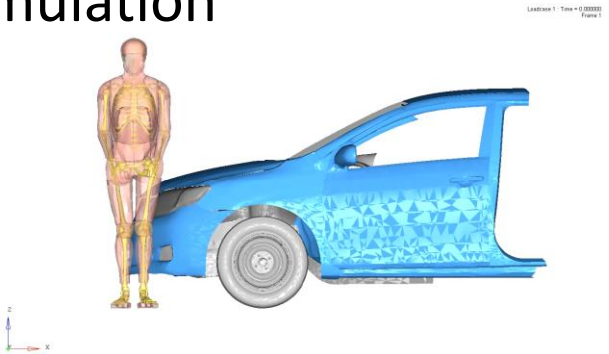
Comparison of Pedestrian Dummy and HBM

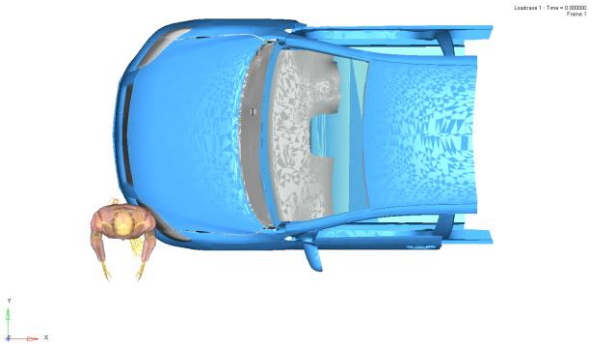
- We compared the behavior of the pedestrian dummy in the impact test and HBM behavior in the numerical simulation to confirm the performance of the pedestrian dummy.
- The Hybrid II AM50 pedestrian dummy was used.
- For HBM, the THUMS AM50 pedestrian model was used.

Test

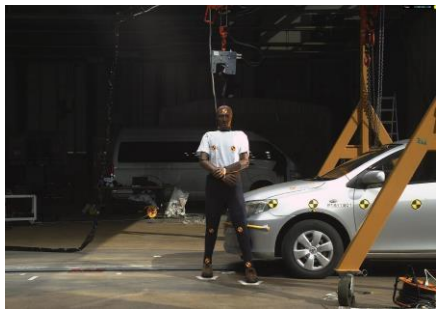
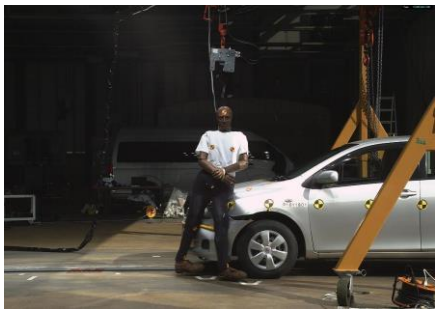
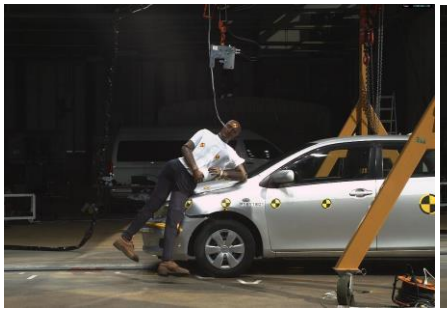
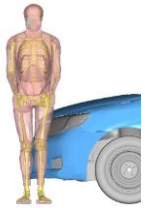
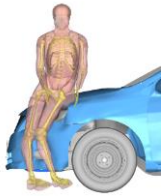
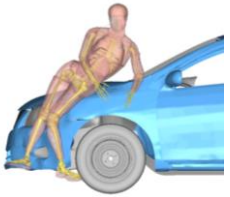
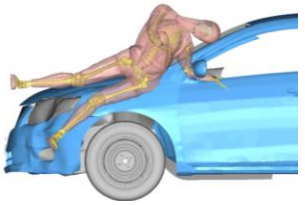


Simulation



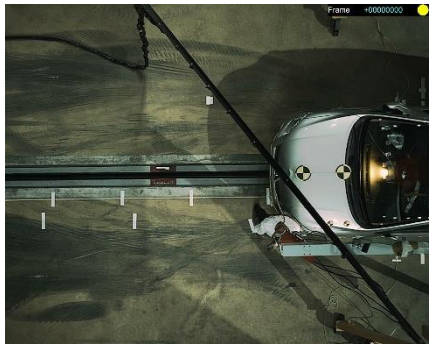
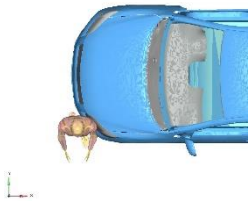
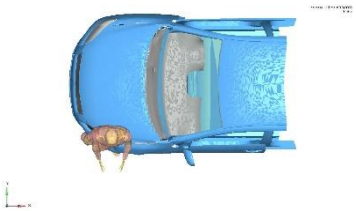
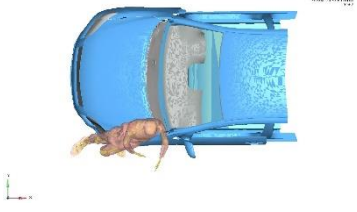
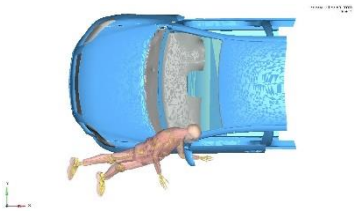


Comparison of Pedestrian Dummy and HBM

	0 ms	40 ms	80 ms	131ms
Test				
Simulation				

- Impact times were almost the same.
- Impact points were different.

Comparison of Pedestrian Dummy and HBM

	0 ms	40 ms	80 ms	131ms
Test				
Simulation				

- The pelvis moved further outside in the simulation case than in the test case.

Pedestrian Head Protection Tests at Various Speeds

- We conducted the pedestrian head protection tests in which the impactor struck the A-pillar (worst-case condition).
- We conducted the tests according to the R127 specifications except for the test area and test speeds.
- Test speeds were 3 cases, 35 km/h, 25 km/h and 15 km/h.
- The tested vehicles were 3 models, Sedan, Mini-van and Kei-car.

Sedan

Mini-van

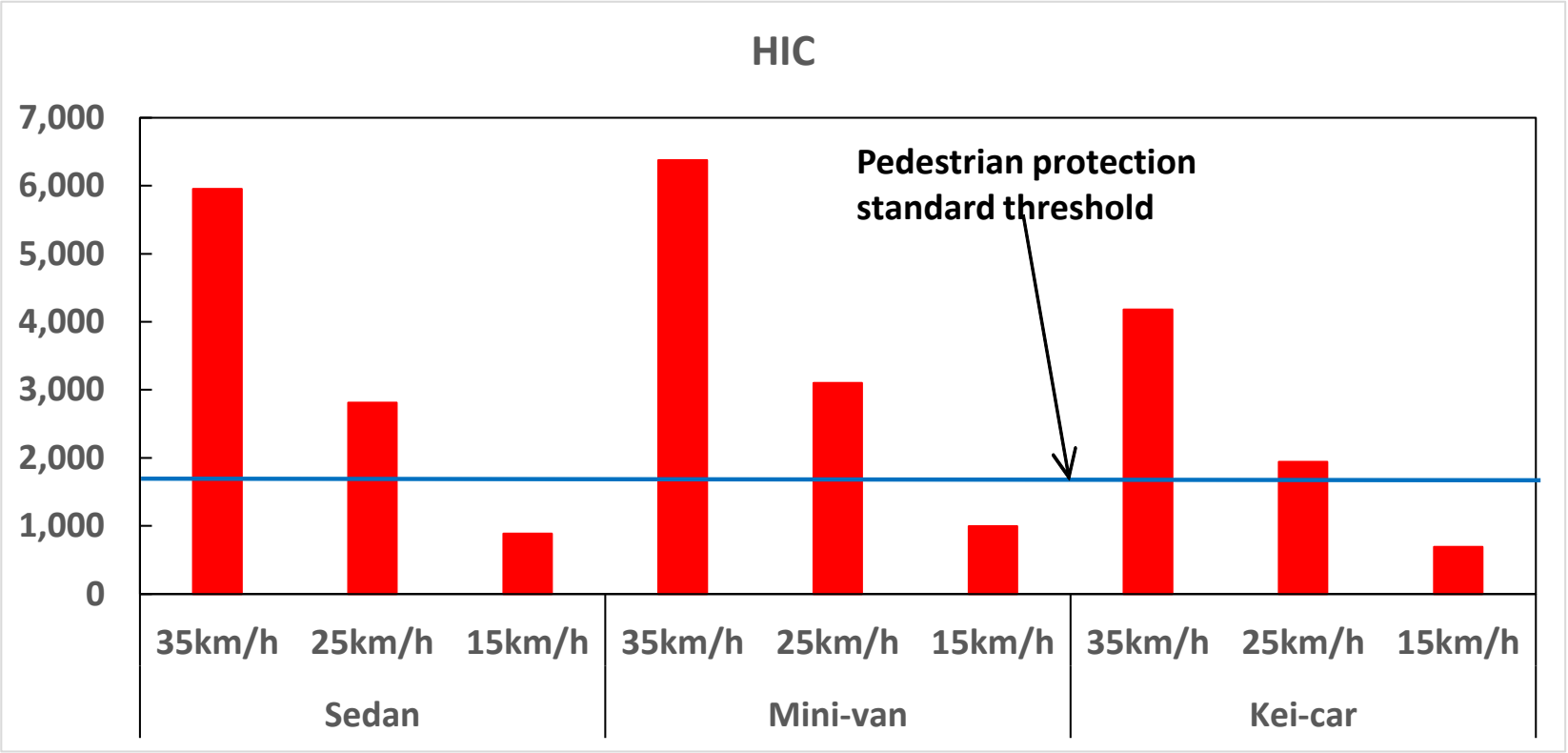
Kei-car

35 km/h

25 km/h

15 km/h

Test Results



- HICs were above the threshold at test speeds of 35 km/h and 25 km/h.
- HICs were below the threshold at the test speed of 15 km/h.
- HIC at 25 km/h was about half of that at 35 km/h. HIC at 15 km/h was about one third of that at 15 km/h.

Conclusion

Accident data

- **In Japan, the regulation for pedestrian protection has been effective, however, pedestrians still account for the largest proportion of recent fatal traffic accidents.**
- **According to the micro accident study from 1993 to 2012 in Japan, in traffic accidents between an adult pedestrian and a vehicle with bonnet resulting in an AIS2+ head injury, in 66% of cases the pedestrian's head struck the A-pillar or lower front wind shield glass frame periphery, both of which are outside of the test area in UN R127.**

The head impact test area in Japan

- **In most cases, WAD of the rear boundary of the head impact test area is less than 1700 and the child head impactor is used. Therefore, in most cases adult pedestrian head protection performance is not evaluated enough in the current regulation.**

Conclusion

Protection performance at A-pillar

- **Pedestrian airbags effectively protect the pedestrian in case the head strikes an A-pillar.**
- **The outermost end of the bumper is out of the bumper test area of UN R127; a test to confirm pedestrian airbag operation using the HYB 2 dummy and Flex leg impactor was performed.**
- **As a result, the pedestrian airbag was deployed.**

Test of head impact with A-pillar at various speeds

- **From the test results, assuming a pedestrian impact accident against the A-pillar at low speed, HICs were below 1000 when the impact speed was 15 km/h and were over 1700 at 25 km/h.**