



AEBS Car to Car(CCRm) Average Deceleration and Peak Deceleration

AEBS IG 7th meeting
Nov. 2018, Geneva

Korea Automobile Testing & Research Institute
Automated Driving Research Office



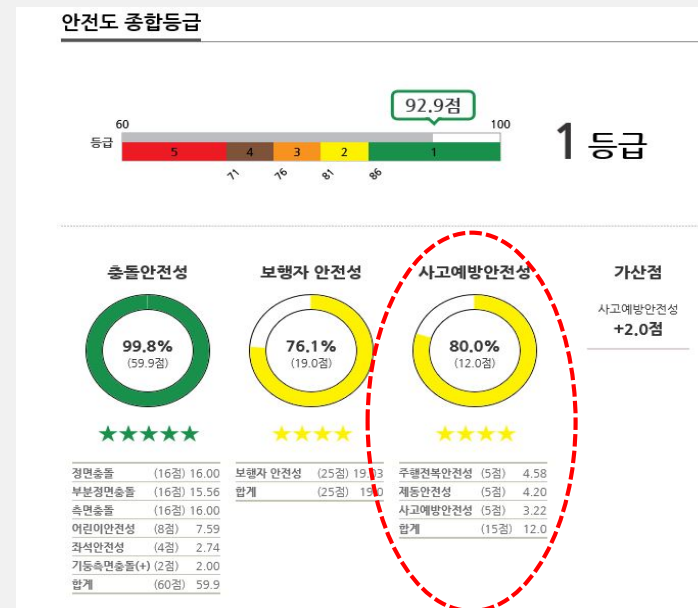
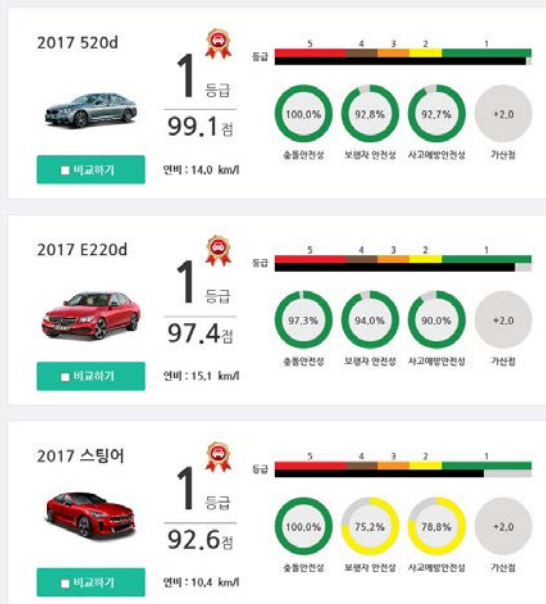
Introduction

- **KNCAP AEBS Test Protocol**
 - Implementation of KNCAP AEB
 - C2C(CCRs - City)
 - C2C(CCRm, CCRb - Interurban)
 - C2P(Adult, Child)
 - KNCAP AEB Plan
 - GST/ C2B
- **C2C(CCRm) Test result**
 - Average Deceleration 3.8m/s² Data
 - Peak Deceleration 6.4m/s² Data
- **Conclusion(Proposal)**
 - Deceleration requirement

KNCAP AEBS Test Protocol

● Implementation of KCNAP AEB

- Since 2017, AEBS testing was carried out as a test item for KCNAP
- Annually more than 9 test car(~2018, Total of 18 tested)
- Every year, KCNAP select this year's safety car based on test results(www.kncap.org)



KNCAP AEBS Test Protocol

● AEBS Test mode

- Car to Car(city)
- Car to Car(Interurban)
- Car to Pedestrian(Adult, Child)



KNCAP AEBS Test Protocol

● KNCAP AEB Plan

- Car to Bicycle(Cyclist, 2020~)
- Automated Vehicle test protocol(AEBS+ESF)
- Car to ??(night and obscure lighting, R&D)



| | BCNU | BCNO | BTLCN | BTRCF | BLD |
|---------------|----------|----------|-------|-------|----------|
| Vehicle Speed | 10~60kph | 20~40kph | 20kph | 10kph | 20~60kph |
| Cyclist Speed | 15kph | 15kph | 15kph | 15kph | 15kph |
| Obstruction | X | O | X | X | X |
| Hit Point | 50% | 50% | 50% | 50% | 20, 50% |

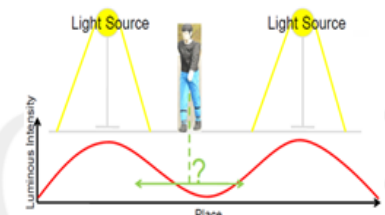
❖ Night and obscure lighting(Euro NCAP)

✓ National Accident Data from Germany(2008-2010)

| Accident Scenarios | Light condition | Fatalities (83%) |
|--------------------|-----------------|------------------|
| [Scenario 1] | Day | 8 |
| | Night | 15 |
| [Scenario 2] | Day | 7 |
| | Night | 23 |
| [Scenario 3] | Day | 3 |
| | Night | 1 |
| [Scenario 4] | Day | 1 |
| | Night | 3 |
| [Scenario 5] | Day | 1 |
| | Night | 2 |
| [Scenario 6] | Day | 5 |
| | Night | 14 |
| TOTAL | Day | 25 |
| | Night | 58 |

야간 충돌사고 시
보행자 상해 심각도
높은 것으로 나타남

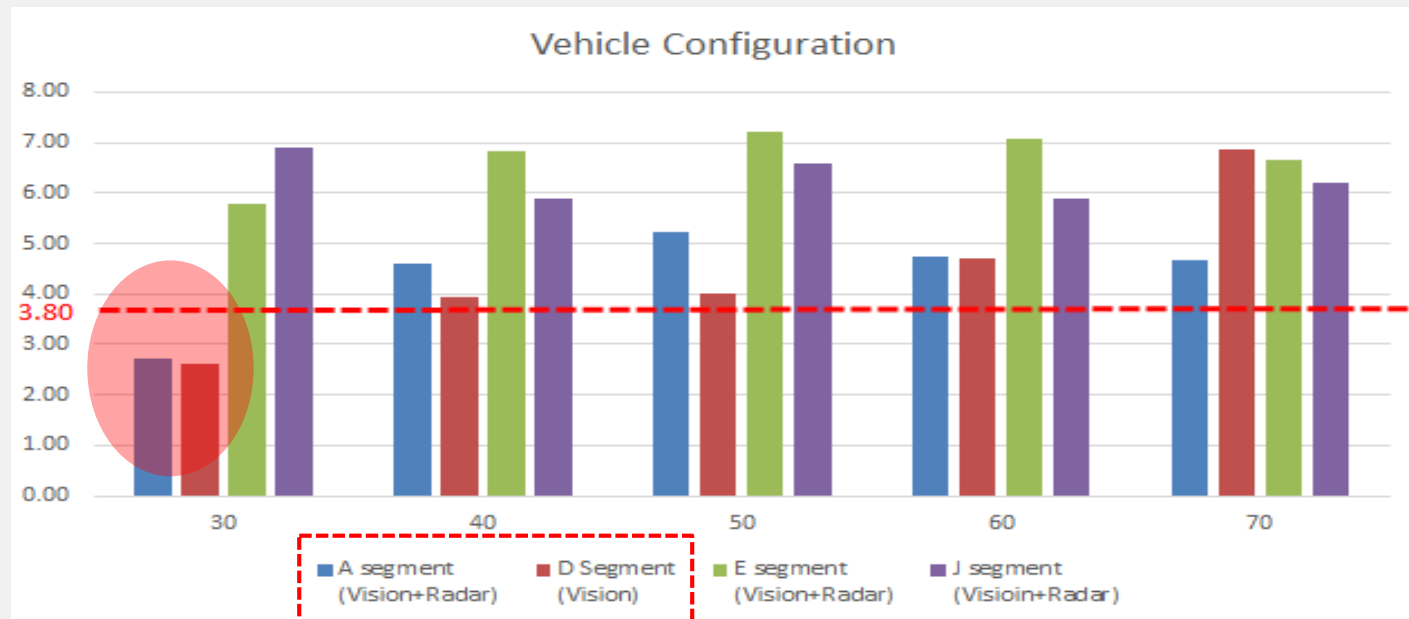
Source: AsPeCSS



C2C(CCRm) Test Result

- Average Deceleration 3.8m/s²

- Regarding the deceleration requirement mentioned in the last 6th meeting
- Vehicles that do not meet the average deceleration value of 3.8m/s² only occurred below D Seg. only at low speed(30km/h)



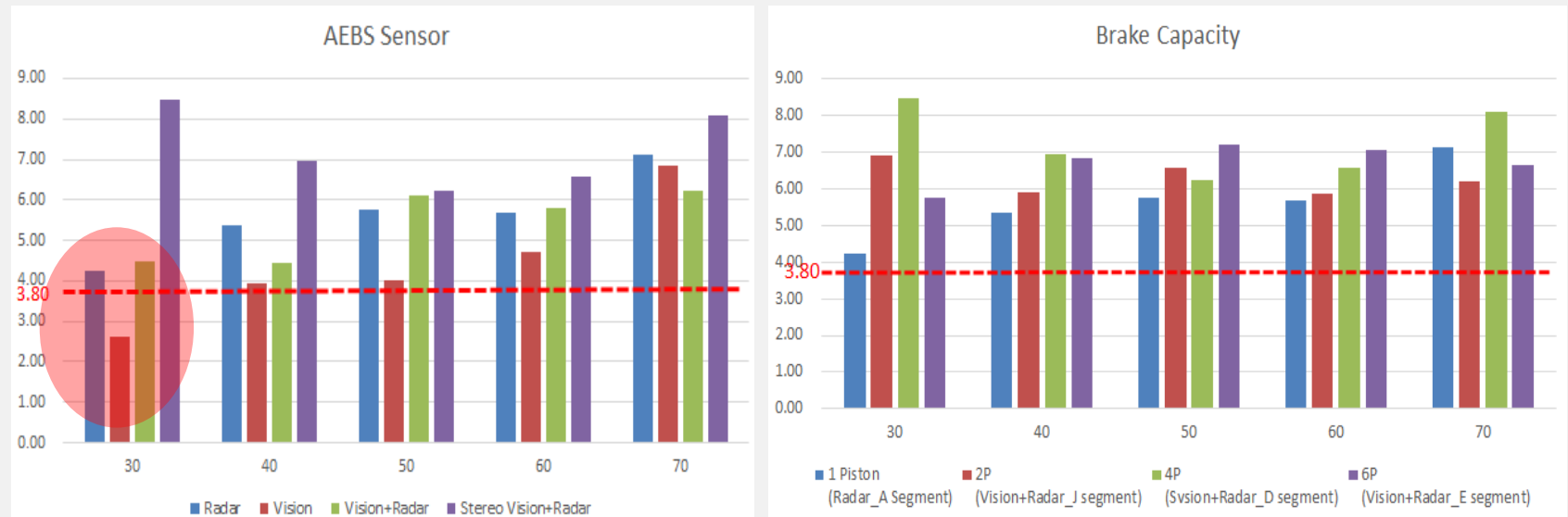
- However, Not all the test vehicles collide

※ The above test results are calculated by averaging test vehicles.

C2C(CCRm) Test Result

● Average Deceleration 3.8m/s²

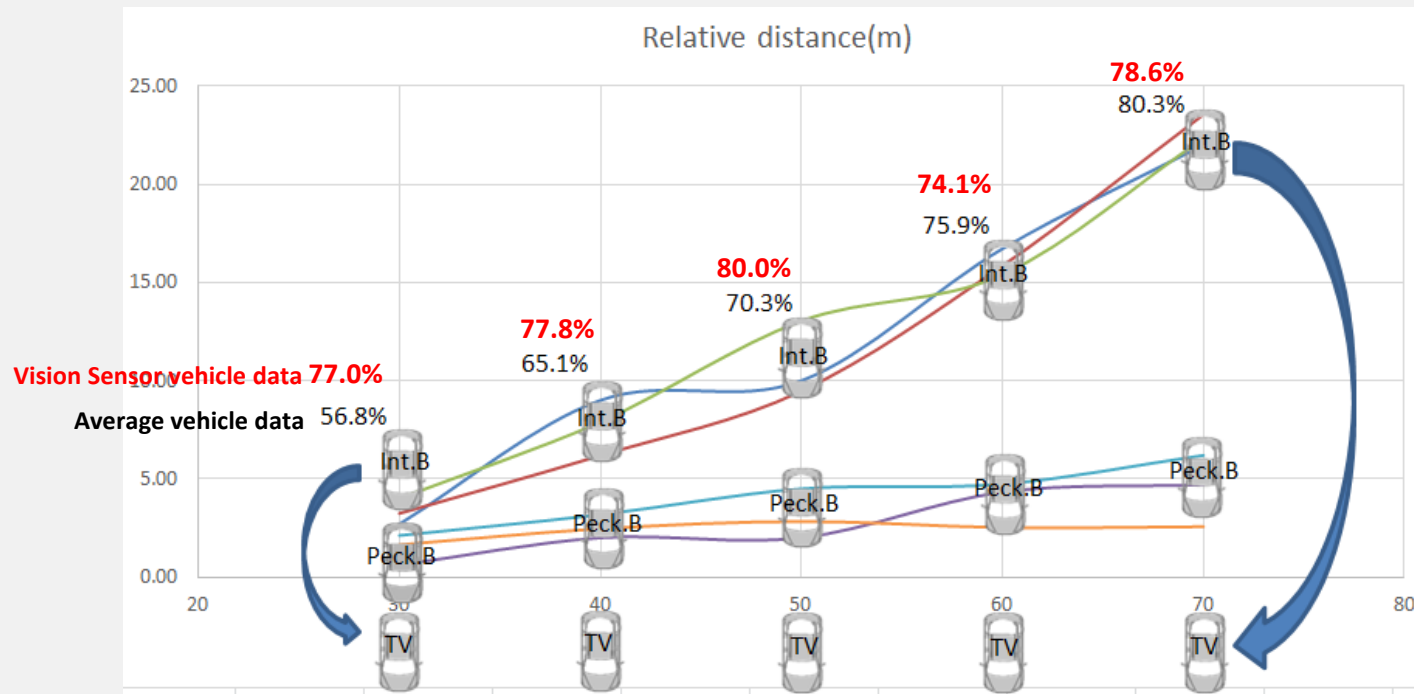
- Vehicle with Vision sensor only had lower average deceleration than vehicles with other sensors
And the average deceleration in the entire speed range
- However, Not all the test vehicles collide
- Although the average deceleration may be low depending on the brake capacity, it is expected to be independent of the AEBS requirements



C2C(CCRm) Test Result

● Reduction rate by test speed

- As the test speed increases, Subject Vehicle shall begin braking in advance and shall not collide with the Target Vehicle. However cars equipped with only vision experienced a deceleration of more than 70% in all speed zones



C2C Test Result

- Peak deceleration 6.43m/s²
 - All test vehicles met the peak deceleration value of 6.43m/s²
 - However, if 6.43m/s² is not satisfied, a collision has occurred

| Vehicle to Vehicle AEBS | | | | Vehicle Name (Peak Deceleration(m/ss)) | | | | | | | | |
|-------------------------|------------------------------|-----------------------------|----------------------------|---|---------------------|-------------|---------------------|---------------------|---------------------|---------------------|-----------------|---------------------|
| Test Mode | Subject vehicle Speed (km/h) | Target Vehicle Speed (km/h) | Target Vehicle Requirement | <A> Vision(M) Radar | Vision(M) Radar | <C> - Radar | <D> Vision(S) Radar | <E> Vision(S) Radar | <F> Vision(M) Radar | <G> Vision(M) Radar | <H> Vision(M) - | <I> Vision(M) Radar |
| CCRs | 10 | 0 | - | 8.60 | 10.50 | 8.00 | 10.00 | 6.80 | 9.00 | 10.00 | 6.00 | 8.50 |
| CCRs | 20 | 0 | - | 8.50 | 11.50 | 8.50 | 8.50 | 6.80 | 10.00 | 9.50 | 9.40 | 7.00 |
| CCRs | 30 | 0 | - | 8.20 | 11.00 | 9.40 | 9.40 | 7.80 | 10.00 | 10.00 | 9.00 | 7.50 |
| CCRs | 40 | 0 | - | 8.00 | 11.00 | 10.50 | 11.50 | 9.50 | 10.00 | 9.50 | 8.00 | 8.00 |
| CCRs | 50 | 0 | - | 8.40 | 11.00 | 10.50 | 11.00 | 8.00 | 10.00 | 9.50 | 8.00 | 8.00 |
| CCRs Average Peak decel | | | | 8.34 | 11.00 | 9.38 | 10.08 | 7.78 | 9.80 | 9.70 | 8.08 | 7.80 |
| CCRm | 30 | 20 | - | 4.50 | 12.00 | 9.50 | 12.00 | 7.50 | 11.00 | 8.00 | 9.50 | 6.50 |
| CCRm | 40 | 20 | - | 7.40 | 11.50 | 9.10 | 12.00 | 7.80 | 11.00 | 9.00 | 10.00 | 8.00 |
| CCRm | 50 | 20 | - | 7.30 | 10.50 | 10.40 | 11.00 | 7.60 | 11.00 | 9.00 | 10.50 | 7.00 |
| CCRm | 60 | 20 | - | 6.80 | 10.40 | 11.00 | 11.50 | 9.00 | 10.50 | 9.00 | 10.00 | 7.50 |
| CCRm | 70 | 20 | - | 7.00 | 10.50 | 10.90 | 12.00 | 8.20 | 11.00 | 9.50 | - | 8.00 |
| CCRm Average Peak decel | | | | 6.60 | 10.98 | 10.18 | 11.70 | 8.02 | 10.90 | 8.90 | 10.00 | 7.40 |
| CCRb | 50 | 50 | 12m(0.2g) | 6.50 | 10.50 | 11.20 | 11.00 | 8.00 | 9.00 | 9.50 | 10.00 | 8.50 |
| CCRb | 50 | 50 | 12m(0.6g) | 8.00 | 11.00 | 11.50 | 10.50 | 11.00 | 9.50 | 9.00 | 10.00 | 9.00 |
| CCRb | 50 | 50 | 40m(0.2g) | 7.00 | 11.00 | 9.30 | 11.00 | 9.50 | 9.00 | 10.50 | 10.00 | 9.00 |
| CCRb | 50 | 50 | 40m(0.6g) | 7.80 | 11.50 | 10.50 | 11.00 | 10.50 | 9.00 | 9.00 | 10.00 | 9.00 |
| CCRb Average Peak decel | | | | 7.33 | 11.00 | 10.63 | 10.88 | 9.75 | 9.13 | 9.50 | 10.00 | 8.88 |

Conclusion

- Average deceleration 3.80m/s²
 - When NCAP test results are analyzed, the average deceleration occurred above 3.8m/s² overall, but some vehicles were not satisfied at low speeds
 - The requirement value of the average deceleration shall be specified
(Because Test results that average deceleration value was low had collision with target car)
 - Average deceleration 3.8m/s²(AEBS IWG) or 3.7m/s²(ACSF IWG – EM requirement)
- Peak deceleration 6.43m/s²
 - Peak deceleration can be satisfied if the service brake requirement of UN R13-H is met
 - If the peak deceleration value is less than 6.43m/s², it is dangerous to collide

