ted by the expert from Republic of Korea

Informal document GRS
(61st GRSP, 8-12 Ma
agenda items 14 ar

Introduction plan for implementing safety requirements of micro mobility

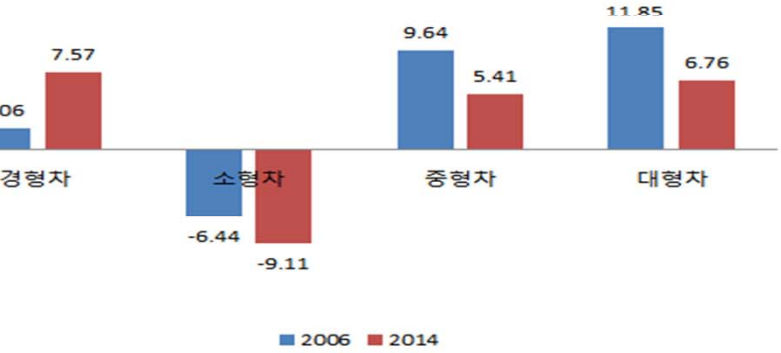
8 – 12 May 2017

Background

Demand for micro mobility increased
due to changes in the social environment

Small vehicle / Large vehicle

ght and small vehicles accounted for 7.57%,
nd large vehicles accounted for 6.76% in 2014.
eepening polarization of preferred cars for small and large
hicles.



Eco-friendly vehicle

- Strengthen CO2 emission requirements.
- Continuing government policies such as tax reduction on eco-friendly vehicles.

		Weight (kg)	CO_2 emission (g/km)			Distance to 2015	
			2010	2015 target (weight)	2015 target (footprint)	Weight-based	Footprint-based
1	Toyota	1,329	129.6	128.3	128.6	1%	1%
2	PSA	1,318	131.2	127.8	127.2	3%	3%
3	Fiat	1,140	125.9	119.7	119.4	5%	5%
4	BMW	1,548	147.5	138.3	135.8	6%	8%
5	Hyundai	1,344	138.2	129.0	129.9	7%	6%
6	Renault	1,295	135.9	126.8	130.0	7%	4%
7	GM	1,359	139.3	129.7	130.0	7%	7%
8	Ford	1,293	136.6	126.7	131.9	7%	3%
9	Volkswagen	1,416	144.0	132.3	131.5	7%	8%
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	Honda**	1,448	146.9	133.8	129.9	9%	12%
12	Suzuki	1,15[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12%
13	Nissan	1,346	[illegible]	[illegible]	[illegible]	[illegible]	12%
14	Mazda	1,319	149.5	127.9	132.0	14%	12%
15	Daimler	1,533	161.3	137.7	135.9	15%	16%
	Average***	1,365	140.3	130.0		7.3%	7.3%

Goals of CO_2 emission reductio
each manufacturer

ble as City Car

ty car emerged as a means of short-distance transportation and
mplementary means of public transportation
ar sharing service was increased due to metropolitanization.

Advanced vehicle

- GM plans to develop a micro mobility with autonomous driving function
- Efforts of Europe, Japan, etc. to strengthen safety of micro mobility.

Research and safety requirement trend in other countries

Europe

icro mobility which is “car-like” was classified
7 category.

ehicle regulations of L7 were strengthened to
Regulation (EU) No. 168/2013” from
Directive 2002/24/EC” in 2013.

EU Regulation 168/2013, safety
quirements on L7 category were added and
rengthened.

or example, “vehicle occupant protection”
quirement was newly established and
earward visibility” requirement was improved.

Dec. 2016, the WP29 addressed the need
improve the safety regulations of the L7
tegory.

- Definition of L7 category

Category	Definition	
L7 Heavy Quadricycle	4 wheels Mass ≤ 450kg(transport of passengers), 600kg(transport of goods) Seating positions ≤ 2 Vmax ≤ 90km/h Pmax ≤ 15kW	

- Regulations of L7 category

Directive 2002/24/EC	EU Regulation 168/2013
• 47 items for type approval. • In this directive, 25 items were mandatory. • L6(Light quadricycle) category is the same as L2 category requirements. • L7(Quadricycle) category is the same as L5 requirements.	• This regulation was amended in Ja 2013, effective from Jan, 2017. • 36 items are mandatory. • Safety requirements were added a strengthened.

Research and safety requirement trend in other countries

Japan

Micro mobility was called as "Ultra small mobility".

In several local governments, pilot projects are under progress.

Through the pilot projects, the usability and safety of ultra small mobility will be evaluated .

Kei car

- Max. Power ≥ 15kW
- Provisions to gradually meet the regulations of category M1.
- Apply the 40km/h frontal impact requirement from 1994.
- Apply the 50km/h frontal impact and side impact requirements from 1998.
- Kei-car accounted for 32% of the entire auto market in 2012, therefore the number of Kei car traffic accidents increased.
- Need to strengthen the Kei-car safety requirements.

Toyota iQ

Ultra Small Mobility

- Included the Kei car sub-category.
- Carrying out the pilot projects to evaluate the usability and safety.
- No safety provisions for Ultra small mobility.
- Ultra small mobility definition

✓ Length, width, height < Kei car

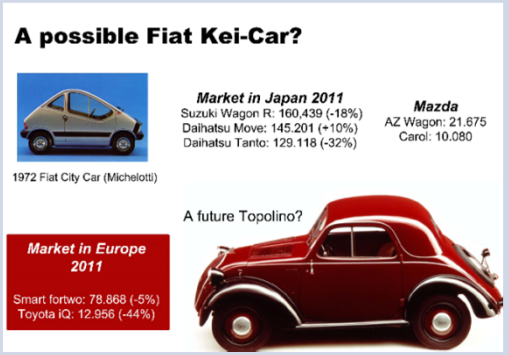
✓ Seating positions ≤ 2

✓ Max. Power ≤ 8kW

✓ Max. Velocity ≤ 90km/h

✓ No roads dedicated exclusively for Ultra small mobility

✓ Compulsory system: Pedestrian alert system, belt, Rear view mirror, Steering wheel



Research outline

Selecting test vehicle
Selection of test vehicle that are available in Korea

Researching regulations
Review of overseas regulations that are applicable in Korea

Testing as following regulations
Tested according to the reviewed regulations

Implementing regulations
Establish micro mobility regulations in Korea

- **Passive safety test**

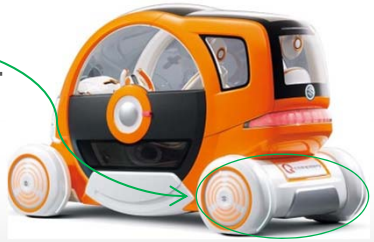
Seat, Safety-belt,
Occupant protection,
Frontal impact, etc.

- **Active safety test**

Braking, Lamps,
Steerability , etc.

- **Performance test**

Battery, EMC,
Fuel consumption, etc.



- **General safety test**

Protective structure
Load platform, etc.

- **Safety regulations**

Safety regulations by sectors of general safety, passive safety, active safety and performance.

Selection of test vehicle

vestigation of development
d sales status

- Development plan of domestic and foreign manufacturers
  - ✓ 5 OEMs : No plan except for Renault-Samsung(Twizy).
  - ✓ 6 medium-sized companies : 2 manufacturers undergoing development, 4 manufactures considering development plan.
  - ✓ Foreign manufacturers(from KAIDA) : No sales plan in Korea.
  - ✓ Foreign manufacturers' development and sales plan (from Literature search) : 15 vehicles.
- Selection of test vehicle
  - ✓ Renault "Twizy".
  - ✓ Only Twizy is available in Korea.
  - ✓ Domestic brand vehicle will not be available within our research period.

Regulations

Review of EU regulations that are applicable in Korea

Directive 2002/24/EC

47 items for type approval.
In this Directive, 25 items were mandatory.
L6(Light quadricycle) category is the same as L2 category requirements.
L7(Quadricycle) category is the same as L5 requirements.

EU Reg. 168/2013

This regulation was amended in Jan, 2013, effective from Jan, 2017.
36 items are mandatory.
Safety requirements were added and strengthened.

plication of EU Regulation 168/2013

Test item for establishing micro mobility safety regulation in Korea based on EU Reg. 168/2013

Applying M1 category regu

Sector	Number of item	Added item for strengthe safety
General Safety	◆ 6 items Mass and dimension, Protective structure, Fuel storage, Load platform, Devices to prevent unauthorized use, Coupling device	-
Active Safety	◆ 2 items Braking, Steerability	Speedometer
Passive Safety	◆ 4 items Rollover, Safety belt, Occupant Protection, Seats	Frontal Impact, Pedestrian, Steering wheel impact, Door lock, Electrical safety
Performance	◆ 9 items Audible warning device, Glazing, Lamp, Rearward visibility, Tire, EMC, Fuel consumption, Engine power, Wipers	REESS safety, QRTV
Total	21 items	8 items

Tests

Tested according to the reviewed EU regulation 168/2013

Sector	Test items	Test results and remarks
General Safety	◆ 6 items Mass and dimension, Protective structure, Fuel storage, Load platform, Devices to prevent unauthorized use, Coupling device	• Mass and dimension - In case of the dimension, considering the application of light pass vehicle regulation in KMVSS. - For mass, gross vehicle weight 550kg including battery. • Other items: Be able to apply of passenger vehicle(M1) regulations
Active Safety	◆ 3 items Braking, Steerability, Speedometer	• Braking - Applying a form derived from two-wheeled motor vehicle braking system. - Need to apply of secondary braking system like a M1 category b system. - Need to develop exclusively Micro mobility ABS. • Steerability: Equivalent to M1 category regulations. • Speedometer: Be able to apply passenger vehicle regulations.
Passive Safety	◆ 9 items Rollover, Safety belt, Occupant Protection, Seats, Frontal impact, Pedestrian, Steering wheel impact, Door lock, Electrical safety	• Rollover: Apply roof crush requirement of KMVSS. • Safety belt: Need to strengthen the applying forces. • Occupant protection - Similar to the requirement for checking radius of curvature. - For other vehicles, no requirement of curvature radius in KMVSS • Steering wheel impact: Considering this requirement in case of no applying frontal impact regulations. • Pedestrian - Expecting the high frequency of exposure to pedestrian. • Door lock, Frontal impact and Electrical safety are not assessed

Tests

Tested according to the reviewed EU regulation 168/2013

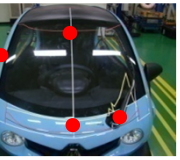
Sector	Test items	Test results and remarks
Performance	◆ 9 items Audible warning device, Glazing, Lamp, Rearward visibility, Tire, EMC, Fuel consumption, Engine power, Wipers, REESS safety, QRTV	• Lamp - Mandatory: Head lamps, Direction indicators, Position lamps, St lamps, Reversing lamps, Rear registrations plate lamps. • Fuel consumption - Need a additional research for the test cycle. - FTP Mode(Passenger vehicle) or WMTC mode(Two-wheeled m cycle) • Wiper - Need the mandatory installation requirements of wiper system w compulsory side door and window pane installation requirement applied. • REESS safety - the tests carried out according to UN R.136. • QRTV: Be able to apply passenger vehicle(M1) regulations.

Examples of performed test

ssive safety tests

Pedestrian

d form Impact



form Impact

Occupant Protection

Head form impact

Door lock

Rollover

Before test

After test

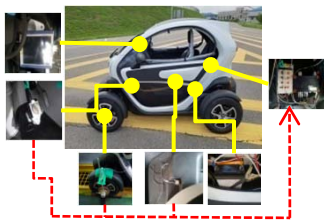
Seat belt

Belt anchorage

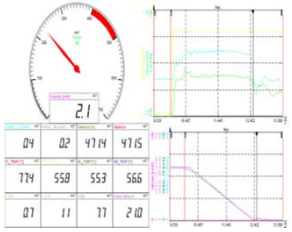
Active safety tests

Braking

Test equipment



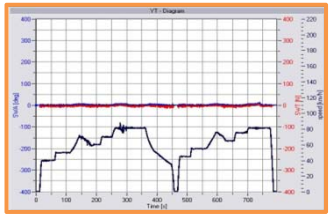
Test result



Steerability

Test equipment

Test result



Speedometer

rformance tests

uel consumption

Lamp

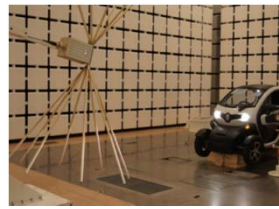
Rearview visibility

Wiper

Audible warning

REESS

EMC



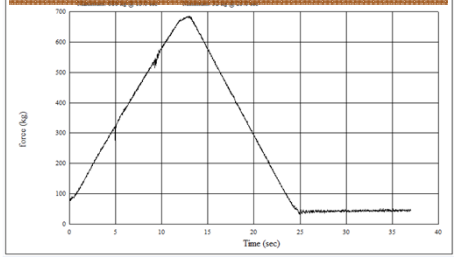
Issues related to crash worthiness

Seat and Safety belt anchorage requirement

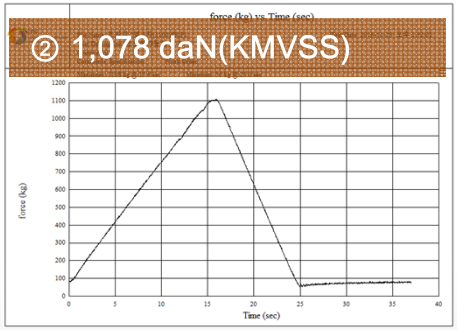
Applied regulations

- Based on EU R.168/2013 and KMVSS 97 and 103.
- The loaded force on the safety belt anchorage is stronger(about twice times) in KMVSS than EU Regulation.
  Tractive force in EU R: 675 daN
  Tractive force in KMVSS: 1,078 daN

① 675 daN(EU R.)



② 1,078 daN(KMVSS)



Performed test

- First test results subject to application of the EU R. are met the requirement.
- In second test according to KMVSS, safety belt anchorages withstood.

① First Row

② Second Row

Test results

- Issue 1.
  Strengthened the loaded force
  In full frontal crash test result, the loaded force value on safe belt was about 800~900 daN.
  We need to strengthen the ap load on the safety belt anchora

  According to test results, there no problem that the test vehicl meets the strengthened requirements from now.

.

Implementing regulations

- Considering the implementati strengthened regulations in K

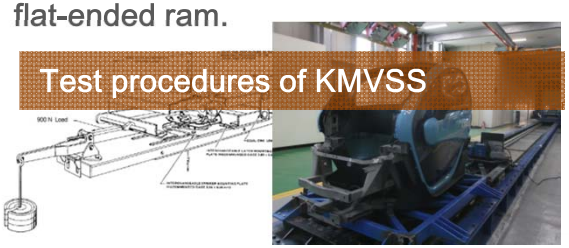
Issues related to crash worthiness

Door Lock system requirement

Applied regulations

- Based on EU R.168/2013 and KMVSS 104(equivalent to GTR 1).
- For evaluating the safety of door lock systems the test procedures of KMVSS is different from those of EU R.

- Static load test in EU R.
  push force of 200 daN, delivered by a flat-ended ram.



- Load test and Inertial test in KMVSS

Performed test

- First test results met the requirements of EU R..
- In second test according to KMVSS, the door lock systems withstood the load and inertial test.

Test results

- Issue 1.
  Strengthened the regulation.
  Door lock systems are very important in vehicle accidents because the door locks will pre passengers from being ejected the car accident.
  According to test results, there no problem that the test vehicl meets the strengthened requirements from now.

Implementing regulations

- Considering the implementati strengthened regulations in K

Issues related to crash worthiness

Pedestrian safety

Applied regulations

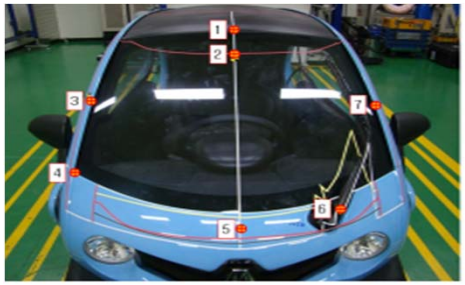
- Based on KMVSS 102-2 (equivalent to GTR No.9) Pedestrian Protection

- Head Test Condition
  - Impactor (Impact angle)
    : Adult Headform(65°),
    : Child Headform(50°)
  - Impact Speed: 35 km/h
  - Injury Criteria: ≦ HIC 1000/1700
  - Location: Worst / Typical area

- Leg Test Condition
  - Impactor: Flex-PLI
  - Impact Speed: 40 km/h
  - Injury Criteria
    1. ACL/PCL: ≦ 13 mm
    2. MCL: ≦ 22 mm
    3. T Bending Moment: ≦ 340 Nm
  - Location: CTR, Corner

Performed test

- Head Test Result



No	Location	HIC	A
1	WAD1900(CTR)	591.60	○
2	WAD1670(CTR)	340.98	○
3	A-plr RH	1712.78	X
4	Hood Corner	1990.99	X
5	WAD 1000(CTR)	1307.07	Δ
6	Wiper	1365.93	Δ
7	A-plr LH	2007.53	X

- Leg Test Result

Location	Injury	Result	A
Corner	Tibia Moment	284.05 Nm	○
	MCL/ACL/PCL	6.95/4.19/3.67	○
CTR	Tibia Moment	378.15 N/m	Δ
	MCL/ACL/PCL	9.02/4.86/2.83	○

Test results

- Issue 1 : Head form Test
  : Not adequate Test Area
  , or Extremely Narrow Test Are
  - Due to the short front
  - Not effective assessment
    (by the current regulation)
- Issue 2 : identification of Bumpe
  /Hood
  : Hard to distinguish bumper/hoo
  - Due to the distinctive design
    (exposed tire, small front cover
  - Not effective test area
    (if exemption zone is considere

Implementing regulations

- Need to consider the new regulations of micro vehicles for pedestrian protection, if necessa

Issues related to crash worthiness

Crash safety

Applied regulations

Based on KMVSS 102, UN R.94 and UN R.95
(KMVSS 102 similar to UN R.137)

KMVSS 102(Full frontal)
- Test speed: 48 km/h
- Rigid barrier impact test
- Dummy: Hybrid III 50%ile
- Injury measurement:
  Head, Neck, Chest, Leg

UN R.94(Offset)
- Test speed: 56 km/h
- 40% Offset
- Honeycomb block impact test
- Dummy: Hybrid III 50%ile
- Injury measurement:
  Head, Neck, Chest, Leg

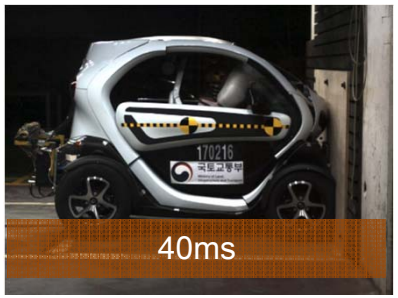
UN R.95(Side)
- Test speed: 50 km/h
- Movable barrier impact test
- Dummy: EuroSID II
- Injury measurement:
  Head, Chest, Pelvis

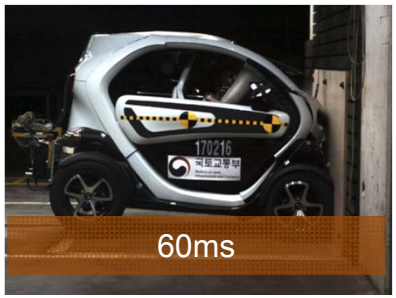
Performed test and results

Sector	Injury	Requirement	Measurement		
			Full frontal	Offset	Side
Head	HIC36	1000	860	893	2452
	Acceleration	80		76.6	-
Neck	Shear force	3.1	0.37	0.67	-
	Tension force	3.3	1.56	1.49	-
	Moment	57	48.2	23.7	-
Chest	Deflection	50 / 42	19.0	19.4	6 / 19.9 / 25.2
	VC	1.0	0.17	0.09	0.23
	Acceleration	60	71.2		-
T12	Compression force	2.0	-	-	3.49
	Moment	200	-	-	175.4
Abdomen	Abdominal peak force	2.5	-	-	2.13
Pelvis	Pubic symphysis force	6	-	-	2.89
Femur	Compression force	9.07	L: 3.12 / R: 4.83	L: 3.25 / R: 3.14	-
Tibia	Compression force	8.0	L: 4.5 / R: 6.4	L: 2.05 / R: 2.66	-

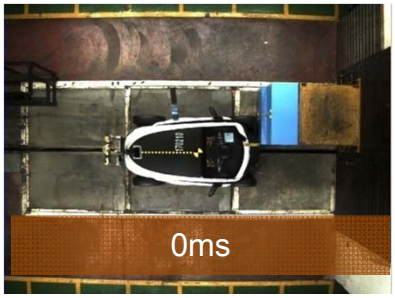
Issues related to crash worthiness

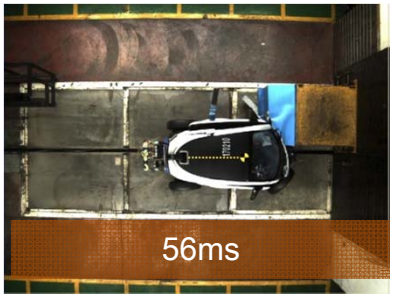
tal impact

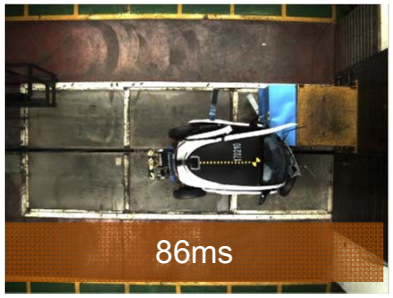


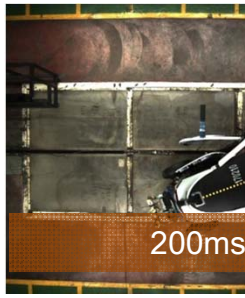


npact









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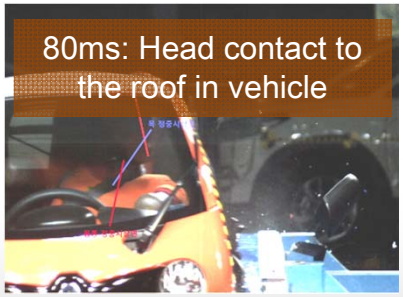
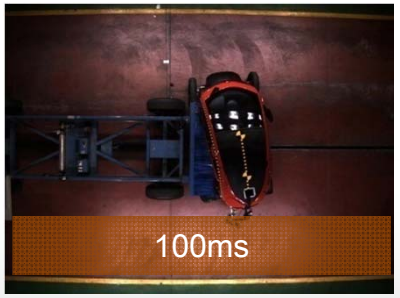




Comparing KATRI crash test results with 2014 EuroNCAP test results

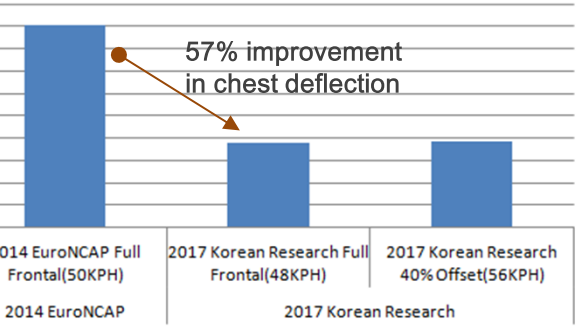
rontal impact test results

Head and neck injuries of 2014 EuroNCAP are similar to 2017 KATRI test.

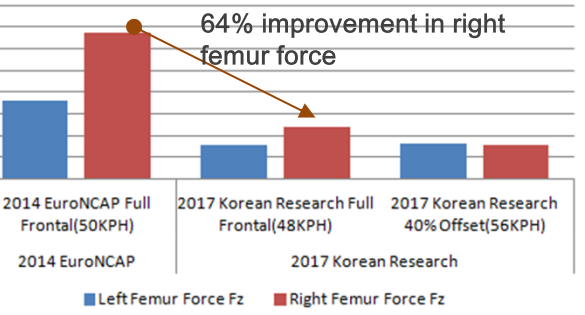
n the case of chest injuries, the result of chest deflection in KATRI test improved significantly compared with those in 2014 EuroNCAP.

Femur force value improved.

Chest Deflection



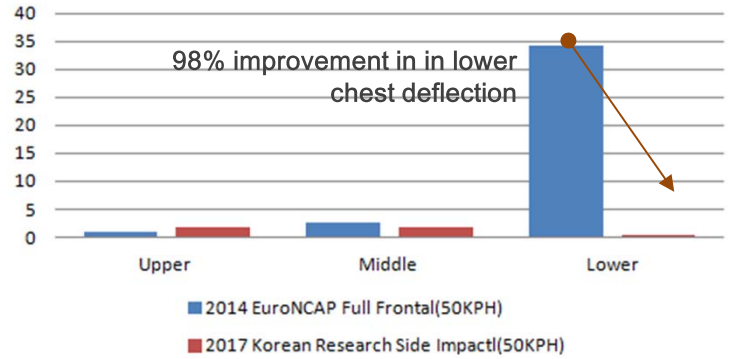
Femur Force



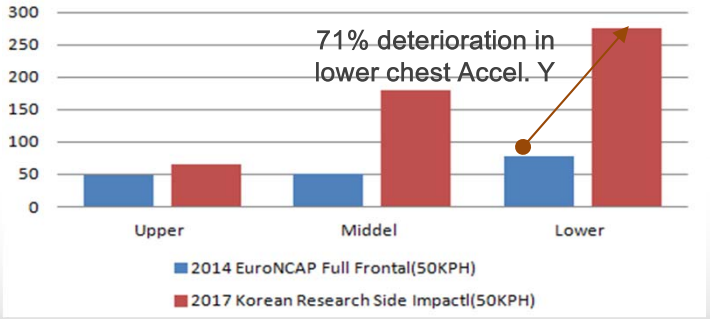
Side impact test results

- In 2017 research, dummy head contacted the roof of vehicle and HIC value exceeded 1000.
- Lower chest deflections improved significantly in 2017 KATRI research.
- But, chest acceleration results was worse.
- T1 and T12 injuries of spine in 2014 EuroNCAP were similar to those in 2017 KATRI research.

Chest Deflection



Chest Accel. Y



Remarks and issues

- The comparison of crash tests showed that some areas of the test vehicle in 2017 KATRI research improved over 2014 EuroNCAP.
- Based on KATRI test results Korea is considering the strengthening of crashworthiness requirements.

Implementing regulations in Korea

Phase-in application of micro mobility regulations

	Application
Phase 1	◆ 43 items amendment in KMVSS • General safety: 20 items including mass and dimension, control and tell-tale signs, fuel storage, etc, • Active safety: 3 items including braking, steerability, speedometer. • Passive safety: 4 items including safety-belt, Door lock, etc. • Performance: 16 items including tire, glasses, fuel consumption, lamps, etc.
Phase 2	◆ 4 items • Frontal impact • Side impact • Pedestrian safety • Braking(ABS)

Thank you for your attention.

MOLIT
Ministry of Land, Infrastructure and Transport

TS Korea Transportation Safety Authority
Korea Automobile Testing & Research Institute