Japanese Perspective for Compatibility Tests

Japan

GRSP Informal Group on Frontal Impact

April 18, 2011

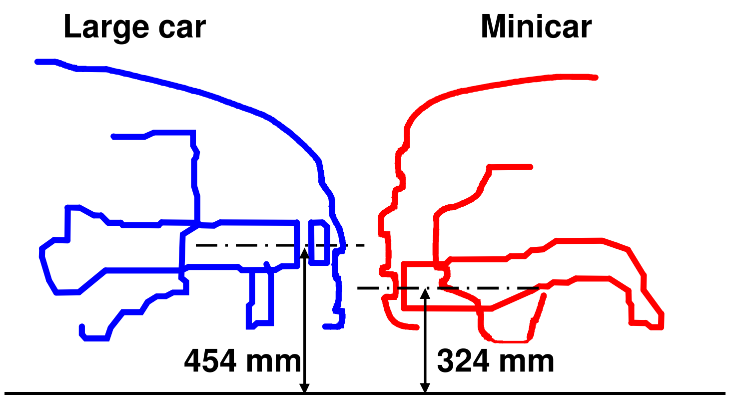
Outline

- Car-to-car crash
  - Front rail height matching
  - Effectiveness of SUV SEAS
- Test method
  - FWRB + Option 2
  - FWDB Tests for SEAS Evaluation
- Harmonization
- Conclusions

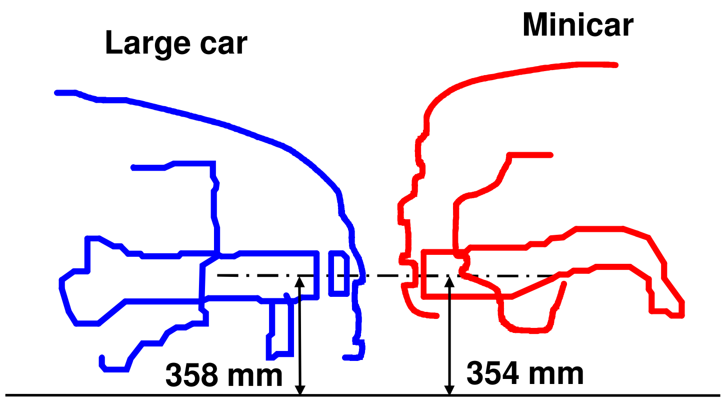
Front Rail Height Matching

Front Rail Height

Test 1: Original height (Front rail passed)



Test 2: Height matching



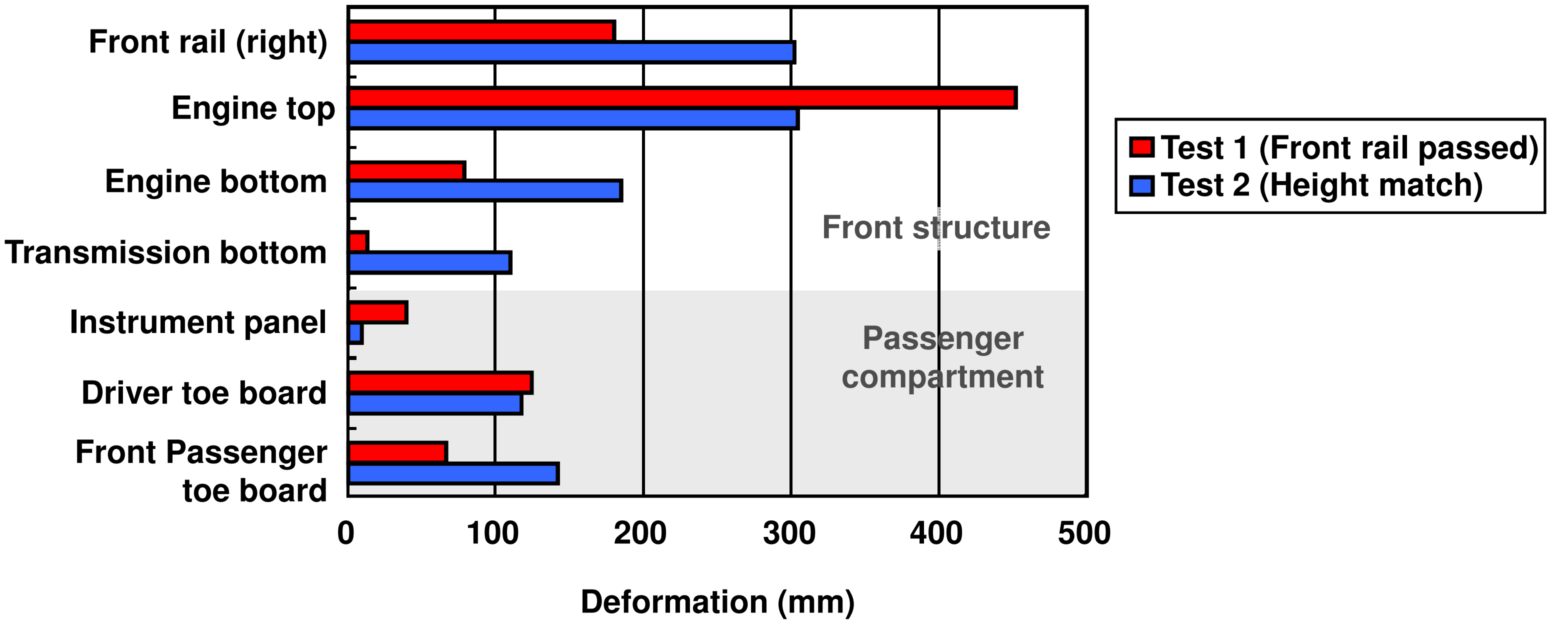
Deformation - Minicar

Test 1:
Original height

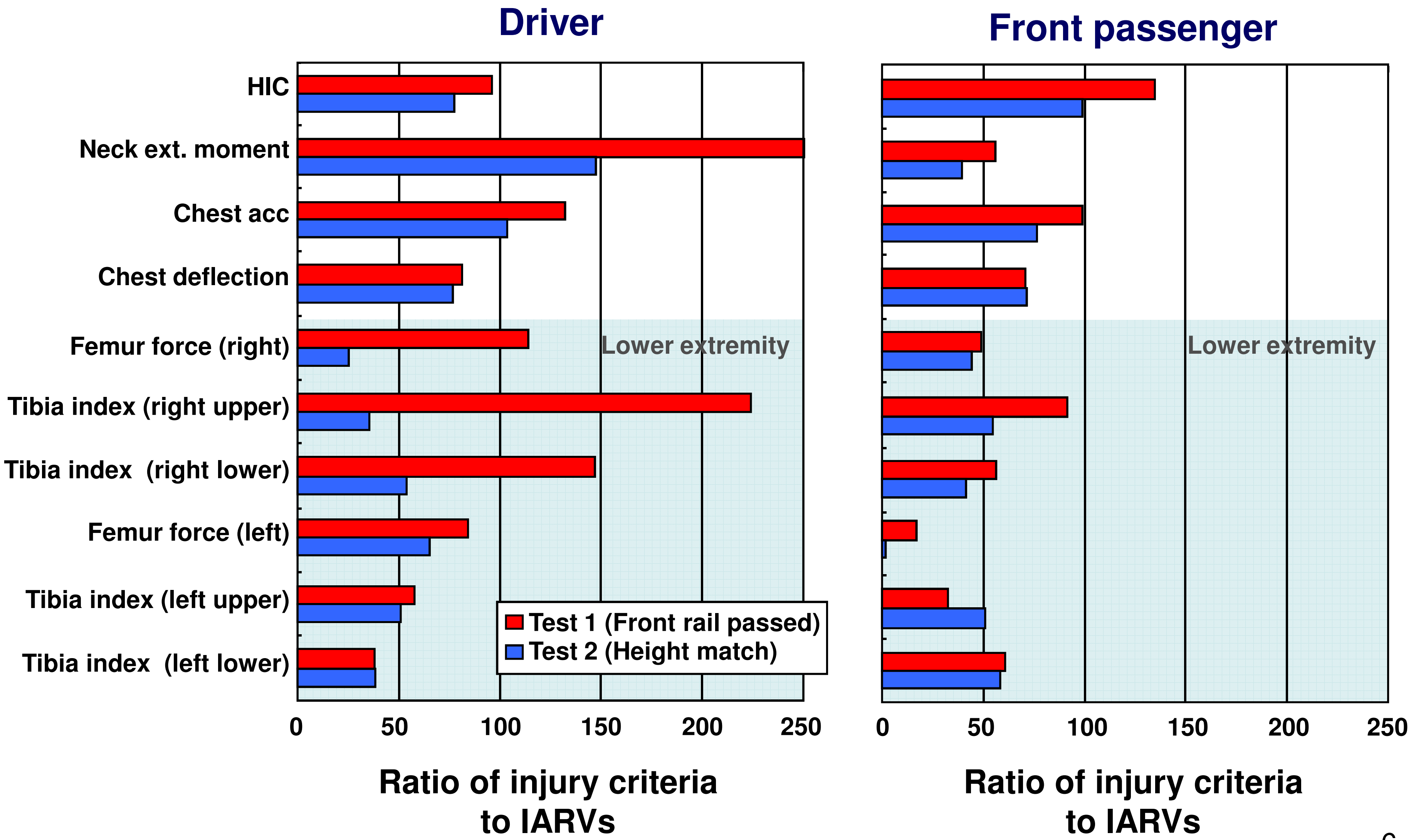
Front rails passed

Test 2:
Front rail height matching

Front rails made contact

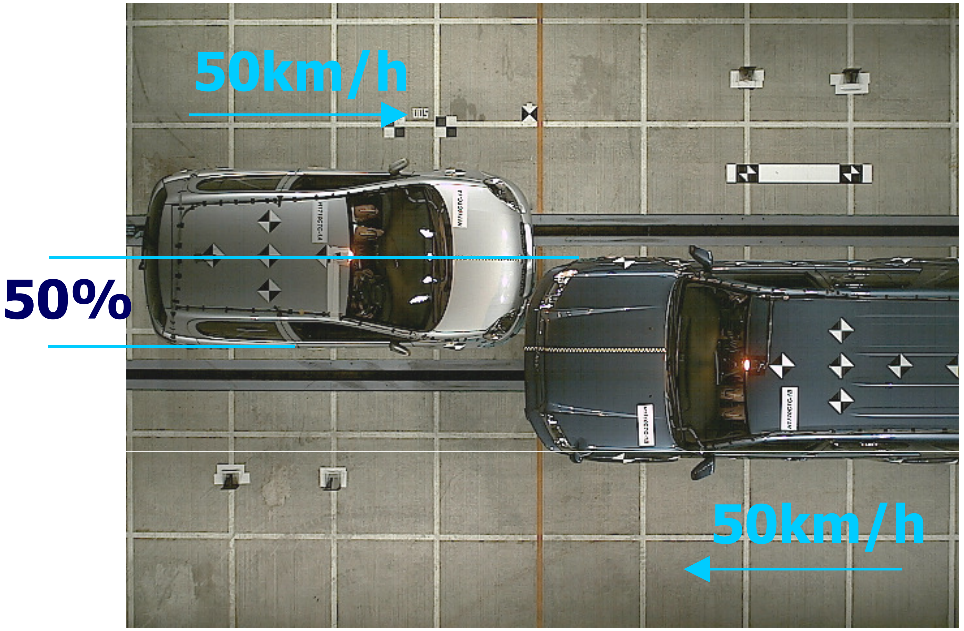


Injury Criteria (Minicar)



Effectiveness of SUV SEAS

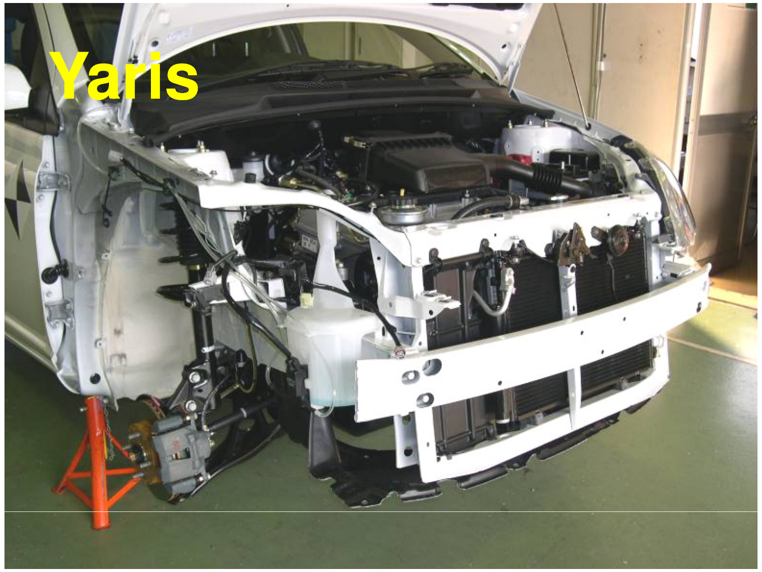
Test conditions

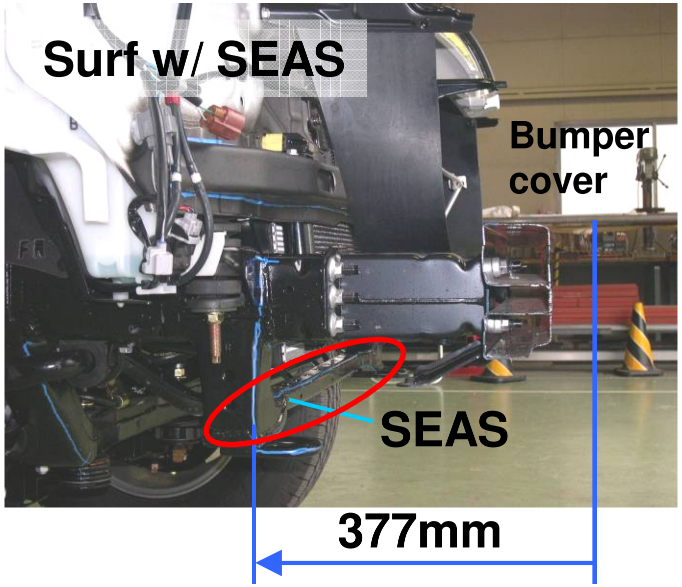


Yaris (test mass 1091kg)
Surf (frame-type, test mass 2076 kg)

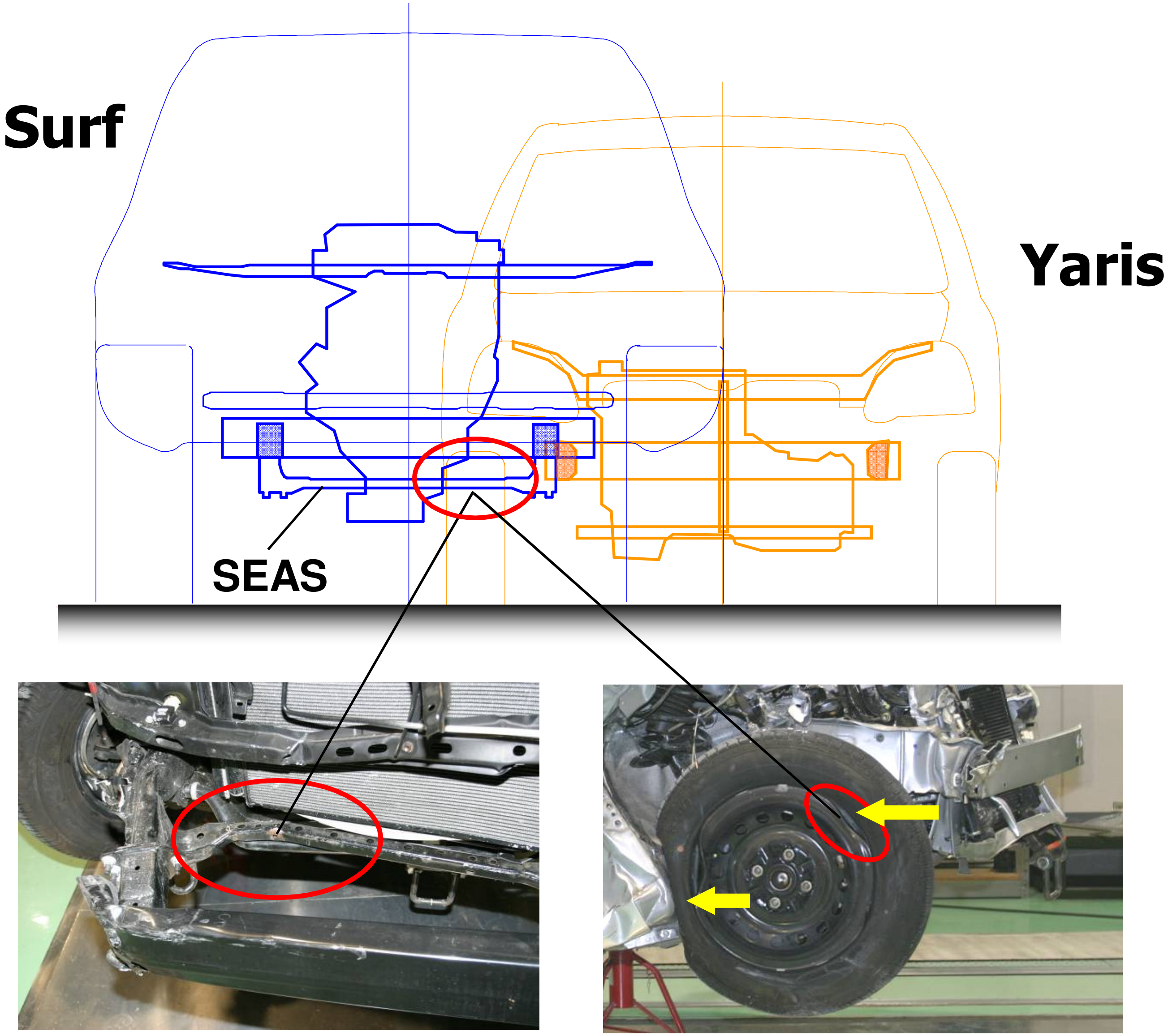
Test 1	Yaris	Surf (w/SEAS)
Test 2		Modified Surf (w/o SEAS)

Front Structures

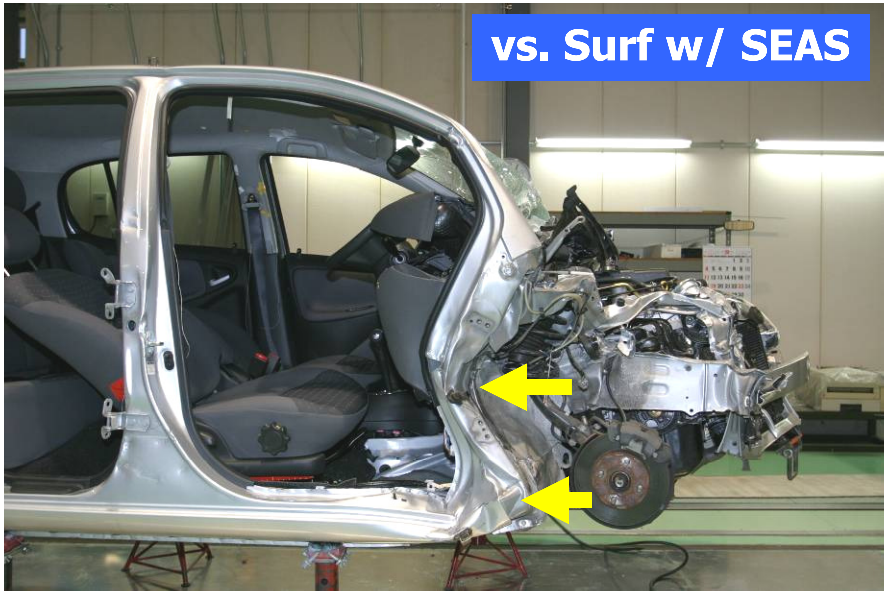


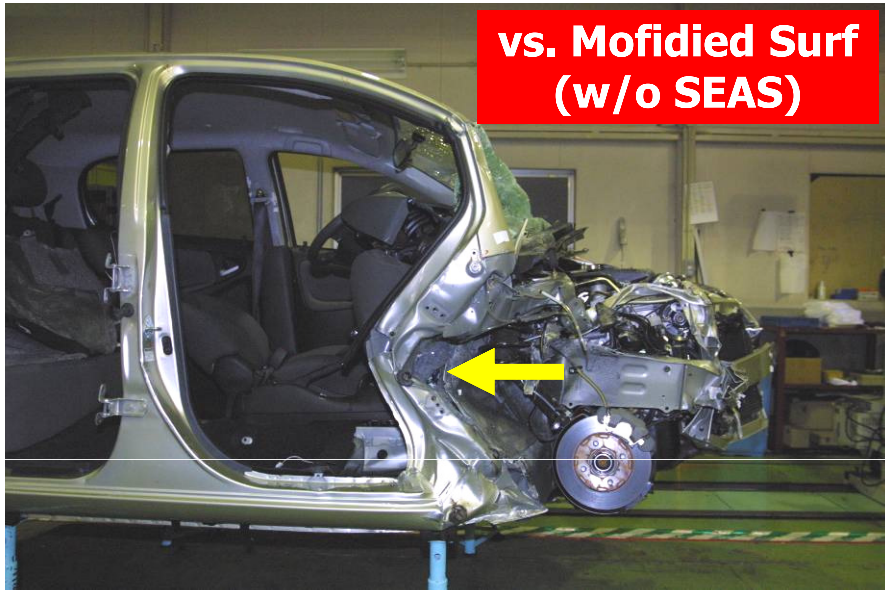


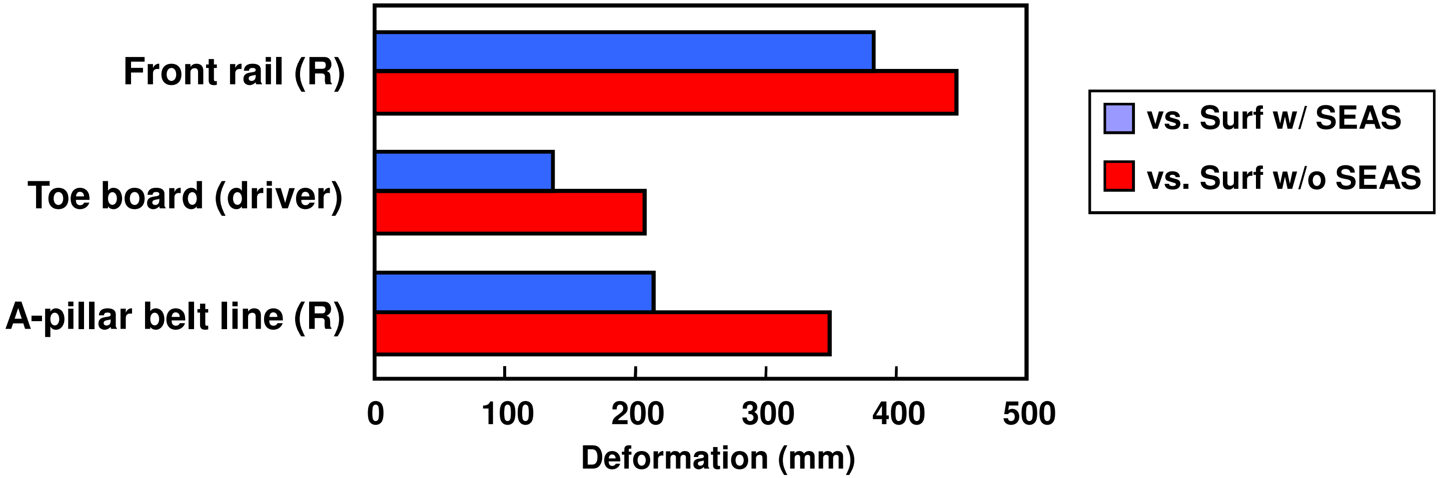
Structural Interaction



Deformation - Yaris -







Injury Criteria

	vs. Surf w/ SEAS		vs. Surf w/o SEAS	
	Driver	Passenger	Driver	Passenger
HIC 36ms	713	421	384	435
Neck-MY (Nm)	50	23	46	19
Chest 3ms (G)	53.4	32.8	53	35.9
Chest Def. (mm)	29	28.4	23.8	25.4
Femur-R (kN)	6.47	2.85	13.41	2.11
Femur-L (kN)	2.29	1.32	4.22	1.52
Knee-Disp.-R (mm)	20.7	13	27.9	14.6
Knee-Disp.-L (mm)	13.2	1.6	15.4	0
TI-Upr.-R	2.47	0.97	2.85	0.91
TI-Upr.-L	0.59	0.25	0.72	0.48

Summary of Crash Tests

- Front rail matching is a first step for compatibility.
- SEAS of SUV reduced the intrusion to compartment of small car.

Test Method

TWG Voluntary Agreement

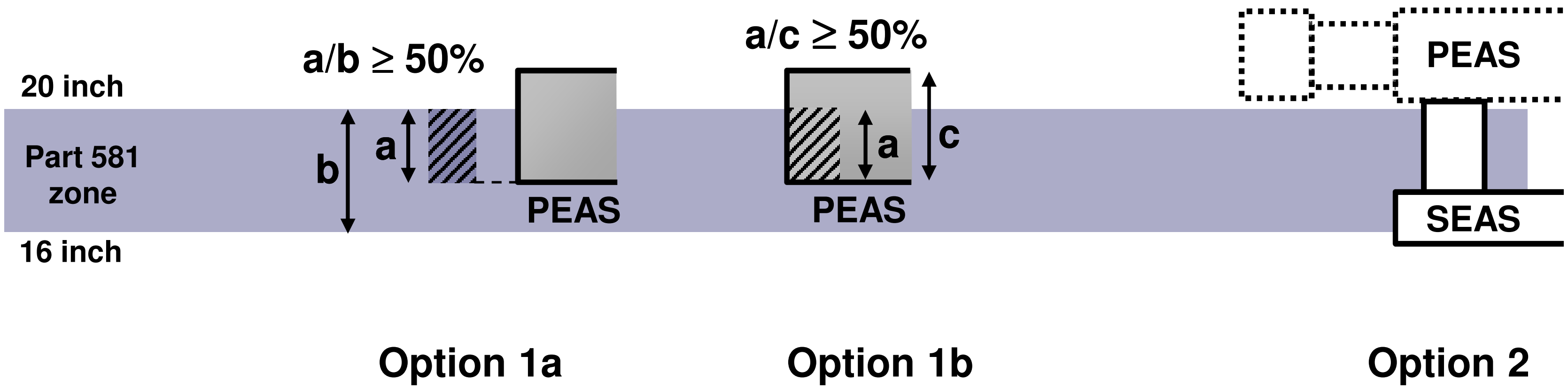
OPTION 1

The light truck's primary frontal energy absorbing structure (PEAS) shall overlap at least 50 percent of the Part 581 zone (Option 1a)

AND at least 50 percent of the light truck's PEAS shall overlap the Part 581 zone (Option 1b)

OPTION 2

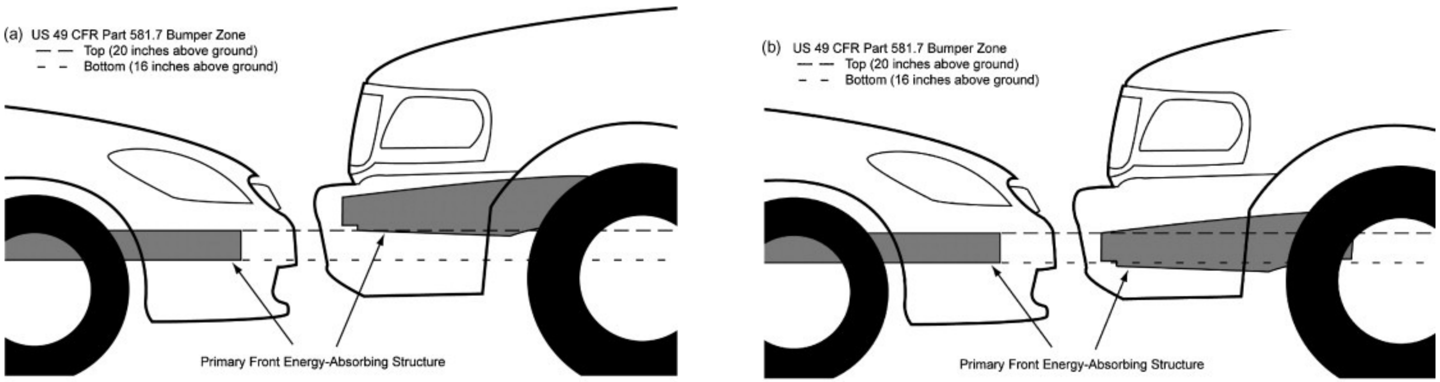
If a light truck does not meet the criteria of Option 1, there must be a secondary energy absorbing structure (SEAS), connected to the primary structure, whose lower edge shall be no higher than the bottom of the Part 581 bumper zone.



Effectives of TWG Voluntary Agreement

From IIHS accident analysis, the effectiveness of the TWG agreement has been demonstrated

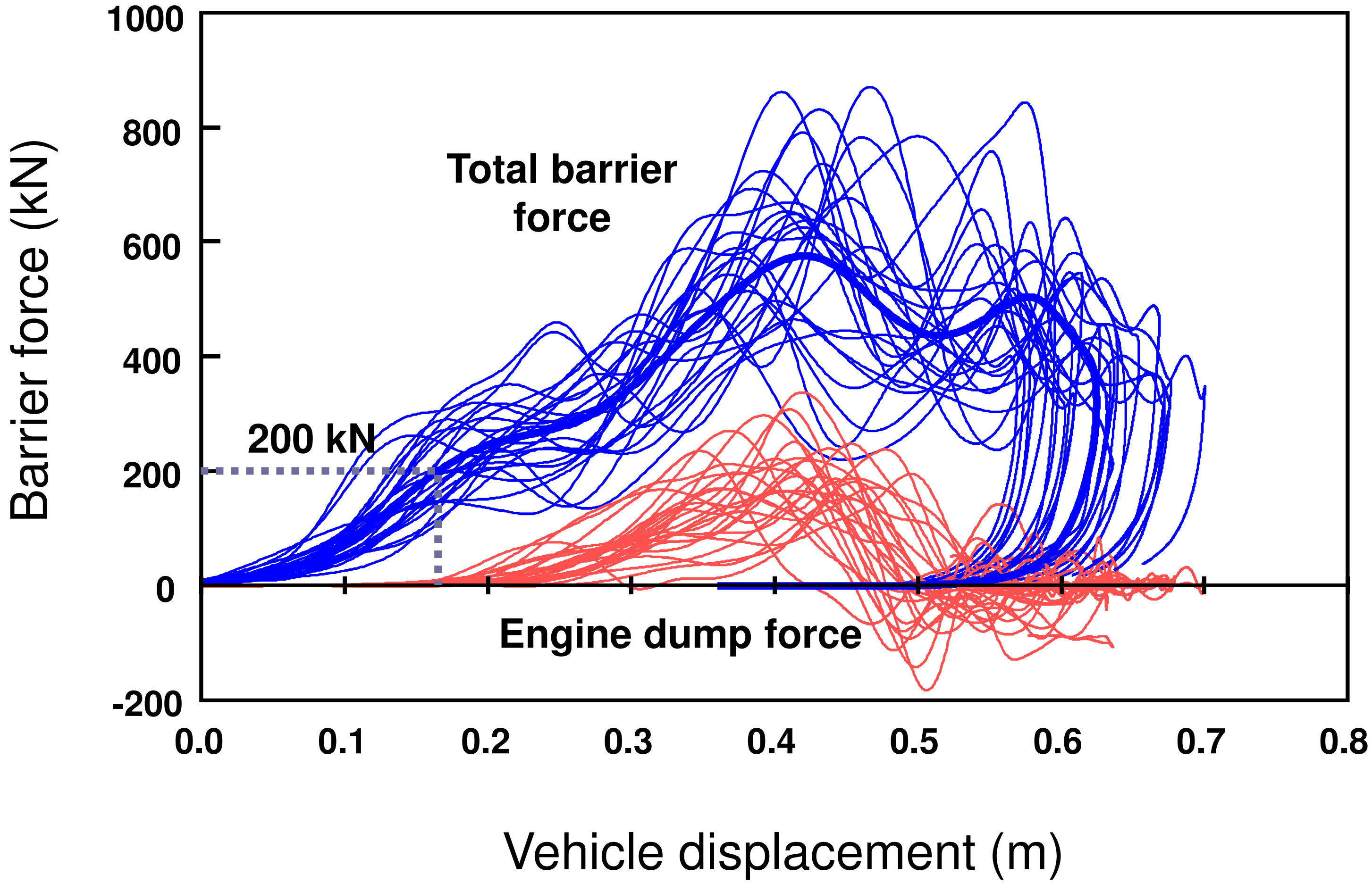
- Driver fatality risks in cars were compared for the collisions of light trucks that met TWG agreement with that of light trucks not meeting the agreement
- The estimated benefits were a **19 percent reduction in fatality risk** to belted car drivers in front-to-front crashes with light trucks and a **19 percent reduction in fatality risk** to car drivers in front-to-driver-side crashes with light trucks.



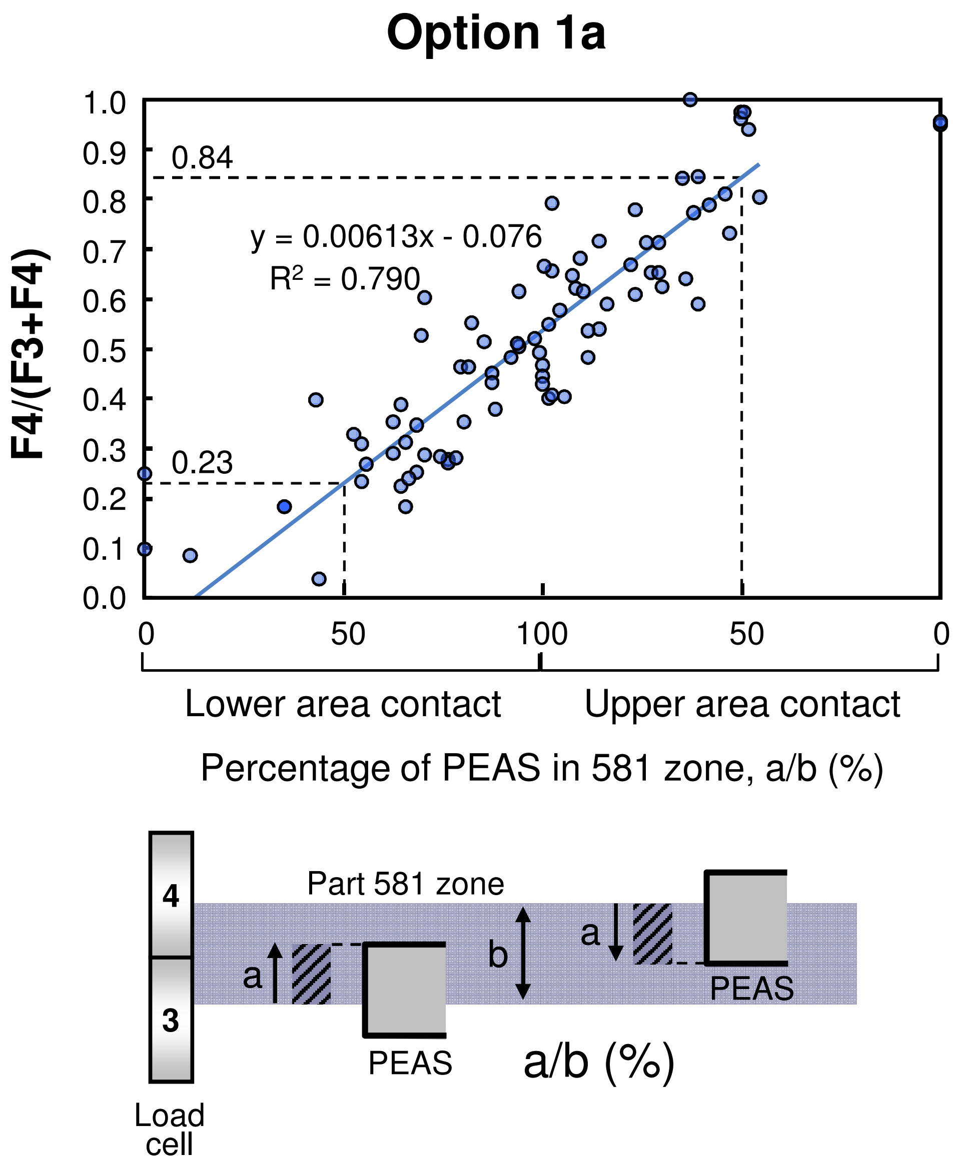
Crash compatibility between cars and light trucks: Benefits of lowering front-end energy-absorbing structure in SUVs and pickups, Bryan C. Baker, Joseph M. Nolan, Brian O'Neill, Alexander P. Genetos ∗ ,*Insurance Institute for Highway Safety,* Accident analysis and prevention, 2008

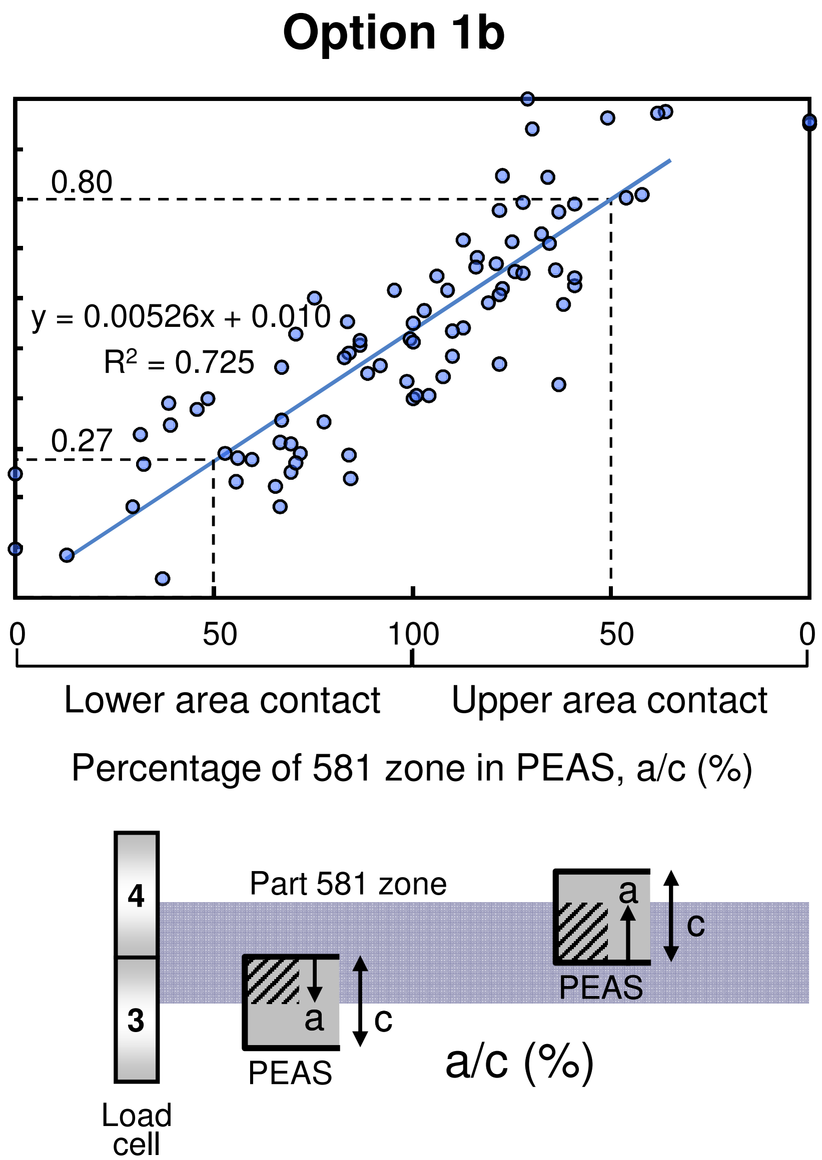
FWRB Test + Option 2

Total Barrier Force in Full-Width Rigid Barrier (FWRB) Tests



F4/(F3+F4) in FWRB





Note: PEAS ground height was corrected according to impact location (z)

Front Rail Height Metrics of FWRB

Original Japanese measure

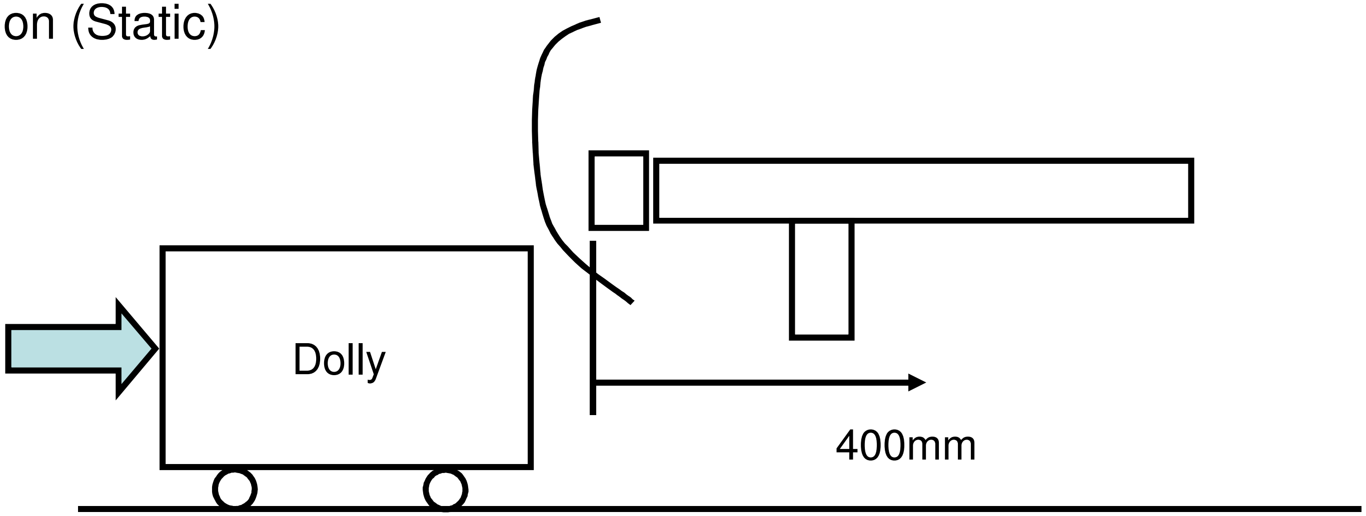
- F3+F4 > 80 kN
- 0.2 < F3/(F3+F4) < 0.8

FIMCAR modification

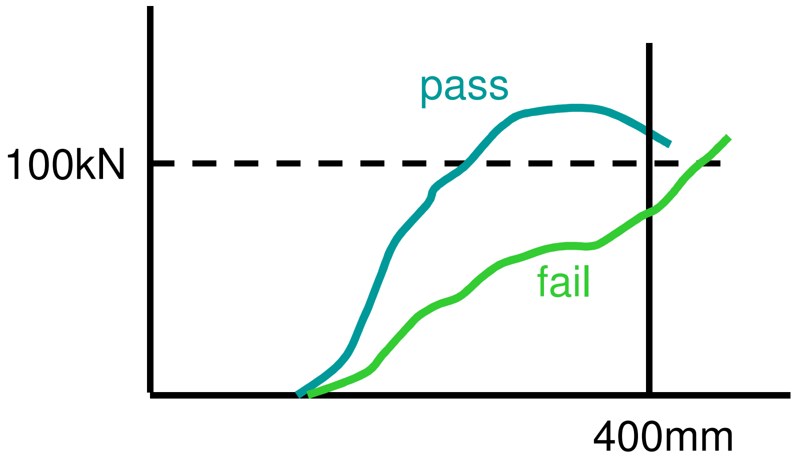
F3+F4 ≥ [100-LR] kN
F4 ≥ 35 kN
F3 ≥ 35 kN
LR=Min [(F2+F1-25 kN); 35 kN]

Test conditions and criteria for SEAS in US self regulation (Option 2)

Test condition (Static)



Criteria



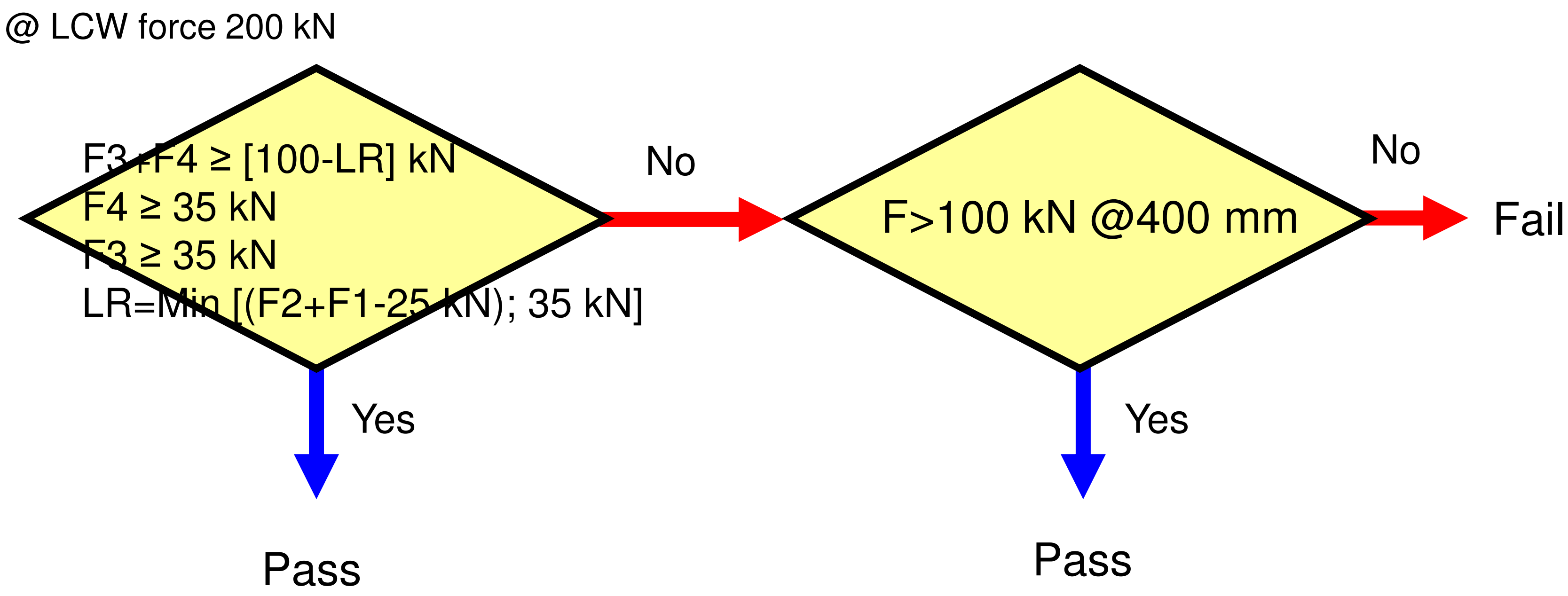
Same test condition and criteria as truck RURP test (ECE R93)

Surf has met the Option 2 requirement with enough margin

Test Method

Stage 1: FWRB test

Stage 2: Option 2 test



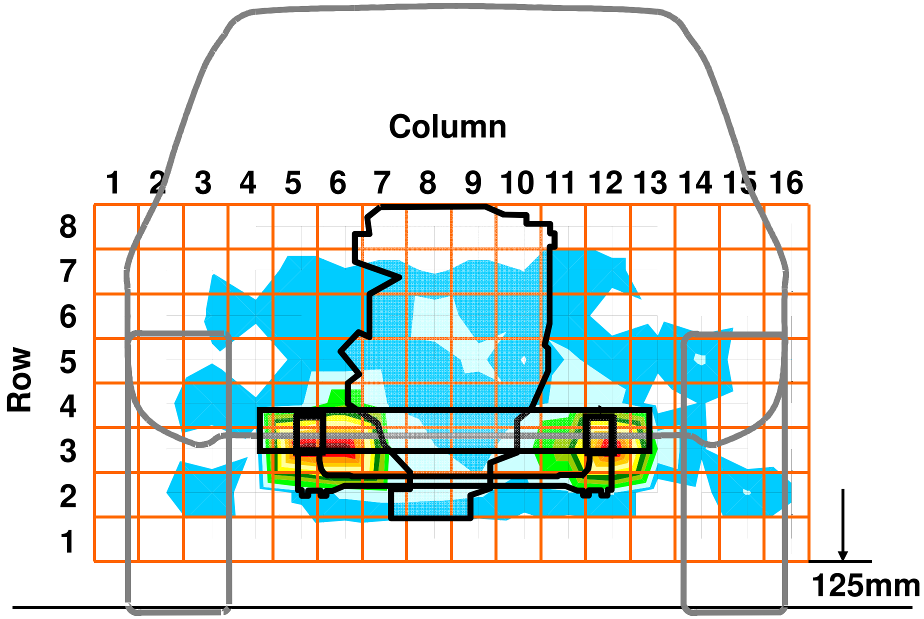
Other Merits of SEAS

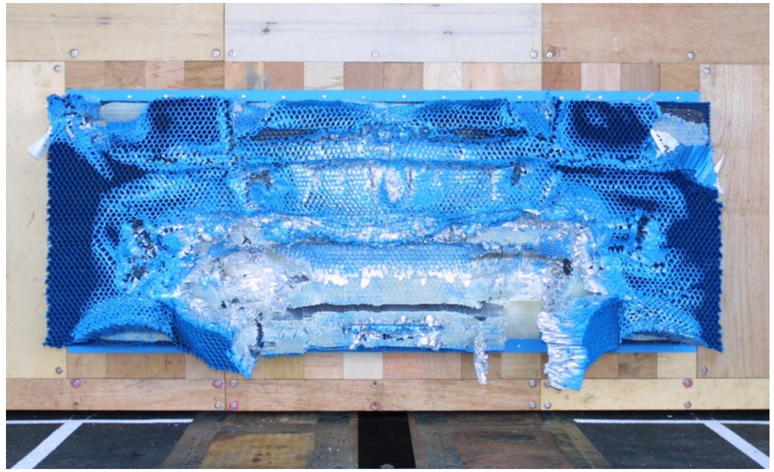
- Robust performance to prevent the override/underrun is increased if the SEAS has enough performance. (In the accident data, there was a case that override/underrun occurred as though the same sized cars are crashed.)

FWDB Tests for SEAS Evaluation

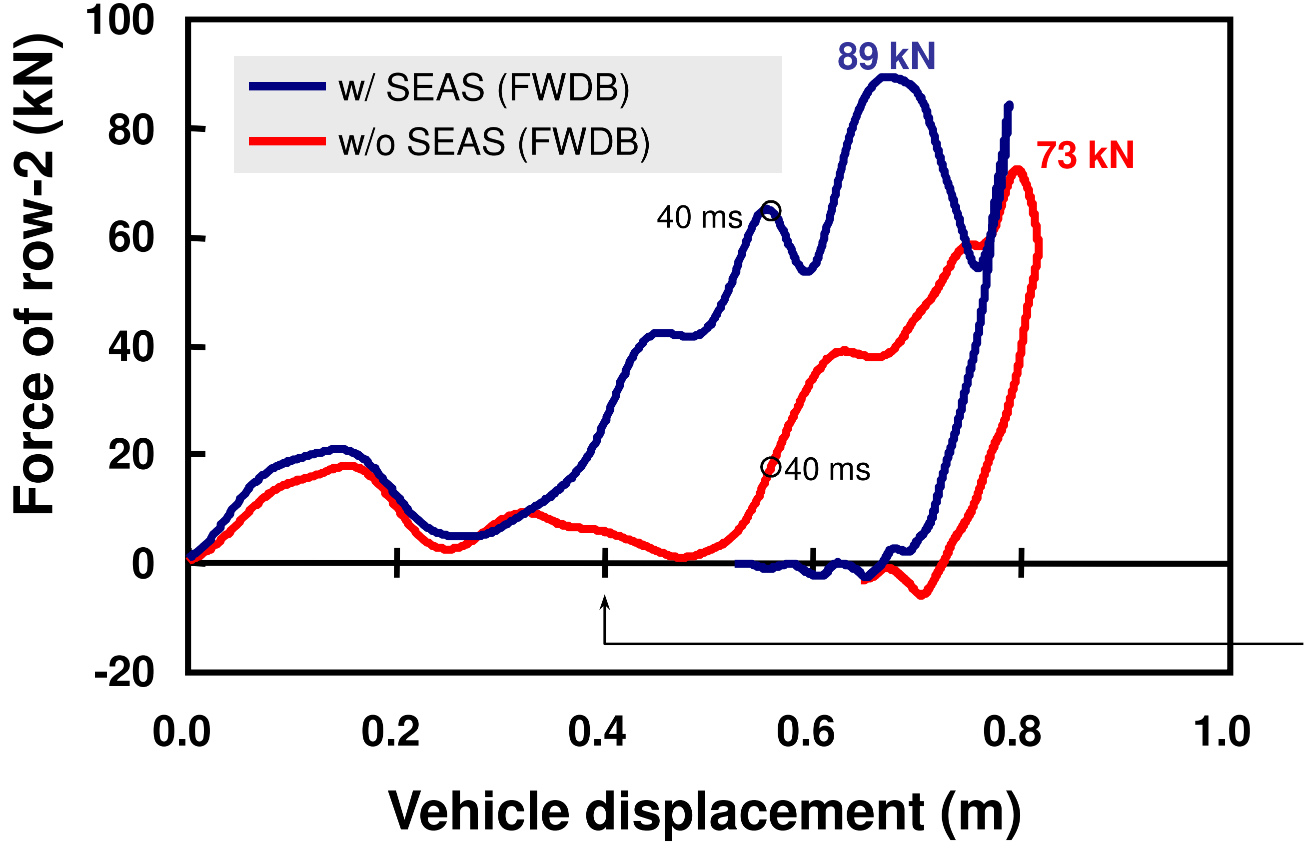
SEAS Detection (FWDB)

- Full-width deformable barrier tests were conducted using Toyota SURF with and without SEAS
- The SEAS was in alignment with row 2 in a load cell barrier





Row-2 Force vs. Vehicle Displacement



Honeycomb is so deep that the SEAS cannot transfer a reaction force to the barrier

FIMCAR criterion
Max. until 40 ms
(>100 kN)

w/ SEAS	F2: 65 kN (Fail)
w/o SEAS	F2: 18 kN (Fail)

Summary of FWDB Tests for SEAS

- In the SUV FWDB test, the barrier force of the SEAS was too small to be detected, though this SEAS (meets the Option 2) was demonstrated effective in car-to-car crash.

Harmonization

Harmonize of Full Frontal Test

- A second step to improve frontal impact regulation shall be envisaged preferably by means of a GTR in TOR.
- US, Australia and Japan already introduced the FWRB as full frontal impact test, so probably harmonization is easier for the FWRB when the GTR is considered for the target.

Conclusions

FWRB and FWDB

	Importance	FWRB	FWDB
PEAS height evaluation	High	Very Good	Good
SEAS detection	High	Impossible	Poor
Harmonization	Medium	Good	Poor
Cost	Medium	Good	Poor

- Both FWRB and FWDB tests can evaluate the PEAS height.
- FWDB cannot evaluate the SEAS effectively.
- Harmonization with the US is easier for the FWRB when the GTR is considered for the target.
- It costs $5,000 (honeycomb) for every test in FWDB.

Conclusions

- By the combination of FWRB and Option 2 (SEAS) test, the structural interaction of vehicles can be evaluated, effectively.
- When considering GTR for the target, the FWRB may be accepted easier for the harmonization with the US.
- FWRB test is more economical than FWDB test in terms of PEAS height evaluation.
- Japan recommends the FWRB with Option 2 test.