



Injury comparison of WS50 and ES-2re dummies in the different door armrest stiffness using the sled simulations

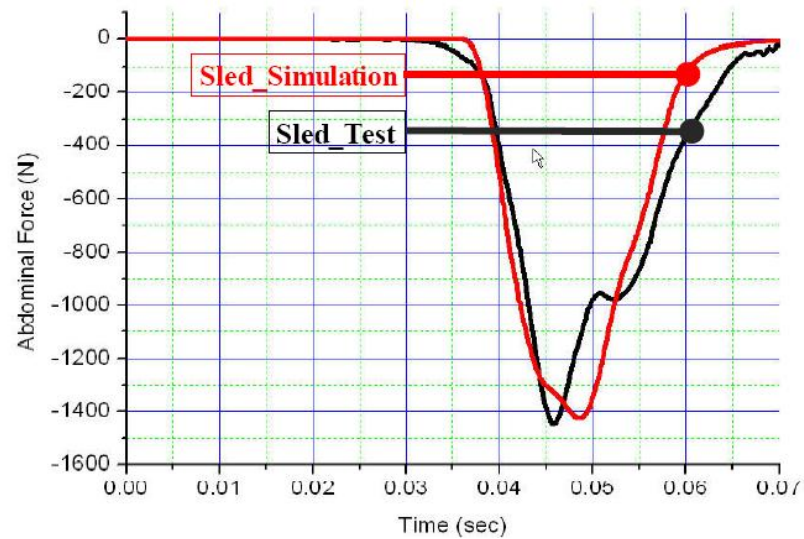
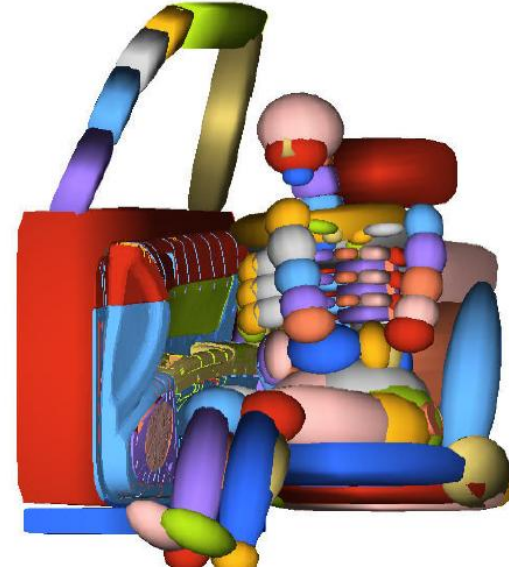
2011. 10.26

Korea Automobile Testing & Research Institute(KATRI), Korea Univ. of Technology & Education

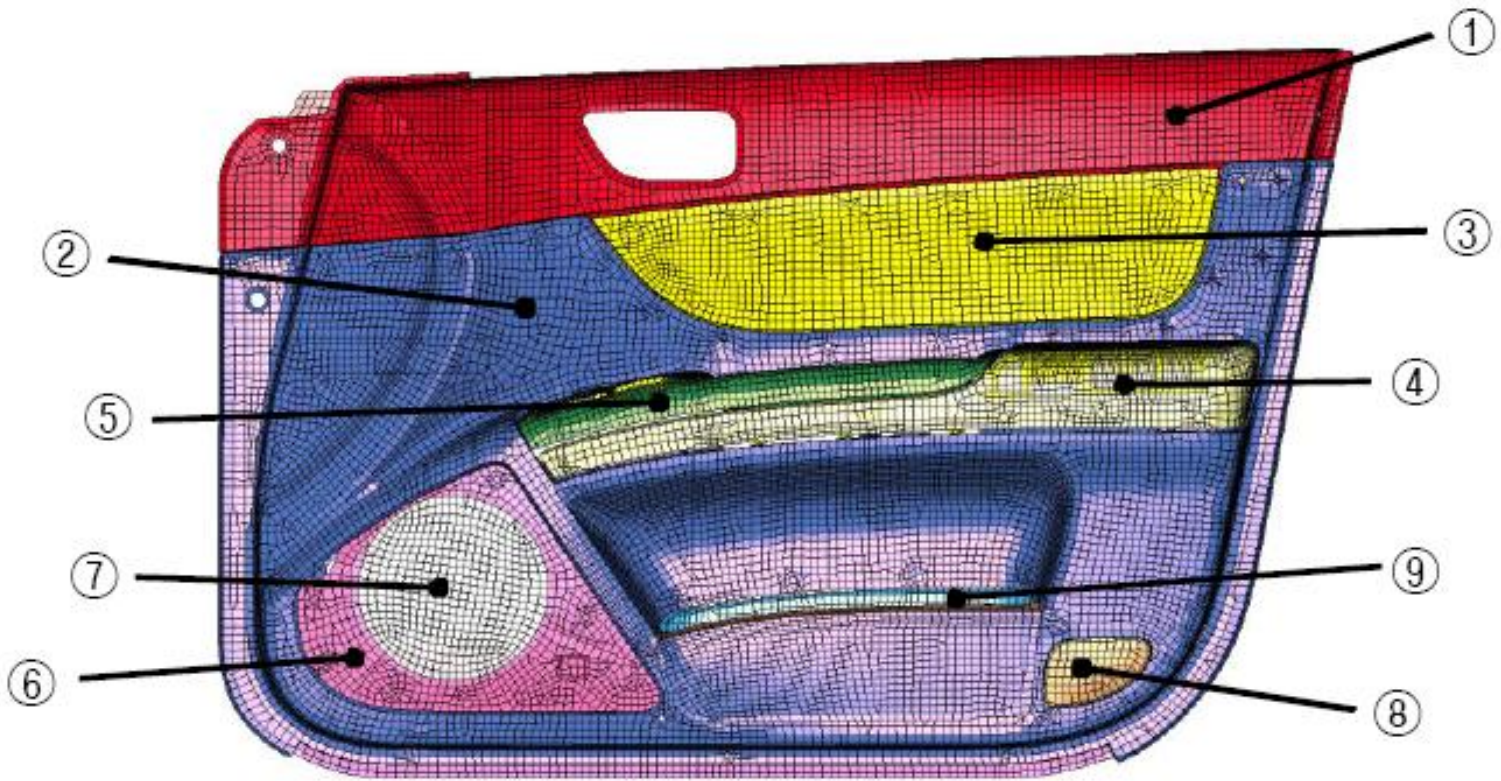
OBJECTIVE

- WorldSID dummy was shown to have considerably better biofidelity than the ES-2re. (ECE/TRANS/WP.29/2010/82)
- As NHTSA's opinion, WorldSID dummy appears to be suitable for regulatory testing.
- KMVSS, KNCAP specified use of ES-2re dummy, but positive to harmonization. From 2010 Side KNCAP (Similar to EuroNCAP protocol with 55km/h), all vehicles have 5 stars.
- Need a series of evaluation process for WorldSID
- First, check the affects of the injury values with 3 different types of door trim (armrest) stiffness in simulation models (Currently no physical WorldSID model is available)

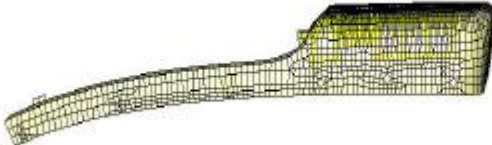
Model Validation with ES-2re



Door trim FEM Models



Door Armrest

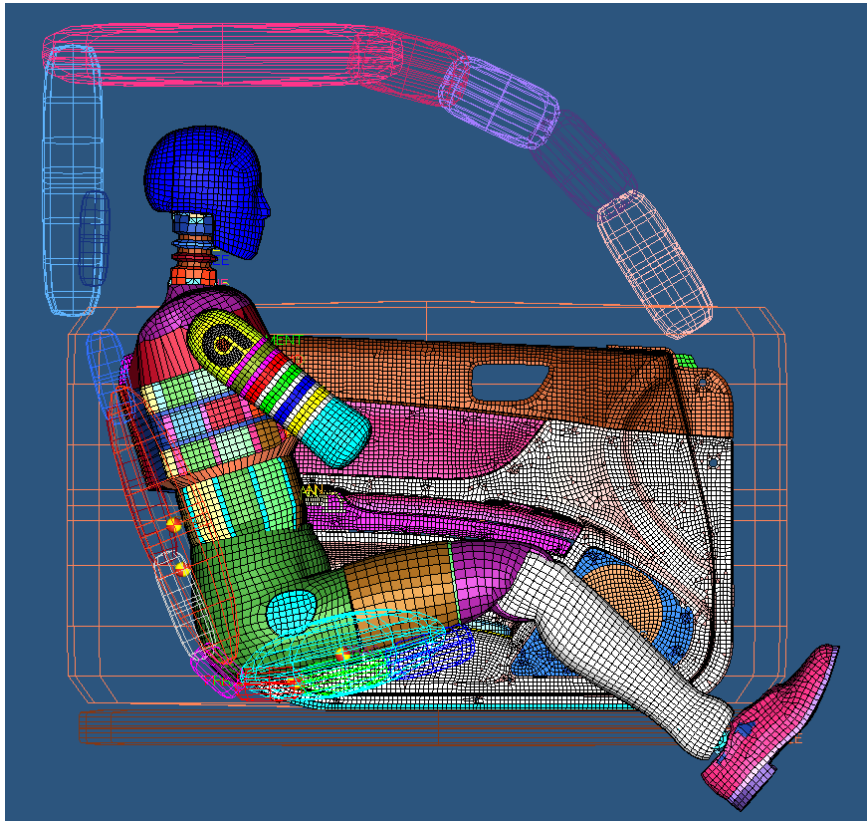
4	A/REST PADD'G		ABS (MS225_18)	585 X 118X 2.5t
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Simulation Models

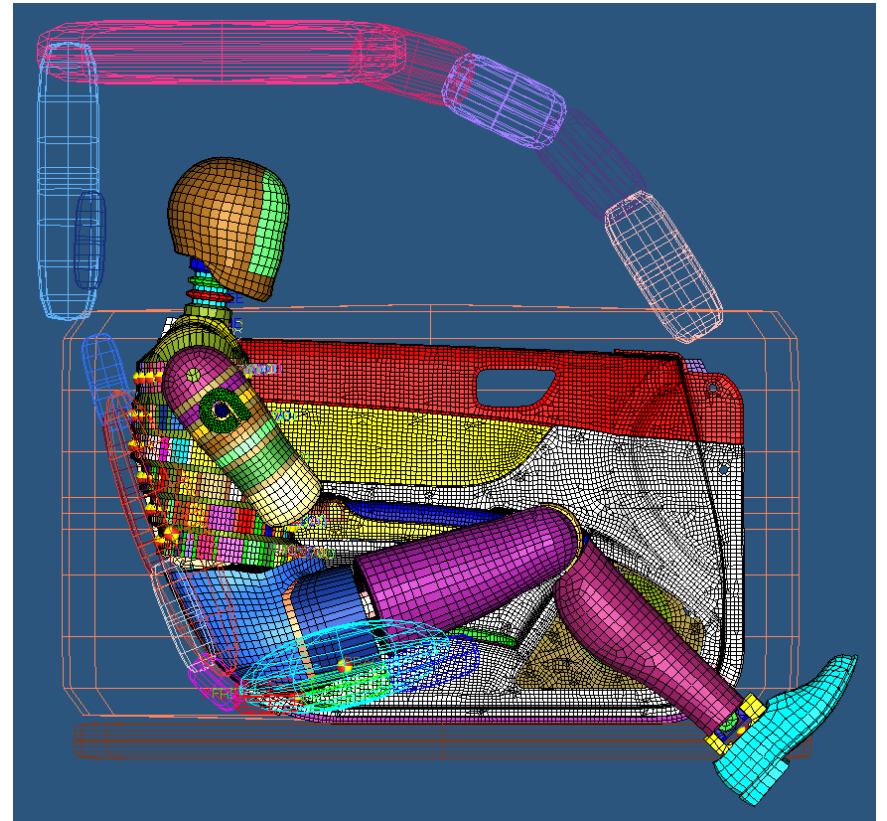
- Solver: MADYMO
- Dummy: WorldSID 50th , ES-2re Facet Model
(FEM dummy models are not available)
- Model: Sled type model
- Door : Rigid ellipsoid model
- Door trim: FEM model
- Simulation: KNCAP side impact (55km/h)

Door trim type	Materials	Elastic Modulus	Yield Stress	Ref.
Soft Arm rest	ABS	3.54 Gpa	39.6 Mpa	80%
Medium Armrest	ABS	4.43 GPa	49.5 Mpa	100%
Hard Armrest	ABS	5.32 GPa	59.4 Mpa	120%

WS50 & ES-2re Seating Postures

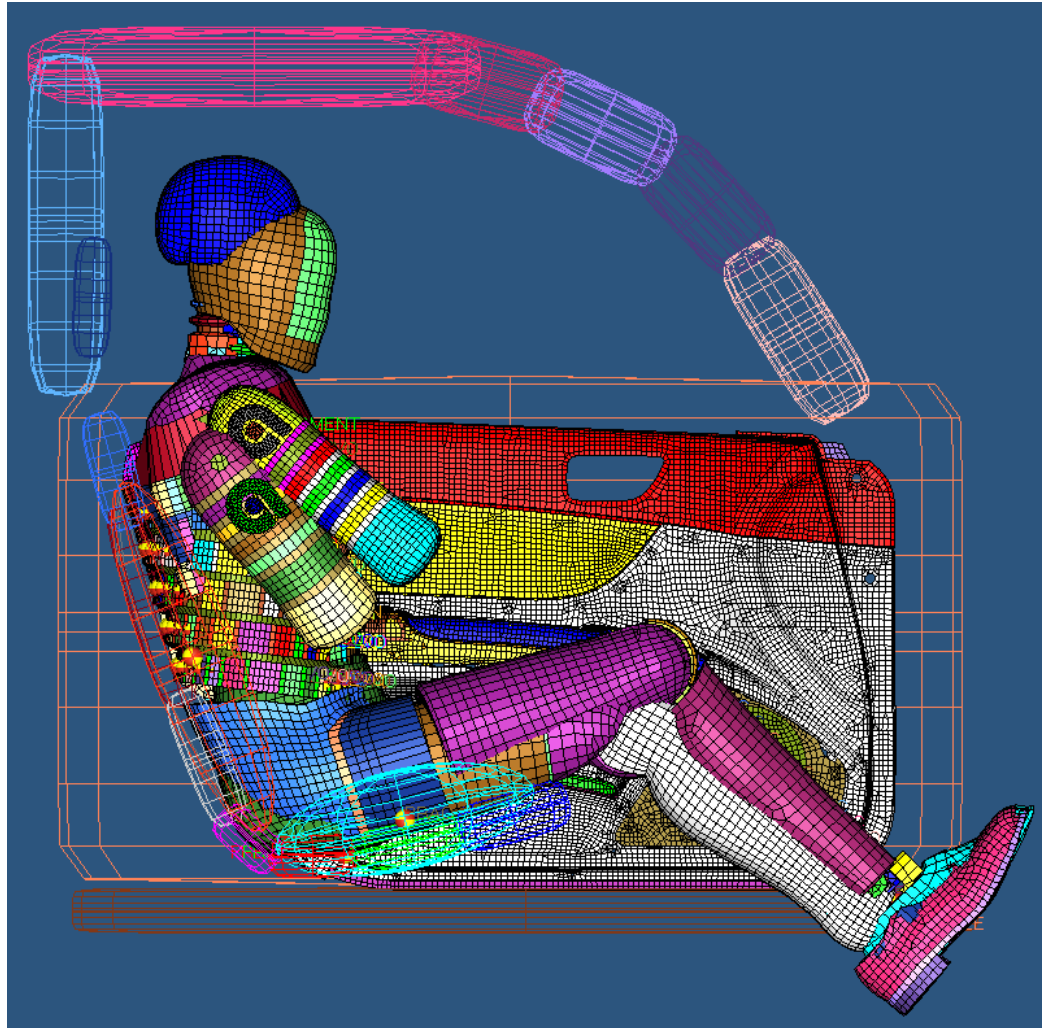


ES-2re Model



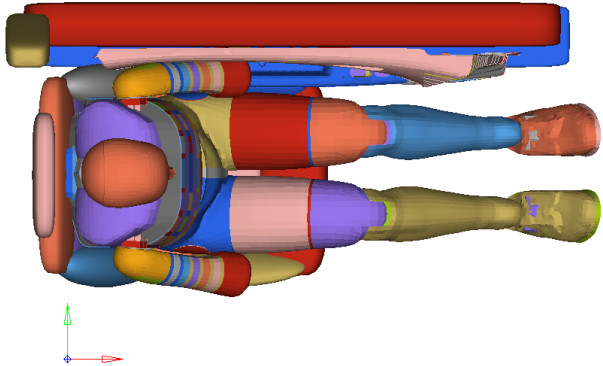
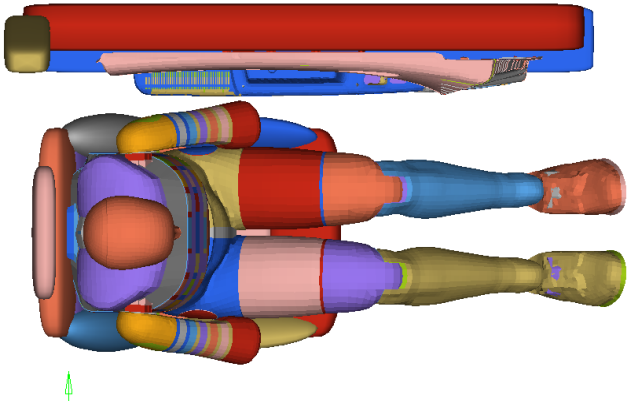
WorldSID 50th Model

WS50 & ES-2re Seating Postures

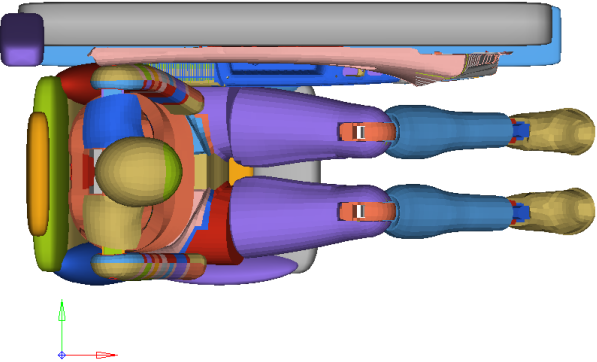
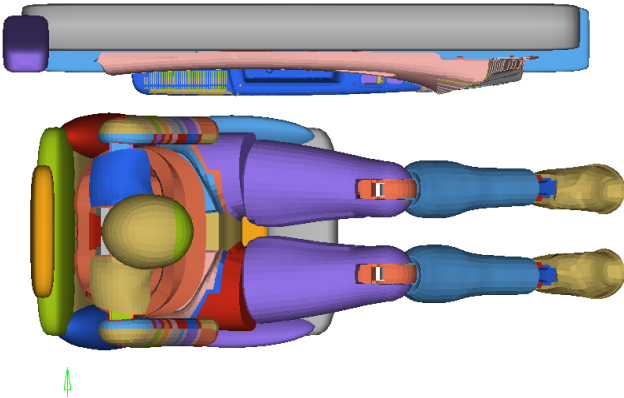


Dummies in Motions with Medium Armrest Stiffness

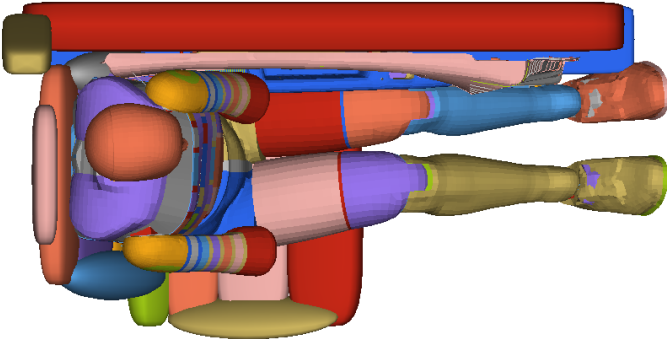
ES-2re



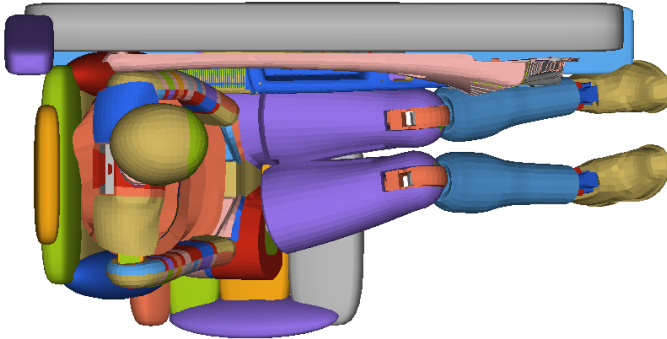
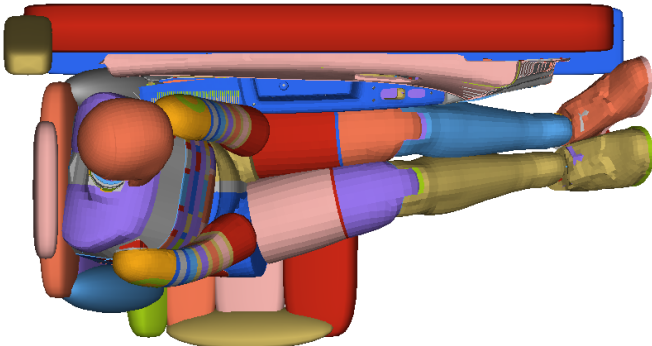
WorldSID



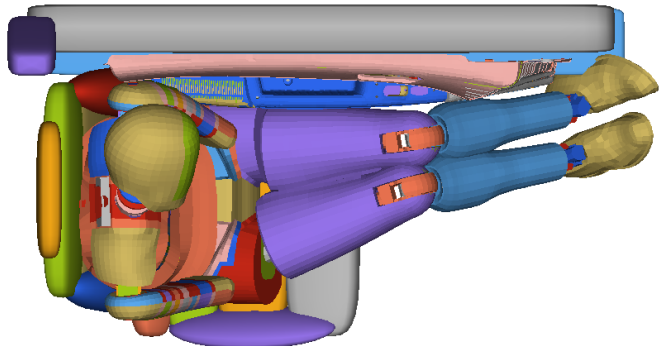
Dummies in Motions with Medium Armrest Stiffness



ES-2re



WorldSID



Simulation Results

		EuroSID2-re			WorldSID		
		Soft	Normal	Hard	Soft	Normal	Hard
Shoulder Force (kN)	Y axis	1.8422	1.8331	1.8307	2.5147	2.5321	2.5719
Rib Deflection (mm)	Upper	19.907	19.803	19.765	22.038	22.211	22.549
	Mid	3.5690	2.8787	3.0151	21.859	21.965	22.304
	Lower	5.2340	5.7252	5.7259	27.918	28.248	27.918
T12 Acc. (g)	Y axis	39.560	44.250	43.628	43.334	44.274	45.709
Pubic Force (kN)	Y axis	2.9459	2.8136	2.9508	1.6702	1.6563	1.6344
Pelvis Acc. (g)	Y axis	78.863	78.075	77.593	63.152	63.458	64.440

Results and Discussions

1. Due to lower sitting height of WorldSID 50th dummy, shoulder is fully contact and move away in parallel.
2. Higher shoulder Y forces in WorldSID50th dummy due to the lowering the seating postures.
3. For WorldSID, 3rd rib deflections were largest, while ES-2re, 1st rib deflection were largest.
4. For ES-2re dummy, the ribs deflections have larger variation and different patterns among the upper to lower ribs (#1,#2,#3)
5. With the different armrest stiffness, T12 Y acceleration of WorldSID are insensitive.
6. In general, the level of injury values are similar each other.



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Injury comparison of WorldSID 50 and ES-2re dummies with the different door intrusion patterns

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Univ. of Technology & Education

OBJECTIVE

- WorldSID dummy was shown to have considerably better biofidelity than the ES-2re. (ECE/TRANS/WP.29/2010/82)
- WorldSID capable to $+30^{\circ}$ ~ -30° Impact angles.
- As NHTSA's opinion, WorldSID dummy appears to be suitable for regulatory testing.

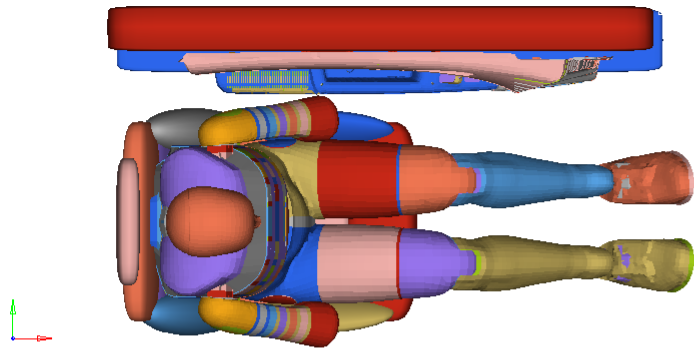
- KMVSS, KNCAP specified use of ES-2re dummy, but positive to harmonization. From 2010 Side KNCAP (Similar to EuroNCAP protocol with 55km/h), all vehicles have 5 stars.
- Need a series of evaluation process for WorldSID
- First, check the affects of the injury values with 3 different types of door intrusion patterns in simulation models (Currently no physical WorldSID model is available)

Simulation Models

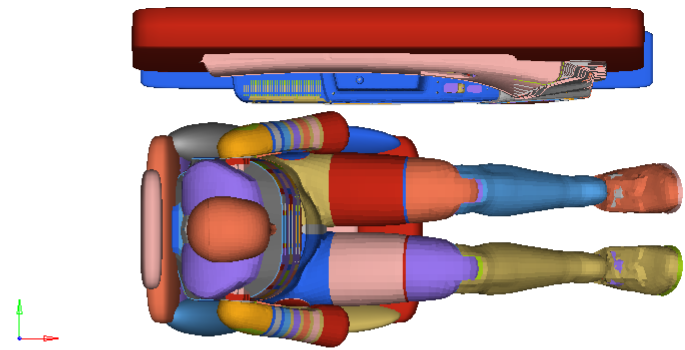
- Solver: MADYMO
- Dummy: WorldSID 50th , ES-2re Facet Model
(FEM dummy models are not available)
- Model: Sled type model
- Door : Rigid ellipsoid model
- Door trim: FEM model
- Simulation: KNCAP side impact (55km/h)
- Door intrusion pattern
 - 1) parallel to impact direction
 - 2) Rotate +5° in Z axis
 - 3) Rotate +5° in X axis
 - 4) Rotate - 5° in X axis

Seating Positions different door intrusion patterns

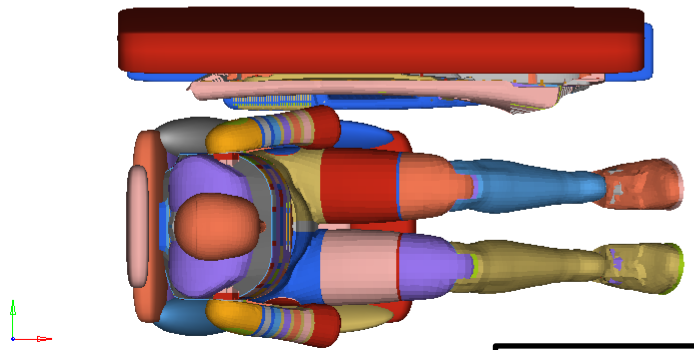
Normal



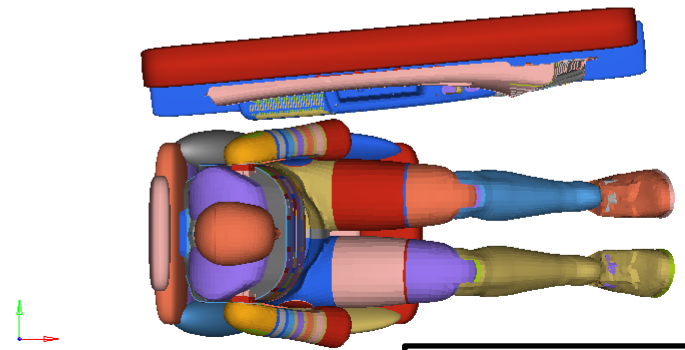
Tilted bottom



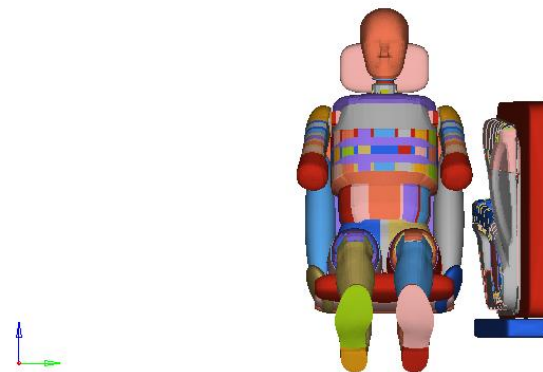
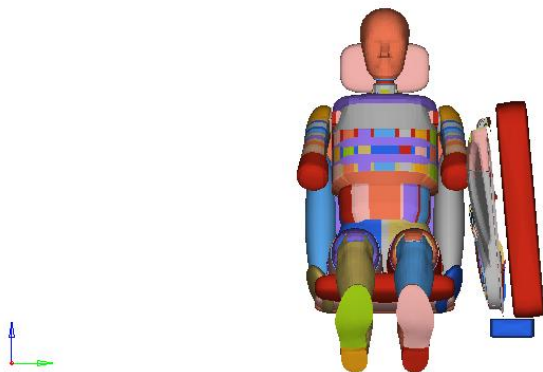
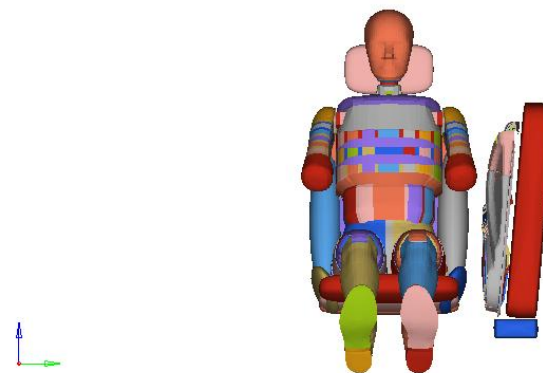
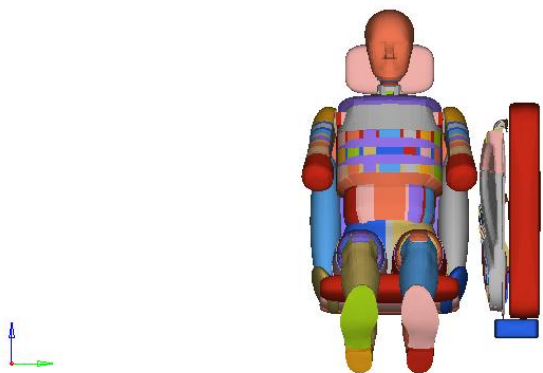
Tilted upper



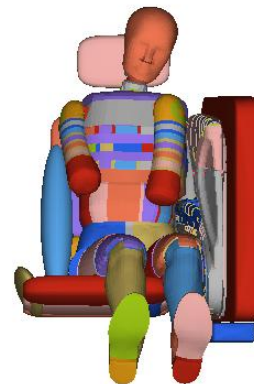
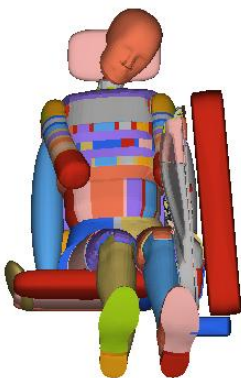
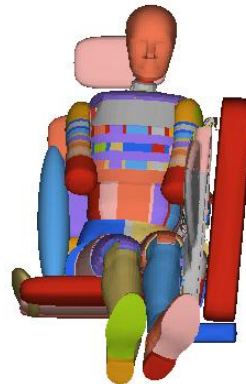
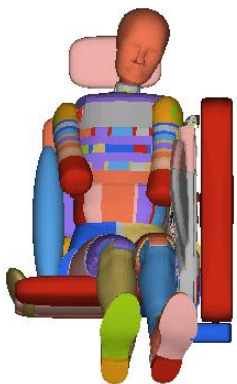
Tilted backward



Motions with different door intrusion patterns



Motions with different door intrusion patterns



Simulation Results

		EuroSID2-re				WorldSID			
		Normal	X upper	X bottom	Z	Normal	X upper	X bottom	Z
Shoulder Force(kN)	Y axis	1.8331	1.4352	2.9103	1.9092	2.5321	2.0969	2.7287	2.6098
Rib Deflection (mm)	Upper	19.803	11.474	24.639	20.415	22.211	36.995	51.455	52.068
	Mid	2.8787	1.866	12.518E	12.677	21.965	16.418	26.214	21.072
	Lower	5.7252	2.3183	3.9799	8.0319	28.248	26.103	28.560	30.471
T12 Acc.	Y axis	44.250	46.212	37.544	43.308	44.274	38.159	43.795	45.098
Pubic Force (kN)	Y axis	2.8136	2.4972	2.4679	2.7326	1.6563	1.4358	1.5302	1.6058
Pelvis Acc. (g)	Y axis	78.075	73.398	80.320	71.751	63.458	59.821	68.064	61.249

Results and Discussions

1. For WorldSID, the door intrusion patterns (tilting) were strongly influenced the deflection of ribs
2. Tilted backward (rotate z axis) is most influencing rib #1 deflection for WorldSID
3. In normal door intrusion, the largest rib deflection is 3rd rib, while tilted cases, upper rib deflection were largest regardless of door intrusion patterns.
4. In ES-2re, the 2nd, 3rd ribs deflection patterns are differ from the 1st rib deflection pattern, while thorax ribs of WorldSID show similar deflection patterns
5. Shoulder forces in WorldSID were insensitive regardless of the tilted door intrusions
6. 6. In general, the level of injury values are similar each other.