

Semi-Rigid Seat LS-Dyna Model

User Manual and Validation Results

Krystoffer Mroz (Autoliv)

July 5, 2021

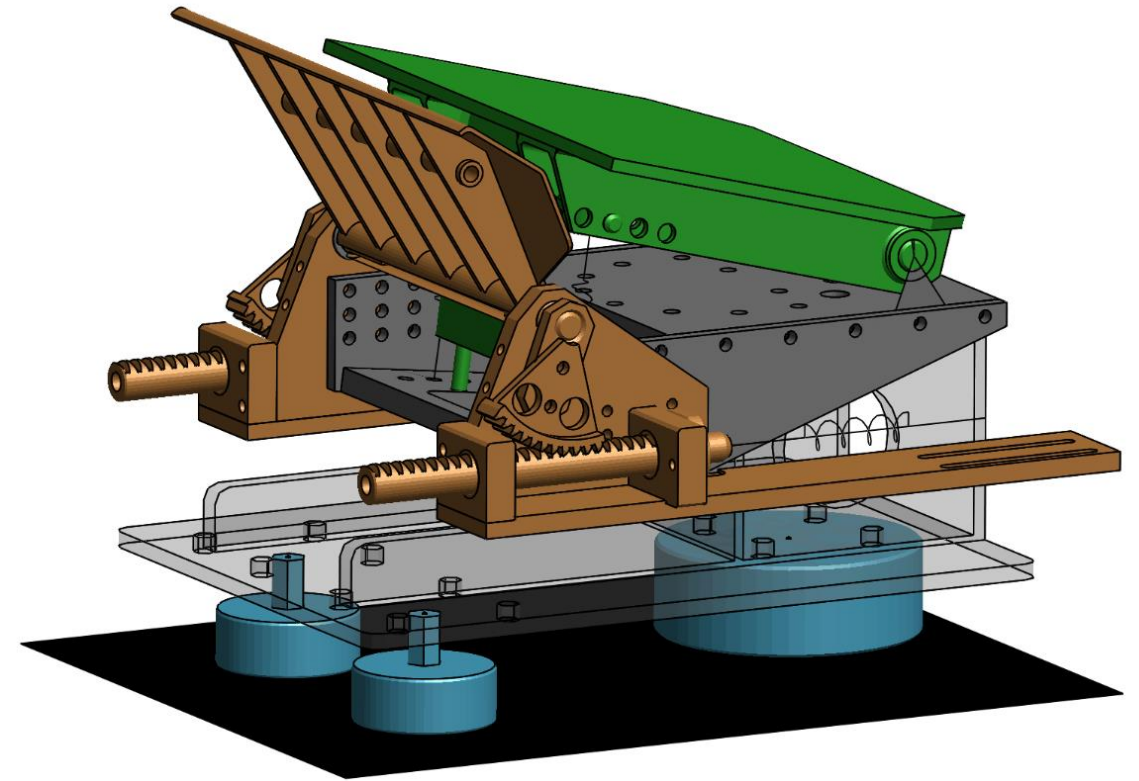


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■ User Manual

- ☐ Revision history
- ☐ Parameter settings
- ☐ Model output

■ Semi-rigid seat validation



- File name: 02_semi_rigid_seat_210705.k
- Units: S3 - mm, kg, ms, kN, GPa
- File type: LS-Dyna Version mpp971_s_R9.2.0_119543 keyword file

- Integrate seat model to the interior using rigid part 50000 (floor)

- Weight seat model:
 - 67.1 kg
 - 56.7 kg (excluding floor and load cells)

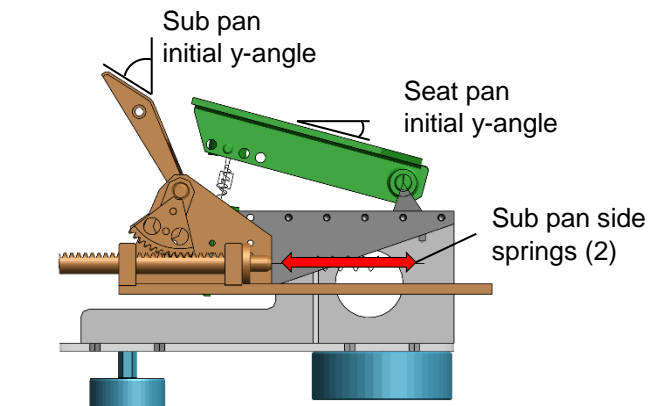
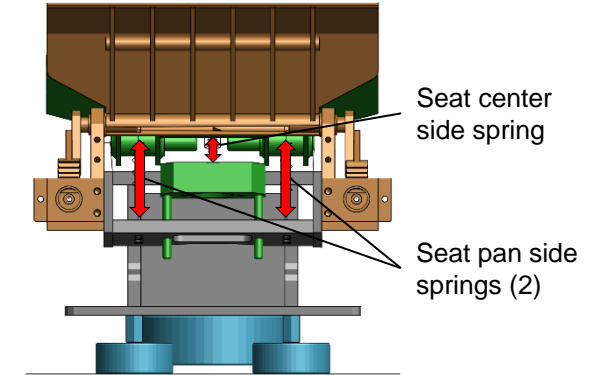
Revision History

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$ -----  
$ File name (version): 02_generic_seat_alr_22_210525.k  
$ Date: May 21, 2021 (Mehrdad Ranjbar, Autoliv)  
$  
$- Load cell measurement directions updated  
$  
$ -----  
$ File name (version): 02_semi_rigid_seat_210705.k  
$ Date: July 5, 2021 (Krystoffer Mroz, Autoliv)  
$  
$- Load cell geometry update.  
$- Seat pan shortened from 320 to 280 mm.  
$- Lower two baseplates replaced by a floor.  
$- All parameter definitions moved to the main seat file.  
$- Changed so that seat and sub pan angle parameters are given in absolute angles.  
$- Added sensor cards for the activation of the anti-rebound device.  
$ Anti-rebound element changed to discrete beam instead if spring.  
$  
$ =====
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Parameter Settings

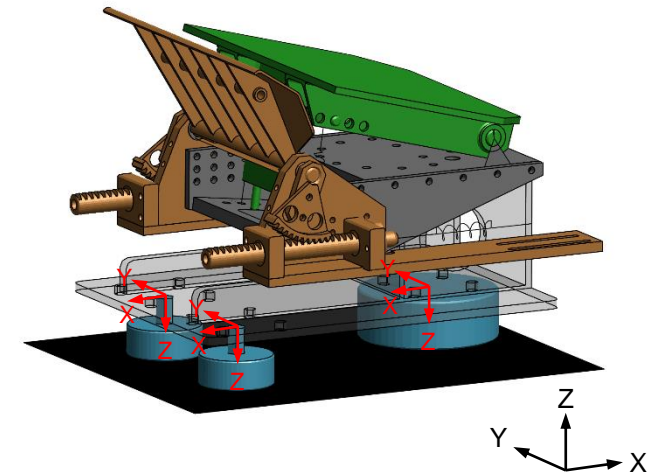
Seat Parameter	LS-Dyna Parameter Name	Default Setting*	Alternative Settings and References
Anti-rebound device (0=off, 1=on):	AntiReb	1 (on)	0=anti-rebound device deactivated
Seat pan initial y-angle (deg)	SeatP_ry	15.0	-
Sub pan assembly initial vertical position (mm)	SubP_z	0.0 (front config)	Front config: 0.0 Rear config: -30.0 (down)
Sub pan assembly initial y-angle (deg)	SubP_ry	32.5	-
Seat pan side spring stiffness (*DEFINE_CURVE ID)	SeatP_fs	51128 (128 N/mm)	Front config (Uriot 2015, Richardson 2020): 51128 (128 N/mm) Rear config (Uriot 2015): 51037 (37 N/mm)
Seat pan center spring stiffness (*DEFINE_CURVE ID)	SeatP_fc	52379 (379 N/mm)	Uriot 2015: 52350 (350 N/mm) Richardson 2020: 52379 (379 N/mm)
Sub pan spring stiffness (*DEFINE_CURVE ID)	SubP_f	53132 (132 N/mm)	Front config (Uriot 2015): 53123 (123 N/mm) Front config (Richardson 2020): 53132 (132 N/mm) Rear config (Uriot 2015): 51037 (37 N/mm)
Seat pan initial gap (mm)	SeatP_ig	28.0	Uriot 2015, Richardson 2020

* Default corresponds to the settings as used in Richardson 2020.



Model Output

Output	LS-Dyna ID	Entity Type	Direction
Seat Pan Displacement	SEAT_SEATPAN_DISP_FRONT_1	*DATABASE_HISTORY_NODE	Z-Disp
Sub Pan Displacement	SEAT_SUBPAN_SPRING_LEFT	*DATABASE_HISTORY_DISCRETE	X-Disp
Seat Pan Rotation	SEAT_SEATPAN_ROT	*DATABASE_HISTORY_DISCRETE	Y-Angle
Sub Pan Rotation	SEAT_SUBPAN_ROT	*DATABASE_HISTORY_DISCRETE	Y-Angle
Load Cell Rear (6 DoF)	SEAT_LOAD_CELL_REAR	*DATABASE_HISTORY_BEAM	Mx, My, Mz, Fx, Fy, Fz
Load Cell Front Left (1 DoF)	SEAT_LOAD_CELL_FRONT_LEFT	*DATABASE_HISTORY_BEAM	Fz
Load Cell Front Right (1 DoF)	SEAT_LOAD_CELL_FRONT_RIGHT	*DATABASE_HISTORY_BEAM	Fz



Validation Load Cases

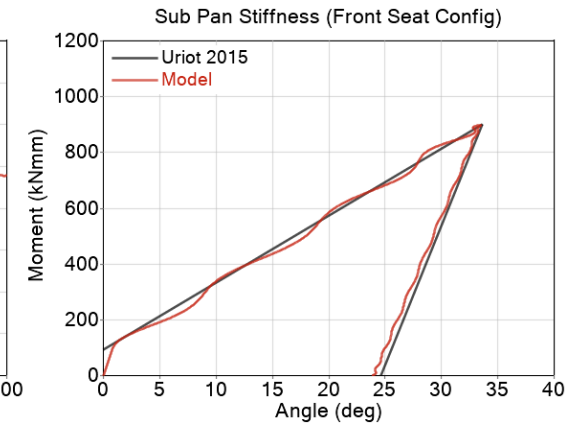
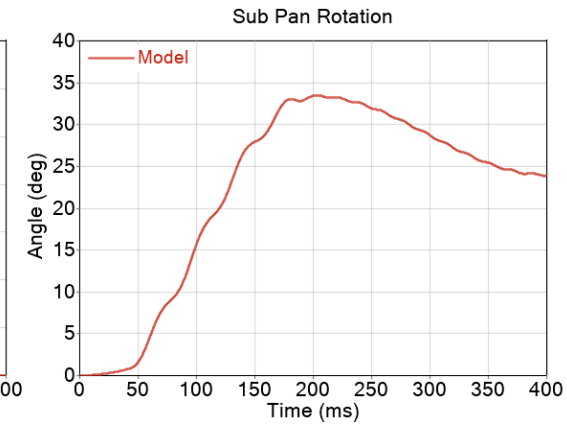
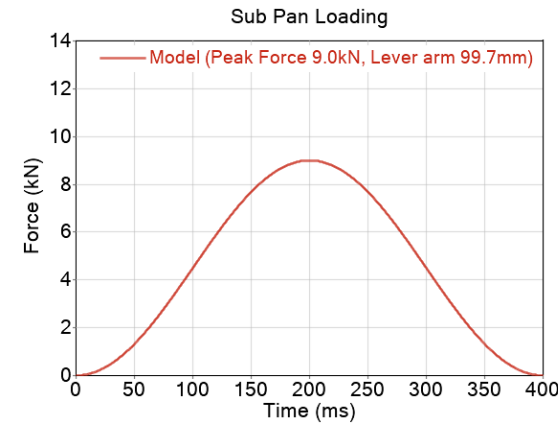
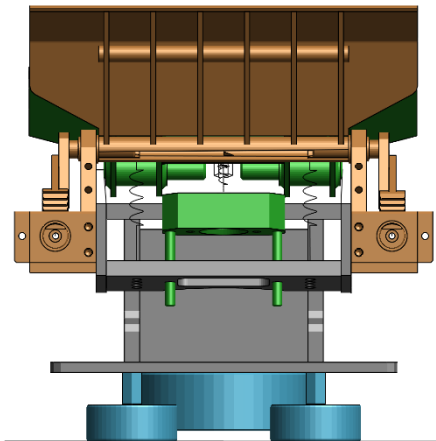
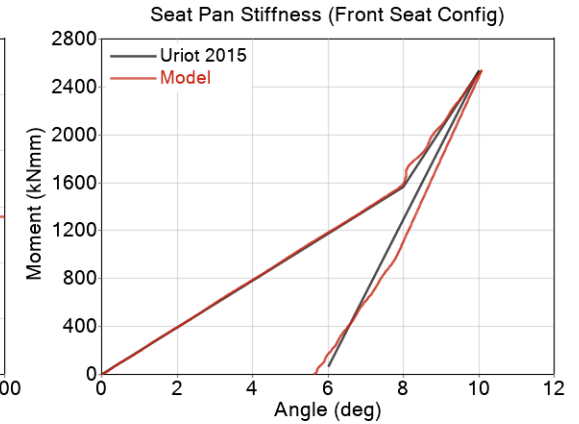
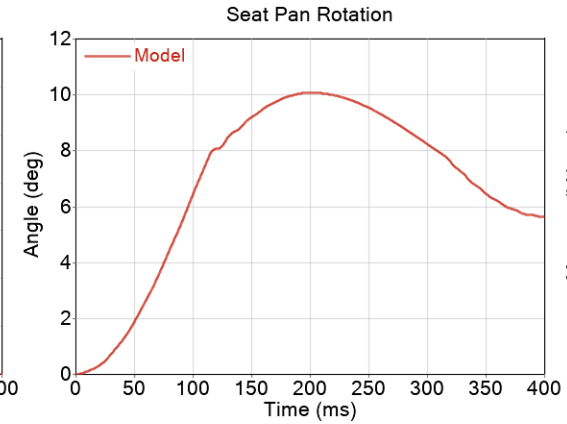
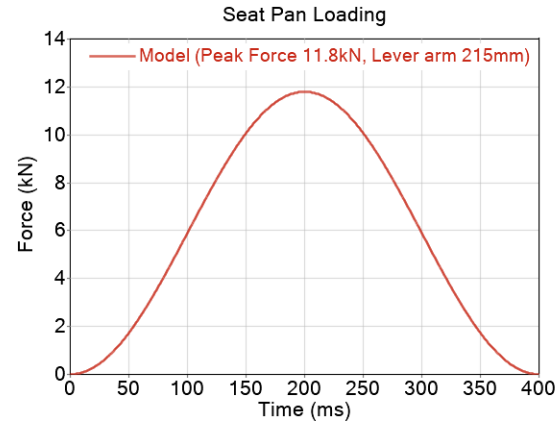
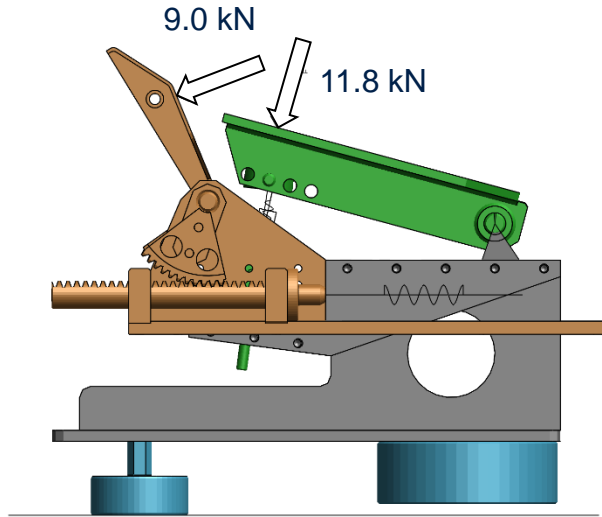
The semi-rigid seat model was validated to published moment-rotation characteristics (Uriot 2015) in three configurations:

1. Front Seat Configuration with anti-rebound device
2. Front Seat Configuration without anti-rebound device
3. Rear Seat Configuration with anti-rebound device

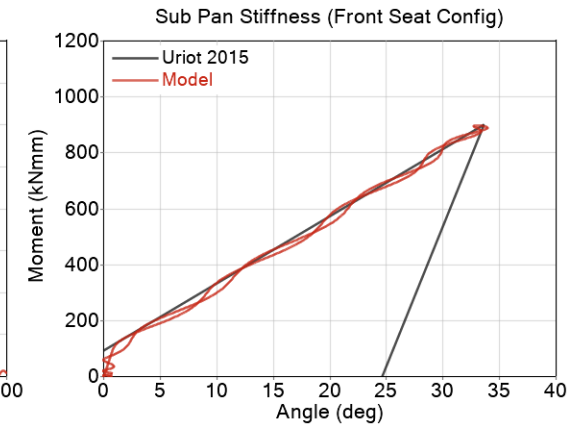
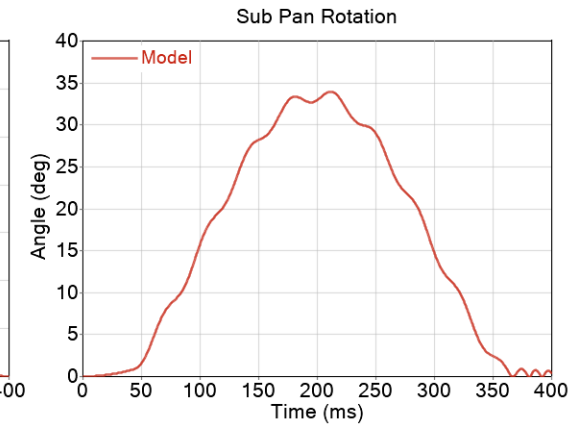
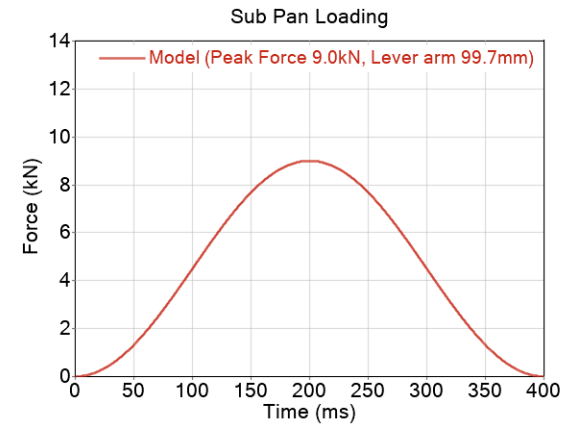
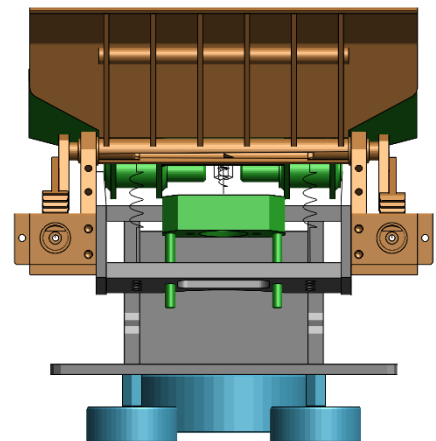
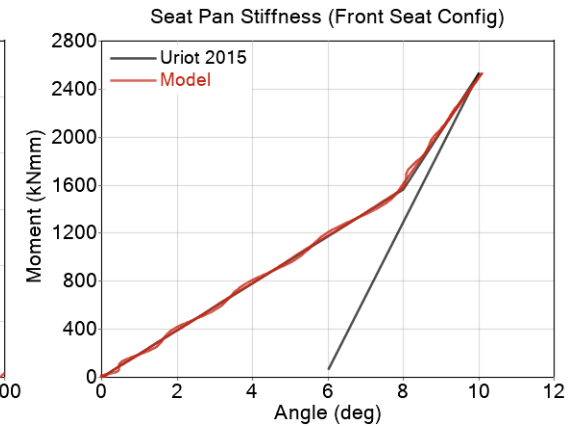
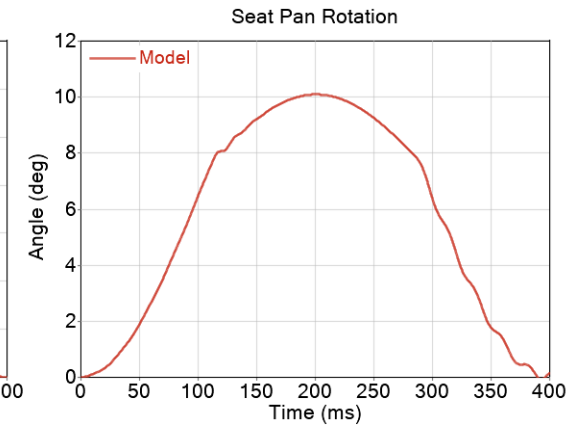
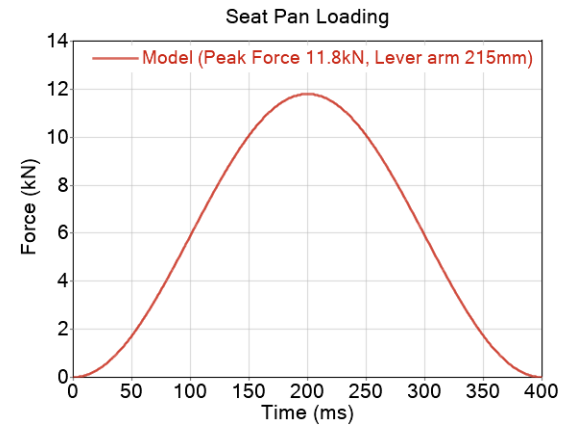
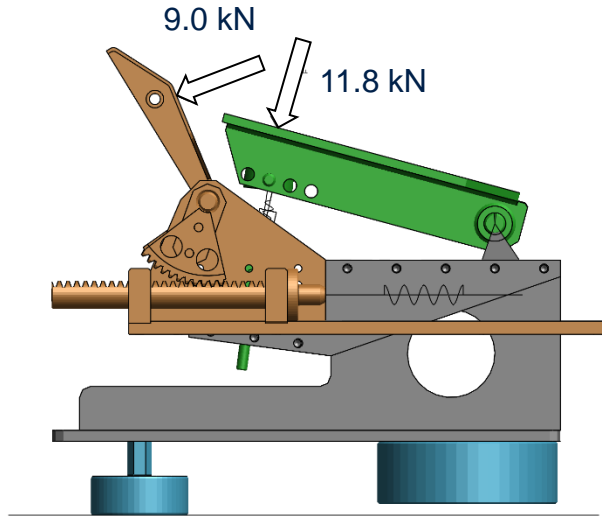
Point loads are applied normal to the seat and sub pan surfaces during the whole simulation run.

Seat Parameter	1 Front Seat Configuration (With Anti- Rebound Device)	2 Front Seat Configuration (Without Anti- Rebound Device)	3 Rear Seat Configuration (With Anti- Rebound Device)
Anti-rebound device	1 (on)	0 (off)	1 (on)
Seat pan initial y-angle (deg)	15.0 deg	15.0 deg	15.0 deg
Sub pan assembly initial vertical position (mm)	0.0 mm	0.0 mm	-30.0 mm
Sub pan assembly initial y-angle (deg)	32.5 deg	32.5 deg	32.5 deg
Seat pan side spring stiffness (N/mm)	128 N/mm	128 N/mm	37 N/mm
Seat pan center spring stiffness (N/mm)	350 N/mm	350 N/mm	350 N/mm
Sub pan spring stiffness (N/mm)	123 N/mm	123 N/mm	37 N/mm
Seat pan initial gap (mm)	28.0 mm	28.0 mm	28.0 mm

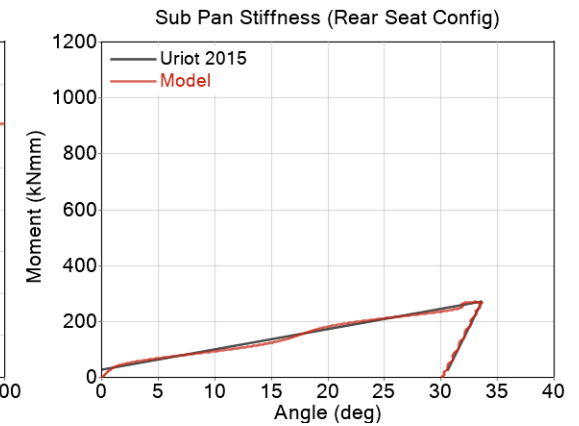
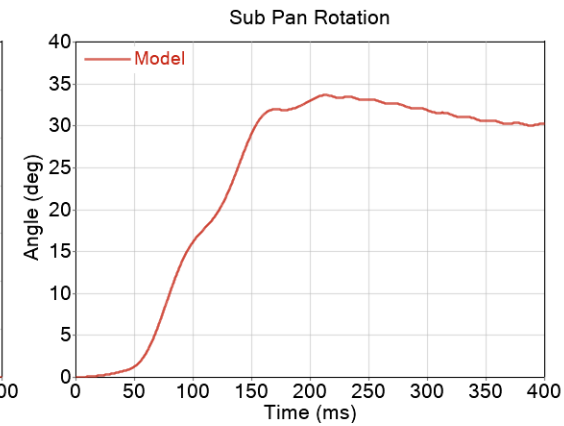
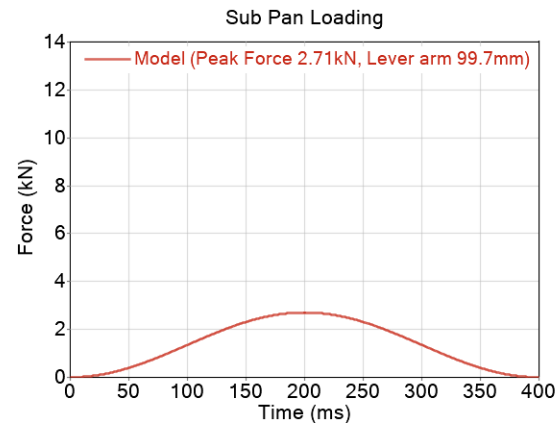
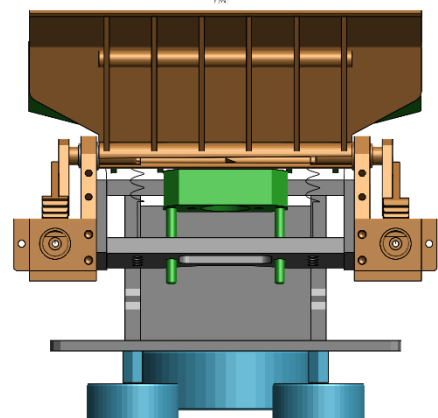
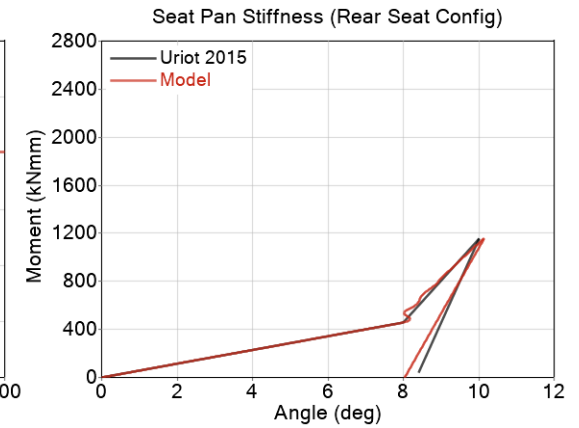
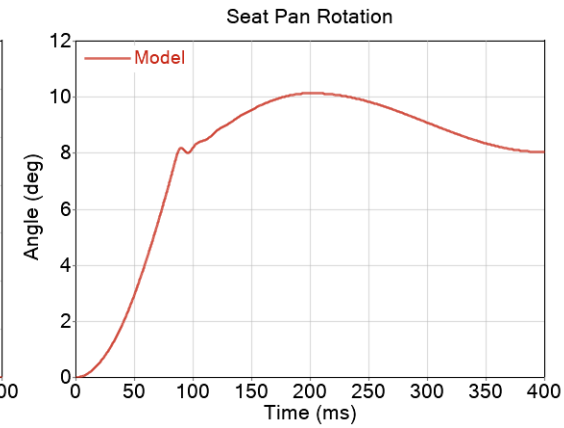
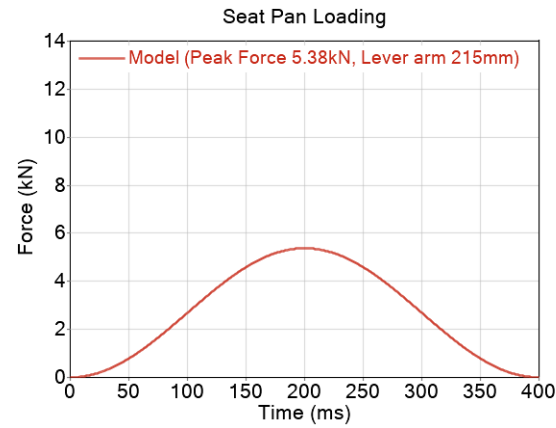
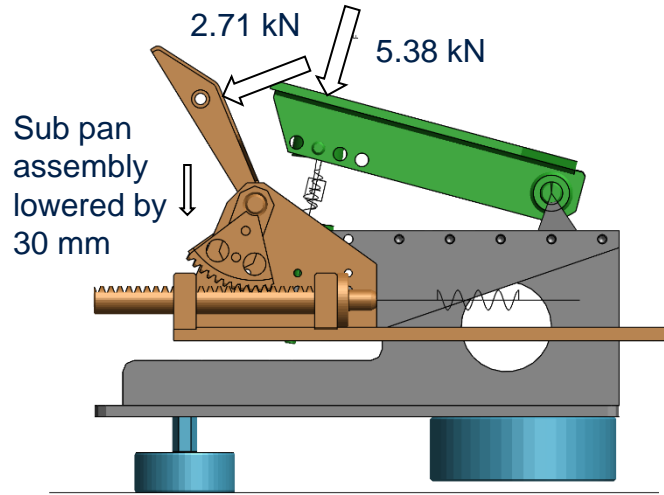
Validation – Front Seat Configuration (With Anti-Rebound Device)



Validation – Front Seat Configuration (Without Anti-Rebound Device)



Validation – Rear Seat Configuration (With Anti-Rebound Device)



- Uriot, J., Potier, P., Baudrit, P., Trosseille, X. et al., "Reference PMHS Sled Tests to Assess Submarining", Stapp Car Crash Journal, 2015 Nov; 59:203-23.
- Richardson, R., Donlon, J-P., Jayathirtha, M., Forman, J.L. et al., Shaw, G., Gepner, B., Kerrigan, J.R., Ostling, M., Mroz, K., Pipkorn, B., "Kinematic and Injury Response of Reclined PMHS in Frontal Impacts", Stapp Car Crash Journal Vol. 64, 2020.