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STUDY ON IMPACT RESPONSE (INJURY VALUE) VARIATION FACTORS FOR BIORID-II DUMMIES

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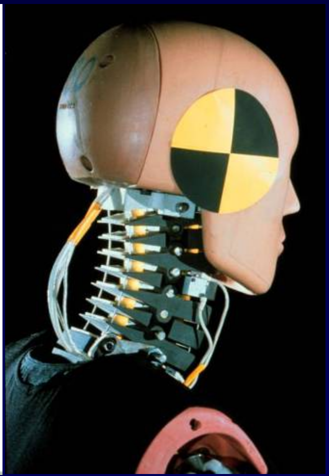
UN ECE/WP29 GRSP

gtr No.7 (“Head Restraint gtr Informal Meeting”) → Phase2, since 2009/12

→ a injury criteria, a test method of sled test etc. are being discussed.

→ As for the dummy, BioRID-II is being used.

BioRID-II (**Bio**fidelic **R**ear **I**mpact **D**ummy **- II**)



Characteristics:

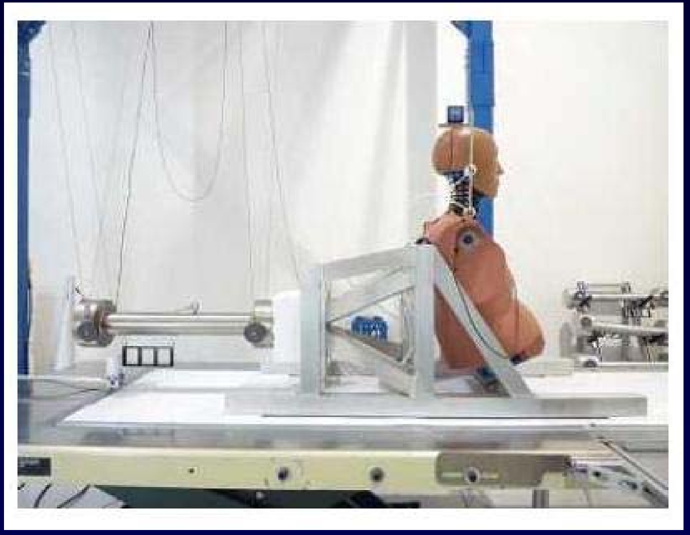
- Most biofidelic dummy among Rear Impact Dummies
- Spine comprising of 24 vertebrae
- Mechanical characteristics resemble the responses of human body parts in volunteer sled tests.

Repeatability of Sled test is Important.

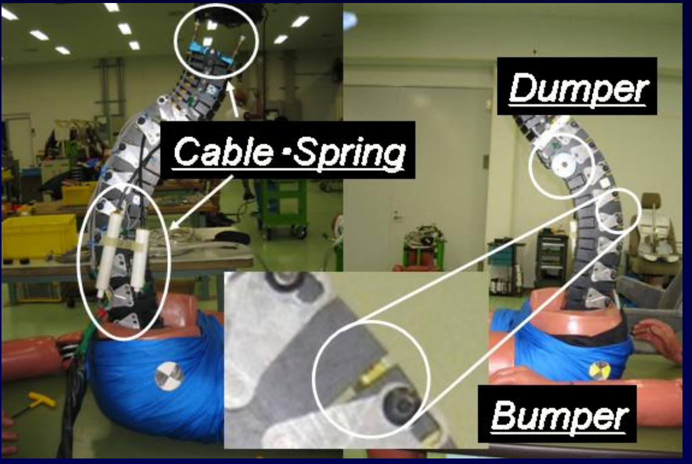
Example of factors for the variation in BioRID-II

Individual differences of dummies	Adjustment condition of the dummy in Calibration test	Dummy’s setting in Sled test

Calibration test method for BioRID-II



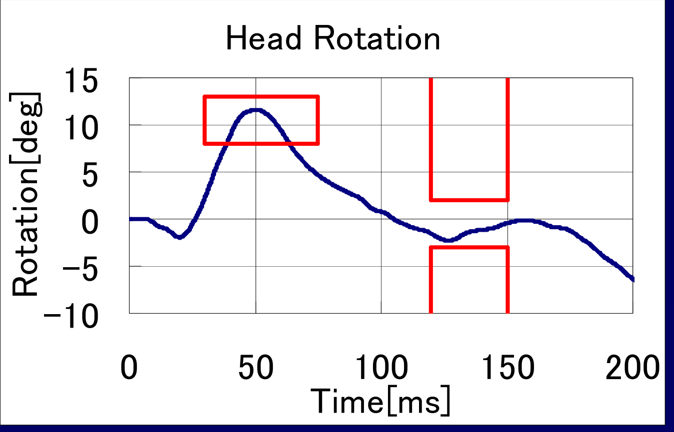
Adjustment Parameter



Measurement Parameter (Example)

Pot.A：Head Rotation
Pot.B：Neck Link Rotation
Pot.C:T1 Rotation

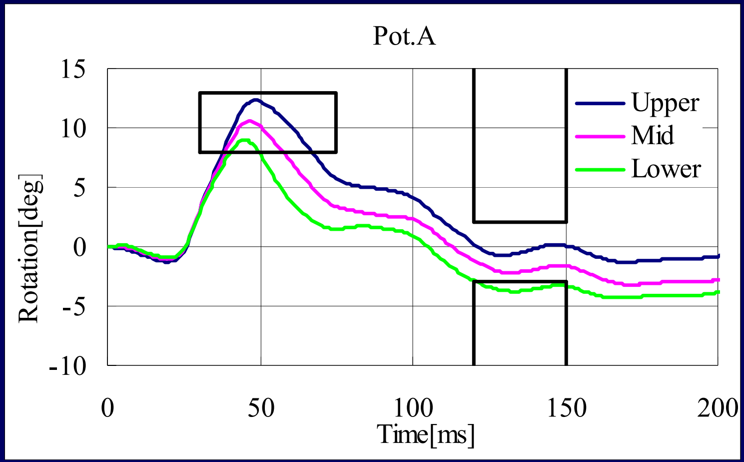
Corridor（Example）



Purpose of this study :

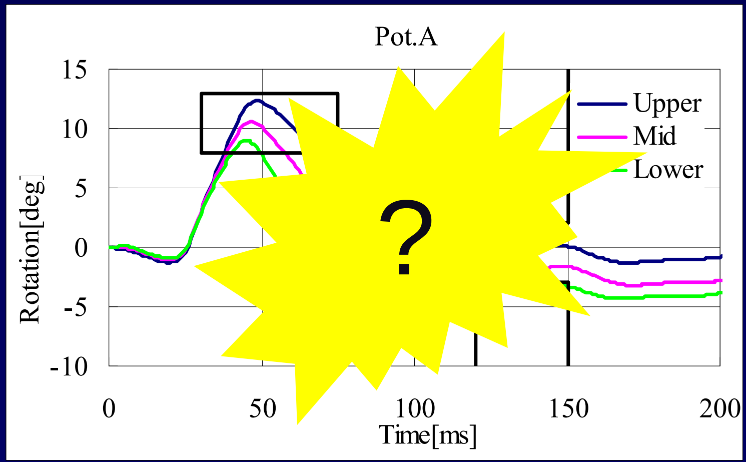
The focus of this research is on whether or not variations of the dummy in calibration testing affects dummy responses in rear impact sled test by using the simulation analysis.

Calibration Test



Variation

Sled Test



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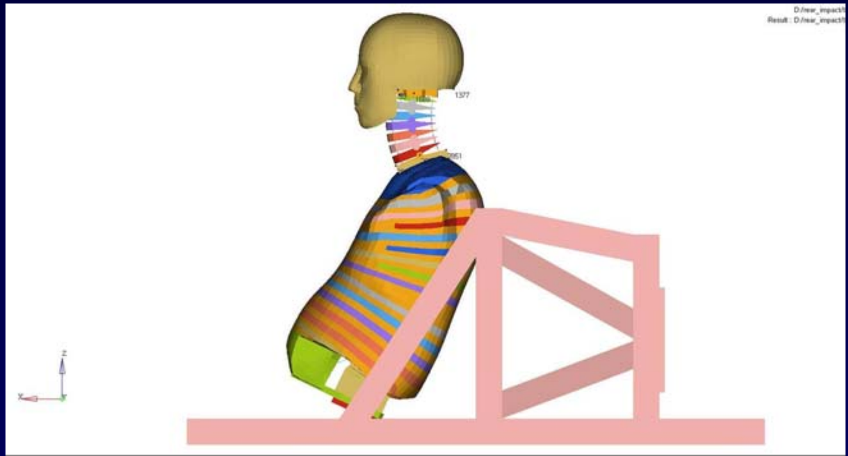
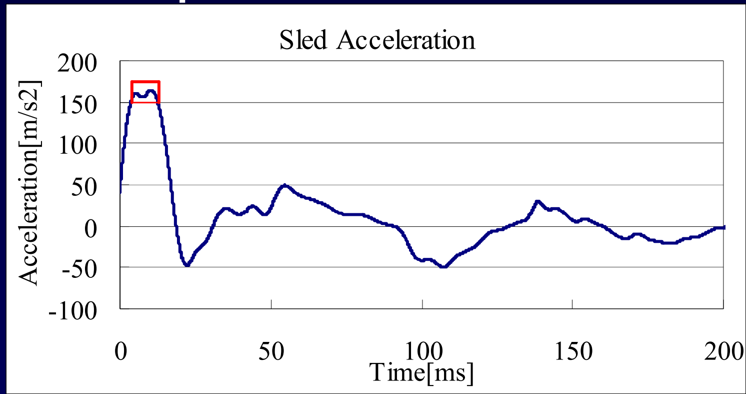
Simulation model of Calibration test

Solver : MADYMO Ver7. 2

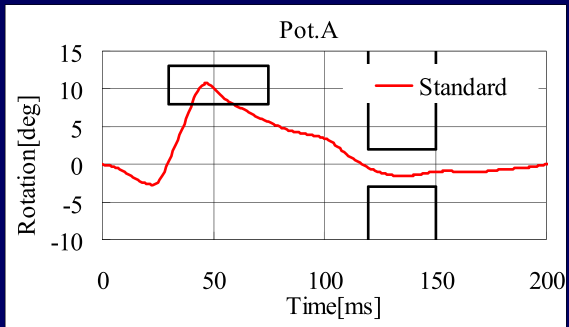
Dummy model : TASS･BioRID-II Facet Ver3. 0

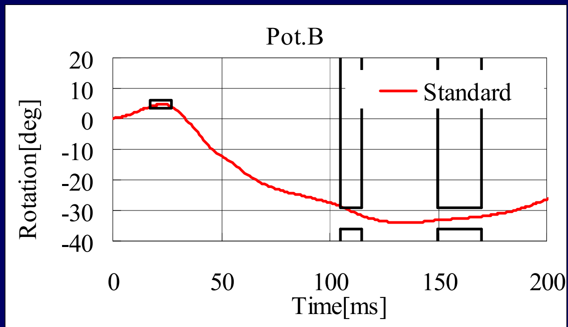


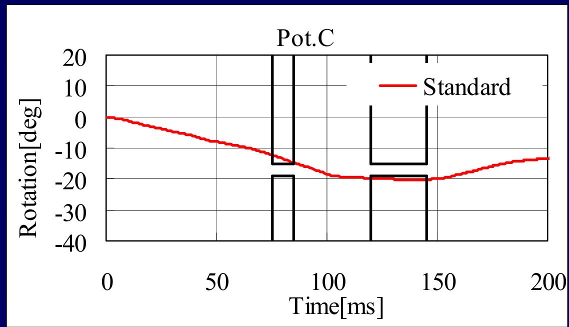
Input Acceleration



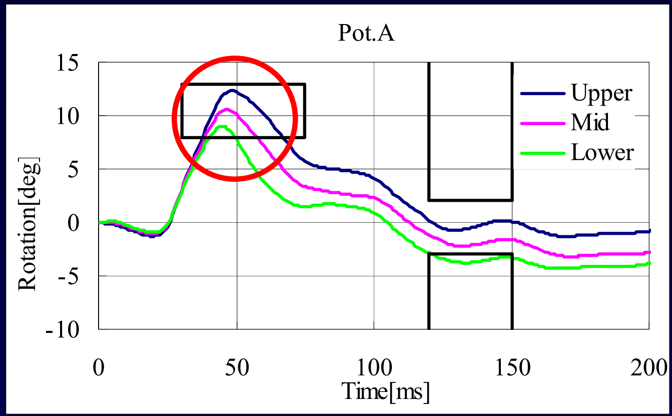
Parameter study was performed so that the corridor specified at the time of a calibration test might be satisfied.







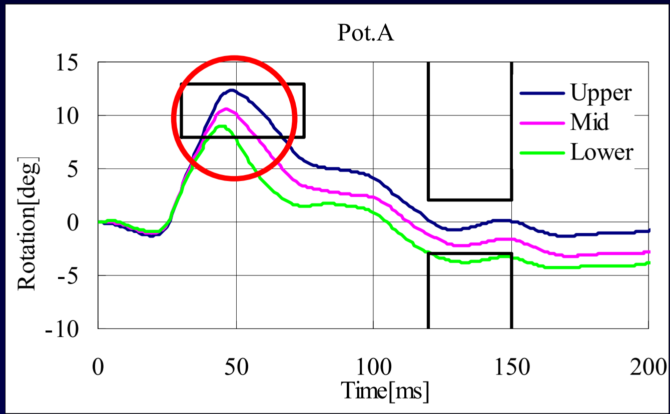
Setup of Simulation Parameters

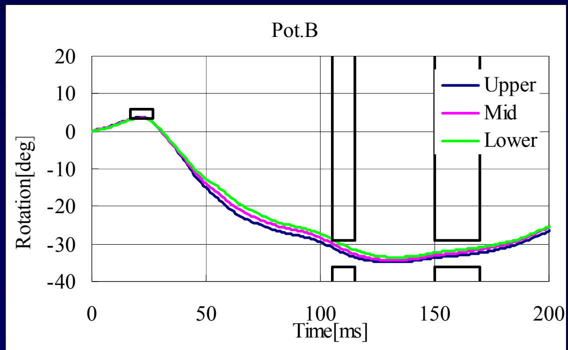


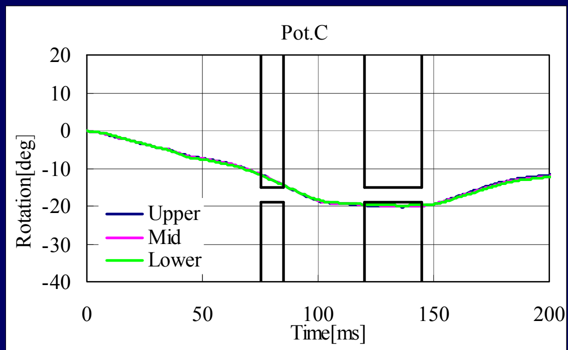
✓ Simulation models were produced for the cases of passing the upper, middle and lower portions of each corridor for Pot.A, Pot.B, and Pot.C.

✓ When a corridor in Pot.A was divided into upper, middle and lower portions, conditions were made so that all the other corridors in Pot.B and Pot.C would, as much as possible, be satisfied.

Simulation Parameter of Pot.A





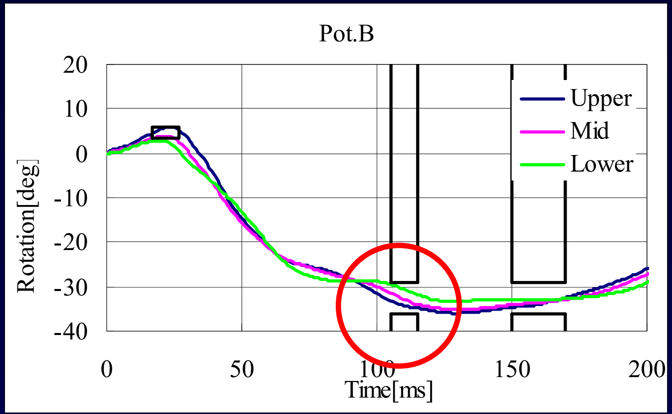


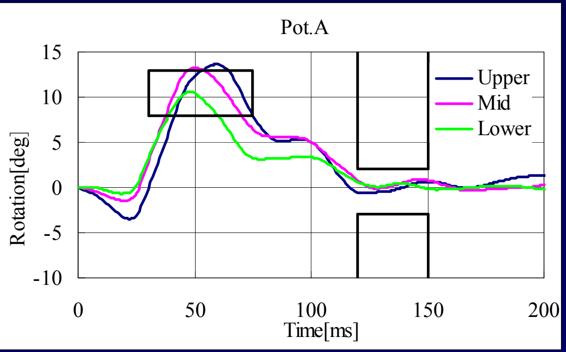
Modifying the characteristics of the simulation model's cervical spine joint covering C1-C2

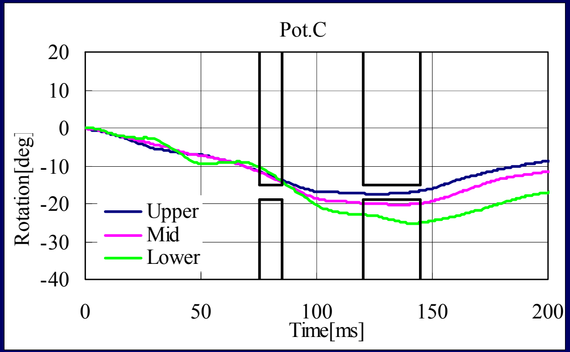
Upper	0.7
Middle	0.3
Lower	0.15

Unit：Times

Simulation Parameter of Pot.B







Modifying the characteristics of the simulation model's cervical spine joint covering C1-C2

Upper	0.005
Middle	0.1
Lower	0.25

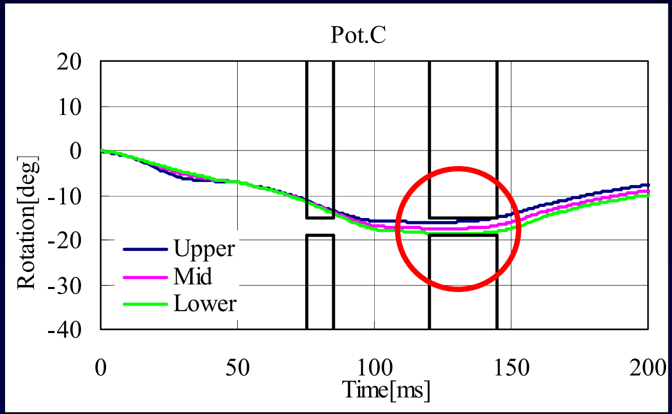
Unit：Times

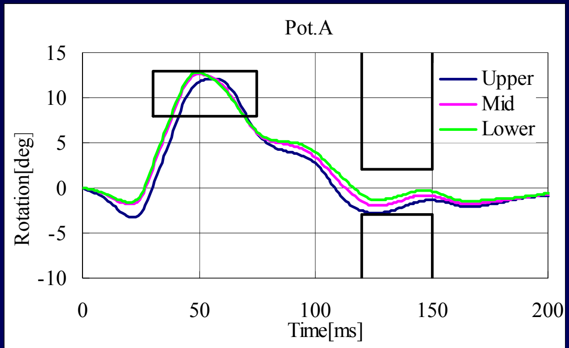
Modifying the characteristics of the simulation model's thoracic spine joint covering C7-T1 and T1-T12

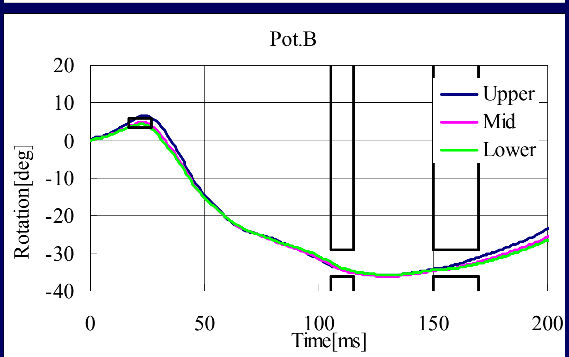
Upper	12
Middle	6
Lower	1

Unit：Times

Simulation Parameter of Pot.C







Modifying the characteristics of the simulation model's cervical spine joint covering C1-C2

Upper	0.025
Middle	0.08
Lower	0.1

Unit：Times

Modifying the characteristics of the simulation model's thoracic spine joint covering C7-T1

Upper	12
Middle	6
Lower	6

Unit：Times

Modifying the characteristics of the simulation model's thoracic spine joint covering T1-T12

Upper	18
Middle	12
Lower	9

Unit：Times

Result of Simulation

Pot.A	NIC [m²/s²]	UpperNeck FX [N]	UpperNeck FZ [N]	UpperNeck MY-Flx. [Nm]	UpperNeck MY-Ext. [Nm]	LowerNeck FX [N]	LowerNeck FZ [N]	LowerNeck MY-Flx. [Nm]	LowerNeck MY-Ext. [Nm]
Upper	51.1	235.4	220.5	11.8	-16.4	280.7	230.9	2.0	-35.2
Mid	50.3	228.9	210.7	13.4	-15.0	272.0	218.3	2.1	-33.4
Lower	49.3	224.6	237.2	15.0	-14.0	263.2	242.0	1.9	-32.5
Average	50.2	229.6	222.8	13.4	-15.1	272.0	230.4	2.0	-33.7
S.D.	0.9	5.5	13.4	1.6	1.2	8.8	11.9	0.1	1.4
C.V.[%]	1.8	2.4	6.0	12.0	7.7	3.2	5.2	5.8	4.1

Pot.B	NIC [m²/s²]	UpperNeck FX [N]	UpperNeck FZ [N]	UpperNeck MY-Flx. [Nm]	UpperNeck MY-Ext. [Nm]	LowerNeck FX [N]	LowerNeck FZ [N]	LowerNeck MY-Flx. [Nm]	LowerNeck MY-Ext. [Nm]
Upper	49.3	306.7	209.3	8.8	-20.1	318.5	234.3	1.8	-41.2
Mid	51.4	245.1	222.8	10.9	-17.2	285.2	235.1	2.0	-36.2
Lower	48.9	173.9	222.6	13.6	-18.0	247.9	226.6	1.6	-23.0
Average	49.8	241.9	218.2	11.1	-18.5	283.9	232.0	1.8	-33.4
S.D.	1.3	66.5	7.7	2.4	1.5	35.3	4.7	0.2	9.4
C.V.[%]	2.7	27.5	3.5	21.5	8.1	12.4	2.0	13.6	28.1

Pot.C	NIC [m²/s²]	UpperNeck FX [N]	UpperNeck FZ [N]	UpperNeck MY-Flx. [Nm]	UpperNeck MY-Ext. [Nm]	LowerNeck FX [N]	LowerNeck FZ [N]	LowerNeck MY-Flx. [Nm]	LowerNeck MY-Ext. [Nm]
Upper	47.0	331.0	222.8	10.7	-17.6	340.4	249.9	2.3	-44.0
Mid	49.5	268.6	243.5	11.5	-17.4	318.4	266.1	1.6	-39.8
Lower	50.3	259.9	231.0	11.3	-17.8	308.9	246.5	1.6	-38.3
Average	48.9	286.5	232.4	11.2	-17.6	322.5	254.2	1.9	-40.7
S.D.	1.7	38.8	10.4	0.4	0.2	16.2	10.4	0.4	2.9
C.V.[%]	3.6	13.5	4.5	3.7	1.0	5.0	4.1	21.7	7.2

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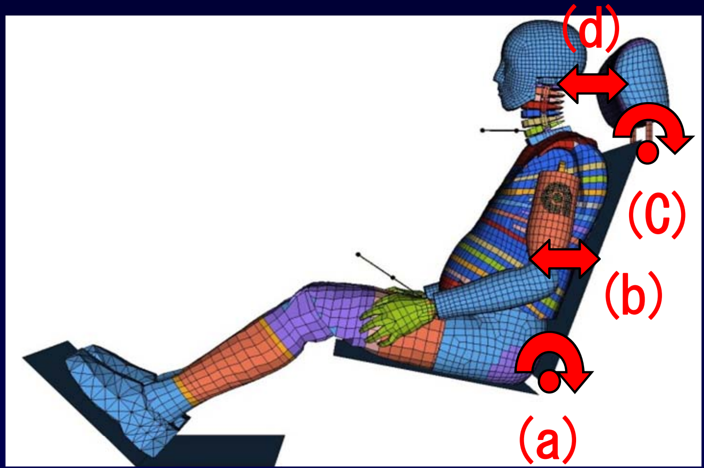
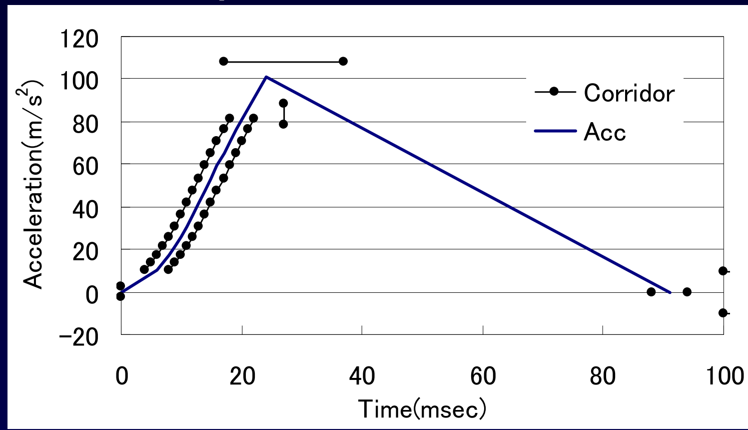
Simulation model of Sled test



(a)(b)(c)(d) were adjusted to the seat characteristics of static test.

Input Acceleration



Dummy Setting

Initial Position of Dummy		
Backset	60	mm
Head − HeadRestraint(Height)	42	mm
Head Angle	0	deg
Pelvis Angle	22	deg
SeatBack Angle	20	deg

Solver : MADYMO Ver7．2
Dummy model : TASS･BioRID-II Facet Ver3．0
Seat model : simple model（head restraint, seatback and seat cushion）

- The simulation parameters, same as a calibration test.

Result of Simulation

Pot.A	NIC [m²/s²]	UpperNeck FX [N]	UpperNeck FZ [N]	UpperNeck MY-Flx. [Nm]	UpperNeck MY-Ext. [Nm]	LowerNeck FX [N]	LowerNeck FZ [N]	LowerNeck MY-Flx. [Nm]	LowerNeck MY-Ext. [Nm]
Upper	24.0	152.3	1058.1	20.9	-12.0	672.0	711.9	11.8	-32.2
Mid	24.0	150.7	1050.8	26.6	-12.7	678.4	704.3	10.2	-32.4
Lower	23.4	149.4	1040.2	37.2	-12.5	665.5	693.5	9.2	-32.2
Average	23.8	150.8	1049.7	28.2	-12.4	672.0	703.3	10.4	-32.3
S.D.	0.3	1.4	9.0	8.2	0.4	6.4	9.2	1.3	0.1
C.V.[%]	1.3	1.0	0.9	29.2	3.0	1.0	1.3	12.6	0.3

Pot.B	NIC [m²/s²]	UpperNeck FX [N]	UpperNeck FZ [N]	UpperNeck MY-Flx. [Nm]	UpperNeck MY-Ext. [Nm]	LowerNeck FX [N]	LowerNeck FZ [N]	LowerNeck MY-Flx. [Nm]	LowerNeck MY-Ext. [Nm]
Upper	23.1	174.5	1035.1	20.0	-7.1	724.2	675.6	13.4	-34.9
Mid	24.3	155.1	1066.9	19.3	-11.3	671.9	715.8	13.0	-31.9
Lower	20.1	130.3	1071.4	32.7	-9.3	625.1	684.3	9.3	-27.5
Average	22.5	153.3	1057.8	24.0	-9.2	673.7	691.9	11.9	-31.4
S.D.	2.2	22.2	19.8	7.6	2.1	49.6	21.1	2.3	3.7
C.V.[%]	9.6	14.5	1.9	31.5	22.7	7.4	3.1	19.0	11.9

Pot.C	NIC [m²/s²]	UpperNeck FX [N]	UpperNeck FZ [N]	UpperNeck MY-Flx. [Nm]	UpperNeck MY-Ext. [Nm]	LowerNeck FX [N]	LowerNeck FZ [N]	LowerNeck MY-Flx. [Nm]	LowerNeck MY-Ext. [Nm]
Upper	23.0	146.1	1040.4	16.2	-8.0	721.2	638.7	14.4	-35.0
Mid	23.4	167.6	1043.1	17.5	-10.2	725.4	677.6	13.5	-35.3
Lower	24.2	159.4	1060.1	18.3	-11.3	685.0	710.3	13.6	-32.8
Average	23.5	157.7	1047.9	17.3	-9.8	710.5	675.5	13.8	-34.4
S.D.	0.6	10.9	10.7	1.1	1.7	22.2	35.8	0.5	1.4
C.V.[%]	2.6	6.9	1.0	6.3	17.1	3.1	5.3	3.6	4.0

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1. Background
2. Simulation Analysis of Calibration tests
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Comparison of Variations between Calibration Tests and Sled Tests (C.V.)

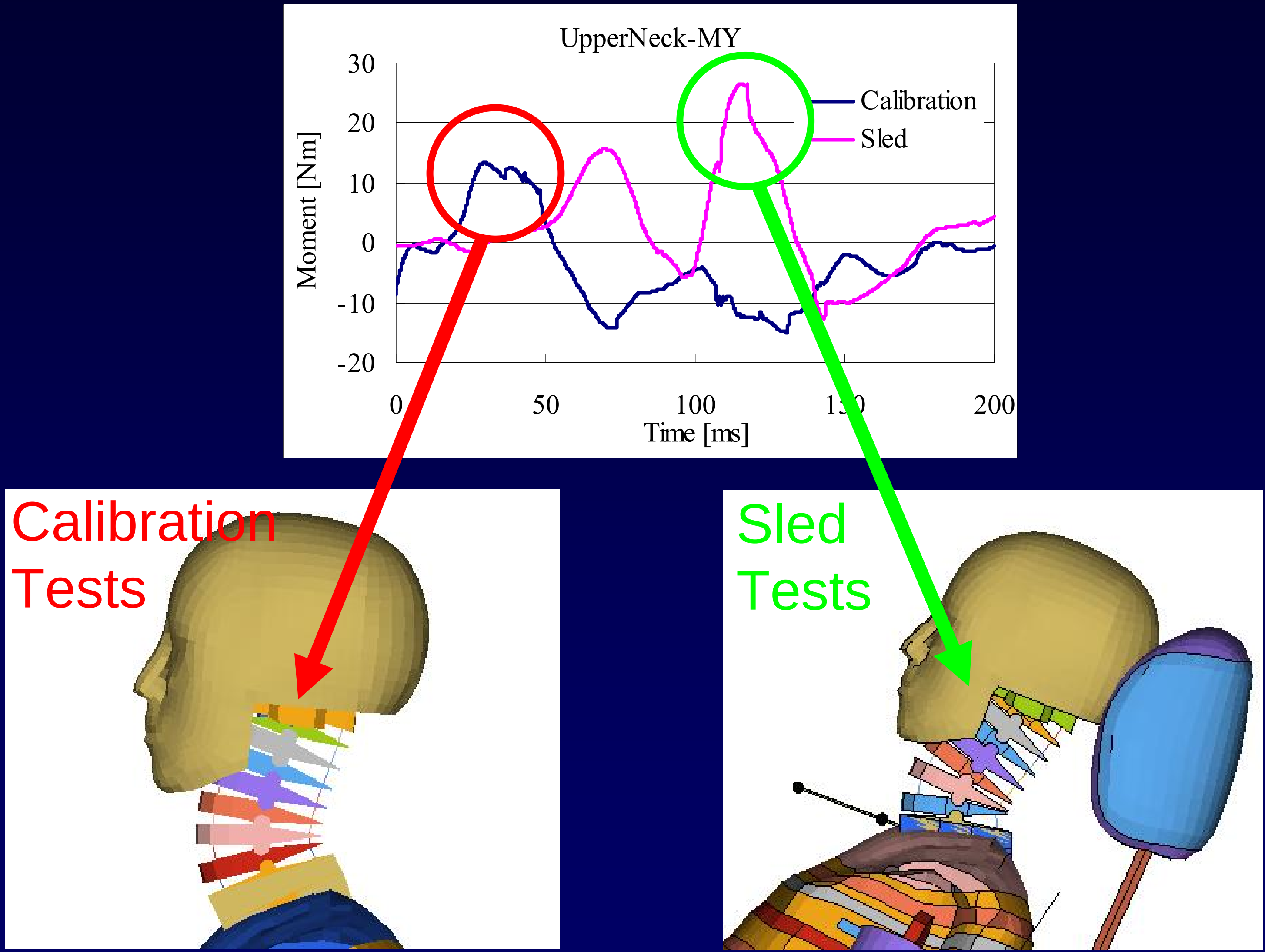
Pot.A	NIC [m²/s²]	UpperNeck FX [N]	UpperNeck FZ [N]	UpperNeck MY-Flx. [Nm]	UpperNeck MY-Ext. [Nm]	LowerNeck FX [N]	LowerNeck FZ [N]	LowerNeck MY-Flx. [Nm]	LowerNeck MY-Ext. [Nm]
Calibration	1.8	2.4	6.0	12.0	7.7	3.2	5.2	5.8	4.1
Sled	1.3	1.0	0.9	29.2	3.0	1.0	1.3	12.6	0.3

Pot.B	NIC [m²/s²]	UpperNeck FX [N]	UpperNeck FZ [N]	UpperNeck MY-Flx. [Nm]	UpperNeck MY-Ext. [Nm]	LowerNeck FX [N]	LowerNeck FZ [N]	LowerNeck MY-Flx. [Nm]	LowerNeck MY-Ext. [Nm]
Calibration	2.7	27.5	3.5	21.5	8.1	12.4	2.0	13.6	28.1
Sled	9.6	14.5	1.9	31.5	22.7	7.4	3.1	19.0	11.9

Pot.C	NIC [m²/s²]	UpperNeck FX [N]	UpperNeck FZ [N]	UpperNeck MY-Flx. [Nm]	UpperNeck MY-Ext. [Nm]	LowerNeck FX [N]	LowerNeck FZ [N]	LowerNeck MY-Flx. [Nm]	LowerNeck MY-Ext. [Nm]
Calibration	3.6	13.5	4.5	3.7	1.0	5.0	4.1	21.7	7.2
Sled	2.6	6.9	1.0	6.3	17.1	3.1	5.3	3.6	4.0

- The results indicated that most of the dummy’s injury values with a large C.V. in the calibration test also gave a large C.V. in the sled test.
- The rotation angle with the largest variations of the dummy’s injury value is Pot.B.

Difference of conditions of the neck（Pot.A）



➢ The configuration of the neck is different.

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Conclusion

The results of the study indicated that if variations of dummy's injury value are generated in the calibration test, the similar variations will be generated in the sled test.

→ It will be possible to reduce injury value variations in sled test by reducing such variations in the calibration test.

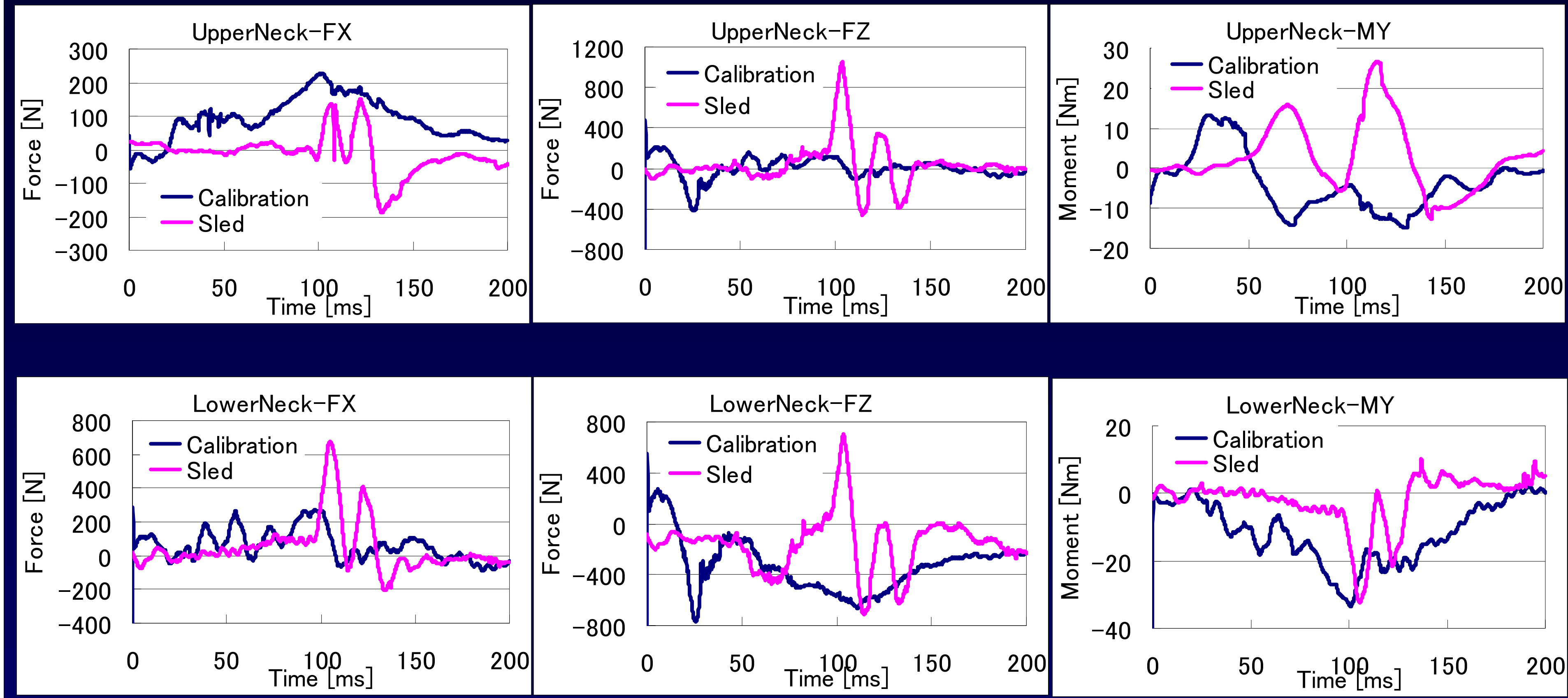
→ But, in the current calibration test without headrest, the dummy motion and behavior differed from that of the sled test.

→ Consequently, it may be possible to reduce injury value variations by reproducing in the calibration tests the similar dummy behavior observed in the sled test.

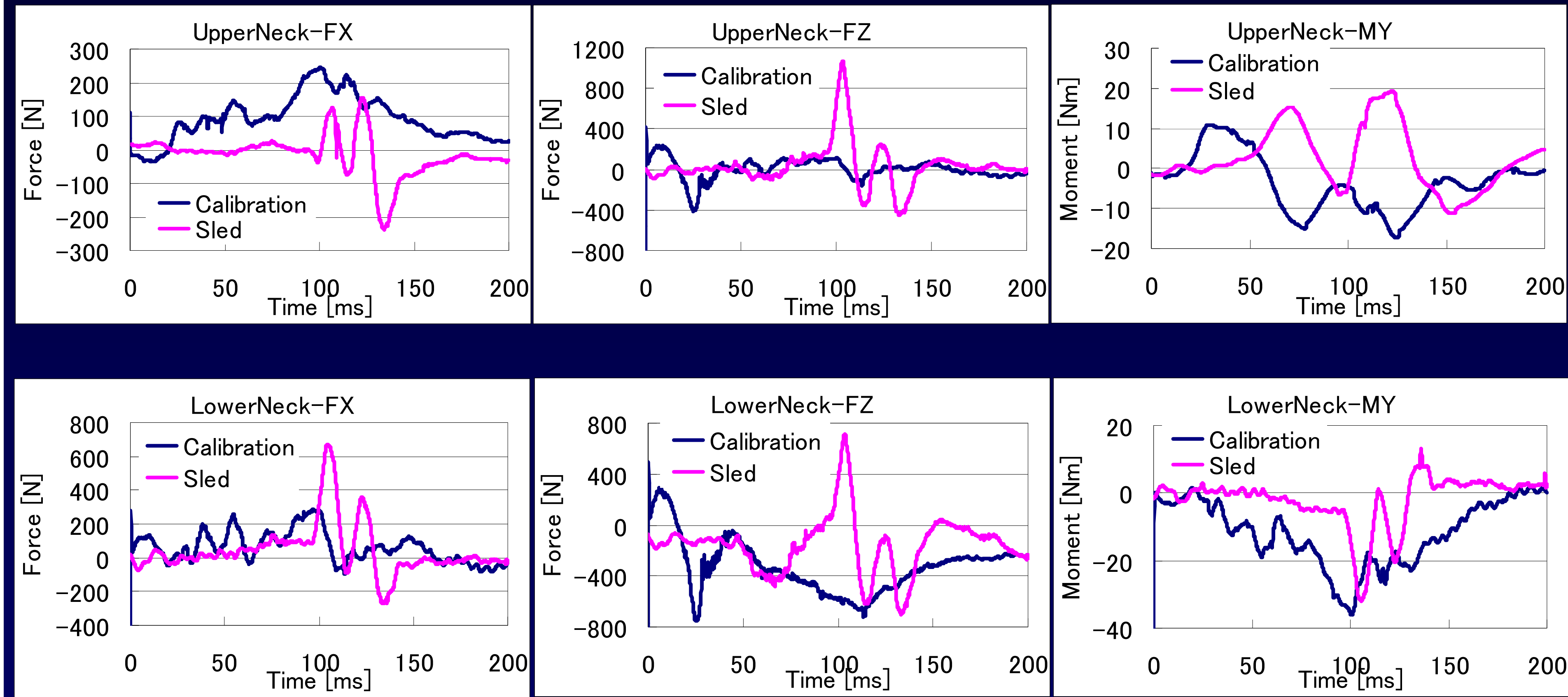
→ As a future topic for research, the current calibration test without headrest needs to be reviewed, and it is also thought that the new calibration test method with headrest is also required.

Thank you for your attention

Waveform(Pot.A)



Waveform（Pot.B）



Waveform（Pot.C）