



Review the BioRIDII Setting & Pulse Tolerances by FE Simulation

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Korea Automobile Testing and Research Institute**

Objective of research

□ Objectives

- To provide justification for the reduction of tolerance for BioRID II setting & acceleration pulse in the test procedures by analyzing the variations of test results due to various tolerance levels
- ❖ Computer simulation was utilized because of difficulties in repeating dummy setting & acceleration pulse in real tests

□ Method

- Tools (LS-Dyna program)
 - Seat : sedan driver FE seat model (element 108,528ea)
 - Dummy : FAT BioRID II g ver 2.5 (element 189,556 ea)
- Design of Variables : Design of experiment using the orthogonal arrays
- Analysis : ANOM(analysis of means) & coefficient variation(CV)
- BioRID II neck injury Indicators : HRCT, T1 acc, U_Fx, U_Fz, NIC, Nkm, HRV

Tolerance & DOE Factors

❑ Tolerance (NCAP)

▪ BioRID II setting

Location	Target measure	Tolerance
H-point (X-axis)	+20mm Forward	±10mm
H-point (Z-axis)	0mm	±10mm
Pelvis angle	26.5°	±2.5°
Head plane angle	0°	±1°
Backset	15mm Forward	±5mm

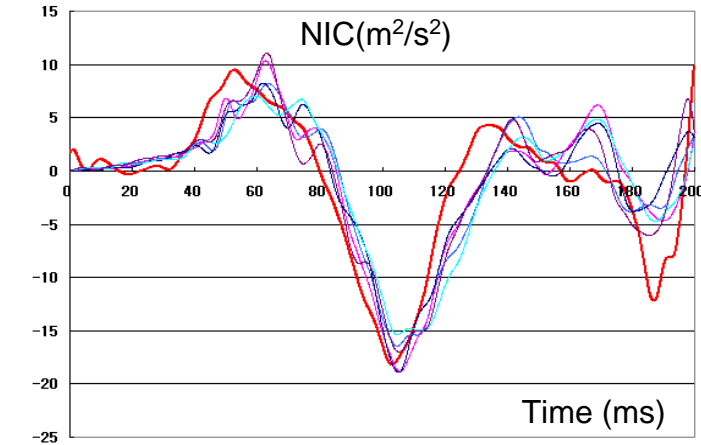
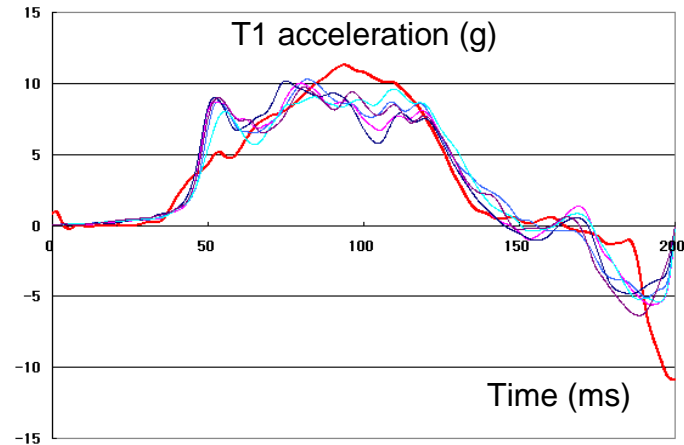
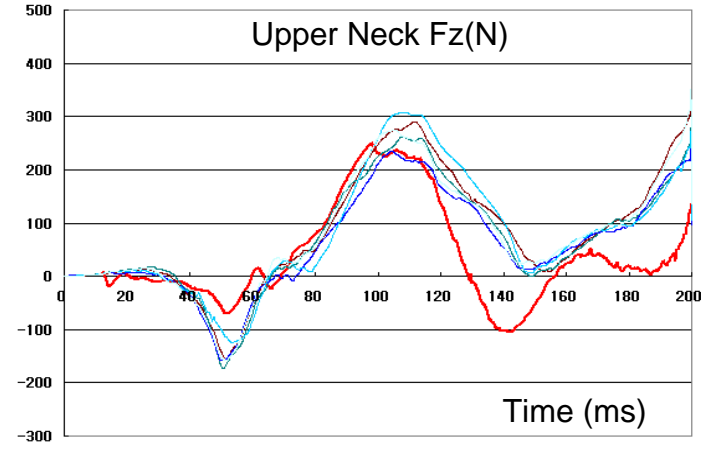
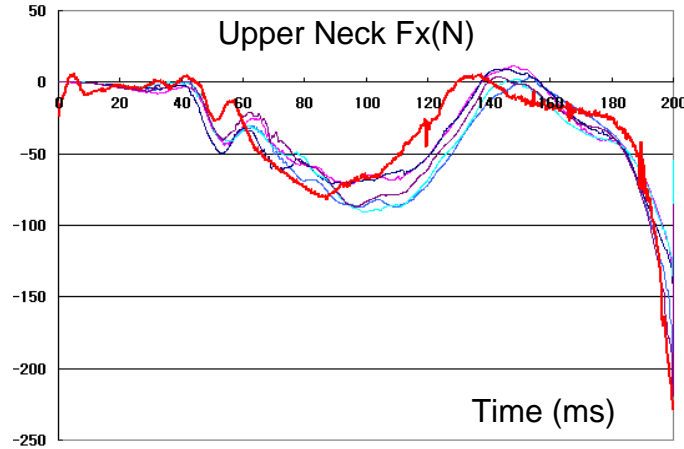
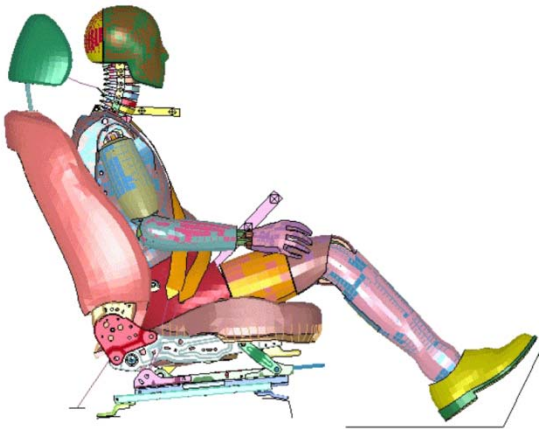
▪ Pulse

Acceleration	Min	Max
T=0 Acceleration	-0.25g	0.50g
T=27ms Acceleration	9.5g	10.5g
Duration time	88ms	94ms
Delta V	14.8km/h	16.2km/h

❑ Control factors & levels

Control factor			Level 1	Level 2	Level 3
A	H-Point	X direction	-10mm	0mm	+10mm
B		H direction	-10mm	0mm	+10mm
C	Dummy pelvis angle		25.5°	26.5°	27.5°
D	Test pulse		ΔV=14.85kph	ΔV=15.65kph	ΔV=16.45kph

Correlation for test & simulation



— : FE Simulation
others 5 lines : sled test results

DOE & Results by Simulation

L9 (3 ⁴)	A H-Point x-dir.	B H-Point z-dir	C Dummy Pelvis Angle	D Test Pulse Velocity	BioRID II Neck Injury Indicators						
					HRCT (ms)	T1 (g)	UN_Fx (N)	UN_Fz (N)	NIC (m ² /s ²)	Nkm	HRV (m/s)
1	1 -10mm	1 -10mm	1 25.5°	1 14.85 kph	57.9	12.7	0	305	15.91	0.19	3.8
2	1 -10mm	2 0mm	2 26.5°	2 15.65 kph	58.6	12.6	2.2	330	16.28	0.21	3.94
3	1 -10mm	3 +10mm	3 27.5°	3 16.45 kph	59.8	10.8	12.4	393	14.92	0.21	4
4	2 0mm	1 -10mm	2 26.5°	3 16.45 kph	58.2	12.5	1.6	343	15.94	0.19	3.85
5	2 0mm	2 0mm	3 27.5°	1 14.85 kph	57.8	11.3	2.9	370	16.42	0.21	3.85
6	2 0mm	3 +10mm	1 25.5°	2 15.65 kph	63	12.4	2.4	456	20.21	0.19	4.13
7	3 +10mm	1 -10mm	3 27.5°	2 15.65 kph	55.7	11.3	0.5	339	16.77	0.21	3.81
8	3 +10mm	2 0mm	1 25.5°	3 16.45 kph	60.3	12.3	2.6	411	18.59	0.17	3.95
9	3 +10mm	3 +10mm	2 26.5°	1 14.85kph	61.6	10.8	2.9	448	18.66	0.2	4.07

BioRID II Repeatability within Tolerance

□ Coefficient variation

Coefficient variation (CV)						
HRCT	T1	UN_Fx	UN_Fz	NIC	Nkm	HRV
3.7	6.7	119.5	14.1	9.9	7.0	2.9

$$CV = \frac{S_d}{\bar{X}} 100 (\%)$$

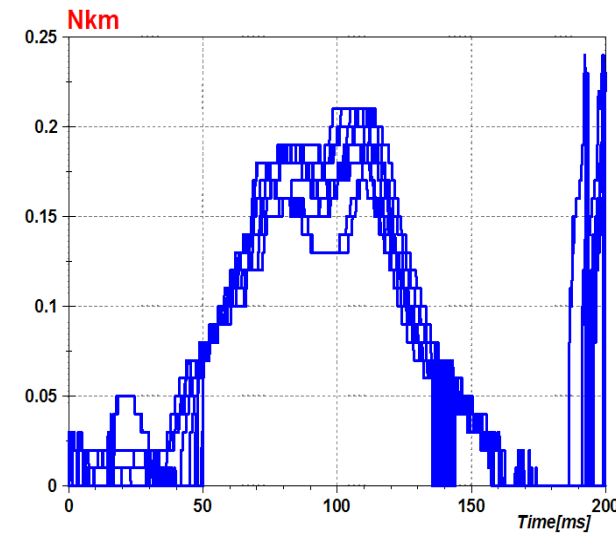
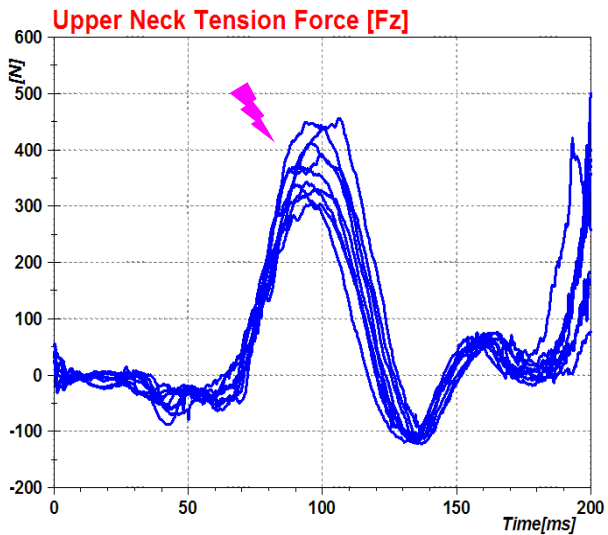
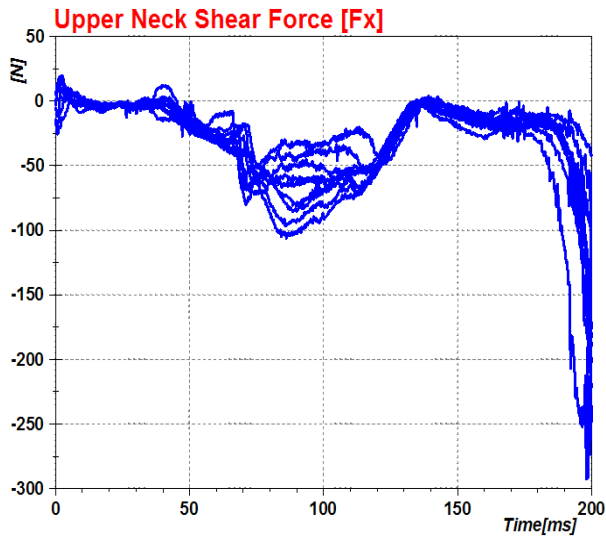
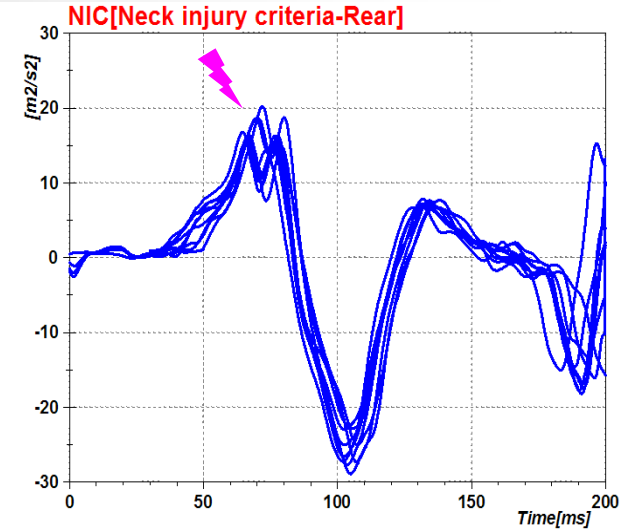
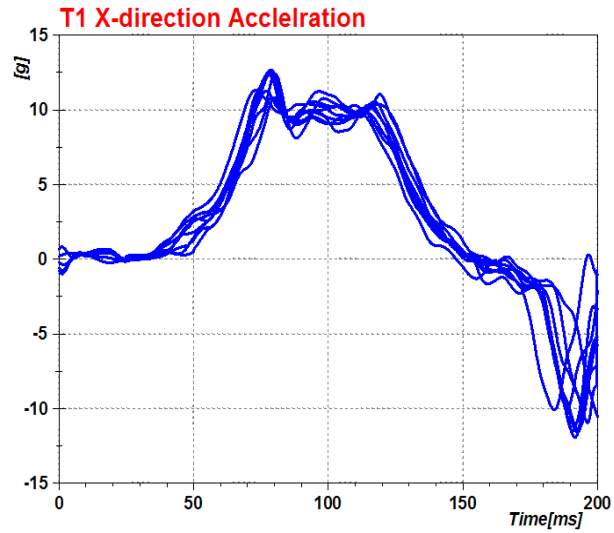
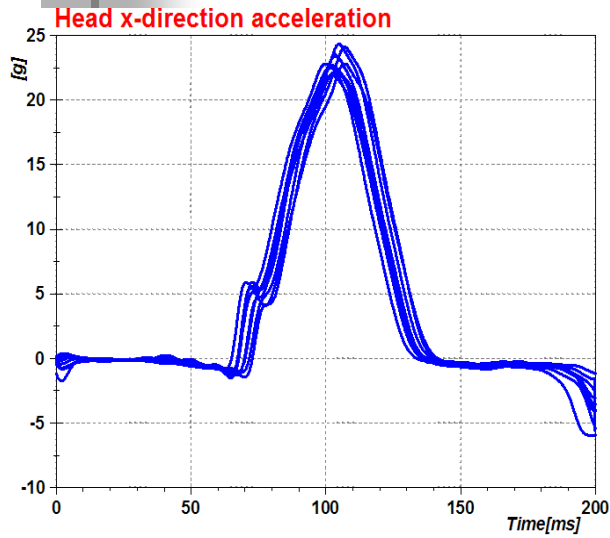
\bar{X} = Mean value

S_d = Standard deviation

** UN_Fx : This case is that mean value was grater than standard deviation

Times	1	2	3	4	5	6	7	8	9	Mean	
Max values(N)	0	2.2	12.4	1.6	2.9	2.4	0.5	2.6	2.9	3.06	3.65

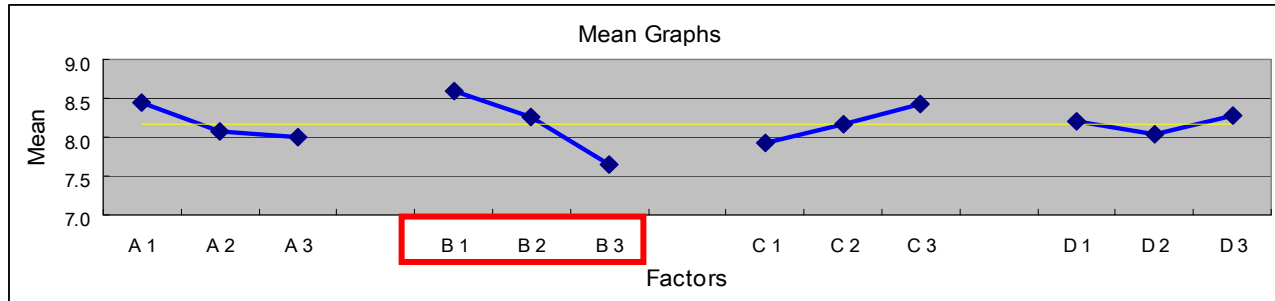
Graphs by Simulation



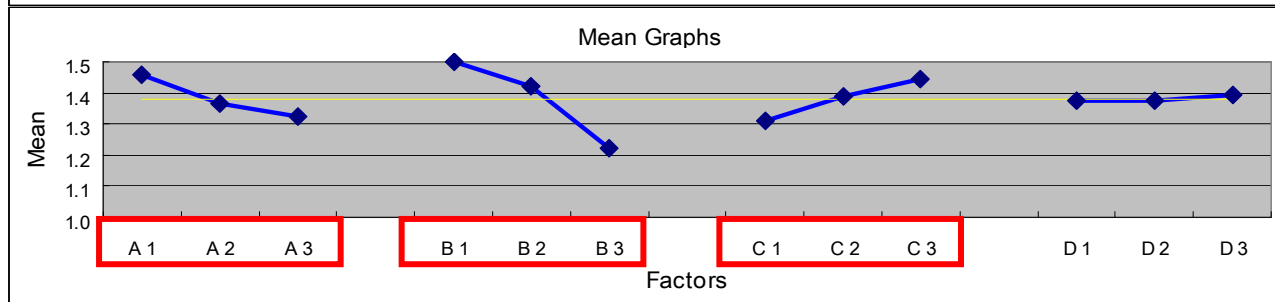
ANOM (Analysis of Mean)

ANOM by KNCAP score

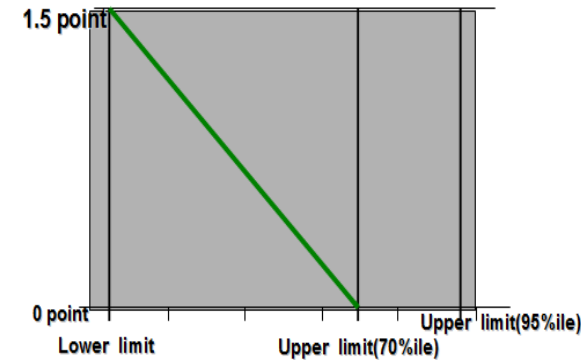
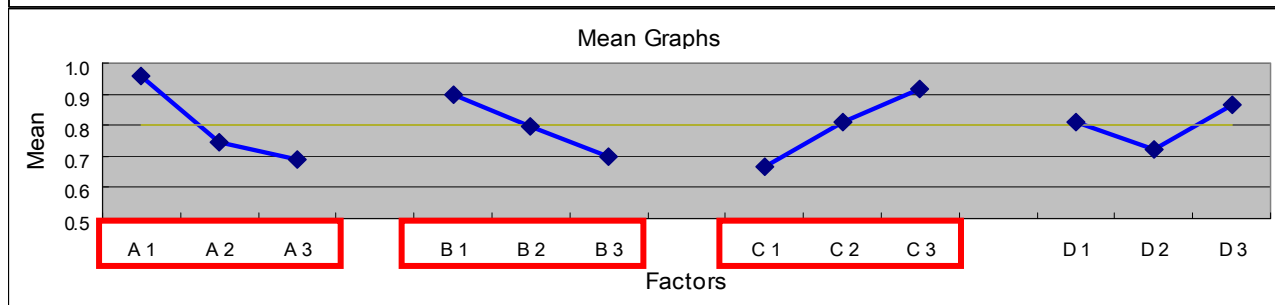
Over all score



UN_Fz score



NIC score



Method of the KNCAP score

A (H-point x-dir.), B (H-point z-dir.), C (dummy pelvis angle) affected the results

Summary

- Simulation results due to dummy setting & acceleration pulses variations designed with Orthogonal arrays
 - CV's of upper neck tension force among injury indicators exceeded 10 or were close to 10 even though simulation were carried out within tolerance limit
 - Something other than CV may be devised in case of upper neck shear force
 - Upper neck tension force & NIC were found to be sensitive to variations of H-point x & z, and pelvis angle in KNCAP evaluation
- Current low level of confidence in repeatability & reproducibility of real tests may be due to high tolerance of some factors for dummy
- Current tolerance for BioRID II setting should be reconsidered in establishing test procedures in the GTR No.7 2nd phase



Thank you for your attention

Q & A

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