Evaluation Test Methods for Gtr 7

Verification for the difference in the waveform configuration on the 095G dummy

JASIC/JAPAN

Verification Tests

In the calibration test without headrest（GTR7-06-06） conducted last year, the waveform configurations（phase shift） of 095G dummy were different from those of 102G dummy and 115G dummy. The causes of these differences were then investigated.

<u>Verification method and test condition</u>
095G dummy and 102G dummy were used, and verification test with exchanged jackets was performed. Calibration test without headrest using light probe was suggested, therefore, this verification test was also performed using light probe.

1) **095G Spine ＋ 102G Jacket**
2) **102G Spine ＋ 095G Jacket**

Calibration test with headrest was also performed according to the above conditions. And the factors analyzed include the difference in the waveform configuration, etc.
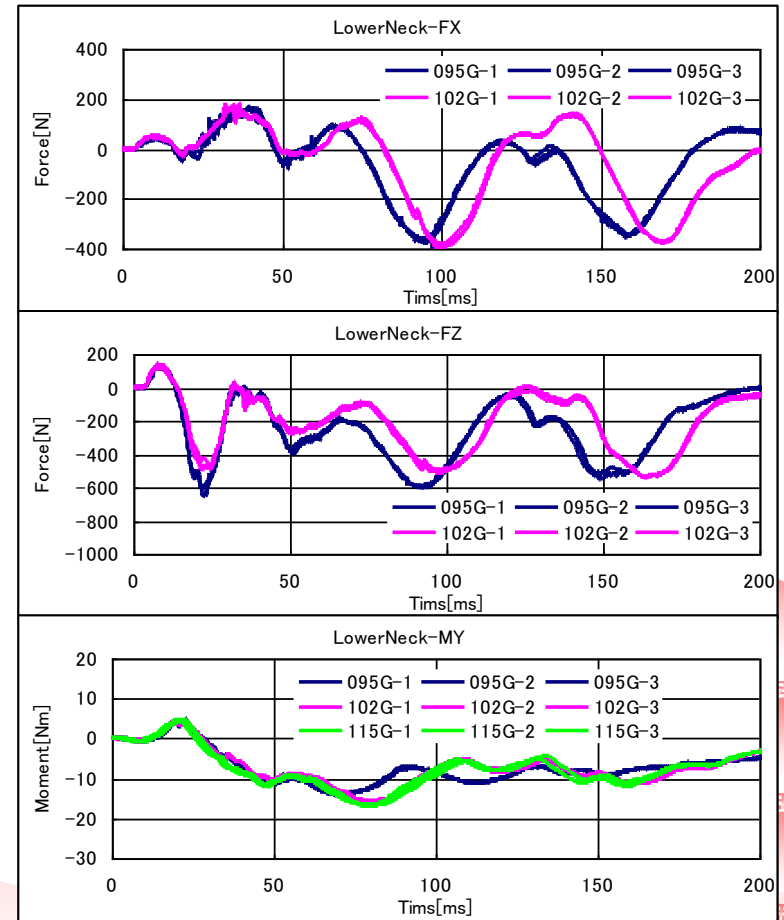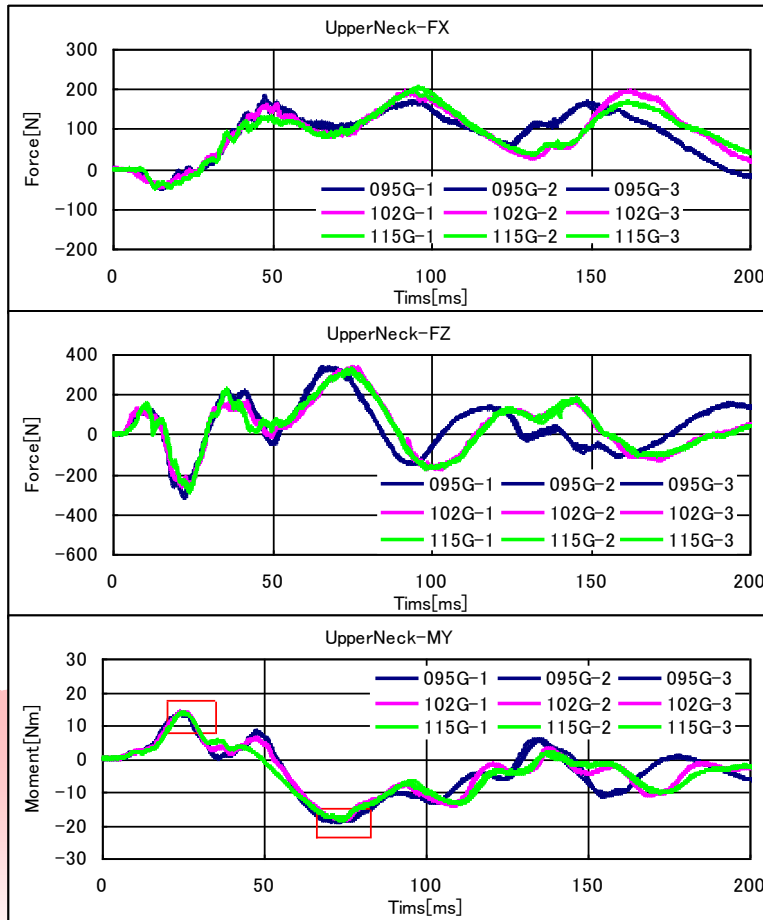
2012/3/20

Results （without headrest, UpperNeck-FX・FZ・MY）

Calibration test without headrest（GTR7-06-06）
It was shown that the waveform configurations（phase shift）of 095G dummy were different from those of 102G dummy and 115G dummy.
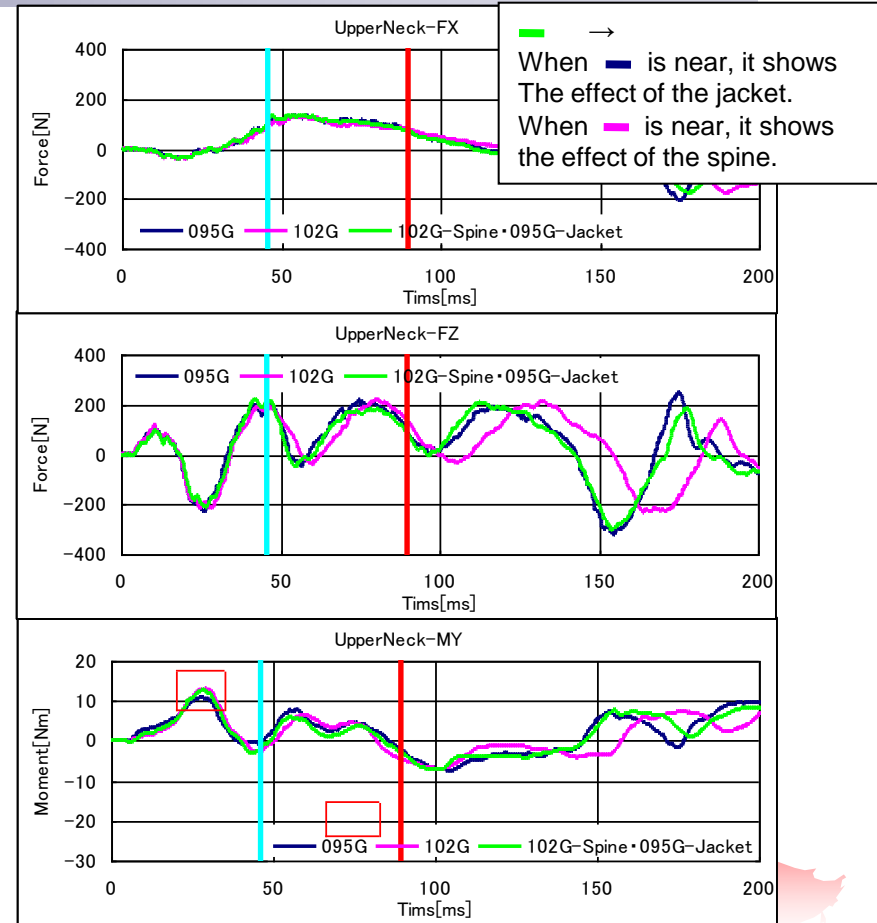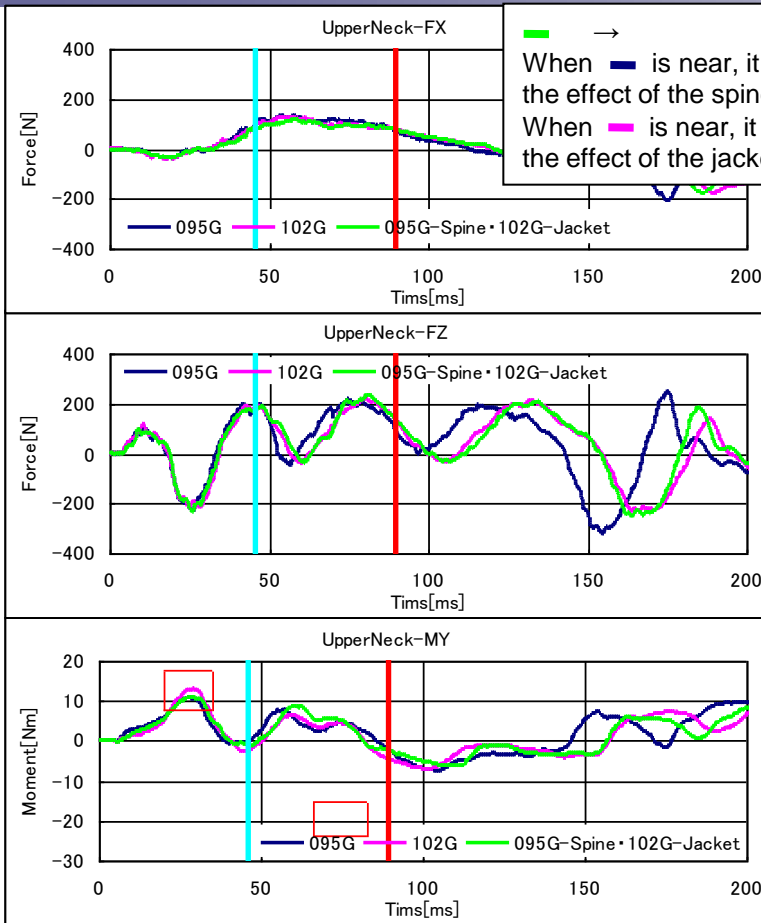
GTR7-06-06：Calibration test without headrest（light probe）

Results（with headrest, UpperNeck-FX・FZ・MY）

1) 095G Vertebrae・102G Jacket

2) 102G Vertebrae・095G Jacket

For the HRCT time range from 0 to end
➢ For the FX, there is almost no difference.
➢ For the FZ, the influence of the jacket occurred and difference was not shown in the dummy equipped with the same jacket.
➢ For the MY, it was influenced (phase shift) by the jacket.

Results （with headrest, LowerNeck-FX・FZ・MY）

1) 095G Spine + 102G Jacket

2) 102G Spine + 095G Jacket
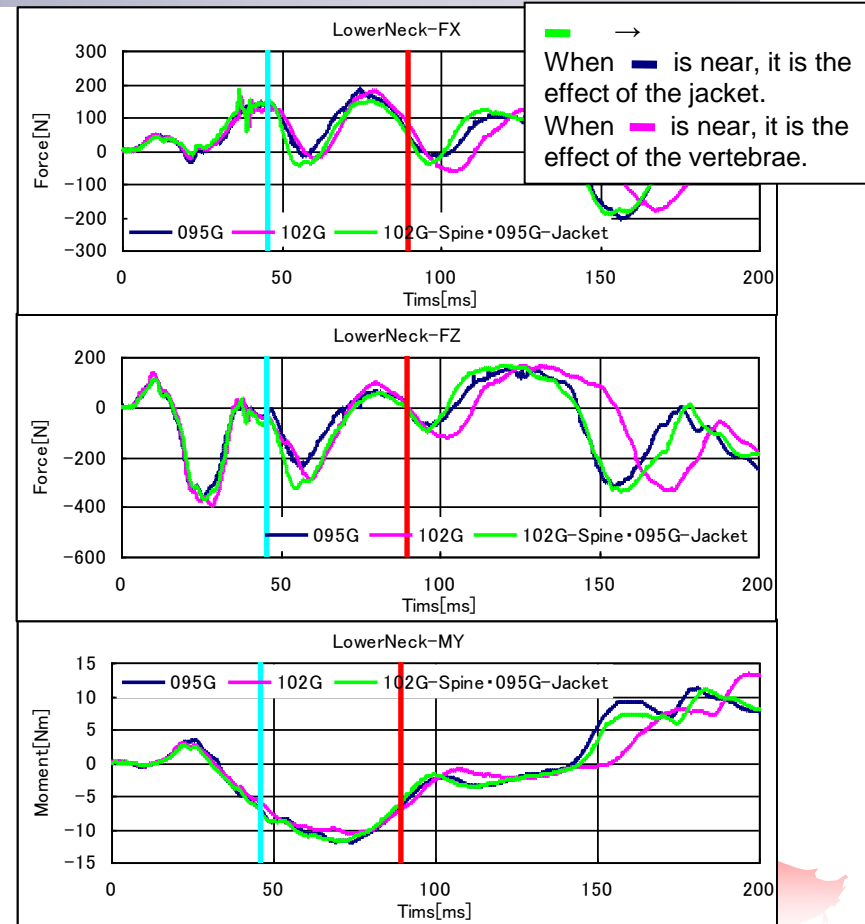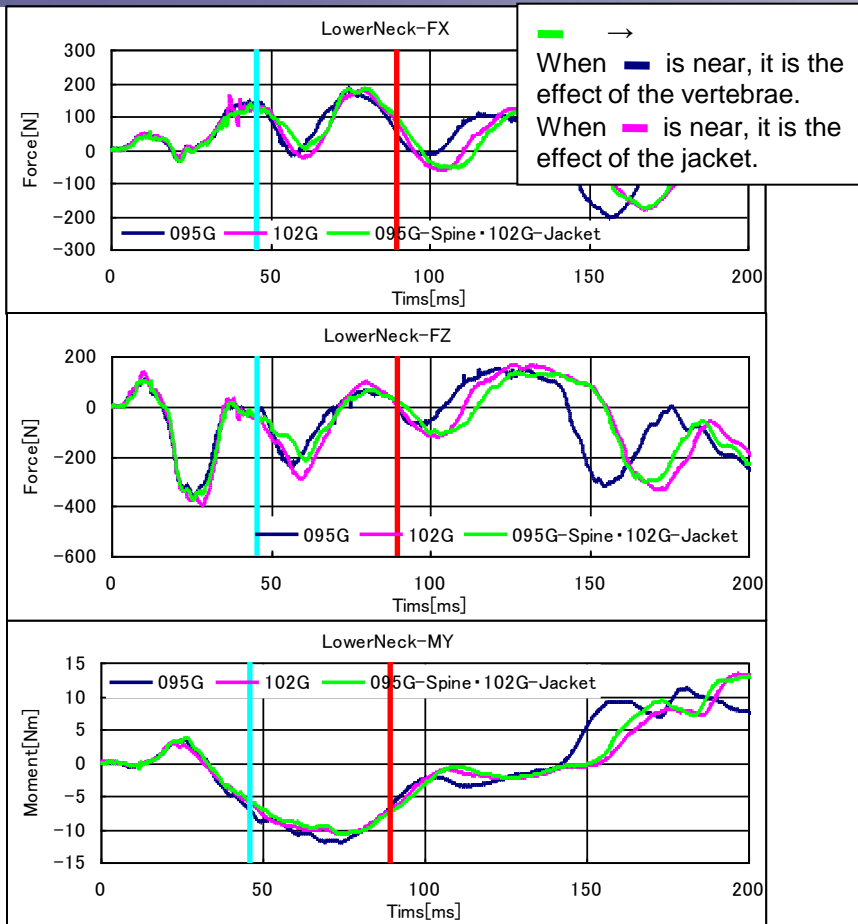
For the HRCT time range from 0 to end
- About the FX and FZ, there's no influence until HRCT-Start. But, was influenced (phase shift) by the jacket when the head made contact with the headrest.
- For the MY, the influence of the jacket occurred, the difference was not shown in the dummy equipped with the same jacket.

Results （with headrest, T1 Acceleration）

1) 095G Spine + 102G Jacket   2) 102G Spine + 095G Jacket
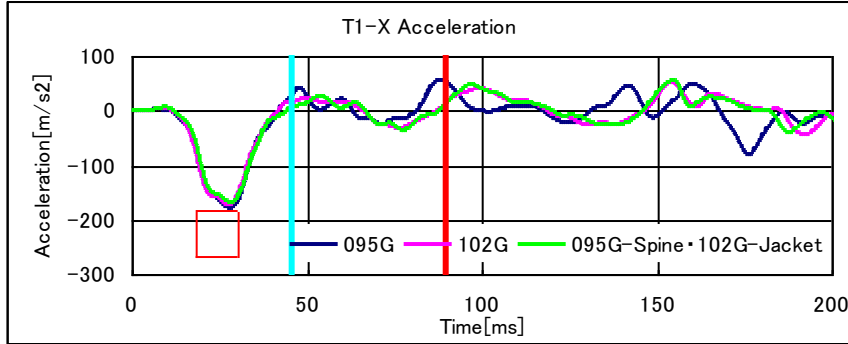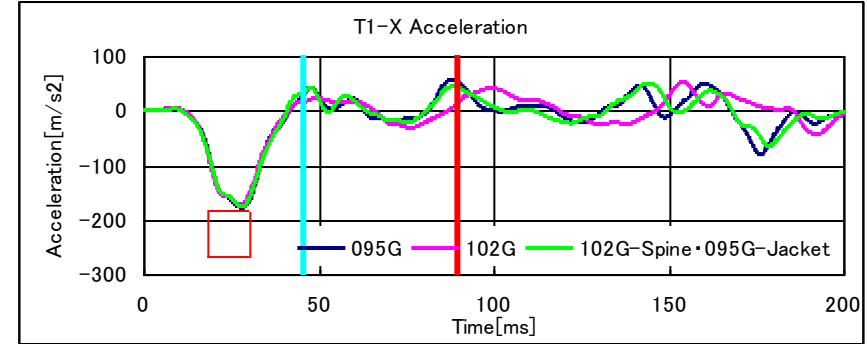
By having exchanged jacket, differences were shown on the dummy's neck force and moment. It was thought that it also had influence on T1 acceleration.

<u>T1 Acceleration</u>
There was no influence with the exchanged jacket until the HRCT-Start. But influences (phase shift) were found with the exchanged jacket when the head made contact with the headrest.

Summary of verification test results （with headrest）
1) 095G Spine + 102G Jacket   2) 102G Spine + 095G Jacket

UpperNeck and LowerNeck Force ・ Moment ・ T1 Acceleration

→ **By having exchanged jackets, the difference had occurred in the phase shift of the waveform.**

In the Light probe test, it was pointed out that the characteristic of the jacket has influence on the dummy's injury value（phase shift of the waveform）.

Influence of the characteristic of the jacket（Hardness of rubber flesh）

・The hardness of the jacket of 095G dummy is "hardness of 6".
・The hardness of the jacket of 102G dummy and 115G dummy are "hardness of 3".
⇒ The jacket of 095G dummy is harder than the other jackets.

When the jacket becomes hard, phase shift of waveform will be early. When the jacket becomes soft, phase shift of waveform will be late. Therefore, the difference in the hardness of the jacket can cause change of the phase shift of the waveform.

＜Reference 1＞
The error range of the product when manufacturing a dummy jacket is between "hardness of 3 to 6". When the error range of a product is seen, it conforms to the regulation. But in order to improve the repeatability of the jacket, there is the need to make the variation of the product as small as possible.

＜Reference 2＞
Hardness of rubber flesh：The volume of relative displacement of the resistance when forcing the surface for the needle which is not sharp. There are JIS K 6253 and ISO 7619. Note: Human skin has a hardness of about 10.

Jacket calibration test

Purpose
To conduct the newly proposed calibration test of the jacket, and to identify the characteristics of the jacket alone. Furthermore to verify the jacket tests methods.

Description
Conduct a calibration test on the jacket alone, using three BioRID-II jackets and verify the reproducibility of the jacket.

Dummies used
BioRID-II dummy (Ver. G):
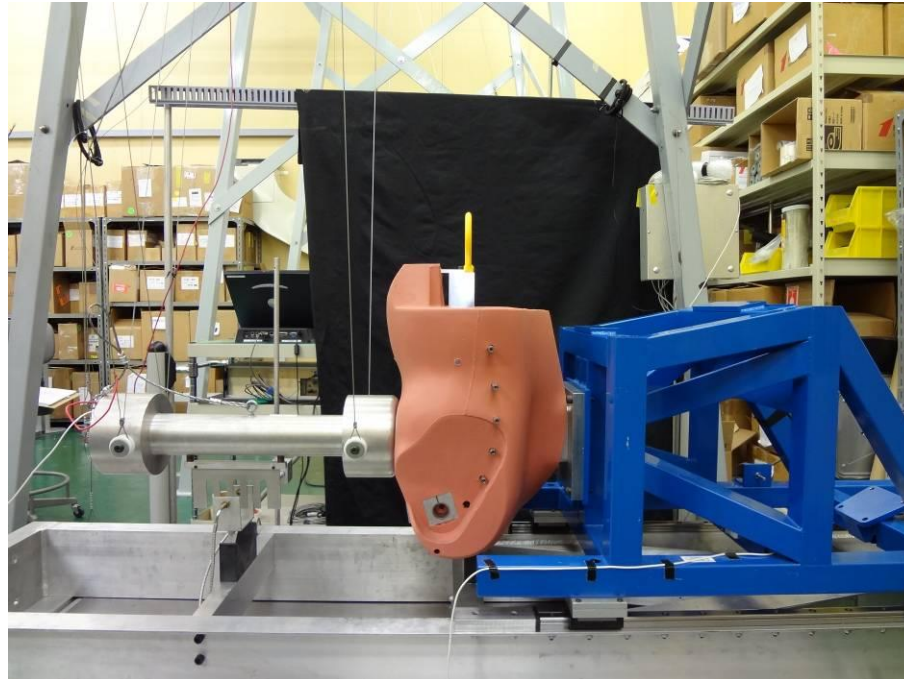095G dummy, 102G dummy, (JARI dummy used in this year's tests)
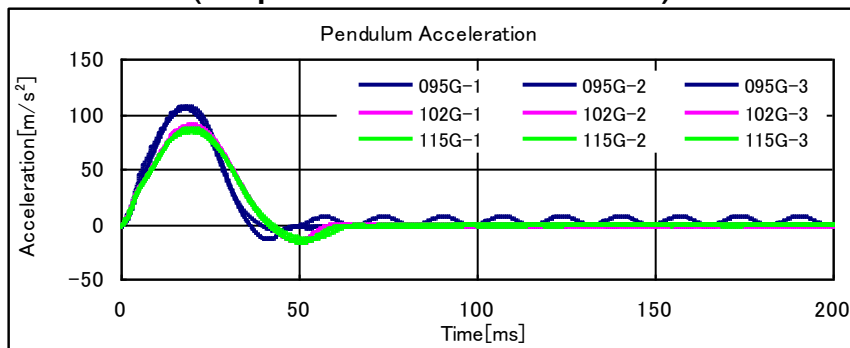115G dummy (Humanetics dummy used in this year's tests),

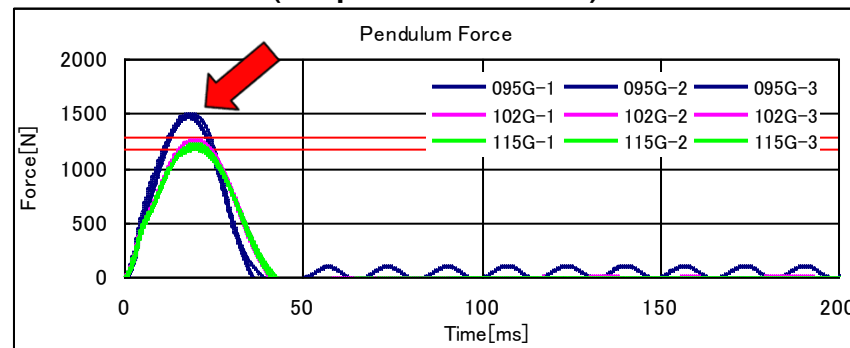Calibration test on the jacket alone (light probe, 13.97 kg)

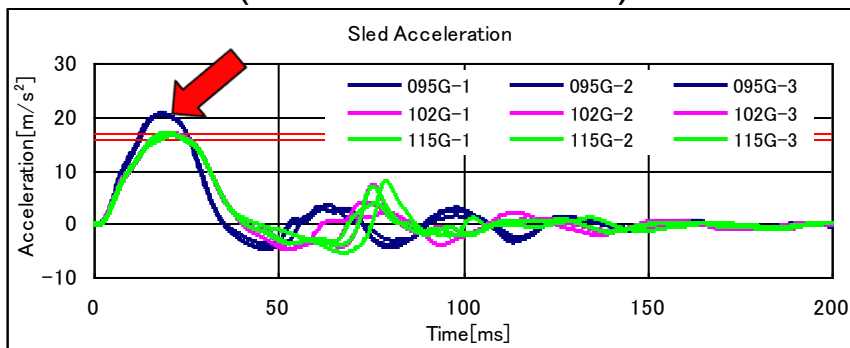Measurement items: Impactor acceleration, sled acceleration

(Impactor acceleration)

Pendulum Acceleration

Legend: 095G-1, 095G-2, 095G-3, 102G-1, 102G-2, 102G-3, 115G-1, 115G-2, 115G-3

Y-axis: Acceleration[m/s²], X-axis: Time[ms]

(Impactor force)

Pendulum Force

Legend: 095G-1, 095G-2, 095G-3, 102G-1, 102G-2, 102G-3, 115G-1, 115G-2, 115G-3

Y-axis: Force[N], X-axis: Time[ms]

* It was confirmed that the waveform at acceleration of 095G included electric noise (in one case only).

(Sled acceleration)

Sled Acceleration

Legend: 095G-1, 095G-2, 095G-3, 102G-1, 102G-2, 102G-3, 115G-1, 115G-2, 115G-3

Y-axis: Acceleration[m/s²], X-axis: Time[ms]

(Sled velocity)

Sled Velocity

Legend: 095G-1, 095G-2, 095G-3, 102G-1, 102G-2, 102G-3, 115G-1, 115G-2, 115G-3

Y-axis: Velocity[m/s], X-axis: Time[ms]

For all the items, **only 095G dummy showed different phase shift of waveform**. Further, 095G dummy showed a peak value of impactor force of about 10% higher and a peak value of sled velocity about 20% higher than those of the other dummies.

(Impactor acceleration)
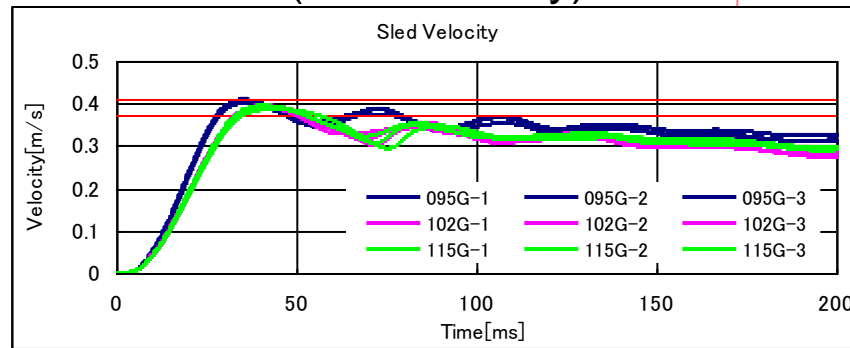

(Impactor force)

* It was confirmed that the waveform at acceleration of 095G included electric noise (in one case only).
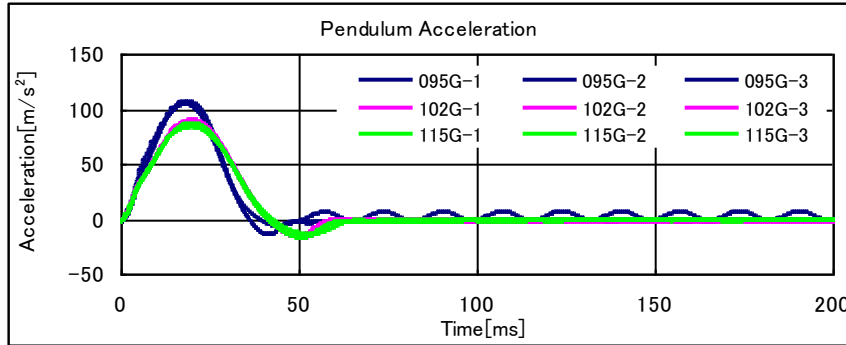
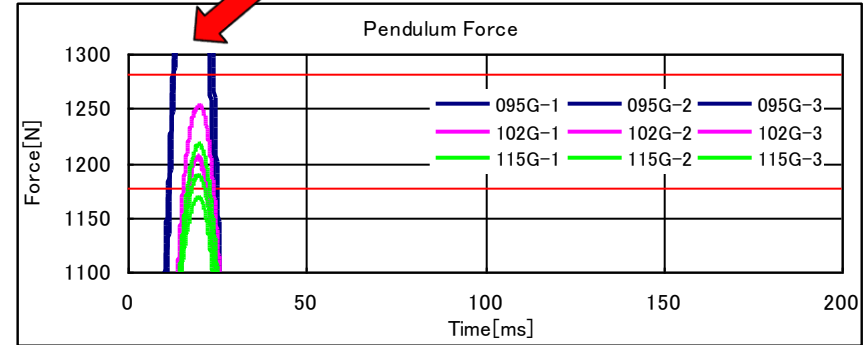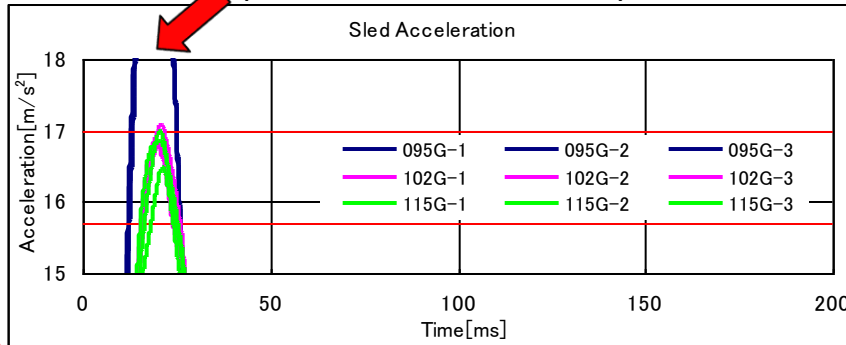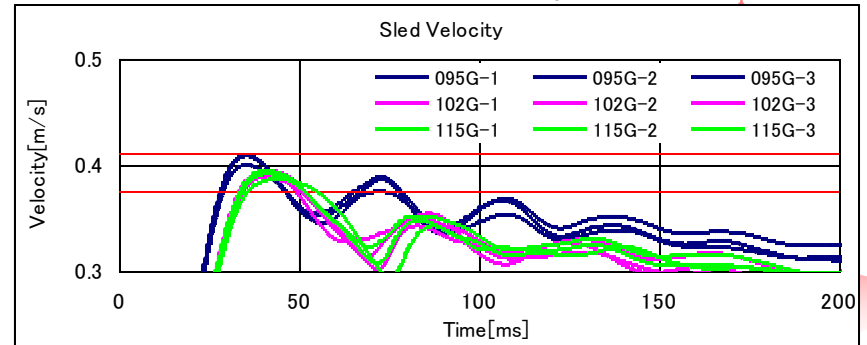## (Sled acceleration)

(Sled velocity)

For sled velocity, all the tests satisfied the corridor. For impactor force and sled acceleration, however, some tests went out of the corridor.

Test Results (Peak Value Table)

(Repeatability, reproducibility, and hardness)

Jacket	Impact Acc. (m/s^2)	Impact Force (N)	SLED Acc. (m/s^2)	SLED Vel. (m/s)	Hardness Before	Hardness After
095G-1	106.2	1483.8	20.2	0.4	6	6
095G-2	106.2	1483.9	20.5	0.4	6	6
095G-3	104.7	1462.9	20.5	0.4	6	6
C.V.(%)	0.8	0.8	0.9	1.3		
Ave.	105.7	1476.9	20.4	0.4		
S.D.	0.9	12.1	0.2	0.0		
102G-1	89.7	1252.6	17.1	0.4	3	3
102G-2	86.2	1204.7	16.8	0.4	3	3
102G-3	86.3	1205.7	16.8	0.4	3	3
C.V.(%)	2.2	2.2	1.0	0.8		
Ave.	87.4	1221.0	16.9	0.4		
S.D.	2.0	27.4	0.2	0.0		
115G-1	83.7	1168.7	16.5	0.4	3	3
115G-2	87.1	1216.8	16.9	0.4	3	3
115G-3	85.1	1188.2	17.0	0.4	3	3
C.V.(%)	2.0	2.0	1.6	1.0		
Ave.	85.3	1191.2	16.8	0.4		
S.D.	1.7	24.2	0.3	0.0		
Reproducibility						
C.V.(%)	6.1	6.1	5.8	1.1		
Ave.	92.8	1296.4	18.0	0.4		
S.D.	9.8	137.3	1.8	0.0		

The dummies showed good repeatability and reproducibility, which were less than 10% for all the items.

In the measurement of the jacket hardness, only 095G indicated a hardness of 6, while 102G and 115G showed a hardness of 3. None of the tests indicated any change of hardness during the test.

The tests were conducted at an interval of 30 to 60 minutes.

Hardness: The resistant relative displacement to be observed when the surface of the test subject is pricked with a blunt-point needle. Applicable standards include JIS K 6253 and ISO 7619. E.g. The hardness of human skin is around 10.

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Discussion

What caused the phase shift of waveforms of 095G dummy?

The calibration test of dummies with a headrest using the light probe showed phase shifts of waveforms in the force and acceleration of 095G dummy. The present test of the jacket alone also showed phase shifts in the waveforms. The hardness of the jacket was 6 for 095G dummy and 3 for 102G and 115G dummies. This made the starting slope of waveforms of 095G dummy steeper and the peak higher than the other dummies.

The above figures show that difference in jacket hardness influences the waveform phases and peaks. Only, in actual tests, effects will be substantially negligible, because the impact energy is higher than that of the present test. Yet, to unify the impact characteristics of dummies, **we need to standardize jacket characteristics. No difference in hardness was observed between the front and back sides of the jacket**.
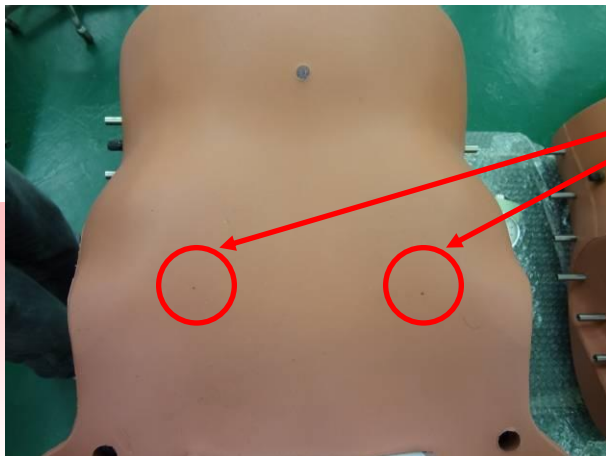
Where hardness was checked
(Hit with a probe)

Summary
(Test on Jacket Alone)

- **For impactor acceleration and pendulum force, only 095G dummy showed different waveform phases. For sled acceleration and sled velocity, too, only 095G dummy showed different waveform phases**.

- For sled velocity, all the tests satisfied the corridor. For impactor force and sled acceleration, however, some tests went out of the corridor.

-The dummies showed good repeatability and reproducibility, which were less than 10% C.V.

- In the measurement of the jacket hardness, only 095G indicated a hardness of 6, while 102G and 115G showed a hardness of 3. This shows that the difference in hardness of the jacket changes the waveform phases and peaks in force and acceleration.

- Only, in actual tests, effects will be substantially negligible, because the impact energy there is higher than that of the present test. Yet, to standardize the impact characteristics of dummies, we need to unify jacket characteristics.

In conclusion, it was found that, in tests on jackets alone, too, difference in hardness of the jacket influences the output of the dummy. Standardization of the hardness characteristic of jackets is necessary.