THE BIOFIDELITY TEST RESULTS ON SID AND EUROSID

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ABSTRACT

JARI/JAMA has been involved since 1983 in research into the side impact test method for occupants protection. Our study is mainly classified into the following three themes :

(1) Study of full-scale test methods
(2) Evaluation of side impact dummies
(3) Study of component test methods and simulation models.

This report gives the evaluation test results of the NHTSA-designed SID dummy and the EEVC-developed EUROSID dummy currently available to JARI/JAMA for use.

In the light of the evaluation test results of the dummies, improvements must be made to the side impact dummies for the following reasons :

(1) Lack of repeatability
(2) Failure to satisfy calibration specifications
(3) Failure to satisfy the requirements of DTR9790-1 adopted ISO/TC22/SC12.

Further efforts must also be made to classify the performance items from the biomechanical point of view as into the items which preferably be harmonized and the items which are not necessary or difficult to harmonize.

It was concluded, based on the tests, that the SID and EUROSID dummies indicate substantially different performance, and it is difficult to treat both as the same type of dummy.

The Biofidelity Test Results on SID and EUROSID

JARI
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1. Introduction

JARI/JAMA has been involved since 1983 in research into the side impact test method for occupants protection. Our study is mainly classified into the following three themes:

(1) Study of full-scale test methods
(2) Evaluation of side impact dummies
(3) Study of component test methods and simulation models

This report gives the evaluation test results of the NHTSA-designed SID dummy and the EEVC-developed EUROSID dummy currently available to JARI/JAMA for use.

2. Tests conducted

JARI/JAMA conducted the following three kinds of tests using both SID and EUROSID dummies. Two each of the dummies were purchased: the SID Dummy from ARL in March 1987 and the EUROSID Dummy from TNO in June 1987.

Test items

(1) Calibration test.....Based on the calibration test method
(2) Repeatability test.....The impactor test ware repeated five times for comparison
(3) Biofidelity test....Based on the test method specified in ISO/ DTR-9790

3. Test results

3.1 Calibration test

As a result of studies of the performance according to the calibration test method specified for each of the

dummies, it was found, as shown in Table 1, that both the SID and the EUROSID dummies failed to meet a number of requirements.

From these studies, we consider that improvements on both dummies are necessary, in order to satisfy the requirements specified in the calibration test.

3.2 Repeatability test

(1) Repeatability

The results of tests repeated five times under the same test conditions were compared. It is said that a dummy lacks in repeatability, when the value of C.V., i.e., the ratio of standard deviation (σ) relative to the average ($\bar{\chi}$) of the results of five repeated tests, exceeds 10%. From the test results as shown in Table-2, the test items which the C.V. exceeded 10%, are as follows:

a. Upper spine Y-maximum acceleration in the thorax test of SID dummy.
b. Upper and lower spine Y-maximum acceleration in the thorax test of EUROSID dummy.

(2) Reproducibility

From these test results shown in Table-3, the test items for which noticeable lack of reproducibility was recorded are as follows:

a. Lower rib Y-maximum acceleration of SID dummy.
b. Lower spine and lower rib Y-maximum acceleration of EUROSID dummy.

(3) Differences between SID and EUROSID Dummy

Despite the same test conditions applied, it was found, as shown in the test results, that there is a

notable difference in the value of acceleration at the thorax and pelvis between SID and EUROSID dummy, and thus it was not possible to consider both as the same type of dummy.

Taking the above consideration into account, we consider that it is not desired to allow both dummies to be used compatibly with each other in side impact tests.

3.3 Biofidelity test

The test items were tested three to five times respectively, according to the test methods specified in DTR9790-1 to 6 adopted at the meeting of ISO/TC22/SC12. The test items covered and the results of judgement, are presented in Table 5. Our consideration through the test results are as follows:

(1) The SID dummy failed to meet all of the requirements, and thus requires improvement.

(2) The EUROSID dummy satisfied only three of the 17 test items, and thus also requires improvement.

(3) With regard to the problems concerning arms which exerts a major effect on acceleration of the thorax, there exists a substantial difference in response between SID and EUROSID dummies. Therefore, the concept about the problems concerning arms should at least be harmonized.

It seems that there is a gap that cannot be filled by altering the filter class in data processing.

4. Conclusion

In the light of the evaluation test results of the dummies, improvements must be made to the side impact dummies for the following reasons:

(1) Lack of repeatability

(2) Failure to satisfy calibration specification

(3) Failure to satisfy the requirements of DTR9790-1 to 6 adopted by ISO/TC22/SC12

Further efforts must also be made to classify the performance items from the biomechanical point of view as into the items which preferably be harmonized and the items which are not necessary or difficult to harmonize.

It was concluded, based on the tests, that the SID and EUROSID dummies indicate substantially different performance, and it is difficult to treat both as the same type of dummy.

Table 1 Results of Calibration Tests

	SID		EUROSID	
	Judgement	Summary of test results	Judgement	Summary of test results
Head	×	Maximum acceleration is lower and 50G-level time is short.	○	Satisfied requirements
Neck	−	No test conducted because forward and backward tests are specified.	×	Slightly different from requirements
Shoulder	−	No regulation specified for calibration tests	×	Satisfied static tests, but indicated somewhat higher value for max, acceleration of impactor in dynamic test.
Thorax	×	∘ Acceleration for lower spine recorded less than half of requirements ∘ Relationship between load and displacement slightly out of range	○	Satisfied requirements
Adbomen	−	No test conducted because forward and backward tests are specified	×	Indicated slightly high value for max, acceleration of impactor
Pelvis	○	Satisfied requirements	×	Satisfied static tests, but recorded only 60 to 80% of requirements in dynamic tests

Notes : ○: Satisfied all of requirements
×: Failed to satisty all of requirements demanded

Table 2 Repeatability of SID and EUROSID

Body parts	Model of dummy / Parts measured	SID			EUROSID		
		$\bar{x}$	σ	$\sigma/\bar{x}\times100$ (%)	$\bar{x}$	σ	$\sigma/\bar{x}\times100$ (%)
Head (2.1m/s)	Max. head C. G. Y direction acceleration(G)	127.0	5.58	4.4	115.8	7.91	6.8
Thorax (4.2m/s)	Max. upper spin Y direction acceleration(G)	10.6	1.07	10.1	10.7	1.08	10.1
	Max. Lower spin Y direction acceleration(G)	9.6	0.80	8.3	14.6	1.77	12.1
	Rib displacement (mm)	21.0	1.05	5.0	20.7	0.41	2.0
	Max. Lower rib Y direction acceleration(G)	26.0	1.70	6.5	31.0	1.22	3.9
Pelvis (4.2m/s)	Max. pelvis Y direction acceleration(G)	46.0	1.58	3.4	22.5	0.63	2.8

$\bar{x}$; Average of five tests

σ ; Standard deviation

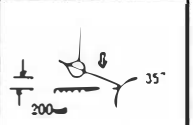
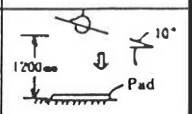
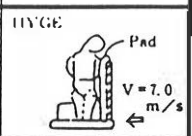
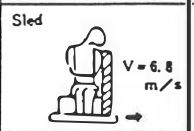
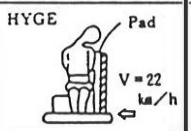
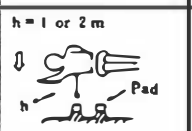
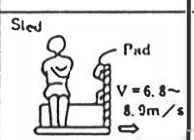
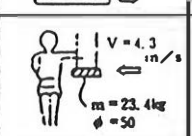
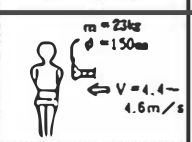
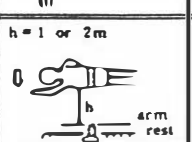
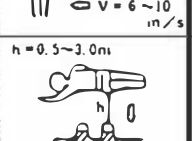
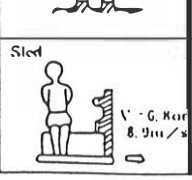
Notes : Rib displacement of the EUROSID represents a max. displacement of the middle rib.

Table 3 Reproducibility of SID and EUROSID

Body parts	Model of dummy / Parts measured	SID			EUROSID		
		$\bar{x}_1$	$\bar{x}_2$	$\frac{\bar{x}_1-\bar{x}_2}{\bar{x}_1}\times 100$ (%)	$\bar{x}_1$	$\bar{x}_2$	$\frac{\bar{x}_1-\bar{x}_2}{\bar{x}_1}\times 100$ (%)
Head (2.1m/s)	Max. head C. G. Y direction acceleration(G)	127.0	137.0	7.9	115.8	125.8	8.6
Thorax (4.2m/s)	Max. upper spin Y direction acceleration(G)	10.6	10.8	1.9	10.7	11.7	9.3
	Max. Lower spin Y direction acceleration(G)	9.6	9.1	5.2	14.6	20.4	39.7
	Rib displacement (mm)	21.0	20.8	1.0	20.7	20.0	3.4
	Max. Lower rib Y direction acceleration(G)	26.0	21.4	17.7	31.0	25.5	17.7
Pelvis (4.2m/s)	Max. pelvis Y direction acceleration(G)	46.0	49.1	6.7	22.5	24.3	8.0

$\bar{x}_1$; Average of five tests for No.1 Dummy
$\bar{x}_2$; Average of five tests for No.2 Dummy
Notes : Rib displacement of the EUROSID represents a max. displacement of the middle rib.

Table 4 ISO/DTR9790- 1～6 JARI/JAMA Test Plan

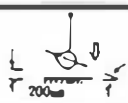
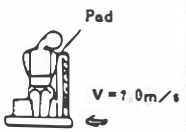
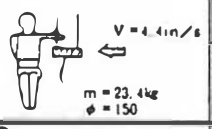
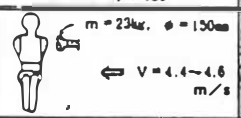
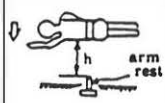
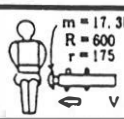
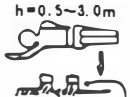
Test Region	Req. No.	Test device	SID	EUROSID
Head	1		◎	◎
	2		×	×
Neck	1		◎	◎
	2		×	×
	3		×	×
Thorax	1		◎	◎
	2		◎	◎
	3		◎	◎
Shoulder	1		◎	◎
Abdomen	1		◎	◎
Pelvis	1		◎	◎
	2		◎	◎
	3		◎	◎

◎ Conducted
× No Test plan.

Manufacturer and delivered date of test dummys.
SID : 1987. 3. ARL
('85 model)
EUROSID : 1987. 6. TNO

◎ . Better ○ . Good × Bad

Table 5 Results of DTR 9790 Anthropomorphic Side Impact Dummy Test

ISO No.		Test Device		Response Requirements Item		SID		EUROSID	
						Item Judgement	synthesis Judgement	Item Judgement	synthesis Judgement
DTR 9790-1 (Head)	Req. 1			Peak Head Acceleration (G)	Non-Impacted Side	×	×	○	○
DTR 9790-2 (Neck)	Req. 1	HYGH 		Peak T1 Acceleration (G)	Lateral	○	×	○	×
				Maximum T1 Displacement (mm)	Horizontal	×		○	
				Peak Head C.G Acceleration (G)	Lateral	×		◎	
					Vertical	○		○	
				Maximum Head C.G Displacement (mm)	Horizontal	○		×	
					Vertical	○		×	
				Maximum Head C.G Excursion Time (sec)	Horizontal	×		×	
				Maximum Head Flexion (degree)	S-laxis	◎		◎	
DTR 9790-3 (Thorax)	Req. 1	h = 1 or 2 m  Rigid or Padded	h = 1.0m (Rigid)	Impacted Surface Force-Time Curve	Force	×	×	×	×
					Time	×		×	
				Rib Deflection (mm)	Lateral	×		×	
			h = 2.0m (Padded)	Impacted Surface Force-Time Curve	Force	○	×	○	×
					Time	×		×	
				Rib Deflection (mm)	Lateral	×		×	
	Req. 2	HYGE Rigid or Padded  6.8 or 8.9m/s	V=6.8 m/s (Rigid)	Impacted Surface Force-Time Curve	Force	×		×	×
					Time	○		○	
			V=8.9 m/s (Rigid)	Impacted Surface Force-Time Curve	Force	×		×	×
					Time	○		○	
			V=8.9 m/s (Padded)	Impacted Surface Force-Time Curve	Force	×	×	◎	◎
					Time	○		◎	
	Req. 3			Impactor Acceleration-Time Curve	Acceleration	×	×	×	×
					Time	×		×	
				T1 Lateral Acceleration-Time Curve	Acceleration	×	×	×	×
					Time	×		×	
DTR 9790-4 (Shoulder)	—			Impactor Force-Time Curve	Force	×	×	○	○
					Time	◎		◎	
DTR 9790-5 (Abdomen)	—	h = 1 or 2 m 	h = 1.0m	Impacted Surface Force-Time Curve	Force	×	×	×	×
					Time	×		×	
				Peak Acceleration (G)	T12	×		×	
					9th Rib	×		○	
			h = 2.0m	Impacted Surface Force-Time Curve	Force	×	×	×	×
					Time	×		×	
				Peak Acceleration (G)	T12	×		×	
					9th Rib	×		○	
DTR 9790-6 (Pelvis)	Req. 1			Peak Impacted Surface Force (kN)	———	×	×	×	×
	Req. 2	h=0.5~3.0m  Rigid or Padded	h=0.5m	Peak Pelvis Acceleration (G)	———	×	×	×	×
			h=1.0m	Peak Pelvis Acceleration (G)	———	×		×	
			h=2.0m	Peak Pelvis Acceleration (G)	———	×		○	
	Req. 3	HYGE Rigid or Padded  6.8 or 8.9m/s	V=6.8 m/s (Rigid)	Peak Impacted Surface Force (kN)	———	×	×	×	×
				Peak Pelvis Acceleration (G)	———	×		×	
			V=8.9 m/s (Rigid)	Peak Impacted Surface Force (kN)	———	◎	×	◎	×
				Peak Pelvis Acceleration (G)	———	×		×	
			V=8.9 m/s (Padded)	Peak Impacted Surface Force (kN)	———	○	×	○	×
				Peak Pelvis Acceleration (G)	———	×		×	