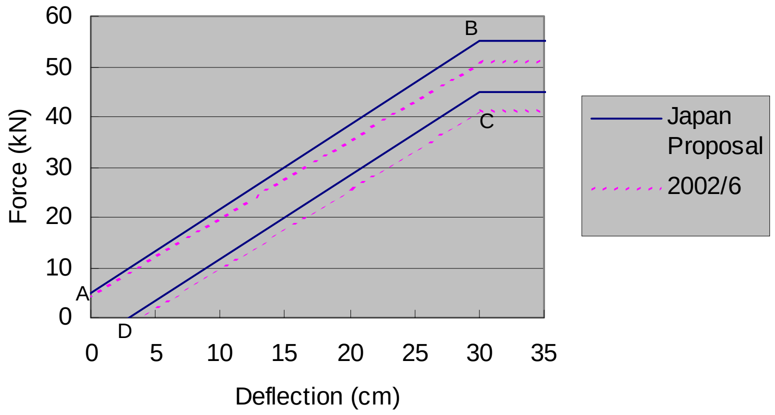
Informal document No. **4**
(31st GRSP, 13-17 May 2002,
Agenda Item 1.8.)

Proposal Concerning the Deformable Barrier Specifications
Proposed in TRANS/WP.29/GRSP/2002/6

<u>Transmitted by the Expert from Japan</u>

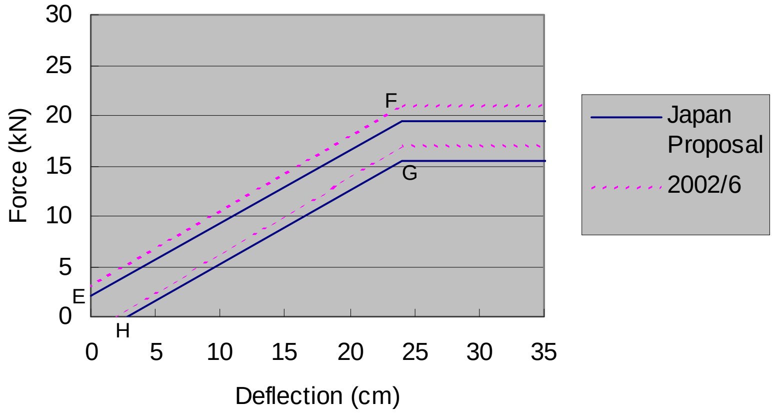
PROPOSAL

With respect to the TRANS/WP.29/GRSP/2002/6 "Proposal for Draft Amendments to Regulation No.95 (Lateral Collision Protection)" presented by EEVC, Japan proposes that the static corridors for the Blocks 1&3 and Block 4 of Appendix 1 of Annex 5 be amended as shown in Figure 1a&1b below.



	2002/6		Proposal	
	Defl. (cm)	Force (kN)	Defl. (cm)	Force (kN)
A	0	4	0	5
B	30	51	30	55
C	30	41	30	45
D	5	0	3	0

<u>Fig.1a Block 1&3</u>



	2002/6		Proposal	
	Defl. (cm)	Force (kN)	Defl. (cm)	Force (kN)
E	0	3	0	2
F	24	21	24	19.5
G	24	17	24	15.5
H	2	0	2.5	0

<u>Fig.1b Block 4</u>

1. Background and Detail of Proposal

To evaluate the single-layer deformable barrier (D/B) proposed by EEVC WG13, Japan in 2001 and 2002 performed a barrier evaluation test using D/Bs made by four companies in Japan, the United States and Europe. The objective of this test was to determine differences in the performance and reproducibility of D/Bs between makers.

The results indicated lessened variance in load-displacement characteristics as compared with the past characteristics tests of conventional laminated barriers. The results however indicated no D/B that could satisfy all the performance requirements. There were cases where test items aimed at the middle portion of the static characteristics corridor deviated from the middle portion of the dynamic characteristics corridor.

Analysis was therefore conducted on the static and dynamic characteristics of the D/Bs employed in the barrier evaluation tests, and problems were found in the relationship between static and dynamic characteristics (Attachment 1).

To render the relationship between static and dynamic characteristics more appropriate, Japan proposes that the static corridors of Blocks 1&3 and Block 4 load-displacement characteristics be amended as shown in Figure 1a&1b.

2. Other Problems

Along with the above barrier evaluation test, a full-scale test was also conducted using the D/Bs of three companies in Japan and Europe. The results indicated a problem pertaining to a variance of 50 mm or more in the vehicle deformation values obtained from the deformable barriers made by the three makers. (For the results of the 2001 test and Japan's comments addressed to the EEVC WG13 chairman, please refer to Attachment 2).

This problem was attributed to a moderate difference in the Block 2 dynamic load-displacement characteristics among the D/Bs of the three makers, and was considered to be correctable by narrowing the width of the Block 2 corridor. Japan therefore hopes that countries will supply their respective data on Block 2 and review the appropriateness of the Block 2 dynamic corridor.

ATTACHMENT 1

Examination of Deformable Barrier Static-Dynamic Ratios

1. Introduction

Japan conducted a barrier evaluation test to verify the performance and reproducibility of six cases of D/Bs made by three Japanese and European companies in 2001. Similarly an evaluation tests was conducted in 2002, employing five cases of D/Bs made by three Japanese and U.S. companies.

2. Barrier Certification Test

2.1 Test Conditions

For the 2001 test, two cases each of single-layer D/Bs made by Showa Aircraft Industry, Yokohama Rubber, and Cellbond Composites were employed. For the 2002 test, two cases each of single-layer D/Bs made by Showa Aircraft Industry and Yokohama Rubber and one case of D/B made by Plascore were used.

2.2 Test Results

The results of the 2001 test indicated similar load-displacement characteristics among all but Block 2 of the three makes of D/Bs and similar dynamic characteristics among the D/Bs as whole units. Regarding Block 2, the D/B made by Cellbond showed a load notably larger than those of the other two makers' D/Bs.

As for the results of the 2002 test, the three upper blocks of Plascore's D/B indicated a notably larger load in comparison with the other two D/Bs and widely deviated away from the corridor. Furthermore, in most of the tests the characteristics of Block 4 slightly exceeded the upper limit of the corridor.

The amount of energy absorption surpassed the requirement value in some blocks. The amount of dynamic deformation went beyond the requirement value in one case.

Table 1 Test Results

Test No.		B01_0201	B01_0202	B02_0201	B02_0202	B01_0203	B01_0204	B02_0203	B02_0204	B01_0301	B01_0401	B02_0205	Requirement
Maker		Showa	Showa	Showa	Showa	Yokohama	Yokohama	Yokohama	Yokohama	Cellbond	Cellbond	Plascore	-
Impact speed		35.1	35.1	35.1	35.2	35.2	35.1	35.2	35.1	35.1	35.2	35.2	35±0.5
Barrier mass		14.2	14.2	14.3	14.2	12.6	12.5	12.8	13.0	13.76	13.84	15.5	-
MDB mass		949	949	948	948	947	947	947	947	949	949	950	950±5
Deflection	Ver.	±0	±0	5	5	±0	±0	5	5	+5	+5	2	±10
	Hor.	+5	+3	-2	0	+3	+6	5	2	±0	+3	0	±10
Energy absorption	Block 1	8.6	9.7	9.1	9.5	9.5	8.5	9.0	10.0	8.1	8.2	8.7	9.5±2
	Block 2	14.5	14.4	15.1	15.5	15.2	15.8	15.8	15.1	16.7	16.4	13.9	15±2
	Block 3	9.7	8.7	9.5	9.6	9.5	9.0	9.2	9.3	8.6	8.0	9.0	9.5±2
	Block 4	4.6	4.7	5.0	5.2	4.9	5.4	5.1	4.9	4.9	5.2	5.9	4±1
	Block 5	3.6	3.7	3.3	3.3	3.1	3.8	3.5	2.9	3.6	3.3	4.3	3.5±1
	Block 6	4.1	3.8	4.1	3.9	3.8	4.2	4.1	3.8	3.9	3.8	4.7	3.5±1
	Total	44.9	44.9	46.1	47.0	45.9	46.6	46.8	46.0	45.8	44.9	46.4	45±5
Dynamic deformation		329.0	327.1	330.6	336.2	337.7	351.4	347.8	336.5	334.7	338.1	315.7	330±20
Level B deformation	Right	310	310	310	312	317	324	325	315	312	320	290	310±20
	Left	312	310	313	315	320	330	330	317	313	323	295	

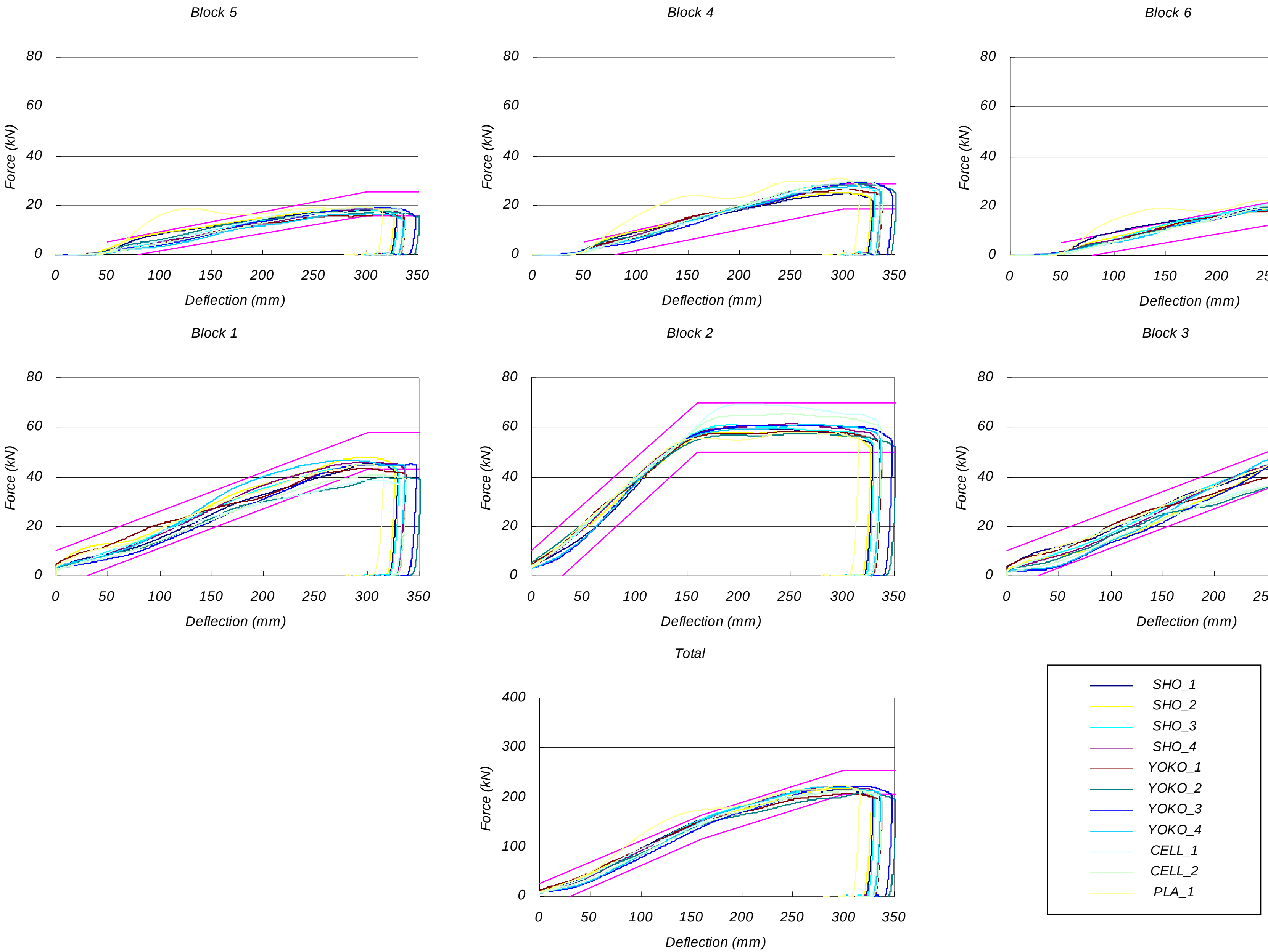


Fig. 1 Load-Displacement Characteristics

3. Conclusion

Compared to the widely divergent test results obtained from conventional barriers, the tests that Japan conducted in 2001 and 2002 gave less variant results of load-displacement characteristics. Nevertheless, none of the tested D/Bs fully satisfied the performance requirements.

Moreover the relationship between static and dynamic characteristics was unclear in the D/Bs, as suggested by the fact that the test items aimed at the middle portion of the static characteristics corridor deviated from the middle portion of the dynamic characteristics corridor.

4. Examination of Static-Dynamic Ratios

From the results of the Japanese tests and the European evaluation results distributed at the recent EEVC WG13 subgroup meeting, the static-dynamic ratio was calculated for each block of the D/B. The dynamic and static loads in the area where the load-displacement characteristics become horizontal (displacement of 305 mm over for Blocks 1, 3, 4, 5 and 6 and 165 mm over for Block 2) are shown in Figure 2. The calculated static-dynamic ratios are given in Table 2.

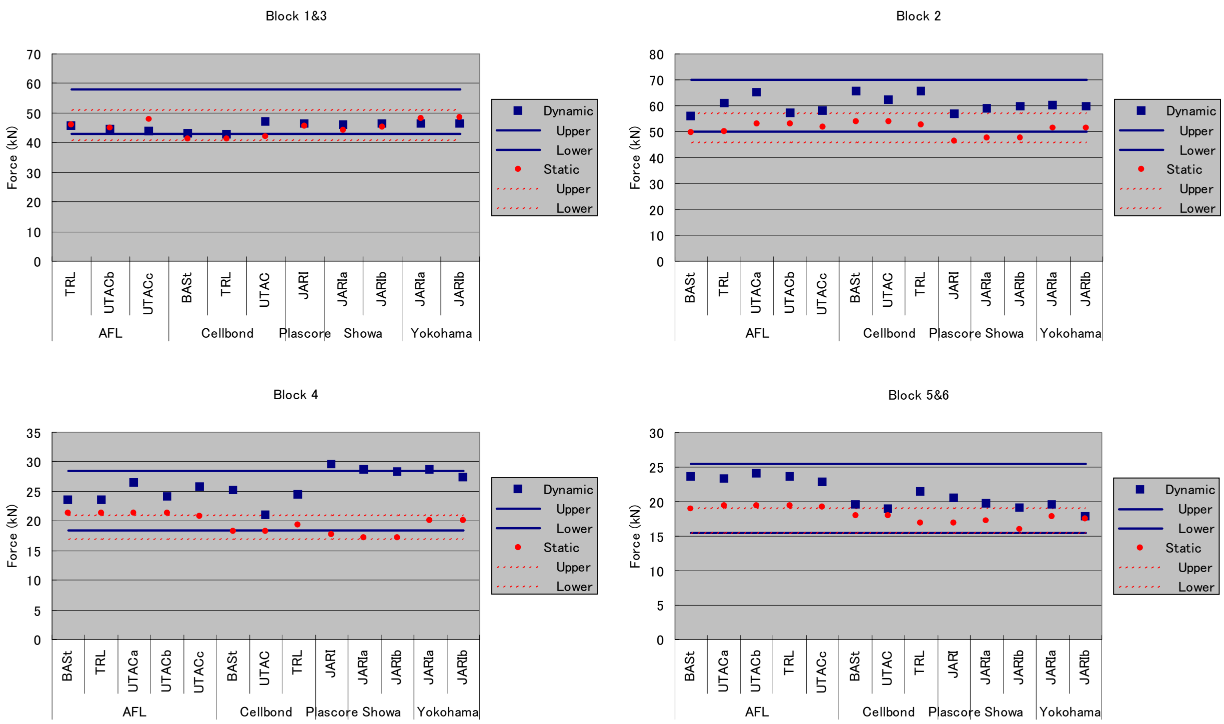


Fig. 2 Distribution of Dynamic and Static Loads

Table 2　Calculated Results of Static-Dynamic Ratios

	Block 1&3										
	AFL			Cellbond			Plascore	Showa		Yokohama	
	TRL	UTACb	UTACc	BASt	TRL	UTAC	JARI	JARIa	JARIb	JARIa	JARIb
Dynamic	45.70	44.46	43.92	42.95	42.75	46.93	46.34	45.89	46.30	46.14	46.25
Static	45.82	44.78	47.66	41.35	41.35	41.82	45.41	44.00	45.31	48.28	48.42
Ratio	1.00	0.99	0.92	1.04	1.03	1.12	1.02	1.04	1.02	0.96	0.96

	Block 2												
	AFL					Cellbond			Plascore	Showa		Yokohama	
	BASt	TRL	UTACa	UTACb	UTACc	BASt	UTAC	TRL	JARI	JARIa	JARIb	JARIa	JARIb
Dynamic	55.69	60.84	65.02	57.26	57.92	65.23	62.07	65.53	56.76	58.75	59.56	59.81	59.73
Static	49.56	49.89	52.88	52.88	51.49	53.95	53.95	52.67	46.11	47.56	47.56	51.26	51.26
Ratio	1.12	1.22	1.23	1.08	1.13	1.21	1.15	1.24	1.23	1.24	1.25	1.17	1.17

	Block 4												
	AFL					Cellbond			Plascore	Showa		Yokohama	
	BASt	TRL	UTACa	UTACb	UTACc	BASt	UTAC	TRL	JARI	JARIa	JARIb	JARIa	JARIb
Dynamic	23.44	23.53	26.50	24.03	25.74	25.22	20.94	24.36	29.57	28.68	28.29	28.65	27.30
Static	21.29	21.30	21.30	21.30	20.77	18.29	18.29	19.27	17.70	17.21	17.21	19.98	19.98
Ratio	1.10	1.10	1.24	1.13	1.24	1.38	1.14	1.26	1.67	1.67	1.64	1.43	1.37

	Block 5&6												
	AFL					Cellbond			Plascore	Showa		Yokohama	
	BASt	UTACa	UTACb	TRL	UTACc	BASt	UTAC	TRL	JARI	JARIa	JARIb	JARIa	JARIb
Dynamic	23.55	23.33	24.10	23.52	22.88	19.59	18.92	21.34	20.49	19.66	19.00	19.48	17.86
Static	18.90	19.34	19.34	19.34	19.27	17.96	17.96	16.81	16.95	17.12	15.94	17.79	17.46
Ratio	1.25	1.21	1.25	1.22	1.19	1.09	1.05	1.27	1.21	1.15	1.19	1.10	1.02

Then, the average values of static-dynamic ratios were calculated for each block from the above results. Also, static loads were determined for each block from the central value of static loads in the horizontal part of the dynamic corridor (Table 3).

Table 3 Average Values of
Static-Dynamic Ratios and Calculated Results of Loads

	Ratio	Dynamic	Static
Block 1&3	1.01	50.5	50.0
Block 2	1.19	60.0	50.5
Block 4	1.34	23.5	17.6
Block 5&6	1.17	20.5	17.6

On the basis of the results shown in Table 3, the static corridors were amended as shown in Figure 3, while the width of the each corridor was kept identical with that of the static corridors proposed by EEVC.

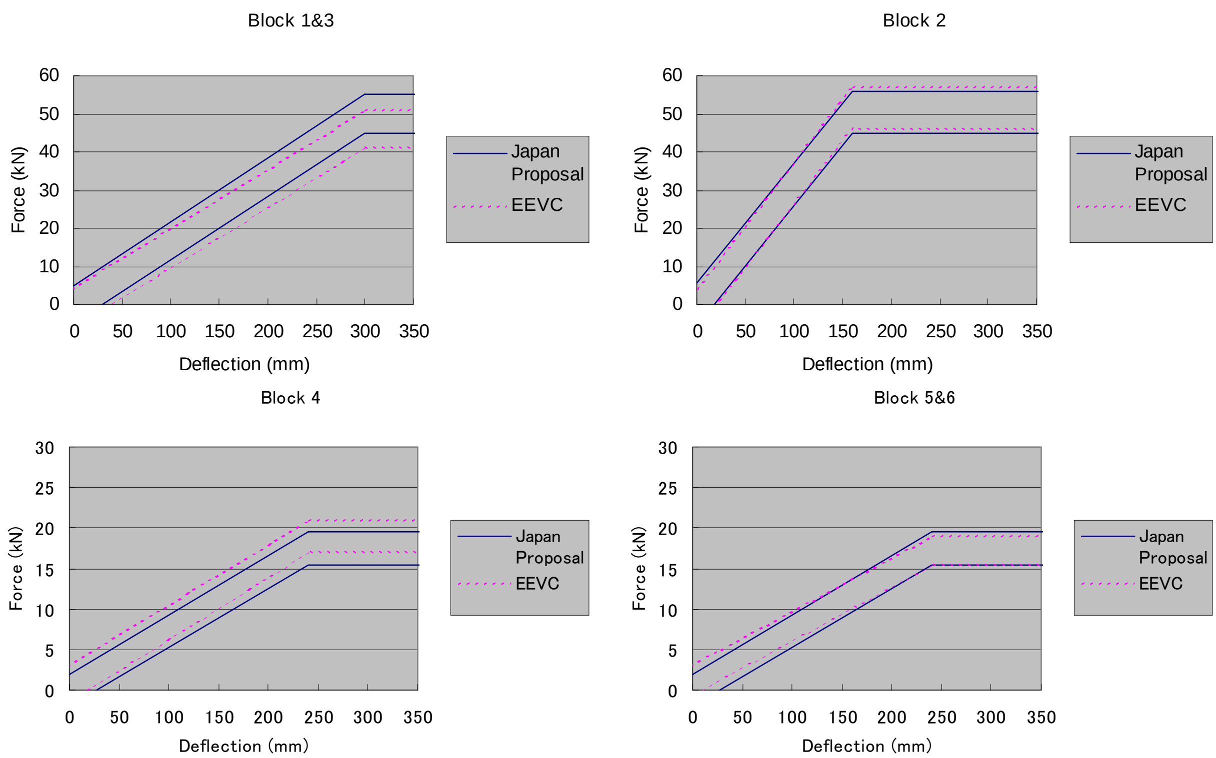


Fig. 3 Amended Static Corridors

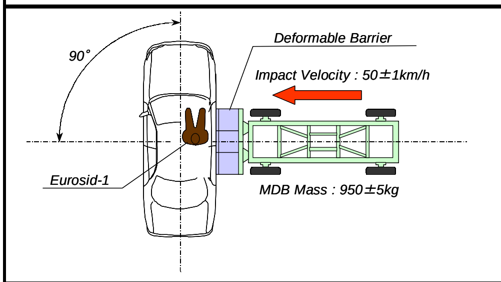
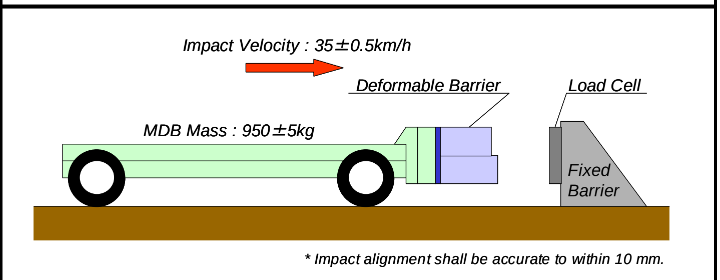
ATTACHMENT 2

JASIC Comments on Draft Barrier Specification proposed by EEVC WG13

1. Introduction

In Japan, three deformable barriers made by Japanese and European honeycomb supplier were used in the evaluation tests of progressive deformable barriers. The purpose of the tests was to check items such as differences in performance and reproducibility between makers, and six barrier certification tests and three vehicle impact tests were conducted.

Table 1 Test Matrix

Full Scale Test				Flat Wall Test					
									
Test No.	F00_0201	F00_0202	F01_0301	B00_0201	B00_0202	B00_0203	B00_0204	B01_0301	B01_0401
Test Vehicle	4Dr. Sedan	←	←	—	—	—	—	—	—
D/B	Showa	Yokohama	Cellbond	Showa	←	Yokohama	←	Cellbond	←
Fr.Dummy	Eurosid-1	←	←	—	—	—	—	—	—
Rr.Dummy	—	—	—	—	—	—	—	—	—
Cork Sheet	Without	←	←	←	←	←	←	With	Without

2. Barrier Certification Test

2.1 Test Conditions

Two tests each were conducted on the progressive deformable barriers made by Showa Aircraft Industry Co., Ltd., The Yokohama Rubber Co., Ltd., and Cellbond Composites, Ltd. In the Showa and Yokohama Rubber tests, no cork sheet was inserted between the ventilation frame and the barrier dolly; in the Cellbond tests, one test was conducted with a cork sheet and one without.

2.2 Test Results

2.2.1 Force-Deflection Characteristics

The force-deflection characteristics were stipulated in the draft not only for the corridor of a conventional dynamic test but for that of a static test as well. All three barriers displayed practically the same tendencies for all blocks and for the overall dynamic characteristics. Block 2 of the Cellbond barrier had a higher load than those of the other barriers, and the load became even larger when the cork sheet was used. As for the static characteristics, those of the

Yokohama Rubber and Cellbond barriers stayed for the most part in the middle of the corridor, whereas Showa lowered the Block 4 characteristics below the corridor values so that they would be the same as the Block 5 and Block 6 characteristics, after receiving the results of previously conducted development tests.

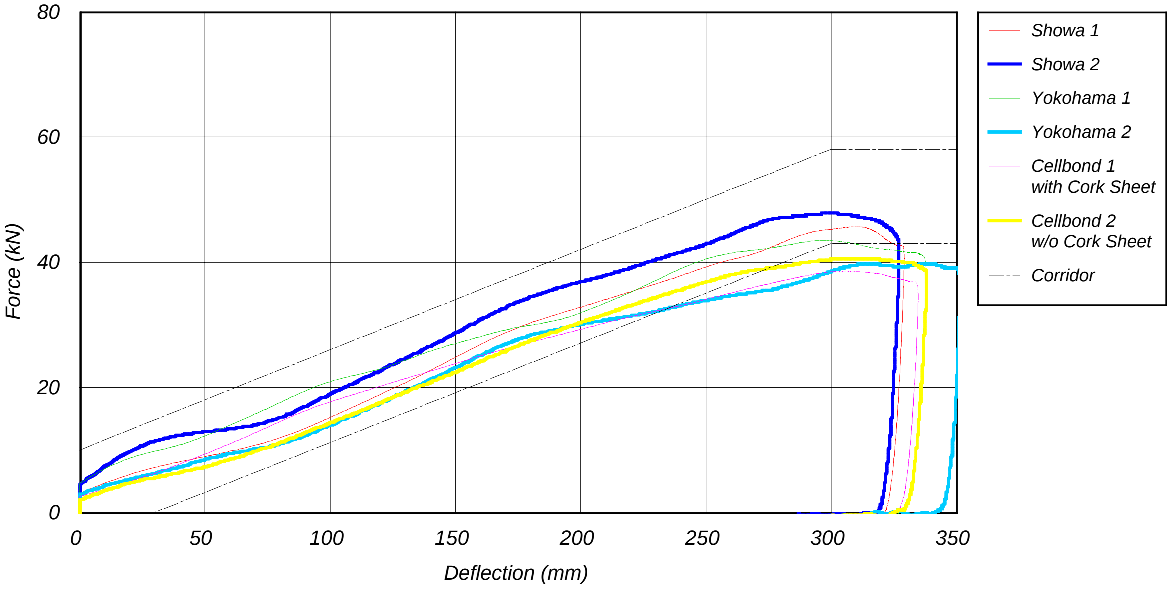


Fig.1 Force-Deflection Curves of Block 1

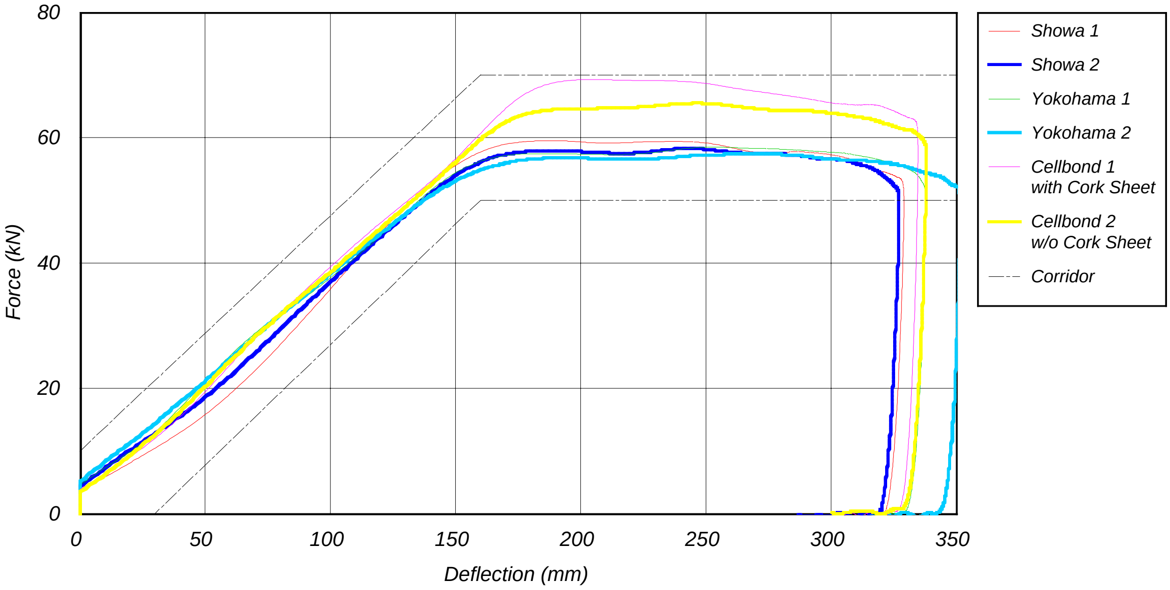


Fig.2 Force-Deflection Curves of Block 2

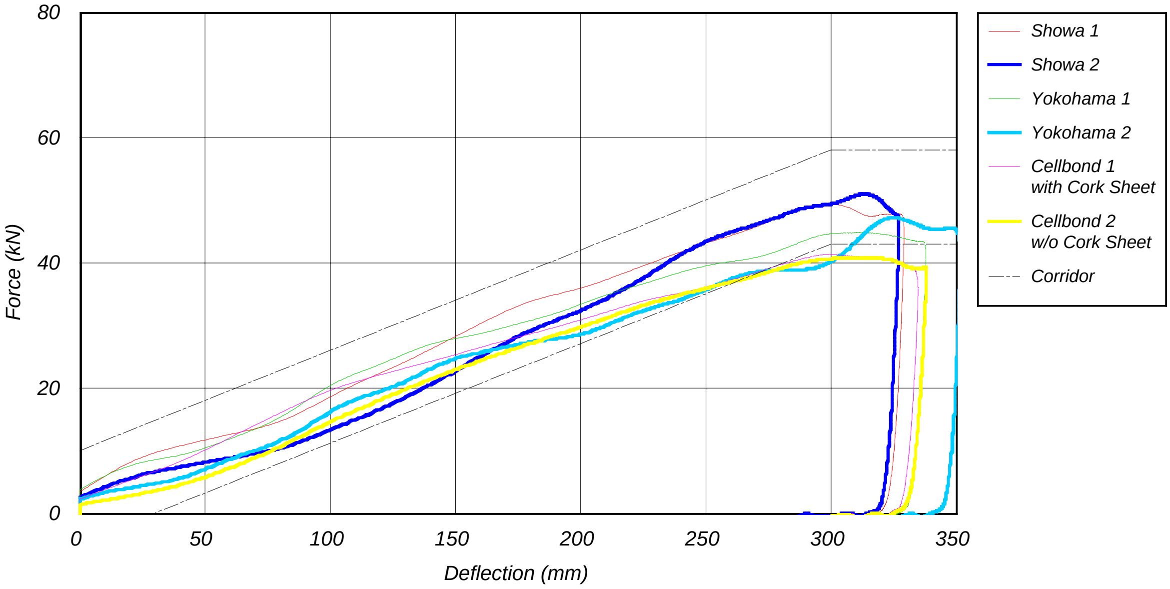


Fig.3 Force-Deflection Curves of Block 3

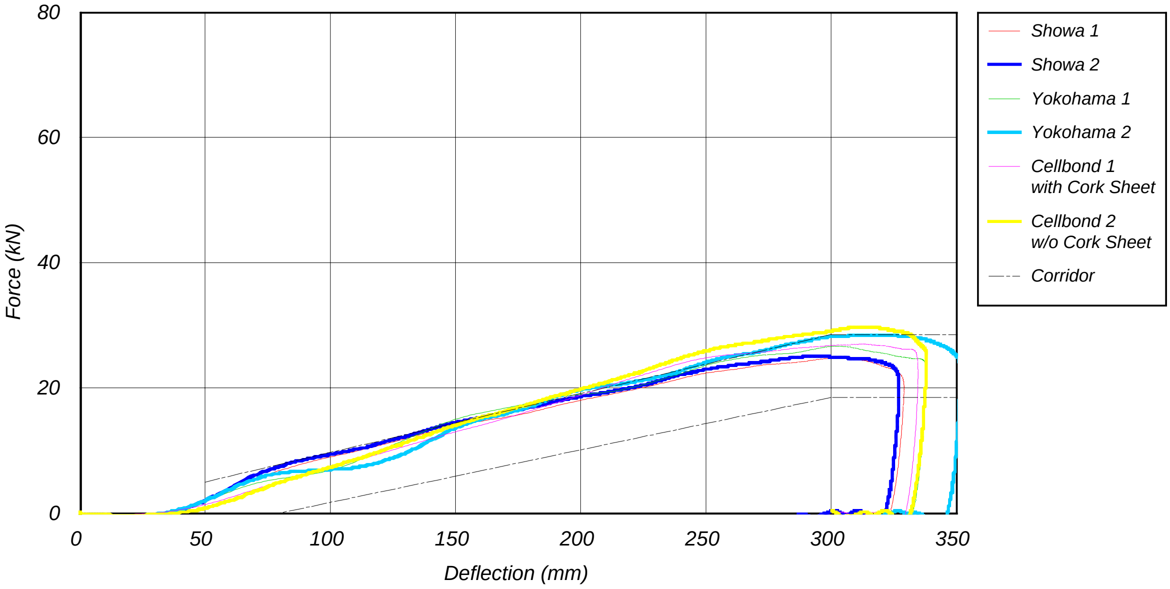


Fig.4 Force-Deflection Curves of Block 4

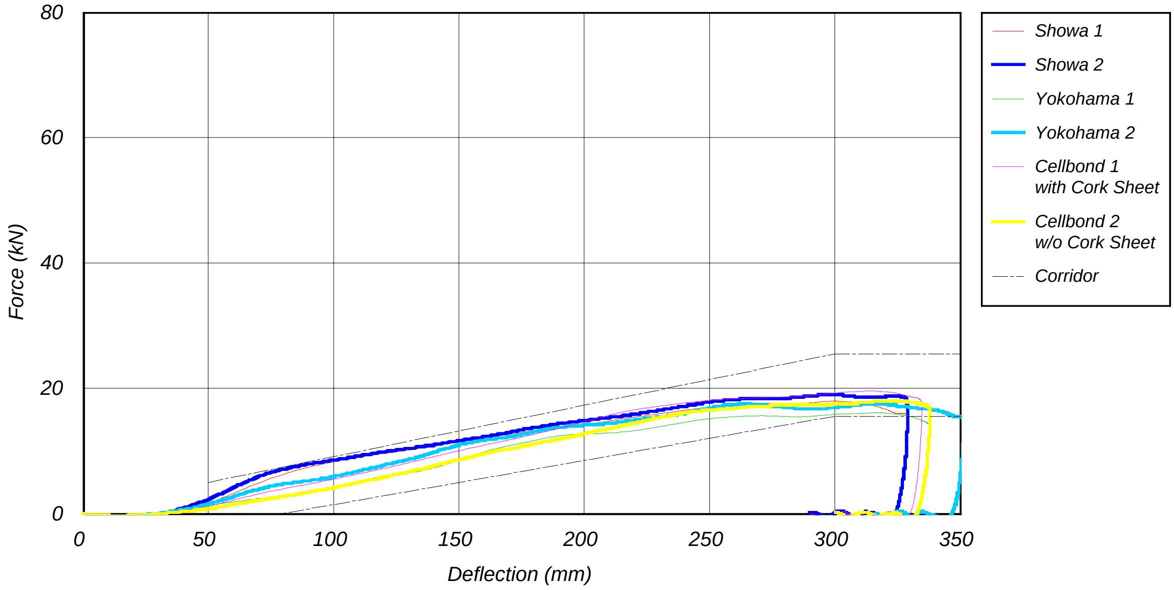


Fig.5 Force-Deflection Curves of Block 5

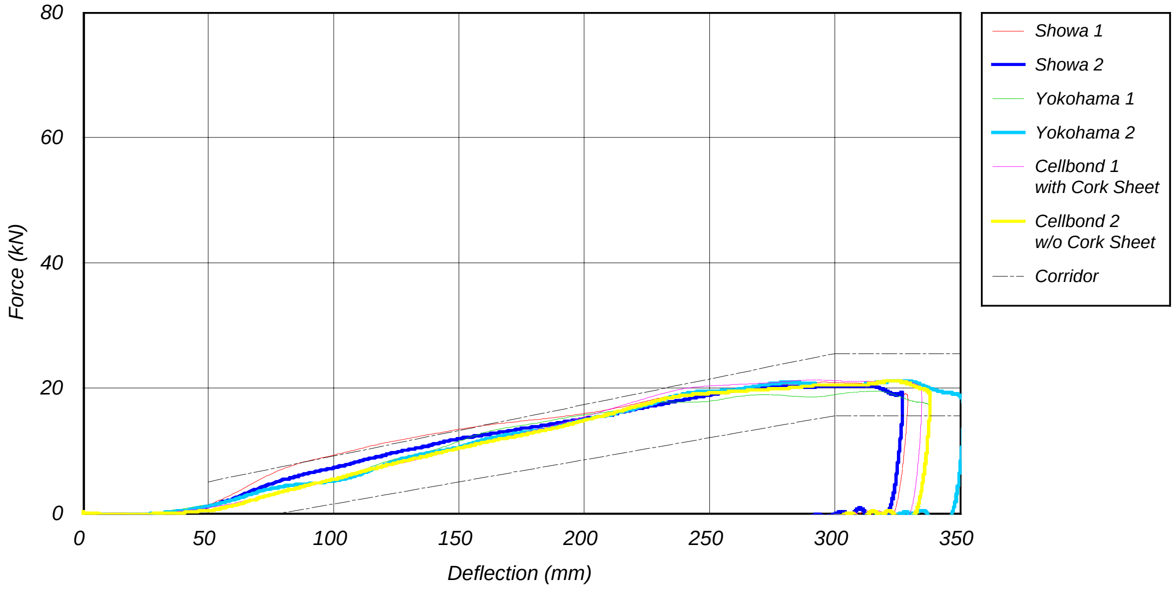


Fig.6 Force-Deflection Curves of Block 6

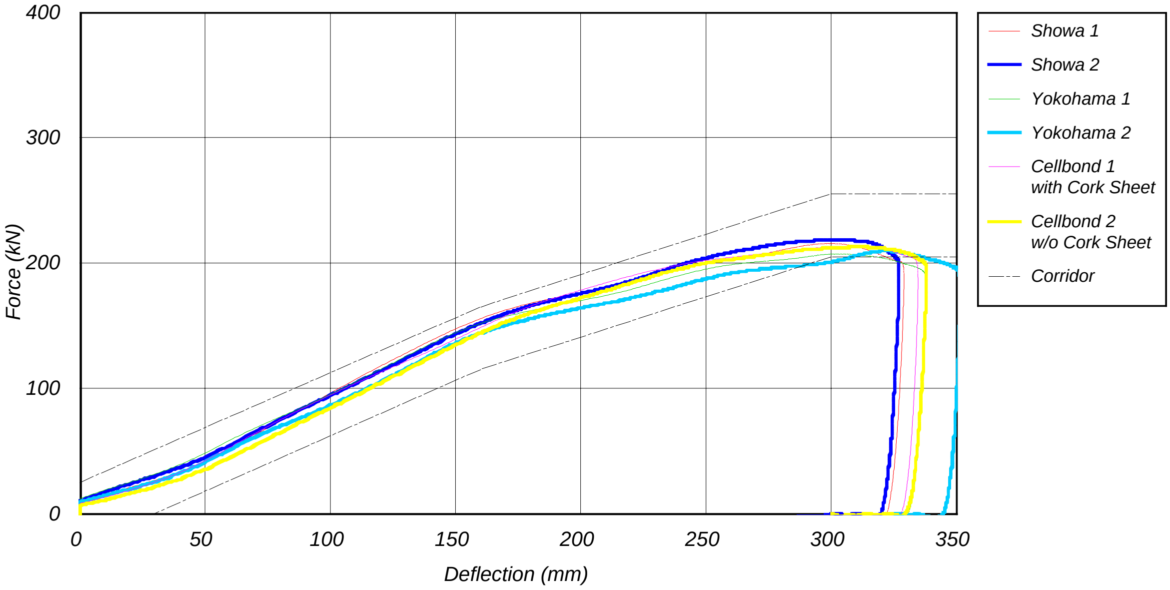


Fig.7 Force-Deflection Curves of Whole Barrier

2.2.2 Energy Absorption

In some blocks the amount of energy absorbed exceeded the required energy. It became evident, however, that the required energy in the draft had been incorrectly recorded, so the results were re-assessed against the conventional required energy. Even so, the desired value was still exceeded in some blocks.

2.2.3 Deflection of Level B

The deflection of level B satisfied the required deflection in all the barrier tests, being near the lower limit of the required deflection range. The deflection was measured as the permanent deflection after the tests.

Table 2 Inpulse, Energy Absorption and Deflection of Level B

		Showa		Yokohama		Cellbond	
		B01_0201	B01_0202	B01_0203	B01_0204	B01_0301	B01_0302
Impulse (kgm/s)	Block 1	1814.9	1972.3	1926.5	1764.8	1651.4	1706.7
	Block 2	2737.6	2693.5	2869.2	2919.0	3198.3	3088.0
	Block 3	2015.0	1904.3	1960.4	1921.5	1760.2	1690.8
	Block 4	970.2	984.8	1072.6	1163.7	1068.4	1143.0
	Block 5	736.2	780.0	664.9	767.3	785.4	713.8
	Block 6	850.0	805.1	809.9	880.8	852.9	830.9
	Total	9123.9	9139.8	9303.6	9417.0	9316.7	9173.1
	Theoretical	9252.8	9252.8	9259.6	9233.3	9252.8	9279.1
	Difference (%)	-1.39	-1.22	0.48	1.99	0.69	-1.14

		Showa		Yokohama		Cellbond		Requirement
		B01_0201	B01_0202	B01_0203	B01_0204	B01_0301	B01_0302	
Energy (kJ)	Block 1	8.58	9.67	9.47	8.54	8.07	8.20	10±2
	Block 2	14.46	14.36	15.16	15.79	16.74	16.40	14±2
	Block 3	9.65	8.67	9.47	8.99	8.63	8.05	10±2
	Block 4	4.55	4.65	4.92	5.40	4.85	5.22	4±1
	Block 5	3.58	3.73	3.07	3.75	3.62	3.26	3.5±1
	Block 6	4.08	3.77	3.80	4.16	3.87	3.82	3.5±1
	Total	44.90	44.85	45.89	46.63	45.76	44.94	45±5
	Theoretical	45.11	45.11	45.27	45.01	45.11	45.36	
	Difference (%)	-0.46	-0.57	1.37	3.59	1.45	-0.93	
Deflection of Level B (mm)		311	310	319	327	313	322	330±20

: Fail

3. Vehicle Impact Tests

3.1 Test Conditions

The test vehicle was a compact passenger car (4-door sedan) with the EuroSID-1 dummy installed in the driver's seat. The barriers used were single-layer deformable barriers made by Showa Aircraft Industry, Yokohama Rubber, and Cellbond. The impact speed in all cases was 50±1 km/h, and the MDB mass was in the range of 950±5 kg.

3.2 Test Results

3.2.1 Dummy Injury Value

The RDC and V*C values in the chest area showed no significant differences when they were compared with the test results of conventional multi-layer deformable barriers. The APF values in the stomach area showed a reduced injury value, whereas the HPC values in the head area and PSPF values in the pelvic region were high only in the Cellbond tests.

Table 3 Dummy Data

		F01_0201	F01_0202	F01_0301	F991201
Barrier Type		Showa Progress	Yokohama Progress	Cellbond Progress	Showa Multi-layer
HPC		188	148	344	138
RDC (mm)	Upper Rib	42.7	43.7	40.6	42.0
	Middle Rib	26.6	29.5	25.1	23.6
	Lower Rib	16.0	17.7	15.7	11.4
V*C (m/s)	Upper Rib	0.54	0.60	0.62	0.55
	Middle Rib	0.26	0.36	0.25	0.23
	Lower Rib	0.13	0.14	0.12	0.07
APF (kN)		1.65	1.60	1.46	2.45
PSPF (kN)		3.19	3.17	4.21	3.10

3.2.2 Vehicle Deflection

When the three types of progressive barriers were compared, it was found that the Showa and Yokohama Rubber test results had practically the same vehicle deflection values and deflection modes. On the other hand, the deflecion values in the Cellbond tests, tended to be about 50 mm greater at maximum deflection, even though the deflection modes were the same as in the other tests.

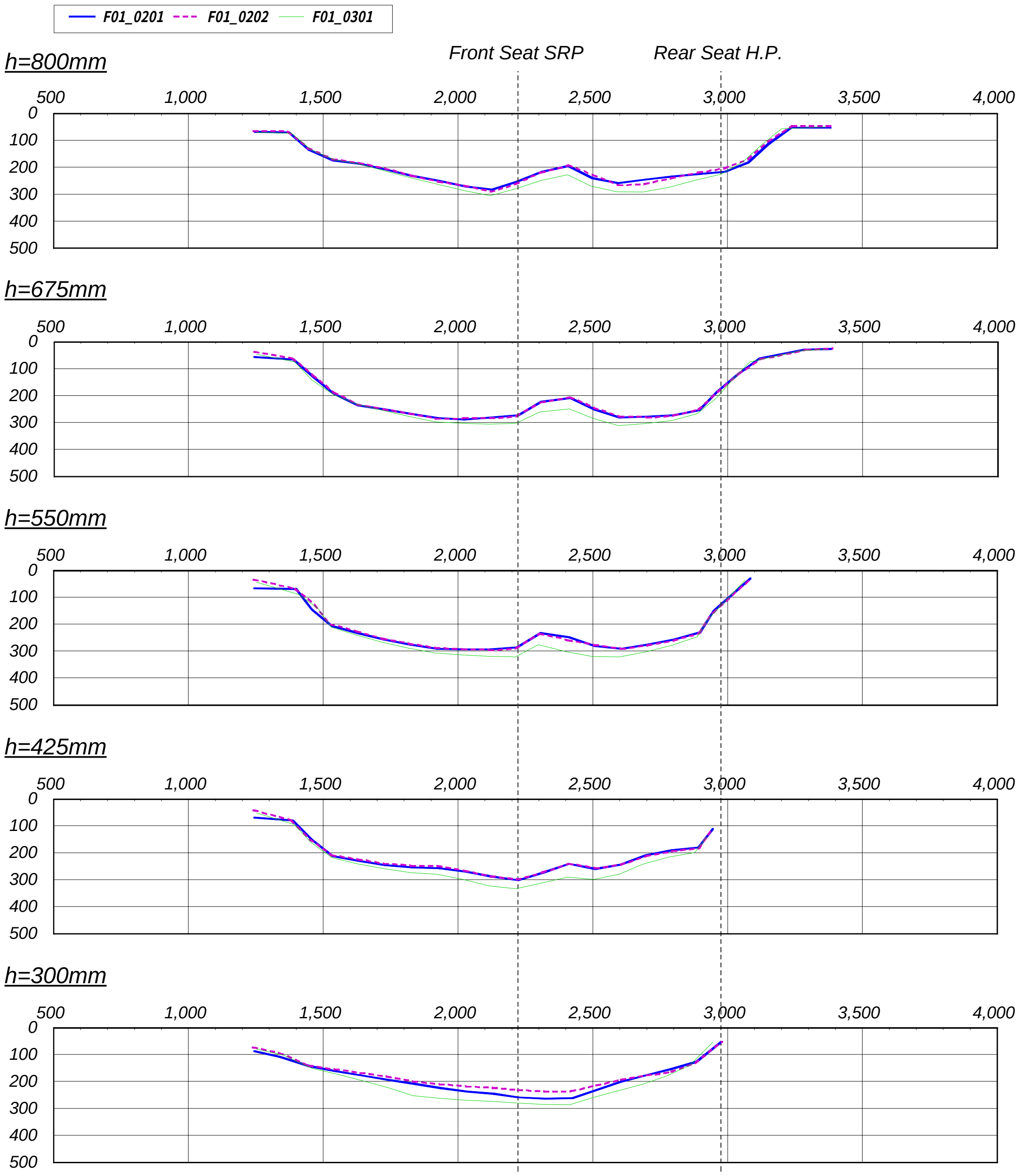


Fig.8 Deflection of Test Vehicles

3.2.3 Barrier Deflection

All three barriers had different amounts of deflection. The barrier with the greatest deflection was that made by Yokohama Rubber, the one with the least deflection was the Cellbond barrier, and the barrier made by Showa Aircraft Industry had an intermediate amount of deflection. The difference between the largest and smallest deflection was about 100 mm.

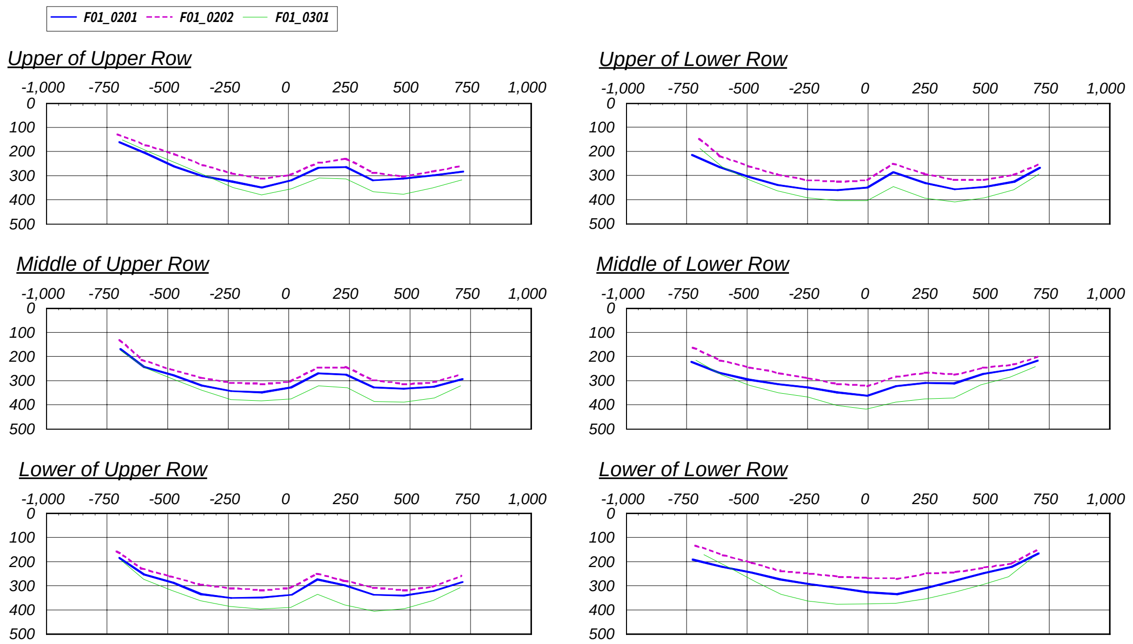


Fig.9 Deflection of Deformable Barriers

4. Summary

4.1 Conclusion

The barrier certification tests showed less variance in load-displacement characteristics, compared with certification tests of conventional laminated barriers. The results of actual vehicle tests conducted in Japan focused on the following problems, causing Japan to conclude that the draft required revision.

4.2 Problems

(1) The results of the Japanese tests found no barrier that could satisfy all the dynamic requirements. Studies should therefore be continued for a while in order to confirm production feasibility.

(2) The results of the actual vehicle tests showed a difference of at least 50mm in in body side deflection. Japan cannot approve of such a large difference.
Since it is thought to be due to the difference in the Block 2 characteristics:
* the Block 2 dynamic corridor must be narrowed to 8kN; and
* the ventilation frame must be improved so that it has better air removal characteristics.

(3) The relationship between static and crash characteristics was not clarified. In the Japanese test results, it was evident that test items aimed at the middle portion of the static characteristics corridor and in some cases did not look at the middle portion of the dynamic characteristics corridor. Based on the currently reported test results, therefore, a statistical analysis of the static-dynamic ratio should be conducted, with the aim of verifying the appropriateness of the relationship between the static and dynamic corridors in the draft.

5. Other Items

The following items, which were left undecided at the closing of the July 18 meeting, must be cleared up.

Paragraph 2.1.1 Geometrical characteristics
The dimensional tolerance of the honeycomb with a cell size of 19 mm is too narrow. The honeycomb dimensional tolerance shall therefore be widened (500±7 mm, 250±5 mm), or the front and back plate dimensions shall be stipulated with the honeycomb dimensions as reference values.

Paragraph 2.1.1 Geometrical characteristics
Since the number of cells is inefficient, it should be substituted with the block mass proposed at the July 18 meeting.

Paragraph 2.1.5.13 Impactor deformation
Since the level B deformation values of most barriers were near the bottom limit of the desired range, the desired value range or the measuring method needs to be reviewed.

Paragraph 2.2.1.1 Geometrical characteristics (Front Plate)
The front plate thickness of 0.8±0.05 mm, which was proposed at the July 5 and 18 meetings, presents no problems, however the tolerance stipulated in the Japanese Industrial Standard (JIS) is ±0.06 mm.

Paragraph 2.2.2 Material characteristics (Front Plate)
The front plate material characteristics were set as follows at the July 18 meeting: Brinell hardness of 50±5 HBS; minimum elongation of 12%; and minimum tensile strength of 175 N/mm^2. However, since a hardness value is not stipulated in ISO and other standards, generally stipulated tensile strength and elongation values can be considered sufficient.

Paragraph 2.3.2 Material characteristics (Back Plate)
The back plate tensile strength (235-285 N/mm^2) and elongation (3% minimum) shall be stipulated as in the case of the front plate material characteristics.

Paragraph 2.5.2 Bonding
The minimum bonding strength shall be 0.6 MPa, as stipulated in the July 5 and 18 meetings.

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