EUROPEAN ENHANCED VEHICLE-SAFETY COMMITTEE

EEVC Working Group 13 Report
Recommendations for the Revision of the Side Impact MDB Face Specification.

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EEVC WG13 Recommendations for the Revision of the Side Impact MDB Face Specification

BACKGROUND.

ECE Regulation 95 and EU Directive 96/27/EC. include a dynamic full scale impact of a mobile deformable barrier (MDB) into the side of the target vehicle. The MDB comprises a deformable face attached to a trolley. The deformable face is currently defined by overall and element dimensions together with force-deflection and energy dissipation requirements in a certification test against a flat rigid load cell wall at an impact speed lower than the impact test speed. It has been reported that different designs of MDB face, that perform similarly under the certification test, produce significantly different results when used to test cars

EEVC Working Group 13 has developed a methodology for evaluating the performance of different designs of deformable faces for the mobile barrier used in the EEVC Side Impact Test Procedure, as currently specified in the Directive and Regulation.

A representative sample of most of the currently available MDB faces have been subject to both the normal certification test and to the special EEVC tests. Much of the evaluation and assessment of the performance of the MDB faces is derived from a careful scrutiny of the high speed video records of the behaviour of the faces in the test. An expert panel[*] of engineers, experienced in side impact tests of vehicles, was created to evaluate the barrier face performances from both the high speed videos and the transducer records and to make recommendation to EEVC regarding the options available to improve the specification of the MDB. The Expert Panel report was presented to and reviewed by EEVC WG13.

This report describes the MDB faces used in this programme, summarises their performance in the tests and describes the EEVC conclusions and recommendations, taking the Expert Panel's report into account.

TEST PROGRAMME

The tests were designed to be able to differentiate between both 'good' and 'bad' MDB faces and identify differences in construction and design strategies that might affect dynamic crush behaviour.

Since the EEVC Side Impact Test Procedure, as implemented in the EC Directive and ECE Regulation, involves a perpendicular impact rather than a crabbed impact, the effect of shear on the MDB faces was not specifically addressed.

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[*] See Appendix 1.

The tests undertaken in this study are specified in EEVC WG13 document "Side Impact Barrier performance Testing: Procedures for the Assessment of the Relative Performance of EEVC Side Impact Barrier Deformable Elements under Realistic Loading Conditions[Ψ]".

The test conditions for the special tests were:

1. High speed flat wall test. A flat rigid load cell wall test, as for the certification test, but at the full test speed of 50km/h. For this test it was necessary to add an additional deformable element behind the existing MDB face to absorb the additional kinetic energy of the mobile barrier. This test was designed to determine whether the deformable face performance changed with impact speed. This could be important since the current certification test is performed at 35km/h while the vehicle test impact speed is currently 50km/h.

2. Pole impacts. Two tests were defined where the MDB face impacts a vertical half cylinder placed against the load cell wall. One test positioned the pole central to the MDB face and in the second configuration the pole was placed at the vertical intersection between the central elements and the adjacent elements at one side These tests were intended to evaluate the realism of the load transfer across the MDB face and how well the elements are connected. It partly represents an impact to a strong B-pillar. The structural integrity of the design is evaluated also in these tests.

3. Rigid angled wall tests. These tests generate non-parallel loading to the deformable elements with the angles of the walls selected to represent typical deformation profiles observed in full scale side impact tests. Two tests are proposed, separating out the effects of angled loading to the sides of the MDB face and to the lower edge from the car sill.

   3.1 Rigid Edge Loading Wall Test. This first loads the edges of the MDB face, producing a final profile in the horizontal plane similar to that of the MDB faces seen in car impact tests.

   3.2 Rigid Sill Loading Wall Test. This loads the lower edge of the MDB face in a way which duplicated (in a controlled uniform manner) the non parallel loading generated by the stiff sill member of a car. To avoid the angled wall lifting the whole MDB in this test, the wall and MDB face were both inverted

4. Yielding Wall Test. In this test the MDB face impacts a surface that is initially flat but which deforms to a 'concave' shape representing a deformed car profile. This is achieved in a repeatable manner by using a central flat panel which can translate rearwards by deforming the supporting crumple tubes, and two hinged side panels whose free edge rests on this central panel.

[Ψ] Also published in "Test Methods for Evaluating and Comparing the Performance of Side Impact Barrier Faces", by de Coo, Roberts, Seeck and Cesari, on behalf of EEVC WG13. Proc 16th ESV Conference, June 1998.

Test Protocol

A complete test protocol has been prepared as an EEVC WG13 Working Document, which included a comprehensive evaluation procedure. "Side Impact Barrier Evaluation: Evaluation procedure for the Assessment of the Relative Performance of EEVC Side Impact Barriers under Realistic Loading Conditions" The test institutes involved in the programme also produced detailed testing and data post-processing procedures in order to reduce inter-test house variations in results.

MDB Face Faces Used In The Test Programme

The EC Directive indicates that the MDB face should be manufactured from aluminium honeycomb but other alternative materials are permitted if equivalence can be demonstrated.

The manufacturers of barrier faces produced in accordance of the requirements for the EC Side Impact directive were invited to supply their MDB face for the evaluation programme. In total seven MDB face designs were put forward. An eighth MDB face, based on a profiled honeycomb design that is known to produce particularly variable results when impacted against vehicles, was also included in the programme in order to ensure that the supplementary test procedures could distinguish a 'poor design'. At least three different 'profiled' honeycomb type MDB faces have or are being used. A special version was therefore acquired with a continuous front face from a co-operating manufacturer, in order to investigate this alternative design philosophy. No MDB face to this design philosophy is currently supported by a manufacturer.

The barriers tested in the EC Evaluation Programme can be classified into three groups based on their generic design. Photographs of the MDB faces are shown in Appendix 2.

A Multi-Layer Aluminium Honeycomb Barrier Designs

Multi-layer honeycomb barriers use aluminium honeycomb blocks of different crush strengths to achieve the progressive force-deflection corridors specified in the current Directive. The weakest blocks are at the front of the barrier face, and the stiffest blocks at the rear. The honeycomb is held together with interface layers. The material used for the interface layers varies between different MDB face manufacturers. The MDB faces in the EEVC evaluation programme conforming to this generic design were:

1. Cellbond Composites Ltd (UK) – Multi-2000 Barrier
2. Showa Aircraft Industry Co Ltd (Japan) – European Deformable Barrier Face
3. Yokohama (Japan) – MDB Barrier Face for Side Impact
4. Plascore (USA) – European Side Impact Barrier

B Progressive MDB face Designs

The MDB faces in this category use single blocks of honeycomb which have their properties modified in order to change the crush characteristics progressively along the block.
The MDB faces in the EEVC evaluation programme conforming to this generic design were:

1. AFL (France) – Progress Barrier
2. Darchem (UK) – Side Impact Deformable Barrier

The two MDB faces achieve the progressive performance by different methods. In the AFL MDB face, the honeycomb is differentially etched so that the cell wall thickness of the honeycomb is thinnest for the weakest section of the MDB face (at the front) and thickest at the rear of the MDB face. In the Darchem MDB face, the property of the honeycomb is modified by punched holes in the cell walls. The larger the diameter of the holes the weaker the honeycomb structure becomes. The punched hole diameter is therefore larger at the front of the MDB face and tapers away towards the rear of the MDB face.

C Profiled Barrier Designs

An alternative method for producing the progressive force-deflection curves in the Directive is to profile the energy absorbing material from which the MDB face is constructed. The profiled area becomes larger the further barrier face deforms, progressively increasing the resistance to the impact and increasing the force measured on the load cell wall. The MDB faces in the EEVC evaluation programme conforming to this generic design were:

1. Fritzmeier (Germany) – EEVC Element
2. Cellbond Composites (UK) – Pyramid Barrier

The current Fritzmeier MDB face is manufactured from polyurethane foam and is the only MDB face in the programme not manufactured from Aluminium honeycomb. The Cellbond Pyramid MDB face was the special barrier face included in the programme to ensure that the supplementary test procedures in the test programme could identify the problems already experienced in full-scale vehicle testing with profiled honeycomb MDB face designs.

MDB Face Design And Ventilation Provision

In a honeycomb barrier a large volume of air can be trapped during crush, assuming that the ends of the cells are sealed during crush. The performance of the barrier as it is crushed will therefore be a combination of honeycomb crush and the compression/release of entrapped air.

Consequently, as it was felt that ventilation from the hollow aluminium honeycomb sections during impact could affect the dynamic response, it was decide to standardise this for all tests. The interface between the various mobile barriers normally used at each test institute varied from a completely solid sheet, with no ventilation possible, to an open framework with very high ventilation capacity. To ensure that the performance between institutes was comparable, it was decided to standardise on a flat unventilated sheet on the mobile barrier as the interface. The

MDB face manufacturers were informed of this and asked to provide any ventilation required with the deformable face. The MDB Faces were then tested with according to the recommendations of the manufacturer with any ventilation system specified attached directly to the flat unventilated interface. This aspect needs to be addressed in the Directive.

Of the eight barriers tested in the programme, four of them required ventilation and the other four were self-ventilating. The same ventilation system defined for each barrier design was used at each test institute. The ventilation systems were:

Cellbond Multi-2000– A special ventilation plate was specified with this barrier. This was an aluminium plate with drilled holes that matched the holes in he barrier back-plate. The ventilation plate had spacers that created a 3mm gap allowing the ventilation of air to the outside world at the plate/MDB interface.

AFL, Showa, Yokohama **–** A ladder 'style' frame was specified for the purpose of ventilating these barriers. The frame was constructed of 15mm square cross-section steel tube. The frame consisted of an outer rectangle (with the same dimensions as the barrier back-plate) with fourteen vertical struts connecting the upper and lower edges. Ventilation was achieved via twenty eight 8mm holes drilled on the outer edge of the frame, midway between the vertical struts.

Fritzmeier, Plascore, Darchem, Cellbond Triangular **-** These barriers were self-ventilating and thus required no special interface between the barrier back plate and the MDB.

Test Matrix

Each barrier face, except the specially produced triangular face, was certified at each institute according to the standard certification test procedure. In addition the test programme was also designed to evaluate 'typical' barrier repeatability. The Cellbond Multi2000 barrier was selected for this 'repeatability' evaluation, since it was widely used and also basically the same design as the barrier face being used in the EuroNCAP programme

Table 1 shows the distribution of the tests between test institutes.

Table 1 MDB evaluation test matrix

Test	**Barrier**	**Institute**				
		BASt	**TNO**	**TRL**	**UTAC**	**JARI**
Repeatability	Multi2000	1	1	1	1	1
Certification	Pyramid	1				
Certification	All	7	7	7	7	7
High speed cert.	All				8	
Centre pole	All					8
Offset pole	All	8				
Yielding wall	All		8			
Edge wall	All			8		
Sill wall	All			8		

TEST RESULTS AND OBSERVATIONS

The conclusions of the Expert Panel were drawn from a review of the transducer records and high speed films of the impact tests and from comments and observations of the test Institute personnel

MDB Face Production and Supply.

The manufacturers of the MDB Faces were issued with a questionnaire requesting details of supply and manufacture. The following information was taken from the responses.

Costs. The quoted costs of the MDB faces ranged from £770 to £2700 (approximately 1200 to 4000 Euro) although most were in the region £1600 to £1900 (approximately 2500 to 3000 Euro)

Quality Assurance. Most of the faces were produced under ISO9001 or 9002, Plascore being built under a US Military specification. There was a wide range of methods used by the manufacturers to ensure quality control. This could result in some designs being more consistent than others. This should form part of the MDB face specification.

Design Rights. All designs, except for the Cellbond designs, were subject to patents or patent applications. All manufacturers had expressed a willingness to permit others to use their design, should a design specification be selected, normally subject to a licensing agreement. If this were to be the way of specifying the MDB face in future, the cost implications of any licence fee may be influential in selecting a particular design.

Test Institute Comments on Test Details

The observations of the test institutes regarding the use of the different barrier faces and on the test procedures were reported to the Expert Panel and to the Working Group.

1 Decisions regarding mounting the deformable faces onto the mobile barrier and on the ventilation had to be made by the Consortium as they are not specified within the Directive nor Regulation. (Where Directive is mentioned here, it should be taken to include reference to the ECE Regulation also.)

2 Some of the deformable faces had backplates that were larger than the deformable elements, simplifying mounting onto the trolley. Others had backplates that were the same size as the deformable element, making mounting more complex. This issue also needs to be addressed in the Directive.

3 The tolerances of several of the test parameters, such as mass, speed and alignment, were considered to be unnecessarily large and were reduced in the test protocol for the Consortium programme in order to reduce the risk of inter institute variation. The test institutes reported no difficulties in achieving the revised tolerances.

4 The different participating institutes had load cell walls of differing design and dimensions. The Expert group felt that the design and construction of the load cell wall was an important issue in defining the dynamic performance of a barrier face and must be specified more closely if this is not to add to the variation in test results.

5 There were differences in the appearance in the build quality of the MDB faces, but this did not appear to have any effect on their dynamic performance.

Dynamic Tests Results

1. Yielding Wall Tests.

The analysis of these tests was based on the high speed film records and on the output from the linear potentiometers behind the flat yielding face and accelerometers on the mobile barrier.

The limited development testing of this test procedure resulted in some problems with the equipment which were mostly resolved after testing the first barrier face. From the high speed films of the tests, the inertia of the interface seems to be rather greater than that for a vehicle, so that much of the face deformation occurred against the undeformed walls. Nevertheless useful information was gained from this part of the programme.

The barrier faces seemed to perform similarly from the high speed film records. The Plascore barrier deformed the wall more than average and the Yokohama less than average for their generic type group. The Cellbond pyramid and the Fritzmeier MDB faces also resulted in lower final deformation of the yielding wall than the overall average..

2 Rigid Angled Wall Test (Edge Loading Test)

Darchem. The Darchem barrier failed along the weld lines between the corrugated aluminium sheets, causing some material to underride the bottom of the wall
AFL There was a slight separation of the upper and lower blocks. No lateral separation between the blocks was observed. Otherwise it deformed in a progressive manner.

Multi-2000 There was a slight separation of the upper and lower blocks. No lateral separation between the blocks was observed. Otherwise deformed in a progressive manner..
Showa There was a slight separation of the blocks laterally and there appears to have been slight buckling late in the impact.

Yokohama There was a slight separation of the blocks laterally, possibly associated with bending of the outer blocks.
Plascore Separation of front plate was observed. The initial gaps between block did *not* appear to increase. Otherwise it deformed in a progressive manner..

Fritzmeier This face deformed by crush and cracking of the rigid foam, with severe shearing at the rear joint with the backplate. The front aluminium plate did not take up the shape of the profiled wall, as did the other faces.
Cellbond Pyramid The front blocks bent and collapsed. The subsequent deformation was mostly by buckling.

The calculated energy absorption was less than average for the Darchem and Fritzmeier, and more than average for the Plascore.

3 Rigid Angled Wall Test (Sill Loading Test)

This test appeared to the Expert Panel to be the most discriminating test in this programme with this set of MDB face designs.

Darchem This test led to a considerable collapse of the Darchem face, resulting in the trolley making contact with the angled wall. From the high speed film records, this appeared to be due to a combination of failure at the welds and bending at the holes in the aluminium and failure of the bond of the aluminium honeycomb to the backplate
AFL The lower blocks of the barrier face rotated towards the sill representation, which assisted in the controlled collapse of the honeycomb

Multi-2000 There was slight rotation of the lower blocks but subsequent progressive collapse of the blocks
Showa There was more distinct rotation of the lower blocks than the Multi 2000 and AFL faces, which rotated in the same direction, initiated by collapse of the rear blocks from their rear surface. Slightly greater separation top and bottom layers. Otherwise, there was progressive collapse of the blocks.
Yokohama More significant collapse of the blocks than the Showa, Multi 2000 and AFL faces. The collapse was initiated at the rear of the rear blocks, resulting in the lower blocks rotating *away* from the sill representation followed by more buckling and vertical displacement of the blocks.
Plascore The honeycomb collapsed progressively without rotation or translation of the blocks. The initial gaps between block did *not* appear to increase.

Fritzmeier There was severe shearing of the rigid foam at the rear joint with the backplate followed by the collapse and disintegration of the face. The front aluminium plate did not take up the shape of the profiled wall, as did the other faces.
Cellbond Pyramid The lower profiled blocks bent and interacted with the front blocks. Deformation was mostly by buckling in an uncontrolled manner.

The Expert group thought that the `expansion' direction of the aluminium honeycomb would affect the manner of the behaviour in this test and that, consequently, this would be an important aspect of design specification and control.

4 Centre Pole Test.

As the pole impacts the barrier face, the front plate is forced into the deformable elements and the undeformed part of the plate to either side of the pole has to translate sideways. This is an exaggerated version of a real effect in MDB-to-car impacts and the influence of this motion on the barrier face behind it is important. The pole tests appear to be a useful means of assessing this behaviour.

Darchem There appeared to be some load transfer from the impact site to other parts of the face. As the front plate deformed and translated sideways, it transferred the shear into the side blocks.
AFL With this face, the crush was restricted to the honeycomb immediately behind the impact site. The shear from the front plate motion was completely limited to the forward part with no transmission of shear to the deeper levels. The collapse seems to be well controlled

Multi-2000 The crush was restricted to the honeycomb immediately behind the impact site. The shear from the front plate was restricted to the front blocks with no transmission of shear to the deeper layers. The collapse seems to be well controlled
Showa The backplate of this barrier face bent forward at the edges, probably due to inertia and poor attachment to the trolley. The shear from the front plate was restricted to the front layer and was not transmitted to the deeper layers.
Yokohama The shear from the front plate was transmitted beyond the first layer. This was thought possibly to be due to this design being only 4-layers in the top blocks and the relative stiffnesses of the layers.
Plascore Similarly, the shear from the front plate was transmitted beyond the first layer.

Fritzmeier The rigid foam failed in shear and collapsed in an uncontrolled manner
Cellbond Pyramid The front `solid' blocks folded around the pole, separating from the profiled elements leaving the elements in an inappropriate orientation for further impact

5 Offset Pole Test

Darchem The honeycomb block "shrank" sideways in a "concertina" fashion as the pole penetrated. Also the top and bottom corrugated aluminium sheets separated.
AFL The backplate deformed forwards at mid height (thought to be an inertia effect). The blocks did not separate but the side blocks folded round a little. The collapse of the honeycomb was mostly behind the pole. It collapsed in a controlled manner with no transmission of shear to the deeper levels, probably die to the separation of the front aluminium sheet from the honeycomb behind it.

Multi-2000 The shear from the front plate was restricted to the front blocks with no transmission of shear to the deeper layers.
Showa The backplate of this barrier face again bent forward at the edges. The rear blocks initiated collapse from the rear surface, causing the blocks to twist and shear slightly
Yokohama As with the Showa, the rear blocks initiated collapse from the rear surface, causing the blocks to twist and shear slightly. The front elements separated from those behind
Plascore The front blocks separated from those behind. The centre blocks twisted towards the pole separating them from the outer blocks.
Fritzmeier The rigid foam failed in shear at rear followed by rapid twisting, collapsing in an uncontrolled manner
Cellbond Pyramid The front `solid' blocks separated from the profiled elements which twisted, leaving the elements in an inappropriate orientation for further impact

For multilayer MDB face designs, the stiffness of the front and subsequent layers of the blocks may affect the transmission of shear to the lower levels of the face.

5 Certification Test

None of the barrier faces was totally within the corridors and supplementary requirements, although most of them were within the corridors for most of the deformation. It should be emphasised that this aspect was not of primary concern to EEVC WG13 nor to the Expert Panel since repeatability was considered to be more important than full compliance with corridors, which are exceeded in any case by real vehicles.

The Multi-2000 was tested twice at each institute as a measure of repeatability at each test house and of reproducibility between test houses. The repeatability of this MDB face was good at each institute, being better than the reproducibility between institutes. However the reproducibility was normally within the width of the corridors.

The other MDB faces were tested once at each institute so the variation seen was a combination of inter-sample variance and inter-institute variance. Interestingly, the variation seemed to depend on barrier face type. The different institutes used load cell walls of different designs and it is likely that some barrier face designs are more sensitive to load cell wall design than others.

It is not the intention to report in detail all of the Certification test results. The results and conclusions of the Expert Panel are given here in summary:

Darchem Some variations were seen in the test results, especially in the maximum deformation. This is likely to be due to the failures of the structure mentioned above.
AFL The force-deflection curves showed very good repeatability between test institutes, including the crush distance.

Multi-2000 The force-deflection curves showed reasonable repeatability with a little more variability in final crush.
Showa The force-deflection curves showed good repeatability

Yokohama The force-deflection curves showed good repeatability except at one institute where the force was lower between 100 and 240mm.
Plascore The force-deflection curves showed poor repeatability, with all of the "whole MDB face" results lying partly outside the corridors, exceeding the upper force limits for part of the crush.

Fritzmeier An inertial spike was seen at an early stage of the crush. The force-deflection curves were fairly repeatable initially but deviating later and variation seen in maximum crush (the final crush was not measurable due to total failure of rigid foam).

The Cellbond Pyramid barrier face was not tested for repeatability since its inclusion in the programme was to verify that the other test procedures could demonstrate known problems.

6 High Speed Flat Wall Test

In these tests, the force-deflection results appear to show that, at the start of the deformation, there is not much difference in the responses of each MDB face at high speed compared with the standard certification speed. It was noticeable that, for some of the faces, the force plateau at the end of the test was higher in the high speed test than in the certification test. This was thought to be due to the higher energy of the high speed test requiring more energy to be absorbed. As a result, the high speed test caused the rear (and stiffer) blocks of the basic MDB face to deform while they remained undeformed (and thereby un-tested) in the Certification test. Consequently, the rear layers of the MDB face may well be involved in car impacts but are currently uncontrolled by the Certification test.

Darchem There were some variations in the force-deflection curves but it was concluded that this may be inter-sample variance.
AFL The results at the two impact speeds were similar up to the same energy absorption levels.
.
Cellbond The results at the two impact speeds were similar up to the same energy absorption levels.
Showa The results at the two impact speeds were similar up to the same energy absorption levels r.
Yokohama There were some small differences at beginning where the force curve appears to be time shifted.
Plascore At the start of the deformation the curves were similar but there were differences at greater levels of deformation.

Fritzmeier There were some differences in the force-deflection curves apparently due to a time shift in the data.

EEVC WG13 CONSIDERATIONS

EEVC WG13 has considered the results of the test programme, the conclusions of the Expert Panel and the options for resolving the problems that the current barrier face specification has produced.

Many factors have been taken into account but particular observations noted by the expert panel and by WG13 members as being significant were:

1 Most of the barrier faces were close to the required performance corridors. However, there were differences between the different designs of MDB faces, even within one design category, that could result in differences in vehicle performance in the side impact test.

2 Some barrier faces showed less variation between test institutes than others.

3 Review of the *unfiltered* force data demonstrated that multilayer barrier faces showed distinct stepped force-deflection responses while the progressive barrier faces showed smooth responses. The size of the steps was influenced by the interlayer design. Smooth responses are more likely to provide repeatable results in MDB-to-car impact tests.

4 Pre-crushing the rear faces of the multilayer blocks could result in tilting or rotating of the block and possible subsequent shear of the elements. It may also lead to undesirable load spreading or load distribution in the event of a concentrated force, such as was seen in the pole test.

5 Lateral translation of the front plate should be able to occur without transmitting shear forces into the depth of the remote parts of the barrier face, as demonstrated in the pole tests.

6 The direction of expansion and the construction method of the honeycomb could influence the failure mode under non-collinear loading (Angled Edge and Sill loading tests).

Objectives

In considering the possible options for improvement in the specification of the MDB face, WG13 identified certain objectives.

WG13 was *not* re-defining the MDB Face, only how it should be specified

WG13 was *not* intending to make the EEVC/EC/ECE Side Impact Test Procedure more severe nor less severe

Noting that _no_ current design fully meets the existing performance requirements, the objectives set out by WG13 in making its recommendations were

To define the requirements and specification for the MDB such that it:

(a) approximates to the EEVC performance corridor targets

(b) is repeatable

(c) does not deform in an unstable nor uncontrollable manner when impacting cars

(d) is not single sourced

Options

The following options were produced by the Expert Panel and were accepted by EEVC WG13 as possible ways forward:

1. Do nothing
2. Keep existing requirements + definition of trolley to barrier face interface and attachment system
3. Modify existing requirements (but based on the same philosophy) + definition of trolley to barrier face interface and attachment system
4. Keep existing requirements + definition of trolley to barrier face interface and attachment system *(Solution 2)* + stipulate 'continuous aluminium honeycomb design (no voids)
5. Keep existing requirements + definition of trolley to barrier face interface and attachment system + stipulate 'continuous aluminium honeycomb design i.e. no voids *(Solution 4)* + design limited to one generic type
6. Keep existing requirements + definition of trolley to barrier face interface and attachment system + stipulate 'continuous aluminium honeycomb design i.e. no voids *(Solution 4)* + one or more supplementary performance tests
7. Keep existing requirements + definition of trolley to barrier face interface and attachment system + stipulate 'continuous aluminium honeycomb design i.e. no voids + design limited to one generic type *(Solution 5)* + one or more supplementary performance tests
8. Specify two designs and construction, one for each of the more successful `generic types' – progressive and multilayer + 'element' production conformity tests (partial harmonisation with Offset Frontal Impact Directive/Reg. 94 deformable face specification method)
9. Specify a single design and construction + 'element' production conformity tests (harmonise with Offset Frontal Impact Directive/Reg. 94 deformable face specification method)

The first option *(Do nothing)* was not considered to be acceptable on the basis of the test results and experience and was not considered further.

The potential benefits and drawbacks of each of the remaining options were considered in turn, taking into account the findings from the MDB Face Evaluation Programme.

2. *Keep existing requirements + definition of trolley to barrier face interface and attachment system*

The Expert panel stated that, on the basis of the results of this test programme, this is not a viable course of action

3. *Modify existing requirements (but based on the same philosophy) + definition of trolley to barrier face interface and attachment system*

<u>Advantages</u>

a) Quick to implement (early implementation)

b) Allows at least one MDB face to be certified

<u>Disadvantages</u>

a) Unlikely to resolve known problems

4. *Keep existing requirements + definition of trolley to barrier face interface and attachment system + stipulate 'continuous aluminium honeycomb design (no voids)*

<u>Advantages</u>

a) Removes some known undesirable collapse modes

b) Quick to implement (early implementation)

<u>Disadvantages</u>

a) Will not ensure undesirable and unpredictable collapse modes are eliminated

b) Compromises repeatability and reproducibility (worse than 5)

5. *Keep existing requirements + definition of trolley to barrier face interface and attachment system + stipulate 'continuous aluminium honeycomb design i.e. no voids + design limited to one generic type*

<u>Advantages</u>

a) Removes some known undesirable collapse modes

b) Quick to implement (early implementation)

Disadvantages

a) Will not ensure undesirable and unpredictable collapse modes are eliminated

b) compromises repeatability and reproducibility (worse than 6)

6. *Keep existing requirements + definition of trolley to barrier face interface and attachment system + stipulate 'continuous aluminium honeycomb design i.e. no voids + one or more supplementary performance tests*

Advantages

a) More control of repeatability than existing (less than 7)

b) Removes some undesirable collapse modes

c) Opportunity for novel designs (this point was seen as disadvantage by vehicle manufacturers

Disadvantages

a) Time to develop test procedures

b) Multiple designs for vehicle manufacturers

c) More variation than 7

7. *Keep existing requirements + definition of trolley to barrier face interface and attachment system + stipulate 'continuous aluminium honeycomb design i.e. no voids + design limited to one generic type + one or more supplementary performance tests*

Advantages

a) More repeatable than existing if 'generic' well defined

b) May provide alternative designs that could cope with odd results

Disadvantages

a) Time taken to develop necessary new tests

b) Development of objective requirements

c) Multiple MDB faces for vehicle manufacturers

d) Probably more variable than option 8

8. *Specify two designs and construction, one for each of the more successful `generic types' – progressive and multilayer + 'element' production conformity.*

<u>Advantages</u>

a) Would restrict repeatability and reproducibility although less than 9

b) Easier than Option 9 to make the design selection

<u>Disadvantages</u>

a) Effects of different generic designs in vehicle tests not known (especially test severity)

<u>c)</u> Potentially reduces global harmonisation (in comparison with option 9)

<u>d)</u> Provides 2 designs for vehicle manufacturers to consider

9. *Specify a single design and construction + 'element' production conformity test(s)*

<u>Advantages</u>

a) Optimum route to good repeatability and reproducibility

b) Brings into line with all other regulations where test tool design is specified

c) Can develop, certify vehicles and do Regulatory and consumer testing with the same single MDB face design (i.e. minimise number of tests conditions for vehicle manufacturers

d) Assists global compatibility of test methods.

e) Quick solution for solving the problem at hand

<u>Disadvantages</u>

a) Design restrictive

b) Delays in novel design (however, already anticipate another change by around 2008 following IHRA activities)

c) Need to define carefully the manufacturing techniques and conformity of production (depends on design selected) - However, this is common to all test tools

EEVC WG13 RECOMMENDATIONS:

All of the EEVC experts and their industry advisors agreed that the best solution would be Option 9: *“Specify a single design and construction together with supplementary tests to ensure performance conformity of the elements of the MDB Face”.*

The JASIC observers favoured Option 8 : *“Specify the design and construction of two MDB Faces, one for each of the more successful `generic types’ –the progressive and the multilayer together with supplementary tests to ensure performance conformity of the elements of the MDB Face.*

For Option 9, the opinion of the Expert Panel in their report to EEVC WG13 on the preferred single design selected from those within the test programme were as follows:

Expert		Preferred MBD Face Design
EEVC	1	AFL
	2	AFL
	3	AFL
ACEA	1	AFL
	2	AFL
JASIC	1	Showa
	2	Showa
EuroNCAP	1	AFL:
Test Institutes	1	AFL
	2	AFL
	3	Showa/AFL
	4	AFL

EEVC WG13 Opinion

For Option 9, of the MDB Face designs that were used in the evaluation study (all of those commercially available at the start of the test programme) WG13 unanimously preferred the progressive design generic type, of which the only face to perform acceptably was the AFL design.

WG13 stressed that these conclusions were subject to:

1. verification in MDB to car impact tests, especially as there was very little experience with the AFL face in car tests
2. evaluation of the repeatability and reproducibility of the selected MDB face design(s)
3. the ability to specify and control the manufacturing process to ensure consistency in performance

4. the development of effective conformity of production testing routines

The recommendation of EEVC WG13 is to be seen as a recommendation to specify the MDB face in terms of a single design specification (with supplementary quality assurance component testing) based on a progressive design similar to that exemplified by the AFL Progress barrier face used in this test programme. It is not necessarily an endorsement of this specific design.

When considering repeatability and reproducibility, WG13 emphasise that the spread and phase of fluctuations in force – deflection responses was an important aspect.

EEVC WG13 further wishes to emphasise that the certification load cell wall specification and performance needs to be closely specified it the response to load cell wall is to form any part of the barrier face specification.

RECOMMENDED FUTURE ACTIONS

EEVC recommends that a task force be created with invited participation of interested MDB face manufacturers, to define (a) the design specification, (b) production definition and control and (c) supplementary quality assurance component testing for the single design of progressive MDB face to be used for the side impact test specified in the Directive and Regulation

Prepared by R W Lowne
On behalf of EEVC WG13

APPENDIX 1

Members of the Expert Panel:

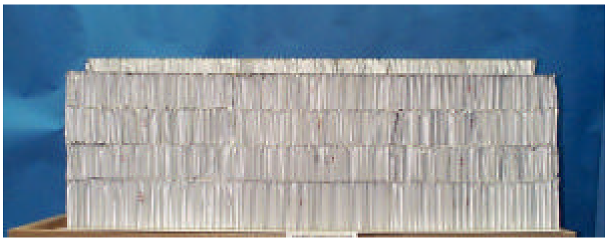
Chairman:	Prof. R Lowne
EEVC experts:	Mr C. Fourgeaud
	Mr A Roberts
	Mr T Versmissen
ACEA experts	Mr J Green
	Mr D Pouget
JASIC experts	Mr. Ohmae
	Mr T Kasai
EuroNCAP expert	Mr A Hobbs
Test Institute experts	Mr S Knack
	Miss C Owen (Consortium leader)
	Mr Ueno
	Mr R Zuljar

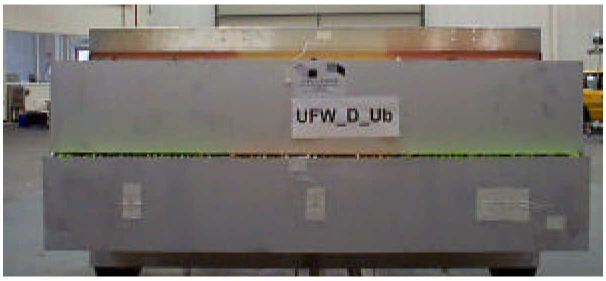
APPENDIX 2

<u>MDB Face Designs used in the Evaluation Programme.</u>

Multi-Layer Aluminium Honeycomb Barrier Designs

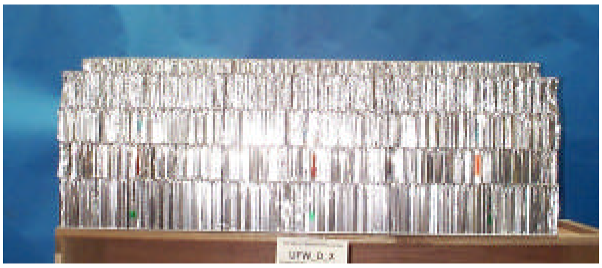
Cellbond Composites Ltd - Multi-2000 Barrier

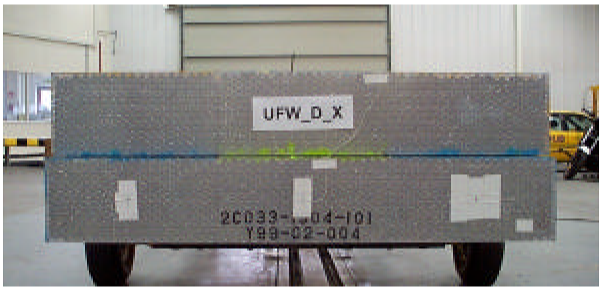




Showa Aircraft Industry Co Ltd – European Deformable Barrier Face

Yokohama – MDB Barrier Face for Side Impact



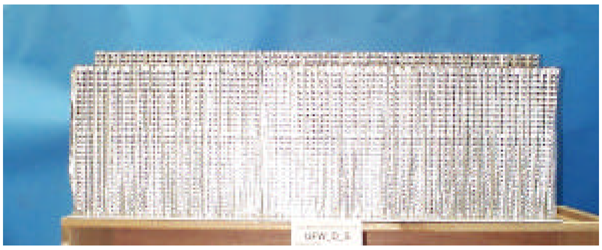


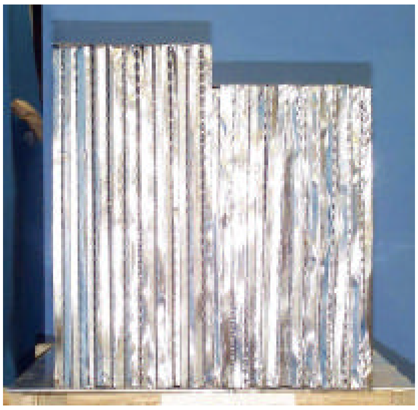
Plascore – European Side Impact Barrier

Progressive Barrier Designs

AFL – Progress Barrier

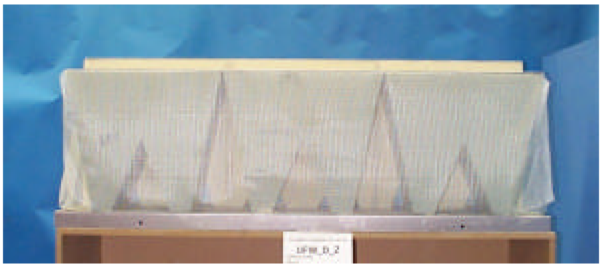
Darchem – Side Impact Deformable Barrier





Profiled Barrier Designs

Fritzmeier – EEVC Element



Cellbond Composites – Pyramid Barrier