EEVC/CEVE

European Experimental Vehicles Committee

EEVC Report on the Side Impact Test Procedure

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REPORT ON THE EEVC SIDE IMPACT TEST PROCEDURE

Prepared by EEVC Working Group 9 APRIL 1990

Abstract

The EEVC first proposed a Test Procedure for Side Impact protection at the Fifth ESV Conference. Since that time the test procedure has been further developed, a specification for a mobile deformable barrier produced and a dummy specifically for use in lateral impacts has been developed. Over the last two years it has been possible to evaluate the test procedure because Production Prototypes of the dummy, EUROSID, and satisfactory examples of the deformable barrier face have been produced.

EEVC Working Group 9 has been created to support the development of the test procedure, including the dummy and MDB face and to consider the implications of the use of component test procedures and mathematical modelling in legislative testing. This report describes the current status of the test procedure, including some results of tests performed to this procedure using the new dummy and the MDB faces and draws conclusions from these tests and tests comparing the EEVC and NHTSA Barriers.

Introduction

EEVC first proposed a procedure for the evaluation of the performance of vehicles in side impacts at the Fifth ESV Conference in 1974(1). The proposals were in general terms but included the evaluation of the performance of the vehicle by the use of dummies.

The proposals were further developed at the Ninth ESV Conference (2). This revised procedure was to impact a stationary target car at 50 km. per hour with a mobile barrier, to the front of which was attached a deformable face. The trajectory of the mobile barrier was to be perpendicular to the longitudinal axis of the target car and the centre of the barrier face was to be aligned with the R-point of this vehicle (Figure 1). The deformable barrier face was intended to have crush characteristics based on test results with a number of European cars and was sub-divided into six blocks, each with its own force/deflection characteristics (Figure 2). The performance of the car would be judged by the readings taken on a dummy. Since that time, the procedure has been further developed, three designs of Mobile Deformable Barrier faces have been produced and a dummy has been produced specifically for use in side impact tests (EUROSID).

A major review of the original proposal was made at the 11th Experimental Vehicles Conference , 1987 (3) following test experience with early versions of the Mobile Deformable Barriers (MDBs) and the Component Prototype version of EUROSID. The main parameters of the test procedure were confirmed with the exception that the height of the barrier face was raised from 250mm. to 300mm. and a proposal was made to permit excursions from the barrier force specification during the first 150mm of crush. Further testing to the EEVC procedure has followed using the Production Prototype EUROSID and later versions of the MDB faces.

EEVC Working Group 9 was created in 1988 to support the development of the test procedure, including the dummy and the MDB. This report of WG9 describes recent experience with side impact testing to the EEVC procedure.

It should be noted that the test procedure proposed by ERGA differs from the EEVC test procedure. In particular, the ERGA procedure specifies the use of only one dummy, which is located in the front seat position and the specification for the seat position differs. There is no supplementary head impact test requirement in the ERGA procedure.

Eurosid

Twenty four Production Prototype EUROSIDs have been produced for evaluation by a wide range of test institutes and the experience gained from this testing is being used to produce the specification and design of the first production version of the dummy. Some improvement has been made to the biofidelity of the dummy and problems with some of the instrumentation have now been eliminated(4). The specification of the production dummy, EUROSID 1, is given in a separate paper.

In the view of EEVC, EUROSID 1, the production version of this dummy, provides an adequate tool for assessing the likelihood of injury from side impacts and is sufficiently reliable and consistent for use in the proposed side impact regulation dynamic test.

Mobile deformable barrier face

Mobile Deformable Barrier (MDB) faces constructed from rigid polyurethane foam and designed to meet the EEVC specification have been extensively tested by government and industry in both Europe and North America. Two designs have been developed within the EEVC, one manufactured by Fritzmeier GmbH and the other by Kenmont Ltd. A further design has been produced by UTAC in France. Although each appears to have satisfactory characteristics, none of them fully meets the original EEVC specifications (1).

A review of Japanese research (5) shows that the performance corridors for the EEVC MDB face still represents typical Japanese and European cars, although the force-time curves of many cars exhibit some excursions from the corridors.

At the main meeting of the EEVC steering committee in 1989, Working Group 9 recommended that, now, the design of the barrier face should be specified in addition to a performance requirement. At the request of EEVC, WG9 has reconsidered this but reaffirms the recommendation to specify the design as well as a supplementary performance requirement, provided that the design and construction criteria would control the scatter in performance variation and would allow any manufacturer to build the deformable faces, for two principle reasons;

1. to reduce variability in the test procedure,

2. to enable suppliers to provide MDB faces in a way that can be controlled effectively.

Experience with the test procedure

The EEVC Test Procedure specifies two side impact dummies; one in the front seat and one in the rear seat, both on the struck side. However, in order to improve photography of the inside of the vehicle, only the front dummy was used in these tests.

Reproducibility

Side impact tests have been performed at four institutes on the same model of target vehicle; a small two door hatchback passenger car. The same make of MDB face was used for all tests.

Table 1 shows the results for these tests and Table 2 presents the effect of applying the proposed EEVC Performance Criteria to the results. The main inconsistency is in the pubic symphysis force, but these tests were performed using a pubic symphysis transducer which is now known to produce erroneous results. A new force transducer is now specified for EUROSID (See Ref 4). The tests performed at INRETS used an earlier version of EUROSID.

Table 1
Test results on a Small Passenger Car
Performed at Four Test Institutes

Test Institute	BASt	BASt	TRRL	Ford	INRETS
Parameter					
HEAD					
HIC	448	758	275	267	247
THORAX					
Peak Rib Deflection (mm.)	30.5	35.0	33.5	36.0	35.5
Peak Viscous Criterion (m/s)	0.6	0.7	0.5	0.7	0.6
Max. TTI	138	132	132	-	97
ABDOMEN					
Force> 4.5kN. @39mm. (Switch contact)	no	no	no	no	no
PELVIS					
Peak Ilium force (kN.)	1.9	2.7	2.5	2.6	2.0
Peak pubic symphysis force (kN)	7.3	8.1	11.2	10.3	-
MDB Peak longitudinal accel.(g)	14.2	14.3	15.3	15.5	17.9

With the exception of the HIC values which are all well below the criterion level, it can be seen that the results are very consistent for full scale tests suggesting satisfactory reproducibility for the test procedure.

Table 2
Results of Applying Proposed EEVC Test Criteria to Test Results on a Small Car Performed at Four test Institutes

Test Institute Parameter and Proposed Criterion	BASt	BASt	TRRL	Ford	INRETS
HEAD					
HIC (1000)	pass	pass	pass	pass	pass
THORAX					
Peak Rib Deflection (42mm)	pass	pass	pass	pass	pass
Peak Viscous Criterion(1.0) (m/s)	pass	pass	pass	pass	pass
ABDOMEN					
Force> 4.5kN. @39mm. (Switch contact)	pass	pass	pass	pass	pass
PELVIS					
Peak Ilium force (10kN)	pass	pass	pass	pass	pass
Peak pubic symphysis force* (10 kN)	pass	pass	fail	fail	(no data)

* original transducer with known errors

Sensitivity

Tests to determine the effect of barrier impact speed have been performed at two Laboratories, BASt(6) and TRRL(7). The results are shown in Table 3.

There is a general progression in the value of the parameters with increase in speed. This is more noticeable with the vehicle used in the BASt tests, which was a small hatchback car, than with the TRRL tests, which used a medium size hatchback.

TRRL has performed tests to investigate the effect of the mass of the Mobile Deformable Barrier on the injury parameters (7). The results of the tests, which were performed using a medium size hatchback car, are shown in Table 4. The barrier masses selected are those proposed for the EEVC (950kg) and the NHTSA (1350kg) test procedures.

Table 3
The Effect of the Impact Speed of the
Mobile Deformable Barrier on the Measured Dummy Parameters

Parameter			
		BASt	
Impactor speed (km/h)	45	50	55
HIC	167	265	-
Peak Chest Deflection (mm.)	30.0	38.5	44.5
Peak Pubic Symphysis Force (kN)	4.4	4.7	5.6
Peak Ilium Force (kN)	0.9	1.0	1.2
		TRRL	
Impactor Speed (km/h)	41	50	61
HIC	145	792	905
Peak Chest Deflection (mm.)	45.0	48.0	47.0
Peak Viscous Criterion (m/s)	1.0	1.3	1.4
Maximum TTI	135	169	218
Peak Pubic Symphysis Force (kN)	5.3	6.9	13.5
Peak Ilium Force (kN)	1.2	2.5	1.9

Table 4
The Effect of MDB Mass on Dummy Transducer Readings

Barrier Face	EEVC	EEVC
Barrier Mass (kg)	950	1350
Dummy	EUROSID	EUROSID
HIC	792	434
Peak Chest Deflection (mm.)	48.0	46.0
Peak Viscous Criterion (m/s)	1.3	1.3
Maximum TTI	169	167
Peak Pubic Symphysis Force (kN)	6.9	6.9
Peak Ilium Force (kN)	2.5	1.9

There do not appear to be any systematic differences between the results with the different barrier masses, at least with the vehicle model tested.

Comparison of EEVC and NHTSA Test Procedures

BASt, TNO and TRRL have reported tests aimed at establishing the effects of the differences between the test procedures proposed by EEVC and NHTSA (6,8,7). These results are summarised in Table 5. In all the tests quoted below, the dummy used was EUROSID to permit the effect of the test procedure, rather than the dummy, to be examined.

Table 5
Comparison of EEVC and NHTSA Test Procedures

	BASt	
Test Procedure	EEVC	NHTSA**
Barrier Face*	EEVC	EEVC
HIC	265	160
Peak Chest Deflection (mm.)	38.5	37.5
Peak Pubic Symphysis Force (kN)	4.7	3.6
Peak Ilium Force (kN)	1.0	0.7

* 250mm ground clearance for both tests.
** MDB mass 1100kg.

		TNO	
Test Procedure	EEVC	EEVC	NHTSA
Barrier Face	EEVC	EEVC	NHTSA
HIC	115	240	611
Peak Chest Deflection (mm.)	40.0	39.5	27.5
Peak Viscous Criterion (m/s)	0.5	0.5	0.4
Max TTI	121	128	136
Abdomen Switch Contact	yes	no	yes
Peak Pubic Symphysis Force (kN)	3.23	4.21	16.62
Peak Ilium Force (kN)	0.87	1.26	1.01

switch contact force set at 4kN instead of 4.5kN

		TRRL	
Test Procedure	EEVC	NHTSA	Car-Car
Barrier Face	EEVC	NHTSA	Car
HIC	792	-	254
Peak Chest Deflection (mm.)	48.0	30.0	53.0
Peak Viscous Criterion (m/s)	1.3	0.6	1.7
Max TTI	169	123	143
Abdomen Switch Contact	no	no	no
Peak Pubic Symphysis Force (kN)	6.9	15.8	6.6
Peak Ilium Force (kN)	2.5	-	1.3

The BASt tests, in which EEVC barrier faces were used for both tests, indicate that the crabbed test at 54km/h impact speed and 1100kg barrier mass is slightly less severe than the 50 km/h perpendicular impact with a barrier mass of 950kg. but the differences are small.

The TNO and TRRL tests, which used different target car models, suggest that the NHTSA test procedure is likely to be less severe to the thorax area but more severe to the pelvis. The TRRL tests indicate that the EEVC test procedure gives closer results to the car to car test than does the NHTSA test procedure, at least for the models of target and bullet cars used.

Conclusions

1. The EEVC test procedure appears to give reproducible results; tests at four different laboratories gave similar results on one vehicle model.

2. The results are sensitive to impact speed of the mobile barrier but do not appear to be very sensitive to the barrier mass within the range tested (950 - 1350kg).

3. For the same barrier face, the perpendicular impact mode seems to be slightly more severe than the crabbed mode but the differences are small.

4. The NHTSA test procedure (using EUROSID) appears to be slightly less severe to the thorax area but more severe to the pelvis. The test results with the EEVC procedure were closer to those of a car-to-car test than were the results using the NHTSA test procedure.

5. The EEVC Test Procedure appears to be able to discriminate between different models of vehicle and would encourage the design of vehicles with improved protection for occupants in side impacts.

6. The MDB face should be specified by defining the design and construction of the face together with a performance requirement for the materials. This specification should be based on one of the designs produced to meet the EEVC MDB specification which continues to represent typical European and Japanese cars.

7. The EEVC believes that there is a need to investigate the requirements for a supplementary headform test.

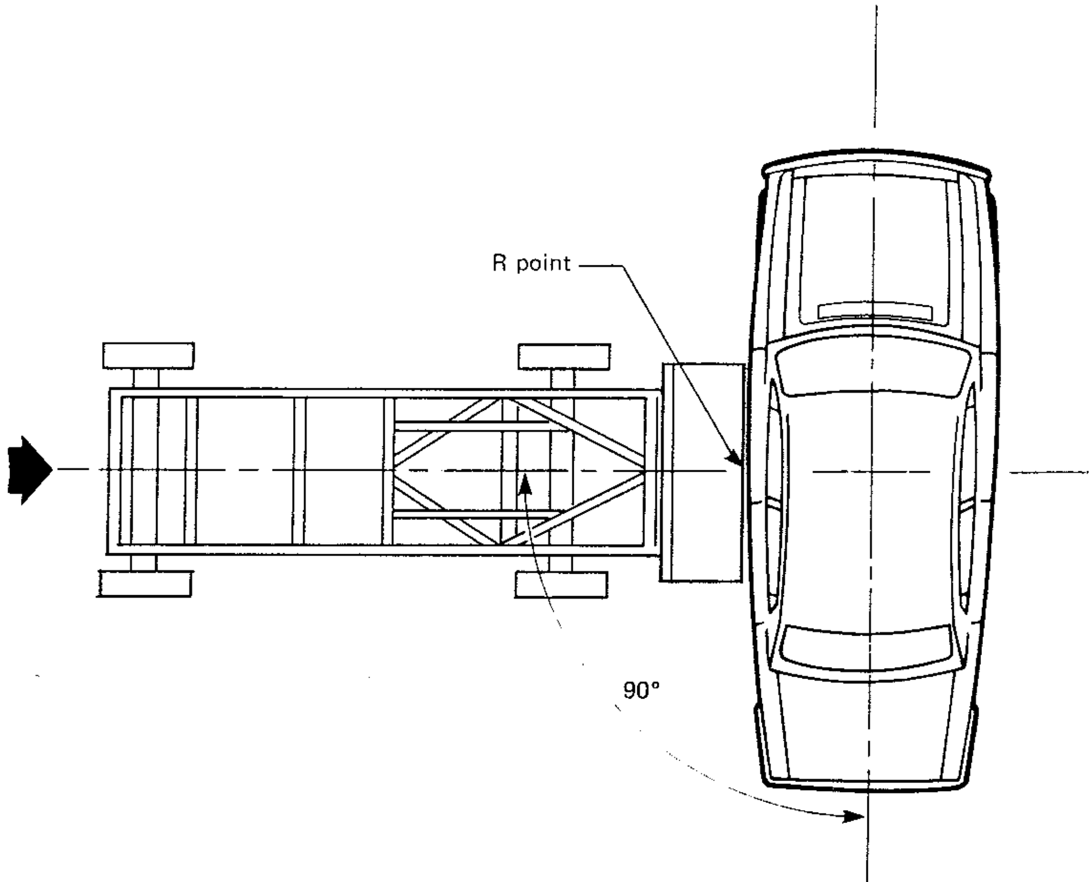

Fig.1 Configuration of the EEVC side impact test procedure

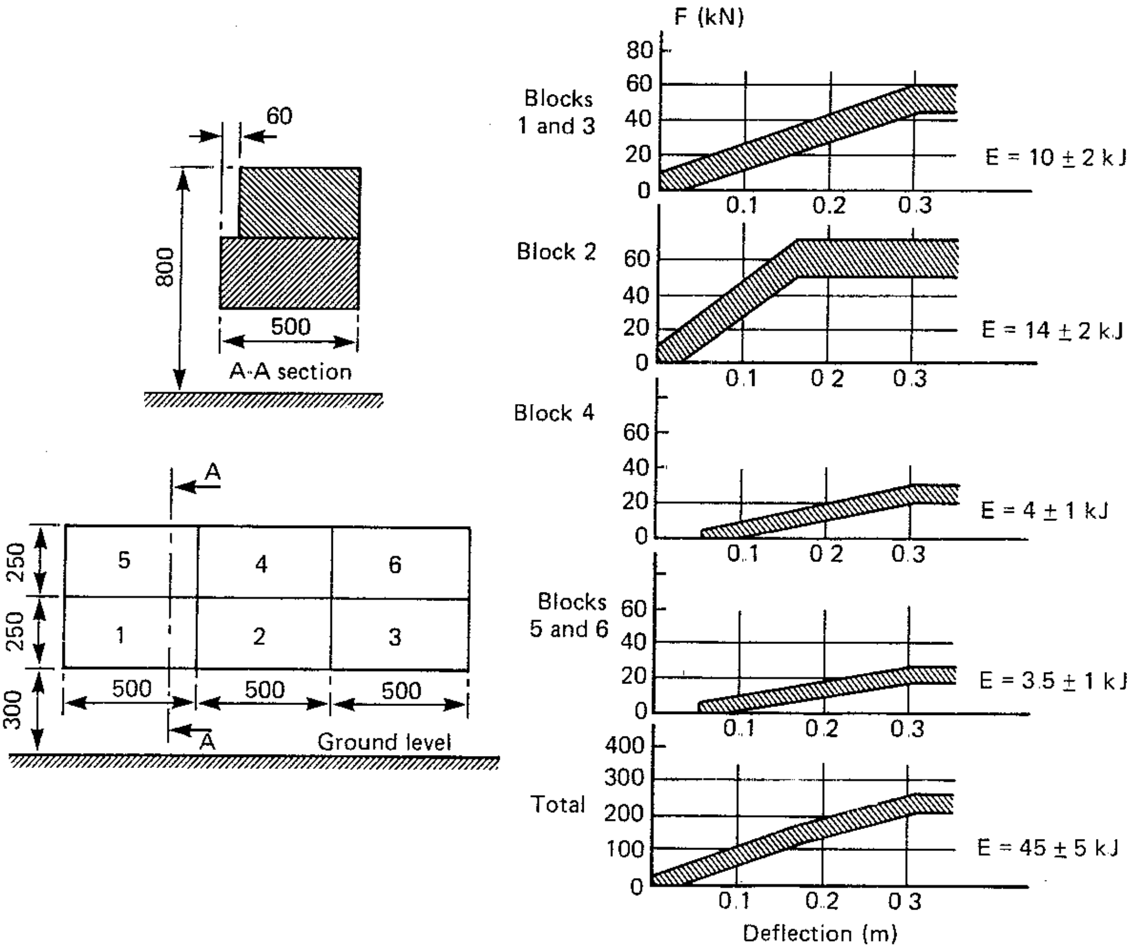

Fig.2 Main characteristics of the EEVC mobile deformable barrier

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Appendix

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