Volvo Side Impact Testing

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Abstract

The improvement of side impact protection is today a major concern to the crashworthiness community. A prerequisite for making this development possible is the establishment of a common side impact test method, representative of several traffic environments.

Volvo has made a study aimed at determining the suitability of a moving barrier test as a tool for the development of side impact protection. Traffic accident data from car-to-car accidents have been used as references to full-scale tests. Certain test parameters have been varied to find out if an improved correlation is possible between real-world accidents and laboratory collisions. To further understand the interaction between the occupant and the car structure, sled testing has been used as a complement.

The conclusion of the study is that a suitable side impact test method is a moving deformable barrier (MDB) impacting in a 90° noncrabbed configuration. A good resemblance to real-life accidents is achieved with a CCMC MDB 76, mass 1,400kg, ground clearance 250mm, and impact speed 35mph.

Future work at Volvo will include further accident investigations, improvement of measurement techniques, development of subsystem testing, and evaluation of different MDB front faces in terms of force-crush characteristics.

Background

Volvo strives to continuously improve the crashworthiness of Volvo cars by a conscious development and design strategy, the Volvo Safety Design Philosophy(1,2).

In short, this means the experience from traffic accident studies is used as an important source for establishing crashworthiness requirements, which, in combination with other requirements, form the input to the establishment of laboratory test methods. Requirements on performance in these tests are established and further developed into requirements on systems and subsystems in the car. These requirements provide the basis for the actual design work of the car structure and the interior safety systems.

Side impact collisions have been focused on for several years, and a broad analysis of the Volvo accident material was published in 1982(3). Here the complexity of the problem was enlightened, for instance, the varying injury patterns due to different collision objects, and it was recommended, to cover different types of side impacts, that a car-to-car simulating full-scale test should be accompanied by complementary subsystem testing.

Since then, further in-depth studies of side impact accidents have been conducted to improve the input data for the development of test methods.

This paper focuses on the simulation of car-to-car accidents and the establishment of a corresponding test method. Irrespective of the severity of lateral collisions with poles and trucks, car-to-car side impacts still constitute an essential problem to be dealt with.

Volvo has followed the development of the CCMC moving deformable barrier, the MDB 76(4). This barrier is thought to be a good representative of modern cars, not only European but also American(5). It has a good repeatability and makes a suitable substitute for actual cars. However, comparisons with struck Volvo cars in real-life accidents have shown certain discrepancies that have initiated part of the Volvo study presented here.

The objective of the study has been to find the effect of variations of certain test parameters and to establish a test configuration corresponding to real-life experience.

Side Impact Accident Studies

The side impact test procedure described in this paper has partly been chosen on the basis of a comparative analysis of Volvo 240 field accidents and laboratory collisions in corresponding crash configurations.

Two different investigation levels were used in the accident sample. From Volvo's statistical accident material (large number of accidents, limited investigation depth), 645 car-to-car side impact cases were chosen for analysis, the selection criteria being that the occupant compartment was impacted and an occupant was seated nearside.

To these accidents were added 23 side impact cases investigated by Volvo's multidisciplinary in-depth study team and chosen to insure accident conditions comparable to the laboratory crash tests. The selection criteria were: Volvo 240 accidents where the compartment was run into by a medium-size car or a van at 60° to 120° (orientation angle) and with an occupant seated on the near side. The in-depth study cases were analyzed thoroughly with a view to the degree and shape of deformation (B-pillar intrusion) and the degree of injury severity (MAIS) to the near side occupant.

In spite of the absence of reliable crash severity calculation methods for side impacts, it has been possible to establish a fairly reliable assessment of the connection between the degree of deformation, the impact speed (for a homogenous group of specified striking cars), and the resulting injury to occupants, since laboratory crash tests corresponding to the field accident conditions were available.

The results are shown in Figures 1, 2, and 3.

Both the accident statistics (Figure 1) and the analysis of the in-depth study cases (Figure 2) show that serious injuries (AIS 3+) start to occur more frequently at deformations corresponding to impact speeds exceeding 30 to 35mph. This does not mean that AIS 3 injuries necessarily occur in such collisions. Occupants sometimes escape with minor or moderate injuries (AIS 1 to 2) at B-pillar intrusions corresponding to approximately 35mph (see Figure 3).

It should be pointed out the deformation pattern analysis described here does not necessarily imply that a mere reinforcement of the side structure—and consequently a reduced deformation—would reduce the severity of injuries.

The deformation shape of a Volvo 240 run into by the CCMC barrier does not satisfactorily correspond to the deformation shape in the field accidents investigated. The barrier causes a considerably greater deformation at shoulder/head height, (see Figure 2).

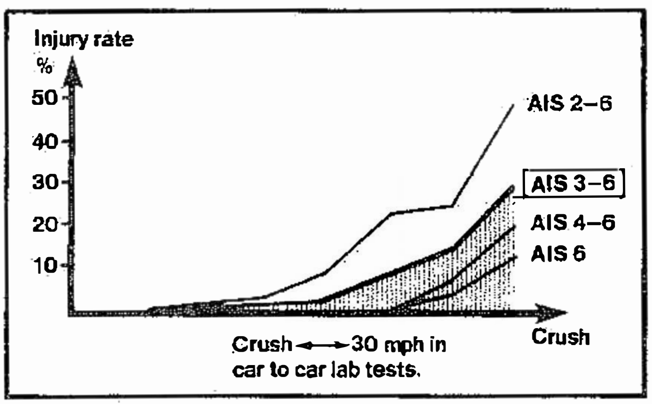


Figure 1. Injury rate as a function of deformation—Volvo 240 accidents from 1974 to 1976 (645 cases)

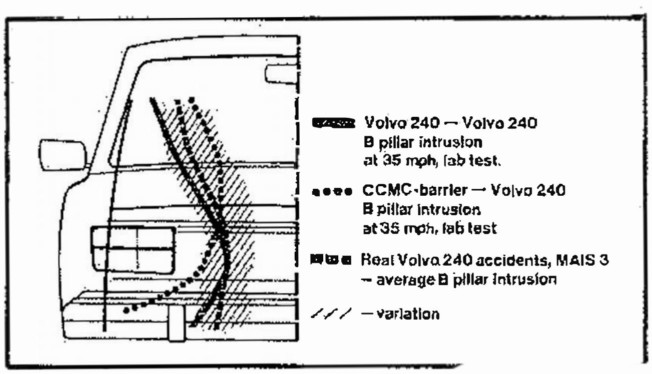
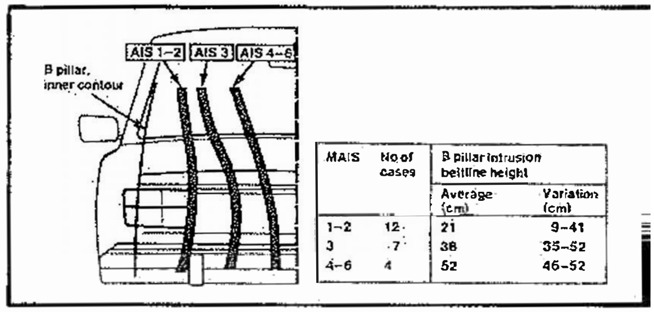


Figure 2. Comparison between laboratory tests at 35mph and real-life accidents—MAIS 3



MAIS	No of cases	B pillar intrusion beltline height	
		Average (cm)	Variation (cm)
1–2	12	21	9–41
3	7	38	35–52
4–6	4	52	46–52

Figure 3. Injury severity as a function of B-pillar intrusion—summary of 23 in-depth study cases—Volvo 240

Full-Scale Tests

The traffic accident experience shows the necessity of improving the resemblance of today's laboratory tests to actual side impacts. The basis for this study has been the CCMC test method(4). At present, the CCMC test configuration and barrier are felt to be the most representative setup. Volvo cars have also been tested earlier according to this.

Test Matrix

Six full-scale tests were conducted in Volvo's crash testing facility, (see Table 1).

In all tests, the target was standing still and was run into by the bullet vehicle on the driver's side. In tests 1 to 5, the bullet hit the target perpendicularly with centerline in bullet at SRP-position in target. Test 6 was conducted in a 90°/27° crabbed configuration. The varied parameters were—

- Type of bullet
- Mass of bullet
- Ground clearance of barrier
- Structural reinforcements and padding
- Crash configuration

Based upon experience from a previous side impact study of the Volvo 240, the Volvo 760—the most recent production car—was chosen as the target vehicle in this study. In tests 5 and 6, the target was an experimentally reinforced Volvo 760 (see Table 1).

Choice of Varied Test Parameters

Type of Bullet

The comparison between cars and MDB's as bullets was made to give an idea of the difference between a mid-size car with US-bumper system, such as a Volvo

Table 1. List of conducted full-scale tests

Test No.	Bullet Type	Mass (kg)	Ground Clearance (mm)	Target Type	Mass (kg)	Test Type	Impact Velocity (mph)
1	Volvo 240	1400	—	Volvo 760	1690	90°	35
2	MDB 76	1400	300	Volvo 760	1690	90°	35
3	MDB 76	950	300	Volvo 760	1690	90°	35
4	MDB 76	1400	250	Volvo 760	1690	90°	35
5	MDB 76	1400	250	Volvo 760 reinforced	1690	90°	35
6	MDB 76	1400	250	Volvo 760 reinforced	1625	90°/27°	35 simul. 39 resulting

240, and an MDB 76(4) regarding intrusions, wall speeds, and dummy responses. The bullet had a mass of 1,400kg in both cases (tests 1 and 2 in Table 1). A comparison was also made with the previous study of the Volvo 240 as target and with field cases.

Mass of Bullet

The mass was varied to ascertain the effect on wall speeds and dummy responses. The levels chosen were 950kg in accordance with CCMC specifications and 1,400kg, a typical medium-size car mass close to the NHTSA barrier(6). Ground clearance in the compared tests was 300mm (tests 2 and 3 in Table 1).

Ground Clearance of Barrier

The barrier's ground clearance was reduced in test 4 to 250mm, as the basic MDB 76 ground clearance of 300mm turned out to give greater loads on the structure and the dummies at chest height as compared with the Volvo 240, and poor resemblance of intrusion profiles in the field cases. The bullet in the full-scale tests compared had a mass of 1,400kg (tests 1, 2, and 4 in Table 1). A comparison was also made with the earlier tests where the target was a Volvo 240.

Structural Reinforcements and Padding

The target was reinforced primarily to permit investigation into how an MDB 76 reacts, regarding its resistance to bottoming out when put up against a test object that is essentially stronger (test 5 in Table 1). The target vehicle was also equipped with padding.

Crash Configuration

It was also decided to study the effect of testing in crabbed configuration, as it is generally considered this type of test better simulates side impacts in the field. The same test configuration was chosen as is used in the joint NHTSA and VW(5) project MIV, i.e., a 90°/27° crabbed configuration.

Nonvaried Test Parameters

MDB

No comparative testing was made on the different deformable fronts available. The CCMC MDB 76 was chosen as the bullet due to its force-crush characteristics and good repeatability.

Test Speed

The speed of the bullet at right angles to the target was, in all cases, 35mph. The reason for this is that severe injuries (AIS 3+) in the Volvo 240 field accidents start to occur more frequently at impact speeds exceeding 30 to 35mph. To improve side impact protection, the relevant test criteria, therefore, must be met at an impact speed of 35mph).

Choice of Structure-Related Evaluation Parameters

In the full-scale tests, a large number of parameters were measured with the aid of accelerometers and high-speed cameras. Some of the relevant structure-related parameters were chosen for a comparative analysis of the various tests.

The injuries affecting the nearside occupant in a side impact depend to a large extent on the speed of the intruding side structure. It is therefore essential that intrusion speeds are correctly simulated. In traffic accidents, only postcrash data are available. A comparison between laboratory tests and traffic accidents must rely on such data, e.g., residual deformation. For the evaluation of the full-scale tests, comparison is made for--

- Wall speed at chest height
- Wall speed at pelvis height
- Residual internal deformation of B-pillar

A further indication of the fundamental side impact mechanisms is also the velocity increase to which the target is exposed in relation to the velocity increase of the side structure, i.e.---

- The target's rigid body movement pattern
- The movement pattern of the side structure
- The relation between these two

The velocity, in chest- and pelvis-level, of the intruding side structure is graphically established from high-speed film of the B-pillar at the time of dummy impact. This method of measuring the wall speed is more reliable than using accelerometer readings from the structure that actually impacts the dummy. The wall speed is looked upon as a structural parameter since its importance as an injury-producing parameter is reduced when padding is introduced. The time of dummy impact is assessed by using the chest acceleration resultant graph.

Since this is a comparative analysis, the different evaluation parameters are normalized so that values in one test are set to 1.0. The values in the tests to which the first test is compared are all in relation to this.

Comments

The wall speeds must be interpreted with care due to both the inaccuracy of the measuring method used and the fact that the dummy responses are not only dependent on wall speed at the time of contact, but also on the wall speed history during the total period of contact. Thus, wall speeds and dummy response in some cases may appear to be contradictory.

Choice of Dummy-Related Evaluation Parameters

The APROD-81 dummy has been used as a measuring device. This dummy is basically a Part 572 dummy with a special chest designed to measure chest deflection at two levels(7).

This dummy was preferred to the American SID dummy because the deflection and deflection rate are biomechanically better related to injury than acceleration is. However, during testing it was found that imperfect design of the chest, especially the shoulder part, has reduced the information from the chest deflection readings and the reliability of these measurements.

The following parameters are used for the evaluation of test results:

- Maximum head acceleration (>3ms)
- Maximum chest acceleration (>3ms), center of gravity
- Peak resultant chest acceleration
- Peak acceleration upper rib
- Peak acceleration lower rib
- Maximum hip acceleration (>3ms)

Sled Test Method

As a complement to full-scale testing, a test method is required for studying the interaction between the car side interior and the occupant. This test method must simulate the desired dummy contact speed and also provide further acceleration for the dummy as long as it is in contact with the wall.

In the sled test, a test rig is mounted on an HYGE crash simulator. Padding is fastened to two steel plates attached to the rig by six load transducers. Two bars project from the rig, and the seat with the APROD dummy moves along these (see Figure 4).

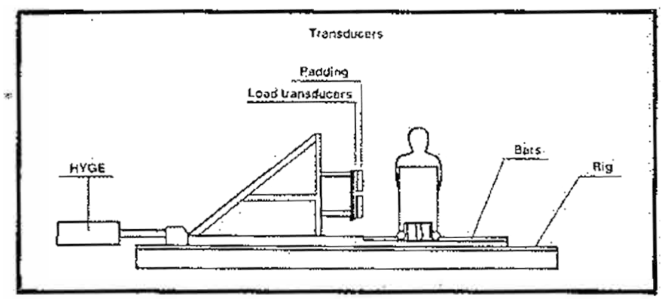


Figure 4. Side collision rig mounted on HYGE

The rig is geared to the desired impact speed and acceleration after dummy impact. The dummy seat remains still until the wall hits the dummy.

Three load transducers and an accelerometer are mounted on each steel plate to which chest padding and pelvis padding are fastened (Figure 5). They measure the load and rate of acceleration at pelvis and chest when the dummy is hit. Impact times for chest and pelvis padding are recorded by means of two zero triggers. The accelerometers on the steel plate and on the far side of the ribs record the intrusion in the padding after two integrations. As an extra check on the padding intrusion, a sliding potentiometer is also used. With a few additions, the rig can easily be adapted for simulation of B-pillar impact.

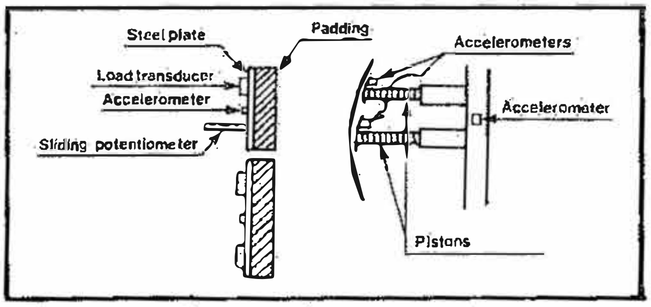


Figure 5. Transducer positioning in wall and dummy chest

Results of Full-Scale Tests

Type of Bullet

Structure

Tests 1 and 2, i.e., Volvo 240 versus Volvo 760 and MDB versus Volvo 760 (see Table 1), show the residual deformation is considerably greater at chest height in the case of an MDB 76 than in that of a Volvo 240. At pelvis height, on the other hand, the deformation is greater for the Volvo (Figure 6). The same results are obtained using

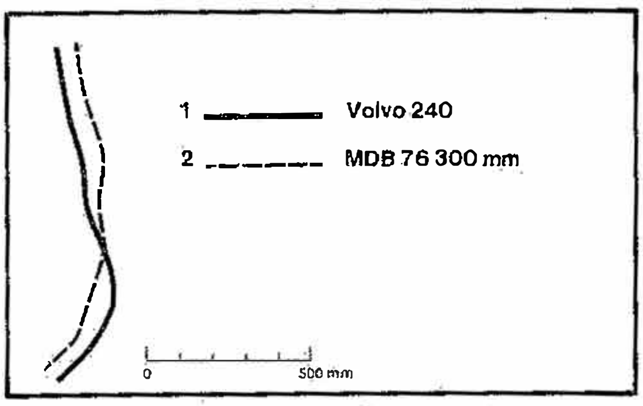


Figure 6. Internal deformation of B-pillar in tests 1 and 2

a Volvo 240 as target in the 90° test configuration (Figure 7). The Volvo 240, however, is relatively rigid in the bumper region compared with other car models, which can also be seen from the field accidents that have been analyzed.

The field cases (Figure 2) also show the residual deformation of the B-pillar caused by the MDB 76 is greater at chest height, the difference being equivalent to that in Figure 6.

Figure 8 shows the wall speed on impact with the dummy is the same both at chest and pelvis height in test 2. It can also be seen that vc (wall speed at chest height) and vp (wall speed at pelvis height) are somewhat lower in test 1, and also that vc < vp. This suggests that the MDB

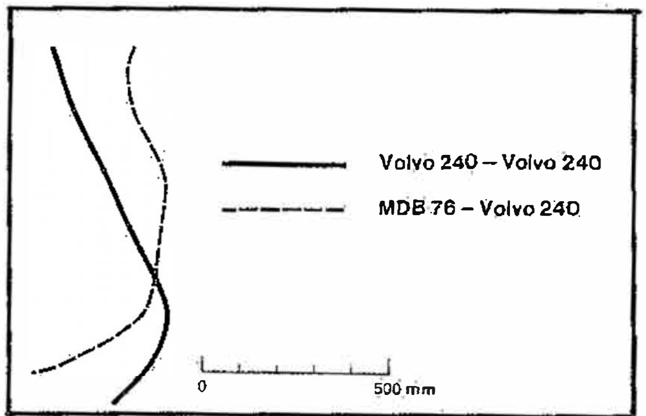


Figure 7. Internal deformation of B-pillar in earlier Volvo test series

76 loads the target's side structure more than the Volvo 240, and the load is more evenly distributed.

The dynamic intrusion process illustrated in Figure 8 shows there is no difference, at the time of dummy impact, between the Volvo 240 and MDB 76 at the point in the structure where measurement was made.

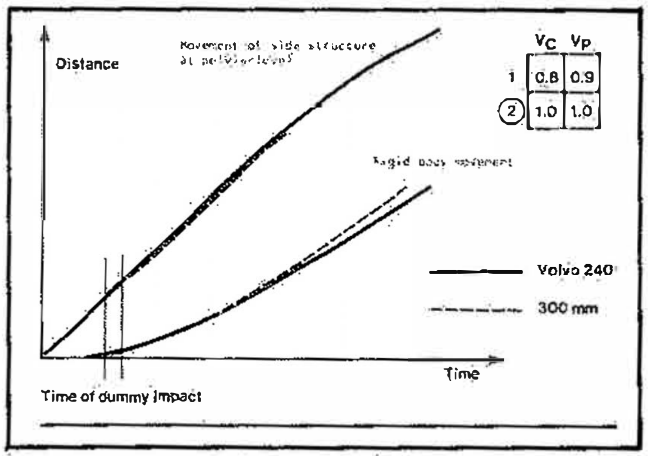


Figure 8. Comparison of intrusion patterns and wall speeds (v) in tests 1 and 2

Interior

The load on the dummy, like the residual deformations, varies greatly regarding chest and pelvis from test 1 to test 2 (see Figure 9).

The different evaluation parameters are for the comparative analysis normalized so that values in test 2 are set to 1.0, and the values for test 1 are given in relation to this.

The level of acceleration at the ribs depends on the impact speed, and maximum acceleration occurs soon after the dummy is hit. Max Cr occurs when the dummy's deflection pistons bottom out, since the dummy is relatively compressible to begin with before going too rigid. The Cr level is thus extremely dependent, at a later stage, on the intrusion speed.

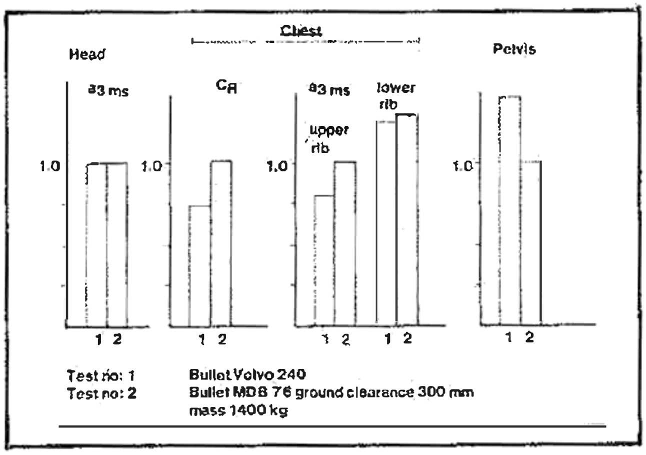


Figure 9. Dummy response in tests 1 and 2—normalized values

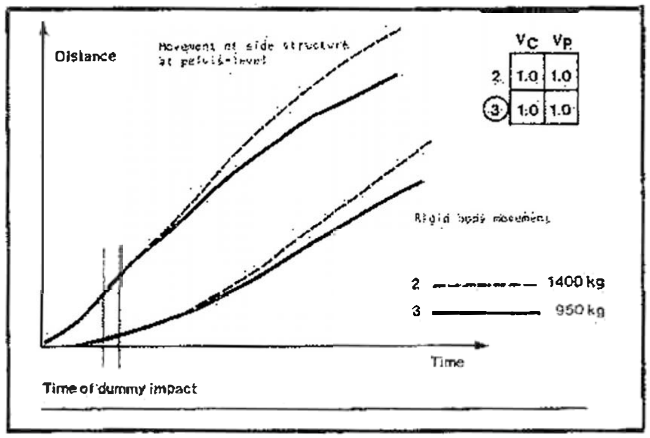


Figure 10. Comparison of intrusion pattern and wall speeds (v) in tests 2 and 3

Figure 9 shows that the Cr in the dummy is higher with an MDB 76 with a ground clearance of 300mm as the bullet than for a Volvo 240, while the acceleration levels at pelvis height are lower.

Comments

It is clearly unsuitable to model a car's side impact protection on the basis of a specific car model as the bullet. The above results suggest, however, that the MDB 76, 300mm, does not satisfactorily represent either the Volvo 240 or the colliding vehicles in the field accident analysis. It is our opinion tests should be carried out with a bullet that, in respect of the decisive criteria, is more representative of the average car. Certain modifications to improve the resemblance of the CCMC barrier to the average car are discussed further on.

Mass of the Bullet

Structure

A reduction of 450kg in the mass turned out to have little effect on wall speed at chest and pelvis level on impact with the dummy (Figure 10).

Figure 10 shows that dynamic intrusion is not affected appreciably until after impact with the dummy, when the greater kinetic energy in test 2 results in a greater acceleration and, in the end, a greater residual deformation (Figure 11).

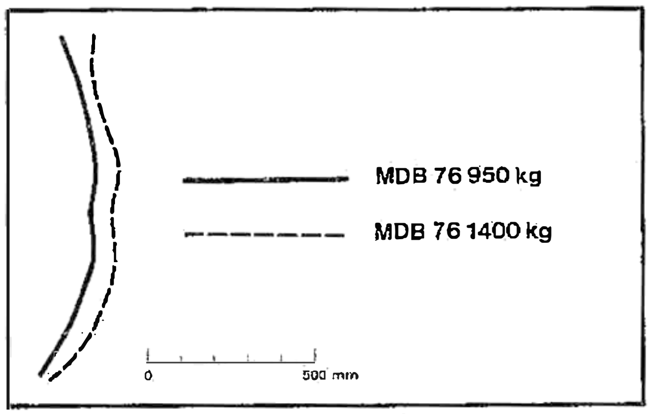


Figure 11. Internal deformation of B-pillar in tests 2 and 3

Interior

The speed of the intruding wall at chest and pelvis height at the time of impact is the same in both tests (see Figure 10). However, in the case of the lower barrier mass, the speed of the intruding wall at the time of head impact is lower, thus giving less severe head impact (see Figure 12).

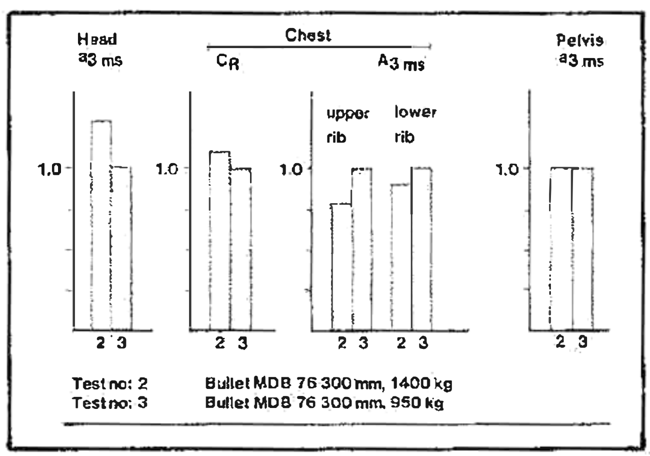


Figure 12. Dummy response in tests 2 and 3—normalized values

Comments

Greater mass means greater deformation of the target but no decisive difference in the loading of the dummy.

We find it preferable, for development reasons, to maintain a high mass in the bullet: first, to cause greater deformation in the target enabling us to pinpoint weaknesses in the structure, and, second, to take into consideration the heavier vehicles in the field.

Ground Clearance of the Bullet

Structure

Lowering the ground clearance from 300 to 250mm means the overlap of the deformable foam front over the door sill structure of the target is bigger. This, however, has little effect on the wall speeds at chest and pelvis height on impact with the dummy (see Figure 13).

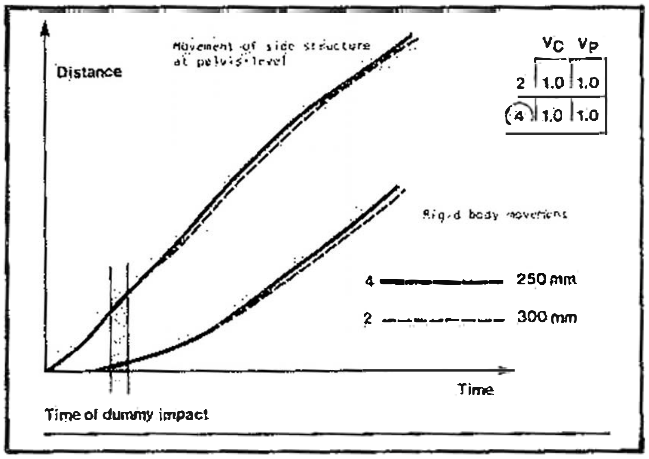


Figure 13. Comparison of intrusion pattern and wall speeds (v) in tests 2 and 4

The residual deformation of the B-pillar at chest height is less than the intrusion caused by a barrier height of 300mm. Thus, the 250mm barrier height better resembles the situation for a Volvo 240 (see Figure 14).

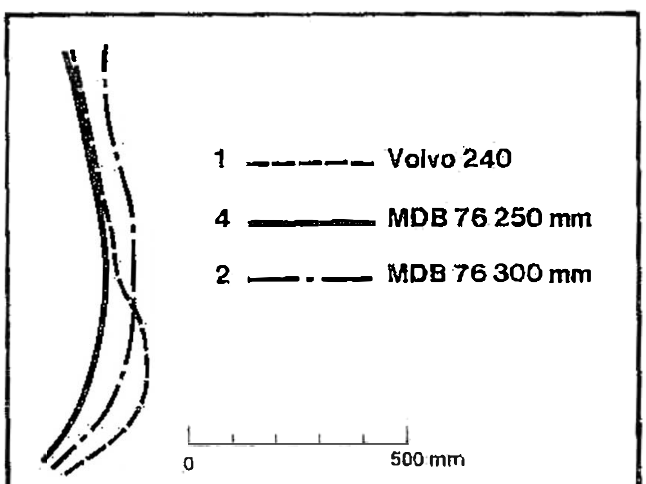


Figure 14. Internal deformation of B-pillar in tests 1, 2, and 4

Intrusion at pelvis height is, however, considerably greater with the Volvo 240. This car is stiffer than average in the bumper region, as was mentioned above, and this is also shown in Figure 15.

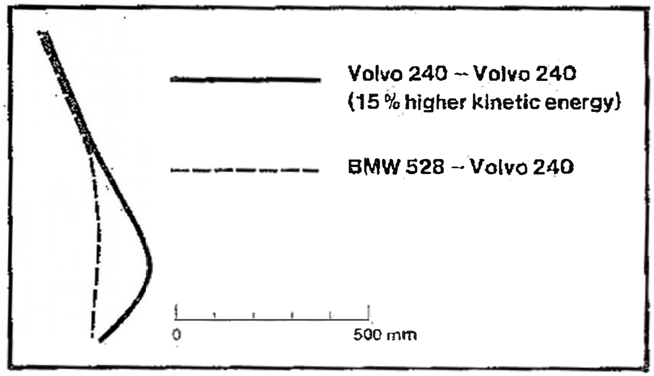


Figure 15. Internal deformation of B-pillar from Volvo test series in 1978

Interior

Lowering the ground clearance by 50mm resulted in a lower load on the chest. The load on the pelvis, however, was a little higher than with a 300mm barrier (see Figure 16). The chest value shows a good resemblance with the Volvo 240 as a test bullet, but the difference at pelvis height still remains. It should be pointed out the Volvo 240 is representative of the average car at chest height but is more stiff in the bumper region (see Figures 2 and 15).

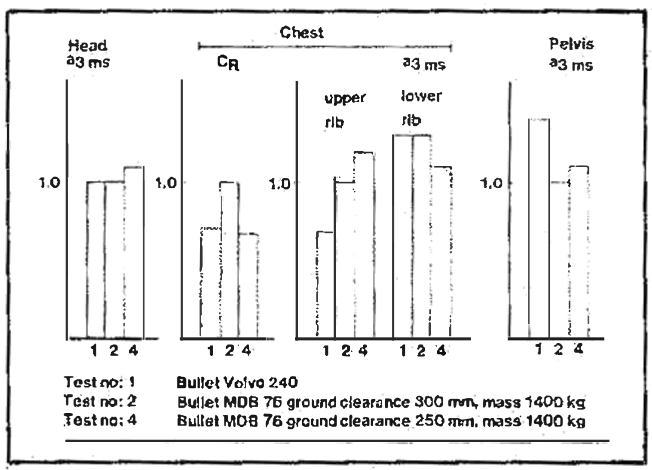


Figure 16. Dummy response in tests 1, 2, and 4—normalized values

Comments

Figures 2, 14, 15, and 16 together indicate that lowering the ground clearance to 250mm provides a more realistic load on the target's side structure and therefore a more realistic dummy response.

Structural Reinforcements and Padding

The residual deformation is appreciably less in test 5 than in test 4, which means the bullet must absorb more deformation energy (Figure 17). Despite this, the MDB 76 functions well and shows no tendency to bottom out. It should be mentioned that the target's mass, which amounts to 1,690kg with the two dummies, is considerably greater than that of many car models on the market.

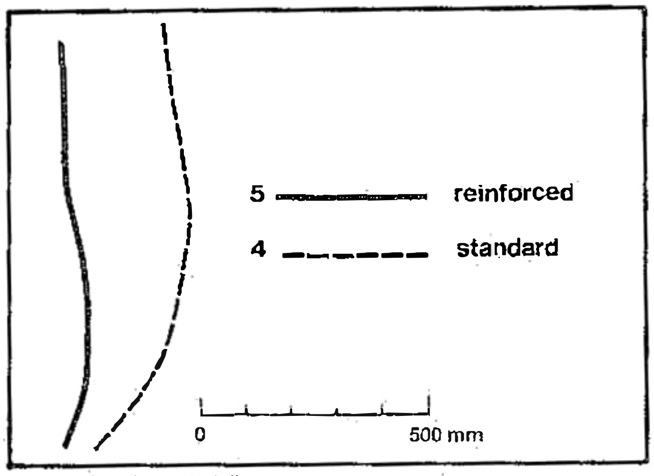


Figure 17. Internal deformation of B-pillar in tests 4 and 5

Comment

A structural reinforcement as extensive as that in test 5 considerably reduces wall speeds on impact with the dummy (Figure 18). This reinforcement leads to an increase of the velocity in the nondeformed parts of the target, which, in general, causes an increase in the relative velocity of the occupant's body as compared with that of the intruding side structure. The result of this could be a reduced effect of the reinforcement. However, this increase of velocity is very small at the moment the dummy is hit, and the reduction in velocity of the intruding side structure predominates, as can be seen from Figure 18.

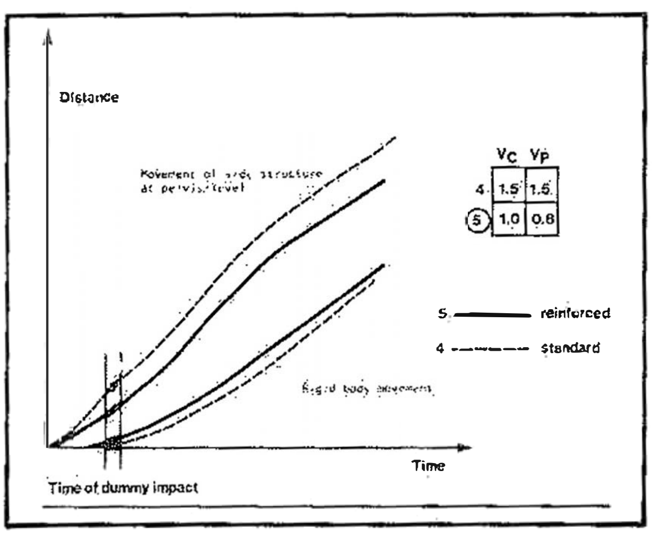


Figure 18. Comparison of intrusion pattern and wall speeds (v) in tests 4 and 5

The dummy response in Figure 19 shows the acceleration levels in the chest are considerably lower when padding is added together with a substantial reinforcement of the body structure.

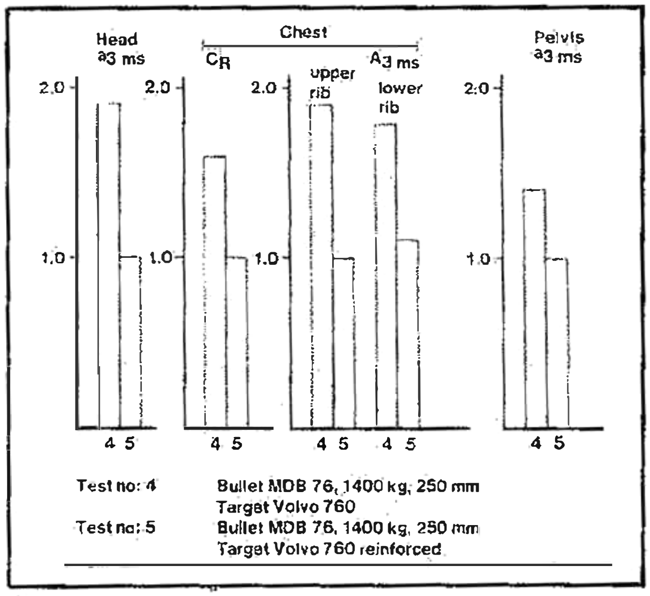


Figure 19. Dummy response in tests 4 and 5—normalized values

Crabbed Configuration

Test 6 was carried out in a 90°/27° crabbed configuration(5). Compared to test 5, the wall speeds with this configuration are affected to the extent that a small increase occurs at chest height and a slight decrease at pelvis height. Impact with the dummy takes place at about 20ms. Figure 20 shows no appreciable rotation of the target occurs until after about 40ms. However, the target is moved in parallel along a line about 10° from its lateral direction. This means that during the first 40ms, the target is exposed to a load that is almost the same as with a perpendicular configuration at 35mph.

The residual deformation of the B-pillar is slightly less than in the corresponding 90° collision, due to the fact that a large proportion of the bullet's kinetic energy is transformed into rotational energy throughout the system (see Figure 21).

Taking the cross sensitivity of the accelerometers into account, it is a very difficult task to plot the intrusion process and target acceleration laterally, since the target and the bullet do not move in the rectilinear manner throughout the process of deformation as in the case of the 90° configuration.

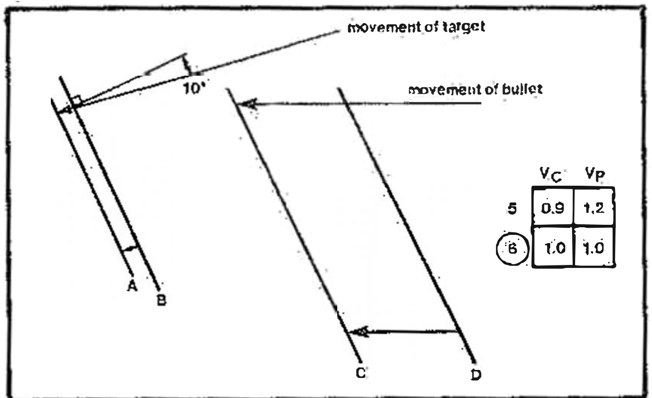


Figure 20. Movement of target and bullet in test 6 and wall speeds (v) in tests 5 and 6 (lines B and D—center line of target and rigid part of bullet at 0ms respectively; lines A and C—center line of target and rigid part of bullet respectively at around 40ms)

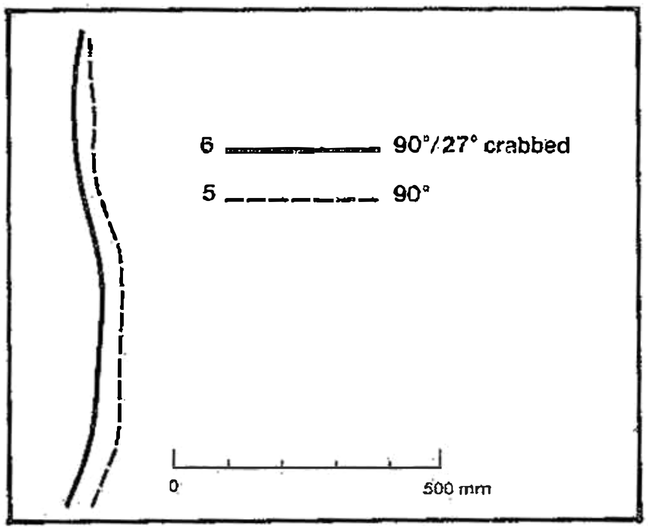


Figure 21. Internal deformation of B-pillar in tests 5 and 6

Interior

The effect of a 90° / 27° configuration on the response of the dummy is that the dummy does not impact the B-pillar of the Volvo 760. The head at 3ms is lower and the Cr increases, since no load is transferred through the shoulder part of the dummy but is entirely directed to the chest. The greatest difference concerns the load on the head, while the difference regarding chest and pelvis acceleration is fairly small (Figure 22).

Comments

The test in crabbed configuration showed the load on the car body is less severe laterally compared to the 90° configuration, and the dummy moves somewhat differently. The latter difference can, in development testing,

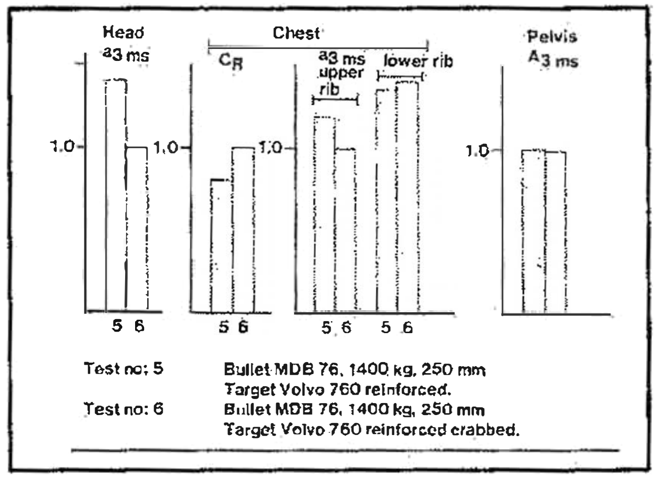


Figure 22. Dummy response in tests 5 and 6—normalized values

be obviated by altering the position of the seat so the dummy does not impact the B-pillar in case of a perpendicular configuration.

The perpendicular situation leads to greater lateral load on the structures added to improve side impact protection, as most of the kinetic energy is used for the deformation of the deformable front, deformation of the target's side structure, and acceleration of the target, without any significant amount transformed into rotation in the system. The perpendicular situation is thus more severe than the crabbed one, as far as the structure is concerned, when the impact speed normal to the side is the same. Even if the judgment is that field accidents are simulated more realistically by a crabbed configuration, there is, with the discussion above in view, still reason to let the main part of the development tests be conducted in the 90° perpendicular configuration.

Conclusion

The conclusion from this study is that a suitable side impact test method is a moving deformable barrier impacting in a 90° noncrabbed configuration. A good resemblance to real-life accidents is achieved with a CCMC MDB 76, mass 1,400kg, ground clearance 250mm, and impact speed 35mph. The motives for this are discussed above and briefly summed up below.

A moving deformable barrier was chosen as the bullet, since it is unsuitable to model a car's side impact protection on the basis of a specific car as the striking vehicle. The MDB 76 used with its standard ground clearance of 300mm did not satisfactorily represent the striking cars in the field accidents investigated, nor in the laboratory tests. Lowering the ground clearance by 50mm gave good results, however, in terms of car resemblance. Reduction of the mass to 950kg did not appreciably affect the dummy response, so the mass 1,400kg was chosen for development reasons to cover also the American medium-size cars as striking vehicles and to pinpoint weaknesses in the side structure.

The chosen impact speed, 35mph, is in the upper range of the speed interval where severe and more serious injuries (AIS 3+) start to occur more frequently in Volvo 240 side impact accidents today. Therefore, this level must be kept if the object of future car designs is to improve side impact protection.

The differences, in terms of dummy response, between a crabbed configuration and a noncrabbed one were small. The advantage of a greater field accident realism, when conducting the tests in the crabbed configuration, were found to be overruled by the disadvantage of an increased test complexity. Thus, for development work, it is believed the noncrabbed configuration is more suitable. For the evaluation of certain design solutions, the performancein the crabbed situation must, ofcourse, be checked at regular intervals.

Volvo will continue to work with the improvement of test methods for side impact testing. Some steps in this process will be—

- Further accident investigations and development of methods to assess side impact crash severity as a basis for improvement of the resemblance between real life accidents and laboratory tests
- A complete evaluation of the different MDB's in terms of force-crush characteristics
- Testing with the NHTSA honeycomb MDB in different crabbed configurations
- Development of an MDB, based on the MDB 76, that measures deflection and force in several sections of the front
- Further development of the MDB front face based on experience from both field accidents and laboratory testing
- Extending the test methods with supplementary subsystem testing
- Further development work on side impact dummies
- Extending the test methods to cover accident types other than car to-car impacts

References

1. Almqvist, R , H, Mellander, and M. Koch, "Frontal crash protection in a modern car concept," Proceedings Ninth International Technical Conference on Experimental Safety Vehicles, Kyoto, Japan, November 1982.
2. Norin, H., and J. Korner, "Volvo traffic accident research," Paper presented at SAE Conference, Detroit. Michigan, February 1985.
3. Norin, H., A. Nilsson-Ehle, and C. Gustafsson, "Volvo traffic accident research system as a tool for side impact protection evaluation and development," Proceedings Ninth International Technical Conference on Experimental Saftey Vehicles, Kyoto, Japan, November 1982.
4. Gebbels, D.R., "The CCMC mobile deformable barrier for lateral collision testing," to be published, Proceedings Tenth International Technical Conference on Experimental Safety Vehicles, Oxford, England, July 1985.
5. Klaus, G., R. Sinnhuber, and G. Hoffmann, "Mobile deformable barrier for lateral collision testing—a contribution toward a harmonization of future side impact performance requirements," SAE Paper 840888.
6. Hackney, J.R., et al., "Results of the National Highway Traffic Safety Administration's thoracic side impact protection research program," SAE Paper 840886.
7. Hue, B., et al., "Injury criteria in lateral collisions, when an APROD dummy is used," Proceedings Ninth International Technical Conference on Experimental Safety Vehicles, Kyoto, Japan, November 1982.

Side Impact Testing

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Abstract

Basic parameters that determine the occupant injury gravity, in a side crash are speed and the hit sidewall hardness. These two parameters are intimately linked together, and a full-scale reconstitution of a lateral collision does not permit their separation easily.

A method is presented in this paper that uses a subsystem-type test arrangement, reproducing the physical lateral shock sequence while having the two parameters separated. It then becomes possible to show the role played by different elements involved in a real-life impact:

- Impacting vehicle deformable front end part
- Impacted vehicle structure at the door inner panel, where deformability plays an energy-absorbing role